Alongo Mines (#2)

Removal Site Evaluation Report

Final | September 25, 2018

Stantec

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

Stantec

Alongo Mines (#2) Removal Site Evaluation Report - Final

September 25, 2018

Prepared for:

Navajo Nation AUM Environmental Response Trust
– First Phase

Prepared by:

Stantec Consulting Services Inc.

Title and Approval Sheet

Title: Alongo Mines Removal Site Evaluation Report - Final

Approvals

This Removal Site Evaluation Report is approved for implementation without conditions

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Sign-off Sheet

This document entitled *Alongo Mines Removal Site Evaluation Report* was prepared by MWH, now part of Stantec Consulting Services Inc. (Stantec) on behalf of the Navajo Nation AUM Environmental Response Trust – First Phase (the "Client") for submittal to the Navajo Nation Environmental Protection Agency (NNEPA) and United States Environmental Protection Agency (USEPA) (collectively, the "Agencies"). The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Per the *Navajo Nation AUM Environmental Response Trust Agreement – First Phase*, *Section 5.4.1,* (United States [US], 2015) the following certification must be signed by a person who supervised or directed the preparation of the Removal Site Evaluation report: "Under penalty of law, I certify that to the best of my knowledge, after appropriate inquiries of all relevant persons involved in the preparation of this report, the information submitted herein is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

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LIST OF ATTACHMENTS – PROVIDED ELECTRONICALLY TO THE AGENCIES

- Site-specific geodatabase
- Tabular database files
- 2017 Cooper aerial survey orthophotographs and data files
- Historical documents referenced in this RSE Report (refer to Section 7 for complete citation)
    - Bechtel Environmental Inc, 1996 – Expanded Site Inspection, King Tutt Mesa Aggregate Site, Oak Springs, New Mexico
    - Chenoweth, 1984 - Historical Review of Uranium-Vanadium Production in the Eastern Carrizo Mountains, San Juan County, New Mexico, and Apache County, Arizona
    - Chenoweth, 1985 – Historical Review Uranium-Vanadium Production in the Northern and Western Carrizo Mountains, Apache County, Arizona
    - Chenoweth, 1997 – Geology, Exploration, Production of History of the Alongo and Red Wash Uranium-Vanadium Mines on H.S. Begay's Mining Permits, San Juan County, New Mexico
    - Hendricks, 2001 – An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation
    - McLemore, 1993 – Uranium and Thorium Occurrences in New Mexico: Distribution, Geology, Production, and Resources, with Selected Bibliography
    - NAML, 1999 – Carrizo #1 AML Project Contract Documents
    - NSP, 2004 – Draft Site Inspection Report King Tutt Mesa Aggregate Site Red Valley Chapter, Navajo Nation
    - NSP, n.d. – Navajo Superfund Program/Navajo Nation Environmental Protection Agency (NNEPA), CERCLA Preliminary Assessment report

- TerraSpectra Geomatics, 2004 – Red Valley Chapter Screening Assessment Report – Review Draft. Navajo Abandoned Uranium Mine Lands Study Arizona, New Mexico, and Utah
- USEPA, 2007a – Abandoned Uranium Mines and the Navajo Nation. Navajo Nation AUM Screening Assessment Report and Atlas with Geospatial Data
- Weston Solutions, 2011 – Reassessment Report King Tutt Mesa Site, Oak Springs, Apache County, Arizona

Executive Summary

Introduction

The Alongo Mines site (the Site) is located within the Navajo Nation, Shiprock Bureau of Indian Affairs (BIA) Agency, Red Valley Chapter in northwestern New Mexico, near the border of New Mexico and Arizona. The Site is one of 46 "priority" abandoned uranium mines (AUMs) within the Navajo Nation selected by the United States Environmental Protection Agency (USEPA) in collaboration with the Navajo Nation Environmental Protection Agency (NNEPA) for further evaluation based on radiation levels and potential for water contamination (USEPA, 2013). Mining for uranium occurred prior to, during, and after World War II, when the United States (US) sought a domestic source of uranium located on Navajo lands (USEPA, 2007a).

On April 30, 2015, the *Navajo Nation AUM Environmental Response Trust Agreement – First Phase* (the *Trust Agreement*) became effective. The *Trust Agreement* was made by and among the US, as Settlor and as Beneficiary on behalf of the USEPA, the Navajo Nation, as Beneficiary, and the Trustee Sadie Hoskie. The *Trust Agreement* was developed in accordance with a settlement on April 8, 2015 between the US and Navajo Nation for the investigation of 16 specified priority AUMs. The priority sites were selected by the US and Navajo Nation, as described in the *Trust Agreement*:

> "based on two primary criteria, specifically, demonstrated levels of Radium-226[1]: (a) at or in excess of 10 times the background levels and the existence of a potentially inhabited structure located within 0.25 miles of AUM features; or (b) at or in excess of two times background levels and the existence of a potentially inhabited structure located within 200 feet (ft)."

The purpose of this report is to summarize the objectives, field investigation activities, findings, and conclusions of Site Clearance and Removal Site Evaluation (RSE) activities conducted between August 2015 and September 2017 at the Site. The primary objectives of the RSEs are to provide data required to evaluate relevant site conditions and to support future removal action evaluations at the Sites. It is not intended to establish cleanup levels or determine cleanup options or potential remedies. The purpose of the RSE data (e.g., the review of relevant information and the collection of data related to historical mining activities) is to determine the volume of technologically enhanced naturally occurring radioactive material (TENORM) at the Site in excess of Investigation Levels (ILs) as a result of historical mining activities. ILs are based on the background gamma measurements (in counts per minute [cpm]), and Radium-226 (Ra-226) and metals concentrations, determined through statistical analyses, that are used to evaluate potential mining-related impacts.

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[1] The Agencies selected the priority mines based on gamma radiation but the *Trust Agreement* erroneously states "levels of Radium -226".

Site History and Physical Characteristics

The Site is located within the Colorado Plateau physiographic province, which is an area of approximately 240,000 square miles in the Four Corners region of Utah, Colorado, Arizona, and New Mexico. Regionally, the Site is located in the King Tutt Mesa mining area. Bedrock on the Site consists of the Jurassic Morrison Formation. The Morrison Formation produced approximately 4.7 million pounds of uranium from areas of Arizona and New Mexico. The Site is also located within the San Juan River watershed, an area of approximately 24,600 square miles spanning Utah, Colorado, New Mexico, and Arizona. Topographically the Site is located along the western side of a sandstone mesa and Red Wash with elevation ranges from approximately 5,370 ft to 5,470 ft above mean sea level. On-site overland surface water flow, when present, is controlled along the approximate edge of the mesa by a decrease in elevation to the west from along the mesa top to Red Wash. Red Wash is an ephemeral stream that flows only in direct response to surface runoff precipitation or melting snow.

Mine workings on-site consisted of two adits that were approximately 150 ft apart (Chenoweth, 1997). The Site was in operation during 1956 and produced 26.74 tons (approximately 53,480 pounds) of ore that contained 75.96 pounds of 0.14 percent U_3O_8 (uranium oxide) and 76.04 pounds of 0.14 percent V_2O_5(vanadium oxide) (McLemore, 1983 and Chenoweth, 1997).

From 1989 to 2004, the NNEPA and USEPA conducted preliminary assessments (PAs), site inspections (SIs), and an expanded site inspection (ESI) at the King Tutt Mesa (KTM) site (BEI, 1996). The area of the Site was included in the KTM site. In 2010 Weston Solutions (Weston) performed a surface gamma survey on behalf of the USEPA, on the area of the Site.

Summary of Removal Site Evaluation Activities

The Trust's RSE was performed in accordance with the *Site Clearance Work Plan* (MWH, 2016a) and the *Removal Site Evaluation Work Plan* ([*RSE Work Plan*] MWH, 2016b). The *Site Clearance Work Plan* and the *RSE Work Plan* were approved in April and October 2016, respectively, by the NNEPA and the USEPA (collectively, the Agencies). The Trust conducted Site Clearance activities as the initial task for the RSE work to obtain information necessary to develop the *Removal Site Evaluation Work Plan* ([*RSE Work Plan*] MWH, 2016b). Following Site Clearance activities, the Trust conducted two sequential tasks to complete the RSE: Baseline Studies activities and Site Characterization Activities and Assessment. Details of the Site Clearance activities, Baseline Studies activities, and Site Characterization and Assessment activities are as follows:

- **Site Clearance activities** consisted of a desktop study of historical information, site mapping, potential background reference area evaluation, biological (vegetation and wildlife) surveys, and cultural resource survey. Results of the Site Clearance activities provided historical information, site access information, potential background reference area data, and vegetation, wildlife, and cultural clearance of the Site for the Baseline Studies activities and Site Characterization and Assessment activities to commence.

- **Baseline Studies activities** included a background reference area study, site gamma radiation surveys, and a Gamma Correlation Study. Results of the Baseline Studies were used to plan and prepare the Site Characterization Activities and Assessment. Data collected in the background reference area (soil sampling, laboratory analyses, surface gamma surveying, and subsurface static gamma measurements) were used to establish ILs for the Site. Data collected from the site gamma radiation survey were used, along with sampling, to evaluate potential mining-related impacts in areas containing radionuclides. The Gamma Correlation Study objectives were to determine the correlations between: (1) gamma measurements and concentrations of Ra-226 in surface soils; and (2) gamma measurements and exposure rates; to use as screening tools for site assessments.

- **Site Characterization Activities and Assessment** included surface and subsurface soil and sediment sampling. The results of the surface and subsurface soil and sediment sampling analyses were used to evaluate mining impacts and define the lateral and vertical extent of TENORM at the Site.

Findings and Discussion

Surface and subsurface soil and sediment sampling results. Three background reference areas were selected to develop surface gamma, subsurface static gamma, Ra-226, and metals ILs for the Site. Ra-226, arsenic, uranium, and vanadium concentrations and gamma radiation measurements in soil/sediment exceeded their respective ILs and are confirmed constituents of potential concern (COPCs) for the Site. ILs for selenium and molybdenum were not identified because sample results were non-detect in the background areas, with one exception. However, because selenium and molybdenum were detected in soil/sediment samples from the Survey Area (i.e., the full areal extent of the Site surface gamma survey), they are also confirmed COPCs for the Site. Based on the data analyses performed for this report along with the multiple lines of evidence, approximately 2.2 acres, out of the 18.2 acres of the Survey Area, were estimated to contain TENORM. Of the 2.2 acres that contain TENORM, 1.24 acres contain TENORM exceeding the surface gamma ILs. The volume of TENORM in excess of ILs was estimated to be 1,805 cubic yards (yd^3) (1,380 cubic meters).

Gamma Correlation Study results. The Gamma Correlation Study indicated that surface gamma survey results correlate with Ra-226 concentrations in soil. The model was made of the correlation results predicting the concentrations of Ra-226 in surface soils from the mean of the gamma measurements in five correlation locations. However, the regression equation predicted Ra-226 concentrations that were less than zero for a large area of the Site. Users of the regression equation should be aware of the limitations of the dataset and be cautious when estimating radium-226 concentrations. Additional correlation studies may be needed to identify the relationship between gamma and Ra-226.

Based on the Site Clearance and RSE data collection and analyses for the Site, potential data gaps were identified and are presented in Section 4.8 of this RSE report. These potential data gaps can be taken into consideration for subsequent evaluations in support of future Removal or Remedial Action evaluations at the Site.

Acronyms/Abbreviations

°F	degrees Fahrenheit
e.g.	exempli gratia
etc.	et cetera
ft	feet
ft2	square feet
i.e.	id est
mg/kg	milligram per kilogram
µR/hr	microRoentgens per hour
pCi/g	picocuries per gram
yd^3	cubic yards
Adkins	Adkins Consulting Inc.
ags	above ground surface
amsl	above mean sea level
AUM	abandoned uranium mine
bgs	below ground surface
BEI	Bechtel Environmental, Inc.
BIA	Bureau of Indian Affairs
$CaCo_3$	calcium carbonate
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R	Code of Federal Regulations
COPC	constituent of potential concern
cpm	counts per minute
Dinétahdóó	Dinétahdóó Cultural Resource Management
DMP	Data Management Plan
DQO	Data Quality Objective
ERG	Environmental Restoration Group, Inc.
ESA	Endangered Species Act
ESI	expanded site inspection
FSP	Field Sampling Plan
GIS	geographic information system
GPS	global positioning system
HASP	Health and Safety Plan
ICAL	initial calibration
ICB/CCB	initial/continuing calibration blank
ICV	initial calibration verification

IL	Investigation Level
KTM	King Tutt Mesa
LCS/LCSD	laboratory control sample/laboratory control sample duplicate
MARSSIM	Multi-agency Radiation Survey and Site Investigation Manual
MBTA	Migratory Bird Treaty Act
MLR	Multivariate Linear Regression
MS/MSD	matrix spike/matrix spike duplicate
MWH	MWH, now part of Stantec Consulting Services Inc. (formerly MWH Americas, Inc.)
NaI	sodium iodide
NAML	Navajo Abandoned Mine Lands Reclamation Program
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NNDFW	Navajo Nation Department of Fish and Wildlife
NNDOJ	Navajo Nation Department of Justice
NNDNR	Navajo Nation Division of Natural Resources
NNDWR	Navajo Nation Department of Water Resources
NNEPA	Navajo Nation Environmental Protection Agency
NNESL	Navajo Nation Endangered Species List
NNHP	Navajo Natural Heritage Program
NNHPD	Navajo Nation Historic Preservation Department
NORM	Naturally Occurring Radioactive Material
NSP	Navajo Superfund Program
PA	preliminary assessment
PUF	polyurethane foam
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
R^2	Pearson's Correlation Coefficient
Ra-226	Radium-226
Redente	Redente Ecological Consultants
RSE	Removal Site Evaluation
SI	site inspection
SOP	standard operating procedure
Stantec	Stantec Consulting Services Inc.
T&E	threatened and endangered
Th-230	thorium-230
Th-232	thorium-232
TENORM	Technologically Enhanced Naturally Occurring Radioactive Material
U-235	uranium-235
U-238	uranium-238
U_3O_8	uranium oxide

UCL	upper confidence limit
US	United States
U.S.C.	United States Code
UTL	upper tolerance limit
USAEC	US Atomic Energy Commission
USDA	US Department of Agriculture
USEPA	US Environmental Protection Agency
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
V_2O_5	vanadium oxide
Weston	Weston Solutions

Glossary

Adit – a level, horizontal drift or passage from the surface into a mine (Glossary of Mining Terms, 2018).

Alluvium – material deposited by flowing water.

Arroyo – a steep sided gully cut by running water in an arid or semiarid region.

Bin Range – as presented in the RSE report, a range of values to present surface gamma measurement data in relation to: (1) the surface gamma Investigation Level (IL); (2) multiples of the surface gamma IL; or (3) the mean and standard deviation of the predicted Radium-226 (Ra-226) concentrations for the Site based on the correlation equation.

Colluvium – unconsolidated, unsorted, earth material transported under the influence of gravity and deposited on lower slopes (Schaetzl and Thompson, 2015).

Composite sample – "Volumes of material from several of the selected sampling units are physically combined and mixed in an effort to form a single homogeneous sample, which is then analyzed" (USEPA, 2002a).

Constituent of potential concern (COPC) – analytes identified in the *RSE Work Plan* where their levels were confirmed based on the results of the RSE.

Data Validation – "an analyte- and sample-specific process that extends the evaluation of data beyond, method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set" (USEPA, 2002b).

Data Verification – "the process of evaluating the completeness, correctness and conformance/compliance of a specific data set against the method, procedural, or contractual requirements" (USEPA, 2002b).

Drift mining – mining of an ore deposit, by underground methods, accessed by adits driven into the surface outcrop of the ore seam (Thrush, 1968).

Earthworks – human-caused disturbance of the land surface related to mining or reclamation.

Eolian – a deposit that forms as a result of the accumulation of wind-driven products from the weathering of solid bedrock or unconsolidated deposits.

Ephemeral – ephemeral streams flow only in direct response to surface runoff precipitation or melting snow, and their channels are at all times above the water table (USGS, 2003). This concept also applies to ephemeral ponds that contain water in response to surface runoff precipitation or melting snow and are at all times above the water table.

Ethnographic – relating to the scientific description of peoples and cultures with their customs, habits, and mutual differences.

Gamma – a type of radiation that occurs as the result of the natural decay of uranium.

Geochemical – the chemistry of the composition and alterations of the solid matter of the earth (American Heritage Dictionary, 2016).

Geomorphology – the physical features of the surface of the earth and their relation to its geologic structures (English Oxford Dictionary, 2018).

Grab sample – a sample collected from a specific location (and depth) at a certain point in time.

Investigation Level (IL) – based on the background gamma measurements (in counts per minute [cpm]) and, Radium-226 (Ra-226) and metals concentrations, determined through statistical analyses, that are used to evaluate potential mining-related impacts.

Isolated Occurrences – in relation to the Site Cultural Resource Survey: Any non-structural remains of a single event: alternately, any non-structural assemblage of approximately 10 or fewer artifacts within an area of approximately 10 square meters or less, especially if it is of questionable human origin or if it appears to be the result of fortuitous causes. The number and/or composition of observed artifact classes are a useful rule of thumb for distinguishing between a site and an isolate (NNHPD, 2016).

Mineralized – economically important metals in the formation of ore bodies that have been geologically deposited. For example, the process of mineralization may introduce metals, such as uranium, into a rock. That rock may then be referred to as possessing uranium mineralization (World Heritage Encyclopedia, 2017).

Naturally occurring radioactive material (NORM) – "materials which may contain any of the primordial radionuclides or radioactive elements as they occur in nature, such as radium, uranium, thorium, potassium, and their radioactive decay products, that are undisturbed as a result of human activities" (USEPA, 2017).

Orthophotograph – an aerial photograph or image geometrically corrected such that the scale is uniform: the photograph has the same lack of distortion as a map. Unlike an uncorrected aerial photograph, an orthophotograph can be used to measure distances, because it is an accurate representation of the earth's surface, having been adjusted for topographic relief, lens distortion, and camera tilt.

Pan Evaporation – evaporative water losses from a standardized pan.

Perennial water bodies – a water body that is full or flowing throughout all or most years except in years of severe or unusual drought (Lake, 2011).

Radium-226 (Ra-226) – a radioactive isotope of radium that is produced by the natural decay of uranium.

Remedial Action (or remedy) – "those actions consistent with permanent remedy taken instead of, or in addition to, removal action in the event of a release or threatened release of a hazardous substance into the environment, to prevent or minimize the release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment…For the purpose of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the term also includes enforcement activities related thereto" (USEPA, 1992).

Remove or removal – "the cleanup or removal of released hazardous substances from the environment; such actions as may be necessary taken in the event of the threat of release of hazardous substances into the environment; such actions as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances; the disposal of removed material; or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare of the United States or to the environment, which may otherwise result from a release or threat of release…" (USEPA, 1992).

Respond or response – "remove, removal, remedy, or remedial action, including enforcement activities related thereto" (USEPA, 1992).

Secular equilibrium – a type of radioactive equilibrium in which the half-life of the precursor (parent) radioisotope is so much longer than that of the product (daughter) that the radioactivity of the daughter becomes equal to that of the parent with time; therefore, the quantity of a radioactive isotope remains constant because its production rate is equal to its decay rate. In secular equilibrium the activity remains constant.

Static gamma measurement – stationary gamma measurement collected for a specific period of time (e.g., 60 seconds).

Technologically enhanced naturally occurring radioactive material (TENORM) – "naturally occurring radioactive materials that have been concentrated or exposed to the accessible environment as a result of human activities such as manufacturing, mineral extraction, or water processing", which includes disturbance from mining activities. Where "technologically enhanced means that the radiological, physical, and chemical properties of the radioactive material have been concentrated or further altered by having been processed, or beneficiated, or disturbed in a way that increases the potential for human and/or environmental exposures" (USEPA, 2017).

Thorium (Th) – "a naturally occurring radioactive metal found at trace levels in soil, rocks, water, plants and animals. Thorium (Th) is solid under normal conditions. There are natural and man-made forms of thorium, all of which are radioactive" (USEPA, 2017).

Th-230 – a radioactive isotope of thorium that is produced by the natural decay of thorium.

Th-232 – a radioactive isotope of thorium that is produced by the natural decay of thorium.

Upper Confidence Limit (UCL) – the upper boundary (or limit) of a confidence interval of a parameter of interest such as the population mean (USEPA, 2015).

Upper Tolerance Limit (UTL) – a confidence limit on a percentile of the population rather than a confidence limit on the mean. For example, a 95 percent one-sided UTL for 95 percent coverage represents the value below which 95 percent of the population values are expected to fall with 95 percent confidence. In other words, a 95 percent UTL with coverage coefficient 95 percent represents a 95 percent UCL for the 95th percentile (USEPA, 2015).

Uranium (U) – a naturally occurring radioactive element that may be present in relatively high concentrations in the geologic materials in the southwest United States.

U-235 – a radioactive isotope of uranium that is produced by the natural decay of uranium.

U-238 – a radioactive isotope of uranium that is produced by the natural decay of uranium.

Walkover gamma radiation survey – referred to as a scanning survey in the Multi-agency Radiation Survey and Site Investigation Manual (*MARSSIM*; USEPA, 2000). A walkover gamma radiation survey is the process by which the operator uses a portable radiation detection instrument to detect the presence of radionuclides on a specific surface (i.e., ground, wall) while continuously moving across the surface at a certain speed and in a certain pattern (USEPA, 2000). Referred to in the RSE report as surface gamma survey after the first mention in the report.

Wind rose – a circular graph depicting average wind speed and direction.

1.0 INTRODUCTION

1.1 BACKGROUND

This report summarizes the purpose and objectives, field investigation activities, findings, and conclusions of Site Clearance and Removal Site Evaluation (RSE) activities conducted between August 2015 and September 2017 at the Alongo Mines site (the Site) located in northwestern New Mexico, near the border of New Mexico and Arizona, as shown in Figure 1-1. The Site is also identified by the United States Environmental Protection Agency (USEPA) as abandoned uranium mine (AUM) identification #2 in the *Navajo Nation AUM Screening Assessment Report and Atlas with Geospatial Data* (the *2007 AUM Atlas*; USEPA, 2007a). The *2007 AUM Atlas* was prepared for the USEPA in cooperation with the Navajo Nation Environmental Protection Agency (NNEPA) and the Navajo Abandoned Mine Lands Reclamation Program (NAML). The claim boundary polygon (refer to Figure 2-1) used for the RSE encompassed an area of approximately 8.7 acres (378,972 square feet [ft^2]) and was provided as part of the *2007 AUM Atlas*. Per the *2007 AUM Atlas* this polygon and other factors represent the location and surface extent of the AUM.

Stantec Consulting Services Inc. (Stantec; formerly MWH), performed Site Clearance activities in accordance with the *Site Clearance Work Plan* (MWH, 2016a), and performed RSE activities in accordance with the *Removal Site Evaluation Work Plan* ([*RSE Work Plan*] MWH, 2016b). The *Site Clearance Work Plan* and the *RSE Work Plan* were approved in April and October 2016, respectively, by the NNEPA and the USEPA (collectively, the Agencies). Stantec conducted this investigation on behalf of Sadie Hoskie, Trustee pursuant to Section 1.1.21 of the *Navajo Nation AUM Environmental Response Trust Agreement – First Phase* (the *Trust Agreement*), effective April 30, 2015 (United States [US], 2015). The *Trust Agreement* is made by and among the US, as Settlor, and as Beneficiary on behalf of the USEPA, the Navajo Nation, as Beneficiary, and the Trustee. The *Trust Agreement* was developed in accordance with a settlement on April 8, 2015 between the US and Navajo Nation for the investigation of 16 specified "priority" AUMs.

A "Site" is defined in the *Trust Agreement* as:

> "each of the 16 AUMs listed on Appendix A to the Settlement Agreement, including the proximate areas where waste material associated with each such AUM has been deposited, stored, disposed of, placed, or otherwise come to be located." *Trust Agreement*, § 1.1.25.

The Site is one of 46 priority AUMs within the Navajo Nation selected by the USEPA in collaboration with the NNEPA for further evaluation based on radiation levels and potential for water contamination (USEPA, 2013). The 16 priority AUMs included in the *Trust Agreement* are located on Navajo Lands throughout southeastern Utah, northeastern Arizona, and western New

Mexico, as shown in Figure 1-1. The 16 priority AUMs were selected by the US and Navajo Nation, as described in the *Trust Agreement*:

> "based on two primary criteria, specifically, demonstrated levels of Radium-226[2]: (a) at or in excess of 10 times the background levels and the existence of a potentially inhabited structure located within 0.25 miles of AUM features; or (b) at or in excess of two times background levels and the existence of a potentially inhabited structure located within 200 feet (ft)." *Trust Agreement*, Recitals.

In addition, the 16 priority AUMs are, for the purposes of this investigation, a subset of priority mines for which a viable private potentially responsible party has not been identified. Mining for uranium occurred prior to, during, and after World War II, when the US sought a domestic source of uranium located on Navajo lands (USEPA, 2007a). *Trust Agreement*, Recitals.

1.2 OBJECTIVES AND PURPOSE OF THE REMOVAL SITE EVALUATION

The primary objectives of the RSEs are to provide data required to evaluate relevant site conditions and to support future removal action evaluations at the Sites. It is not intended to establish cleanup levels or determine cleanup options or potential remedies. The purpose of the RSE data (e.g., the review of relevant information and the collection of data related to historical mining activities) is to determine the volume of technologically enhanced naturally occurring radioactive material (TENORM) at the Site in excess of Investigation Levels (ILs) as a result of historical mining activities. ILs are based on the background gamma measurements (in counts per minute [cpm]), and Radium-226 (Ra-226) and metals concentrations, determined through statistical analyses, that are used to evaluate potential mining-related impacts. The USEPA (2017) defines TENORM as:

> "naturally occurring radioactive materials that have been concentrated or exposed to the accessible environment as a result of human activities such as manufacturing, mineral extraction, or water processing" (mine waste or other mining-related disturbance).
>
> "Technologically enhanced means that the radiological, physical, and chemical properties of the radioactive material have been concentrated or further altered by having been processed, or beneficiated, or disturbed in a way that increases the potential for human and/or environmental exposures."

An understanding of the extent and volume of TENORM that exceeds the ILs at the Site is key information for future Removal or Remedial Action evaluations, including whether, and to what extent, a Response Action is warranted under federal and Navajo law. Definitions presented in the glossary for "Removal", "Remedial Action", and "Response" are defined in 40 Code of

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[2] The Agencies selected the priority mines based on gamma radiation but the *Trust Agreement* erroneously states "levels of Radium -226".

Federal Regulations (CFR) Section 300.5 of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; USEPA, 1992).

The Trust conducted Site Clearance activities to obtain information necessary to develop the *RSE Work Plan*. Site Clearance activities consisted of two separate tasks: a "desktop" study (e.g., literature and historical documentation review) and field activities.

Desktop study – included review of readily available and reasonably ascertainable information including:

- Historical and current aerial photographs to identify any potential historical mining features, and to identify if buildings, homes and/or other structures, and potential haul roads were present within 0.25 miles of the Site
- Topographic and geologic maps
- Available data concerning perennial surface water features and water wells
- Previous studies and reclamation activities
- Meteorological data (e.g., predominant wind direction in the region of the Site)

Site Clearance field activities – included the following:

- Site reconnaissance to evaluate in the field: access routes to the Site, location of site boundaries, and observations presented in the Weston Solutions (Weston)(2011) report
- Mapping of site features and boundaries
- Evaluation of potential background reference areas
- Biological surveys (wildlife and vegetation)
- Cultural resource surveys

Following Site Clearance activities, two sequential tasks were conducted to complete the RSE: Baseline Studies and Site Characterization and Assessment. Baseline Studies activities were completed to establish the basis for the Site Characterization and Assessment activities.

Baseline Studies activities – included the following:

- Background Reference Area Study – walkover gamma radiation survey (referred to hereafter as surface gamma survey), subsurface static gamma radiation measurements (referred to hereafter as subsurface static gamma measurements), surface and subsurface soil/sediment sampling, and laboratory analyses
- Site gamma survey – surface gamma survey

- Gamma Correlation Study – co-located surface static gamma measurements and exposure-rate measurements at fixed points, high-density surface gamma surveys (intended to cover 100 percent of the survey area), surface soil/sediment sampling, and laboratory analyses

Site Characterization Activities and Assessment – included the following:

- Characterization of surface soils and sediments – surface soil and sediment sampling and laboratory analyses.
- Characterization of subsurface soils and sediments – static gamma measurements (at surface and subsurface hand auger borehole locations), and subsurface sampling and laboratory analyses. Hand auger borehole locations are referred to hereafter as boreholes.

Details regarding the Site Clearance activities are provided in the *Alongo Mines Site Clearance Data Report* (*Site Clearance Data Report*; MWH, 2016c) and summarized in Section 3.2 of this report. Details regarding the Baseline Study activities are provided in the *Alongo Mines Site Baseline Studies Field Report* (Stantec, 2017) and summarized in Section 3.3 of this report. Details regarding the Site Characterization Activities and Assessment are provided in Section 3.3 of this report. Findings are presented in Section 4.0 of this report.

1.3 REPORT ORGANIZATION

This report presents a comprehensive discussion of all RSE activities, including applicable aspects of the outline suggested in the *Multi-Agency Radiation Survey and Site Investigation Manual – Appendix A* ([*MARSSIM*] USEPA, 2000), and consists of the following sections:

Executive Summary – Presents a concise description of the principal elements of the RSE report.

Section 1.0 Introduction – Describes the purpose and objectives of the RSE process, and organization of this RSE report.

Section 2.0 Site History and Physical Characteristics – Presents the history, land use, and physical characteristics of the Site.

Section 3.0 Summary of Site Investigation Activities – Summarizes the Site Clearance and RSE activities.

Section 4.0 Findings and Discussion – Presents the results of the Site Clearance and RSE activities, areas that exceed ILs, areas of Naturally Occurring Radioactive Material (NORM) and TENORM, and the volume of TENORM that exceeds the ILs. Potential data gaps are also presented, as applicable.

Section 5.0 Summary and Conclusions – Summarizes data and presents conclusions based on results of the investigations completed to date.

Section 6.0 Estimate of Removal Site Evaluation Costs – A statement of actual or estimated costs incurred in complying with the *Trust Agreement*, as required by the *Trust Agreement*.

Section 7.0 References – Lists the reference documents cited in this RSE report.

Tables Included at the end of this RSE report.

Figures Included at the end of this RSE report.

Appendices – Appendices A through F.1 are included at the end of this RSE report and Appendix F.2 is provided as a separate electronic file due to its file size and length.

- **Appendix A** – Includes the radiological characterization report for the Site
- **Appendix B** – Includes photographs of the Site
- **Appendix C** – Includes copies of RSE field activity forms
- **Appendix D** – Provides the potential background reference areas selection and the methods and results of the statistical data evaluation for the Site
- **Appendix E** – Includes the biological evaluation report and the biological and cultural resources compliance forms
- **Appendix F** – Includes the Data Usability Report, laboratory analytical data, and data validation reports for the RSE analyses

Attachments – Site-specific geodatabase, tabular database files, and available historical documents referenced in this RSE report.

2.0 SITE HISTORY AND PHYSICAL CHARACTERISTICS

2.1 SITE HISTORY AND LAND USE

2.1.1 Mining Practices and Background

The Site is located on the Navajo Nation near the border of Arizona and New Mexico and approximately 7.5 miles north of Red Valley, Arizona, as shown in Figure 1-1 inset. The Red Valley Chapter House is also located in Red Valley, Arizona. The Site is located in the eastern Carrizo Mountain region, within the King Tutt Mesa mining area, as shown in Figure 2-1. A summary of historical mining on the Site is presented below.

In 1944, the Union Mines Development Corporation conducted a geological survey in the eastern Carrizo Mountain region, within the King Tutt Mesa mining area (Coleman, 1944). The survey focused on four outcrops (numbered S-W1 through S-W4) of the Salt Wash Member of the Jurassic Morrison Formation. Of note, outcrops S-W1 and S-W2 were coincident with the RSE Site (i.e., Alongo Mines). At the time of the survey, vanadium mining was occurring in the King Tutt Mesa mining area and it was thought that these outcrops contained uranium-vanadium mineral deposits of interest. However, the survey results determined that the outcrops were not economically viable for vanadium mining (Coleman, 1944). By 1945, mines in the Carrizo Mountain region became in-active due to the decreased need for vanadium (Chenoweth, 1984 and Chenoweth, 1985).

After 1947, prospecting and mining for uranium increased in the eastern Carrizo Mountains region (Chenoweth, 1984 and Chenoweth, 1985). In light of new regulations, exploration drilling by both the US Atomic Energy Commission (USAEC) and uranium mining companies increased in 1953 and additional ore bodies were discovered.

In August 1955, Hosteen Setah Begay was issued mining permit MP336 for 19.78 acres (Chenoweth, 1997). Of note, outcrops S-W1 and S-W2 (i.e., the RSE Site) were located on the 19.78 acre parcel. In September 1955, the mining rights to MP336 were assigned to E.J. Alongo. E.J. Alongo began exploration efforts at outcrops S-W1 and S-W2 by drilling 32 exploration boreholes behind the mineralized outcrops. Based on the exploration drilling results, E.J. Alongo then drift mined into outcrops S-W1 and S-W2 to extract the uranium-vanadium deposits. The drift mining technique created two adits, one into each of the outcrops. The adits were accessed by two portals that were approximately 150 ft apart, with the northern adit being approximately 45 ft long and the southern adit being approximately 65 ft long. In February 1956, the first shipment of ore from the Site was delivered to the USAEC ore-buying station in Shiprock, New Mexico. In March 1956, the second shipment of ore was delivered from the Site to the ore-buying station in Shiprock, New Mexico. The ore mined from the Site was naturally high in calcium carbonate ($CaCO_3$; i.e., lime), which complicated the milling process used to extract the uranium from the ore. Because of the complications associated with the elevated $CaCO_3$, the mill would financially penalize the mine permit owner if ore exceeded 6.0 percent $CaCO_3$.

Therefore, after shipping the second shipment of ore, E.J. Alongo decided to abandon the Site, due to the elevated $CaCO_3$ content and the low uranium-vanadium grade of the ore (Chenoweth, 1997). The USAEC records reported total ore production from the Site was 26.74 tons (approximately 53,480 pounds) of ore that contained 75.96 pounds of 0.14 percent U_3O_8 (uranium oxide) and 76.04 pounds of 0.14 percent V_2O_5 (vanadium oxide) (McLemore, 1983 and Chenoweth, 1997).

2.1.2 Ownership and Surrounding Land Use

The Site is located within the Navajo Nation, Shiprock Bureau of Indian Affairs (BIA) Agency in Section 36 of Township 29 North, Range 21 West, New Mexico Principal Meridian. Land ownership where the Site is located falls under Navajo Trust lands. The Site is located within the Red Valley Chapter of the Navajo Nation, as shown in Figure 1-1, and is in Grazing Unit 12, as designated by the Navajo Nation Division of Natural Resources (NNDNR, 2006). The Site is currently uninhabited, but one home-site is located west of and within 0.25 miles of the Site, as shown in Figure 2-1.

2.1.3 Site Access

In 2015, the Navajo Nation Department of Justice (NNDOJ) provided the Trustee with legal access to all Navajo Trust lands to implement work in accordance with the *Trust Agreement*. The Trustee also obtained individual written access agreements from residents living at or near the Site, or with an interest in lands at or near the Site, such as home-site leases and grazing rights, as applicable. In addition, the Trustee consulted with the Red Valley Chapter officials and nearby residents and notified them of the work.

2.1.4 Previous Work at the Site

2.1.4.1 1989 through 2010 King Tutt Mesa Site Assessment Activities

From 1989 to 2004, the NNEPA and USEPA, in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act, as amended (CERCLA), conducted preliminary assessments (PAs), site inspections (SIs), and an expanded site inspection (ESI) at 16 AUM sites located on King Tutt Mesa (Bechtel Environmental, Inc. [BEI],1996). The 16 AUM sites were comprised of 28 individual mine sites that were contiguous or in close proximity to each other. Because of their close proximity to each other, the USEPA decided to evaluate them as a single, aggregate site referred to as the King Tutt Mesa (KTM) site. In this section of the RSE report (Section 2.1.4), to distinguish the Trust's AUM Site (called the Alongo Mines) from the KTM site and any alternative names or aliases historically used for the Alongo Mines site, the Trust site will be referenced as the Trust Alongo Mines AUM where applicable. The area of the Trust Alongo Mines AUM was included in the KTM site and was called the Navajo Canyon View (Alongo Claim) site or NA-0817 (Navajo Superfund Program [NSP], 2004). Data collected from the PAs, SIs, and ESI for the KTM site were used to perform reclamation work at the KTM site between 1992 and 2002. The PAs, SIs, ESI, and reclamation that occurred at the KTM site included the following:

- 1989 and 1990 – NNEPA conducted PAs at the KTM site. The purpose of the PAs was to review existing information on the KTM site and its environs, to assess the threat(s), if any, posed to public health, welfare, or the environment, and to determine if further action was warranted under CERCLA (Navajo Superfund Program [NSP], n.d.). The date of the NSP/NNEPA, CERCLA Preliminary Assessment report is unknown.

- 1990, 1991, and 1992 – NNEPA conducted SIs at the KTM site. The SIs included the collection of soil, sediment, surface water, and groundwater samples for chemical analyses. No media samples were collected at the Trust Alongo Mines AUM. Media sample results are summarized in the *Draft Site Inspection Report King Tutt Mesa Aggregate Site Red Valley Chapter, Navajo Nation* (NSP, 2004).

- 1992 – Reclamation work began at the KTM site by NAML (BEI, 1996).

- 1994 through 1996 – BEI performed an ESI at the KTM site, on behalf of the USEPA (BEI, 1996). The ESI included the collection of soil, sediment, surface water, and groundwater samples, for chemical analyses, at various sample locations on the KTM site. Soil and sediment samples were collected at the Trust Alongo Mines AUM during the ESI. Media sample results are summarized in the *Expanded Site Inspection Report for the King Tutt Mesa Aggregate Site* (BEI, 1996).

- 1999 - NAML issued an invitation for bids for the reclamation of 14 AUMs, referred to as the Carrizo #1 NAML Project (NAML, 1999). The Trust Alongo Mines AUM was included in the Carrizo #1 NAML Project bid document, and was referred to in the bid document as “Alongo” or “NA-0817”. NA-0817 was inclusive of the “Alongo” site as well as the Red Wash Mine site. The Red Wash Mine site was located 0.3 miles southwest of the Trust Alongo Mines AUM. The bid document stated that NA-0817 contained three portals; two located on “Alongo” and one located on the Red Wash Mine site. The bid document also included a historical drawing of NA-0817 showing the location of the portals. The bid document listed the following reclamation activities were needed for the “Alongo” portion of NA-0817:

    - Close the two portals with bulkheads made of polyurethane foam (PUF). Portal dimensions were 5 ft wide by 4 ft high and 4 ft wide by 4 ft high.

    - Place a minimum of 2 ft of rock or earth-facing in front of the PUF bulkhead for ultraviolet ray protection. Slope the rock or earth-facing to blend with the native topography.

    - Eliminate access roads by ripping.

- 2002 – NAML completed reclamation activities at 27 of the 28 mine sites included in the KTM site (TerraSpectra Geomatics, 2004). The Trust Alongo Mines AUM was one of the 27 sites where reclamation was completed. Reclamation work was also completed at seven additional mine sites that were located within the areal extent of the KTM site but were not included in the PAs, SIs, and ESI for the KTM site. Also, four additional mine sites located within the areal extent of the KTM site but not included in the PAs, SIs, and ESI for the KTM site, were left un-reclaimed by NAML.

- 2004 – NNEPA collected soil, sediment, surface water, and groundwater samples, for chemical analyses, as part of an on-going SI reassessment at the KTM site (NSP, 2004). No media samples were collected at the Trust Alongo Mines AUM; refer to Figure 3-4 in NSP (2004) for 2004 SI sample locations. Media sample results are summarized in NSP (2004).

From 1989 through 2004, (when the PAs, SIs, and ESI were performed) site assessment activities did not occur on each individual mine within the KTM site. Therefore, after reviewing the PAs, SIs, and ESI the USEPA decided that further investigations were necessary to more completely evaluate the KTM site (Weston, 2011). From 2008 to 2010, Weston, on behalf of the USEPA, performed a reassessment. The reassessment included the original KTM site and the inclusion of 13 additional mine sites. The 13 added mine sites were located within the original KTM site boundary, but were not included in the 1989 to 2004 PAs, SIs, or ESI. The KTM site was then comprised of 41 individual mine sites. The purpose of the reassessment was to review existing information and collect additional data to assess the relative threat associated with actual or potential releases of hazardous substances at the KTM site. Additional information collected from the KTM site reassessment activities included the following:

- 2008 – Weston, on behalf of the USEPA, performed a surface gamma survey at the KTM site. The area of the Trust Alongo Mines AUM was not included in the survey. Refer to Figures 3-2a through 3-3d in Weston (2011) for 2008 surface gamma survey areas.

- 2010 – Weston assessed the 2008 surface gamma survey data and concluded that of the 41 individual mine sites within the KTM site, 32 warranted additional surface gamma surveying. Therefore, in June 2010, Weston, on behalf of the USEPA, performed additional surface gamma surveying at the KTM site. The Trust Alongo Mines AUM was surveyed in 2010 and the highest gamma measurements collected at the Trust Alongo Mines AUM were greater than 19 times the site-specific background levels used for the screening. Refer to Figures A-3 and A-4 in Weston (2011) for the gamma measurements and survey area. Figures A-3 and A-4 also show two waste piles located in the southeast area of The Trust Alongo Mines AUM. In addition, Table 2-1 in Weston (2011) reported two portals and two prospect mining features were also present at the Trust Alongo Mines AUM. The location of the two portals and two prospect mining features were not shown in the Weston report figures (2011); however, the locations are included in the *2007 AUM Atlas*. Table 2-1 in Weston (2011) was a summary of NAML records, as reported in the *2007 AUM Atlas*, and was not a separate indication of features identified by Weston at the Trust Alongo Mines AUM.

2.1.4.2 1994 through 1999 Aerial Radiological Surveys

Between 1994 and 1999, aerial radiological surveys were conducted at 41 geographical areas within the Navajo Nation, including the Red Valley area, which included the location of the Site (Hendricks, 2001). The surveys were done at the request of the USEPA Region 9 and were performed by the Remote Sensing laboratory, a US Department of Energy facility, National Nuclear Security Administration Nevada Operations Office. The intent of the surveys was to characterize the overall radioactivity levels and excess bismuth-214 activity (i.e., a radioisotope that is an indicator of uranium ore deposits and/or uranium mines) within the surveyed areas. Data collected from the surveys was used to assess the risks (i.e., average gross exposure rate) in mined areas and to determine what action, if any, was needed.

The aerial radiological survey for the Red Valley area covered approximately 33.04 square miles and included the location of the Site. The aerial radiological survey results for the area within a 0.25 mile radius of the Site indicated a gross exposure rate range of 6 μR/hr to 7 μR/hr and no excess bismuth (i.e., bismuth activity greater than approximately 3.5 μR/hr) (*2007 AUM Atlas*). The aerial radiological survey results for the Red Valley area indicated a gross exposure rate range of 2.92 μR/hr to 42.23 μR/hr and excess bismuth (i.e., bismuth activity greater than approximately 3.5 μR/hr) present in approximately 0.32 square miles of the 33.04 square miles of the Red Valley flight area (Hendricks, 2001).

2.2 PHYSICAL CHARACTERISTICS

2.2.1 Regional and Site Physiography

The Site is located within the Colorado Plateau physiographic province, which is an area of approximately 240,000 square miles in the Four Corners region of Utah, Colorado, Arizona, and New Mexico. Figure 2-2 presents a current regional aerial photograph (BING® Maps, 2018) of the Site within a portion of the Colorado Plateau. The Colorado Plateau is typically high desert with scattered forests and varying topography having incised drainages, canyons, cliffs, buttes, arroyos, and other features consistent with a regionally uplifted, high-elevation, semi-arid plateau (Encyclopedia Britannica, 2017). The physiographic province landscape includes mountains, hills, mesas, foothills, irregular plains, alkaline basins, some sand dunes, and wetlands. This physiographic province is a large transitional area between the semi-arid grasslands to the east, the drier shrub-lands and woodlands to the north, and the lower, hotter, less-vegetated areas to the west and south.

The Colorado Plateau includes the area drained by the Colorado River and its tributaries: the Green, San Juan, and Little Colorado Rivers (Kiver and Harris, 1999). The physiographic province is composed of six sections: Uinta Basin, High Plateaus, Grand Canyon, Canyon Lands, Navajo, and Datil-Mogollon. The Site is located within the Navajo section.

The Site is located in the central portion of the Colorado Plateau. Figure 2-3 presents the regional US Geological Survey (USGS) topographic map of a portion of the Colorado Plateau in the vicinity of the Site. Figure 2-4 presents the Site topography (Cooper Aerial Surveys Company [Cooper; refer to Section 3.2.2.1]) within a portion of the Colorado Plateau. The Site is located along the western side of a sandstone mesa and Red Wash with elevation ranges from approximately 5,370 ft to 5,470 ft above mean sea level (amsl) (refer to Figure 2-4).

2.2.2 Geologic Conditions

2.2.2.1 Regional Geology

Regionally the Site is located within the Colorado Plateau, which is a massive outcrop of generally flat-lying sedimentary rocks ranging in age from the Paleozoic Era to the Cenozoic Era (USGS, 2017). The plateau has very little regional structural deformation, compared with the mountainous basin-and-range region to the west, and the sedimentary beds range widely in thickness from less than one inch to hundreds of feet. Changes in paleoclimate and elevation produced alternating occurrences of deserts, streams, lakes, and shallow inland seas; and these changes contributed to the type of rock deposited in the region. The rock units of the plateau consist of shallow submarine or sub-aerially deposited rocks including sandstone, shale, limestone, mudstone, siltstone, and various other sedimentary rock subtypes.

Bedrock on the Site consists of the Jurassic Morrison Formation. The Morrison Formation is composed of various rocks of lacustrine and fluvial continental origin, including mudstone, sandstone, limestone, and siltstone (USGS, 1967). Figure 2-5 depicts a regional geology map showing the Site in relation to the regional extent of the Morrison Formation. The sandstone strata of the Morrison Formation contain the majority of uranium ore reserves in the US (USGS, 1967). Deposition of the Morrison Formation may have coincided with uplift of the western basin-and-range region and the beginning of the Nevadan orogeny. The Morrison Formation covers an area of approximately 600,000 square miles and is centered in Wyoming and Colorado, with outcrops in Canada, Montana, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Utah, Idaho, New Mexico, and Arizona (Turner and Peterson, 2004). The Morrison Formation produced approximately 4.7 million pounds of uranium from areas of Arizona and New Mexico (USEPA, 2007a).

2.2.2.2 Site Geology

Bedrock outcrops on or adjacent to the Site consist of the Salt Wash Member and the Bluff Sandstone Member of the Morrison Formation, as shown in Figure 2-6a. The Salt Wash Member is a yellowish-gray to greenish-gray cross-bedded very fine- to medium-grained calcareous sandstone interbedded with greenish-gray and reddish–brown claystone. The Bluff Sandstone Member is a moderate reddish-orange to light-brown, fine- to medium-grained laminated sandstone that is approximately 5 to 10 ft thick on-site. A geologic profile of the Site is shown in Figure 2-6a. Shallow or outcropping mineralized bedrock on-site, of the Morrison Formation, is shown in Figure 2-6b.

Unconsolidated deposits on-site are alluvium, colluvium, and eolian deposits consisting of variable amounts of silt, sand, and gravel. During the Site Characterization field activities, boreholes were advanced through the unconsolidated deposits using a hand auger until: (1) refusal at bedrock/hard surface; (2) subsurface static gamma measurements were below initial background levels; (3) measurements of consistently low subsurface static gamma levels; or (4) caving sands (refer to Section 3.3.2.2 and Appendix C.2 for borehole logs). The unconsolidated deposits ranged in depth from 0.5 ft to greater than 3.4 ft below ground surface (bgs).

According to the US Department of Agriculture (USDA) Soil Survey for San Juan County, soils on-site that have not been disturbed, are classified as Shalet-Rock Outcrop Complex consisting of eolian soil that is sandy clay loam, shallow in depth, and well drained (USDA, 2001).

2.2.3 Regional Climate

The Colorado Plateau is located in a zone of arid temperate climates characterized by periods of drought and irregular precipitation, relatively warm to hot growing seasons, and winters with sustained periods of freezing temperatures (National Park Service, 2017). The average monthly high temperature at weather station 298284, Shiprock, New Mexico (Western Regional Climate Center, 2017) located approximately 19 miles northeast of the Site, ranges between 43.0 degrees Fahrenheit (°F) in January to 94.6°F in July. Daily temperature extremes reach as high as 109°F in summer and as low as -26°F in winter. Shiprock receives an average annual precipitation of 7.0 inches, with August being the wettest month, averaging 1.0 inches, and June being the driest month, averaging 0.29 inches.

Potential evaporation in the area is greater than the area's average annual precipitation. The potential evaporation noted at the Shiprock weather station averages 73 inches of pan evaporation annually (Western Regional Climate Center, 2017). Average wind speeds in the area are generally moderate, although relatively strong winds often accompany occasional frontal activity, especially during late winter and spring months. Blowing dust, soil erosion, and local sand-dune migration/formation are common during dry months. The Farmington, New Mexico airport, located approximately 43 miles to the northeast of the Site, had the most complete record of wind conditions. A wind rose for the Farmington airport is presented on Figure 1-1. The wind rose was produced using data contained in the *2007 AUM Atlas* for the years 1996 to 2006. Predominant winds were from the east (refer to the wind rose on Figure 1-1).

2.2.4 Surface Water Hydrology

The Site is located within the San Juan River watershed, an area of approximately 24,600 square miles spanning Utah, Colorado, New Mexico, and Arizona, as shown in Figure 1-1. The Site is also located within a portion of San Juan County, New Mexico that is characterized by escarpments separated by major river washes (refer to Appendix E). On-site surface water flow (i.e., overland flow) is controlled along the approximate edge of the mesa (refer to Figure 2-7) by a decrease in elevation to the west from along the mesa top to Red Wash. Red Wash is an ephemeral stream that flows only in direct response to surface runoff precipitation or melting snow. Precipitation run-off on-site either terminates within the unconsolidated deposits or drains west into Red Wash. Red Wash then joins the San Juan River approximately 15 miles northeast of the Site (refer to Figure 1-1 inset).

Adkins Consulting Inc. (Adkins), under contract to Stantec, performed a wildlife evaluation as part of the Site Clearance field investigations and identified a strip of arid riparian vegetation on-site within the Red Wash floodplain (refer to Appendix E). The area was dominated by stunted woody vegetation, discontinuous saltcedar and scattered willow. The hydrology system of the small strip of arid riparian vegetation was characterized by intermittent flooding.

2.2.5 Vegetation and Wildlife

In the spring and summer of 2016, biological surveys were conducted as part of Site Clearance activities. In April 2016, Adkins conducted a wildlife survey. In May 2016, Redente Ecological Consultants (Redente), under contract to Stantec, conducted a spring vegetation survey and in July 2016, Redente conducted a summer vegetation survey. Information about each survey is provided in Appendix E, which includes the Site biological evaluation reports and the *Navajo Nation Department of Fish and Wildlife* (NNDFW) *Biological Resources Compliance Form*. A summary of the survey activities and findings are provided in Section 3.2.2.3.

Vegetation communities found within the physiographic transitional area described in Section 2.2.1 include shrublands with big sagebrush, rabbitbrush, winterfat, shadscale saltbush, and greasewood; and grasslands of blue grama, western wheatgrass, green needlegrass, and needle-and-thread grass. Higher elevations may support pinyon pine and juniper woodlands. Vegetation communities on-site within the Red Wash floodplain/arid riparian area were discontinuous saltcedar, rubber rabbitbrush, and sporadic Russian olive (refer to Appendix E). The vegetation communities outside of the Red Wash floodplain/arid riparian area were mainly scattered shrubs and grasses including blue grama, alkali sacaton, Indian ricegrass, broom snakeweed, shadscale saltbush, and sagebrush (refer to Appendix E). During the surveys, Stantec and/or its subcontractors observed on-site wildlife including turkey vulture, common raven, American kestrel, prairie falcon, and cottontail rabbit (refer to Appendix E).

2.2.6 Cultural Resources

In March 2016, as part of Site Clearance activities, Dinétahdóó Cultural Resource Management (Dinétahdóó), under contract to Stantec, conducted a cultural resource survey, as well as ethnographic and historical data reviews, and interviewed a local resident living near the Site (Dinétahdóó, 2016). The local resident stated he/she remembered underground mining, using blasting and hauling techniques, occurred at the Site.

During the cultural resource survey Dinétahdóó identified one archaeological site and eight isolated occurrences. Appendix E includes a copy of the *Cultural Resource Compliance Form,* and findings of the cultural resource survey are summarized in Section 3.2.2.4.

2.2.7 Observations of Potential Mining

During RSE activities, Stantec field personnel (field personnel) observed the following features indicative of potential mining activates at the Site: two portals, two waste piles, a potential rim strip area, and a potential haul road. Details regarding these observations are presented in Section 3.2.2.1. These observations were used, along with additional lines of evidence (refer to Section 3.3.3), to identify areas at the Site where TENORM was present (refer to Section 4.6).

3.0 SUMMARY OF SITE INVESTIGATION ACTIVITIES

3.1 INTRODUCTION

This section summarizes Site Clearance and other RSE activities conducted between August 2015 and September 2017. Site Clearance activities were performed in accordance with the approved *Site Clearance Work Plan*. Resulting RSE activities were performed in accordance with the approved *RSE Work Plan*.

The primary objectives of the RSEs are to provide data required to evaluate relevant site conditions and to support future removal action evaluations at the Sites. It is not intended to establish cleanup levels or determine cleanup options or potential remedies.

The *RSE Work Plan* is comprised of a Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), Health and Safety Plan (HASP), and a Data Management Plan (DMP). The FSP guided the fieldwork by defining sampling and data-gathering methods. The QAPP presented quality assurance/quality control (QA/QC) requirements designed to meet Data Quality Objectives (DQOs) for the environmental sampling activities. The HASP listed site hazards, safety procedures and emergency protocols. The DMP described the plan for the generation, management, and distribution of project data deliverables. The FSP, QAPP, HASP, and DMP provided the approved requirements and protocols to be followed for the RSE data collection, data management, and data analyses performed to develop this RSE report. Any deviations or modifications from the *RSE Work Plan* are described in the appropriate RSE report sections.

The RSE process followed applicable aspects of the USEPA DQO Process and *MARSSIM*, to verify that data collected during the RSE activities would be adequate to support reliable decision-making (USEPA, 2006). The USEPA DQO Process is a series of planning steps based on the scientific method for establishing criteria for data quality and developing survey designs. *MARSSIM* provides technical guidance on conducting radiation surveys and site investigations.

The USEPA DQO Process is a seven-step process[3] that was performed as part of the *RSE Work Plan* to identify RSE data objectives. The goal of the USEPA DQO Process is to minimize expenditures related to data collection by eliminating unnecessary, duplicate, or overly precise data and verifies that the type, quantity, and quality of environmental data used in decision making will be appropriate for the intended application. It provides a systematic procedure for defining the criteria that the survey design should satisfy. This approach provides a more effective survey design combined with a basis for judging the usability of the data collected (USEPA, 2006).

The USEPA DQO Process performed for the RSE is presented in the *RSE Work Plan*, Section 3, and identifies the purpose of the data collected as follows:

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[3] (1) State the problem; (2) Identify the goals of the study; (3) Identify the information inputs; (4) Define the boundaries of the study; (5) Develop the analytical approach; (6) Specify the tolerance on decision errors; and (7) Optimize sampling design (USEPA, 2006).

1. Background reference area soil sampling, laboratory analyses, surface gamma surveying, and subsurface static gamma measurements to establish background analyte concentrations and gamma measurements, which will be used as the ILs, for the Site.

2. Site sampling (soil and sediment), laboratory analyses, surface gamma surveying, and subsurface static gamma measurements for comparison with ILs, to define the lateral and vertical extent of contamination at the Site to characterize the Site to support future Removal or Remedial Action evaluations.

The USEPA DQO Process was used in conjunction with *MARSSIM* guidance for RSE planning and data collection. Per *MARSSIM* guidance, "planning radiation surveys, using the USEPA DQO Process, can improve radiation survey effectiveness and efficiency, and thereby the defensibility of decisions" (USEPA, 2000).

The applicable aspects of *MARSSIM* incorporated into the RSE process include:

- Historical site assessment
- Determining RSE DQOs
- Selecting background reference areas
- Selecting radiation survey techniques
- Site preparation
- Quality control
- Health and safety
- Survey planning and design
- Baseline surface gamma surveys and subsurface static gamma measurements
- Field measurement methods and instrumentation
- Media sampling and preparation for laboratory analyses

The RSE process also used applicable aspects of *MARSSIM* for interpretation of the RSE results, including:

- Data quality assessment through statistical analyses
- Evaluation of the analytical results
- Quality assurance and quality control

Sections 3.2 and 3.3 summarize the preparation, field investigation methods, and procedures for data collection during the Site Clearance activities and other RSE activities. Activities subsequent to the Site Clearance are described in detail in the *RSE Work Plan,* Section 4. Appendix A includes the radiological characterization report prepared by Environmental Restoration Group, Inc. (ERG), under contract to Stantec. Appendix B includes photographs of features at the Site and the surrounding area, Appendix C.1 includes soil/sediment sample field forms and Appendix C.2 includes borehole logs.

3.2 SUMMARY OF SITE CLEARANCE ACTIVITIES

The Site Clearance activities consisted of two tasks: a desktop study and field investigations. The desktop study was completed prior to field investigations, and the findings of the desktop study were used to guide field investigations. The Site Clearance activities are detailed in the *Site Clearance Data Report* and are described below.

3.2.1 Desktop Study

The desktop study included:

- Review of historical aerial photographs (USGS, 2016). Photographs were selected based on sufficient scale, quality, resolution, and whether the photograph met one or more of the following criteria:
  - Showed evidence of active mining or grading of the Site, or provided information on how the Site was developed or operated (e.g., haul roads and open pits).
  - Showed evidence of reclamation (e.g., soil covers).
  - Showed significant changes in ground cover compared to current photographs.
- Review of current aerial photographs for identification of buildings, homes and other structures, and potential haul roads within 0.25 miles of the Site.
- Review of topographic and geologic maps.
- Review of information related to surface water features and water wells on the Navajo Nation within a one-mile radius of the Site, provided by: (1) the Navajo Nation Department of Water Resources (NNDWR, 2016); and (2) ESRI Shapefiles data contained in the *2007 AUM Atlas*.
- Review of previous studies, information related to potential past mining, and reclamation activities.
- Identification of the predominant wind direction in the region of the Site.

Based on the list above, the following findings were identified during the desktop study:

- Historical photographs (USGS, 2016) for the Site were selected from 1950, 1952, 1953, 1965, 1975, 1997 and 2005 for comparison against a current 2017 image (Cooper, 2017). The selected historical photographs are shown in Figure 3-1a. Figure 3-1b compared the aerial photograph from 1952 and the current 2017 image. Figure 3-1c compared the aerial photograph from 1975 and the current 2017 image. When comparing the 1952 or 1975 photographs to the current 2017 image it was difficult to distinguish topographic differences on the mesa top or mesa sidewall. However, the mesa wash and flood plain of Red Wash appeared different when comparing the 1952 and 1975 photographs to the current 2017 image (i.e., the course of Red Wash changed and the vegetation on either side of Red Wash increased). The 1952 and 1975 historical photographs were presented because they provided the best resolution of what the Site looked like after mining began on-site.

- The current aerial photograph review confirmed that the Site was uninhabited but one home-site was located west of and within 0.25 mile of the Site, as shown in Figure 2-1. Numerous dirt roads were identified within 0.25 miles of the Site, refer to Figure 2-1. The road type (i.e., potential haul road or road unrelated to historical mining) was identified by the current aerial photograph review, historical document review, and visual identification during the Site Clearance field investigations (refer to Section 3.2.2.1).

- Two potential water features were identified based on the review of information provided by the NNDWR and the *2007 AUM Atlas*, refer to Table 3-1 and Figure 2-1.

- The predominant regional winds were from the east (refer to Section 2.2.3 and Figure 1-1).

Previous studies and information related to past mining are discussed in Sections 2.1.1 and 2.1.4.

3.2.2 Field Investigations

3.2.2.1 Site Mapping

The *Site Clearance Work Plan* specified that the following features at and near the Site, if present, should be mapped, marked, and/or their presence confirmed:

- Claim boundaries and the 100-ft buffers of the claim boundaries

- Roads, fences/gates, utilities: haul roads to a distance of 0.25 miles or to the intersection with the next major road, whichever is closer

- Structures, homes, buildings, livestock pens, etc.

- Surface water and water well locations: surface water channels that drain the Site to a distance of 0.25 miles away from the Site or to the confluence with a major drainage, whichever is closer; surface water features and water wells identified within a one-mile radius of the Site

- Topographic features

- Potential background reference areas

- Type of ground cover, including rock, soil, waste rock, etc.

- Physical hazards

Based on the list above, the following site features were mapped during field investigations:

- Claim boundaries – 100-ft buffers of the claim boundaries, as shown in Figure 2-7, were marked in the field with stakes and/or flagging and mapped with a global positioning system (GPS).
- Drainage – Two drainages were mapped, Red Wash and Blackrock Wash, as shown in Figure 2-7 and Appendix B photograph numbers 5, 6, 8, and 9. Blackrock Wash was an ephemeral stream that flowed only in direct response to surface runoff precipitation or melting snow. Blackrock Wash joined Red Wash south of the Site. Red Wash was also an ephemeral stream that ran through the Site and joined the San Juan River approximately 15 miles northeast of the Site (refer to Figure 1-1 inset).
- Topographic features – The mapped area can be divided into three topographic areas: (1) the mesa top; (2) the mesa sidewall (i.e., the vertical cliffs and steep colluvium-covered bedrock slope); and (3) the wash and flood plain (i.e., the sediment/soil filled drainage channel and related flood plain). The three topographic areas are shown in Figure 2-4 and Appendix B photograph number 9.
- Corral – Two corral areas were mapped, as shown in Figure 2-7, located southwest of the Site.
- Fence – A fence was mapped, as shown in Figure 2-7. The fence bordered the home-site and corrals, and was slightly within the 100-ft buffer of the western claim boundary.
- Utilities – An overhead power line was mapped, as shown in Figure 2-7. The power line ran from the edge of Red Wash to the corrals and home-site.
- Portals – Two portals were mapped (Portal-1 and Portal-2), as shown in Figure 2-7. The portals are shown in Appendix B photograph numbers 1, 2, 3, and 4. Field personnel observed that the portals were reclaimed, both portals were covered by boulders of varying sizes, and the bulkhead at Portal-2 was slightly visible behind the boulders.
- Potential haul road – One potential haul road was mapped, as shown in Figure 2-7. Field personnel observed that the portion of the potential haul road that crossed Red Wash to access the portals was destroyed. The destruction of the potential haul road could have been because it was washed out naturally or it was eliminated during reclamation. Eliminating access roads by ripping was included as one of the reclamation needs listed by NAML (refer to Section 2.1.4).
- Roads – One road was mapped that led to the home-site and also connected with the potential haul road, as shown in Figure 2-7. Additional dirt track roads were present east of the Site on the mesa top (visible on Figure 2-7 and the 1975 photo on Figure 3-1c). The dirt tracks were adjacent to the Site and accessed the mesa top portion of the Site.
- Waste piles – Two waste piles were mapped (Waste Pile 1 and Waste Pile 2), as shown in Figure 2-7 and Appendix B photograph numbers 6 and 11. The waste piles were downgradient from the two portals and along the mesa side wall. The waste piles are also shown as earthworks in Figures 2-6a and 2-6b.

- Potential rim strip area – A potential rim strip area was mapped, as shown in Figure 2-7 and Appendix B photograph number 7. Field personnel observed that overburden material in this area appeared to have been removed or scaled down with tools. The potential rim strip area is also shown as earthworks in Figures 2-6a and 2-6b.

- Structures – The Site is currently uninhabited, but one home-site was located west of and within 0.25 mile of the Site, as shown in Figure 2-1. A gate was present across the driveway to the home-site, as shown in Figure 2-7.

- Water features – Field personnel assessed the two water features identified from the desktop study, as shown in Figure 2-1. The water features and field personnel observations are included in Table 3-1. In addition, during site mapping activities field personnel identified two additional water features (i.e., minor seeps and Red Wash), as described in Table 3-1.

- Ground cover – Ground cover and vegetation observed on-site are discussed in Sections 2.2.2.2 and 2.2.5, respectively.

During site mapping, field personnel did not observe the exploration boreholes described in Section 2.1.1 or the two NAML identified prospect mining features described in Section 2.1.4.

In June 2018, the USEPA provided the Trust with a copy of a NNDWR database that was generated in 2018. The USEPA stated that there were discrepancies between the NNDWR water feature locations in the 2018 database and those provided in the 2016 NNDWR database used by the Trust. This information was provided after Site Characterization activities had occurred and was therefore not included in the RSE for the Site. Comparison of the 2018 NNDWR database against the 2016 NNDWR database and the *2007 AUM Atlas* will require additional field work and it is recommended that this be addressed in future studies for the Site.

In addition to the Site mapping activity, the Trust took high-resolution aerial photographs and collected topographic data at the Site. The objective of the high-resolution aerial photography survey was to develop orthophotographs and topographic data of the Site to:

- Assist with identifying ground cover (e.g., soil versus bedrock)

- Assist with delineating historical mine features (e.g., haul roads, portals, and waste piles)

- Allow additional evaluation of areas that were inaccessible due to steep or unsafe terrain

- Provide site base maps (high resolution imagery and elevation data) that could be used to support future Removal or Remedial Action evaluations at the Site

Stantec proposed to perform aerial photography in order to provide an overview of the Site and identify features that could not otherwise be accomplished safely on foot. USEPA is not authorized to allow drones on sites it oversees: therefore, drone use was not an option. Although aerial photography was not included in the approved *Scope of Work* (MWH, 2016d), the Trustee notified the Agencies and obtained approval prior to commencement of the work. The Trust also consulted with Red Valley Chapter officials and nearby residents and notified them of the aerial photography survey. On June 16, 2017, Cooper flew over the Site in a piloted fixed-wing aircraft and collected 3.5-centimeter digital color stereo photographs of the Site. Cooper provided the following data:

- Digital, high-resolution color orthophotograph imagery
- AutoCAD files (2-dimensional and 3-dimensional) that included elevation contours (refer to Figure 2-4) and plan features
- Elevation point files
- Triangular Irregular Network surface files

The site orthophotographs and supporting data files were used for data analyses, including estimating volumes of potentially mining-impacted material at the Site. They also were used as the base image for selected figures included in this RSE report, to the extent applicable.

3.2.2.2 Potential Background Reference Area Evaluation

The desktop study findings and field investigation observations were used to identify three potential background reference areas (BG-1 through BG-3) for the Site, as shown in Figure 3-2, and described in Appendix D.1. BG-1, BG-2, and BG-3 were also selected as suitable background reference areas for the Site for the following reasons:

- BG-1 encompassed an area of 644 ft^2 (approximately 0.01 acres), was located 380 ft south of the claim boundary, and cross-wind and hydrologically cross-gradient from the Site. The colluvium-covered slopes and bedrock outcrops represented the mesa sidewall area of the Site, and are the same geologic formation, the Morrison Formation. The vegetation and ground cover at BG-1 were similar to the Site.
- BG-2 encompassed an area of 838 ft^2 (approximately 0.02 acres), was located 330 ft south of the claim boundary, and cross-wind and hydrologically upgradient from the Site. The alluvial sediments and valley bottom Quaternary deposits represented the areas downslope of the mine portals on the mesa sidewall and the area within the wash. The vegetation and ground cover at BG-2 were similar to the Site.
- BG-3 encompasses an area of 2,755 ft^2 (approximately 0.06 acres), was located 410 ft south of the claim boundary, and cross-wind and hydrologically cross-gradient from the Site. The thin soils and bedrock outcrops represented the mesa top and mesa sidewall portions of the Site, and were the same geologic formation, the Morrison Formation. The vegetation and ground cover at BG-3 were similar to the Site.

The potential background reference areas were selected based on *MARSSIM* guidance (i.e., similar geology and ground conditions, upwind of the Site, distance from the Site, etc.) to:

1. Represent undisturbed conditions at the Site (e.g., pre-mining conditions)
2. Provide a basis for establishing the ILs

The approved *RSE Work Plan* did not specify any minimum or maximum size criteria for these areas. Stantec does not view the size of the selected background reference areas as affecting the validity of the background concentrations. The sizes were based on professional judgment that the identified areas were generally representative of the Site.

The background reference areas were selected in areas outside of the Site that were considered to be representative of the general conditions observed at the Site. However, an important consideration is that the background gamma radiation and metals concentrations within soil and bedrock can be variable and often contain a wider range of concentrations than what was measured at the selected background reference areas. The ILs derived from the background reference areas provide a useful reference for comparison to the Site. However, it will be important to consider the variations in concentrations when conducting site assessment work and/or to support future Removal or Remedial Action evaluations at the Site.

3.2.2.3 Biological Surveys

The objective of the biological surveys was to determine if identified species of concern or potential federal or Navajo Nation Threatened and Endangered (T&E) species and/or critical habitat are present on or near the Site. Biological (vegetation and wildlife) clearance was required at the Site before RSE activities could begin, to determine if the RSE activities could affect potential species of concern or federal or Navajo Nation listed T&E species and/or critical habitat. The Site biological evaluation reports, the *NNDFW Biological Resources Compliance Form*, and the US Fish and Wildlife Service (USFWS) consultation email are provided in Appendix E.

The Federal Endangered Species Act (ESA) of 1973, 16 U.S.C. §1531 et seq., requires that each Federal agency confer with the USFWS on any agency action that is likely to jeopardize the continued existence of any proposed T&E species or result in the destruction or adverse modification of critical habitat proposed to be designated for such species 16 U.S.C. §1536(a)(4). An “action area”, as defined in the regulations implementing the ESA, includes “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action”. 50 C.F.R §402.2.

The vegetation and wildlife surveys were conducted according to guidelines of the ESA and the NNDFW-Navajo Natural Heritage Program (NNHP), including the procedures set forth in the Biological Resource Land Use Clearance Policies and Procedures, RCS-44-08 (NNDFW, 2008), the Species Accounts document (NNHP, 2008), and the USFWS survey protocols and recommendations (USFWS, 1996).

Based on the results of the vegetation and wildlife surveys, the NNDFW’s opinion was that the RSE Baseline Studies and Site Characterization Activities,

> “with applicable conditions, [were] in compliance with Tribal and Federal laws protecting biological resources including the Navajo Endangered Species and

> Environmental Policy Codes, US Endangered Species, Migratory Bird Treaty, Eagle Protection and National Environmental Policy Acts".

A copy of the *NNDFW Biological Resources Compliance Form* is included in Appendix E. In addition, after the Trust submitted the results of the biological survey, USEPA consulted with John Nystedt of the USFWS on August 26, 2016, and received an email response on August 29, 2016 stating:

> "Based on the information you [Stantec] provided [i.e., there is no habitat for any Federally listed species in the action area], we [the USFWS] believe no endangered or threatened species or critical habitat will be affected by the project; nor is this project likely to jeopardize the continued existence of any proposed species or adversely modify any proposed critical habitat" (Nystedt, 2016).

A copy of the Nystedt email is included in Appendix E. In light of the results of the biological surveys described below, the USFWS recommended no further action from the USFWS for the project unless the project or regulations change, or a new species is listed.

Vegetation Survey - In May 2016, Redente performed a spring vegetation survey and in July 2016, Redente performed a summer vegetation survey, as part of the Site Clearance field investigations. Complete details of the vegetation survey, including the *NNDFW Biological Resources Compliance Form*, are included in Appendix E and summarized below.

In preparation for the vegetation survey, Redente submitted data requests for species of concern to the NNDFW and NNHP, and for Federal T&E species, to the USFWS. The NNDFW-NNHP responded to MWH (now Stantec) by letter dated November 19, 2015. The letter provided a list of species of concern known to occur within the proximity of the Site and included their status as either Navajo Nation Endangered Species List (NNESL), and/or Federally Endangered, Federally Threatened, or Federal Candidate. The NNESL species were further classified as G2, G3, or G4[4]. A copy of this letter is included in Appendix E.

The NNDFW listed five T&E plant species that may occur on-site; Parish's alkali grass (G4), Rydberg's thistle (G4), alcove bog-orchid (G3), alcove death camas (G3), and Navajo sedge (USFWS threatened). The USFWS listed three T&E plant species that may occur on-site; Knowlton's cactus (endangered), Mancos milk-vetch (endangered), and Mesa Verde cactus (threatened). Parish's alkali grass is a native annual grass that grows in a series of widely discontinuous populations ranging from southern California to eastern Arizona and western New Mexico in alkaline seeps, springs and seasonally wet areas, and washes at elevations from 5,000 ft to 7,200 ft amsl. Rydberg's thistle is a native perennial forb that occurs in hanging gardens, seeps, and stream banks below hanging gardens at elevations from 3,297 ft to 6,946 ft amsl. Its

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[4] G2 classification includes endangered species or subspecies whose prospect of survival or recruitment are in jeopardy, G3 classification includes endangered species or subspecies whose prospect of survival or recruitment are likely to be in jeopardy in the foreseeable future, and G4 classification are "candidates" and includes those species or subspecies which may be endangered but for which sufficient information is lacking to support being listed (refer to Appendix E).

distribution includes southern San Juan County along with Coconino and Apache Counties in Arizona. Alcove bog-orchid is a native perennial forb that grows in seeps, hanging gardens, and moist stream areas from the desert shrub to the Pinyon Juniper communities. This species is found in New Mexico, Utah, and Arizona at elevations from 4,003 ft to 7,201 ft amsl. Alcove death camas is a native perennial forb that grows in hanging gardens, seeps, and alcoves mostly on the Navajo Sandstone formation. This species is endemic to the Colorado Plateau in southern Utah and northern Arizona at elevations from 3,698 ft to 6,999 ft amsl. Navajo sedge is a native perennial grass-like plant that grows in seeps and hanging gardens primarily on sandstone cliffs and alcoves. Known populations occur at elevations from 4,600 ft to 7,200 ft amsl in San Juan County, Utah, and northern Arizona. Knowlton's cactus is one of the rarest cacti in the US and is known to occur only in a very limited area in San Juan County, New Mexico on alluvial deposits that form rolling-gravelly hills dominated by pinyon, juniper and black sagebrush. Mancos milkvetch is a native perennial forb that grows in small depressions and sand-filled cracks in light colored sandstone on or near ledges and mesa tops in San Juan County, New Mexico and Montezuma County, Colorado from 4,921 ft to 5,905 ft amsl. Mesa Verde cactus is a native cacti that grows in clay-rich soils on the tops of hills, on benches and slopes mostly in saltbush communities with low plant cover and occurs in San Juan County, New Mexico and Montezuma County, Colorado at elevations from 4,898 ft to 5,945 ft amsl.

Before beginning the Site vegetation surveys, Redente reviewed the ecologic and taxonomic information for the T&E species to understand ecological characteristics of the species, habitat requirements, and key taxonomic indicators for proper identification (Arizona Native Plant Society, 2000). Redente also reviewed currently accepted resource agency protocols and guidelines for conducting and reporting botanical inventories for special status plant species (USFWS, 1996). An experienced Redente botanist with local flora knowledge conducted the rare plant survey. The botanist walked transect lines on the Site with emphasis on areas with suitable habitat for the T&E species, specifically alkali seeps, seeps and hanging gardens, small depressions and sand-filled cracks in light colored sandstone on or near ledges and mesa tops, and clay-rich soils.

The Redente botanist did not identify any of the eight T&E species at the Site based on observations he made during the on-site survey. The botanist concluded he did not identify any of the T&E species at the Site because the Site was not a likely habitat for the T&E species. Observed vegetation communities within the Red Wash floodplain/arid riparian area (refer to Section 2.2.4) were stunted woody vegetation, discontinuous saltcedar, rubber rabbitbrush, and sporadic Russian olive. Vegetation communities outside the Red Wash floodplain/arid riparian area were sporadic shrubs and grasses.

Wildlife Survey - In April 2016, Adkins performed a wildlife evaluation survey as part of the Site Clearance field investigations. The completed wildlife survey, including the *NNDFW Biological Resources Compliance Form*, are included in Appendix E and are summarized below.

Adkins performed the survey under a permit issued by NNDFW for the purpose of assessing habitat potential for ESA-listed or NNESL animal species. Adkins biologists with experience identifying local wildlife species led the field survey, which consisted of walking transects 10 ft apart throughout the Site, including a 100-ft buffer beyond the claim boundary. The surrounding areas were visually inspected with binoculars for nests, raptors, or signs of raptor use.

The wildlife evaluation was performed for species listed as NNESL, Federally Endangered, Federally Threatened, or Federal Candidate, and species protected under the Migratory Bird Treaty Act (MBTA) that have the potential to occur on-site. Prior to the start of the wildlife survey, Adkins submitted data requests to USFWS and NNDFW for animal species listed under the ESA. The NNESL species were further classified as G2, G3, or G4. The USFWS included seven ESA-species with the potential to occur in the area of the Site; two birds (southwestern willow flycatcher and western yellow-billed cuckoo), three fish (Colorado pikeminnow, razorback sucker, and Zuni bluehead sucker), and two mammals (Canada lynx and New Mexico meadow jumping mouse). The NNDFW included: four birds (mountain plover [G4], American peregrine falcon [G4], golden eagle [G3], and ferruginous hawk [G3]), one mammal (black footed ferret [USFWS endangered]), and one amphibian (northern leopard frog [G2]). All species on the USFWS list and all species from the NNDFW list, with the exception of the golden eagle, ferruginous hawk, and American peregrine falcon were eliminated from further evaluation because there was no potential for those species to occur on the Site due to lack of suitable habitat. Based on the preparation data, three birds remained as species of concern warranting further analysis during the Site survey: golden eagle, ferruginous hawk, and American peregrine falcon.

In addition, Adkins reviewed species protected under the MBTA that have the potential to occur in the area of the Site. The MBTA review resulted in the potential for identification of 16 bird species in addition to those listed above, known as Priority Birds of Conservation Concern with the Potential to Occur"[5] in the areas of the Site: black-throated sparrow, Brewer's sparrow, gray vireo, loggerhead shrike, mountain bluebird, mourning dove, sage sparrow, sage thrasher, scaled quail, Swainson's hawk, vesper sparrow, bald eagle, Bendire's thrasher, pinyon jay, prairie falcon, and western burrowing owl. These 16 MBTA bird species were added for further analysis during the survey for effects to potential habitat.

The wildlife survey revealed three NNESL species of concern that has the potential to occur within or near the Site based on habitat suitability or actual recorded observation: golden eagle, ferruginous hawk, and American peregrine falcon. Based on these findings Adkins recommended the use of best management practices to protect potential habitat during RSE activities, specifically: (1) confining equipment travel to within the boundaries of the Site; (2) minimizing travel corridors as much as possible; (3) limiting truck and equipment travel within the Site when surfaces are wet and soil may become deeply rutted; and (4) using previously disturbed areas for travel when possible. The recommended best management practices were followed to protect potential habitat during RSE activities.

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[5] USFWS, 2008. Birds of Conservation Concern 2008. United States Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. 85 pp.

3.2.2.4 Cultural Resource Survey

In March 2016, Dinétahdóó conducted a cultural resource survey as part of the Site Clearance field investigations. Navajo Nation Historic Preservation Department (NNHPD) issued a Class B permit to Dinétahdóó on behalf of the Trust to conduct the cultural resource survey. Following the cultural resource survey, the NNHPD issued a Cultural Resources Compliance Form that included a "Notification to Proceed" with RSE field work. A copy of the Cultural Resources Compliance Form is included in Appendix E. According to NNHPD, this form is the equivalent of a "permit" to conduct the work (NNHPD, 2018[6]).

The survey included the areas within the claim boundary and the 100-ft claim boundary buffer, as shown in Figure 2-7. Dinétahdóó did not survey areas on steep terrain due to safety concerns. The survey identified one archaeological site and eight isolated occurrences. For confidentiality reasons, details regarding the archaeological site and isolated occurrences are not provided herein. NNHPD can be contacted for additional information. NNHPD contact information is located on the *Cultural Resource Compliance Form* included in Appendix E.

Based on the survey findings, Dinétahdóó recommended during RSE activities that the boundaries of the archaeological site be flagged and that an archaeologist monitor all ground disturbing activities, including soil sampling, within 50 ft of the archaeological boundaries. Dinétahdóó also stipulated that RSE activities be halted at any time if cultural resources were encountered. Stantec complied with Dinétahdóó's recommendations while conducting RSE activities on–site.

Dinétahdóó also escorted field personnel during: (1) the collection of subsurface soil/sediment samples at the background reference areas (refer to Section 3.3.1.1); and (2) during Site Characterization borehole subsurface soil/sediment sample collection in locations outside the 100-ft buffer (refer to Section 3.3.2.2). The Trust and NNHPD agreed that Dinétahdóó's archeologist would be present because the subsurface sample locations were outside of the area originally surveyed during the Site Clearance cultural resource survey.

3.3 SUMMARY OF REMOVAL SITE EVALUATION ACTIVITIES

The RSE activities consisted of two additional tasks following the Site Clearance Activities: Baseline Studies and Site Characterization activities. The Baseline Studies included a Background Reference Area Study, Site gamma survey, and Gamma Correlation Study. The results of the Baseline Studies were used to plan and prepare the Site Characterization field investigations, which included surface and subsurface soil and sediment sampling. Results of the RSE activities are presented in Section 4.0. Baseline Studies and Site Characterization activities are summarized in Sections 3.3.1 and 3.3.2, respectively.

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[6] Call with Sadie Hoskie, Tamara Billie of NNHPD, and Linda Reeves, June 8, 2018.

3.3.1 Baseline Studies Activities

3.3.1.1 Background Reference Area Study

The Background Reference Area Study activities were completed at the background reference areas selected for the Site. Refer to Section 3.2.2.2 for an explanation of the selection of the background reference areas for the Site. The Background Reference Area Study included a surface gamma survey, static surface and subsurface gamma measurements, surface soil/sediment sampling, and subsurface soil/sediment sampling. The soil/sediment sample locations in the background reference areas were initially selected using a triangular grid, set on a random origin. Where possible, samples were collected at the center points of the triangles. However, in some instances, the actual sample locations had to be moved in the field if sampling was not possible (e.g., the location consisted of exposed bedrock or there was a large bush blocking access). In these cases, the closest accessible location was selected instead.

The background reference areas were selected based on a variety of factors, including *MARSSIM* criteria, which indicated whether the areas were representative of unmined locations, regardless of the sizes of the area. These factors are described in this RSE report and accompanying appendices. The objectives of the background reference area study were to measure gamma radiation levels emitted by naturally occurring, undisturbed uranium-series radionuclides, and concentrations of other naturally occurring constituents. The results were used to establish background gamma levels and concentrations of Ra-226 and specific metals (uranium, arsenic, molybdenum, selenium, and vanadium). The soil/sediment sampling locations at the background reference areas are presented in Figure 3-3. Field personnel performed the Background Reference Area Study in accordance with the *RSE Work Plan,* Sections 4.2, 4.4, and 4.5.

The surface gamma surveys at BG-1 and BG-2 were completed in May 2016 and at BG-3 in May 2017. ERG performed the surface gamma surveys using Ludlum Model 44-10 2-inch by 2-inch sodium iodide (NaI) high-energy gamma detectors (the detectors). Each detector was coupled to a Ludlum Model 2221 ratemeter/scaler that in turn was coupled to a Trimble ProXRT GPS unit with a NOMAD 900 series datalogger. The detector tagged individual gamma measurements with associated geopositions recorded using the Universal Transverse Mercator Zone 12 North coordinate system. ERG matched and calibrated the detector to a National Institute of Standards and Technology-traceable cesium-137 check source, and function-checked the equipment prior-to and after each workday. ERG performed the surveys by walking the background reference areas with the detector carried by hand, along transects that varied depending on encountered topography. The gamma measurements were collected with the height of the detector varying from 1 ft to 2 ft above ground surface (ags) with an average height of 1.5 ft ags to accommodate vegetation, rocks, or other surface features. If field personnel encountered an immovable obstruction (e.g., a tree) during the surface gamma surveys they went around the obstruction. Subsequent to each workday, ERG downloaded the gamma measurements to a computer and secure server.

The same equipment used for the surface gamma surveys was also used to collect static one-minute gamma measurements at the ground surface and down-hole (subsurface) at borehole locations S002-SCX-003 (BG-1) and S002-BG3-011 (BG-3). Surface static gamma measurements were not collected at borehole S002-SCX-004 (BG-2) and only subsurface static gamma measurements were collected. Refer to Appendix C.2 for borehole logs. Static gamma measurements were categorized as surface measurements where they were collected at ground surface (0.0 ft) and as subsurface measurements where depths were below ground surface due to the influence of downhole geometric effects on subsurface static gamma measurements (refer to Section 4.1). Gamma measurements were collected according to the methods described in the *RSE Work Plan,* Section 4.2 and Appendix E.

Soil/sediment samples collected as part of the background study are detailed in Table 3-2 and sample locations are shown in Figure 3-3. Soil/sediment samples were categorized as surface samples where sample depths ranged from 0.0 to 0.5 ft bgs and as subsurface samples where sample depths were greater than 0.5 ft bgs. Field personnel collected the following samples from the background reference areas:

- BG-1 – In October 2016, 11surface soil grab samples were collected from 11 locations and one subsurface soil grab sample was collected from borehole S002-SCX-003.
- BG-2 – In October 2016, 11 surface sediment grab samples were collected from 11 locations and two subsurface sediment composite samples were collected from borehole S002-SCX-004.
- BG-3 – In August 2017, 11 surface soil grab samples were collected from 11 locations. No subsurface soil samples were collected from BG-3. Borehole S002-BG3-011 was attempted one time at BG-3 but the hand auger met refusal on hard sandstone at 0.25 ft bgs. A grab sample was collected from 0 ft to 0.25 ft bgs at borehole S002-BG3-011 but this was categorized as a surface sample.

The lack of subsurface soil samples from BG-3 will not affect the derivation of Ra-226 or metal ILs because the Ra-226 and metals ILs (i.e., surface and subsurface) were based on surface soil samples (refer to Section 4.1). The lack of subsurface samples is identified as a data gap in Section 4.8.

Samples were shipped to a USEPA approved laboratory, ALS Environmental Laboratories in Fort Collins, Colorado for analyses. Samples were collected according to the methods described in the *RSE Work Plan,* Section 3.8.1.1. The results of the surface gamma survey, static surface and subsurface gamma measurements, and surface and subsurface soil/sediment sample analytical results provided background reference data to guide the Site Characterization surface and subsurface soil/sediment sampling (refer to Section 3.3.2). The Background Reference Area Study results are presented in Section 4.1. The ERG survey report in Appendix A provides further details on the gamma surveys. Field forms, including borehole logs, are provided in Appendix C.1 and C.2.

3.3.1.2 Site Gamma Radiation Surveys

Baseline Studies activities included a surface gamma survey of the Site in accordance with the *RSE Work Plan,* Section 4.2 and Appendix E. Approximately 2.8 acres of the mesa sidewall were not surveyed because field personnel were unable to safely access these areas, as shown in Figure 3-4. This is identified as a data gap in Section 4.8. In addition, the dirt track roads on the mesa top were not surveyed due to oversight by field personnel. Only the shoulders of the potential haul road were surveyed, and the centerline was not, due to miscommunication with the field personnel. These items are identified as potential data gaps in Section 4.8.

The surface gamma survey was used to evaluate the extent of potential mining-related impacts or areas containing elevated radionuclides associated with uranium mineralization. In addition, surface and subsurface soil and sediment samples were also collected and used to evaluate mining-related impacts (refer to Section 3.3.2).

In October 2016 and September 2017, the surface gamma survey was performed using the methods and equipment described in Section 3.3.1.1 with the exception that the detector was carried in a backpack when topographical features did not allow field personnel to carry the detector by hand for safety reasons. The surface gamma survey included the claim area, a 100-ft buffer around the claim area, and roads and drainages out to approximately 0.25 miles from the Site. The *RSE Work Plan* specified that the surface gamma survey would be an iterative process where the surface gamma survey would be extended laterally until gamma measurements appeared to be within background levels. Subsequent to each workday, the gamma measurements were evaluated by ERG and Stantec, and compared to the background reference areas to determine if additional surface gamma surveying was needed.

The full areal extent of the surface gamma survey is referred to as the Survey Area, as shown in Figure 3-4. The Survey Area was 18.2 acres and was subdivided into two separate survey areas, as shown in Figure 3-4, based on *MARSSIM* criteria, including different geologic conditions on-site. Survey Area A is within the Quaternary Deposits (based on BG-2), and Survey Area B is within the Morrison Formation (based on BG-3).

BG-3 was selected over BG-1 to represent the Morrison Formation because BG-1 contained surface gamma measurements that were not representative of the mesa top. However, BG-1 does provide a valuable comparison to BG-3 regarding the variation in gamma measurements that may occur in areas that are background and the heterogeneity that is present within the Morrison Formation, so BG-1 is included in this RSE report for discussion purposes (refer to Appendix D.1 and Section 4.2). Gamma survey measurements, soil and sediment sample results, and subsurface static gamma measurements collected from BG-2 and BG-3 were used for the remainder of the RSE for the Site (refer to Section 4.1).

It was necessary to subdivide the Survey Area based on geologic conditions and present the findings in Section 4.0 based on the subdivision, because geologic formations can have different geochemical compositions (i.e., gamma levels and concentrations of Ra-226, uranium, arsenic, molybdenum, selenium, and vanadium). The surface gamma survey results are presented in

Section 4.2. The ERG survey report in Appendix A provides further detailed information on the surface gamma survey.

3.3.1.3 Gamma Correlation Study

Baseline Studies activities included a Gamma Correlation Study in accordance with the *RSE Work Plan,* Section 4.3. The objectives of the Gamma Correlation Study were to determine correlations between the following constituents to use as screening tools for site assessments:

- Gamma measurements (in cpm) and concentrations of Ra-226 in surface soils (in picocuries per gram [pCi/g])
- Gamma measurements (in cpm) and exposure rates (in microRoentgens per hour [µR/hr])

Two regression analyses were conducted for these correlations. The first regression analysis was performed using co-located high-density surface gamma measurements and laboratory concentrations of Ra-226 in surface soil/sediment to develop a correlation equation (refer to Section 4.2.2). The correlation equation allows for Ra-226 concentrations in soil and sediment to be estimated (predicted) based on gamma measurements in the field.

This correlation equation was not used in the field to estimate Ra-226 concentrations or to evaluate the extent of Ra-226 concentrations. The correlation was used to develop a site-specific prediction for Ra-226 concentrations from the actual gamma survey data, as presented in Section 4.2.2. The correlation can be used as a site-specific field screening tool during site assessments, using the same gamma survey methods as in this RSE (e.g., walkover gamma survey) and based on site-specific conditions. The data related to the correlations are provided in Appendices A and C.

The second regression analysis was performed using co-located static one-minute gamma measurements and exposure rates to develop an exposure-rate correlation equation. Exposure rates can be predicted, based on gamma measurements, using the developed exposure-rate correlation equation. The exposure rate correlation also provides a standard by which future gamma measurements can be compared to previous gamma measurements, if those previous gamma measurements were also correlated with exposure. In addition, exposure rates can be used to provide an estimate of gamma radiation levels when an exposure meter is used as a health and safety tool for field personnel working on-site. The exposure rate correlation was not used for Site Characterization. Because the exposure rates are not part of the data analyses for the RSE report, a summary of the exposure rate correlation is not presented in this report. Appendix A provides a discussion of the correlations and the regression equations for both correlations.

In October 2016, field personnel identified five areas for the Gamma Correlation Study, as shown in Figure 3-5, by considering the results of the Site surface gamma survey (described in Section 3.3.1.2), field conditions (e.g., suitable terrain), and feasibility of sampling. To minimize variability when determining a correlation between gamma measurements (in cpm) and concentrations of Ra-226 in soil/sediment, the study area soil/sediment must: (1) represent a specific gamma measurement within the range of gamma measurements collected at the Survey Area; and (2) be as homogenous as possible with respect to soil/sediment type, and gamma measurement within the correlation area. At each area, field personnel completed a high-density surface gamma survey (intended to cover 100 percent of the survey area) and collected one five-point composite surface soil/sediment sample per area (refer to Table 3-2). Field personnel made a field modification from the *RSE Work Plan* by adjusting the size of the 900 ft^2 area smaller at four of the Gamma Correlation Study locations and larger at one of the Gamma Correlation Study locations, to minimize the variability of gamma measurements observed. The area used for the Gamma Correlation Study is shown in Figure 3-5, where the box shown at the five study locations represents a 900 ft^2 area in comparison to the actual area covered for the study, as shown by the extent of the gamma measurements within each area.

Field personnel collected, logged, classified, packaged, and shipped the samples in accordance with the *RSE Work Plan,* Sections 4.4, 4.9, 4.11, and Appendix E. Soil/sediment samples were collected for analyses of Ra-226 and isotopic thorium, as described in the *RSE Work Plan,* Section 3.4.1.

The objectives of the thorium analyses were for site characterization and evaluation of potential effects of thorium on the correlation. The data can be used to assess the potential effects of thorium-232 (Th-232) series radioisotopes on the correlation of gamma measurements to concentrations of Ra-226 in surface soils (i.e., if gamma-emitting radioisotopes in the Th-232 series, such as actinium-228, lead-212, and thallium-208, are impacting gamma measurements at the Site), as discussed in Section 4.2.2. Uranium, radium, and thorium occur in three natural decay series (uranium-238 [U-238], Th-232, and U-235), each of which include significant gamma emitters (USEPA, 2007b). Therefore, in order to develop a correlation between gamma radiation and Ra-226 concentrations, the gamma radiation from each significant decay series present at the Site, may need to be considered. Typically, only U-238, and sometimes Th-232, are present in significant quantities. The contribution from the U-235 decay series to gamma measurements can be excluded because U-235 is only approximately 0.72 percent of the total uranium concentration. If the Th-232 decay series is present in significant quantities, it should be accounted for in the correlation to accurately predict Ra-226 concentrations based on all significant sources of gamma radiation.

3.3.1.4 Secular Equilibrium

The Gamma Correlation Study soil/sediment samples (refer to Section 3.3.1.3) were also analyzed for thorium-230 (Th-230), in accordance with the *RSE Work Plan,* Section 3.4.1. The activities of Th-230 and Ra-226 can be compared to evaluate the status of secular equilibrium within the U-238 decay series (USEPA, 2007b). The U-238 decay series is in secular equilibrium when the radioactivity of a parent radionuclide (e.g., U-238) is equal to its decay products (refer to Appendix A). If the U-238 decay series is out of secular equilibrium, the quantities of the daughter products become depleted. This could be considered for potential site assessments (e.g., when evaluating the contribution of the daughter products to the total risk related to U-238 during a human health and/or ecological risk assessment). As part of the RSE, the secular equilibrium evaluation was a general indicator (e.g., screening level assessment) of the status of equilibrium at the sites. It was not used to characterize the extent of constituents of potential concern (COPCs) at the Site. The secular equilibrium evaluation is discussed here only because Th-230 was included in the isotopic thorium analysis.

3.3.2 Site Characterization Activities and Assessment

3.3.2.1 Surface Soil and Sediment Sampling

Site Characterization activities included surface soil and sediment sampling and associated laboratory analyses. The soil and sediment surface sampling locations within the Survey Area were selected based on professional judgment (i.e., non-randomly) to evaluate concentrations of Ra-226 and metals in relation to the surface gamma survey measurements and site features (e.g., historical mining features and geologic features). Based on the surface gamma survey results and site features, a limited number of samples were collected and analyzed where the gamma survey measurements were within background levels, mining and or exploration-related features were not present, and no ground disturbance was observed. The results were compared to the site-specific ILs and published regional concentrations to support the overall evaluation of potential mining impacts (refer to Section 4.3). Soil/sediment samples were categorized as surface samples where sample depths ranged from 0.0 to 0.5 ft bgs and as subsurface samples where sample depths were greater than 0.5 ft bgs. Samples collected in drainages were classified as sediment samples.

In October 2016 and May and September 2017, samples were collected from the locations shown in Figure 3-6a and are summarized in Table 3-2. Sample locations and the locations of mining-related features are shown in Figure 3-6b. The numbers of surface samples collected within specific mine features are listed in Table 3-3. Twenty-five surface soil/sediment grab samples were collected from 25 locations in the Survey Area (five from Survey Area A and 20 from Survey Area B). Field personnel collected, logged, classified, packaged, and shipped the samples in accordance with the *RSE Work Plan,* Sections 4.4, 4.9, 4.11, and Appendix E. Samples were shipped to ALS Environmental Laboratories in Fort Collins, Colorado for analyses of: Ra-226, uranium, arsenic, molybdenum, selenium, and vanadium, as described in the *RSE Work Plan,* Section 4.13.1. The surface soil and sediment analytical results are presented in Section 4.3. Field forms are provided in Appendix C.1 and the laboratory analytical data, data validation reports, and Data Usability Report for the analyses are provided in Appendix F.

3.3.2.2 Subsurface Soil and Sediment Sampling

Site Characterization activities included subsurface soil and sediment sampling and associated laboratory analyses. Similar to the surface soil/sediment sampling discussed in Section 3.3.2.1, subsurface sampling locations were selected based on professional judgment (i.e., non-randomly) to evaluate concentrations of Ra-226 and metals in relation to the surface gamma survey measurements and site features (e.g., historical mining features and geologic features). Grab samples were collected with the intent to characterize specific intervals of interest (e.g., material within zones with elevated static gamma measurements). Composite samples were collected to provide a screening level assessment across an interval (e.g., where elevated gamma measurements were observed). Surface and subsurface static gamma measurements were collected in the borehole using the same equipment as described in Section 3.3.1.1. Static gamma measurements were collected by holding the detector in the borehole for a one-minute integrated count and are not comparable to the surface gamma survey measurements, which were collected as a walkover survey.

Thirteen boreholes were advanced in the Survey Area through the unconsolidated deposits (from 0.5 ft to 3.4 ft bgs; refer to Table 3-2 and Appendix C.2) until: (1) refusal at bedrock/hard surface; (2) subsurface static gamma measurements were below initial background levels; (3) consistently low subsurface static gamma measurements (the use of this criterion was a field error and has been identified as a potential data gap in Section 4.8); or (4) caving sands. Field personnel manually advanced the subsurface boreholes to a desired sample depth by using a 3-inch diameter hand auger. The boreholes were advanced through variable amounts of silt, sand, and gravel (refer to Appendix C.2 for borehole information). Subsurface sampling was limited in some areas on the mesa sidewall due to: (1) unsafe terrain; and (2) the waste piles were comprised of a mix of boulders, cobbles, gravels, and sands and using a hand auger was limited by the volume of boulders and cobbles present. A drill rig was not employed at the Site because the primary areas of Site disturbance were on the mesa sidewall (inaccessible to a drill rig) and on the mesa top where exposed bedrock was prevalent and soil/sediment depths were estimated to be shallow.

In October 2016 and May and September 2017, samples were collected from the locations shown in Figure 3-6a and are summarized in Table 3-2. Sample locations and the locations of mining-related features are shown in Figure 3-6b. The numbers of subsurface samples collected within specific mine features are listed in Table 3-3. Nine subsurface soil/sediment samples were collected from six borehole locations in the Survey Area (multiple subsurface samples were collected from multiple boreholes). One subsurface sample was collected from Survey Area A and eight from Survey Area B. Soil samples were not collected from every borehole location, per the *RSE Work Plan*, where samples were not required or intended to be collected at every subsurface borehole location. Soil samples were not collected at borehole S002-SCX-009 because field personnel encountered saturated and caving sands when advancing the hand auger downhole and the borehole was terminated at 0.5 ft bgs (refer to Appendix C.2). Field observations (e.g., depth to bedrock, etc.) from the borehole were used in Section 4.0 to evaluate the physical conditions of the subsurface.

Field personnel logged, classified, packaged, and shipped the samples in accordance with the *RSE Work Plan,* Sections 4.5, 4.9, 4.11, and Appendix E. Samples were shipped to ALS Environmental Laboratories in Fort Collins, Colorado for analyses of Ra-226, uranium, arsenic, molybdenum, selenium, and vanadium, as described in the *RSE Work Plan,* Section 4.13.1. The subsurface analytical results are presented in Section 4.3. Field forms, including borehole logs showing static gamma measurements and Ra-226 analytical results, are provided in Appendix C.2. The laboratory analytical data, data validation reports, and Data Usability Report for the analyses are provided in Appendix F.

3.3.2.3 Water Sampling

According to the *RSE Work Plan*, Site Characterization activities were to include surface water sampling, and associated laboratory analyses, of perennial water features identified during the Site Clearance desktop study (refer to Section 3.2.1). Per the *RSE Work Plan*, if well water or surface water sample analyte concentrations are above the established ILs then those sample areas would be considered for additional characterization in the future. From the desktop study and site mapping, four surface water features were identified, and their locations are shown in Figure 2-1. The four identified surface water features were not sampled for the following reasons. The minor seeps were not sampled because the volume of water seeping from in-between the sandstone beds was not sufficient enough to pool for water sample collection. Red Wash, Blackrock Wash, and Oak Springs Wash only contain flowing surface water following storm events and do not regularly contain water. Therefore, surface water from Red Wash, Blackrock Wash, and Oak Springs Wash were not sampled as part of the Site Characterization activities in accordance with the requirements of the *Trust Agreement* and *Scope of Work*, which only require sampling of perennial water features. The water features and field personnel observations are also included in Table 3-1.

3.3.3 Identification of TENORM Areas

Areas at the Site where TENORM is present were identified using multiple lines of evidence including:

1. Historical Data Review
    a. Aerial photographs
    b. USAEC records
    c. Reclamation records
    d. Other documents relevant to the Site, including those in the *2007 AUM Atlas*
    e. Interviews with residents living closest to the Site (for those sites where residents were available for interview)
    f. Consultation and site visits with NAML staff to identify reclamation features (for those sites reclaimed by NAML)
2. Geology/Geomorphology
    a. Hydrology/transport pathways with drainage delineation
    b. Site-specific geologic mapping including areas of mineralization
    c. Topography

3. Disturbance Mapping
    a. Exploration
    b. Mining
    c. Reclamation
4. Site Characterization
    a. Surface gamma surveys and subsurface static gamma measurements
    b. Soil/sediment sampling and analyses

Any areas where TENORM was not observed are considered to contain NORM, because soil and/or rock at the Site contain some amount of natural uranium and its daughter products. This area was mined because of the high levels of naturally occurring uranium ore. The areas containing NORM and/or TENORM are presented in Section 4.6. The volume of TENORM is presented in Section 4.7. The areas containing NORM and/or TENORM, along with additional findings of the RSE report, are identified to support future Removal or Remedial Action evaluations at the Site.

3.4 DATA MANAGEMENT AND DATA QUALITY ASSESSMENT

This section summarizes the data management and data quality assessment activities performed for the RSE.

3.4.1 Data Management

The DMP included in the *RSE Work Plan* describes the plan for the generation, validation, and distribution of project data deliverables. Successful data management comes from coordinating data collection, quality control, storage, access, reduction, evaluation, and reporting. A summary of the data management activities performed as part of the RSE process included:

- **Database** – Field-collected and laboratory analytical RSE data were stored in an Oracle SQL relational database, which increased data handling efficiency by using previously developed data entry, validation, and reporting tools. The Oracle SQL database was also used to export project data to a tabular format that can be used in a spreadsheet (e.g., Excel) and to the USEPA Scribe database format.

- **Scribe** – The Stantec Data Manager/Data Administrator was responsible for meeting the project data transfer requirements from the Oracle SQL database to Scribe, which is a software tool developed by the USEPA's Environmental Response Team to assist in the process of managing environmental data. Stantec maintained an Oracle SQL database and exported data from the Oracle SQL database to a Scribe compatible format following completion of each field investigation phase. Custom data queries and "crosswalk" export routines were built in Oracle SQL, to facilitate data export to the Scribe database format with the required frequency.

- **Geographic Information System (GIS)** – Spatial data collected during the RSE (e.g., sample locations and gamma measurements) were stored in a dedicated File Geodatabase for use in the project GIS. The geodatabase format enforces data integrity, version control, file size compression, and ease of sharing to preserve GIS output quality. Periodic geodatabase backups were performed to identify accidentally deleted or otherwise corrupt information that were then repaired or recovered, if applicable.

3.4.2 Data Quality Assessment

The QAPP, included in the *RSE Work Plan*, Appendix B, was followed for RSE data quality assessment, where the QAPP presents QA/QC requirements designed to meet the RSE DQOs. Data quality refers to the level of reliability associated with a particular data set or data point. The Data Usability Report included in Appendix F.1 provides a summary of the data quality assessment activities and qualified data for the RSE. A summary of findings, from the data quality assessment, are included below.

- **Data Verification** – The data were verified to confirm that standard operating procedures (SOPs) specified in the *RSE Work Plan* and *FSP* were followed and that the measurement systems were performed in accordance with the criteria specified in the QAPP. Any deviations or modifications from the *RSE Work Plan* are described in the appropriate RSE report sections. The USEPA definition (USEPA, 2002) for data verification is provided in the glossary.

- **Data Validation** – The data were validated to confirm that the results of data collection activities support the objectives of the RSE as documented in the QAPP. The data quality assessment process was then applied using the validated data and determined that the quality of the data satisfies the intended use. The USEPA definition (USEPA, 2002b) for data validation is provided in the glossary. A copy of the Data Usability Report is included in Appendix F.1 and a summary of the validation results is presented below:

    - **Precision** Based on the matrix spike/matrix spike duplicate (MS/MSD) sample, laboratory control sample/laboratory control sample duplicate (LCS/LCSD) sample, laboratory duplicate sample, and field duplicate results, the data are precise as qualified.

    - **Accuracy** Based on the initial calibration (ICAL), initial calibration verification (ICV), continuing calibration verification (CCV), MS/MSD, and LCS, the data are accurate as qualified.

    - **Representativeness** Based on the results of the sample preservation and holding time evaluation, the method and initial/continuing calibration blank (ICB/CCB) sample results, the field duplicate sample evaluation, and the reporting limit evaluation, the data are considered representative of the Site as reported.

- **Completeness** All media and QC sample results were valid and collected as scheduled (i.e., as planned in the *RSE Work Plan*); therefore, completeness for these is 100 percent.

- **Comparability** Standard methods of sample collection and standard units of measure were used during this project. The analyses performed by the laboratory were in accordance with current USEPA methodology and the QAPP.

Based on the results of the data validation, all data are considered valid as qualified.

4.0 FINDINGS AND DISCUSSION

4.1 BACKGROUND REFERENCE AREA STUDY RESULTS AND CALCULATION OF INVESTIGATION LEVELS

The results of the background reference area surface gamma survey are shown in Figures 4-1a through 4-1c with sample locations in the background reference areas shown on Figures 4-1b and 4-1c. The surface gamma survey in BG-1 did not cover the areal extent of the sample locations. Analytical results of the samples collected from BG-1, BG-2, and BG-3 are summarized in Table 4-1. The gamma measurements and surface soil sample analytical results collected from BG-2 and BG-3 were evaluated statistically to calculate ILs (refer to Appendix D.2) for each corresponding Survey Area (i.e., Survey Area A and Survey Area B, respectively). Background reference area BG-1 contained surface gamma measurements that were not representative of the mesa top (Appendix D.1) and therefore was not used for ILs. The ILs based on BG-1 are presented in (Appendix D.2) for comparison only. As previously discussed in Section 3.3.1.2, the Site was subdivided into two separate Survey Areas based on the geologic formations on-site.

Statistical evaluation of the gamma measurements and soil sample analytical results included identifying potential outlier values, interpreting boxplots and probability plots, comparing group means between the background reference areas and the respective Survey Area data, and calculating descriptive statistics for each of the background reference areas. The descriptive statistics included the 95 percent upper confidence limit (UCL) on the mean gamma measurements and Ra-226/metals concentrations, and the 95-95 upper tolerance limits (UTLs). The data were analyzed using R statistical programming packages and ProUCL 5.1 software (USEPA, 2016).

The DQOs presented in the RSE Work Plan indicate that the ILs would be developed using the 95 percent UCL on the mean of the background sample results. However, the 95-95 UTL was used as the basis for the ILs instead because it better reflects the natural variability in the background data and lends itself to single-point comparisons to the Survey Area data. This was a change from the *RSE Work Plan*, as agreed upon with the Agencies, prior to the Change. The UTL represents a 95 percent UCL for the 95th percentile of a background dataset whereby Survey Area results above this value are not considered representative of background conditions. The UTL is a statistical parameter for the entire population of the variable, whereas the actual results are from a sample of the population. UTLs were calculated in accordance with USEPA's *ProUCL 5.1 Technical Guidance*, Sections 3.4 and 5.3.3 (USEPA, 2015). Appendix D.2 presents a comprehensive discussion on the derivation of the ILs for the Site, which are presented below. The *RSE Work Plan* also stated that gamma radiation measurements from the background surface and subsurface soil would be combined to develop the IL for surface gamma radiation at the Site. However, the surface gamma radiation ILs were instead developed from the surface gamma survey data only. The Agencies have commented that this should be noted as a deviation from the *RSE Work Plan*. The subsurface static gamma measurements were excluded from the derivation of the surface gamma IL for two reasons: (1) they were collected using a different method (static one-minute measurements versus a walkover gamma survey); and (2) because of the downhole geometric effects that influence subsurface static gamma measurements (refer to the discussion of geometric effects below).

The ILs for Survey Area A (i.e., the Quaternary Deposits; refer to Figures 2-6a, 2-6b, and 3-4) were established using statistical analysis of background data collected from BG-2 (refer to Figures 3-3 and 3-4 and Appendix D.2 Tables 4 and 5) and are as follows:

- Arsenic – 1.33 milligrams per kilogram (mg/kg)
- Molybdenum – an IL for molybdenum was not identified because molybdenum sample results in BG-2 were all non-detect
- Selenium – an IL for selenium was not identified because selenium sample results in BG-2 were all non-detect
- Uranium – 0.537 mg/kg
- Vanadium – 8.37 mg/kg
- Ra-226 – 0.944 pCi/g
- Surface gamma measurements – 13,088 cpm

The ILs for Survey Area B (i.e., the Morrison Formation; refer to Figures 2-6a, 2-6b, and 3-4) were established using statistical analysis of background data collected from BG-3 (refer to Figures 3-3 and 3-4 and Appendix D.2 Tables 4 and 5) and are as follows:

- Arsenic – 4.33 mg/kg
- Molybdenum – an IL for molybdenum was not identified because molybdenum sample results in BG-3 were all non-detect except for one sample
- Selenium – an IL for selenium was not identified because selenium sample results in BG-3 were all non-detect
- Uranium – 5.46 mg/kg
- Vanadium – 11.8 mg/kg
- Ra-226 – 4.48 pCi/g
- Surface gamma measurements – 11,686 cpm

No subsurface sample was collected at BG-3 due to hand auger refusal at 0.25 ft bgs (refer to Section 3.3.1.1). The lack of subsurface soil samples from BG-3 did not affect the derivation of Ra-226, metal, or surface gamma ILs because the ILs were based on surface samples/measurements.

It is important to note that comparisons to the IL (i.e., 1.5 times the IL) are provided for context, and evaluations of: (1) areas of the Site; (2) samples or; (3) TENORM that exceed the ILs, which are based on the statistically derived IL values.

In addition to the surface gamma survey performed in the background reference areas, subsurface static gamma measurements were collected in the boreholes completed in the background reference areas to establish subsurface static gamma screening levels for Survey Area A and Survey Area B. Where possible, the selected subsurface static gamma screening level value met the following criteria: (1) it was the lowest value measured at or below 1 ft bgs and (2) it was not directly measured on bedrock. These subsurface static gamma screening levels provide a comparison and assessment tool for Survey Areas A and B, and are included as ILs for the Site.

However, it is important to consider that the subsurface static gamma IL is based on a single measurement, and it is not statistically derived. For this reason, subsurface static gamma IL exceedances should be considered in conjunction with additional lines of evidence including: (1) down-hole trends of static gamma measurements; (2) changes in lithology within the borehole; and (3) a qualitative comparison of subsurface static gamma measurements to Ra-226 and/or metals concentrations in subsurface samples.

Subsurface static gamma measurements from the background reference areas are summarized in Table 4-2 and in Appendix C.2. Subsurface static gamma measurements used to identify subsurface static gamma ILs were as follows:

- Survey Area A – Six subsurface static gamma measurements of 13,019, 14,615, 15,300, 15,071, 14,335 and 13,809 cpm were collected from BG-2 borehole S002-SCX-004 at down-hole depths of 0.5, 1.0, 1.5, 2.0, 2.5, and 2.7 ft bgs, respectively. The lowest measured value (13,809 cpm) was measured at the borehole termination depth (2.7 ft bgs); because the borehole termination was not on bedrock, 13,809 cpm was selected as the subsurface static gamma IL for Survey Area A.

- Survey Area B – One subsurface static gamma measurement of 10,370 cpm was collected from BG-3 borehole S002-BG3-011 at the down-hole refusal depth of 0.3 ft bgs, and therefore, 10,370 cpm is considered the subsurface static gamma IL for Survey Area B. Note that refusal in S002-BG3-011 was confirmed to be on bedrock (i.e., Morrison Formation) and therefore, this subsurface static gamma measurement may be elevated, as a result of the close proximity to bedrock, with naturally elevated concentrations of radionuclides.

It is important to consider that the subsurface static gamma IL measurements may be elevated relative to the surface gamma IL because increases in static gamma measurements with depth can result from the detector being in closer proximity to bedrock that has naturally elevated concentrations of radionuclides, and/or geometric effects. Geometric effects are the result of the detector measuring gamma radiation from all directions, regardless of whether it is in a borehole or suspended in air. Gamma radiation measured with the detector held at the ground surface is primarily from the ground beneath the detector. As the detector is advanced down the borehole it measures gamma radiation from the surrounding material emanating from an increasing number of angles. Therefore, as the detector is lowered in the borehole it will generally measure increasingly higher values to a certain depth given a constant source. At approximately 1ft to 2 ft bgs, the detector is essentially surrounded by solid ground and further increases related to borehole geometry are not expected. Because downhole geometric effects influence static gamma measurements just below ground surface, static gamma measurements collected at or greater than 0.1 ft bgs are considered subsurface.

Due to the differing geometric effects, surface static gamma measurements at borehole locations may only be qualitatively compared to subsurface static gamma measurements, and the subsurface static gamma IL does not apply to the surface static gamma measurements. Instances where the surface static gamma measurement is greater than subsurface static gamma measurements suggest higher levels of radionuclides and may be indicative of the presence of TENORM at the surface, but additional lines of evidence are generally needed to support that conclusion.

The Site gamma measurements, and soil and sediment sample analytical results were compared to their respective ILs to confirm COPCs (refer to Section 4.4) and to identify areas of the Site where ILs are exceeded (refer to Section 4.5). The calculated ILs provide a line of evidence to evaluate potential mining-related impacts, and to support future Removal or Remedial Action evaluations at the Site.

4.2 SITE GAMMA RADIATION SURVEY RESULTS AND PREDICTED RADIUM-226 CONCENTRATIONS

4.2.1 Site Gamma Radiation Results

4.2.1.1 Surface Gamma Survey

Results of the Site surface gamma survey are shown in Figure 4-1a where the calculated surface gamma ILs for each background reference area are used to set bin ranges with color coding to illustrate the spatial extent and patterns of surface gamma measurements within the entire Survey Area. The maximum survey measurement was 115,161 cpm, which was greater than eight times the maximum IL (i.e., BG-2 IL of 13,088 cpm), and occurred in an area approximately coincident with Portal-1 and Waste Pile 2 (refer to Figure 2-7 alongside Figure 4-1a).

Surface gamma measurements were generally highest in three areas: (1) portions of the Survey Area located on the mesa top; (2) the vertical cliffs and/or steep colluvium–covered bedrock slope of the mesa sidewall that are coincident with Portals-1 and -2, and associated Waste Piles 1 and 2; and (3) the flood plain and wash adjacent to the Waste Piles 1 and 2. These areas are shown in Appendix B photograph numbers 1, 2, 3, 4, 6, 7, 8, 10, and 11.

The spatial distribution of surface gamma measurements and IL exceedances are shown in Figures 4-1b and 4-1c for Survey Areas A and B, respectively, and are described below:

- Survey Area A (refer to Figure 4-1b) – Surface gamma IL exceedances (greater than 13,088 cpm) occurred primarily in areas downgradient from Portals-1, Portal-2, and Waste Piles 1 and 2.

- Survey Area B (refer to Figure 4-1c) – Surface gamma IL exceedances (greater than 11,686 cpm) occurred in portions of the Survey Area located on the mesa top and the vertical cliffs and/or steep colluvium–covered bedrock slope of the mesa sidewall that are coincident with Portals-1 and -2, and associated Waste Piles 1 and 2. The location of one area of the elevated gamma measurements is shown in Appendix B, photograph number 10.

Of note, the outcrop with elevated gamma measurements shown in Appendix B, photograph number 10 is not shown as an area exceeding the BG-3 IL in Figure 4-1c. During general site reconnaissance, field personnel spot-checked locations using a gamma meter and identified the weathered portion of the bedrock outcrop as having elevated gamma measurements compared to adjacent areas, including the shaley sandstone underlying the upper sandstone at the top of the outcrop (i.e., gamma measurements were lower in the upper sandstone). Subsequently, the walkover gamma survey was performed, and equivalent elevated gamma measurements in the area were not measured. During the walkover gamma survey, it is possible that the individual transects may not have revisited the precise location measured during general site reconnaissance and/or the elevated measurements from the weathered bedrock near the ground surface were shielded from the meter by overhanging bedrock.

Survey Area B is also compared to the BG-1 surface gamma survey IL-of 16,235 cpm (refer to Figure 4-1c, Appendix D.1, and Table D.1-2). As presented in Appendix D.1, the BG-1 IL is also representative of the mesa sidewall and may be used in conjunction with the BG-3 surface gamma survey IL to distinguish mining-related impacts in the area of the potential rim strip (i.e., gamma measurements in the area of the potential rim strip exceed the BG-3 IL, but do not exceed the BG-1 IL). However, gamma measurements in areas outside of the portals, waste piles, and potential rim strip area were generally less than the BG-3 IL, and the BG-3 IL was adequate for delineating mining-related impacts (refer to Appendix D.1). In addition, the BG-1 IL may be of use for comparison purposes in the future if areas of the mesa sidewall that were inaccessible to gamma surveying on foot during this RSE, are surveyed using remote techniques, and it is identified that gamma measurements in areas of NORM generally exceed the BG-3 IL.

Four potential data gaps were identified for the surface gamma survey, as listed below and described above:

1. Gamma survey measurements were within 1,000 cpm of the IL, but were not below the IL, along portions of the northern, eastern, and southern boundaries of Survey Area B due to field personnel oversight.

2. The gamma survey did not include 2.8 acres of the mesa sidewall because field personnel were unable to safely access this area, refer to Figure 3-4.

3. Only the shoulders of the potential haul road were surveyed, and the centerline was not surveyed due to a miscommunication with the field team.

4. The dirt track roads on the mesa top were not gamma surveyed due to oversight by field personnel.

4.2.1.2 Subsurface Gamma Survey

Surface and subsurface static gamma measurements were collected at all 13 borehole locations and surface static gamma measurements were collected at 11 of the 13 borehole locations. Surface and subsurface static gamma measurement locations are shown in Figures 4-1b and 4-1c. Measurements and corresponding measurement depths are provided in Table 4-2 and are shown on the borehole logs in Appendix C.2. Surface and subsurface static gamma measurements from the boreholes are presented below by Survey Area:

- Survey Area A – Three boreholes were completed in Survey Area A. The maximum subsurface measurement (15,793 cpm) was measured at a depth of 1.0 ft bgs in borehole S002-SCX-008, which was located in the wash west of Waste Pile 2. In general, static gamma measurements increased with depth in the two boreholes where more than one measurement was collected, and then decreased at the refusal depth.

- Survey Area B – Ten boreholes were completed in Survey Area B. Subsurface static gamma measurements exceeded the Survey Area B IL of 10,370 cpm in 9 of 11 boreholes. The subsurface static gamma IL was not exceeded in borehole S002-SCX-012, which was located on the mesa top and was the farthest east sample location. The maximum subsurface static gamma measurement (46,259 cpm) was at a depth of 1.0 ft bgs in borehole S002-SCX-002, which was located downslope from Waste Pile 2. Exceedances in the remaining boreholes were less than two times the subsurface static gamma IL with the exception of three locations on the mesa top (S002-SCX-006, -SCX-014, -SCX-015) where subsurface static gamma measurements were up to three times the IL. Excluding surface static gamma measurements, two boreholes (S002-SCX-005 and S002-SCX-010) had overall increases in static gamma measurements with depth, one borehole (S002-SCX-006) initially increased with depth and then decreased further down-hole, and two boreholes (S002-SCX-002 and S002-SCX-007) had variable static gamma measurements with depth.

4.2.2 Gamma Correlation Results

The high-density surface gamma measurements and concentrations of Ra-226 in surface soils obtained from the Gamma Correlation Study (refer to Section 3.3.1.3) were used to develop a correlation equation, using regression analysis, between the mean gamma measurements and Ra-226 concentrations measured in the co-located composite surface soil samples. This correlation is meant to be used as a general screening tool and provides approximate predicted Ra-226 concentrations.

Analytical results of the correlation samples, which were used to develop the correlation equation, are presented in Table 4-3. The mean value of the gamma survey results from the correlation plots, with their corresponding Ra-226 concentrations and a graph showing the linear regression line and adjusted Pearson's Correlation Coefficient (R^2) value for the correlation, are shown in Figure 4-2a. The regression produced an adjusted R^2 value of 0.99 which is within the acceptance criterion of 0.8 to 1.0 described in the *RSE Work Plan* and indicates that surface gamma results correlate with Ra-226 concentrations in soil. The correlation model may have been influenced by the limited number of correlation sample locations. Users of the regression equation should be aware of the limitations of the dataset and be cautious when estimating radium-226 concentrations. The correlation equation to convert gamma measurements in cpm to predicted surface soil Ra-226 concentrations in pCi/g for the Site is:

$$\text{Gamma (cpm)} = 1{,}612 \times \text{Surface Soil Ra-226 (pCi/g)} + 11{,}380$$

The predicted Ra-226 concentrations in soil, as calculated from the gamma measurements using the developed correlation equation, are shown in Figure 4-2a. Ra-226 concentrations predicted using gamma measurements lower than the minimum (11,319 cpm) and greater than the maximum (47,000 cpm) mean gamma measurements from the Gamma Correlation Study are extrapolated from the regression model and are therefore uncertain. Using the correlation equation, the predicted Ra-226 concentration associated with the minimum mean gamma measurement is -0.04 pCi/g and the concentration associated with the maximum mean gamma measurement is 22.0 pCi/g. Therefore, predicted Ra-226 concentrations less than -0.4 pCi/g and greater than 22.0 pCi/g should be limited to qualitative use only. The correlation locations were intentionally selected to be focused on the lower range of gamma measurements observed at the Site. Mean gamma measurements for correlation locations ranged from 11,319 to 46,805 cpm. The correlation was focused on the lower range because future Removal or Remedial Action decisions are more critical at lower Ra-226 concentrations where the limits of remediation may be defined.

The correlation equation predicted Ra-226 concentrations that were less than zero for gamma survey measurements below 11,380 cpm. The predicted concentrations are shown in Figure 4-2a and the values less than zero are widely distributed throughout the majority of the Site. The elevated predicted Ra-226 concentrations shown in Figure 4-2a occur in the same areas where the elevated surface gamma measurements occur (refer to Section 4.2.1). This is because the predicted Ra-226 concentrations are based on a correlation with the gamma measurements. Predicted Ra-226 concentrations in the Survey Area range from -2.7 to 64.4 pCi/g, with a mean of 0.3 pCi/g, and a standard deviation, of 3.8 pCi/g. Bin ranges in Figure 4-2a are based on these mean and standard deviation values.

The gamma correlation was not used for the Site Characterization, which instead relied on actual gamma radiation measurements and soil analytical results. However, predicted Ra-226 concentrations were compared to the Ra-226 laboratory concentrations measured in surface soil samples collected at surface and borehole locations, as shown in Figure 4-2b. The correlation results were also compared to investigation levels, as shown in Figure 4-2c. Per the Agencies, these comparisons can be used for site characterization and are one of many analyses that can be used to interpret the data (NNEPA, 2018).

When comparing the predicted Ra-226 concentrations to the Ra-226 laboratory concentrations, soil/sediment sample locations are generally not co-located with specific gamma measurement locations (refer to Figure 4-2b). Therefore, the measured Ra-226 laboratory concentrations can only be qualitatively compared to the nearby predicted Ra-226 concentrations. The measured

Ra-226 laboratory concentrations were within the applicable predicted Ra-226 bin ranges for 11 of the 25 sample locations. In 12 of the 14 sample locations where the predicted Ra-226 concentration and the Ra-226 concentration detected in the soil/sediment sample did not agree, the predicted concentration was lower than the reported laboratory concentration and the remaining two sample locations (S002-CX-003 and -SCX-009), both located just downgradient of WP-2, had predicted Ra-226 concentrations that were higher than the Ra-226 concentrations detected in the nearby soil samples. The majority of these 14 sample locations had predicted Ra-226 concentrations that were within one standard deviation (3.8 pCi/g) of the Ra-226 laboratory concentrations, however three sample locations (S002-CX-003, -CX-009 and -SCX-002) had notable differences with more than two standard deviations (greater than 7.6 pCi/g) between the predicted and laboratory Ra-226 concentrations. The differences observed between the predicted and actual Ra-226 values are likely a function of the natural heterogeneity in Ra-226 concentrations and gamma radiation measurements, which affects the correlation based on the five Gamma Correlation Study areas, and the predicted values, based on the subsequent gamma measurements. However, the correlation may be useful as a screening tool as it provides a representative estimate of Ra-226 concentrations across the Site similar to the actual results.

The predicted Ra-226 concentrations were also compared to the Ra-226 ILs from each Survey Area, as shown in Figure 4-2c. The symbols for surface sample locations and boreholes where Ra-226 concentrations in surface soil/sediment samples exceeded the IL are highlighted with yellow halos. The predicted Ra-226 concentrations did not exceed the Ra-226 ILs for the majority of the Survey Area. In addition, with the exception of two soil samples located on the mesa top (S002-CX-009 and -SCX-015), and one sample located in the wash at the base of the mesa sidewall (S002-SCX-011), Ra-226 laboratory concentrations that exceeded the ILs generally occurred in the same areas where the predicted Ra-226 concentrations exceeded the ILs. The area of the Site where predicted Ra-226 values exceeded the ILs is compared to surface gamma IL exceedances in the surface gamma survey in Section 4.5.

The correlation soil samples were also analyzed for thorium isotopes Th-232 and Th-228. The objectives of the thorium analyses were to assess the potential effects of Th-232 series radioisotopes on the correlation of gamma measurements to concentrations of Ra-226 in surface soils (i.e., to evaluate whether gamma-emitting radioisotopes in the Th-232 series are impacting gamma measurements at the Site). The justification for the analysis is provided in Section 3.3.1.3. A multivariate linear regression (MLR) model was performed by ERG to relate the gamma count rate to multiple soil radionuclides simultaneously. The MLR and results are described extensively in Appendix A. ERG identified that the thorium series radionuclides do not affect the prediction of concentrations of Ra-226 from gamma survey measurements at the Site.

4.2.2.1 Secular Equilibrium Results

The activities of Th-230 and Ra-226 were compared to consider whether the uranium series is in secular equilibrium at the Site (refer to Section 3.3.1.4 and Appendix A). A linear regression was performed on the dataset (refer to Appendix A Figure 9). The p-value for the regression slope is significant (i.e., $p < 0.05$) and the adjusted R^2 meets the study DQO (adjusted $R^2 > 0.8$), indicating that Ra-226 and Th-230 exist in equilibrium. However, when compared to a y=x line (this line represents a perfect 1:1 ratio between Th-230 and Ra-226, indicating secular equilibrium), the y=x line falls partially outside of the 95% UCL bands of the Th-230/Ra-226 regression, indicating Ra-226 and Th-230 are not in secular equilibrium at the Site (refer to figures in Appendix A). This may be a consideration in the future if a human health and/or ecological risk assessment is performed.

4.3 SOIL METALS AND RADIUM-226 ANALYTICAL RESULTS

A total of 25 surface soil/sediment grab samples (20 soil and 5 sediment) from 25 locations, and nine subsurface soil/sediment grab samples (eight soil and one sediment) from six borehole locations were collected in Survey Areas A and B (refer to Table 3-2). The metals and Ra-226 analytical results for each Survey Area are compared to their respective ILs and presented in Tables 4-4a and 4-4b. Figure 4-3 presents the spatial patterns, both laterally and vertically, of metals and Ra-226 detections and IL exceedances in the soil/sediment samples.

Ra-226 and/or metals concentrations exceeded their respective ILs in all but one sediment sample in Survey Area A (S002-CX-001) and in 17 out of 28 surface/subsurface soil/sediment samples in Survey Area B. In general, the greatest exceedances of Ra-226 and metals ILs were associated with Waste Piles 1 and 2, which are located below Portals-1 and -2. The maximum concentrations for most analytes were detected in samples S002-CX-005 and –CX-007 which were collected within Waste Piles 2 and 1, respectively, and in S002-SCX-015 collected on the mesa top in Survey Area B. Surface and subsurface soil/sediment IL exceedances for each analyte, with respect to each of the two survey areas, are described below. Presented sample counts include normal samples and do not include duplicate samples:

- Ra-226
  - Survey Area A – the Ra-226 IL (0.944 pCi/g) was exceeded in one out of six sediment samples at borehole S002-SCX-011. Survey Area A Ra-226 concentrations ranged from 0.65 to 1.12 pCi/g and the maximum Ra-226 detection (1.12 pCi/g) was from surface sediment sample S002-SCX-011 collected in the wash, north and downgradient of Waste Piles 1 and 2 and Portals-1 and -2.
  - Survey Area B – the Ra-226 IL (4.48 pCi/g) was exceeded in seven out of 20 surface soil samples and two out of eight subsurface samples (S002-SCX-002). Survey Area B Ra-226 concentrations ranged from 0.6 to 279 pCi/g and the maximum Ra-226 detection (279 pCi/g) was from surface soil sample S002-CX-007 collected from Waste Pile 1.
- Uranium
  - Survey Area A – The uranium IL (0.537 mg/kg) was exceeded in two surface soil samples, and one subsurface sample. Survey Area A uranium concentrations ranged from 0.27 to 0.7 mg/kg. The maximum uranium detection (0.7 mg/kg) was from surface sediment

    sample S002-CX-006 collected in the wash, north and downgradient of Waste Piles 1 and 2 and Portals-1 and -2.

    - Survey Area B – The uranium IL (5.46 mg/kg) was exceeded in seven surface and two subsurface soil samples. Survey Area B uranium concentrations ranged from 0.33 to 840 mg/kg. The maximum uranium detection (840 mg/kg) was from surface soil sample S002-CX-007 collected from Waste Pile 1.

As a broader point of reference, a regional study of the Western US documented uranium concentrations in soil that ranged from 0.68 to 7.9 mg/kg, with a mean value of 2.5 mg/kg (USGS, 1984). Uranium concentrations were within the typical range of regional values in soil/sediment samples from Survey Area A, but exceeded the maximum regional value in Survey Area B.

- Arsenic
    - Survey Area A – the arsenic IL (1.33 mg/kg) was exceeded in three surface sediment samples and one subsurface sample. Survey Area A arsenic concentrations ranged from 1.1 to 2.3 mg/kg. The maximum arsenic detection (2.3 mg/kg) was from subsurface sediment sample S002-SCX-008 collected in the wash, north and downgradient of Waste Pile 1 and Portal-2.
    - Survey Area B – the arsenic IL (4.33 mg/kg) was exceeded in seven surface soil samples and one subsurface sample. Survey Area B arsenic concentrations ranged from 1 to 310 mg/kg. The maximum arsenic detection (310 mg/kg) was from surface soil sample S002-SCX-015 collected on the mesa top.

As a broader point of reference, a regional study of the Western US documented arsenic concentrations in soil that ranged from less than 0.10 to 97 mg/kg, with a mean value of 5.5 mg/kg (USGS, 1984). Arsenic concentrations were within the typical range of regional values in soil/sediment samples from Survey Area A, but exceeded the maximum regional value in Survey Area B.

- Molybdenum – ILs for molybdenum were not identified because molybdenum sample results in the BG-2 were all non-detect and there was only one detection in BG-3.
    - Survey Area A – Molybdenum was non-detect in five samples and was detected in one surface sample (S002-CX-006) at a concentration of 0.52 mg/kg. Sample S002-CX-006 was collected in the wash, north and downgradient of Waste Piles 1 and 2 and Portals-1 and -2.
    - Survey Area B – Molybdenum was detected in thirteen surface soil samples and six subsurface samples from three boreholes. Molybdenum was non-detect in nine samples in Survey Area B, and detected concentrations ranged from 0.25 to 640 mg/kg. The maximum molybdenum detection (640 mg/kg) was from surface soil sample S002-SCX-015 collected on the mesa top.

As a broader point of reference, a regional study of the Western US documented molybdenum concentrations in soil that ranged from less than 3 to 7 mg/kg, with a mean value of 0.85 mg/kg (USGS, 1984). Molybdenum concentrations were within the typical range of regional values in soil/sediment samples from Survey Area A, but exceeded the maximum regional value in Survey Area B.

- Selenium – ILs for selenium were not identified because selenium sample results in the background areas were all non-detect
    - Survey Area A – Selenium was not detected in any of the surface or subsurface samples collected from Survey Area A.
    - Survey Area B – Selenium was detected in five surface and two subsurface soil samples. Survey Area B detected selenium concentrations ranged from 0.99 to 3.7 mg/kg. The maximum selenium detection (3.7 mg/kg) was from surface soil sample S002-CX-009 collected on the mesa top.

As a broader point of reference, a regional study of the Western US documented selenium concentrations in soil that typically ranged from less than 0.10 to 4.3 mg/kg, with a mean value of 0.23 mg/kg (USGS, 1984). Selenium concentrations were within the typical range of regional values in soil/sediment samples from Survey Area A and B.

- Vanadium
    - Survey Area A – The vanadium IL (8.37 mg/kg) was exceeded in two surface sediment samples, and one subsurface sample. Survey Area A vanadium concentrations ranged from 6.2 to 11 mg/kg. The maximum vanadium detection (11 mg/kg) was from surface soil samples S002-CX-006 and –SCX-008, both locations are in the wash, north and downgradient of Waste Pile 1 and Portal-2. S002-CX-006 is also north and downgradient of Waste Pile 2 and Portal-1.
    - Survey Area B – The vanadium IL (11.8 mg/kg) was exceeded in eight surface and six subsurface soil samples from three boreholes. Survey Area B vanadium concentrations ranged from 4.9 to 200 mg/kg. The maximum vanadium detection (200 mg/kg) was from surface soil samples S002-CX-005 collected from Waste Pile 2.

As a broader point of reference, a regional study of the Western US documented vanadium concentrations in soil that ranged from 7 to 500 mg/kg, with a mean value of 70 mg/kg (USGS, 1984). Vanadium concentrations were within the typical range of regional background values in Survey Areas A and B.

4.4 CONSTITUENTS OF POTENTIAL CONCERN

Based on the results presented in Sections 4.2 and 4.3, gamma radiation and concentrations of Ra-226, arsenic, uranium, and vanadium in soil/sediment exceeded their respective ILs in Survey Areas A and B. Therefore, these constituents were confirmed as COPCs for the Site. ILs for selenium and molybdenum were not identified because sample results were non-detect in the background areas with one exception. However, because selenium and molybdenum were detected in Survey Areas A and/or B, they are also confirmed COPCs for the Site.

4.5 AREAS THAT EXCEED THE INVESTIGATION LEVELS

The approximate lateral extent of surface gamma IL exceedances in soil/sediment is 3.1 acres, as shown in Figure 4-4a. To estimate this area, polygons were contoured around portions of the Site that had multiple, contiguous surface gamma IL exceedances and then the total area within the polygons was calculated. Figures 4-4b and 4-4c show larger scale views of each of the two Survey Areas to better display those areas with multiple, contiguous surface gamma IL exceedances. Five sample locations, where IL exceedances occurred, were not included in the 3.1 acres, as follows:

- Survey Area A – surface sample location S002-CX-006 had arsenic, uranium, and vanadium detections where the concentrations were less than two times the IL, and a molybdenum detection within the typical range of regional values (USGS, 1984). Surface sample S002-CX-012 had an arsenic detection where the concentration was less than two times the IL. Surface sample S002-SCX-011 had a Ra-226 detection where the concentration was less than two times the IL and subsurface sample S002-SCX-011 had a static gamma measurement above the IL at 0.5 ft bgs but static gamma measurements below the IL at depths of 0.3 and 0.7 ft bgs.

- Survey Area B – Sample location S002-SCX-006 had static gamma measurements, and arsenic, uranium, and vanadium detections where the measurements/concentrations were less than two times the IL, and molybdenum and selenium detections within the typical ranges of regional values (USGS, 1984). S002-SCX-010 had static gamma measurements that were less than two times the IL.

Figure 4-5 shows the vertical extent of IL exceedances in each borehole by incorporating information from each location, including: (1) depth to bedrock; (2) total borehole depth; and (3) depth range of IL exceedances. Table 4-5 lists the IL exceedances identified at each borehole location and Figure 4-5 also shows the surface gamma IL exceedances for reference.

IL exceedances in metals and Ra-226 concentrations at surface and subsurface sample locations were typically, but not always co-located with surface gamma survey measurements and/or subsurface static gamma measurements that also exceeded their ILs. Variations occur due to natural variability and the different field methods. For example, a small piece of mineralized rock or petrified wood may have been collected in a soil sample but may not have been detected by the gamma meter in the gamma survey due to distance from the meter, the depth below ground surface, or because the gamma meter measures radiation over a larger area than the discrete soil sample location.

The lateral extent of the IL exceedances (for surface gamma data) shown in Figure 4-4a were compared to the predicted Ra-226 concentrations that exceeded ILs in Figure 4-2c. Predicted Ra-226 concentrations exceeded the Ra-226 IL in a smaller area of the Site than the surface gamma IL exceedances. In particular, approximately 40 to 50 percent of the mesa top exceeded the Survey Area B surface gamma IL (11,686 cpm); however, predicted Ra-226 concentrations exceeded the Ra-226 IL in less than approximately one percent of the mesa top. In addition, the area on the mesa sidewall that was located between the two portals and waste piles exceeded the Survey Area B surface gamma IL, however the predicted Ra-226 concentrations did not exceed the Survey Area B Ra-226 IL in the same area. The inconsistency between the predicted Ra-226 exceedances and the surface gamma exceedances within Survey Area B may be the result of the surface gamma IL being relatively low when compared to the Ra-226 IL or because the predicted Ra-226 concentrations are lower than the actual concentrations.

4.6 AREAS OF TENORM AND NORM

A multiple lines of evidence approach was used to evaluate the Site and distinguish areas of TENORM from areas of NORM within the Survey Area, as described in Section 3.3.3. Based on this evaluation, 2.2 acres, out of the 18.2 acres of the Survey Area, were estimated to contain TENORM at the Site. This estimate is inclusive of three areas: (1) portions of the mesa top (Survey Area B); (2) the mesa sidewall (i.e., the vertical cliffs and steep colluvium-covered bedrock slope) including the Waste Piles 1 and 2, Portals-1 and -2 in Survey Area B; and (3) a portion of the wash adjacent to the waste piles and portals in Survey Area A. The area containing TENORM is shown in relation to the lateral extent of IL exceedances in Figure 4-6 and in relation to the gamma measurements in Figure 4-7.

The RSE data that supports the delineation of TENORM at the Site includes:

- Historical Data Review
    - Historical document review indicated that the Site was drift mined from two adits.
    - Historical document review indicated that between February 1956 and March 1956, 26.74 tons of ore that contained 75.96 pounds of 0.14 percent U_3O_8 and 76.04 pounds of 0.14 percent V_2O_5 was produced from the Site.
    - Historical document review indicated NAML performed reclamation activities at the Site that included closure of two portals and elimination of access roads.
- Geology/geomorphology
    - Bedrock at the Site consisted of three geologic Formations: the Jurassic Salt Wash and Buff Sandstone Members of the Morrison Formation, and the Jurassic Summerville Formation. The Morrison Formation is known to have natural enrichments of uranium. In addition, portions of the Site consisted of shallow or outcropping bedrock. Therefore, the geology and geomorphology of the Site was conducive to the presence of NORM at or near the ground surface.
    - One ephemeral drainage, Red Wash, could transport NORM/TENORM to the north northwest. Precipitation run-off on-site either terminates within the unconsolidated

deposits or drains into the Red Wash. Red Wash only flows in direct response to surface run-off precipitation or melting snow.

- Disturbance Mapping – Stantec field personnel observed the following features:
  - Two reclaimed portals were observed on the mesa sidewall. Both portals were covered by boulders of varying sizes, and the bulkhead at Portal-2 was slightly visible behind the boulders.
  - One potential haul road was observed on or within 0.25 miles of the Site. The portion of the potential haul road that crossed Red Wash to the portals was destroyed. The destruction of the potential haul road could have been because it was washed out naturally or it was eliminated during reclamation.
  - A potential rim strip area was observed along the mesa sidewall and between the two reclaimed portals. Overburden material in this area appeared to have been removed or scaled down with tools.
  - Two waste piles were observed that were assumed to be related to historical mining activities that occurred on-site. Waste Piles 1 and 2 are located on the mesa sidewall, immediately downgradient of Portals-2 and Portal-1, respectively.
  - Dirt track roads were present east of the Site on the mesa top and ground disturbance was present in the areas on the mesa top directly above the portals. No obvious evidence of mining disturbance (i.e., waste piles) was present on the mesa top. However, historic mining operations may have accessed the portals from the mesa top (i.e., lowering materials down the mesa sidewall to the portals). Due to this possibility, these areas may contain TENORM.
- Site Characterization – Site Characterization data included surface (lateral) and subsurface (vertical) data.
  - Survey Area A was comprised of the Red Wash drainage and associated flood plain; where portions of Red Wash were located adjacent to and downslope from Portals-1 and -2, Waste Piles 1 and 2, and areas immediately downgradient of the waste piles. Surface gamma IL exceedances in Survey Area A occurred primarily in the portions of the wash adjacent to and downslope from the two portals, the two waste piles, and the areas immediately downgradient of the waste piles. The majority of the gamma measurements collected within the wash did not exceed the surface gamma IL. Ra-226 and/or metals concentrations exceeded their respective ILs in Survey Area A in all but one sediment sample. In general, the greatest exceedances of Ra-226 and metals ILs were from samples collected downgradient of the portals and waste piles. Results of samples collected in the wash downstream from the portals and waste piles, which had static gamma measurements or Ra-226 and/or metals concentrations that exceeded their respective ILs, were either less than or within the typical range of regional values or were less than two times their respective ILs. IL exceedances in samples collected in the wash downstream from the portals and waste piles (S002-CX-006, -SCX-010, and

–SCX-011) were assumed to be NORM that is present as the result of runoff or colluvial transport from the adjacent areas of NORM on the mesa sidewall. However, the waste piles are located on a steep slope uphill from the wash, and there is potential for mine-impacted materials to be transported via surface water runoff or mass wasting downslope toward the wash. In addition, mine-impacted materials within the wash could be transported via surface water flow further downstream. Therefore, additional study is recommended for the portion of the wash between the delineated area of TENORM and sample locations S002-CX-006, -CX-010, and -SCX-011.

- Survey Area B was comprised of the mesa top and mesa sidewall, and was inclusive of Portals-1 and -2, Waste Piles 1 and 2, and the potential rim strip area. Surface gamma IL exceedances in Survey Area B occurred primarily in areas on the mesa top coincident with mineralized bedrock outcrops, or in the area coincident with the waste piles, the portals, and the potential rim strip area. The areas on the mesa top coincident with mineralized bedrock outcrops are assumed to contain NORM, because no mining-related disturbance was observed. The greatest exceedance of the arsenic IL and the maximum molybdenum concentration were observed in a sample collected in an area of the mesa top determined to be NORM (S002-SCX-015). The greatest IL exceedances and maximum concentrations for Ra-226, uranium, and vanadium were associated with samples collected from Waste Piles 1 and 2, located below Portals-1 and -2.

- Mine waste was observed at the ground surface within Waste Piles 1 and 2 and can be seen on aerial photographs of the Site (refer to Figure 3-1b). The material was gray compared to the surrounding soils, which were brown and red, and it was finer grained compared to the natural talus that was present on most of the mesa sidewall. Subsurface samples of the waste piles were not collected, because the waste piles were primarily comprised of boulders, cobbles, gravels, and sands, and hand augering was limited by the number of cobbles and gravels that were present.

- Gamma survey measurements on the potential haul roads did not exceed the IL.

- Metals concentrations in samples collected outside the area of TENORM (12 locations) were less than or within the regional concentration values with the exception of two samples collected on the mesa top. Arsenic and molybdenum concentrations exceeded the regional values in the surface sample collected at S002-SCX-015, and the uranium concentration exceeded the IL at the S002-CX-009 location.

- It is important to consider that the subsurface static gamma ILs were not used as the only evidence to delineate the vertical extent of TENORM that exceeded the ILs at the Site.

The area of the Site considered to contain TENORM (i.e., multiple lines of evidence indicated the presence of mining-related impacts) was 2.2 acres, as shown on Figure 4-8a. Portions of the TENORM exceeded one or more IL, where approximately 1.24 acres contained TENORM that exceeded the surface gamma IL and the majority of the sample locations where TENORM exceed the ILs. TENORM exceeding the ILs was observed at two sample locations that were not coincident with areas of the Site that exceeded the surface gamma IL. TENORM that exceeded the ILs in Survey Area A and Survey Area B is shown on Figures 4-8b and 4-8c, respectively, and is compared to mining-related features in Figure 4-8d.

It should be noted that the COPC concentrations in some of the areas that contain TENORM that exceeded the ILs were generally similar to the COPC concentrations in the area of NORM located outside the TENORM boundary.

4.7 TENORM VOLUME ESTIMATE

The volume estimate of TENORM that exceeded one or more ILs is approximately 1,805 cubic yards (yd^3), as shown in Figure 4-9. The volume and area of TENORM associated with specific mine features is listed in Table 3-3. This estimate was calculated in ESRI ArcGIS Desktop 10.3.1 Spatial Analyst Extension cut/fill tool (ESRI, 2017), utilizing the ground surface elevation contours developed from the orthophotographs coupled with hand-derived contours based on field personnel observations, depth to bedrock in boreholes, gamma measurements, sample analytical data, and historical mining documentation. Field observations included observations of disturbance, changes in vegetation, estimating/projecting the slope of underlying bedrock, and estimating the shape and topography of waste material and/or soil deposits.

TENORM exceeding the ILs at the Site was split into groups based on the depth or type of material to aid in analysis and describing the basis of the volumes. The locations, volume, and areas of these groups are shown in Figure 4-9. The assumptions used to calculate the volume of TENORM with IL exceedances were as follows:

General Assumptions

- It was assumed that subsurface bedrock encountered in boreholes was not previously modified by human activity, and is therefore NORM.
- Exposed bedrock surfaces that were predominantly devoid of unconsolidated material were assumed to be NORM and were excluded from the volume calculation.
- For areas of TENORM at the Site containing large cobbles/boulders at the surface whose heights exceeded the assumed depth of TENORM in that area (e.g., a 4-ft-tall boulder in an area where TENORM was assumed to extend 1 ft bgs on the mesa sidewall), the additional volume of the boulders was assumed to be accounted for by overall TENORM depth estimates.

Group Assumptions

- Group 1 (488 yd^3) – Polygons were best-fit around the TENORM areas that exceeded ILs on the mesa top. No obvious evidence of mining disturbance (i.e., waste piles) was present on the mesa top. However, historic mining operations may have accessed the portals from the mesa top (e.g., lowering materials down the mesa sidewall to the portals). Bedrock was present at the surface in many locations on the mesa top and was encountered in hand auger borings within this area at 0.5 ft bgs. Soil depth was assumed to extend to 0.5 ft bgs within this area.

- Group 2 (809 yd^3) – Polygons were best-fit around the TENORM areas that exceeded ILs on the mesa sidewall. This area includes the portals, potential rim strip, and waste piles. Portions of the area designated as TENORM (i.e., between the waste piles) could not be differentiated from the NORM based on field personnel observations in this area (i.e., the unconsolidated deposits in the area were visually similar), so this area was included as TENORM. Some portions of this area have bedrock exposed at the surface. Soil depth was assumed to extend to 1.0 ft bgs within this area.

- Group 3 (508 yd^3) – A polygon was best-fit around the TENORM areas that exceeded ILs within the wash. Soil depth was assumed to extend to 1.5 ft bgs based on bedrock being encountered at 1.3 ft bgs in borehole S002-SCX-008 in the wash.

4.8 POTENTIAL DATA GAPS AND SUPPLEMENTAL STUDIES

4.8.1 Data Gaps

Six potential data gaps were identified based on the Site Clearance and RSE data collection and analyses for the Site. These data gaps can be considered for subsequent evaluations in support of future Removal or Remedial Action evaluations at the Site.

1. The shoulders of the potential haul road were surveyed but the centerline of the potential haul road was not surveyed during the surface gamma survey. Field personnel observed that the portion of the potential haul road that crossed the wash to the portals was destroyed. The destruction of the potential haul road could have been because it was washed out naturally or it was eliminated during reclamation. Given that the detector records gamma emissions from at least a 3-foot diameter, and the haul roads are, typically, less than 12 ft wide, and that gamma IL exceedances were not observed on the potential haul road, this is not considered a significant data gap.

2. Field personnel were unable to perform the surface gamma survey in some areas along the mesa sidewall because of access and safety issues. Approximately 2.8 acres of the Survey Area could not be surveyed due to unsafe terrain.

3. Gamma survey measurements were within 1,000 cpm of the IL, but were not below IL, along portions of the northern, eastern, and southern boundaries of Survey Area B due to field personnel oversight.

4. The dirt track roads on the mesa top were inadvertently not surveyed.

5. A subsurface soil/sediment sample was not collected at BG-3 due to shallow refusal on hard sandstone bedrock at 0.25 feet during a single hand-auguring attempt. A grab sample was collected from 0 ft to 0.25 ft bgs at the BG-3 borehole (S002-BG3-011) but this was categorized as a surface sample.

6. A subsurface soil sample was not collected in S002-SCX-007, at a depth of 2.25 feet. Initially, Stantec conclude that the stable and low static gamma measurements down-hole at this

location indicated that there were no mining impacts at the location. Using this criterion was a field error. To account for screening of subsurface radiological materials by surface soils, a sample should be collected and analyzed.

4.8.2 Supplemental Studies

Following review of the RSE report data and discussions with the Agencies, a limited number of items were identified for supplemental work to be considered for subsequent evaluations in support of future Removal or Remedial Action evaluations at the Site, as follows:

1. The Agencies have suggested that additional study may be required to develop a background reference area to represent the mesa sidewall and mesa top portions of the Site within the Morrison Formation (NNEPA, 2018).

2. Boulders located along or at the base of the mesa sidewall were included in the area of the surface gamma survey but were not otherwise evaluated. Additional characterization of the boulders may be required in the future.

3. Additional study is recommended for the portion of the wash between the delineated area of TENORM and sample locations S002-CX-006, -CX-010, and -SCX-011 to evaluate if TENORM extends further down the wash and/or whether the IL exceedances present at the listed sample locations are the result of TENORM in the wash or colluvial transport from NORM areas uphill from the sample locations on the mesa sidewall.

4. The waste piles were comprised of a mix of boulders, cobbles, gravels, and sands. Using a hand auger was limited by the volume of boulders and cobbles present. Further evaluation of the waste piles may be considered in the future.

5. Additional correlation studies may be needed to identify the relationship between gamma and Ra-226.

5.0 SUMMARY AND CONCLUSIONS

This report details the purpose and objectives, field investigation activities, findings, and conclusions of the Site Clearance and RSE activities conducted for the Site between August 2015 and September 2017. The Site is known as the Alongo Mines site and is also identified by the USEPA as AUM identification #2 in the *2007 AUM Atlas*.

The primary objectives of the RSEs are to provide data required to evaluate relevant site conditions and to support future removal action evaluations at the Sites. It is not intended to establish cleanup levels or determine cleanup options or potential remedies. The purpose of the RSE data (e.g., the review of relevant information and the collection of data related to historical mining activities) is to determine the volume of TENORM at the Site in excess of ILs as a result of historical mining activities. ILs are based on the background gamma measurements (in cpm), and Ra-226 and metals concentrations, determined through statistical analyses, that are used to evaluate potential mining-related impacts. The RSE included historical data review, visual observations, surface gamma surveys, surface and subsurface static gamma measurements, and soil/sediment sampling and analyses. An estimate of areas containing TENORM was made based on an evaluation of the RSE information/data and multiple lines of evidence. The correlation between gamma measurements (in cpm) and concentrations of Ra-226 in surface soils (pCi/g) was developed as a potential field screening tool for future Removal or Remedial Action evaluations. The gamma correlation was not used for the Site Characterization, which relied instead on the actual gamma radiation measurements and soil/sediment analytical results. However, predicted
Ra-226 concentrations were compared to the actual Ra-226 laboratory results and ILs from the surface soil/sediment samples at the Agencies' request.

The Site was located in the King Tutt Mesa mining area. Mine workings on-site consisted of two adits that were approximately 150 ft apart. The Site was in operation during 1956 and produced 26.74 tons (approximately 53,480 pounds) of ore that contained 75.96 pounds of 0.14 percent U_3O_8 and 76.04 pounds of 0.14 percent V_2O_5.

Three potential background reference areas were considered. Two background reference areas (BG-2 and BG-3) were selected to develop surface gamma, subsurface gamma, Ra-226, and metals ILs for the two Survey Areas (Survey Area A and Survey Area B) at the Site. Background area BG-1 contained surface gamma measurements that were not representative of the mesa top and therefore was not used for determining ILs.

Ra-226, arsenic, uranium, and vanadium concentrations in soil/sediment and gamma radiation measurements exceeded their respective ILs and are confirmed COPCs for the Site. ILs for selenium and molybdenum were not identified because sample results were non-detect in the background areas with one exception. However, because selenium and molybdenum were detected in Survey Areas A and/or B, they are also confirmed COPCs for the Site.

Surface gamma measurements and Ra-226 and metals concentrations were generally highest in areas that were coincident with mining-related features (e.g., Portals-1 and -2, Waste Piles 1 and 2, and the potential rim strip). The maximum surface gamma measurement (115,161 cpm) was greater than eight times the highest surface gamma IL, and occurred in an area that was approximately coincident with Portal-1 and Waste Pile 2. The highest Ra-226, uranium, and vanadium concentrations were detected in surface soil samples collected from within Waste Piles 1 and 2. The highest arsenic and molybdenum concentrations were detected in a surface soil sample on the mesa top in an area assumed to be NORM (i.e., naturally occurring).

The Gamma Correlation Study indicated that surface gamma survey results correlate with Ra-226 concentrations in soil. However, the regression equation predicted Ra-226 concentrations that were less than zero for a large area of the Site. Users of the regression equation should be aware of the limitations of the dataset and be cautious when estimating radium-226 concentrations. Additional correlation studies may be needed to identify the relationship between gamma and Ra-226.

Based on the data analysis performed for this RSE report along with the supporting lines of evidence, approximately 2.2 acres out of the18.2 acres of the Survey Area were estimated to contain TENORM. This estimate is inclusive of three areas: (1) portions of the mesa top (Survey Area B); (2) the mesa sidewall (i.e., the vertical cliffs and steep colluvium-covered bedrock slope) including the Waste Piles 1 and 2, Portals-1 and -2 in Survey Area B; and (3) a portion of the wash adjacent to the waste piles and portals in Survey Area A. The areas outside of the TENORM boundary show no signs of disturbance related to mining and, therefore, are considered NORM. Of the 2.2 acres that contain TENORM, 1.24 acres contain TENORM that exceeds the ILs. The volume of unconsolidated TENORM in excess of ILs is estimated to be 1,805 yd^3 (1,380 cubic meters). It should be noted that the COPC concentrations in some of the area that contains TENORM that exceeds the ILs are generally similar to the COPC concentrations in the area of NORM located outside the TENORM boundary.

Six potential data gaps were identified based on the Site Clearance and RSE data collection and analyses for the Site as listed in Section 4.8. These data gaps can be taken into consideration for subsequent evaluations in support of future Removal or Remedial Action evaluations at the Site.

6.0 ESTIMATE OF REMOVAL SITE EVALUATION COSTS

The Alongo Mines RSE was performed in accordance with the requirements of the *Trust Agreement* to characterize existing site conditions. Project costs related to the RSE include the planning and implementation of the scope of work stipulated in the *Site Clearance Work Plan* and *RSE Work Plan,* and community outreach. Stantec's costs associated with the Alongo Mines RSE were $450,900. Stantec's costs associated with interim actions (sign installation) were $4,500. In addition, Administrative costs provided by the Trust were estimated currently at $191,500[7,8]. Administrative costs will change due to continued community outreach and close out activities.

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[7] This cost is based on an approved budget of May 8, 2018; Administrative work, including community communications, are not yet complete.

[8] Administrative costs were averaged across all Sites.

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Claim (ID# NND986675023); Navajo-King Tutt Point Uranium Mine (ID#NND986667434); Williams Point Mine (ID# NND986673283); Navajo-Canyon View (a.k.a., Alongo Claim) Uranium Mine (ID# NND986667533); Navajo-Red Wash Point Uranium Mine (ID# NND986667459); Navajo-Begay Incline Uranium Mine (ID#NND986675031); Navajo-Begay #1 Uranium Mine (ID# NND986667517); Navajo-Begay #2 Uranium Mine (ID# NND986667509); Vanadium Corp. of America (VCA)-Plot 10 (ID# NND983468034); Navajo-Franks Point/VCA Plot #6 Uranium Mine (ID#NND986675049); Navajo-VCA Plot 7 Uranium Mine (ID# NND986667426); Navajo-Upper Salt Rock (ID# NND986667590); Navajo-Carrizo Mine (ID# NND986667491); and, Navajo-VCA Plot #3 (ID# NND986667475).

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TABLES

Table 3-1
Identified Water Features
Alongo Mines
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase

Identified Water Feature	Source of Identified Water Feature	Water Feature Identification	Field Personnel Observations
Drainage Channel	NNDWR	Oak Springs Wash /12-26	No surface water observed
Drainage Channel	Stantec/Trustee	Red Wash/RV990413RVS008	Contains flowing surface water following storm events and does not regularly contain water. Wash was not sampled as part of the Site Characterization activities in accordance with the requirements of the Trust Agreement and Scope of Work, which require sampling of perennial water features only.
Drainage Channel	NNDWR	Black Rock Wash	No surface water observed
Minor seeps	Stantec/Trustee	Minor seeps	Water seepage was observed in arroyo 0.9 miles west and hydraulically upgradient of the claim boundary. Seepage occurred along the contact between sandstone beds on a vertical wall. The wall was wet, however; the water was not pooling and a water sample could not be collected.

Notes
NNDWR - Navajo Nation Department of Water Resources

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									Sample Types		
Sample Location	Sample Depth (ft bgs)	Sample Media	Sample Category	Sample Collection Method	Survey Area	Sample Date	Easting ^{1}	Northing ^{1}	Metals, Total	Ra-226	Thorium
Background Reference Area Study - Background Area 1											
S002-BG1-001	0 - 0.5	soil	SF	grab	NA	10/1/2016	677724.02	4063984.22	N	N	--
S002-BG1-002	0 - 0.5	soil	SF	grab	NA	10/1/2016	677723.13	4063987.86	N;FD	N;FD	--
S002-BG1-003	0 - 0.5	soil	SF	grab	NA	10/1/2016	677724.71	4063989.23	N;MS;MSD	N	--
S002-BG1-004	0 - 0.5	soil	SF	grab	NA	10/1/2016	677719.32	4063989.65	N	N	--
S002-BG1-005	0 - 0.5	soil	SF	grab	NA	10/1/2016	677720.78	4063992.05	N	N	--
S002-BG1-006	0 - 0.5	soil	SF	grab	NA	10/1/2016	677723.70	4063991.51	N	N	--
S002-BG1-007	0 - 0.5	soil	SF	grab	NA	10/1/2016	677726.28	4063992.59	N	N	--
S002-BG1-008	0 - 0.5	soil	SF	grab	NA	10/1/2016	677726.37	4063993.78	N	N	--
S002-BG1-009	0 - 0.5	soil	SF	grab	NA	10/1/2016	677724.01	4063995.09	N	N	--
S002-BG1-010	0 - 0.5	soil	SF	grab	NA	10/1/2016	677721.74	4063994.46	N	N	--
S002-SCX-003	0 - 0.6	soil	SF	grab	NA	10/13/2016	677725.79	4063987.40	N	N	--
S002-SCX-003	0.5 - 0.75	soil	SB	grab	NA	10/13/2016	677725.79	4063987.40	N	N	--
Background Reference Area Study - Background Area 2											
S002-BG2-001	0 - 0.5	sediment	SF	grab	NA	10/1/2016	677693.54	4063990.31	N;MS;MSD	N	--
S002-BG2-002	0 - 0.5	sediment	SF	grab	NA	10/1/2016	677694.35	4063992.94	N;FD	N;FD	--
S002-BG2-003	0 - 0.5	sediment	SF	grab	NA	10/1/2016	677695.15	4063994.65	N	N	--
S002-BG2-004	0 - 0.5	sediment	SF	grab	NA	10/1/2016	677692.16	4063995.49	N	N	--
S002-BG2-005	0 - 0.5	sediment	SF	grab	NA	10/1/2016	677694.57	4063997.54	N	N	--
S002-BG2-006	0 - 0.5	sediment	SF	grab	NA	10/1/2016	677696.74	4064001.00	N	N	--
S002-BG2-007	0 - 0.5	sediment	SF	grab	NA	10/1/2016	677698.73	4064000.71	N	N	--
S002-BG2-008	0 - 0.5	sediment	SF	grab	NA	10/1/2016	677697.83	4064004.51	N	N	--
S002-BG2-009	0 - 0.5	sediment	SF	grab	NA	10/1/2016	677699.64	4064005.94	N	N	--
S002-BG2-010	0 - 0.5	sediment	SF	grab	NA	10/1/2016	677699.50	4064008.87	N	N	--
S002-SCX-004	0 - 0.5	sediment	SF	grab	NA	10/13/2016	677694.67	4063996.73	N	N	--
S002-SCX-004	0.5 - 1.6	sediment	SB	composite	NA	10/13/2016	677694.67	4063996.73	N	N	--
S002-SCX-004	1.6 - 2.7	sediment	SB	composite	NA	10/13/2016	677694.67	4063996.73	N	N	--
Background Reference Area Study - Background Area 3											
S002-BG3-001	0 - 0.5	soil	SF	grab	NA	8/28/2017	677787.53	4063988.80	N	N	--
S002-BG3-002	0 - 0.5	soil	SF	grab	NA	8/28/2017	677791.12	4063988.79	N	N	--
S002-BG3-003	0 - 0.5	soil	SF	grab	NA	8/28/2017	677795.07	4063989.86	N	N	--
S002-BG3-004	0 - 0.5	soil	SF	grab	NA	8/28/2017	677794.90	4063994.68	N	N	--
S002-BG3-005	0 - 0.5	soil	SF	grab	NA	8/28/2017	677790.98	4063995.30	N	N	--
S002-BG3-006	0 - 0.5	soil	SF	grab	NA	8/28/2017	677791.54	4064000.35	N	N	--
S002-BG3-007	0 - 0.5	soil	SF	grab	NA	8/28/2017	677795.23	4064002.51	N;FD	N;FD	--
S002-BG3-008	0 - 0.5	soil	SF	grab	NA	8/28/2017	677798.09	4064000.90	N;MS;MSD	N	--
S002-BG3-009	0 - 0.5	soil	SF	grab	NA	8/28/2017	677794.99	4064005.97	N	N	--
S002-BG3-010	0 - 0.5	soil	SF	grab	NA	8/28/2017	677799.59	4064006.62	N	N	--
S002-BG3-011	0 - 0.25	soil	SF	grab	NA	8/28/2017	677796.77	4064004.94	N	N	--
Correlation											
S002-C01-001	0 - 0.5	sediment	SF	5-point composite	NA	10/13/2016	677713.60	4064199.12	--	N	N
S002-C02-001	0 - 0.5	soil	SF	5-point composite	NA	10/13/2016	677779.66	4064166.18	--	N;FD	N;FD
S002-C03-001	0 - 0.5	soil	SF	5-point composite	NA	10/13/2016	677777.43	4064158.38	--	N	N
S002-C04-001	0 - 0.5	soil	SF	5-point composite	NA	10/13/2016	677773.20	4064143.96	--	N	N
S002-C05-001	0 - 0.5	soil	SF	5-point composite	NA	10/13/2016	677824.04	4064126.54	--	N	N

Notes

--	Not Sampled
N	Normal
FD	Field Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
Ra-226	Radium 226
NA	Not Applicable
SB	Subsurface Sample
SF	Surface Sample
ft bgs	feet below ground surface
^{1} Coordinate System:	NAD 1983 UTM Zone 12N

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Sample Location	Sample Depth (ft bgs)	Sample Media	Sample Category	Sample Collection Method	Survey Area	Sample Date	Easting ¹	Northing ¹	Sample Types Metals, Total	 Ra-226	 Thorium
Characterization											
S002-CX-001	0 - 0.5	sediment	SF	grab	A	10/13/2016	677713.33	4064198.90	N	N	--
S002-CX-002	0 - 0.5	soil	SF	grab	B	10/13/2016	677779.94	4064166.36	N	N	--
S002-CX-003	0 - 0.5	soil	SF	grab	B	10/13/2016	677778.45	4064156.77	N	N	--
S002-CX-004	0 - 0.5	soil	SF	grab	B	10/13/2016	677773.50	4064143.53	N	N	--
S002-CX-005	0 - 0.5	soil	SF	grab	B	10/13/2016	677783.94	4064147.86	N	N	--
S002-CX-006	0 - 0.5	sediment	SF	grab	A	10/13/2016	677756.73	4064315.07	N;FD;MS;MSD	N;FD	--
S002-CX-007	0 - 0.5	soil	SF	grab	B	10/13/2016	677805.13	4064194.45	N	N	--
S002-CX-008	0 - 0.5	soil	SF	grab	B	10/13/2016	677822.97	4064124.20	N	N	--
S002-CX-009	0 - 0.5	soil	SF	grab	B	10/13/2016	677817.76	4064127.92	N	N	--
S002-CX-010	0 - 0.5	soil	SF	grab	B	10/13/2016	677854.88	4064142.70	N	N	--
S002-CX-011	0 - 0.5	soil	SF	grab	B	5/19/2017	677869.72	4064242.38	N;FD	N;FD	--
S002-CX-012	0 - 0.5	sediment	SF	grab	A	5/20/2017	677713.57	4064091.88	N	N	--
S002-CX-013	0 - 0.5	soil	SF	grab	B	5/20/2017	677765.28	4064132.31	N	N	--
S002-CX-014	0 - 0.5	soil	SF	grab	B	9/13/2017	677828.63	4064040.90	N	N	--
S002-SCX-001	0 - 0.8	soil	SB	grab	B	10/13/2016	677788.95	4064192.62	N;MS;MSD	N	--
S002-SCX-002	0 - 0.5	soil	SF	grab	B	10/13/2016	677770.72	4064149.39	N	N	--
S002-SCX-002	0.5 - 1.25	soil	SB	grab	B	10/13/2016	677770.72	4064149.39	N	N	--
S002-SCX-002	1.25 - 2.6	soil	SB	composite	B	10/13/2016	677770.72	4064149.39	N	N	--
S002-SCX-002	2.6 - 3.4	soil	SB	grab	B	10/13/2016	677770.72	4064149.39	N	N	--
S002-SCX-005	0 - 0.5	soil	SF	grab	B	5/19/2017	677862.06	4064314.17	N	N	--
S002-SCX-005	0.5 - 1.1	soil	SB	composite	B	5/19/2017	677862.06	4064314.17	N	N	--
S002-SCX-006	0 - 0.5	soil	SF	grab	B	5/19/2017	677845.54	4064368.23	N	N	--
S002-SCX-006	0.5 - 1	soil	SB	grab	B	5/19/2017	677845.54	4064368.23	N	N	--
S002-SCX-006	1 - 1.75	soil	SB	grab	B	5/19/2017	677845.54	4064368.23	N	N	--
S002-SCX-007	0 - 0.5	soil	SF	grab	B	5/20/2017	677770.99	4064155.26	N	N	--
S002-SCX-008	0 - 0.5	sediment	SF	grab	A	5/20/2017	677769.49	4064177.28	N	N	--
S002-SCX-008	0.5 - 1.3	sediment	SB	grab	A	5/20/2017	677769.49	4064177.28	N	N	--
S002-SCX-010	0 - 0.5	soil	SF	grab	B	5/20/2017	677782.62	4064240.84	N	N	--
S002-SCX-010	1 - 1.3	soil	SB	grab	B	5/20/2017	677782.62	4064240.84	N	N	--
S002-SCX-011	0 - 0.5	sediment	SF	grab	A	5/20/2017	677773.97	4064284.65	N	N	--
S002-SCX-012	0 - 0.5	soil	SF	grab	B	9/13/2017	677880.94	4064195.89	N	N	--
S002-SCX-013	0 - 0.5	soil	SF	grab	B	9/13/2017	677856.59	4064190.79	N;FD	N;FD	--
S002-SCX-014	0 - 0.5	soil	SF	grab	B	9/13/2017	677830.34	4064097.89	N;MS;MSD	N	--
S002-SCX-015	0 - 0.5	soil	SF	grab	B	9/13/2017	677835.16	4064070.86	N	N	--

Notes

--	Not Sampled
N	Normal
FD	Field Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
Ra-226	Radium 226
NA	Not Applicable
SB	Subsurface Sample
SF	Surface Sample
ft bgs	feet below ground surface
¹ Coordinate System:	NAD 1983 UTM Zone 12N

Table 3-3
Mine Feature Samples and Area
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Mine Feature	Surface Samples	Subsurface Samples	Area (sq. ft)	Volume of TENORM exceeding ILs (yd^3)
Waste Pile 1	1	0	1,565	43
Waste Pile 2	2	0	2,825	105
Potential Rim Strip	0	0	1,541	57
Drainages	3	0	**	509

Notes

sq.ft - square feet

yd^3 - cubic yards

ILs - investigation levels

TENORM - technologically enhanced naturally occurring radioactive material

** Area not determined because the width of the drainages vary throughout the Site

Table 4-1
Background Reference Area Soil and Sediment Sample Analytical Results
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Location Identification	S002-BG1-001	S002-BG1-002	S002-BG1-002 Dup	S002-BG1-003	S002-BG1-004	S002-BG1-005	S002-BG1-006	S002-BG1-007	S002-BG1-008	S002-BG1-009	S002-BG1-010
Date Collected	10/1/2016	10/1/2016	10/1/2016	10/1/2016	10/1/2016	10/1/2016	10/1/2016	10/1/2016	10/1/2016	10/1/2016	10/1/2016
Depth (feet)	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Metals[1] (mg/kg)											
Arsenic	2.8	2	2.5	1.7	1.7	1.6	3	2.1	1.5	1.6	1.5
Molybdenum	0.3	0.28	0.33	0.29	0.28	0.32	0.32	0.36	<0.19	<0.19	0.21
Selenium	<1	<1	<0.89	<0.96	<1	<0.93	<1	<1	<0.96	<0.96	<0.92
Uranium	2	1.9	2.7	2.2	1.8	1.7	2.6	2.7	1.6	1.6	1.6
Vanadium	8.6	7.7	8.8	8.8	8.6	7.2	9.8	12	12	8.6	11
Radionuclides (pCi/g)											
Radium-226	2.06 ± 0.36	2.23 ± 0.36	1.91 ± 0.35	2.07 ± 0.37	1.73 ± 0.35	2.17 ± 0.36	2.03 ± 0.34 J-	2.04 ± 0.34	1.76 ± 0.32	1.5 ± 0.28 J-	1.86 ± 0.32

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
<	Result not detected above associated laboratory reporting limit
J-	Data are estimated and are potentially biased low due to associated quality control data
J+	Data are estimated and are potentially biased high due to associated quality control data

Table 4-1
Background Reference Area Soil and Sediment Sample Analytical Results
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Location Identification	S002-SCX-003	S002-SCX-003	S002-BG2-001	S002-BG2-002	S002-BG2-002 Dup	S002-BG2-003	S002-BG2-004	S002-BG2-005	S002-BG2-006	S002-BG2-007	S002-BG2-008
Date Collected	10/13/2016	10/13/2016	10/1/2016	10/1/2016	10/1/2016	10/1/2016	10/1/2016	10/1/2016	10/1/2016	10/1/2016	10/1/2016
Depth (feet)	0 - 0.6	0.5 - 0.75	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Analyte (Units)											
Metals[1] (mg/kg)											
Arsenic	2.6	3	0.75	0.78	0.83	1.1	0.89	0.83	0.85	1	0.86
Molybdenum	0.36	0.45	<0.19	<0.2	<0.2	<0.2	<0.19	<0.19	<0.17	<0.19	<0.21
Selenium	<1	<0.92	<0.95	<1	<1	<1	<0.93	<0.96	<0.86	<0.95	<1
Uranium	1.6	1.9	0.26 J+	0.25	0.27	0.33	0.24	0.29	0.43	0.25	0.37
Vanadium	9.9	10	4.3 J+	4.5	4.5	6.6	4.7	4.2	5.1	5.7	5.3
Radionuclides (pCi/g)											
Radium-226	1.54 ± 0.28 J-	1.43 ± 0.29 J-	0.47 ± 0.19	0.79 ± 0.19	0.51 ± 0.22	0.59 ± 0.23	0.54 ± 0.18 J-	0.66 ± 0.22	0.81 ± 0.21	0.61 ± 0.22	0.59 ± 0.21

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
<	Result not detected above associated laboratory reporting limit
J-	Data are estimated and are potentially biased low due to associated quality control data
J+	Data are estimated and are potentially biased high due to associated quality control data

Table 4-1
Background Reference Area Soil and Sediment Sample Analytical Results
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Location Identification	S002-BG2-009	S002-BG2-010	S002-SCX-004	S002-SCX-004	S002-SCX-004	S002-BG3-001	S002-BG3-002	S002-BG3-003	S002-BG3-004	S002-BG3-005	S002-BG3-006	S002-BG3-007
Date Collected	10/1/2016	10/1/2016	10/13/2016	10/13/2016	10/13/2016	8/28/2017	8/28/2017	8/28/2017	8/28/2017	8/28/2017	8/28/2017	8/28/2017
Depth (feet)	0 - 0.5	0 - 0.5	0 - 0.5	0.5 - 1.6	1.6 - 2.7	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Analyte (Units)												
Metals[1] (mg/kg)												
Arsenic	0.74	0.99	1.2	1.2	1.2	3.7	2.6	1.8	2	1.8	1.8	3
Molybdenum	<0.19	<0.2	<0.17	<0.18	<0.2	<0.19	<0.2	<0.19	<0.19	<0.2	<0.2	<0.2
Selenium	<0.94	<1	<0.86	<0.88	<1	<0.97	<1	<0.96	<0.97	<1	<1	<0.99
Uranium	0.24	0.29	0.47	0.54	0.9	4.3	4.7	2	2.3	2.4	2.1	2.1
Vanadium	4.3	6	7.6	8.9	8.7	7.1	10	6.6	8.3	8.1	8	9.3
Radionuclides (pCi/g)												
Radium-226	0.65 ± 0.2	0.42 ± 0.15 J-	0.52 ± 0.18	0.96 ± 0.23	0.77 ± 0.21	2.89 ± 0.45	3.58 ± 0.52	1.63 ± 0.32	1.83 ± 0.34	1.6 ± 0.32	1.79 ± 0.31	1.42 ± 0.27

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
[1]	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
<	Result not detected above associated laboratory reporting limit
J-	Data are estimated and are potentially biased low due to associated quality control data
J+	Data are estimated and are potentially biased high due to associated quality control data

Table 4-1
Background Reference Area Soil and Sediment Sample Analytical Results
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Location Identification	S002-BG3-007 Dup	S002-BG3-008	S002-BG3-009	S002-BG3-010	S002-BG3-011
Date Collected	8/28/2017	8/28/2017	8/28/2017	8/28/2017	8/28/2017
Depth (feet)	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.25
Analyte (Units)					
Metals[1] (mg/kg)					
Arsenic	2.4	2	3.3	2	1.6
Molybdenum	0.53	<0.2	0.38	<0.2	<0.2
Selenium	<0.96	<1	<1	<0.99	<1
Uranium	1.9	1.7	2	1.5	1.4
Vanadium	9.7	5.8	6.2	5.8	4.7
Radionuclides (pCi/g)					
Radium-226	1.73 ± 0.35	1.47 ± 0.28	1.68 ± 0.31 J-	1.23 ± 0.28	0.84 ± 0.2

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
<	Result not detected above associated laboratory reporting limit
J-	Data are estimated and are potentially biased low due to associated quality control data
J+	Data are estimated and are potentially biased high due to associated quality control data

Table 4-2
Static Gamma Measurement Summary
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Sample Location	Survey Area	Subsurface Static Gamma Investigation Level (cpm)	Sample Depth (ft bgs)	Media	Static Gamma Measurement (cpm)
S002-SCX-003	Background Area 1	*	0.0	soil	14,603
S002-SCX-003	Background Area 1	*	0.5	soil	15,730
S002-SCX-004	Background Area 2	*	0.5	sediment	13,019
S002-SCX-004	Background Area 2	*	1.0	sediment	14,615
S002-SCX-004	Background Area 2	*	1.5	sediment	15,300
S002-SCX-004	Background Area 2	*	2.0	sediment	15,071
S002-SCX-004	Background Area 2	*	2.5	sediment	14,335
S002-SCX-004	Background Area 2	*	2.7	sediment	13,809
S002-BG3-011	Background Area 3	*	0.0	soil	9,329
S002-BG3-011	Background Area 3	*	0.3	soil	10,370 **
S002-SCX-008	A	--	0.0	sediment	12,466
S002-SCX-008	A	13,809	0.5	sediment	14,104
S002-SCX-008	A	13,809	1.0	sediment	15,793
S002-SCX-008	A	13,809	1.3	sediment	15,319 **
S002-SCX-009	A	13,809	0.5	soil	11,465
S002-SCX-011	A	--	0.0	sediment	10,344
S002-SCX-011	A	13,809	0.3	sediment	12,156
S002-SCX-011	A	13,809	0.5	sediment	15,730
S002-SCX-011	A	13,809	0.7	sediment	12,476 **
S002-SCX-001	B	--	0.0	soil	13,670
S002-SCX-001	B	10,370	0.8	soil	12,966 **
S002-SCX-002	B	10,370	0.5	soil	29,590
S002-SCX-002	B	10,370	1.0	soil	46,259
S002-SCX-002	B	10,370	1.5	soil	39,354
S002-SCX-002	B	10,370	2.0	soil	30,087
S002-SCX-002	B	10,370	2.5	soil	26,018
S002-SCX-002	B	10,370	3.0	soil	23,619
S002-SCX-002	B	10,370	3.3	soil	26,197
S002-SCX-005	B	--	0.0	soil	9,500
S002-SCX-005	B	10,370	0.5	soil	13,305
S002-SCX-005	B	10,370	1.1	soil	14,296 **
S002-SCX-006	B	--	0.0	soil	9,159
S002-SCX-006	B	10,370	0.5	soil	14,379
S002-SCX-006	B	10,370	1.0	soil	21,187
S002-SCX-006	B	10,370	1.5	soil	21,244
S002-SCX-006	B	10,370	1.8	soil	20,589 **
S002-SCX-007	B	--	0.0	soil	12,249
S002-SCX-007	B	10,370	0.5	soil	12,728
S002-SCX-007	B	10,370	1.0	soil	13,494
S002-SCX-007	B	10,370	1.5	soil	13,154
S002-SCX-007	B	10,370	2.3	soil	13,247

Notes

Bold	Bolded result indicates measurement exceeds subsurface gamma investigation level
*	The subsurface gamma investigation levels are derived from the background area measurements, refer to Section 4.1 of the RSE report
**	Measurement collected at interface of unconsolidated material and refusal material (e.g., bedrock)
--	The subsurface gamma investigation level does not apply to surface static gamma measurements
RSE	Removal Site Investigation
cpm	counts per minute
ft bgs	feet below ground surface

Table 4-2
Static Gamma Measurement Summary
Alongo Mines
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 2 of 2

Sample Location	Survey Area	Subsurface Static Gamma Investigation Level (cpm)	Sample Depth (ft bgs)	Media	Static Gamma Measurement (cpm)
S002-SCX-010	B	--	0.0	soil	11,042
S002-SCX-010	B	10,370	0.5	soil	11,946
S002-SCX-010	B	10,370	1.0	soil	12,767
S002-SCX-010	B	10,370	1.3	soil	13,257 **
S002-SCX-012	B	--	0.0	soil	9,622
S002-SCX-012	B	10,370	0.5	soil	9,682 **
S002-SCX-013	B	--	0.0	soil	10,027
S002-SCX-013	B	10,370	0.5	soil	12,347 **
S002-SCX-014	B	--	0.0	soil	18,338
S002-SCX-014	B	10,370	0.5	soil	25,062 **
S002-SCX-015	B	--	0.0	soil	18,880
S002-SCX-015	B	10,370	0.5	soil	30,044 **

Notes

Bold	Bolded result indicates measurement exceeds subsurface gamma investigation level
*	The subsurface gamma investigation levels are derived from the background area □ measurements, refer to Section 4.1 of the RSE report
**	Measurement collected at interface of unconsolidated material and refusal material (e.g., bedrock)
--	The subsurface gamma investigation level does not apply to surface static gamma measurements
RSE	Removal Site Investigation
cpm	counts per minute
ft bgs	feet below ground surface

Table 4-3
Gamma Correlation Study Soil and Sediment Sample Analytical Results
Alongo Mines
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 1

Location Identification	S002-C01-001	S002-C02-001	S002-C02-001 Dup	S002-C03-001	S002-C04-001	S002-C05-001
Date Collected	10/13/2016	10/13/2016	10/13/2016	10/13/2016	10/13/2016	10/13/2016
Depth (feet)	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Analyte (Units)						
Radionuclides (pCi/g)						
Radium-226	0.64 ± 0.2	1.61 ± 0.31	1.43 ± 0.28	14.5 ± 1.8	22.6 ± 2.8	5.1 ± 0.69
Thorium-228	0.56 ± 0.11	0.53 ± 0.13	0.442 ± 0.099	0.399 ± 0.087	0.446 ± 0.095	0.56 ± 0.11
Thorium-230	0.49 ± 0.1	1.23 ± 0.24	1.1 ± 0.2	9.8 ± 1.5	14 ± 2.2	4.04 ± 0.65
Thorium-232	0.63 ± 0.12	0.56 ± 0.13	0.452 ± 0.094	0.432 ± 0.088	0.471 ± 0.093	0.55 ± 0.11

Notes

Bold	Bolded result indicates positively identified compound
pCi/g	picocuries per gram

Table 4-4a
Site Characterization Sediment Sample Analytical Results for Survey Area A
Alongo Mines
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 1

Location Identification		S002-CX-001	S002-CX-006	S002-CX-006 Dup	S002-CX-012	S002-SCX-008	S002-SCX-008	S002-SCX-011
Date Collected		10/13/2016	10/13/2016	10/13/2016	5/20/2017	5/20/2017	5/20/2017	5/20/2017
Depth (feet)		0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0.5 - 1.3	0 - 0.5
Sample Category		surface	surface	surface	surface	surface	subsurface	surface
Sample Collection Method		grab	grab	grab	grab	grab	grab	grab
Media		sediment	sediment	sediment	sediment	sediment	sediment	sediment
Analyte (Units)								
Metals[1] (mg/kg)	Investigation Level							
Arsenic	1.33	1.1	1.7	2.4	1.4	1.7	2.3	1.3
Molybdenum	NA	<0.2	0.52	0.22	<0.2	<0.21	<0.21	<0.21
Selenium	NA	<0.99	<0.98	<0.97	<1	<1	<1	<1.1
Uranium	0.537	0.31	0.7	0.78	0.27	0.55	0.67	0.29
Vanadium	8.37	7.2	11 J	9.7	7.2	11	8.5	6.2
Radionuclides (pCi/g)								
Radium-226	0.944	0.65 ± 0.23	0.76 ± 0.2 J-	0.67 ± 0.22 J-	0.73 ± 0.19	0.71 ± 0.18	0.85 ± 0.22	1.12 ± 0.3

Notes

Bold	Bolded result indicates positively identified compound
Shaded	Shaded result indicates result greater than or equal to the investigation level
Shaded	Shaded result indicates analyte detected, where that analyte does not have an investigation level
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
NA	An investigation level is not identified because selenium and molybdenum sample results in BG-2 were all non-detect
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-diluted value
<	Result not detected above associated laboratory reporting limit
J	Data are estimated due to associated quality control data
J-	Data are estimated and are potentially biased low due to associated quality control data

Table 4-4b
Site Characterization Soil Sample Analytical Results for Survey Area B
Alongo Mines
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 3

Location Identification		S002-CX-002	S002-CX-003	S002-CX-004	S002-CX-005	S002-CX-007	S002-CX-008	S002-CX-009	S002-CX-010	S002-CX-011	S002-CX-011 Dup	S002-CX-013	S002-CX-014
Date Collected		10/13/2016	10/13/2016	10/13/2016	10/13/2016	10/13/2016	10/13/2016	10/13/2016	10/13/2016	5/19/2017	5/19/2017	5/20/2017	9/13/2017
Depth (feet)		0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Sample Category		surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface
Sample Collection Method		grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab
Media		soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil
Analyte (Units)													
Metals[1] (mg/kg)	Investigation Level												
Arsenic	4.33	1	1.4	2.5	14	26	25	67	3.5	2.1	1.8	1.1	2.4
Molybdenum	NA	<0.18	0.83	3	57	36	2.1	5	0.39	<0.21	<0.21	<0.21	3.2
Selenium	NA	<0.91	<0.93	<0.91	1.3	3.5	0.99	3.7	<0.99	<1	<1	<1	<1
Uranium	5.46	0.53	4.7	14	120 D	840 D	6.3	26	1.5	1.2	1.1	0.49	1.2
Vanadium	11.8	7	17	30	200	27	10	16	15	6.3	5.8	5.8	4.9
Radionuclides (pCi/g)													
Radium-226	4.48	0.94 ± 0.26	3.7 ± 0.56	14.6 ± 1.8	105 ± 12	279 ± 33	5.11 ± 0.74	9.2 ± 1.2	1.79 ± 0.33	1.07 ± 0.24	1.13 ± 0.25	0.95 ± 0.25	0.99 ± 0.24

Notes

Bold	Bolded result indicates positively identified compound
Shaded	Shaded result indicates result greater than or equal to the investigation level
Shaded	Shaded result indicates analyte detected, where that analyte does not have an investigation level
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
NA	An investigation level is not identified because selenium sample results in BG-3 were all non-detect, and molybdenum had only one detection in BG-3
[1]	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-diluted value
<	Result not detected above associated laboratory reporting limit
D	Sample dilution required for analysis; reported values reflect the dilution
J	Data are estimated due to associated quality control data
J+	Data are estimated and are potentially biased high due to associated quality control data

Table 4-4b
Site Characterization Soil Sample Analytical Results for Survey Area B
Alongo Mines
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase

Location Identification		S002-SCX-001	S002-SCX-002	S002-SCX-002	S002-SCX-002	S002-SCX-002	S002-SCX-005	S002-SCX-005	S002-SCX-006	S002-SCX-006	S002-SCX-006	S002-SCX-007
Date Collected		10/13/2016	10/13/2016	10/13/2016	10/13/2016	10/13/2016	5/19/2017	5/19/2017	5/19/2017	5/19/2017	5/19/2017	5/20/2017
Depth (feet)		0 - 0.8	0 - 0.5	0.5 - 1.25	1.25 - 2.6	2.6 - 3.4	0 - 0.5	0.5 - 1.1	0 - 0.5	0.5 - 1.0	1.0 - 1.75	0 - 0.5
Sample Category		subsurface	surface	subsurface	subsurface	subsurface	surface	subsurface	surface	subsurface	subsurface	surface
Sample Collection Method		grab	grab	grab	composite	grab	grab	composite	grab	grab	grab	grab
Media		soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil
Analyte (Units)												
Metals^1 (mg/kg)	Investigation Level											
Arsenic	4.33	1.3	2.2	3.5	1.6	1.4	2.3	3.4	2.6	4.8	3.7	1.3
Molybdenum	NA	<0.21	0.97	15	0.78	0.49	0.25	0.32	2	0.57	0.46	<0.21
Selenium	NA	<1	<0.99	<1	<0.93	<0.89	<1	<1	<0.97	1.3	1.5	<1.1
Uranium	5.46	0.39 J+	4	22	3.4	2.7	1.3	2.5	1.1	4.8	6.8	0.73
Vanadium	11.8	8 J+	15	42	16	13	9.5	19	6.4	14	16	7.5
Radionuclides (pCi/g)												
Radium-226	4.48	0.95 ± 0.24	3.03 ± 0.49	16 ± 2	4.85 ± 0.71	1.23 ± 0.26	1.38 ± 0.28	1.65 ± 0.32	1.32 ± 0.25	4.46 ± 0.65	3.2 ± 0.53	0.92 ± 0.26

Notes

Bold	Bolded result indicates positively identified compound
Shaded	Shaded result indicates result greater than or equal to the investigation level
Shaded	Shaded result indicates analyte detected, where that analyte does not have an investigation level
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
NA	An investigation level is not identified because selenium sample results in BG-3 were all non-detect, and molybdenum had only one detection in BG-3
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-diluted value
<	Result not detected above associated laboratory reporting limit
D	Sample dilution required for analysis; reported values reflect the dilution
J	Data are estimated due to associated quality control data
J+	Data are estimated and are potentially biased high due to associated quality control data

Table 4-4b
Site Characterization Soil Sample Analytical Results for Survey Area B
Alongo Mines
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 3 of 3

Location Identification		S002-SCX-010	S002-SCX-010	S002-SCX-012	S002-SCX-013	S002-SCX-013 Dup	S002-SCX-014	S002-SCX-015
Date Collected		5/20/2017	5/20/2017	9/13/2017	9/13/2017	9/13/2017	9/13/2017	9/13/2017
Depth (feet)		0 - 0.5	1.0 - 1.3	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Sample Category		surface	subsurface	surface	surface	surface	surface	surface
Sample Collection Method		grab	grab	grab	grab	grab	grab	grab
Media		soil	soil	soil	soil	soil	soil	soil
Analyte (Units)								
Metals[1] (mg/kg)	Investigation Level							
Arsenic	4.33	1.2	1.1	2.6	4.4	4.8	4.5 J+	310
Molybdenum	NA	<0.24	<0.23	<0.2	<0.2	<0.2	0.56 J	640
Selenium	NA	<1.2	<1.2	<1	<0.98	<1	<0.97	1
Uranium	5.46	0.34	0.33	1.3	2	2.1	5.6	7.3
Vanadium	11.8	6.7	6.7	8.3	11	10	7.9	18
Radionuclides (pCi/g)								
Radium-226	4.48	0.6 ± 0.17	0.74 ± 0.21	1.29 ± 0.25	1.86 ± 0.37	2.01 ± 0.34	4.92 ± 0.68	6.99 ± 0.92

Notes

Bold	Bolded result indicates positively identified compound
Shaded	Shaded result indicates result greater than or equal to the investigation level
Shaded	Shaded result indicates analyte detected, where that analyte does not have an investigation level
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
NA	An investigation level is not identified because selenium sample results in BG-3 were all non-detect, and molybdenum had only one detection in BG-3
[1]	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-diluted value
<	Result not detected above associated laboratory reporting limit
D	Sample dilution required for analysis; reported values reflect the dilution
J	Data are estimated due to associated quality control data
J+	Data are estimated and are potentially biased high due to associated quality control data

Table 4-5
Summary of Investigation Level Exceedances in Soil/Sediment at Borehole Locations
Alongo Mines
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase

Sample Location	Survey Area	Investigation Level Exceedances
S002-SCX-001	B	Static Gamma
S002-SCX-002[1]	B	Mo, U, V, Ra-226, Static Gamma
S002-SCX-005[1]	B	Mo, V, Static Gamma
S002-SCX-006[1]	B	As, Mo, Se, U, V, Static Gamma
S002-SCX-007	B	Static Gamma
S002-SCX-008	A	As, U, V, Static Gamma
S002-SCX-010	B	Static Gamma
S002-SCX-011	A	Ra-226, Static Gamma
S002-SCX-013	B	As
S002-SCX-014[1]	B	As, Mo, U, Ra-226, Static Gamma
S002-SCX-015[1]	B	As, Mo, Se, U, V, Ra-226, Static Gamma

Notes

[1] Detections of Mo and Se included for reference, no ILs are established for Mo and Se

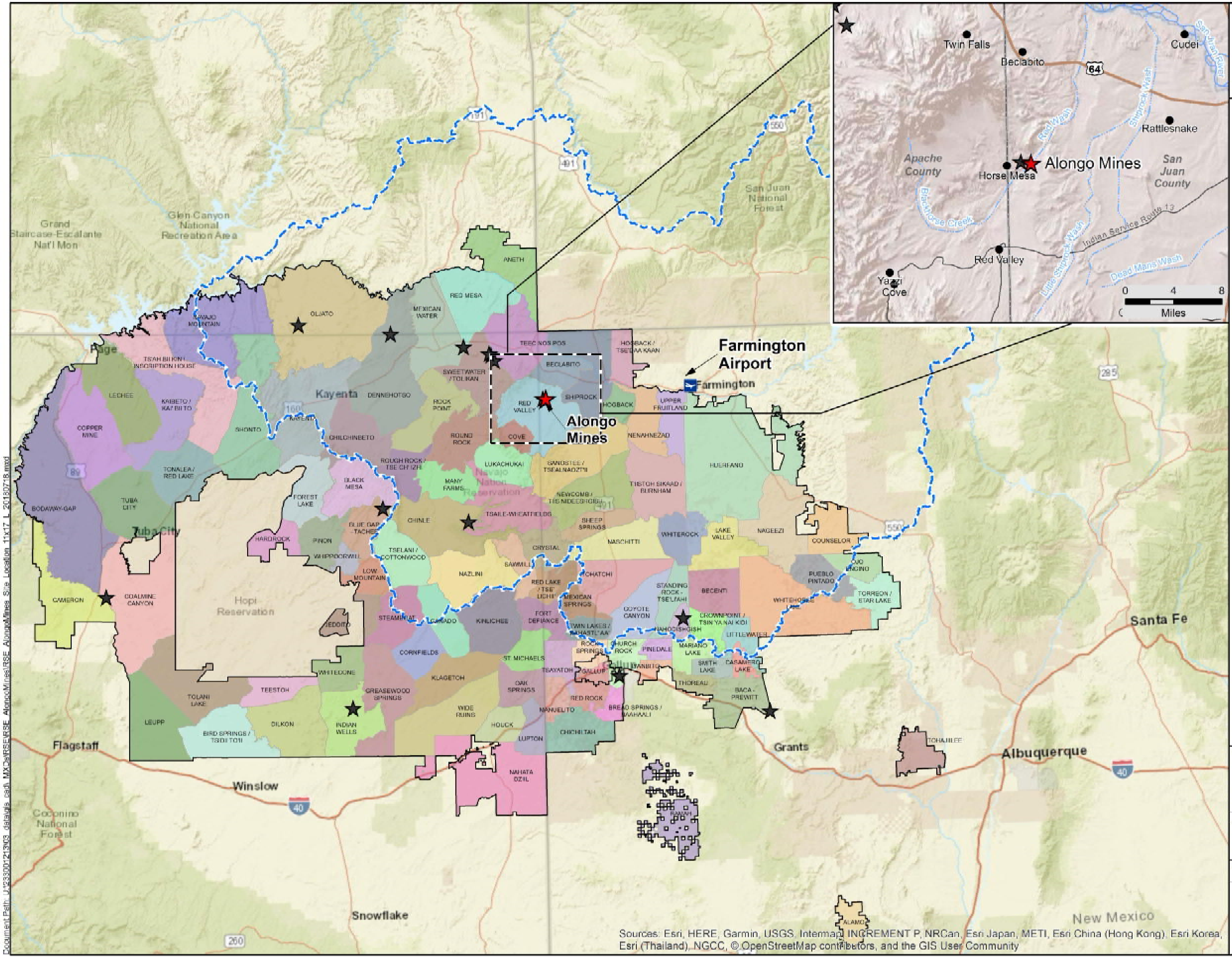
As - Arsenic
Mo - Molybdenum
Ra-226 - Radium 226
Se - Selenium
U - Uranium
V - Vanadium

FIGURES

FIGURE ACRONYMS/ABBREVIATIONS

As	arsenic
BG	potential background reference area
bgs	below ground surface
cpm	counts per minute
ft	feet
IL	investigation level
mg/kg	milligrams per kilogram
Mo	molybdenum
NA	not applicable
NAD	North American Datum
pCi/g	picocuries per gram
Ra	radium-226
Ra-226	radium-226
Se	selenium
TENORM	Technologically Enhanced Naturally Occurring Radioactive Materials
uk	unknown
U	uranium
UTL	upper tolerance limit
UTM	Universal Transverse Mercator
V	vanadium

NAVAJO NATION
AUM Environmental Response Trust-First Phase



LEGEND

- Alongo Mines Site
- Priority Abandoned Uranium Mine (AUM) Site
- Populated Place
- US Highway
- Major Road
- Stream
- Intermittent Stream
- San Juan River Watershed
- Navajo Nation Boundary
- Navajo Nation Chapter

Farmington Airport, New Mexico Wind Rose (KFMN), 1996-2006

Windspeed (mph): >0 - 2; >2 - 4; >4 - 6; >6 - 8; >8

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap: ESRI World Street Map and World Shaded Relief accessed 07/2018.

Wind Rose: USEPA, 2007a

0 25 50
Miles

TITLE:
Site Location

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 7/18/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 1-1

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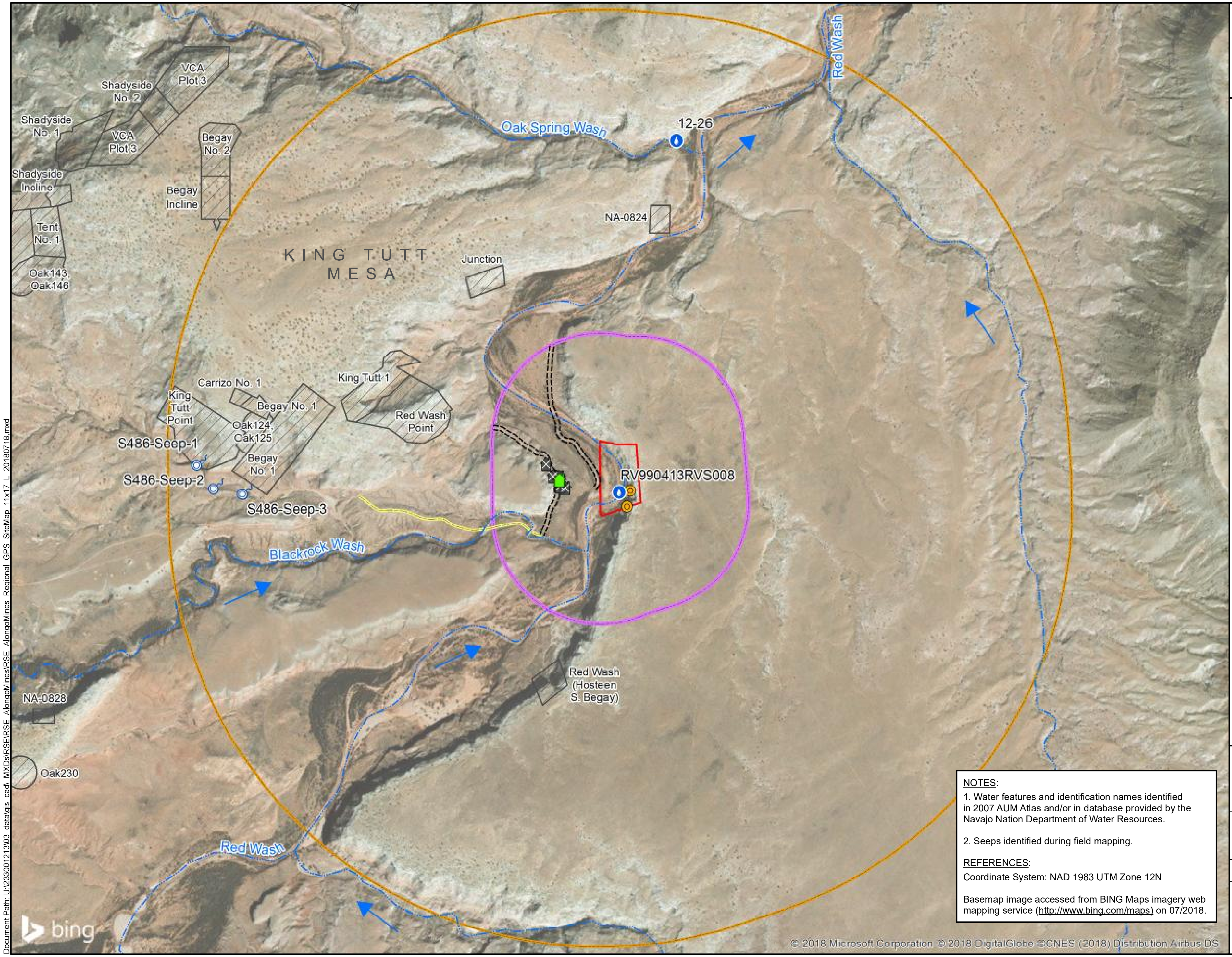

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

💧	Site Clearance Identified Water Feature¹
◎	Portal
🟩	Habitable Building
☒	Uninhabitable Building
♂	Minor Seep²
↑	Flow Direction
-··-··-	Intermittent Stream/River
------	Potential Haul Road
=========	Road
🟥	Claim Boundary
▢	1/4-Mile Claim Boundary Buffer
▢	1-Mile Claim Boundary Buffer
▨	Other Claim Boundary

N
W E
S

0 1,200 2,400
Feet

NOTES:

1. Water features and identification names identified in 2007 AUM Atlas and/or in database provided by the Navajo Nation Department of Water Resources.

2. Seeps identified during field mapping.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 07/2018.

TITLE:

Site Features

PROJECT:

Removal Site Evaluation
Alongo Mines Site

DATE: 7/18/2018

DOCUMENT NAME: Removal Site Evaluation Report

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 2-1

Stantec

Document Path: U:\233001213\03_data\gis_cad\MXDs\RSE\RSE_AlongoMines\RSE_AlongoMines_Regional_GPS_SiteMap_11x17_L_20180718.mxd

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NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

🡑	Flow Direction
—	Road
-·-·-	Intermittent Stream/River
🟥	Claim Boundary
▨	Other Claim Boundary
☐	State Boundary

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 07/2018.

N
W E
S

0 2,000 4,000
Feet

TITLE:
Regional Aerial Photograph

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 7/18/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB

REVIEWER: EY

FIGURE: 2-2

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

🟥 Claim Boundary

▨ Other Claim Boundary

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap: ESRI USA Topo Maps service accessed 07/2018.

N
W E
S

0 2,000 4,000
Feet

TITLE:

Regional Topographic Map

PROJECT:

Removal Site Evaluation
Alongo Mines Site

DATE: 7/18/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB

REVIEWER: EY

FIGURE: 2-3

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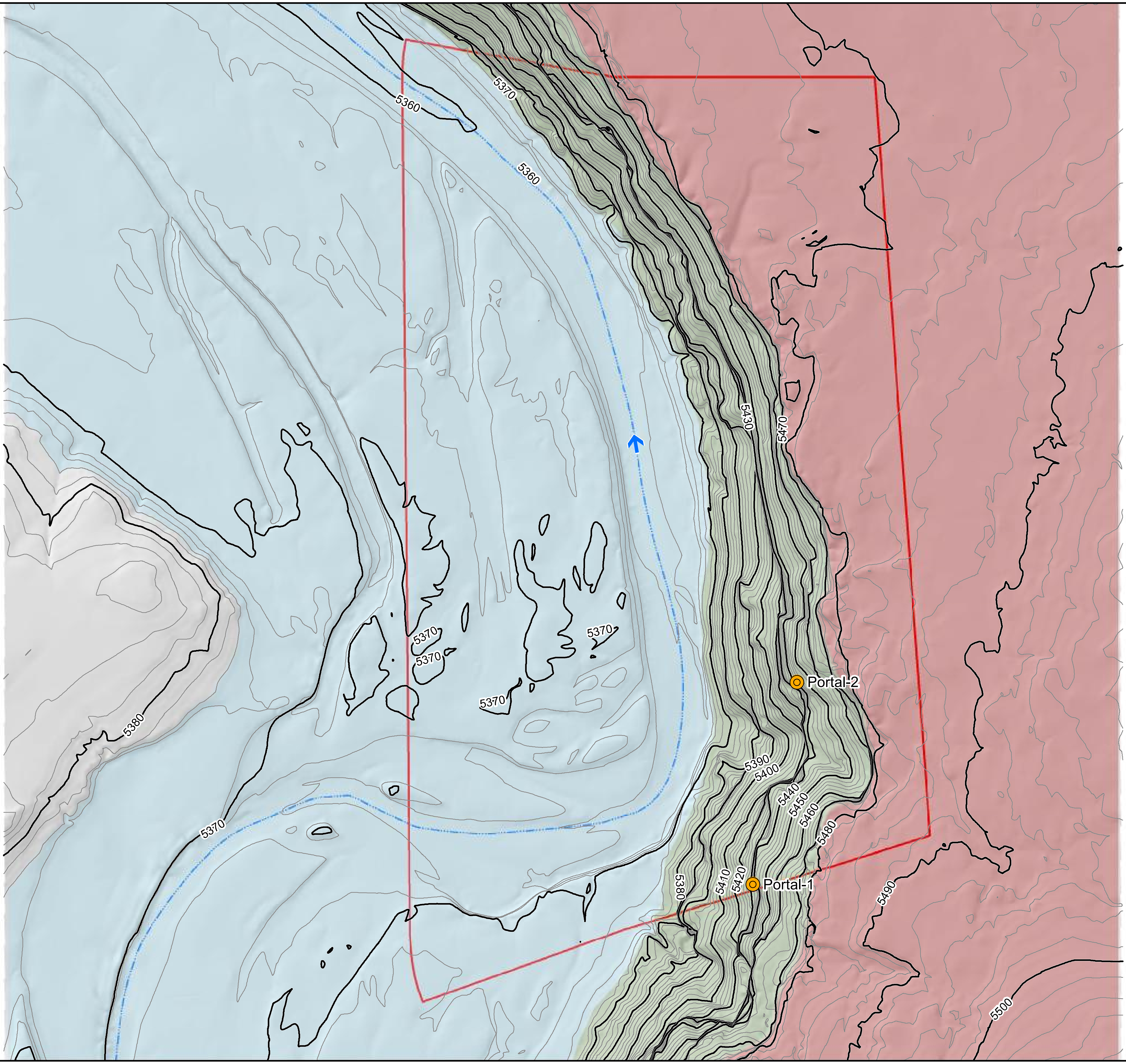

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

● Portal

↑ Flow Direction

Drainage

Index Contour (10 ft Interval)

Intermediate Contour (2 ft Interval)

Claim Boundary

Geomorphology Features

🟥 Mesa Top

🟩 Mesa Sidewall

🟦 Wash and Flood Plain

NOTE:
The extent of the base map is based on the Cooper aerial surveys conducted on June 16, 2017

REFERENCES:
Site-specific contours were generated as part of the Cooper aerial surveys conducted on June 16, 2017.

Coordinate System: NAD 1983 UTM Zone 12N

TITLE:

Site Topography

PROJECT:

Removal Site Evaluation
Alongo Mine Site

DATE: 7/18/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 2-4

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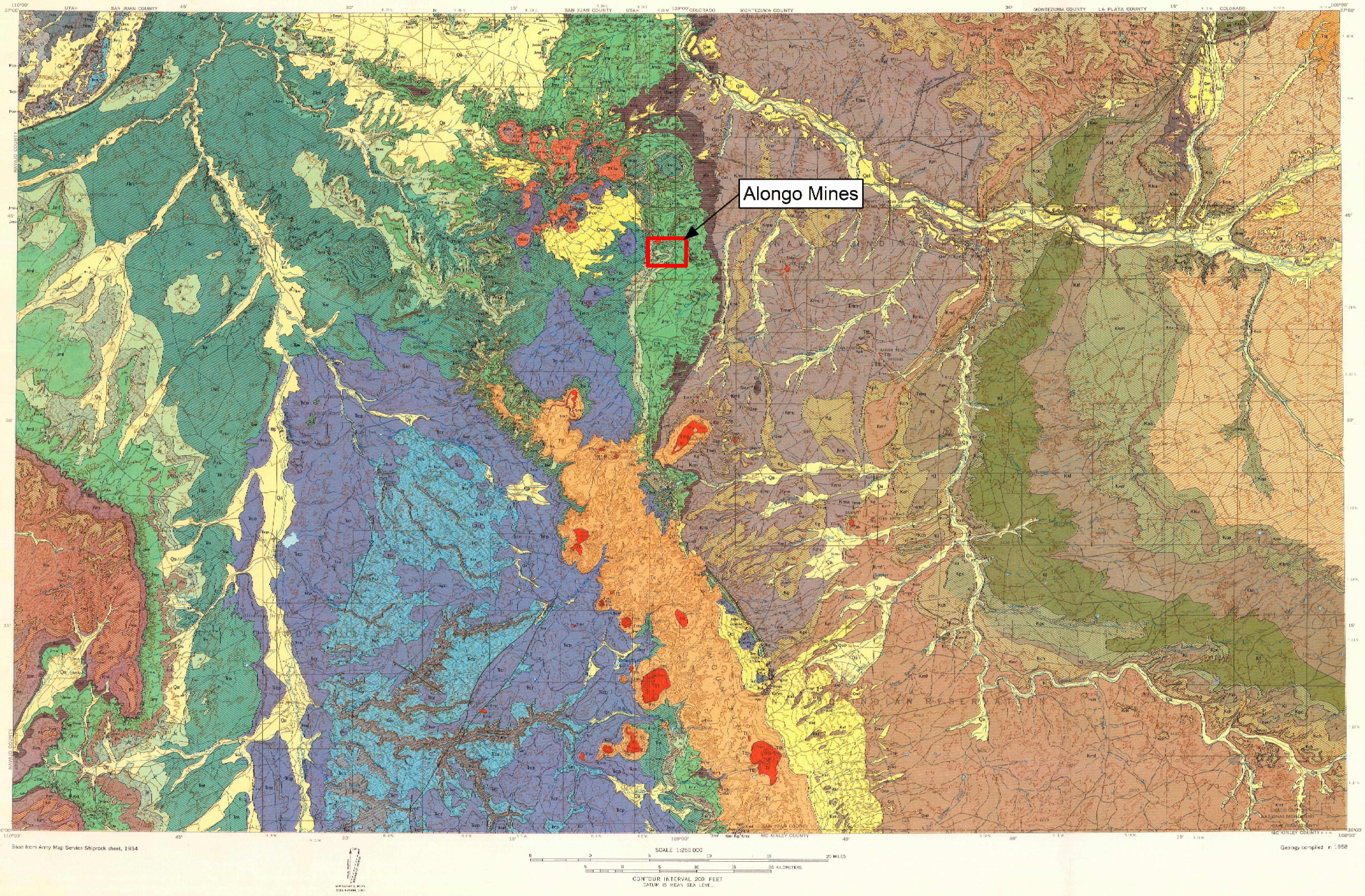
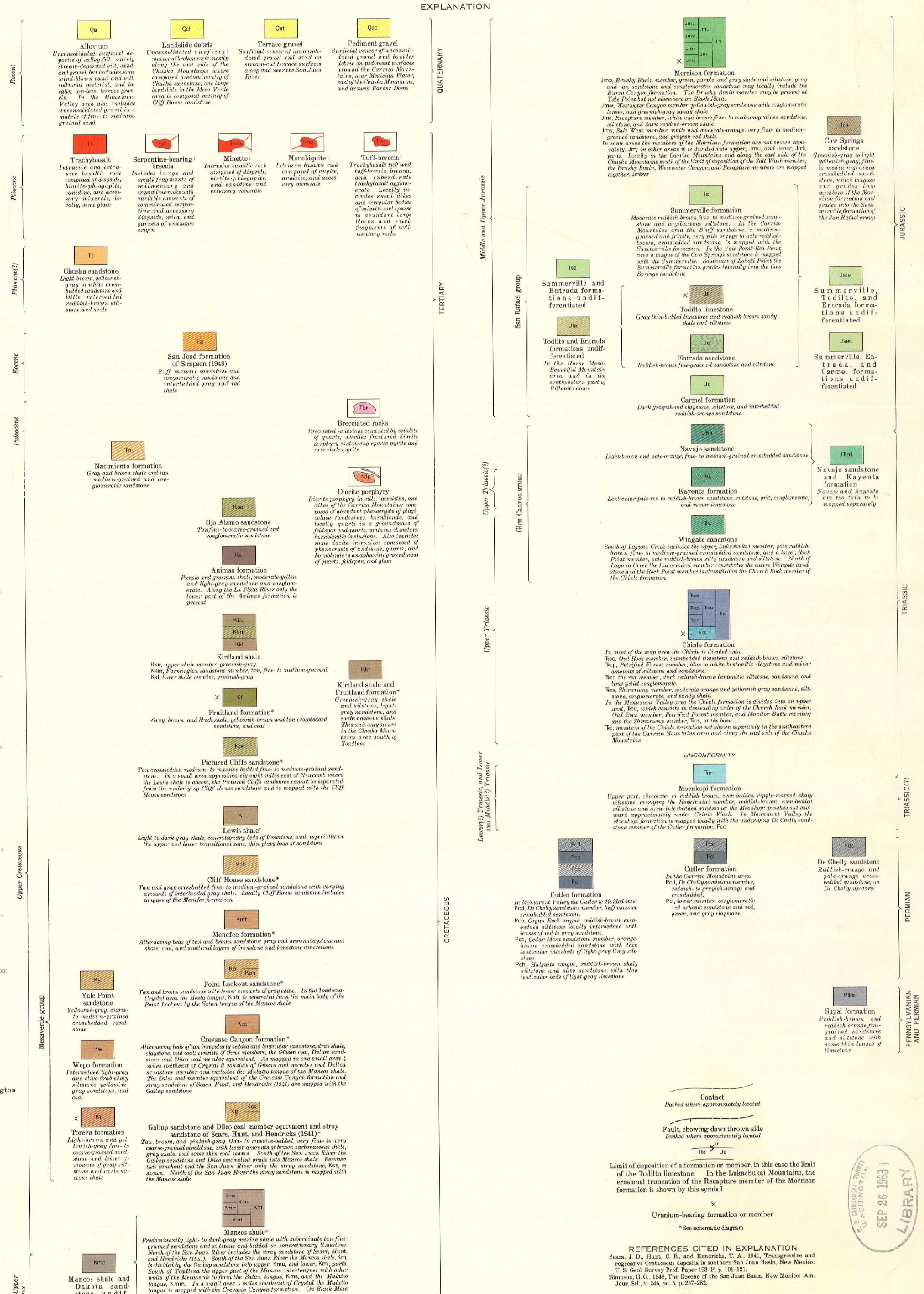
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
U.S. ATOMIC ENERGY COMMISSION

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-345 (SHEET 1-GEOLOGY)





Limit of deposition of a formation or member, in this case the limit of the Todilto limestone. In the Lukachukai Mountains, the erosional truncation of the Recapture member of the Morrison formation is shown by this symbol

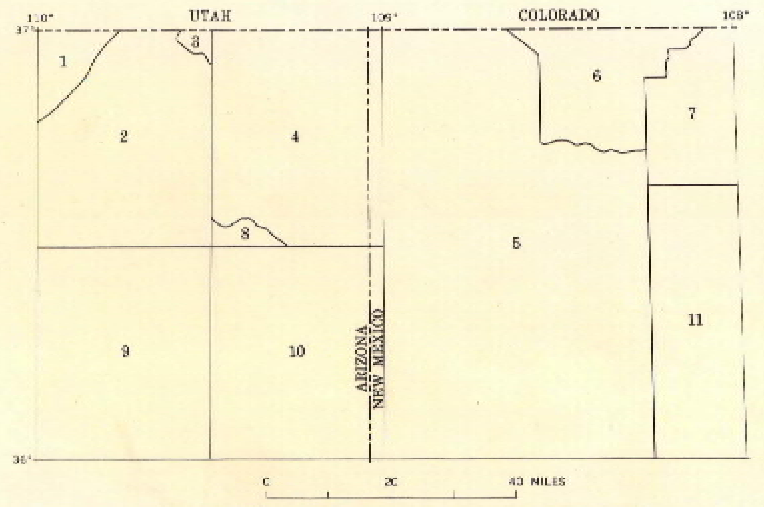
×

Uranium-bearing formation or member

*See schematic diagram

REFERENCES CITED IN EXPLANATION

Sears, J. D., Hunt, C. B., and Hendricks, T. A., 1941, Transgressive and regressive Cretaceous deposits in southern San Juan Basin, New Mexico: U. S. Geol. Survey Prof. Paper 193-F, p. 101-121.
Simpson, G. G., 1948, The Eocene of the San Juan Basin, New Mexico: Am. Jour. Sci., v. 246, no. 5, p. 257-282.

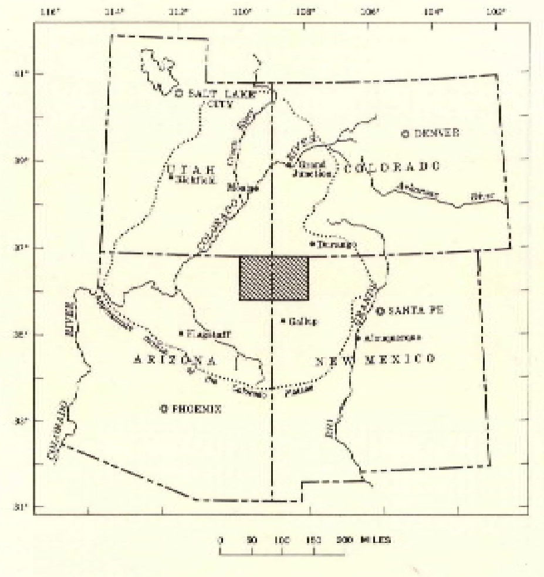


INDEX MAP SHOWING SOURCES OF GEOLOGIC DATA

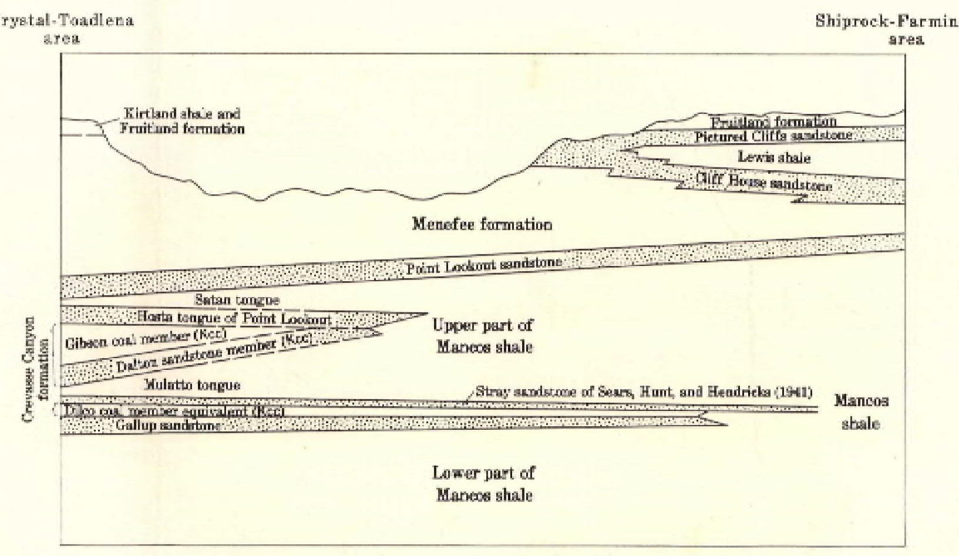
GEOLOGIC SOURCES

Numbers correspond to those given on key map
(*) indicates unpublished maps

1. Witkind, I. J., and others, U. S. Geol. Survey Mineral Inv. Field Studies Maps MF-92, 93, 95.
2. O'Sullivan, R. B., U. S. Geol. Survey detailed mapping (*).
3. Strobell, J. D., Jr., U. S. Geol. Survey detailed and photogeology mapping (*).
4. Strobell, J. D., Jr., U. S. Geol. Survey Oil and Gas Inv. Map OM-160 (supplemented by unpublished data in the central and southern part of the area).
5. O'Sullivan, R. B., and Beaumont, E. C., U. S. Geol. Survey Oil and Gas Inv. Map OM-190.
6. Hayes, P. T., and Zapp, A. D., U. S. Geol. Survey Oil and Gas Inv. Map OM-144.
7. Baltz, E. H., Beikman, H. M., and O'Sullivan, R. B., U. S. Geol. Survey photogeology and detailed geologic mapping (*).
8. Repenning, C. A., U. S. Geol. Survey detailed mapping (*).
9. Repenning, C. A., U. S. Geol. Survey open-file maps (modified in part by reconnaissance mapping by R. B. O'Sullivan).
10. Cooley, M. E., Irwin, J. H., Repenning, C. A., and Stevens, P. R., U. S. Geol. Survey open-file maps (modified in part by reconnaissance mapping by R.B. O'Sullivan).
11. O'Sullivan, R. B., U. S. Geol. Survey reconnaissance mapping (*).



INDEX MAP SHOWING AREA OF SHIPROCK QUADRANGLE



SCHEMATIC DIAGRAM SHOWING STRATIGRAPHIC RELATIONS OF MESAVERDE GROUP, EQUIVALENT FORMATIONS, AND THE MANCOS SHALE

GEOLOGY, STRUCTURE, AND URANIUM DEPOSITS OF THE SHIPROCK QUADRANGLE, NEW MEXICO AND ARIZONA

Compiled by
Robert B. O'Sullivan and Helen M. Beikman
1963

(200)M
MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-345 (SHEET 1-GEOLOGY)

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE\RSE_AlongoMines\RSE_AlongoMines_Geology_22x34_L_20170718.mxd

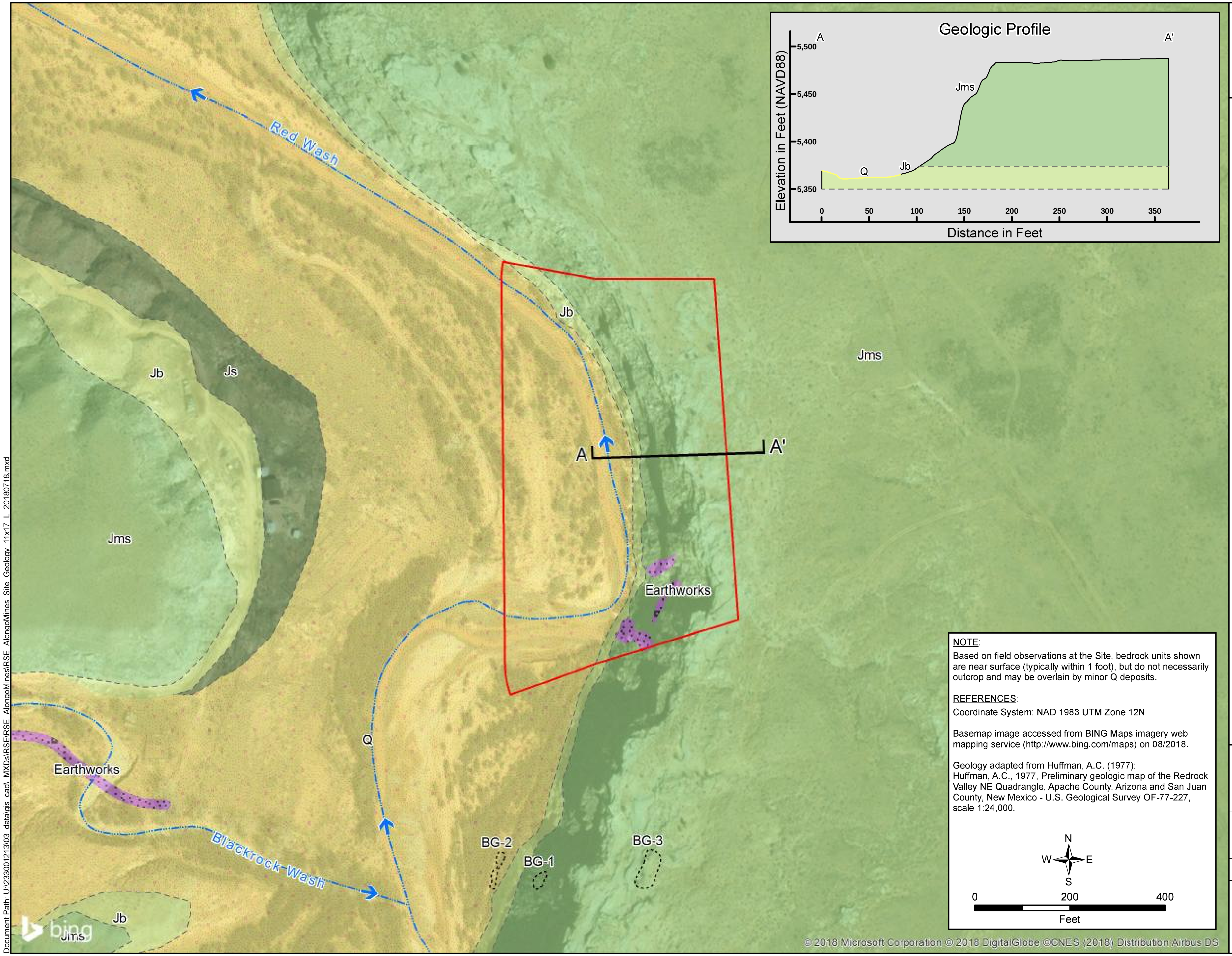
NAVAJO NATION
AUM Environmental Response Trust-First Phase

TITLE:
Regional Geology

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 7/18/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: CBB
REVIEWER: EDZ
FIGURE: 2-5

Stantec



NOTE:

Based on field observations at the Site, bedrock units shown are near surface (typically within 1 foot), but do not necessarily outcrop and may be overlain by minor Q deposits.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 08/2018.

Geology adapted from Huffman, A.C. (1977):
Huffman, A.C., 1977, Preliminary geologic map of the Redrock Valley NE Quadrangle, Apache County, Arizona and San Juan County, New Mexico - U.S. Geological Survey OF-77-227, scale 1:24,000.

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\RSE_AlongoMines_Site_Geology_11x17_L_20180718.mxd

NAVAJO NATION
AUM Environmental Response Trust

LEGEND

Geologic Profile

Flow Direction

Claim Boundary

Potential Background Reference Area

Drainage

Geologic Contact (Inferred)

Site Geology

HOLOCENE

Earthworks: Human-caused disturbance of the land surface

Q: Quaternary Deposits – Undifferentiated (Pleistocene and Holocene) – includes sandy to gravelly colluvial and alluvial deposits, and eolian sand deposits.

JURASSIC

Jms: Salt Wash Member of the Morrison Formation (Upper Jurassic) – Yellowish gray to greenish-gray cross-bedded very fine to medium-grained calcareous sandstone interbedded with greenish-gray and reddish-brown claystone.

Jb: Bluff Sandstone (Upper Jurassic)- Moderate reddish-orange to light-brown, fine to medium grained laminated sandstone.

Js: Summerville Formation (Upper Jurassic) – Reddish-brown to light-orange very fine- to fine-grained flat bedded silty sandstone and thin-bedded silty sandstone, claystone, and siltstone; forms banded steep slopes and cliffs.

TITLE:

Site Geology

PROJECT:

Removal Site Evaluation
Alongo Mines Site

DATE: 8/28/2018

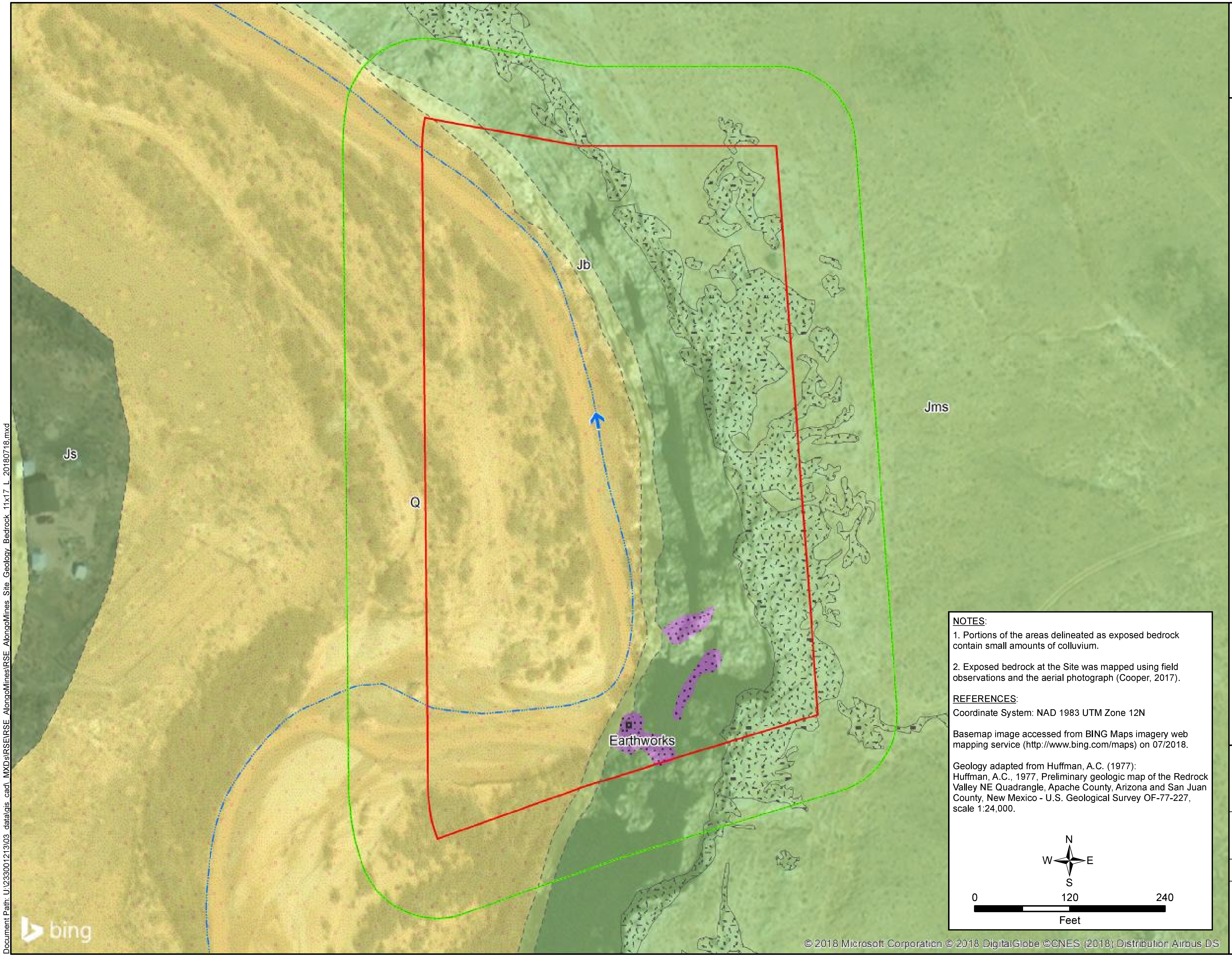
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 2-6a



NOTES:

1. Portions of the areas delineated as exposed bedrock contain small amounts of colluvium.

2. Exposed bedrock at the Site was mapped using field observations and the aerial photograph (Cooper, 2017).

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 07/2018.

Geology adapted from Huffman, A.C. (1977): Huffman, A.C., 1977, Preliminary geologic map of the Redrock Valley NE Quadrangle, Apache County, Arizona and San Juan County, New Mexico - U.S. Geological Survey OF-77-227, scale 1:24,000.

NAVAJO NATION
AUM Environmental Response Trust

LEGEND

↑ Flow Direction

Drainage

Claim Boundary

100-Foot Claim Buffer

Geologic Contact (Inferred)

Exposed Bedrock¹

Site Geology

HOLOCENE

Earthworks: Human-caused disturbance of the land surface

Q: Quaternary Deposits – Undifferentiated (Pleistocene and Holocene) – includes sandy to gravelly colluvial and alluvial deposits, and eolian sand deposits.

JURASSIC

Jms: Salt Wash Member of the Morrison Formation (Upper Jurassic) – Yellowish gray to greenish-gray cross-bedded very fine to medium-grained calcareous sandstone inter-bedded with greenish-gray and reddish-brown claystone.

Jb: Bluff Sandstone (Upper Jurassic)- Moderate reddish-orange to light-brown, fine to medium grained laminated sandstone.

Js: Summerville Formation (Upper Jurassic) – Reddish-brown to light-orange very fine- to fine-grained flat bedded silty sandstone and thin-bedded silty sandstone, claystone, and siltstone; forms banded steep slopes and cliffs.

TITLE:
Site Exposed Bedrock

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 7/18/2018

DOCUMENT NAME: Removal Site Evaluation Report

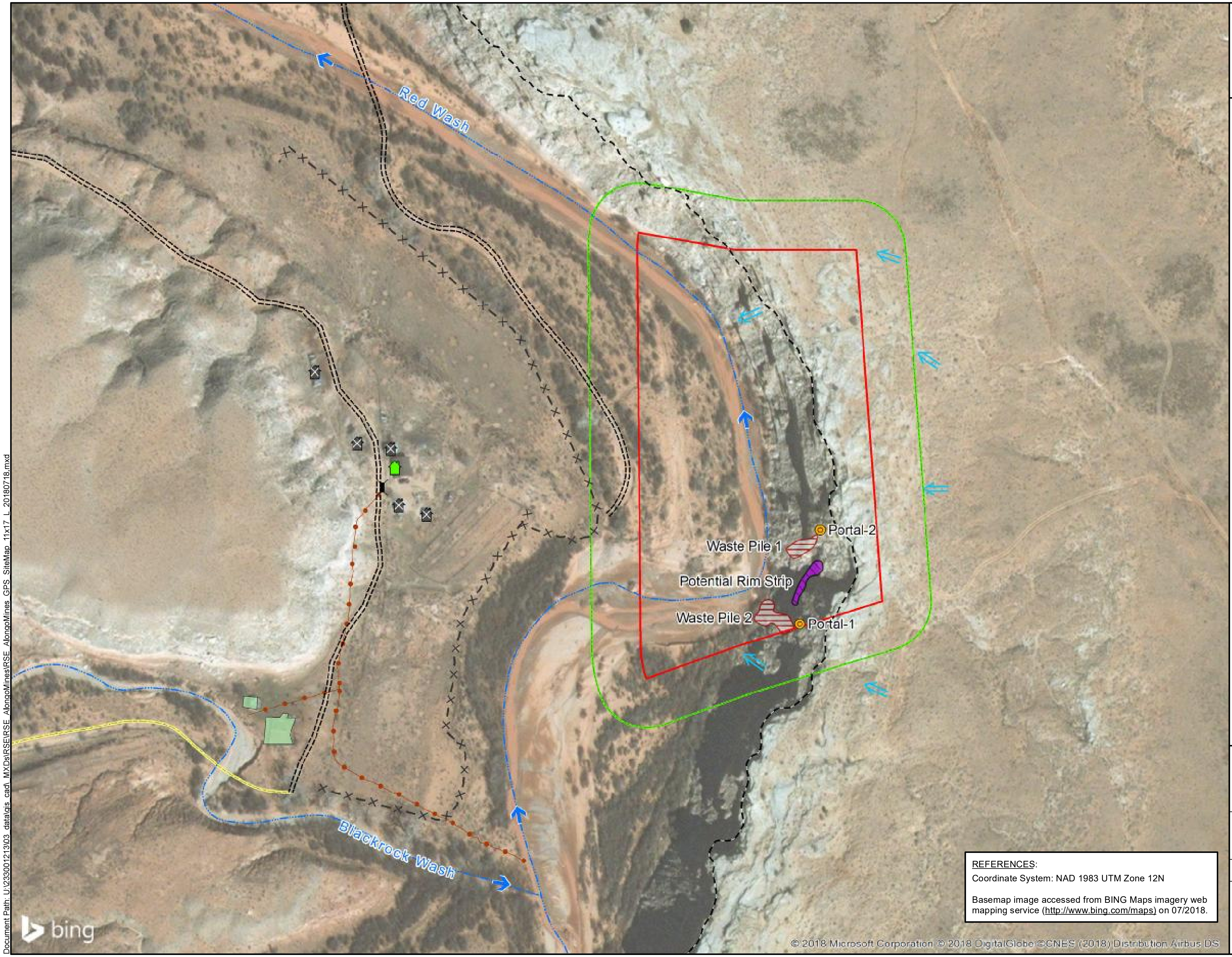
Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 2-6b

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\RSE_AlongoMines_Site_Geology_Bedrock_11x17_L_20180718.mxd



REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 07/2018.

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE AlongoMines\RSE AlongoMines GPS SiteMap 11x17 L 20180718.mxd

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

⌶	Gate
🟩	Habitable Building
◎	Portal
☒	Uninhabitable Building
↑	Flow Direction
⇑	Approximate Overland Water Flow Direction
-·-·-·-	Drainage
×—×—×	Fence
-------	Potential Haul Road
•—•—•	Power Line
=========	Road
- - - -	Approximate Edge of Mesa
🟩	Corral
▨	Potential Rim Strip
▤	Waste Pile
🟥	Claim Boundary
▢	100-Foot Claim Buffer

N
W E
S

0 200 400
Feet

TITLE:
Site Map

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 7/18/2018

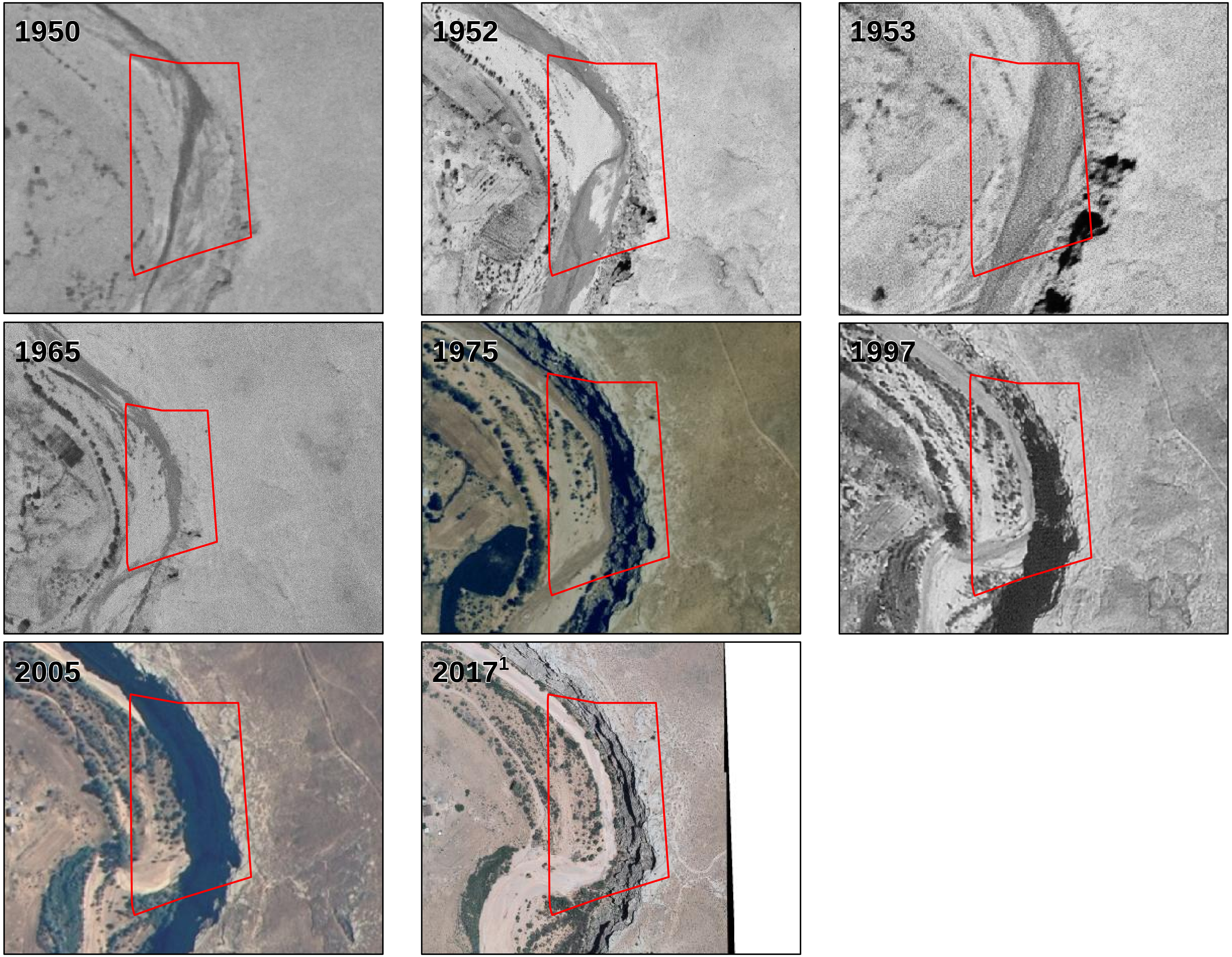
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 2-7



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

🟥 Alongo Mines Claim Boundary

NOTE:
1. Site-specific imagery flown by Cooper Aerial Surveys Co. on June 16, 2017.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Historical Aerial Imagery downloaded from https://earthexplorer.usgs.gov/ (01/2016)

N
W E
S

0 400 800
Feet

TITLE:

Historical Aerial Photograph Comparison

PROJECT:
Removal Site Evaluation
Alongo Mines Mine Site

DATE: 7/18/2018

DOCUMENT NAME: Removal Site Evaluation Report

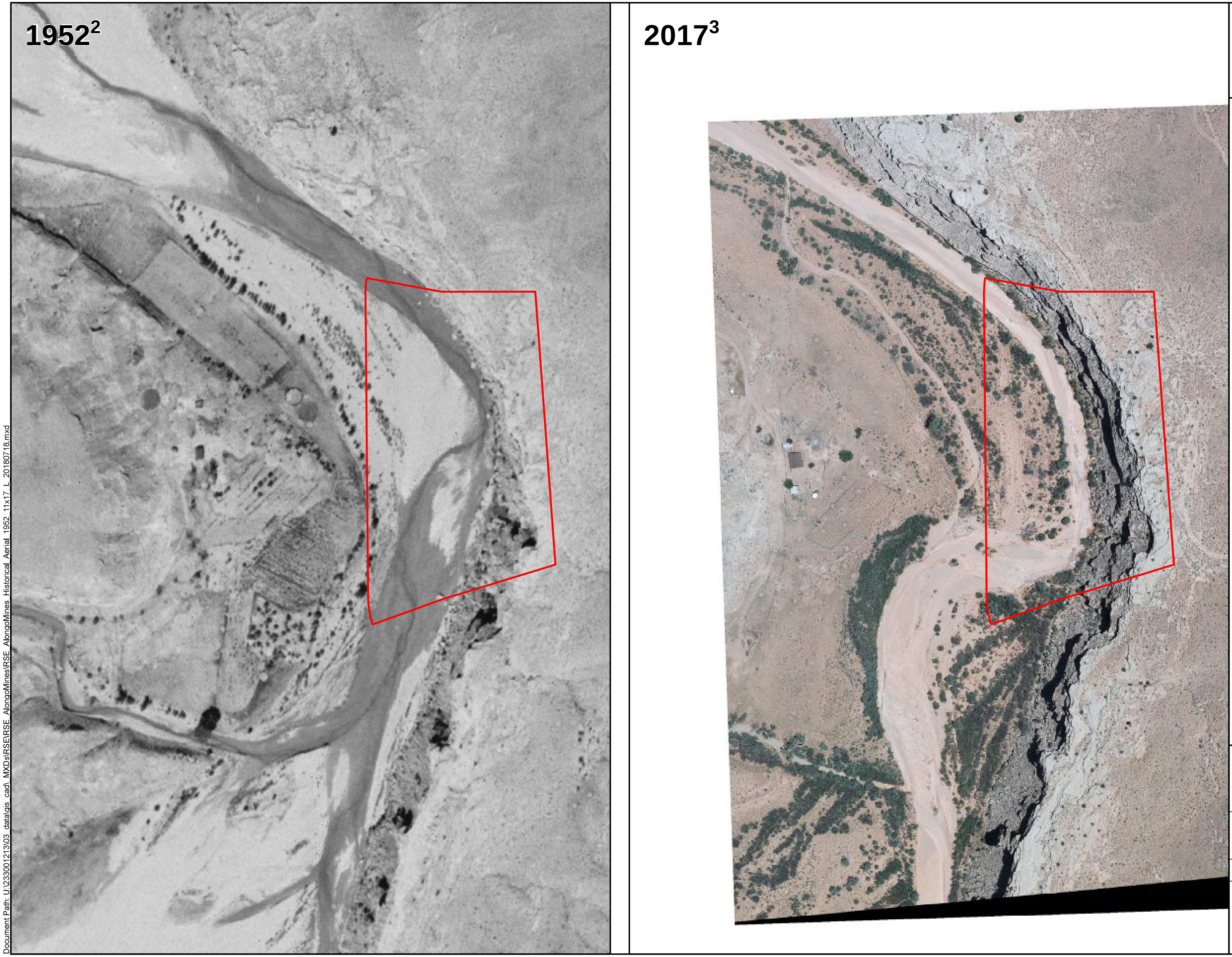
AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 3-1a

Stantec

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\RSE_AlongoMines_Historical_Aerial_Compilation_11x17_L_20180718.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

🟥 Claim Boundary

REFERENCES:

1. Coordinate System: NAD 1983 UTM Zone 12N

2. 1952 aerial image downloaded from https://earthexplorer.usgs.gov/ (01/2016) and georeferenced using current image from BING (03/2016).

3. Site-specific imagery flown by Cooper Aerial Surveys Co. on June 16, 2017.

N
W E
S

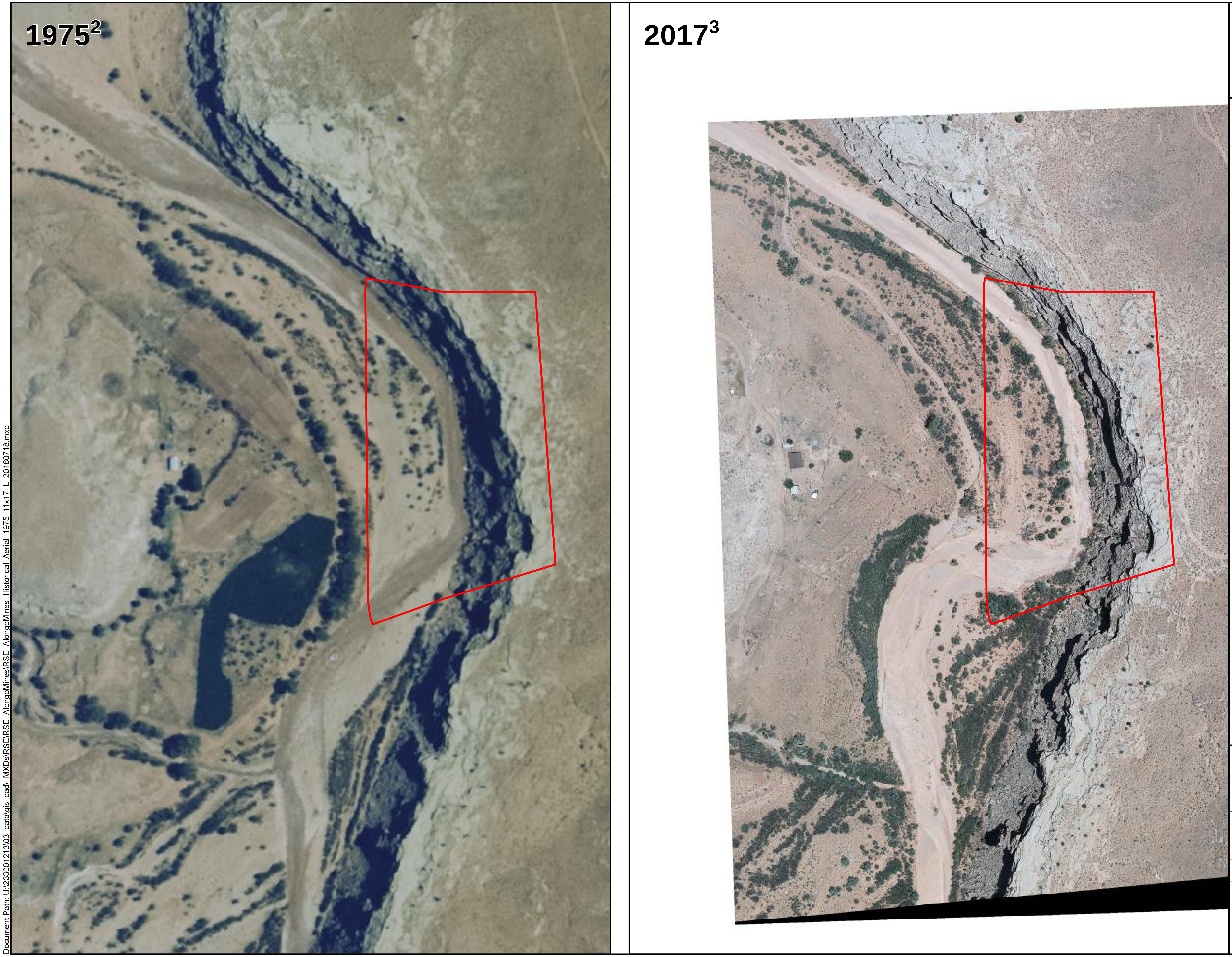
0 250 500
Feet

TITLE:
1952 Historical Aerial
Photograph Comparison

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 7/18/2018	DOCUMENT NAME: Removal Site Evaluation Report
Stantec	AUTHOR: EDZ REVIEWER: CBB
	FIGURE: 3-1b

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\RSE_AlongoMines_Historical_Aerial_1952_11x17_L_20180718.mxd



1975[2]

2017[3]

NAVAJO
NATION
AUM Environmental
Response Trust-First Phase

LEGEND

🟥 Claim Boundary

REFERENCES:
1. Coordinate System: NAD 1983 UTM Zone 12N

2. 1975 aerial image downloaded from https://earthexplorer.usgs.gov/ (01/2016) and georeferenced using current image from BING (03/2016).

3. Site-specific imagery flown by Cooper Aerial Surveys Co. on June 16, 2017.

TITLE:
1975 Historical Aerial
Photograph Comparison

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 7/18/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 3-1c

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE AlongoMines\RSE AlongoMines Historical Aerial 1975 11x17 L 20180718.mxd

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE AlongoMines\RSE AlongoMines Background Areas 11x17 L 20180718.mxd

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NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

↑	Flow Direction
⋯	Drainage
▨	Potential Background Reference Area
🟥	Claim Boundary
🟩	100-Foot Claim Buffer

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 08/2018.

N
W E
S

0 150 300
Feet

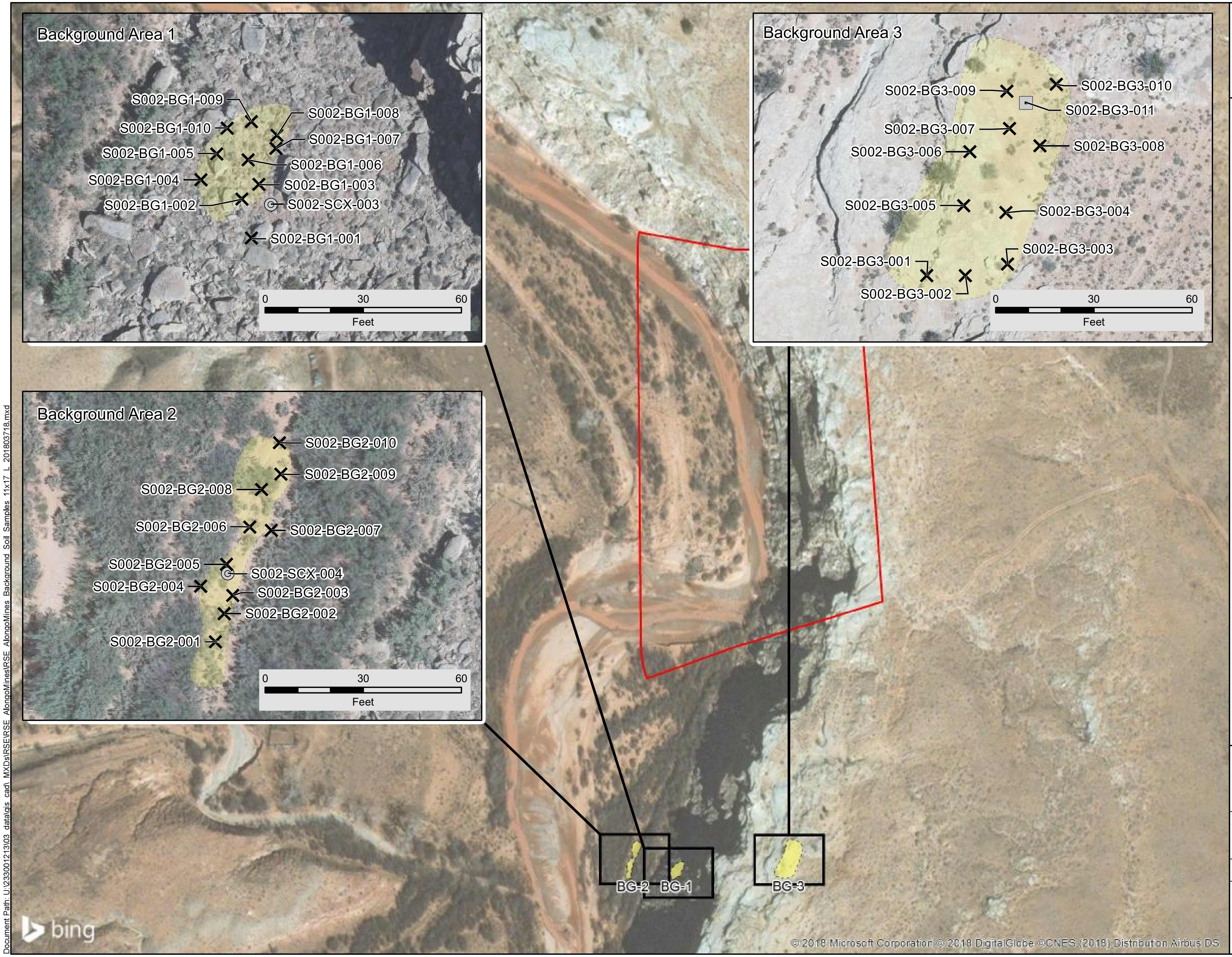
TITLE:
Potential Background Reference Areas

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 8/28/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: EDZ
REVIEWER: CBB
FIGURE: 3-2

Stantec

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\RSE_AlongoMines_Background_Soil_Samples_11x17_L_201803718.mxd



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NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
▣	Borehole Location - Surface Samples Only
🟨	Background Reference Area
🟥	Claim Boundary

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Main display basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 08/2018.

Basemap image insets for Backgroud Areas flown by Cooper Aerial Surveys Co. on June 16, 2017.

N
W E
S

0 200 400
Feet

TITLE:
Background Reference Areas - Sample Locations

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 8/28/2018

DOCUMENT NAME: Removal Site Evaluation Report

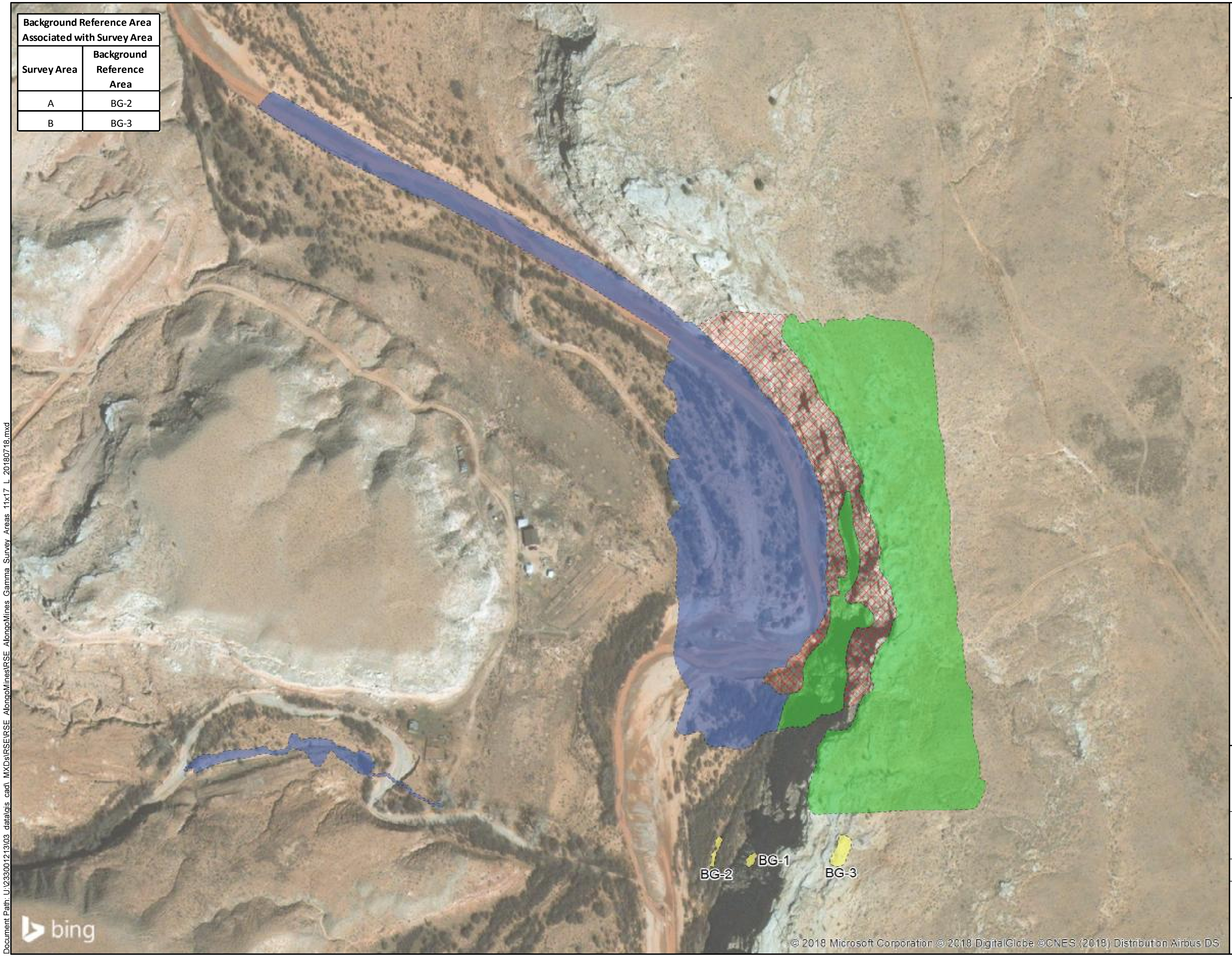
Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 3-3

Background Reference Area Associated with Survey Area	
Survey Area	Background Reference Area
A	BG-2
B	BG-3



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Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\RSE_AlongoMines_Gamma_Survey_Areas_11x17_L_20180718.mxd

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

🟨 Background Reference Area
🟦 Survey Area A
🟩 Survey Area B
▨ Unsurveyed Area[1]

NOTES:
1. Areas within Survey Areas (2.8 acres) that were not surveyed due to steep/unsafe terrain.

2. Gamma survey area is approximately 18.2 acres.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

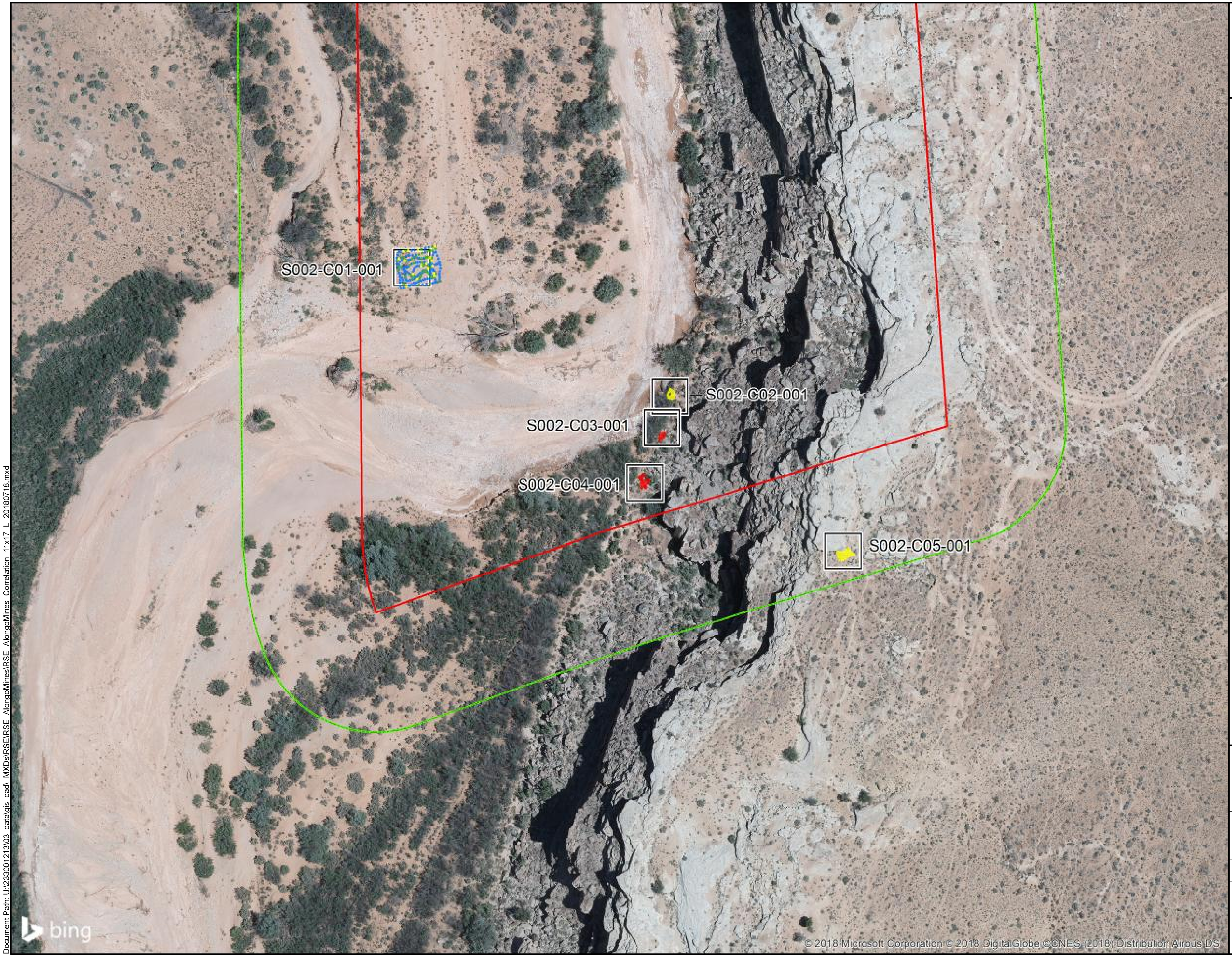
Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 08/2018.

N
W E
S
0 250 500
Feet

TITLE:
Gamma Radiation
Survey Areas

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 8/28/2018	DOCUMENT NAME: Removal Site Evaluation Report	
Stantec	AUTHOR: EDZ	REVIEWER: CBB
	FIGURE: 3-4	



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

☐ S002-C01-001
Correlation Location
(30' x 30')

🟥 Claim Boundary

🟩 100-Foot Claim Buffer

Gamma Survey
Counts per Minute (CPM)

- ● 9,222 - 11,686 (Minimum to BG-3 UTL)
- ● 11,687 - 13,088 (>BG-3 UTL to BG-2 UTL)
- ● 13,089 - 26,176 (>BG-2 UTL to 2x BG-2 UTL)
- ● 26,177 - 56,956 (>2x BG-2 UTL to 5x BG-2 UTL)

NOTE:
Each correlation sample consists of five grab samples collected from 0.0 - 0.5 feet below ground surface, composited together for laboratory analysis.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image flown by Cooper Aerial Surveys Co. on June 16, 2017.

N
W E
S

0 80 160
Feet

TITLE:
Gamma Correlation
Study Locations

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 7/18/2018

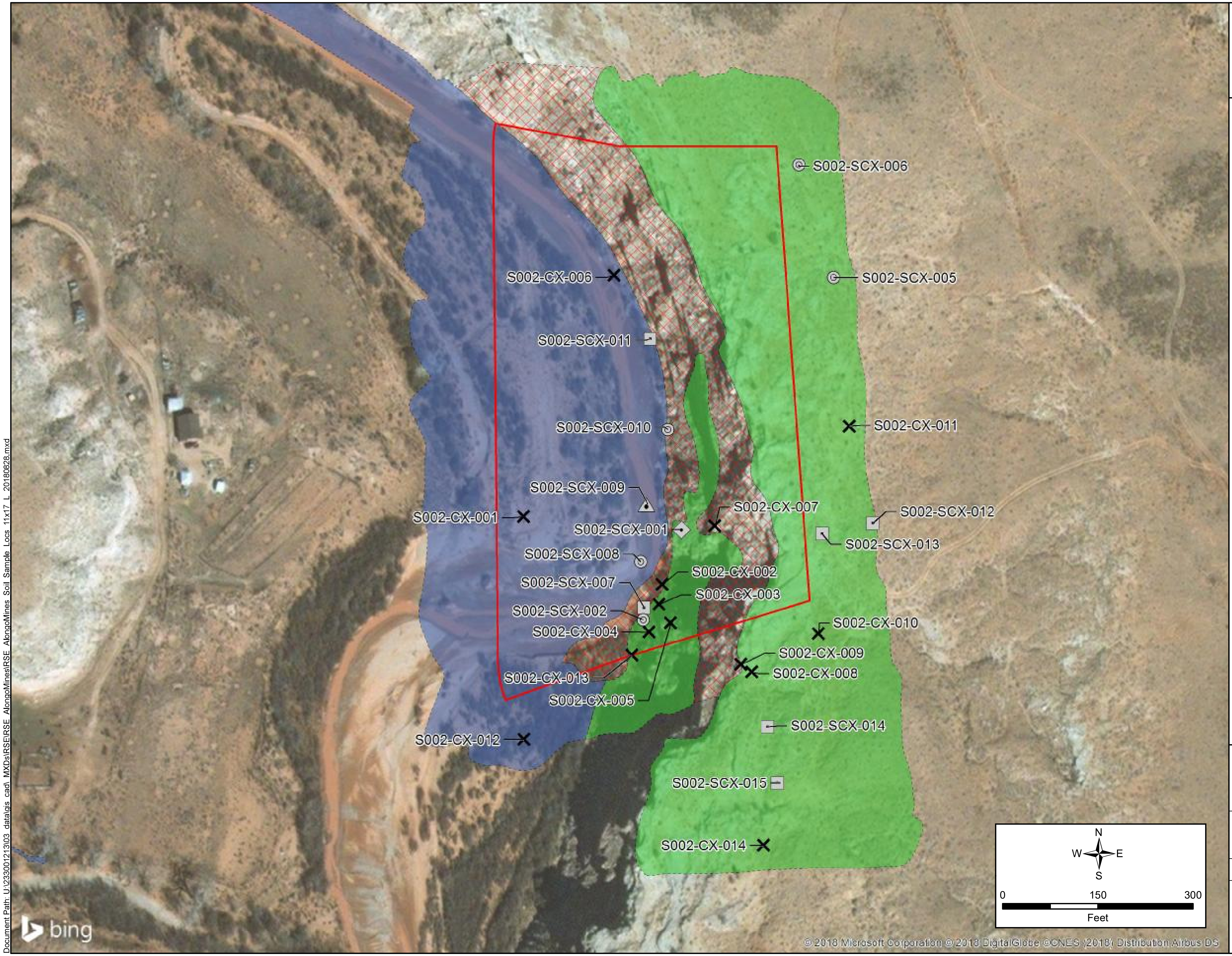
DOCUMENT NAME: Removal Site Evaluation Report

AUTHOR: EDZ
REVIEWER: CBB

Stantec

FIGURE: 3-5

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE AlongoMines\RSE AlongoMines Correlation 11x17 L 20180718.mxd



Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE AlongoMines\RSE AlongoMines Soil Sample Locs 11x17 L 20180828.mxd

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

- ✕ Surface Sample Location
- ◎ Borehole Location - Surface and Subsurface Samples
- ⊡ Borehole Location - Surface Samples Only
- △ Borehole Location - Static Gamma Data Only
- ◇ Borehole Location - Subsurface Sample Only (S002-SCX-001)
- 🟦 Survey Area A
- 🟩 Survey Area B
- ▨ Unsurveyed Area
- 🟥 Claim Boundary

NOTES:

Surface and subsurface static gamma measurements were collected at all borehole locations with two exceptions; only subsurface static gamma measurements were collected at S002-SCX-002 and S002-SCX-009.

Surface soil samples range from 0.0 - 0.5 feet below ground surface (ft bgs)

Subsurface soil samples range from 0.5 - 3.4 ft bgs

Static gamma measurements range from 0.0 - 3.3 ft bgs

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 08/2018.

TITLE:

Site Characterization Surface and Subsurface Sample Locations

PROJECT:

Removal Site Evaluation
Alongo Mines Site

DATE: 8/28/2018

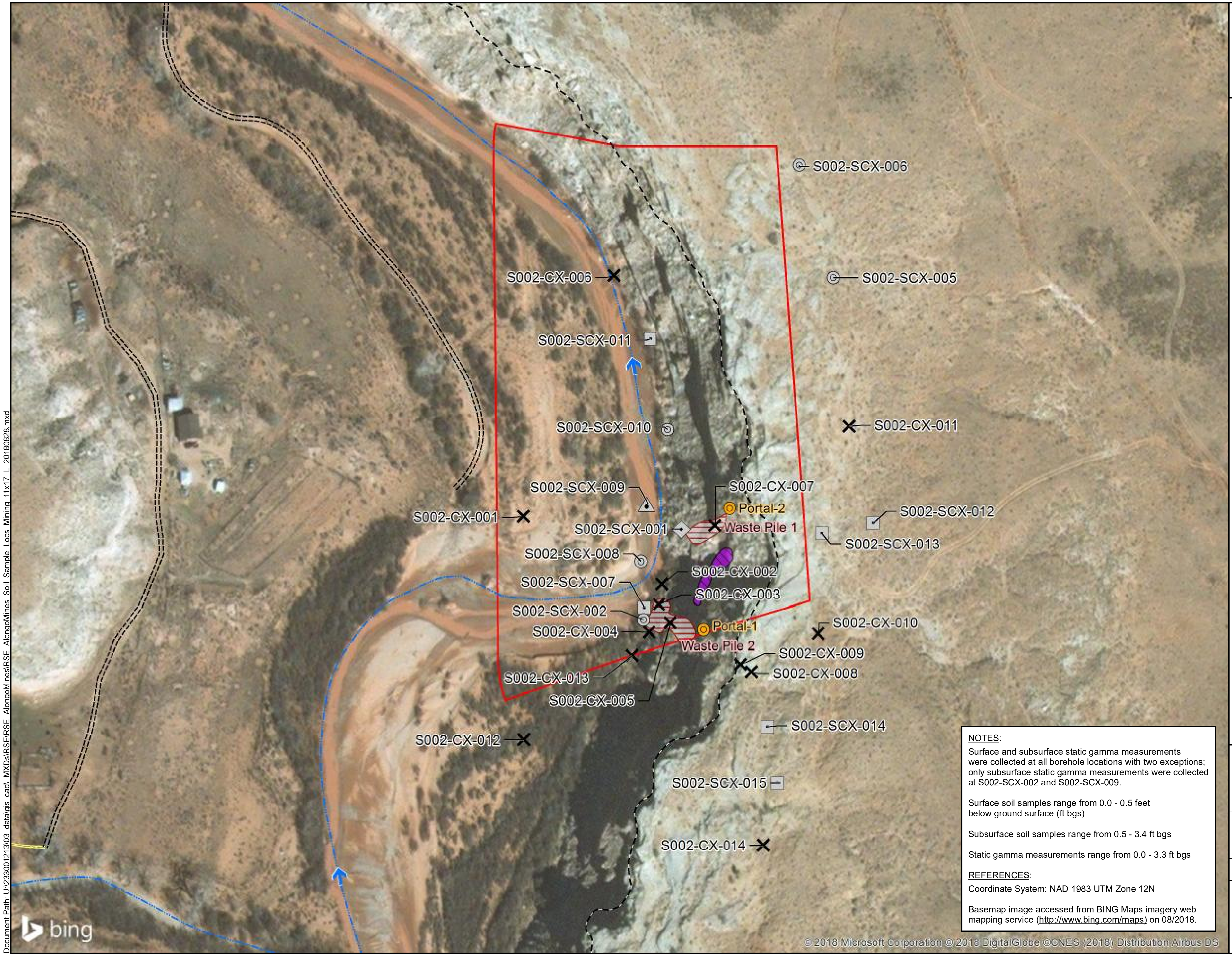
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 3-6a



NOTES:

Surface and subsurface static gamma measurements were collected at all borehole locations with two exceptions; only subsurface static gamma measurements were collected at S002-SCX-002 and S002-SCX-009.

Surface soil samples range from 0.0 - 0.5 feet below ground surface (ft bgs)

Subsurface soil samples range from 0.5 - 3.4 ft bgs

Static gamma measurements range from 0.0 - 3.3 ft bgs

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 08/2018.

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
▣	Borehole Location - Surface Samples Only
△	Borehole Location - Static Gamma Data Only
◈	Borehole Location - Subsurface Sample Only (S002-SCX-001)
◉	Portal
↑	Flow Direction
-·-·-·	Drainage
------	Potential Haul Road
=========	Road
- - - -	Approximate Edge of Mesa
▨	Potential Rim Strip
▤	Waste Pile
☐	Claim Boundary

N
W E
S

0 150 300
Feet

TITLE:
Sample Locations Compared
to Mining-Related Features

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 8/28/2018

DOCUMENT NAME: Removal Site Evaluation Report

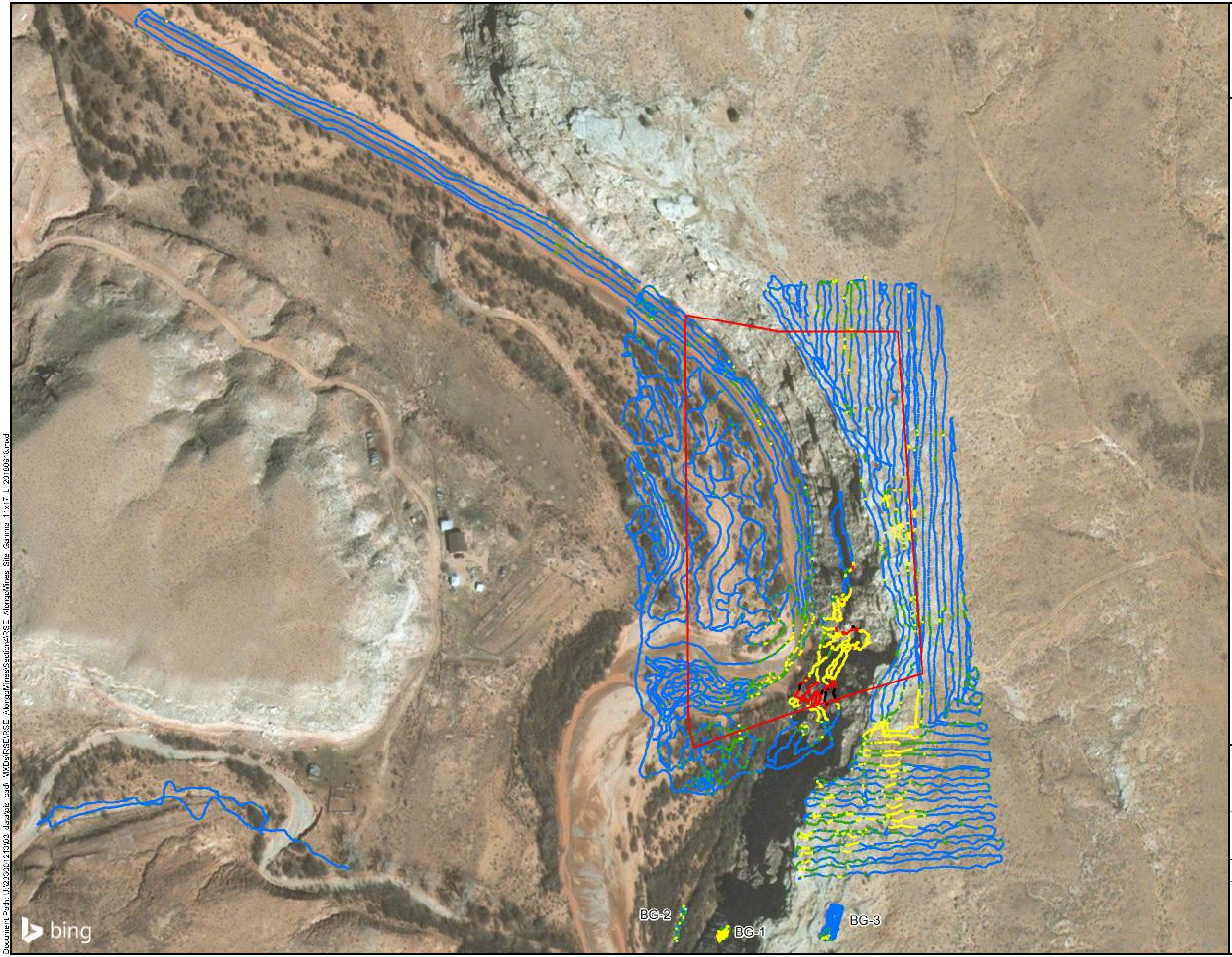
Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 3-6b

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\RSE_AlongoMines_Soil_Sample_Locs_Mining_11x17_L_20180828.mxd



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

🟥 Claim Boundary

Gamma Survey

Counts per Minute (CPM)

- ● 7,074 - 11,686 (Minimum to BG-3 IL)
- ● 11,687 - 13,088 (>BG-3 IL to BG-2 IL)
- ● 13,089 - 26,176 (>BG-2 IL to 2x BG-2 IL)
- ● 26,177 - 65,440 (>2x BG-2 IL to 5x BG-2 IL)
- ● 65,441 - 115,161 (>5x BG-2 IL to Maximum)

NOTE:
Refer to Figure 3-4 for Survey Area delineation.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

N
W E
S

0 200 400
Feet

TITLE:
Gamma Radiation
Survey Results

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/19/2018

DOCUMENT NAME: Removal Site Evaluation Report

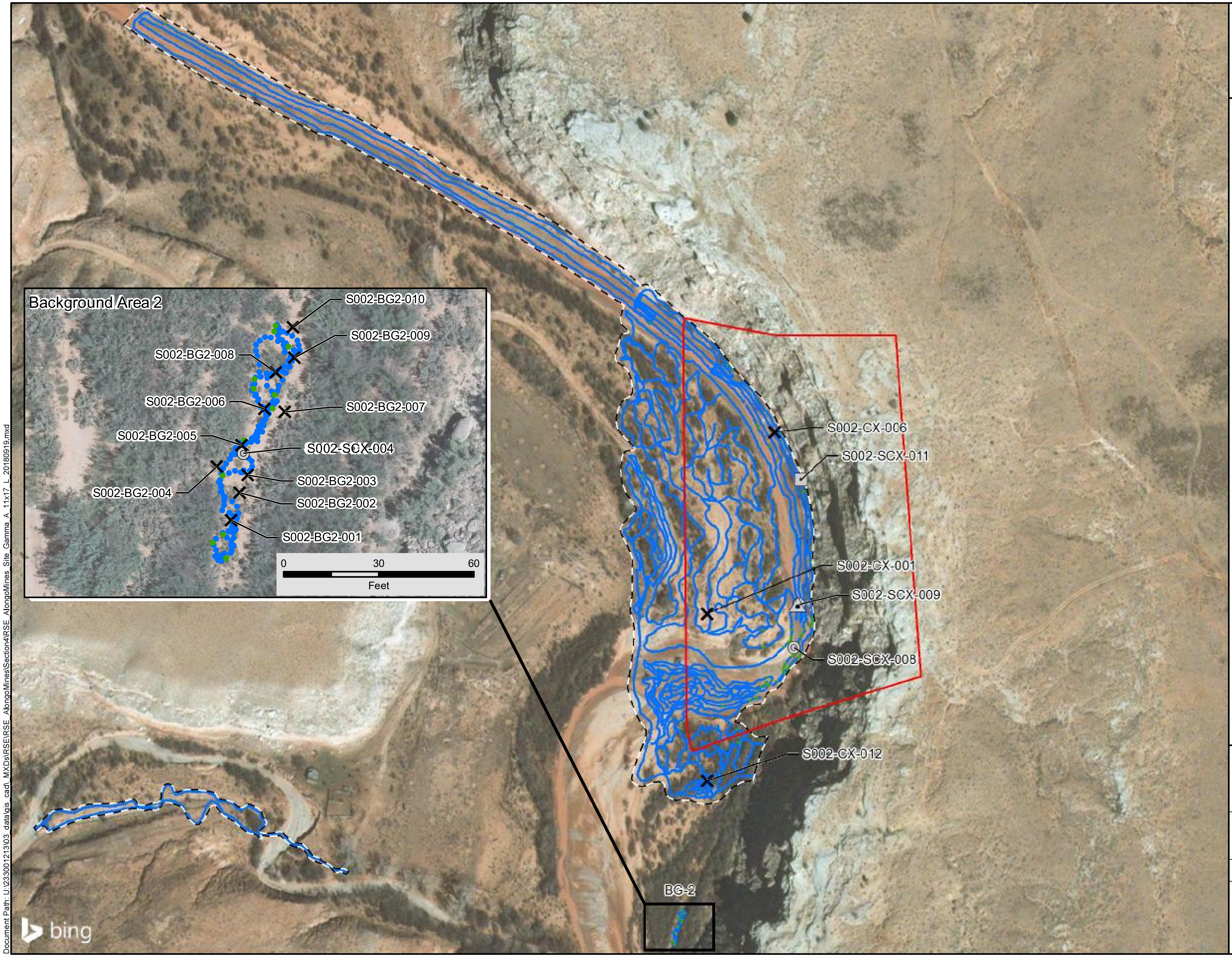
Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-1a

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\Section4\RSE_AlongoMines_Site_Gamma_11x17_L_20180918.mxd



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
▣	Borehole Location - Surface Samples Only
△	Borehole Location - Static Gamma Data Only (SCX-009)
⬚	Survey Area A
🟥	Claim Boundary

Gamma Survey

Counts per Minute (CPM)

●	7,233 - 13,088 (Minimum to BG-2 IL)
●	13,089 - 15,920 (>BG-2 IL to Maximum)

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

Inset basemap image flown by Cooper Aerial Surveys Co. on June 16, 2017.

N
W E
S

0 200 400
Feet

TITLE:
Gamma Radiation Survey
Results for Survey Area A

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/19/2018

DOCUMENT NAME: Removal Site Evaluation Report

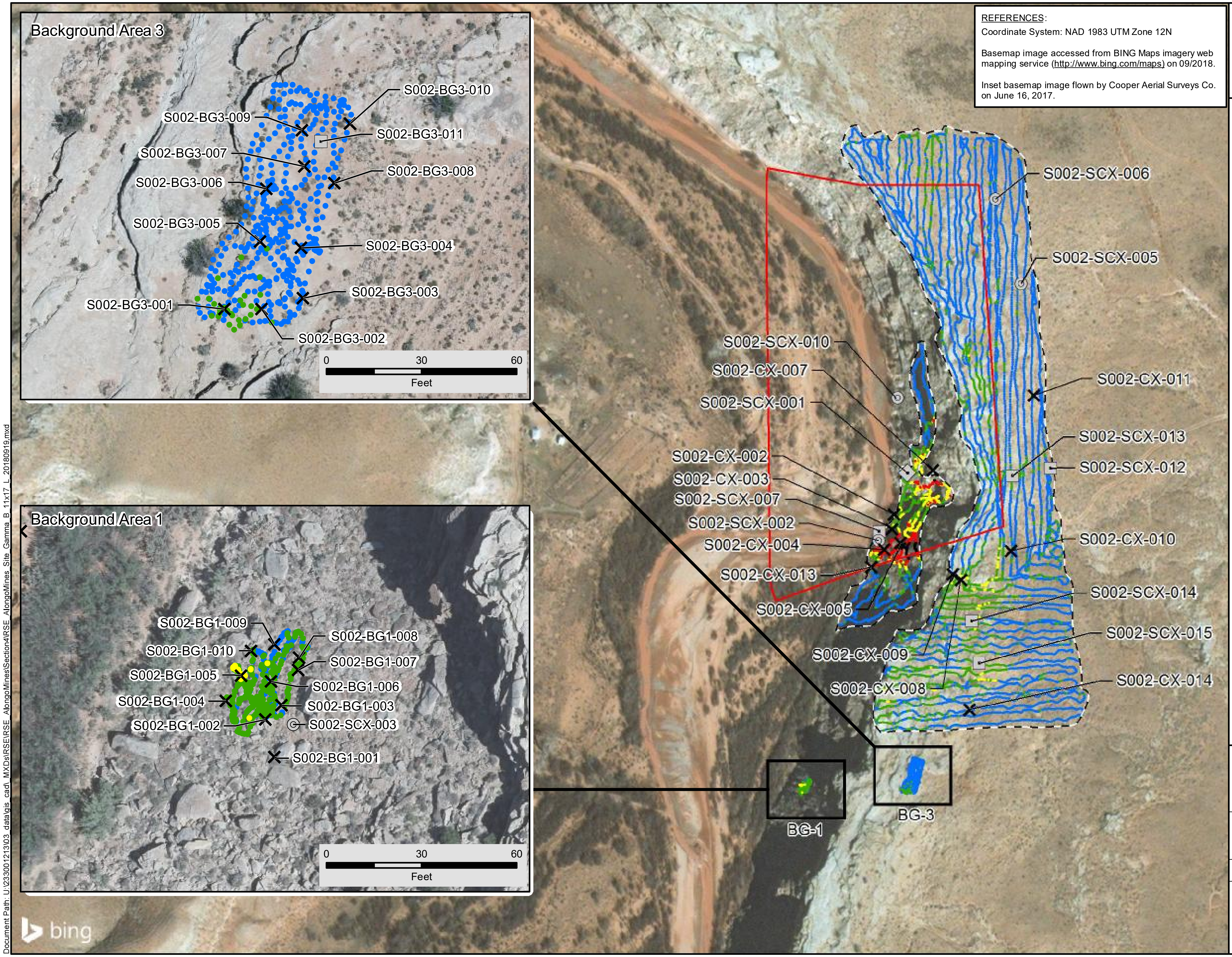
AUTHOR: EDZ

REVIEWER: CBB

Stantec

FIGURE: 4-1b

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\Section4\RSE_AlongoMines_Site_Gamma_A_11x17_L_20180919.mxd



REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

Inset basemap image flown by Cooper Aerial Surveys Co. on June 16, 2017.

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

✕ Surface Sample Location

◎ Borehole Location - Surface and Subsurface Samples

▣ Borehole Location - Surface Samples Only

◈ Borehole Location - Subsurface Sample Only (SCX-001)

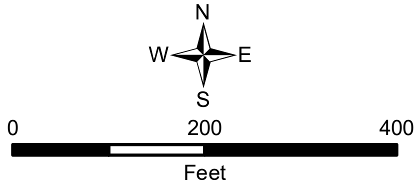
🟥 Claim Boundary

⬚ Survey Area B

Gamma Survey

Counts per Minute (CPM)

- ● 7,074 - 11,686 (Minimum to BG-3 IL)
- ● 11,687 - 16,235 (>BG-3 IL to BG-1 IL)
- ● 16,236 - 23,372 (>BG-1 IL to 2x BG-3 IL)
- ● 23,373 - 58,430 (>2x BG-3 IL to 5x BG-3 IL)
- ● 58,431 - 115,161 (>5x BG-3 IL to Maximum)



TITLE:

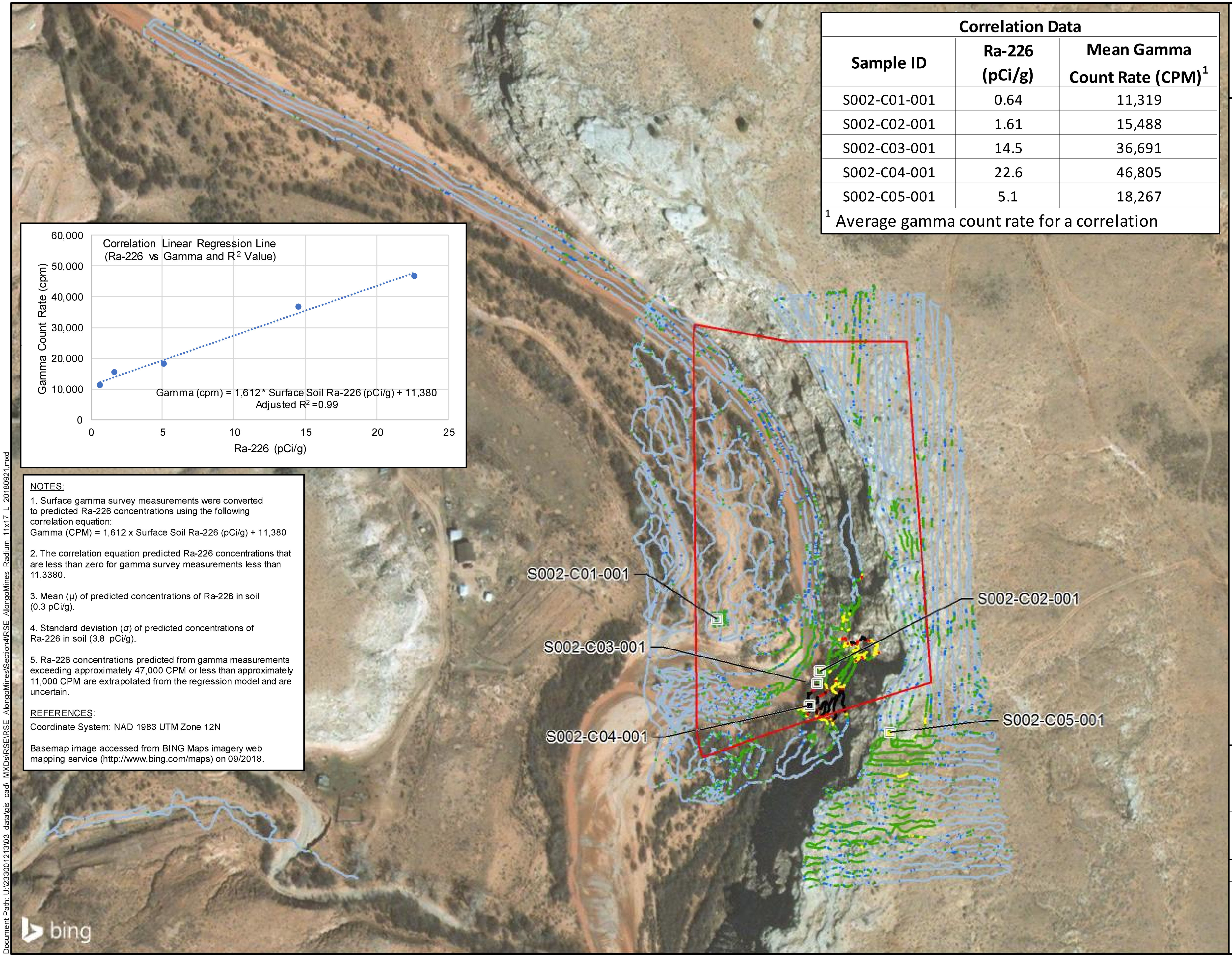
Gamma Radiation Survey
Results for Survey Area B

PROJECT:

Removal Site Evaluation
Alongo Mines Site

DATE: 9/19/2018	DOCUMENT NAME: Removal Site Evaluation Report
Stantec	AUTHOR: EDZ
	REVIEWER: CBB
	FIGURE: 4-1c

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE AlongoMines\Section4\RSE AlongoMines Site Gamma B 11x17 L 20180919.mxd



Correlation Data		
Sample ID	Ra-226 (pCi/g)	Mean Gamma Count Rate (CPM)[1]
S002-C01-001	0.64	11,319
S002-C02-001	1.61	15,488
S002-C03-001	14.5	36,691
S002-C04-001	22.6	46,805
S002-C05-001	5.1	18,267

[1] Average gamma count rate for a correlation

NOTES:

1. Surface gamma survey measurements were converted to predicted Ra-226 concentrations using the following correlation equation:
Gamma (CPM) = 1,612 x Surface Soil Ra-226 (pCi/g) + 11,380

2. The correlation equation predicted Ra-226 concentrations that are less than zero for gamma survey measurements less than 11,3380.

3. Mean (μ) of predicted concentrations of Ra-226 in soil (0.3 pCi/g).

4. Standard deviation (σ) of predicted concentrations of Ra-226 in soil (3.8 pCi/g).

5. Ra-226 concentrations predicted from gamma measurements exceeding approximately 47,000 CPM or less than approximately 11,000 CPM are extrapolated from the regression model and are uncertain.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE\RSE AlongoMines\Section4\RSE AlongoMines Radium 11x17 L 20180921.mxd

NAVAJO
NATION
AUM Environmental
Response Trust-First Phase

LEGEND

☐ S002-C01-001 Correlation Location (30' x 30')

🟥 Claim Boundary

Predicted Ra-226 Concentration [1](pCi/g)

- ● Less than 0[2]
- ● 0 - 0.3 (μ)[3]
- ● 0.4 - 4.1 (μ + 1σ[4])
- ● 4.2 - 7.9 (μ + 2σ)
- ● 8.0 - 11.7 (μ + 3σ)
- ● 11.8 - 64.4[5]

TITLE:
Predicted Concentrations of Ra-226 in Soil Using the Correlation Equation

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/21/2018

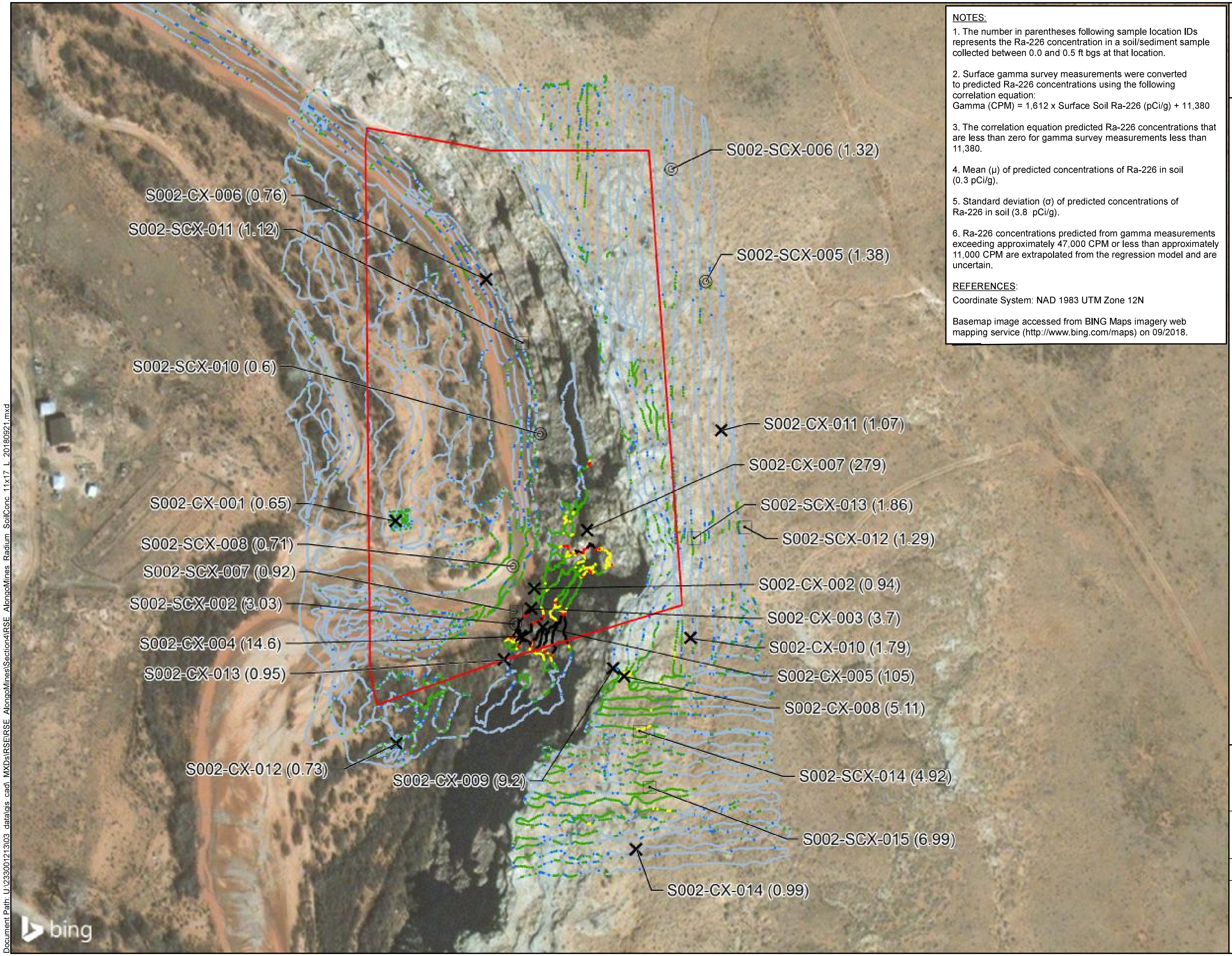
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-2a



NOTES:

1. The number in parentheses following sample location IDs represents the Ra-226 concentration in a soil/sediment sample collected between 0.0 and 0.5 ft bgs at that location.

2. Surface gamma survey measurements were converted to predicted Ra-226 concentrations using the following correlation equation:
Gamma (CPM) = 1,612 x Surface Soil Ra-226 (pCi/g) + 11,380

3. The correlation equation predicted Ra-226 concentrations that are less than zero for gamma survey measurements less than 11,380.

4. Mean (μ) of predicted concentrations of Ra-226 in soil (0.3 pCi/g).

5. Standard deviation (σ) of predicted concentrations of Ra-226 in soil (3.8 pCi/g).

6. Ra-226 concentrations predicted from gamma measurements exceeding approximately 47,000 CPM or less than approximately 11,000 CPM are extrapolated from the regression model and are uncertain.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

NAVAJO
NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
⊡	Borehole Location - Surface Samples Only
🟥	Claim Boundary

Predicted Ra-226 Concentration^2(pCi/g)

●	Less than 0^3
●	0 - 0.3 (μ)^4
●	0.4 - 4.1 (μ + 1σ^5)
●	4.2 - 7.9 (μ + 2σ)
●	8.0 - 11.7 (μ + 3σ)
●	11.8 - 64.4^6

N
W E
S
0 150 300
Feet

TITLE:
Predicted Ra-226 Concentrations in Soil Compared to Ra-226 Concentrations in Soil/Sediment

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/24/2018

DOCUMENT NAME: Removal Site Evaluation Report

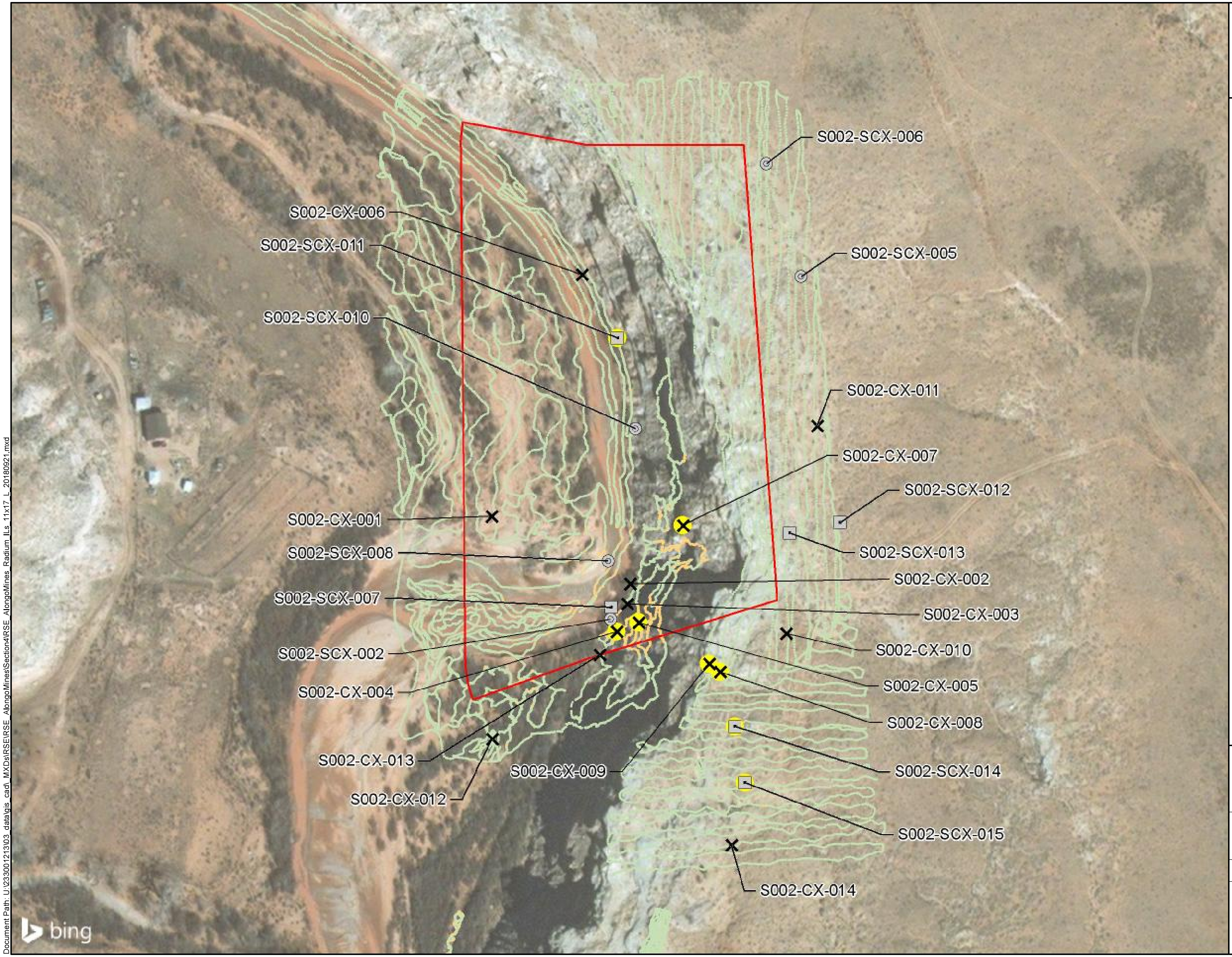
AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-2b

Stantec

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE AlongoMines\Section4\RSE AlongoMines Radium SoilConc 11x17 L 20180921.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
▣	Borehole Location - Surface Samples Only
●	Ra-226 IL Exceedance in Surface Soil
▭	Claim Boundary

Predicted Ra-226
Concentration (pCi/g)

●	IL Not Exceeded Survey Area A: -2.6 - 0.944 Survey Area B: -2.7 - 4.48
●	IL Exceeded Survey Area A: 0.945 - 2.8 Survey Area B: 4.49 - 64.4

NOTES:

1. Surface gamma survey measurements were converted to predicted Ra-226 concentrations using the following correlation equation:
Gamma (cpm) = 1,612 x Surface Soil Ra-226 (pCi/g) + 11,380

2. Refer to Figure 3-4 for Survey Area delineation

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

N
W E
S

0 150 300
Feet

TITLE:
Predicted Ra-226 Concentrations in Soil
Compared to Ra-226 ILs

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/23/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ

REVIEWER: CBB

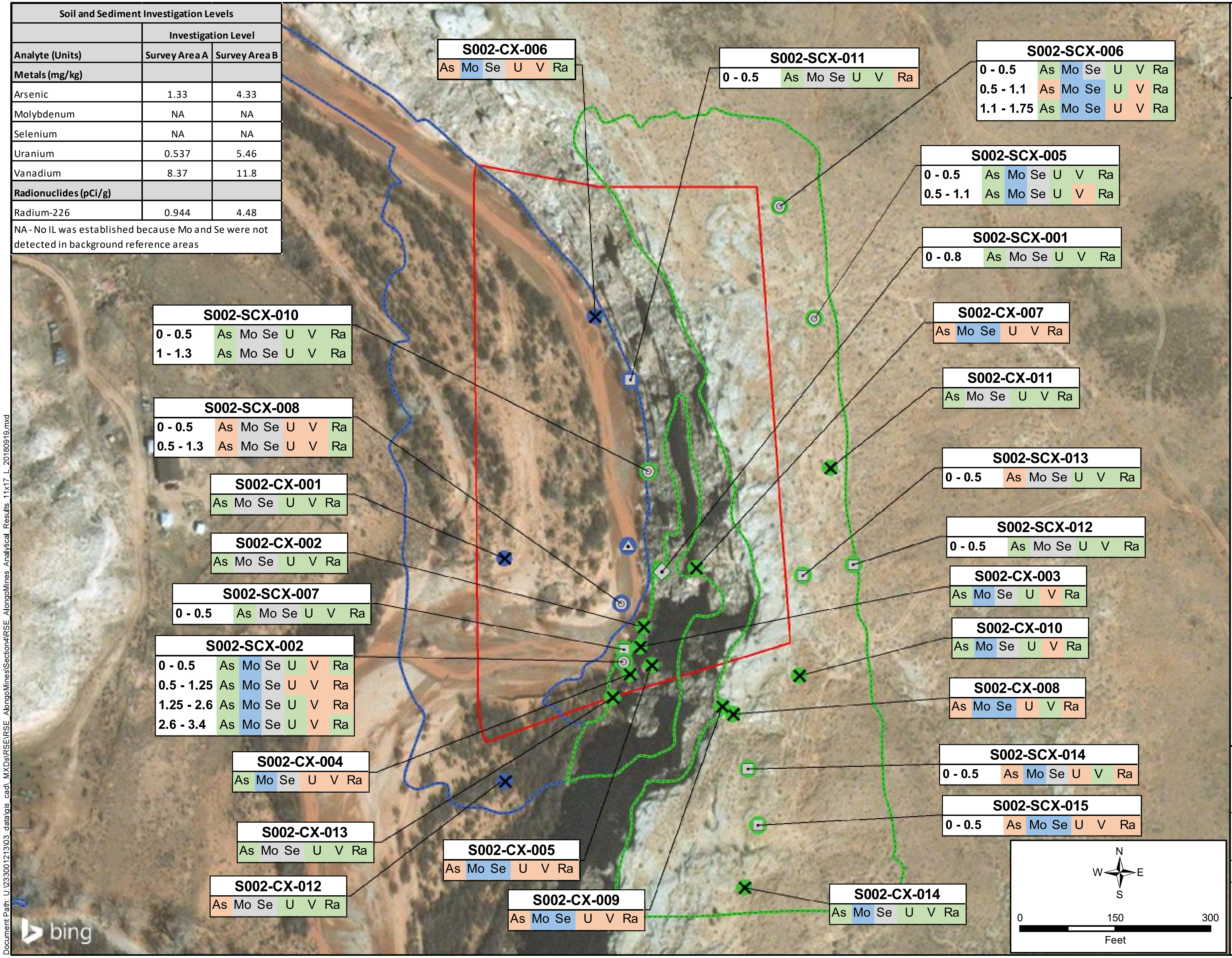
FIGURE: 4-2c

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\Section4\RSE_AlongoMines_Radium_ILs_11x17_L_20180921.mxd

Soil and Sediment Investigation Levels

Analyte (Units)	Investigation Level Survey Area A	Investigation Level Survey Area B
Metals (mg/kg)		
Arsenic	1.33	4.33
Molybdenum	NA	NA
Selenium	NA	NA
Uranium	0.537	5.46
Vanadium	8.37	11.8
Radionuclides (pCi/g)		
Radium-226	0.944	4.48

NA - No IL was established because Mo and Se were not detected in background reference areas



Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\Section4\RSE_AlongoMines_Analytical_Results_11x17_L_20180919.mxd

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

- ⊗ Surface Sample Location
- ◎ Borehole Location - Surface and Subsurface Samples
- ⊡ Borehole Location - Surface Samples Only
- △ Borehole Location - Static Gamma Data Only
- ⊗ Surface Sample Location
- ◎ Borehole Location - Surface and Subsurface Samples
- ⊡ Borehole Location - Surface Samples Only
- ◇ Borehole Location - Subsurface Sample Only (S002-SCX-001)
- ▢ Survey Area A
- ▢ Survey Area B
- ▢ Claim Boundary
- 🟩 Investigation Level Not Exceeded
- 🟧 Investigation Level Exceeded
- 🟦 Analyte Detected - No Investigation Level
- ⬜ Non-detect - No Investigation Level

NOTE:
Sample intervals (e.g. 0 - 0.5) are in ft bgs.

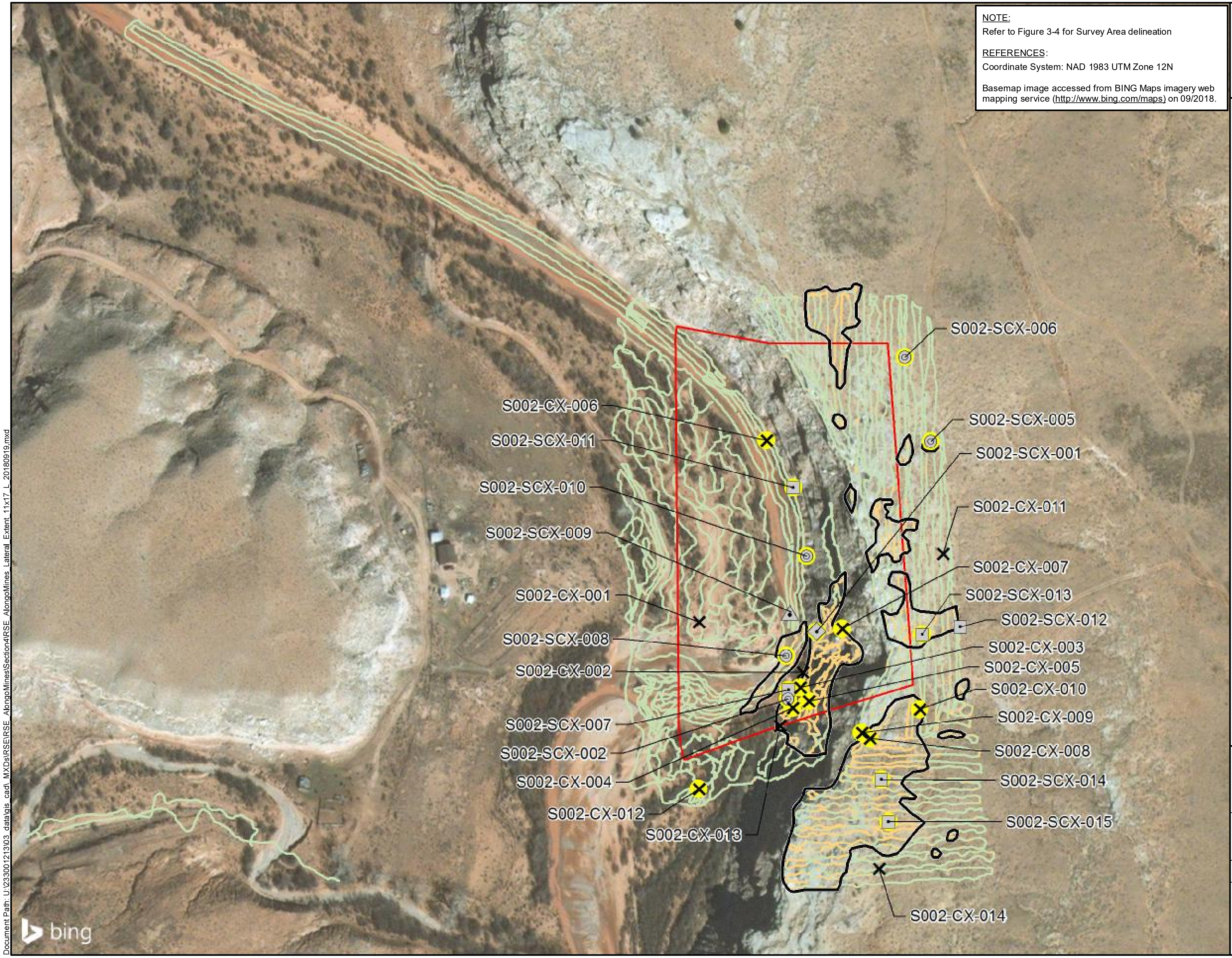
REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

TITLE:
Surface and Subsurface Metals and Ra-226 Analytical Results

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/19/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: EDZ
REVIEWER: CBB
Stantec
FIGURE: 4-3



NOTE:
Refer to Figure 3-4 for Survey Area delineation

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
⊡	Borehole Location - Surface Samples Only
▲	Borehole Location - Static Gamma Data Only (SCX-009)
◇	Borehole Location - Subsurface Sample Only (SCX-001)
●	IL Exceedance in Unconsolidated Material at Location
▢	Approximate Area where Surface Gamma ILs are Exceeded (3.2 acres)
🟥	Claim Boundary

Gamma Survey

Counts per Minute (CPM)

●	IL Not Exceeded Survey Area A: 7,233 - 13,088 Survey Area B: 7,074 - 11,686
●	IL Exceeded Survey Area A: 13,089 - 15,920 Survey Area B: 11,687 - 115,161

N
W E
S

0 200 400
Feet

TITLE:
Lateral Extent of Surface and Subsurface IL Exceedances

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/19/2018

DOCUMENT NAME: Removal Site Evaluation Report

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-4a

Stantec

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NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

- ✕ Surface Sample Location
- ◎ Borehole Location - Surface and Subsurface Samples
- ⊡ Borehole Location - Surface Samples Only
- ▲ Borehole Location - Static Gamma Data Only (SCX-009)
- ● IL Exceedance in Unconsolidated Material at Location
- ▢ Approximate Area where Surface Gamma IL is Exceeded (0.2 acres)
- 🟥 Claim Boundary

Gamma Survey

Counts per Minute (CPM)

- 🟢 7,233 - 13,088 (IL Not Exceeded)
- 🟠 13,089 - 15,920 (IL Exceeded)

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

N
W E
S

0 200 400
Feet

TITLE:
Survey Area A
Lateral Extent of Surface and
Subsurface IL Exceedances

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/19/2018

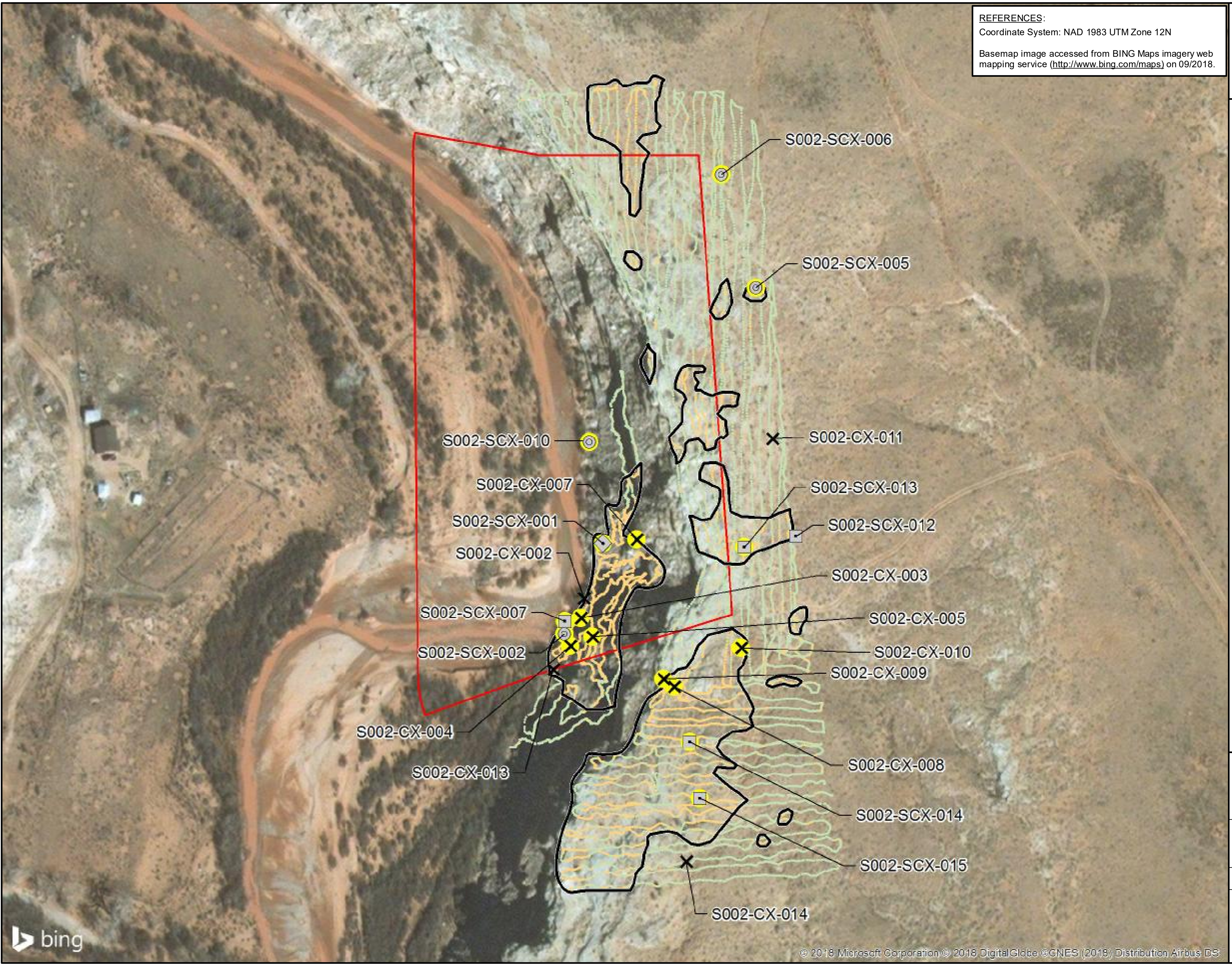
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-4b



REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
▣	Borehole Location - Surface Samples Only
◬	Borehole Location - Static Gamma Data Only
◈	Borehole Location - Subsurface Sample Only (SCX-001)
●	IL Exceedance in Unconsolidated Material at Location
▢	Approximate Area where Surface Gamma IL is Exceeded (3.0 acres)
🟥	Claim Boundary

Gamma Survey
Counts per Minute (CPM)

●	7,074 - 11,686 (IL Not Exceeded)
●	11,687 - 115,161 (IL Exceeded)

N
W E
S

0 150 300
Feet

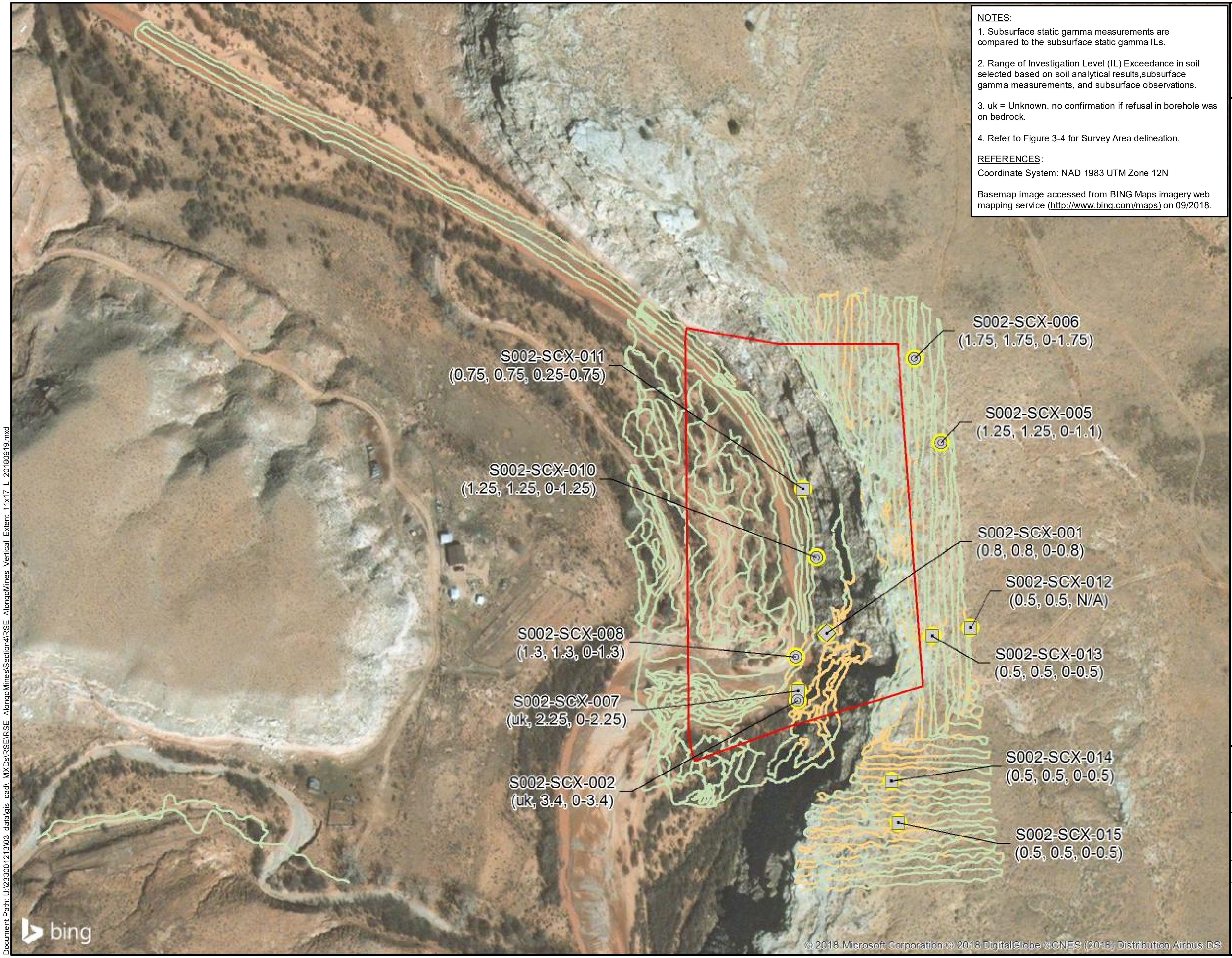
TITLE:
Survey Area B
Lateral Extent of Surface and
Subsurface IL Exceedances

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/19/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: AS
REVIEWER: CBB
FIGURE: 4-4c

Stantec

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\Section4\RSE_AlongoMines_Lateral_Extent_B_11x17_L_20180919.mxd



NOTES:

1. Subsurface static gamma measurements are compared to the subsurface static gamma ILs.

2. Range of Investigation Level (IL) Exceedance in soil selected based on soil analytical results,subsurface gamma measurements, and subsurface observations.

3. uk = Unknown, no confirmation if refusal in borehole was on bedrock.

4. Refer to Figure 3-4 for Survey Area delineation.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

◎ Borehole Location - Surface and Subsurface Samples

▣ Borehole Location - Surface Samples Only

◈ Borehole Location - Subsurface Sample Only (SCX-001)

● IL Exceedance in Borehole

🟥 Claim Boundary

Gamma Survey

Counts per Minute (CPM)

● IL Not Exceeded
Survey Area A: 7,233 - 13,088
Survey Area B: 7,074 - 11,686

● IL Exceeded
Survey Area A: 13,089 - 15,920
Survey Area B: 11,687 - 115,161

N
W E
S

0 200 400
Feet

TITLE:

Vertical Extent of IL Exceedances in Soil

PROJECT:

Removal Site Evaluation
Alongo Mines Site

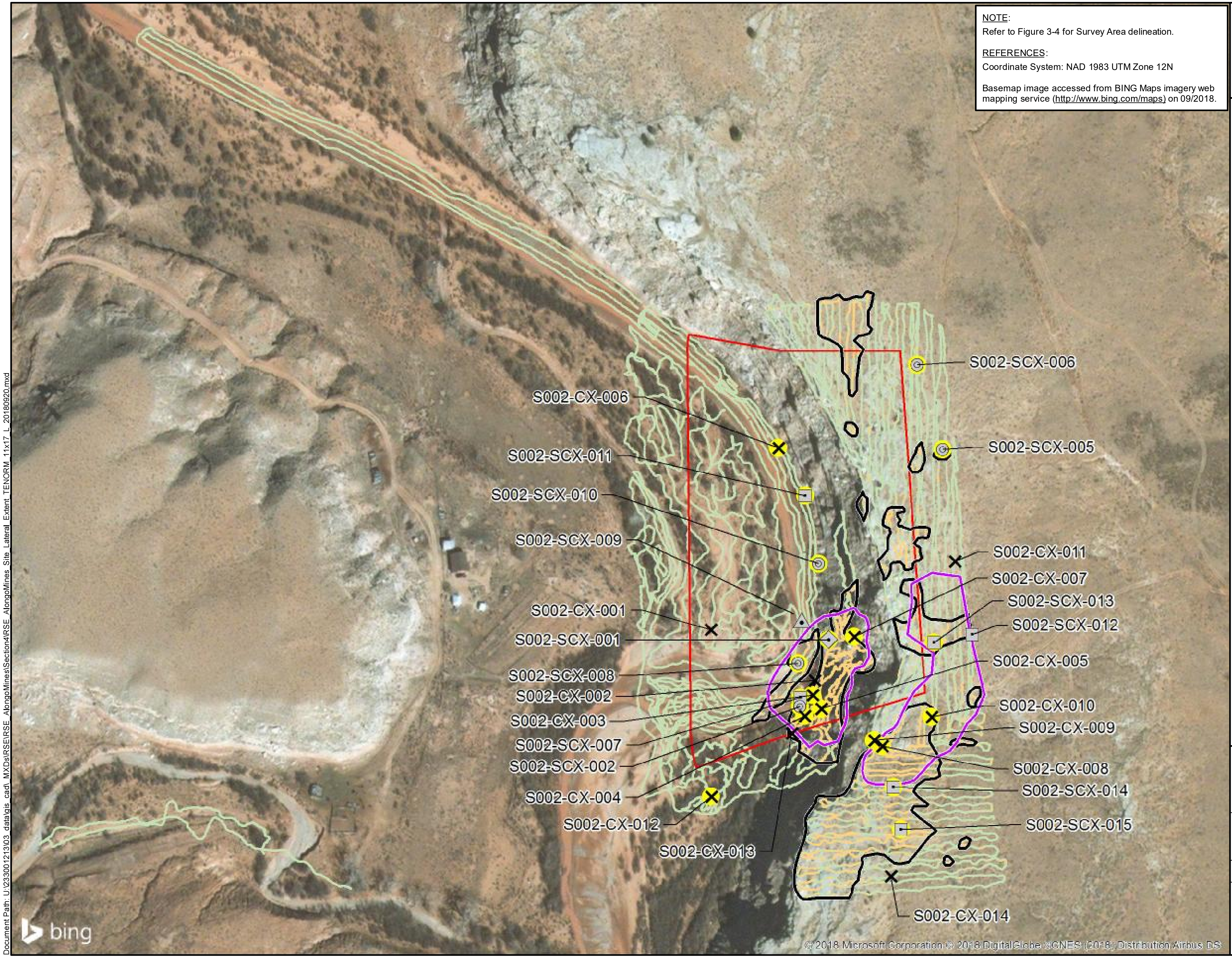
DATE:	DOCUMENT NAME:
9/19/2018	Removal Site Evaluation Report

Stantec

AUTHOR:	REVIEWER:
EDZ	CBB

FIGURE:
4-5

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\Section4\RSE_AlongoMines_Vertical_Extent_11x17_L_20180919.mxd



NOTE:
Refer to Figure 3-4 for Survey Area delineation.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

- ✕ Surface Sample Location
- ◎ Borehole Location - Surface and Subsurface Samples
- ▣ Borehole Location - Surface Samples Only
- △ Borehole Location - Static Gamma Data Only (SCX-009)
- ◇ Borehole Location - Subsurface Sample Only (SCX-001)
- ● IL Exceedance in Unconsolidated Material at Location
- ▢ TENORM (2.2 acres)
- ▢ Approximate Area where Surface Gamma ILs are Exceeded (3.1 acres)
- ▢ Claim Boundary

Gamma Survey

Counts per Minute (CPM)

● IL Not Exceeded
Survey Area A: 7,233 - 13,088
Survey Area B: 7,074 - 11,686

● IL Exceeded
Survey Area A: 13,089 - 15,920
Survey Area B: 11,687 - 115,161

N
W E
S
0 200 400
Feet

TITLE:
TENORM Compared to
Lateral Extent of IL Exceedances

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/20/2018

DOCUMENT NAME: Removal Site Evaluation Report

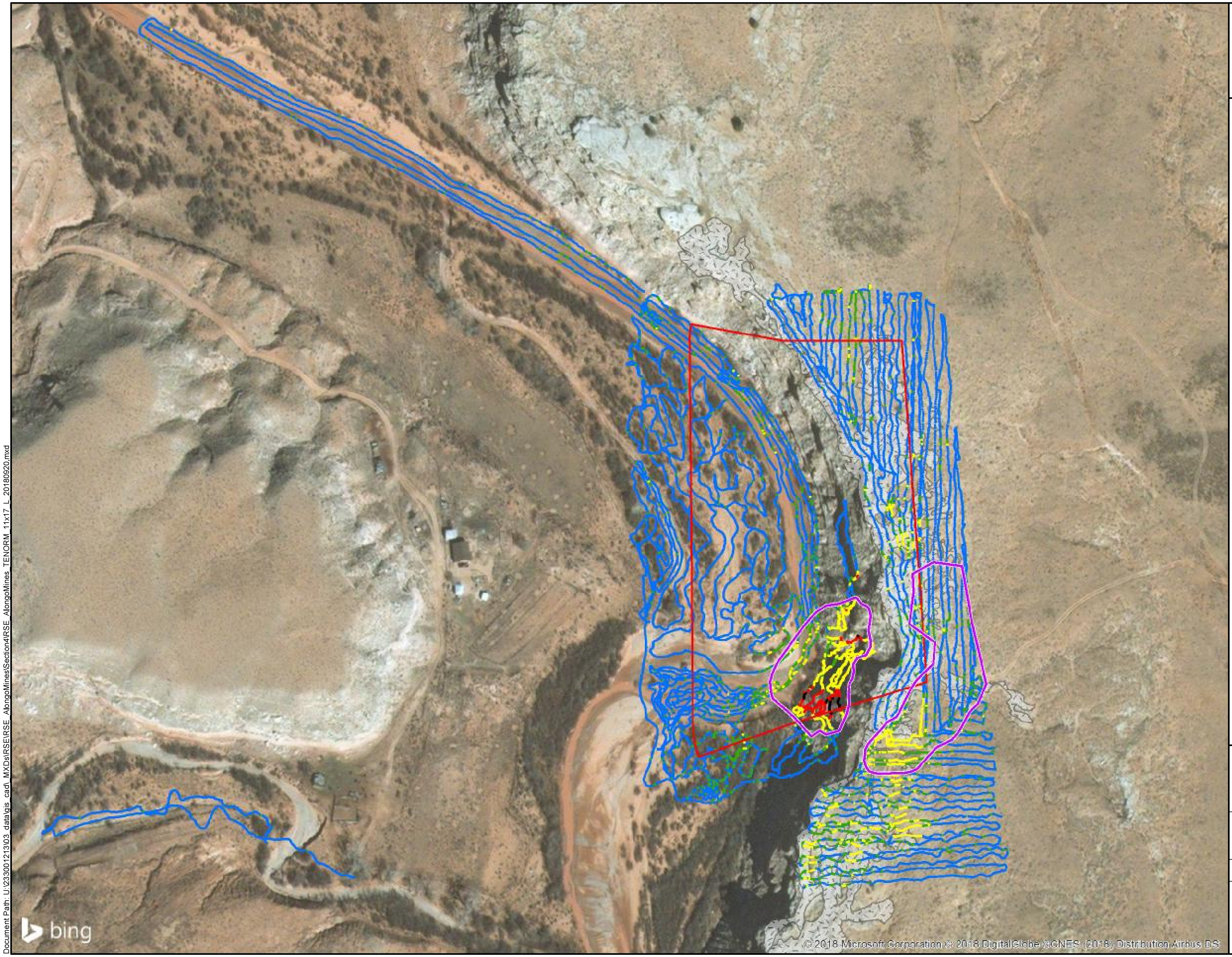
Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-6

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE AlongoMines\Section4\RSE AlongoMines Site Lateral Extent TENORM 11x17 L 20180920.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

- TENORM (2.2 acres)
- ▨ Exposed Bedrock¹
- 🟥 Claim Boundary

Gamma Survey

Counts per Minute (CPM)

- ● 7,074 - 11,686 (Minimum to BG-3 IL)
- ● 11,687 - 13,088 (>BG-3 IL to BG-2 IL)
- ● 13,089 - 26,176 (>BG-2 IL to 2x BG-2 IL)
- ● 26,177 - 65,440 (>2x BG-2 IL to 5x BG-2 IL)
- ● 65,441 - 115,161 (>5x BG-2 IL to Maximum)

NOTE:
1. Portions of the areas delineatd as exposed bedrock contain small amounts of colluvium.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

N
W E
S

0 200 400
Feet

TITLE:
TENORM Compared to Gamma Radiation Survey Results

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/20/2018

DOCUMENT NAME: Removal Site Evaluation Report

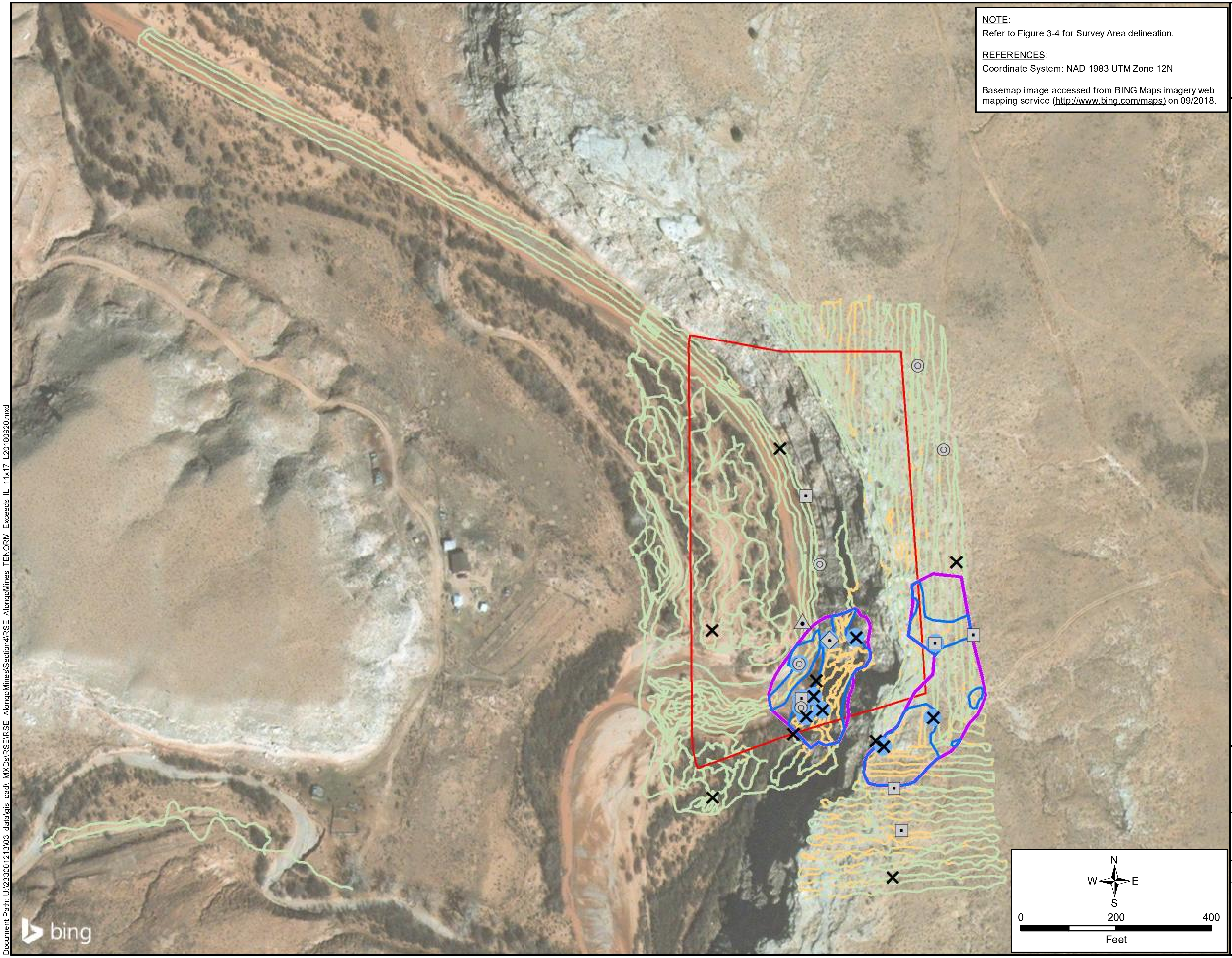
AUTHOR: EDZ

REVIEWER: CBB

Stantec

FIGURE: 4-7

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\Section4\RSE_AlongoMines_TENORM_11x17_L_20180920.mxd



NOTE:
Refer to Figure 3-4 for Survey Area delineation.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

- ✕ Surface Sample Location
- ◎ Borehole Location - Surface and Subsurface Samples
- ⊡ Borehole Location - Surface Samples Only
- △ Borehole Location - Static Gamma Data Only (SCX-009)
- ◇ Borehole Location - Subsurface Sample Only (SCX-001)
- ● TENORM Exceeding IL in Unconsolidated Material at Location
- ▢ TENORM Area Exceeding ILs (1.24 acres)
- ▢ TENORM (2.2 acres)
- ▢ Claim Boundary

Gamma Survey
Counts per Minute (CPM)

- ● IL Not Exceeded
  Survey Area A: 7,233 - 13,088
  Survey Area B: 7,074 - 11,686
- ● IL Exceeded
  Survey Area A: 13,089 - 15,920
  Survey Area B: 11,687 - 115,161

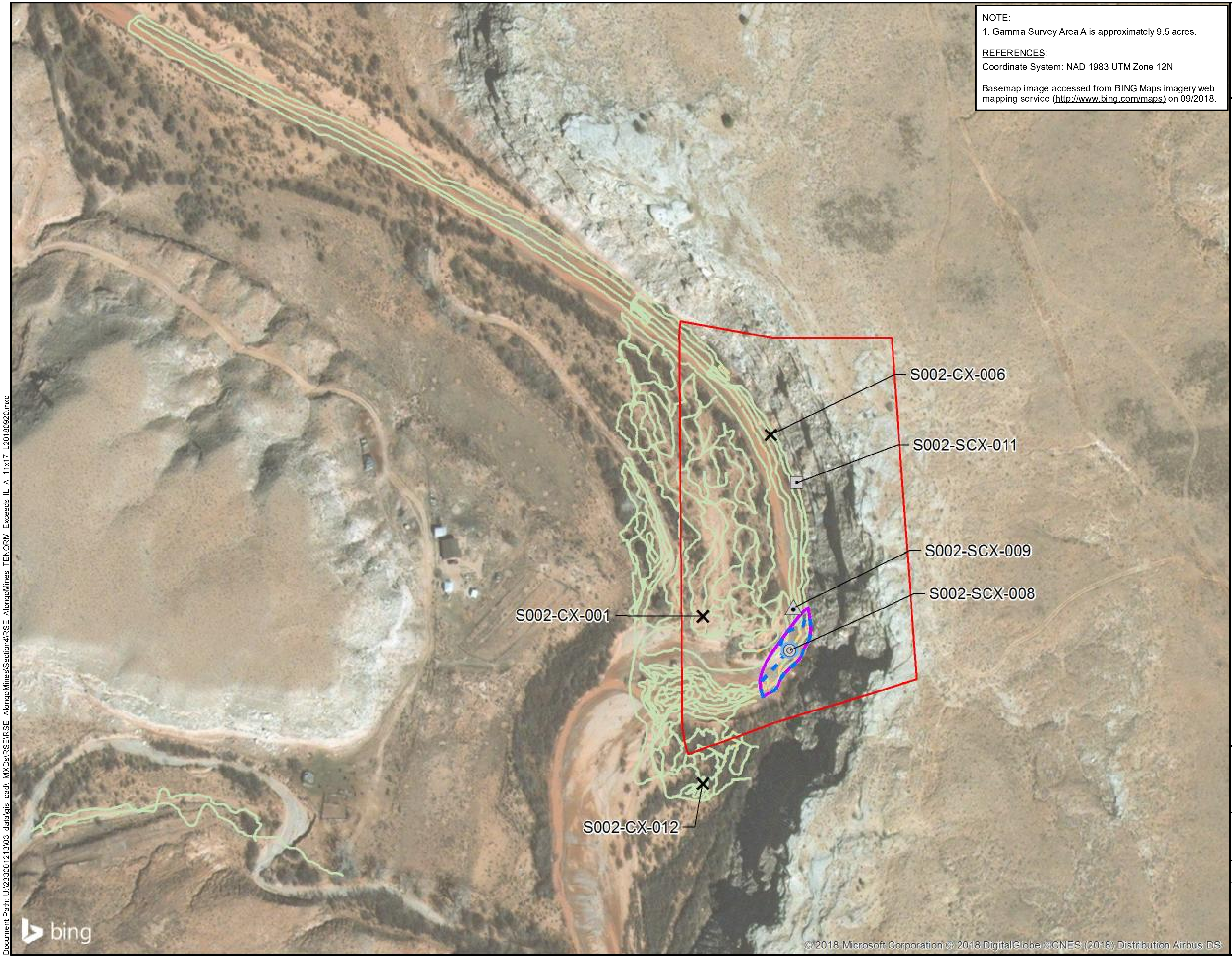
TITLE:
TENORM that Exceeds ILs

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/20/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: EDZ
REVIEWER: CBB
FIGURE: 4-8a

Stantec

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE\RSE_AlongoMines\Section4\RSE_AlongoMines_TENORM_Exceeds_IL_11x17_L20180920.mxd



NOTE:
1. Gamma Survey Area A is approximately 9.5 acres.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
⊡	Borehole Location - Surface Samples Only
△	Borehole Location - Static Gamma Data Only (SCX-009)
●	TENORM Exceeding IL in Unconsolidated Material at Location
⬚	TENORM Area Exceeding ILs (0.14 acres)
◯	TENORM (0.19 acres)
□	Claim Boundary

Gamma Survey
Counts per Minute (CPM)

●	7,233 - 13,088 (IL Not Exceeded)
●	13,089 - 15,920 (IL Exceeded)

N
W E
S

0 200 400
Feet

TITLE:
Survey Area A
TENORM that Exceeds ILs

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/20/2018

DOCUMENT NAME: Removal Site Evaluation Report

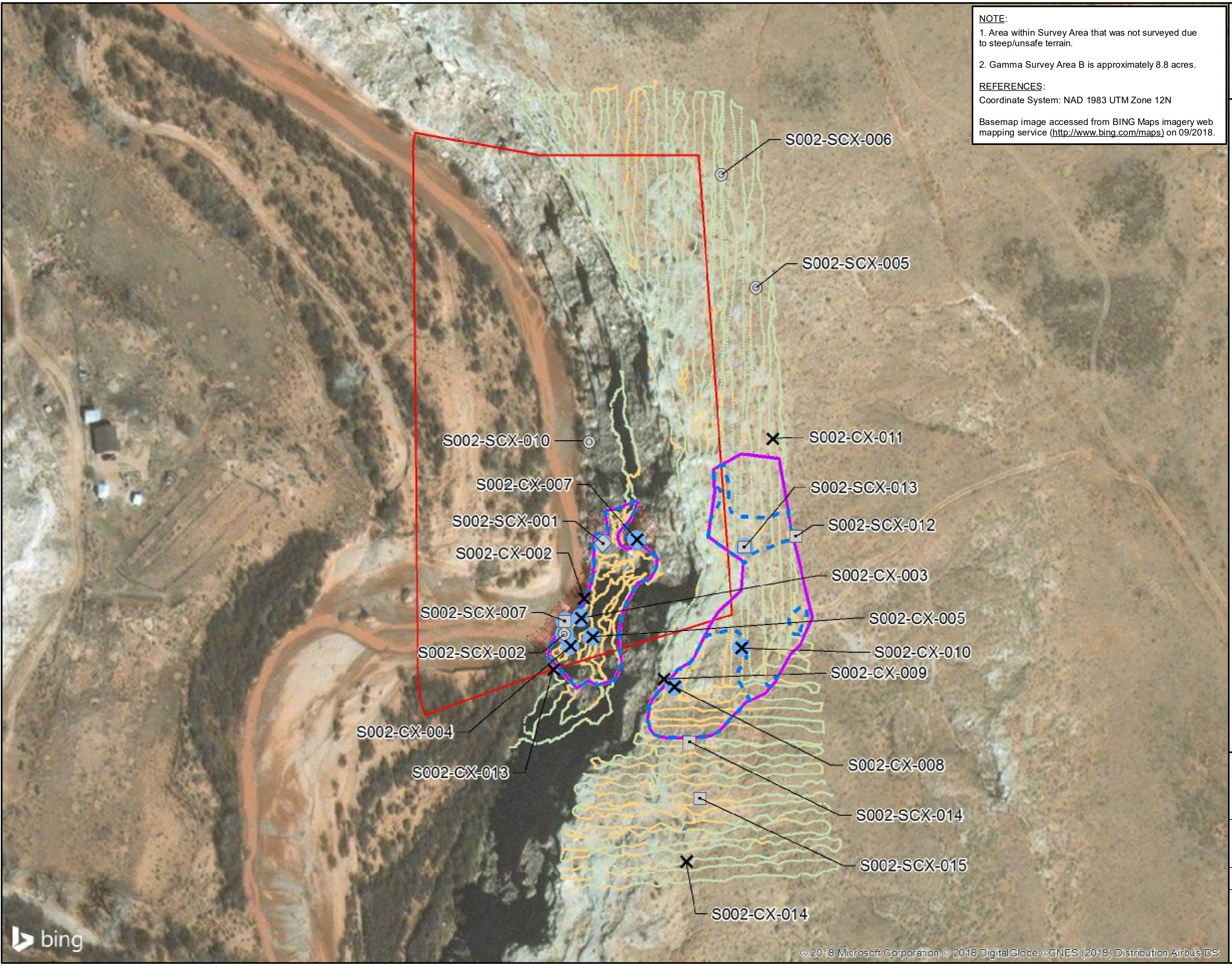
Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-8b

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE\RSE_AlongoMines\Section4\RSE_AlongoMines_TENORM_Exceeds_IL_A_11x17_L20180920.mxd



NOTE:

1. Area within Survey Area that was not surveyed due to steep/unsafe terrain.

2. Gamma Survey Area B is approximately 8.8 acres.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

- ✕ Surface Sample Location
- ◎ Borehole Location - Surface and Subsurface Samples
- ▣ Borehole Location - Surface Samples Only
- ◈ Borehole Location - Subsurface Sample Only (SCX-001)
- ● TENORM Exceeding IL in Unconsolidated Material at Location
- ⬚ TENORM Area Exceeding Surface Gamma ILs (1.10 acres)
- ▢ TENORM (1.76 acres)
- ▨ TENORM Unsurveyed [1](0.22 acres)
- ▢ Claim Boundary

Gamma Survey

Counts per Minute (CPM)

- ● 7,074 - 11,686 (IL Not Exceeded)
- ● 11,687 - 115,161 (IL Exceeded)

N W E S

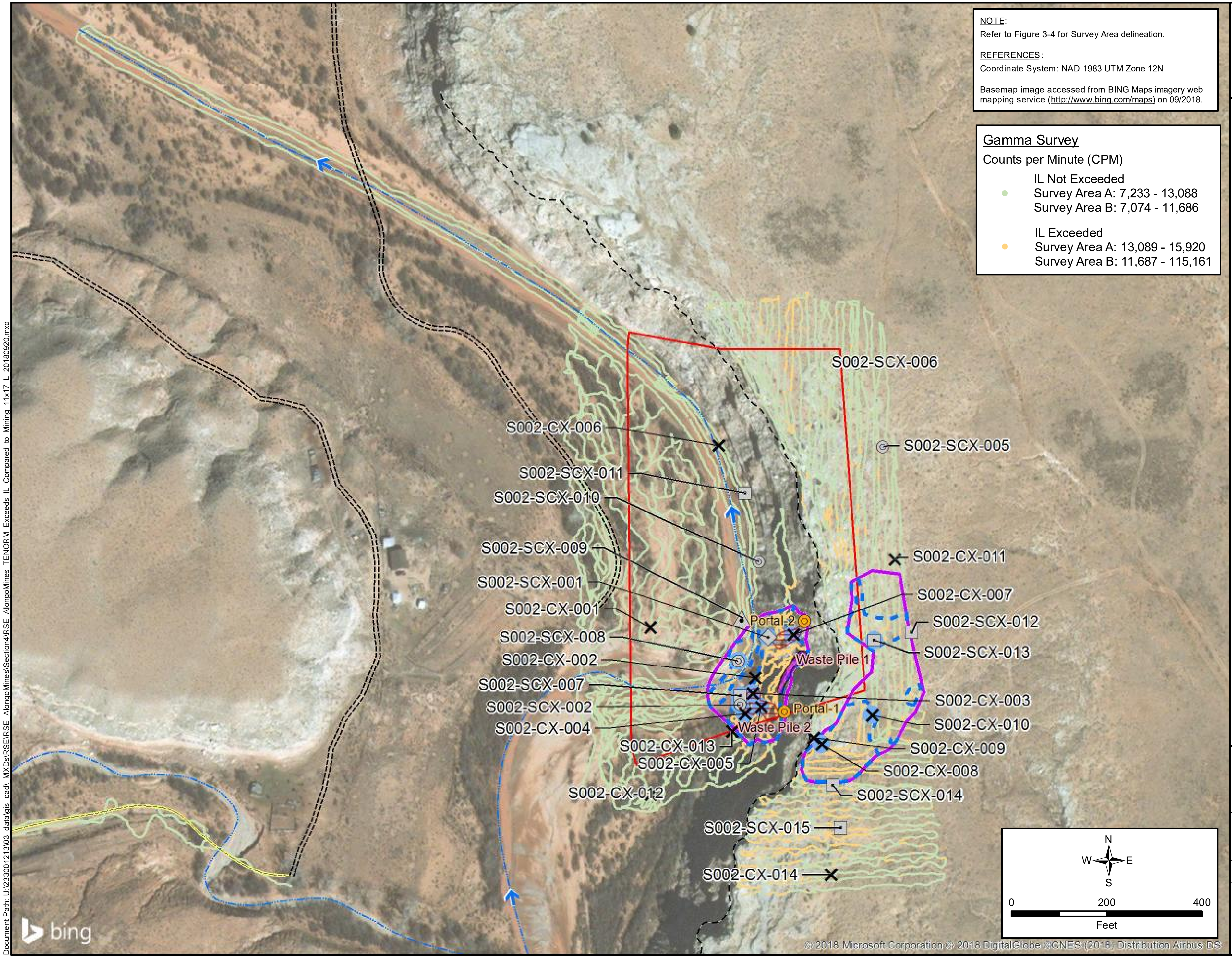
0 150 300
Feet

TITLE:
Survey Area B
TENORM that Exceeds ILs

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/20/2018	DOCUMENT NAME: Removal Site Evaluation Report
Stantec	AUTHOR: AS REVIEWER: CBB
	FIGURE: 4-8c

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\Section4\RSE_AlongoMines_TENORM_Exceeds_IL_B_11x17_L_20180920.mxd



NOTE:
Refer to Figure 3-4 for Survey Area delineation.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

Gamma Survey
Counts per Minute (CPM)

● IL Not Exceeded
Survey Area A: 7,233 - 13,088
Survey Area B: 7,074 - 11,686

● IL Exceeded
Survey Area A: 13,089 - 15,920
Survey Area B: 11,687 - 115,161

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

- ✕ Surface Sample Location
- ◎ Borehole Location - Surface and Subsurface Samples
- ⊡ Borehole Location - Surface Samples Only
- △ Borehole Location - Static Gamma Data Only (S002-SCX-009)
- ◇ Borehole Location - Subsurface Sample Only (S002-SCX-001)
- ● TENORM Exceeding IL in Unconsolidated Material at Location
- ◎ Portal
- ↑ Flow Direction
- Drainage
- Potential Haul Road
- Road
- Approximate Edge of Mesa
- ▨ Potential Rim Strip
- ▤ Waste Pile
- TENORM Area Exceeding ILs (1.24 acres)
- TENORM (2.2 acres)
- Claim Boundary

TITLE:
TENORM that Exceeds ILs Compared to Mining-Related Features

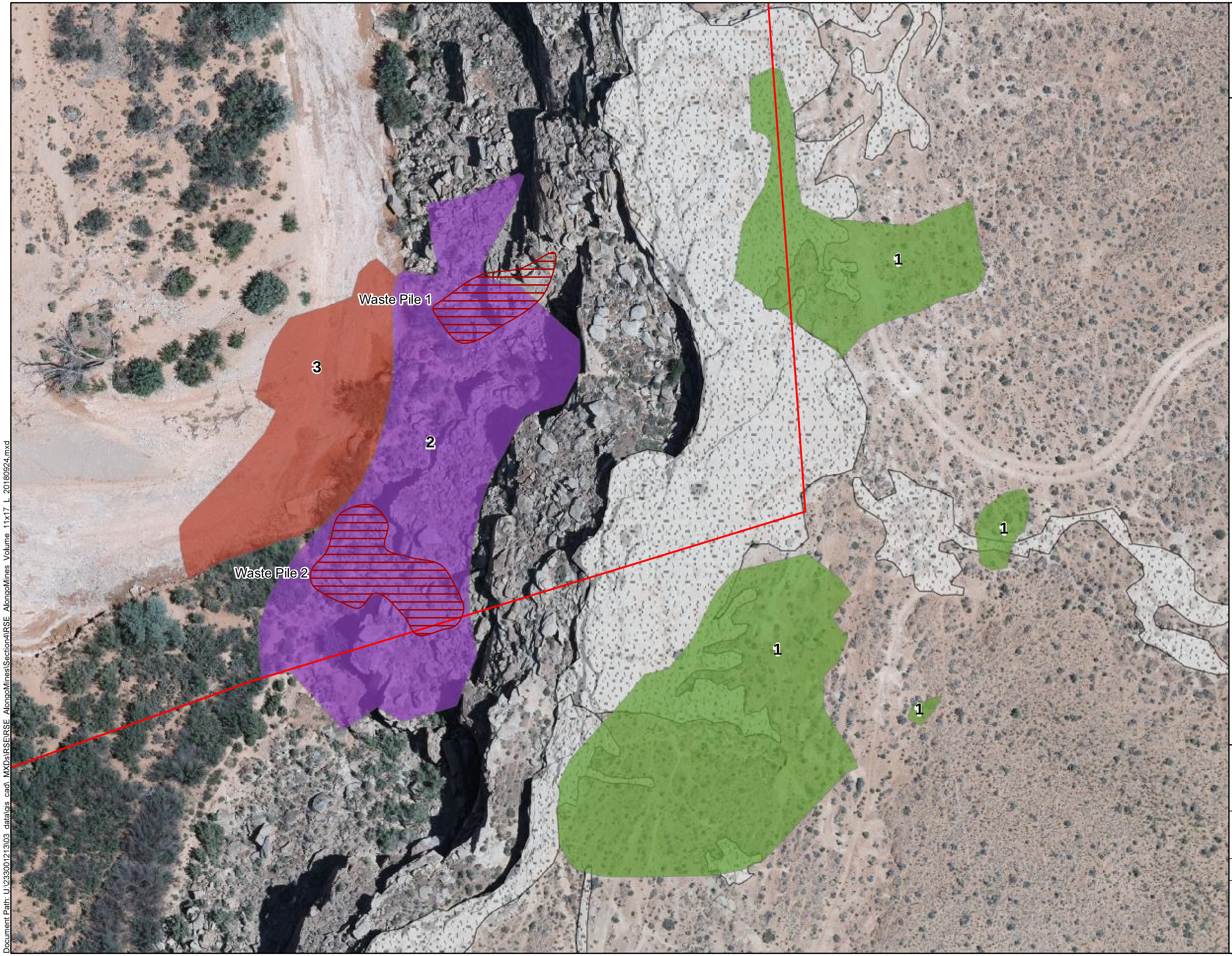
PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/20/2018
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB
REVIEWER: EDZ
FIGURE: 4-8d

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\Section4\RSE_AlongoMines_TENORM_Exceeds_IL_Compared_to_Mining_11x17_L_20180920.mxd



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NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

▭ Waste Pile

▨ Exposed Bedrock¹

▭ Claim Boundary

Average TENORM Depth by Group
(feet below ground surface)

🟩 Group 1 - 0.5 ft

🟪 Group 2 - 1 ft

🟥 Group 3 - 1.5 ft

Group	Location	Area (square feet)	Volume (cubic yards)
1	Mesa Top	26,365	488
2	Mesa Sidewall	21,848	809
3	Wash	9,154	509

NOTE:
1. Portions of the areas delineated as exposed bedrock contain small amounts of colluvium.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image flown by Cooper Aerial Surveys Co. on June 16, 2017.

N
W E
S

0 50 100
Feet

TITLE:
Volume Estimate of
TENORM that Exceeds ILs

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/26/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-9

APPENDICES

Appendix A Radiological Characterization of the Alongo Mines Abandoned Uranium Mine

Radiological Characterization of the Alongo Mines Abandoned Uranium Mine

September 20, 2018

prepared for:

Stantec Consulting Services Inc.

2130 Resort Drive, Suite 350
Steamboat Springs, CO 80487

prepared by:

Environmental Restoration Group, Inc.

8809 Washington St. NE
Suite 150
Albuquerque, NM 87113

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Acronyms

ANSI	American National Standards Institute
AUM	abandoned uranium mine
BG2	Background Reference Area 2
BG3	Background Reference Area 3
cpm	counts per minute
DQOs	data quality objectives
ERG	Environmental Restoration Group, Inc.
ft	foot
GPS	global positioning system
MDC	minimum detectable concentration
µR/h	microRoentgens per hour
pCi/g	picocuries per gram
R^2	Pearson's Correlation Coefficient
RSE	removal site evaluation
σ	standard deviation
Stantec	Stantec Consulting Services Inc.

Executive Summary

This report addresses the radiological characterization of the Alongo Mines abandoned uranium mine (AUM) located in the Red Valley Chapter of the Navajo Nation in Red Rock Valley, New Mexico. It documents part of the implementation of the Navajo Nation AUM Environmental Response Trust, First Phase, Removal Site Evaluation Work Plan (RSE Work Plan: MWH, 2016). The work was performed by Environmental Restoration Group, Inc (ERG) of Albuquerque, New Mexico and MWH, now part of Stantec Consulting Services Inc. (Stantec) on behalf of the Navajo Nation AUM Environmental Response Trust – First Phase.

This report provides the results of a 1) Global Positioning System (GPS)-based gamma radiation (gamma) survey and 2) comparisons of the gamma count rates at this AUM to exposure rates and concentrations of radium-226 in surface soils. The field activities addressed in this report were conducted on May 3, 2016; October 1, 8, and 13, 2016; May 18, 2017; and September 13, 2017. They included a GPS-based radiological survey of land surfaces over a Survey Area consisting of the mine claim area out to a 100-foot (ft) buffer; roads and drainages within a 0.25-mile radius of the 100-ft buffer; and areas where the survey was extended; and correlation studies.

The discussion of the results of soil sampling in this report is limited to concentrations of radium-226 and isotopes of thorium in samples taken from surface soils, as part of correlation studies. The objective of the analysis of thorium isotopes was to 1) assess the potential effects of thorium-232 and thorium-228 on the correlation of gamma count rates to concentrations of radium-226 in surface soils; and 2) evaluate thorium-230 and radium-226 activities to indicate the status of equilibrium in the uranium decay series. These and additional results for the RSE are addressed in the "Alongo Mines Removal Site Evaluation Report" (Stantec, 2018).

The findings of the RSE pertaining to these activities are:

- The horizontal extent and magnitude of mining-related materials were delineated sufficiently to support additional characterization of the subsurface.
- Elevated gamma count rates observed along the southern edge of the mine claim were associated with waste rock.
- Two potential Background Reference Areas were established.
- The mean relationship between gamma count rates and concentrations of radium-226 in surface soils (0 to 0.5 ft below ground surface) is described by a linear regression model:

Gamma Count Rate (cpm) = 1612 x [radium-226 (pCi/g)] + 11380

- The distribution of concentrations of radium-226 in surface soils predicted using this model is rightward tailed. The values in the Survey Area range from -2.7 to 64.4 pCi/g, with a central tendency (median) of -0.5 pCi/g.

- The thorium series radionuclides do not appear to affect the prediction of concentrations of radium-226 in surface soil from gamma count rates.

- There is evidence that the uranium series radionuclides are in equilibrium, but not secular equilibrium.

- The relationship between gamma count rates and exposure rates is described by a linear regression model:

$$\text{Exposure Rate (in microRoentgens per hour [}\mu\text{R/h])} = \text{Gamma Count Rate (cpm)} \times 5\text{x}10^{-4} + 6.7336$$

- The distribution of exposure rates predicted using this model is rightward tailed. The values in the Survey Area range from 10.3 to 64.3, with a central tendency (median) of 12.0 μR/h.

1.0 Introduction

This report addresses the radiological characterization of the Alongo Mines abandoned uranium mine (AUM) located in the Red Valley Chapter of the Navajo Nation in Red Rock Valley, New Mexico. It documents part of the implementation of the Navajo Nation AUM Environmental Response Trust, First Phase, Removal Site Evaluation Work Plan (RSE Work Plan: MWH, 2016). The work was performed by Environmental Restoration Group, Inc (ERG) of Albuquerque, New Mexico and MWH, now part of Stantec Consulting Services Inc. (Stantec) on behalf of the Navajo Nation AUM Environmental Response Trust – First Phase.

The activities described here focus on the characterization of gamma radiation (gamma) emitted by uranium series radionuclides in surface soils at the AUM. This report provides 1) the results of a Global Positioning System (GPS)-based gamma radiation (gamma) survey, 2) comparisons of the gamma count rates at this AUM to exposure rates and concentrations of radium-226 in surface soils, and 3) an assessment of equilibrium in the uranium series.

The objective of the correlation between field gamma count rate and surface soil concentrations of radium-226 was to use field instrumentation to predict surface soil concentrations of radium-226. The objective of the correlation between field gamma count rate and exposure rate was to use field instrumentation to predict exposure rates

The field activities were conducted on May 3, 2016; October 1, 8, and 13, 2016; May 18, 2017; and September 13, 2017 in accordance with the methods described in the RSE Work Plan. They included a GPS-based radiological survey of land surfaces over an approximately 18-acre Survey Area consisting of the mine claim area out to a 100-foot (ft) buffer, roads and drainages within a 0.25-mile radius of the 100-ft buffer, and areas where the survey was extended; and correlation studies. Section 3.0 of the RSE Work Plan provides the data quality objectives (DQOs) for the project.

The discussion of the results of soil sampling in this report is limited to concentrations of radium-226 and isotopes of thorium in samples taken from surface soils, as part of correlation studies. The objective of the analysis of thorium isotopes was to 1) assess the potential effects of thorium-232 and thorium-228 on the correlation of gamma count rates to concentrations of radium-226 in surface soils; and 2) evaluate thorium-230 and radium-226 activities to indicate the status of equilibrium in the uranium decay series. These and additional results for the RSE are addressed in the “Alongo Mines Removal Site Evaluation Report” (Stantec, 2018).

Figure 1 shows the location of the AUM. Background information that is pertinent to the characterization of this AUM is presented in the “Alongo Mines Removal Site Evaluation Report” (Stantec, 2018).

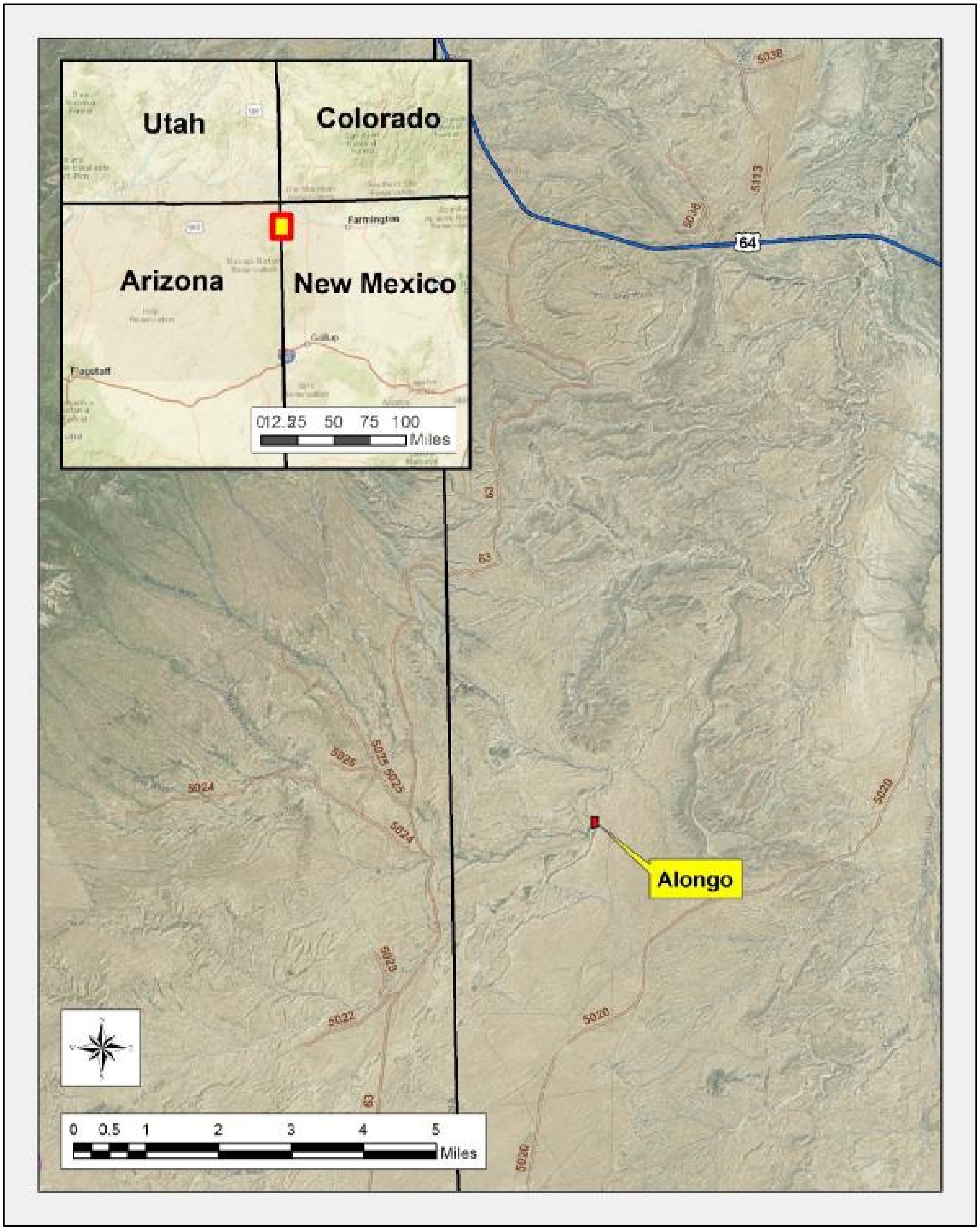


Figure 1. Location of the Alongo Mines Abandoned Uranium Mine

2.0 GPS-Based Gamma Surveys

This section addresses the GPS-based surveys conducted in two potential Background Reference Areas and the Survey Area. The survey was extended to bound areas in which elevated count rates were observed. Table 1 lists the detection systems used in the survey. Pursuant to the approved RSE Work Plan, detectors were function checked each day to ensure the instruments were stable to the limits prescribed by the Work Plan. Detector normalization was not performed as it was not addressed by the RSE Work Plan. Appendix A presents the completed function check forms and calibration certificates for the instruments. Standard operating procedures (SOPs) are discussed in Section 4.2 of the RSE Work Plan and are provided in Appendix E therein. ERG followed the quality assurance and control requirements stipulated in the approved workplan.

The 2x2 sodium iodide (NaI) detectors used in this investigation are sensitive to sub-surface radium-226 decay products and other gamma emitting radionuclides. The purpose of the gamma correlation was to estimate radium-226 concentrations in the upper 15 cm of soil. ERG selected correlation plots based on the range of gamma radiation levels observed. If subsurface soil concentrations of gamma emitting radionuclides were variable between correlation locations, this variability would be included in the regression model, and if the magnitude of the effect were sufficiently large, it would result in failure of the DQOs related to the regression analysis.

Table 1. Detection systems used in the GPS-based gamma surveys.

Survey Area	Ludlum Model 44-10	Ludlum Model 2221 Ratemeter/Scaler
Potential Background Reference Areas	PR303727[a]	254772[a]
Survey Area	PR295014	196086
	PR303727[a]	254772[a]
	PR320678	282971
	PR355763	138368

Notes:
[a]Detection system used in the correlation studies described in Section 3.0.

2.1 Potential Background Reference Areas

Two potential Background Reference Areas were surveyed, the locations and results of which are depicted on Figure 2. BG2 in the figure is Background Reference Area 2. BG3 is Background Reference Area 3.

Table 2 lists a summary of the gamma count rates, which in

- BG2 ranged from 7,889 to 15,166 counts per minute (cpm), with a mean and median of 10,851 and 10,616 cpm, respectively.

- BG3 ranged from 7,147 to 14,331 cpm, with a mean and median of 9,675 and 9,472 cpm, respectively.

Figure 3 depicts histograms of the gamma count rates in BG2 (Figure 3a) and BG3 (Figure 3b). The red and green lines on the figure are theoretical normal and lognormal distributions, respectively. They are presented to show what could be expected if the distributions were normal or lognormal.

Table 2. Summary statistics for gamma count rates in the potential Background Reference Areas.

	Gamma Count Rate (cpm)					
Potential Background Reference Area	**n**	**Minimum**	**Maximum**	**Mean**	**Median**	**Standard Deviation**
2	199	7,889	15,166	10,851	10,616	1,218
3	444	7,147	14,331	9,675	9,472	1,136

Notes:
cpm = counts per minute

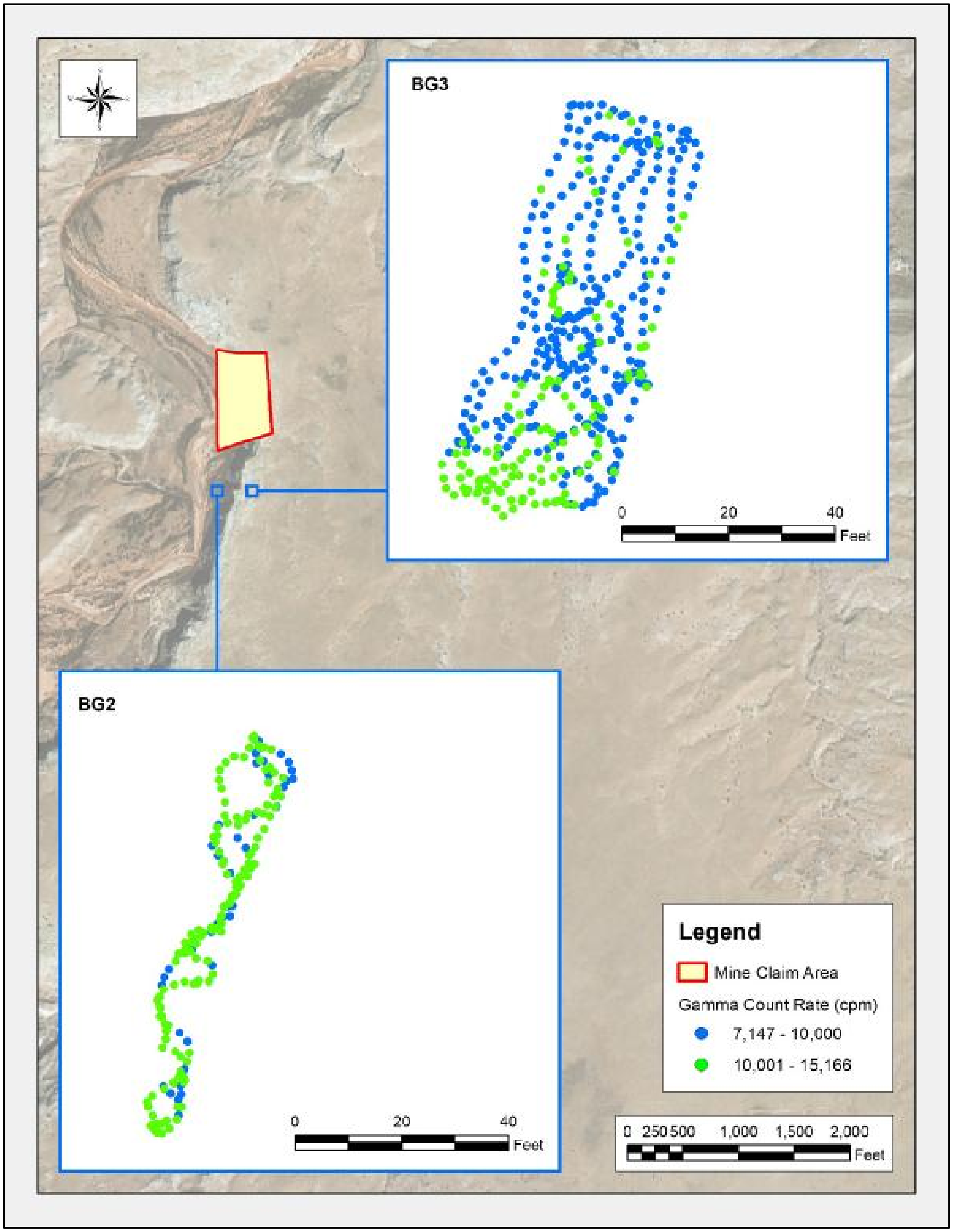
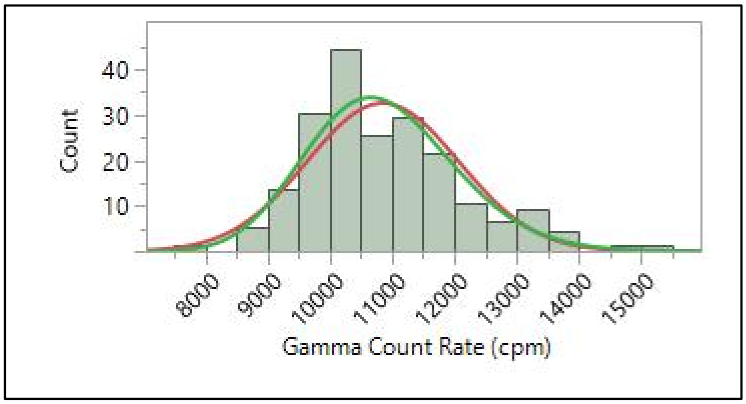
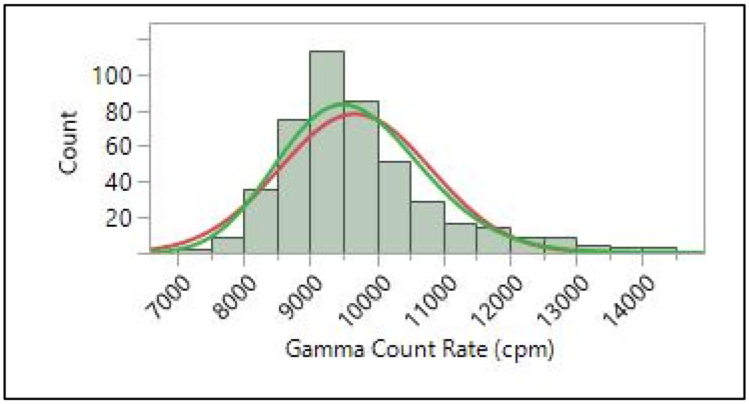


Figure 2. Gamma count rates in the potential Background Reference Areas.



a. Background Reference Area 2



b. Background Reference Area 3

Figure 3. Histograms of gamma count rates in the Background Reference Areas.

2.2 Survey Area

The gamma count rates observed in the Survey Area are depicted in Figure 4. The highest count rates, observed on the south end the mine claim, were associated with waste rock.

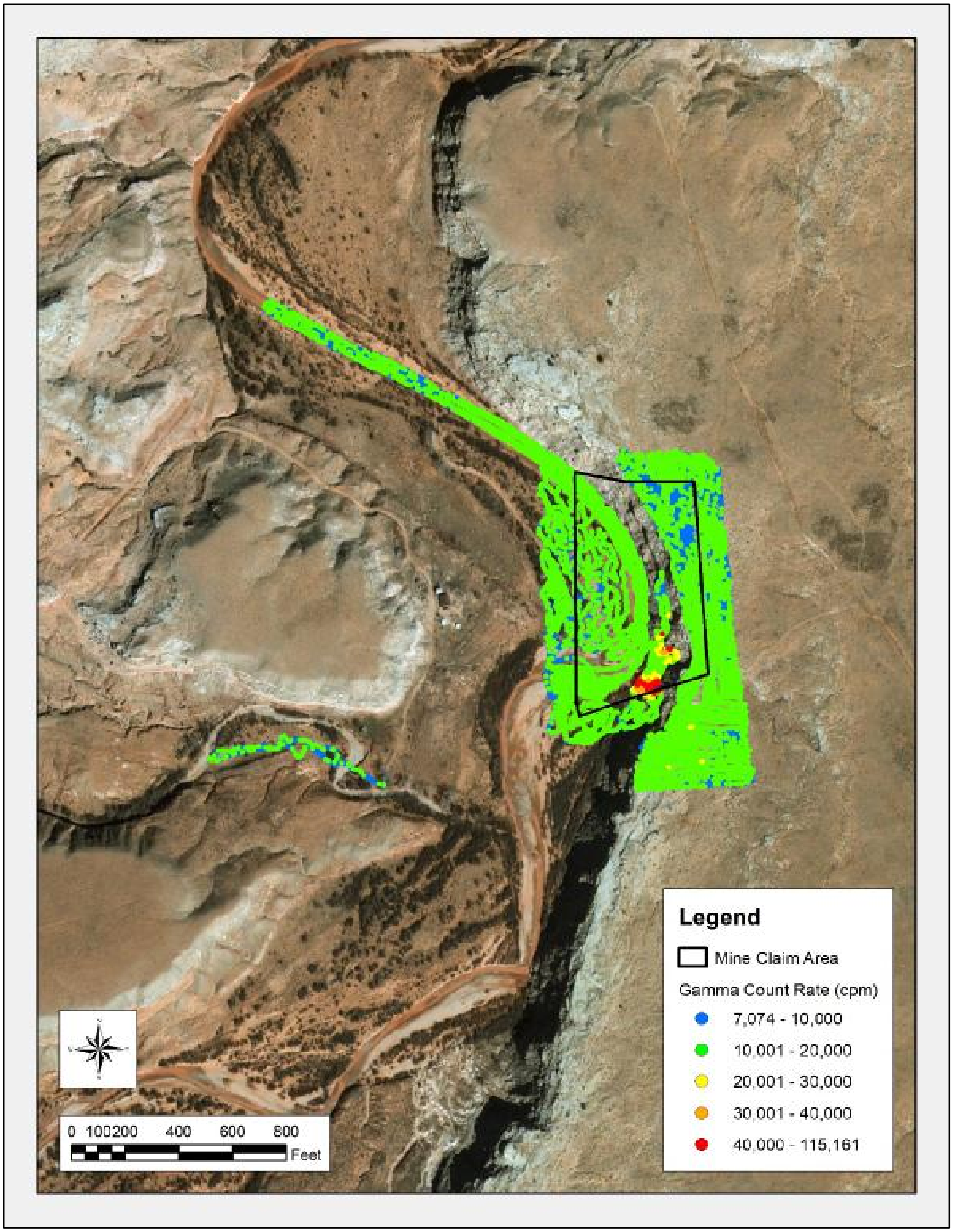


Figure 4. Gamma count rates in the Survey Area.

Figure 5 is a histogram of the gamma count rate measurements made in the Survey Area. The red and green lines on the figure are theoretical normal and lognormal distributions, respectively. They are presented to show what could be expected if the distributions were normal or lognormal. The distribution of the right-tailed set of measurements, evaluated using U.S. Environmental Protection Agency software ProUCL, is not defined. The box plot in Figure 6 depicts cutoffs as horizontal bars, from bottom to top, for the following values or percentiles: minimum, 0.5, 2.5, 10, 25, 50, 75, 90, 97.5, 99.5, and maximum. The 25th, 50th, and 75th percentiles (the three horizontal lines of the box inside the box plot) are 9,882, 10,605, and 11,511 cpm, respectively.

Table 3 is a statistical summary of the measurements, which range from 7,074 to 115,161 cpm and have a central tendency (median) of 10,605 cpm.

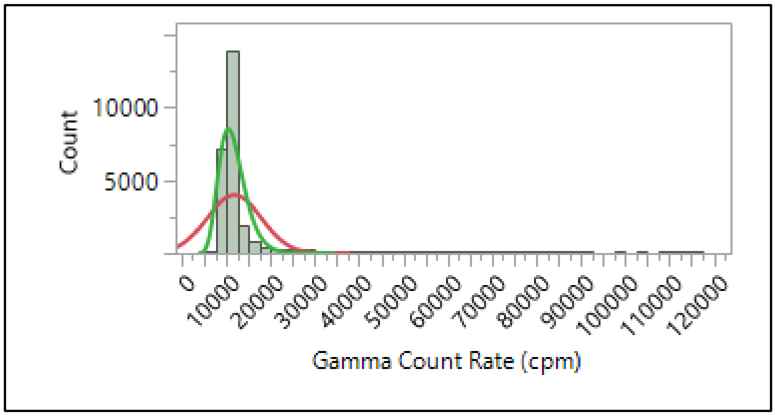


Figure 5. Histogram of gamma count rates in the Survey Area.

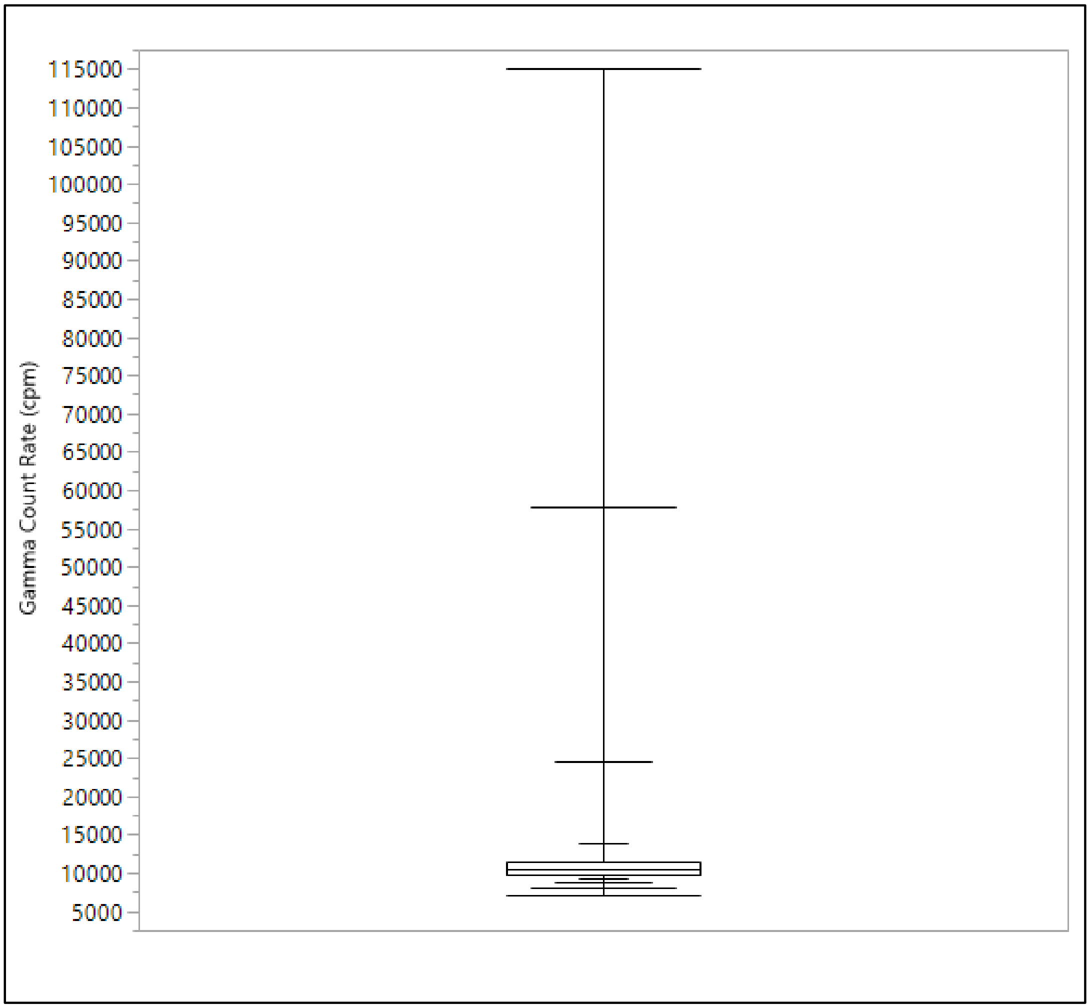


Figure 6. Box plot of gamma count rates in the Survey Area.

Table 3. Summary statistics for gamma count rates in the Survey Area.

Parameter	Gamma Count Rate (cpm)
n	24,442
Minimum	7,074
Maximum	115,161
Mean	11,813
Median	10,605
Standard Deviation	6,125

Notes:
cpm = counts per minute

3.0 Correlation Studies

The following sections address the activities under two types of correlation studies outlined in the RSE Work Plan: comparisons of 1) radium-226 concentrations in surface soils and gamma count rates and 2) exposure rates and gamma count rates. GPS-based gamma count rate measurements were made over small areas for the former study. The means of the measurements were used in this case. Static gamma count rate measurements, co-located with exposure rate measurements, were used in the latter study.

3.1 Radium-226 concentrations in surface soils and gamma count rates

On October 13, 2016, field personnel made GPS-based gamma count rates measurements and collected five-point composite samples of surface soils in each of five areas at the AUM. These areas were selected using criteria established in the RSE Work Plan. No DQO was established for homogeneity of the correlation plots and as described in Section 4.3 and Appendix E of the RSE Work Plan, homogeneity of the correlation plots was evaluated qualitatively. Sub-samples were collected from the correlation plot centroid and at each corner of the plot. The activities were performed contemporaneously, by area and all on the same day, such that variations in the gamma count rate measurements could be limited largely to those posed by the soils and rocks at the locations. Figure 7 shows the GPS-based gamma count rate measurements in the five areas (labeled with location identifiers).

The soil samples were analyzed by ALS Laboratories in Ft Collins, CO for radium-226 and isotopic thorium. The latter analysis was included to assess the potential effects of thorium series isotopes on the correlation and evaluate thorium-230 and radium-226 activities to indicate the status of equilibrium in the uranium decay series. Table 4 lists the results of the measurements and radium-226 concentrations in the soil samples. The means of the gamma count rate measurements range from 11,319 to 46,805 cpm. The concentrations of radium-226 range from 0.64 to 22.6 picocuries per gram (pCi/g).

Table 5 lists the concentrations of isotopes of thorium (thorium-228, -230, and -232) in the same soil samples.

Laboratory analyses are presented in Appendix F.2, Laboratory Analytical Data and Data Validation Reports, in the “Alongo Mines Removal Site Evaluation Report” (Stantec, 2018).

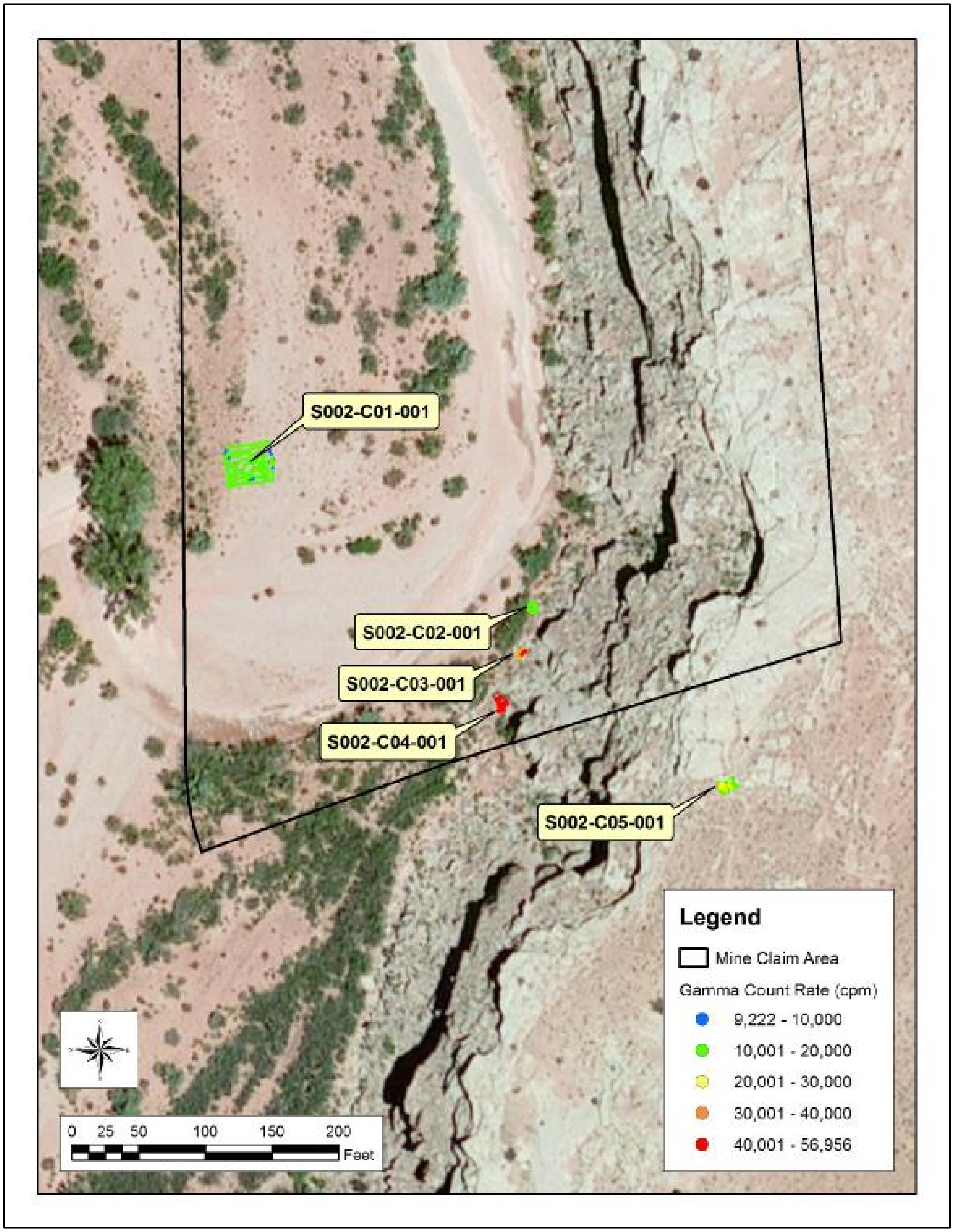


Figure 7. GPS-based gamma count rate measurements made for the correlation study.

Table 4. Gamma count rates and associated concentrations of radium-226 in samples of surface soils obtained in the correlation study.

		Gamma Count Rate (cpm)				Ra-226 (pCi/g)		
Location	**Area (m^2)**	**Mean**	**Minimum**	**Maximum**	**σ**	**Result**	**Error ±2σ**	**MDC**
S002-C01-001	116.0	11,319	9,222	16,947	1,229	0.64	0.2	0.37
S002-C02-001	5.9	15,488	13,152	18,270	1,149	1.61	0.31	0.4
S002-C03-001	2.1	36,691	30,768	45,295	3,866	14.5	1.8	0.6
S002-C04-001	5.4	46,805	35,480	56,956	3,745	22.6	2.8	0.8
S002-C05-001	9.5	18,267	14,947	22,684	1,321	5.1	0.69	0.43

Notes:
cpm = counts per minute
MDC = minimum detectable concentration
m^2 =square meters
pCi/g = picocuries per gram
σ = standard deviation

Table 5. Concentrations of isotopes of thorium in samples of surface soils obtained in the correlation study.

	Thorium-228 (pCi/g)			Thorium-230 (pCi/g)			Thorium-232 (pCi/g)		
Sample ID	**Result**	**Error ± 2 σ**	**MDC**	**Result**	**Error ± 2 σ**	**MDC**	**Result**	**Error ± 2 σ**	**MDC**
S002-C01-001	0.56	0.11	0.03	0.49	0.1	0.07	0.63	0.12	0
S002-C02-001	0.53	0.13	0.09	1.23	0.24	0.1	0.56	0.13	0.03
S002-C03-001	0.399	0.087	0.048	9.8	1.5	0.1	0.432	0.088	0.014
S002-C04-001	0.446	0.095	0.058	14	2.2	0.1	0.471	0.093	0.017
S002-C05-001	0.56	0.11	0.05	4.04	0.65	0.08	0.55	0.11	0.02

Notes:
MDC = minimum detectable concentration
pCi/g = picocuries per gram
σ = standard deviation

A model was made of the results in Table 4, predicting the concentrations of radium-226 in surface soils from the mean gamma count rate in each area. The mean relationship between the measurements, shown in Figure 8, is a linear function with an adjusted Pearson's Correlation Coefficient (adjusted R^2) of 0.99, as expressed in the equation:

$$\text{Gamma Count Rate (cpm)} = 1612 \times [\text{radium-226 (pCi/g)}] + 11380$$

The root mean square error and p-value for the model are 1.8×10^3 and less than 0.001, respectively; these parameters are not data quality objectives (DQOs) and are included only as information. The R^2 value for this model exceeds the project DQO of 0.8.

This equation was used to convert the gamma count rate measurements observed in the gamma surveys to predicted concentrations of radium-226. Table 6 presents summary statistics for the predicted concentrations of radium-226 in the Survey Area. The range of the predicted concentrations of radium-226 in the Survey Area is -2.7 to 64.4 pCi/g, with a mean and median of 0.3 and -0.5 pCi/g, respectively. Note that the radium-226 concentrations predicted from gamma count rate measurements exceeding approximately 47,000 cpm are extrapolated from the regression model and are outside of the correlation dataset and therefore inherently uncertain. While the gamma correlation equation can be used to convert gamma count rates to concentrations of Ra-226 in soil, the resulting radium concentrations are highly uncertain estimates, as the wide prediction interval bands illustrated in Figure 8 demonstrate. Users of the regression equation should be aware of the limitations of the dataset and be cautious when estimating radium-226 concentrations.

Figure 9 shows the predicted concentrations of radium-226, the spatial and numerical distribution of which mirror those depicted in Figure 4.

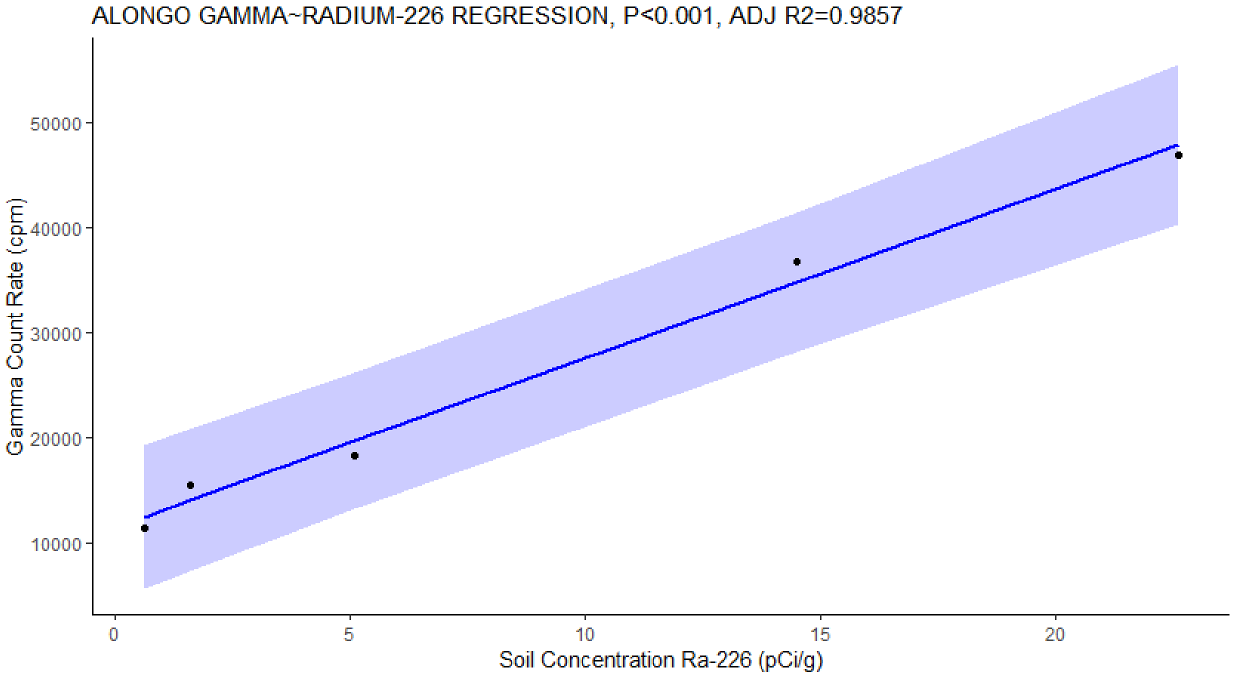


Figure 8. Correlation of gamma count rates and concentrations of radium-226 in surface soils (blue line) with 95% upper prediction level bands plotted (shaded blue area).

Table 6. Predicted concentrations of radium-226 in the Survey Area.

Parameter	Radium-226 (pCi/g)
n	24,442
Minimum	-2.7
Maximum	64.4
Mean	0.3
Median	-0.5
Standard Deviation	3.8

Notes:
pCi/g = picocuries per gram

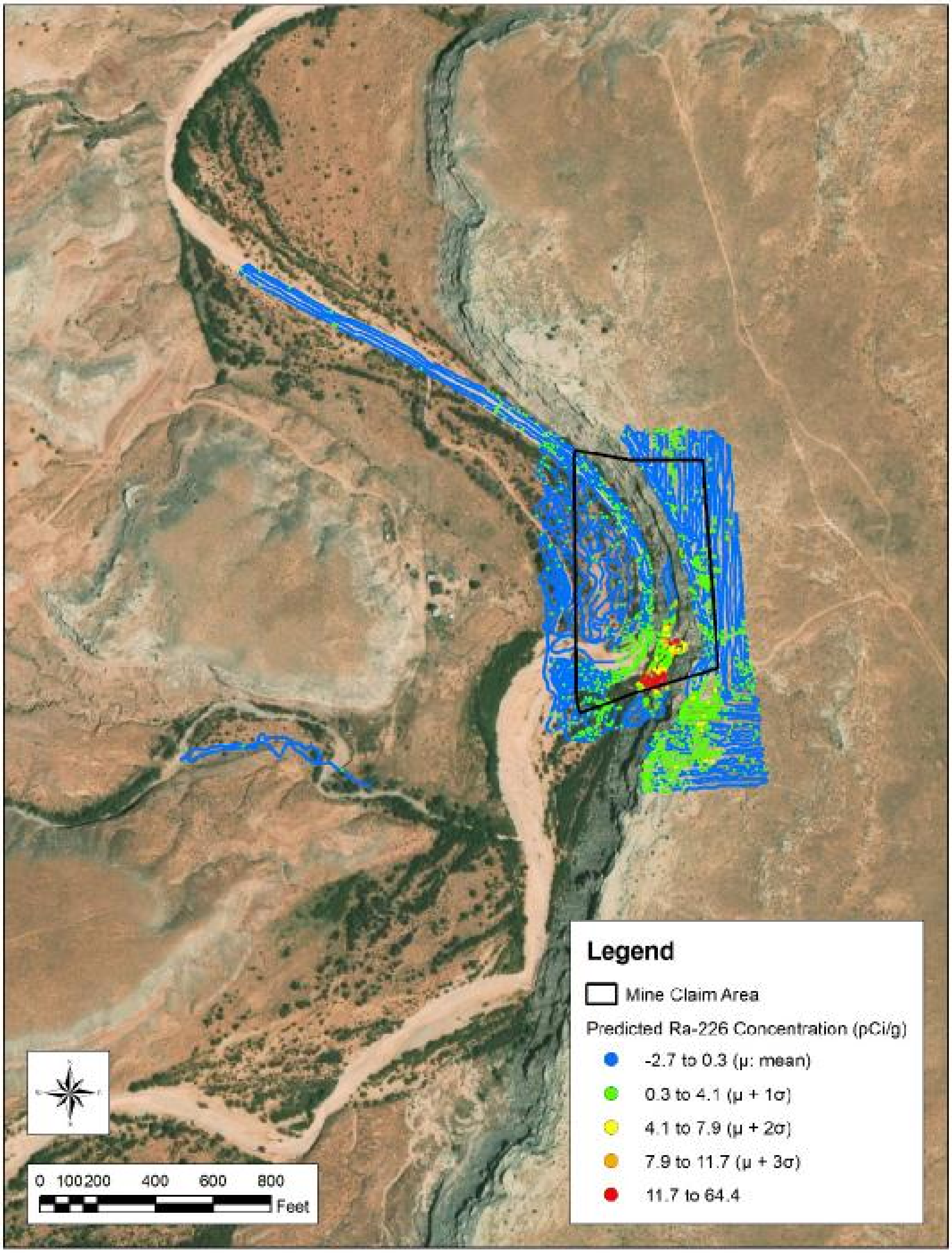


Figure 9. Predicted concentrations of radium-226 in the Survey Area.

Soil concentrations of potassium-40 (K-40) were not expected to be spatially variable within the site, and therefore this radionuclide was not separately accounted for in the RSE Work Plan. If K-40 concentrations did vary, this variability would be included in the regression model and, if the magnitude of the effect were sufficiently large, would result in failure of DQOs related to the regression analysis.

A multivariate linear regression (MLR) was used to evaluate the influence of thorium-232 and thorium-228, isotopes in the thorium series, on the average gamma count rate in the correlation locations. The MLR model was first run using radium-226, thorium-232, and thorium-228 as predictors of gamma count rate. The model failed to produce results because thorium-232 and thorium-228 are colinear. The MLR model was subsequently run without thorium-228. For the second model, the p-values for radium-226 was significant ($p = 0.008$), while that for thorium-232 was not ($p = 0.17$), implying that thorium-232 does not need to be accounted for when predicting concentrations of radium-226 from gamma survey data. Thorium-232 and radium-226 were then each modelled individually as a predictor of gamma count rate. The p-value for thorium-232 coefficient was 0.05 with an adjusted R^2 of 0.71. The thorium-232 coefficient is not significant and the R^2 value does not meet the project DQO. Subsequently we conclude that thorium-232 and thorium-228 concentrations in soil are not significant predictors of gamma count rate. Finally, the p-value for radium-226 as a predictor of gamma count rate was significant ($p < 0.001$), as described above, and the adjusted R^2 value (0.99) exceeded the applicable project DQO ($R^2 > 0.8$).

The depletion of surface radon-222 in surface soil due to environmental factors is assumed to be relatively constant across the correlation locations (i.e., the loss is a fixed fraction of the available source). Provided this is the case, any loss of radon-222 in surface soil is unimportant and accounted for within the statistical model. If the loss is not a consistent fraction at each correlation locations, it is one of many potential correlation confounders that are all linked to spatial heterogeneity of the environmental conditions, and especially spatial heterogeneity of the soil matrix.

The presence of heterogeneous concentrations of gamma emitting radionuclides in sub-surface soil can affect the gamma correlation model. If subsurface soil concentrations of gamma emitting radionuclides were variable between correlation locations, this variability would be included in the regression model, and if the magnitude of the effect were sufficiently large, it would result in failure of the DQOs related to the regression analysis.

3.2 Equilibrium in the uranium series

Secular equilibrium is a condition that occurs when the half-life of a decay-product nuclide is significantly shorter than that of its parent nuclide. After a period of ingrowth equal to approximately seven times the half-life of the decay product, the two nuclides effectively decay with the half-life of the parent. When two radionuclides are in secular equilibrium, their activities are equal.

Equilibrium, for the purpose of this report, is defined as a condition whereby a parent nuclide and its decay product are present in the environment at a fixed ratio, but this ratio – for whatever reason – is not a one-to-one relationship indicative of secular equilibrium. Most commonly, an equilibrium condition results from an environmental process which chemically selects for and transports one nuclide (parent or decay product) away from the other nuclide. Because a consistent fraction of one nuclide has been removed, the two nuclides are present at a fixed ratio other than one-to-one.

Determination of secular equilibrium for an AUM can be an important part of the risk assessment process, as the assumed fraction of radium-226 decay products present in the environment greatly influences a hypothetical receptor's radiation dose and mortality risk. However, it is also acceptable and conservative to assume secular equilibrium between radium-226 and its decay products for the purpose of risk assessment, and therefore to avoid the need to conclusively determine the secular equilibrium status of an AUM. Thus, an inconclusive result regarding secular equilibrium is not a study data gap, as the risk assessment phase may still proceed, provided that conservative assumptions are included regarding equilibrium concentrations of radium-226 decay products.

Regardless, the RSE Work Plan specified that an evaluation of secular equilibrium would be made at each of the 16 Trust AUMs, and so a robust statistical examination of secular equilibrium status for thorium-230 and radium-226 was conducted. The RSE Work Plan did not require an evaluation of equilibrium condition of uranium-238 and uranium-234 because the natural activity abundance for these isotopes is expected and therefore assumed. Likewise, thorium-234 and protactinium-234m were not evaluated since their half-lives are sufficiently short that secular equilibrium can be assumed. Uranium-235 is not in the uranium-238 decay series therefore it was not evaluated. The ratio of thorium-230 to radium-226 can be evaluated even though different analytical methods were used to measure activity concentrations. Radium-226 was measured by EPA method 901.1m, which is a total activity method and thorium-230 was measured by alpha spectroscopy following digestion with hydrofluoric acid, which is also a total-activity method. Thus, it is appropriate to compare the two results.

The evaluation of secular equilibrium for each mine site proceeded as follows:

1. Construction of a figure that depicts soil concentrations of Th-230 plotted against soil concentrations of Ra-226.
2. Simple linear regression is performed on the dataset; the p-value and the adjusted R^2 are recorded. The resulting linear model and the 95% UCL bands are plotted on the figure generated in step 1.
3. The line y=x is added to the figure generated in step 2 (this line represents a perfect 1:1 ratio between Th-230 to Ra-226, indicative of secular equilibrium).
4. An examination of the model and the figure is made sequentially:
    a. If the p-value for the regression slope is insignificant (i.e., $p > 0.05$) or the adjusted R^2 does not meet the study's data quality objective (Adjusted $R^2 > 0.8$), ERG concludes that there is insufficient evidence to conclude that Ra-226 and Th-230 are in equilibrium (secular or otherwise).

b. If the p-value for the regression slope is significant (i.e., $p < 0.05$) and the adjusted R^2 meets the DQO (Adjusted $R^2 > 0.8$) there are two possible conditions, which are evaluated via visual examination of the figure generated in step 3.

   i. If the y=x line falls fully within the bounds of the 95% UCL bands on the regression, ERG concludes that there is evidence that Ra-226 and Th-230 are in secular equilibrium at the site.

   ii. If the y=x line falls partially or completely outside the bounds of the 95% UCL bands on the regression, ERG concludes that there is evidence that Ra-226 and Th-230 are in equilibrium, but not secular equilibrium at the site.

Based on this method, ERG concludes there is evidence that thorium-230 and radium-226 are in equilibrium, but not secular equilibrium (Figure 10).

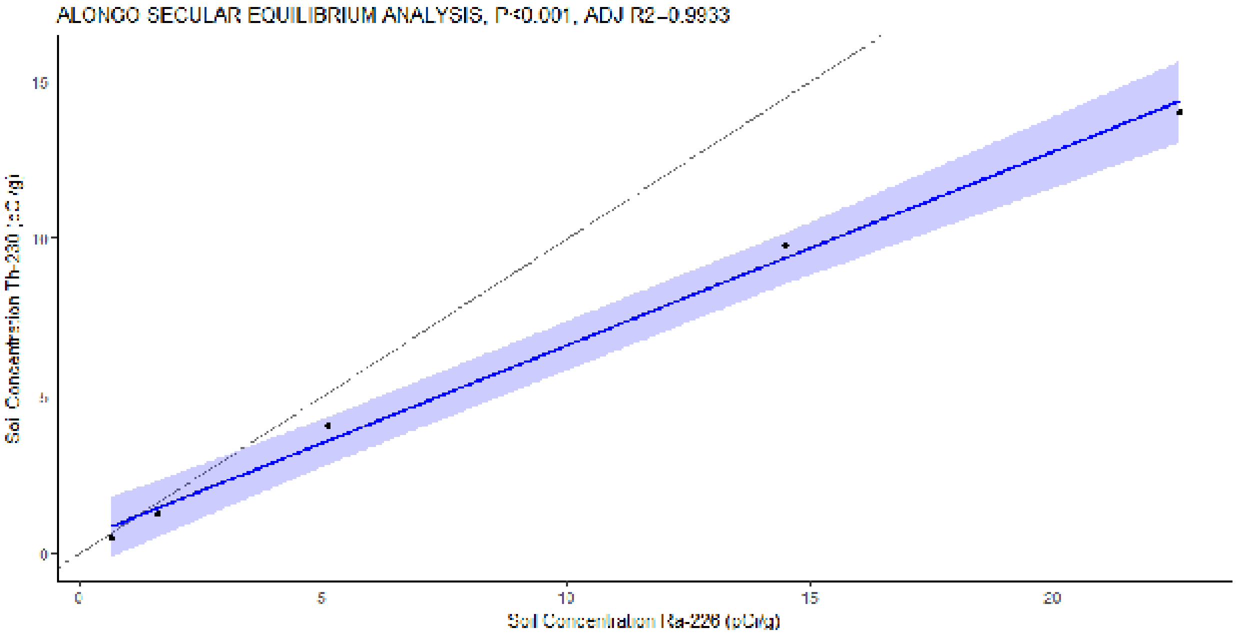


Figure 10. Evaluation of secular equilibrium in the uranium decay series.

3.3 Exposure rates and gamma count rates

Field personnel made co-located one-minute static count rate and exposure rate measurements at the five locations within the Survey Area, representing the range of gamma count rates obtained in the GPS-based gamma survey. Figure 7 shows the locations of the co-located measurements, which were made in the centers of the areas.

The gamma count rate and exposure rate measurements were made on October 13, 2016 at 0.5 m and 1 m above the ground surface, respectively. The gamma count rate measurements were made using one of the four sodium iodide detection systems used in the GPS-based gamma survey of the AUM (Serial

Number PR303727/254772). The exposure rate measurements were made using a Reuter Stokes Model RSS-131 (Serial Number 07J00KM1) high pressure ionization chamber (HPIC) at six-second intervals for about 10 minutes. The exposure rate used in the comparison was the mean of these measurements, less those occurring in initial instrument spikes. The HPIC was in current calibration and function checked before and after use. A correction factor of 1.02 was applied to the measured value per the manufacturer's recommendation by the software of the unit. Calibration forms for the HPIC are provided in Appendix A.

Table 7 presents the results for the two types of measurements made at each of the five locations. Appendix B presents the individual (one second) exposure rate measurements.

The best predictive relationship between the measurements is linear with a R^2 of 0.9896. The root mean square error and p-value for the model are 0.921829 and 0.0004, respectively; these parameters are not DQOs and are included only as information.

The following equation is the linear regression (shown in Figure 11) between the mean exposure rate and gamma count rate results in Table 7 that was generated using MS Excel:

$$\text{Exposure Rate (microRoentgens per hour [}\mu\text{R/h])} = 5\text{x}10^{-4} \text{ x Gamma Count Rate (cpm)} + 6.7336$$

Figure 12 presents the exposure rates predicted from the gamma count rate measurements, the spatial and numerical distribution of which mirror those depicted in Figure 4.

Tables 8 and 9 present summary statistics for the predicted exposure rates in the two potential Background Reference Areas and Survey Area, respectively. The range of predicted exposure rates at BG2 is 10.7 to 14.3 µR/h, with a mean and median of 12.2 and 12.0 µR/h, respectively. The range of predicted exposure rates at BG3 is 10.3 to 13.9 µR/h, with a mean and median of 11.6 and 11.5 µR/h, respectively. The range of predicted exposure rates at the Survey Area is 10.3 to 64.3 µR/h, with a mean and median of 12.6 and 12.0 µR/h, respectively.

Table 7. Co-located gamma count rate and exposure rate measurements.

Location	Gamma Count Rate (cpm)	Exposure Rate (µR/h)
S002-C01-001	10,974	12.1
S002-C02-001	15,169	14.3
S002-C03-001	38,471	23.8
S002-C04-001	48,839	30.9
S002-C05-001	18,658	15.5

Notes:
cpm = counts per minute
µR/h = microRoentgens per hour

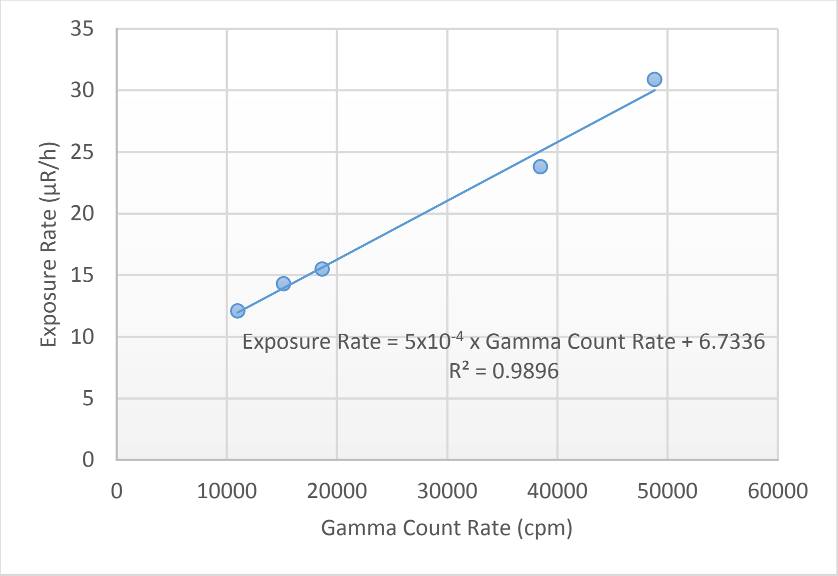


Figure 11. Correlation of gamma count rates and exposure rates.

Table 8. Predicted exposure rates in the potential Background Reference Areas.

Potential Background Reference Area	BG2	BG3
Parameter	**Exposure Rate (µR/h)**	
n	199	444
Minimum	10.7	10.3
Maximum	14.3	13.9
Mean	12.2	11.6
Median	12.0	11.5
Standard Deviation	0.6	0.6

Notes:
µR/h = microRoentgens per hour

Table 9. Predicted exposure rates in the Survey Area.

Parameter	Exposure Rate (µR/h)
n	24,442
Minimum	10.3
Maximum	64.3
Mean	12.6
Median	12.0
Standard Deviation	3.1

Notes:
µR/h = microRoentgens per hour

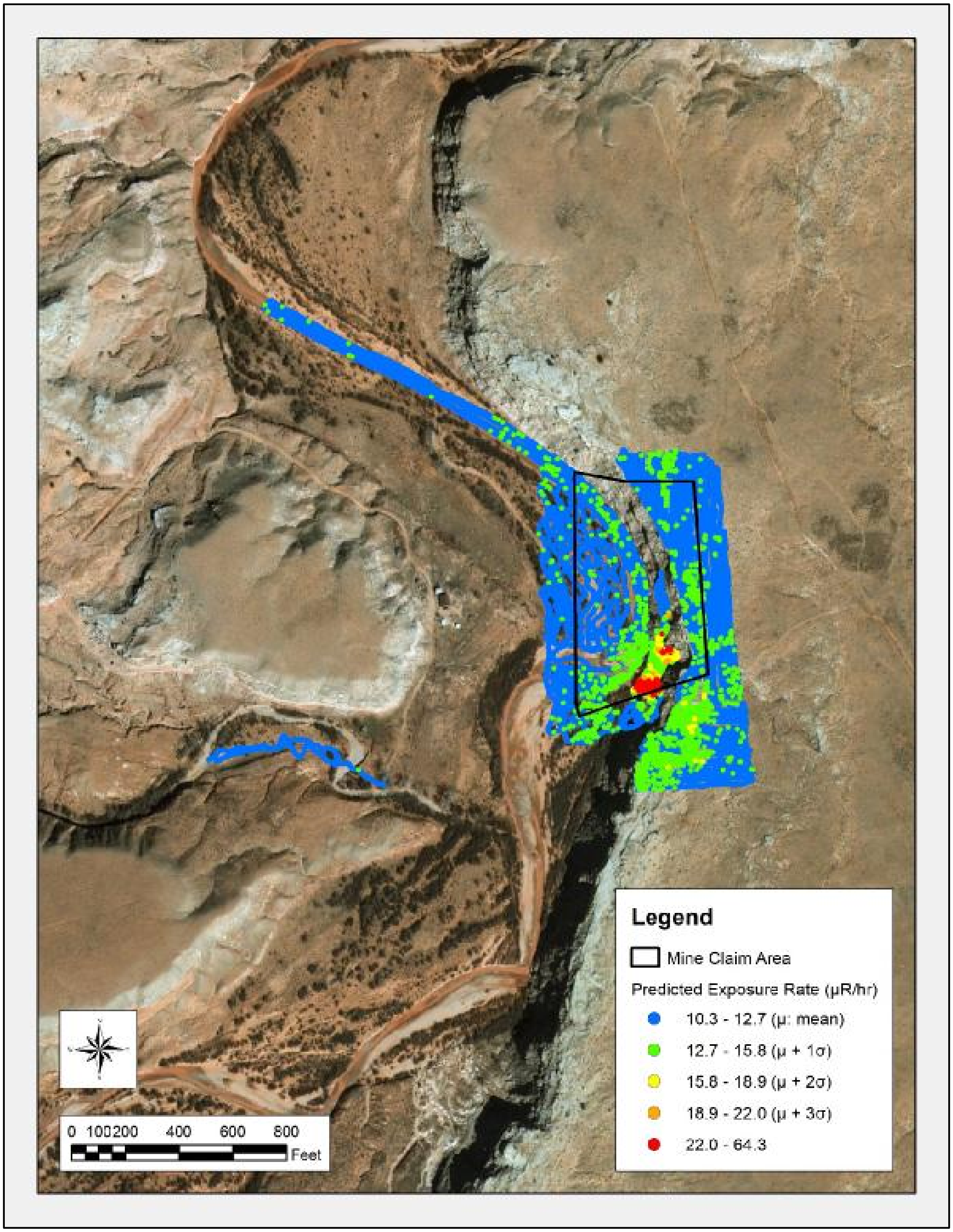


Figure 12. Predicted exposure rates in the Survey Area.

4.0 Deviations to RSE Work Plan

The RSE Work Plan specifies that the comparison of gamma count rates and radium concentrations in surface soils was to occur in 900 square foot areas. Field personnel adjusted the areas as necessary, to minimize the variability of gamma count rates observed, particularly where the spatial distribution of waste rock was heterogeneous.

5.0 Conclusions

The findings of the RSE pertaining to these activities are:

- The horizontal extent and magnitude of mining-related materials were delineated sufficiently to support additional characterization of the subsurface.
- Elevated gamma count rates observed along the southern edge of the mine claim were associated with waste rock.
- Two potential Background Reference Areas were established.
- The relationship between gamma count rates and concentrations of radium-226 in surface soils (0 to 0.5 ft below ground surface) is described by a linear regression model:

Gamma Count Rate (cpm) = 1612 x [radium-226 (pCi/g)] + 11380

- The distribution of concentrations of radium-226 in surface soils predicted using this model is rightward tailed. The values in the Survey Area range from -2.7 to 64.4 pCi/g, with a central tendency (median) of -0.5 pCi/g.
- The thorium series radionuclides do not appear to affect the prediction of concentrations of radium-226 from gamma count rates.
- There is evidence that the uranium series radionuclides are in equilibrium, but not secular equilibrium.
- The relationship between gamma count rates and exposure rates is described by a linear regression model:

Exposure Rate (µR/h) = Gamma Count Rate (cpm) x 5x10-4 + 6.7336

- The distribution of exposure rates predicted using this model is rightward tailed. The values in the Survey Area range from 10.3 to 64.3, with a central tendency (median) of 12.0 µR/h.
- Further work is recommended to support a robust gamma correlation.

6.0 References

ANSI, 1997. Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments, American National Standards Institute (ANSI) Standard N232A. June 20, 2014.

MWH, 2016. Navajo Nation AUM Environmental Response Trust, First Phase, Removal Site Evaluation Work Plan, October 24, 2016.

Stantec, 2018. Alongo Mines Removal Site Evaluation Report, January 2018.

Appendix A Instrument calibration and completed function check forms

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: 254772

Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR303727

✓ 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:

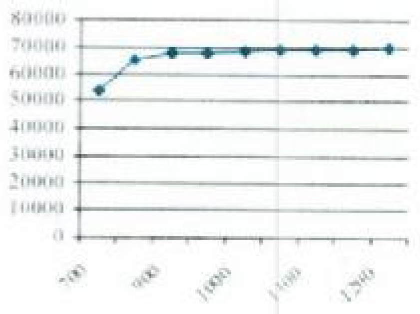
Barometric Pressure: 24.75 inches Hg
Temperature: 74 °F
Relative Humidity: 20 %

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	398857	400
x 1000	100	100	100		100
x 100	400	400	400	39913	400
x 100	100	100	100		100
x 10	400	400	400	3992	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	53620	
800	64979	
900	67955	
950	67795	
1000	68536	9542
1050	69153	
1100	69331	
1150	69346	
1200	69492	

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: ☐ 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: 254772

Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR303727

☑ 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:

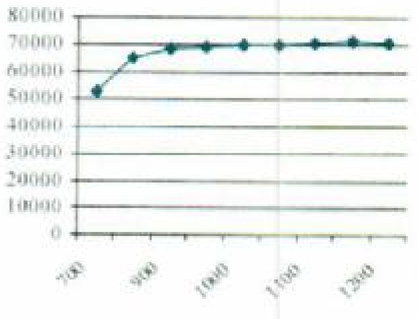
Barometric Pressure: 24.24 inches Hg
Temperature: 78 °F
Relative Humidity: 20 %

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	399859	400
x 1000	100	100	100		100
x 100	400	400	400	39991	400
x 100	100	100	100		100
x 10	400	400	400	4001	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	52821	
800	65213	
900	68644	
950	69245	
1000	69492	9111
1050	69792	
1100	70472	
1150	71183	
1200	70571	

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

Calibrated By:
Reviewed By:

Calibration Date: 2/28/17 ~~2 March 17~~ ASH Calibration Due: 2/28/18 ~~2 March 18~~ ASH

Date: 3-1-17

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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:	196086
Detector:	Manufacturer:	Ludlum	Model Number:	44-10	Serial Number:	PR295014

☑ Mechanical Check ☑ THR/WIN Operation HV Check (+/- 2.5%): ☑ 500 V ☑ 1000 V ☑ 1500 V
☑ F/S Response Check ☑ Reset Check Cable Length: ☐ 39-inch ☑ 72-inch ☐ Other:
☑ Geotropism ☑ Audio Check
☑ Meter Zeroed ☑ Battery Check (Min 4.4 VDC)

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

Threshold: 10 mV
Window:

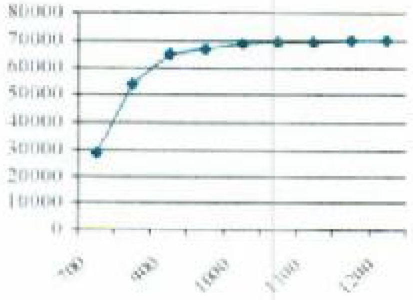
Barometric Pressure: 24.78 inches Hg
Temperature: 74 °F
Relative Humidity: 20 %

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	399802	400
x 1000	100	100	100		100
x 100	400	400	400	39989	400
x 100	100	100	100		100
x 10	400	400	400	3999	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	28456	
800	53330	
900	64430	
950	66209	
1000	68333	
1050	69077	
1100	69121	8924
1150	69973	
1200	70155	

Voltage Plateau



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

Reference Instruments and/or Sources:

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☐ 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 [illegible] 16 Calibration Due: 7-[illegible]-17

Reviewed By: Date: 7/20/16

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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:	196086
Detector:	Manufacturer:	Ludlum	Model Number:	44-10	Serial Number:	PR295014

☑ 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:

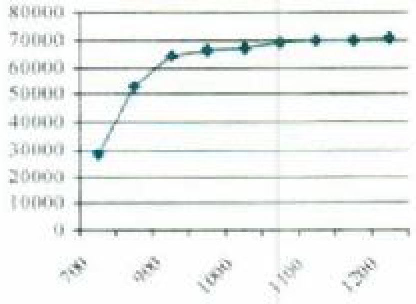
Barometric Pressure: 24.27 inches Hg
Temperature: 78 °F
Relative Humidity: 20 %

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	399386	400
x 1000	100	100	100		100
x 100	400	400	400	39949	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	399	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	28235	
800	52834	
900	64481	
950	66468	
1000	67321	
1050	69009	
1100	69981	9079
1150	69564	
1200	70538	

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: ~~3 March 17~~ 2/28/17 Calibration Due: ~~2 March 18~~ 2/28/18

Date: 3-1-17

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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
✓ 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: 24.78 inches Hg

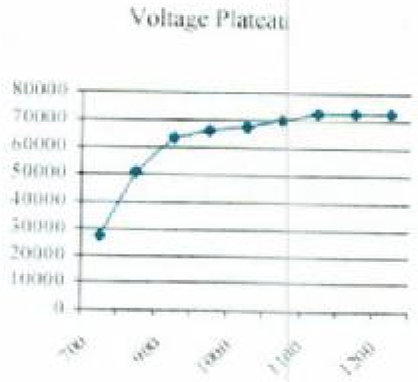
Temperature: 74 °F

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	



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:	282966
Detector:	Manufacturer:	Ludlum	Model Number:	44-10	Serial Number:	PR150507

☑ 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: 60"

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

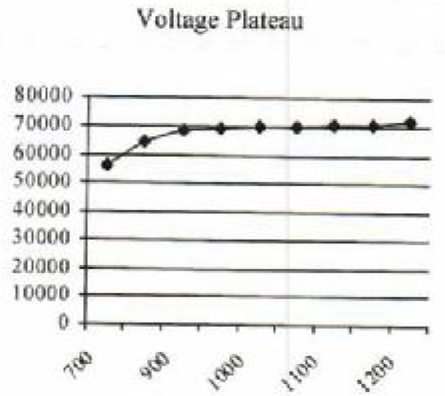
Threshold: 10 mV
Window:

Barometric Pressure: 24.89 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	398753	400
x 1000	100	100	100		100
x 100	400	400	400	39879	400
x 100	100	100	100		100
x 10	400	400	400	3989	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	56463	
800	64304	
900	68534	
950	69331	
1000	69868	9696
1050	70054	
1100	70609	
1150	70681	
1200	71955	


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

Calibrated By:
Reviewed By:

Calibration Date: 10.31.16
Calibration Due: 10.31.17
Date: 10/31/16

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: 271435

Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR295017

☐ 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:

Barometric Pressure: 24.66 inches Hg
Temperature: 76 °F
Relative Humidity: 20 %

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

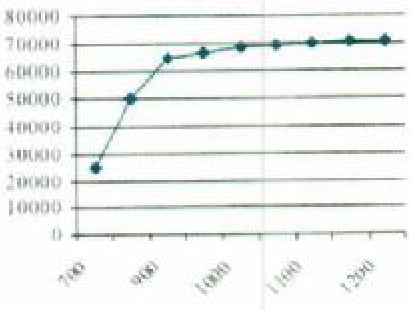
Threshold: 10 mV
Window:

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				

High Voltage	Source Counts	Background
700	24824	
800	50232	
900	64285	
950	66354	
1000	68179	
1050	69312	9393
1100	69955	
1150	70625	
1200	70633	

Voltage Plateau



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 (1/4/1
☐ 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: 3-13-17
Calibration Due: 3-13-18

Reviewed By:
Date: 14 March 2017

ERG Form ITC. 101.A

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

K&S Associates, Inc.
1926 Elm Tree Drive
Nashville, Tennessee 37210-3718
Phone 800-522-2325   Fax 615-871-0856

ACCREDITED
CALIBRATION CERT [illegible]

CALIBRATION REPORT

SUBMITTED BY:
ERG
8809 Washington Street Northeast
Suite 150
Albuquerque, NM 87113

INSTRUMENT: Reuter Stokes RSS-131, #07J00KM1

REPORT NUMBER: 161866
TEST NUMBER(S) M161588
REPORT DATE: June 29, 2016

The CALIBRATION COEFFICIENTS contained in this report were obtained by intercomparison with instruments calibrated by, or directly traceable to, the National Institute of Standards and Technology (NIST). K• S Associates, Inc. is licensed by the State of Tennessee (R-19075-G97, R-19136-B00) to perform calibrations, and is recognized by the Health Physics Society (HPS) as an ACCREDITED INSTRUMENT CALIBRATION LABORATORY. As part of the accreditation K • S participates in a measurement assurance program conducted by the HPS and NIST. K • S also certifies that the calibration was performed using quality policies, methods and procedures that meet or exceed the requirements of ISO/IEC 17025:2005.

This laboratory is accredited by the American Association for Laboratory Accreditation (A2LA) and the results shown in this report have been determined in accordance with the laboratory's terms of accreditation unless stated otherwise in this report

The CALIBRATION COEFFICIENTS stated herein are valid under the conditions specified. It is the instrument user's responsibility to perform the appropriate constancy tests prior to shipment and after return from calibration. It is also the responsibility of the user to assure that the interpretation of the information in this report is consistent with that intended by K • S Associates, Inc.

This report may not be reproduced except in full without the written permission of K• S Associates, Inc.

K&S Associates, Inc
Nashville, Tennessee 37210-3718

ACCREDITED

CALIBRATION CERTIFICATE

Calibration Date: 6/27/2016 Report Number: 161866 Test Number: M161588

K&S certifies that the environmental radiation monitor identified below has been calibrated for radiation measurement using collimated radiation sources whose output has been calibrated with instruments calibrated by or directly traceable to the National Institute of Standards and Technology. K&S is accredited by the American Association for Laboratory Accreditation to perform environmental level calibrations and further certifies that the calibration was performed using accredited policies and procedures (SI 25) that meet or exceed the requirements of ISO/IEC 17025:2005.

Sensor Type: 100 mR/h

Serial Number: 07J00KM1

Average Calibration Coefficient for the range of 0.012 mR/h – 0.220 mR/h*:
1.02 mR/"mR" reading
(Measured at 4 points)

Calibration Coefficient for the 50.0 mR/h point*:
1.12 mR/"mR" reading

Calibration Coefficient for the 80.0 mR/h point*:
1.10 mR/"mR" reading

Found RAC: 2.169e-8

*Multiply the reading in **mR/h** by the Calibration Coefficient to obtain true **mR/h**.

Calibrated By: Richard Hardison Reviewed By: Angela Royer
Title: Calibration Technician Title: Calibration Physicist

Log: M-53 Page: 73

K&S Associates, Inc
Nashville, Tennessee 37210-3718

ACCREDITED
CALIBRATION CERT

AS FOUND DATA
Reuter-Stokes Chamber Calibration

June 27, 2016 ***Test Number*** *M161588*

CHAMBER:

Mfgr: Reuter Stokes
Model: RSS-131
Serial: 07J00KM1

SUBMITTED BY:

ERG

Albuquerque, NM

ORIENTATION/CONDITIONS:

Serial number away from source

"True" background exposure rate of 6.7 uR/h, instrument reading was 0.0076 mR/h

ATMOSPHERIC COMMUNICATION: SEALED

POLARIZING POTENTIAL 401V

LEAKAGE: negligible

BEAM QUALITY				**CALIBRATION**		
BEAM		**EXPOSURE RATE**		**COEFFICIENT**	**UNCERT**	**LOG**
CsEn220	(11mCi)	0.22mR/h	N_x=	1.00 mR/h/rdg	11%	M-53 73
CsEn80	(11mCi)	0.08mR/h	N_x=	1.03 mR/h/rdg	11%	
CsEnv12	(1mCi)	0.012mR/h	N_x=	1.01 mR/h/rdg	11%	
CsEnv15	(1mCi)	0.015mR/h	N_x=	1.02 mR/h/rdg	11%	
Cs199m	(20 Ci)	50mR/h	N_x=	1.12 mR/h/rdg	8%	
Cs252m	(20 Ci)	80mR/h	N_x=	1.10 mR/h/rdg	8%	

Comments Batt: 6.1V, Temp: 24.6 deg C, K&S Environment: Temp:21 deg C , RH 59%, Press: 752 mmHg;
Report Number: 161866
Refer to Appendix I of this report for details on PIC ionization chamber calibrations. Procedure: SI 25
RAC Found: 2.169e-8

Calibrated By Richard Hardison
Richard Hardison
Title: Calibration Technician

Reviewed By:
Title: Calibration Physicist

Checked By:
Prepared By: REH

Form RSS

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.:	254772
Cal. Due Date:	7-9-17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR303727
Cal. Due Date:	7-9-17

Comments:
NNERT

Source: Cs-137
Activity: 5.12 uCi
Source Date: 6-6-94
Distance to Source: 6 inches
Serial No.: 333-94
Emission Rate: NA cpm/emissions

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project reference points
11-18-16	0829	5.4	1015	101	51216	13360	37856	MW	Standing Rock
11-18-16	1517	5.3	1006	100	48629	10616	38013	MW	Gallup lot
11-19-16	0808	5.3	1014	100	43603	5712	37891	MW	Eunice Becenti
11-19-16	1400	5.1	1005	100	44923	5058	39865	NW	Eunice Becenti

12-6-16

Reviewed by:

Review Date: 11/29/16

ERG Form ITC.201.A

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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.:	254772
Cal. Due Date:	7-9-17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR303727
Cal. Due Date:	7-9-17

Comments:

NMGRT

Source: Cs-137

Serial No.: 333-94

Activity: 5.12 uCi

Emission Rate: NA cpm/emissions

Source Date: 6-6-94

Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project reference points
11-9-16	0729	5.6	1009	100	47673	8821	38852	NW	Occurrence B
11-9-16	1415	5.4	1002	99	46465	7541	38924	NW	Chinle lot
11-10-16	0820	5.6	1011	100	47628	9750	37878	NW	Claim 28
11-10-16	1632	5.4	1002	99	50634	8930	41704	NW	Claim 28 (2nd location)
11-11-16	0816	5.5	1010	100	49034	9824	39210	NW	Claim 28
11-11-16	1555	5.4	1002	99	48985	8643	40342	NW	Occurrence B
11-12-16	0819	5.5	1009	100	49296	9054	40242	NW	Hoskie Tso
11-12-16	1340	5.3	1002	99	49800	8556	41244	NW	Hoskie Tso
11-14-16	0818	5.5	1012	100	47737	9609	38128	NW	Hoskie Tso
11-14-16	1637	5.3	1002	99	47714	9150	38564	NW	Hoskie Tso (2nd location)
11-16-16	0809	5.4	1011	100	49413	12340	37073	NW	Standing Rock
11-16-16	1510	5.3	1003	99	49649	11268	38381	NW	Gallup lot

Reviewed by:

Review Date: 11/29/16

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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.:	196086
Cal. Due Date:	7-9-17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR295014
Cal. Due Date:	7-9-17

Comments:

NNERT

Source: Cs-137

Serial No.: 333-94

Activity: 5.12 uCi

Emission Rate: NA cpm/emissions

Source Date: 6-6-94

Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project Reference Points
11-16-16	0812	5.7	1110	101	49614	11731	37883	NW	Standing Rock
11-16-16	1515	5.6	1104	100	48046	10720	37326	NW	Gallup lot
11-18-16	0826	5.7	1116	102	51120	13035	38085	NW	Standing Rock
11-18-16	1512	5.6	1126	101	48583	10155	38428	NW	Gallup lot
11-19-16	0817	5.6	1115	102	44225	4772	39453	NW	Eunice Becenti
11-19-16	1403	5.5	1102	100	43512	4751	38761	NW	Eunice Bicente

12-6-16

Reviewed by:

Review Date: 11/29/16

③

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.:	138638
Cal. Due Date:	7-9-17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR154615
Cal. Due Date:	7-9-17

Comments:
NNEAT

Source: Cs-137
Serial No.: 333-94
Activity: 5.12 uCi
Emission Rate: NA cpm/emissions
Source Date: 6-6-94
Distance to Source: 6 Inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project reference points
11-4-16	1143	5.2	1131	110	46332	8240	38092	NW	occurrence B
11-5-16	1117	5.4	1135	112	46611	8815	37796	NW	Claim 28
11-5-16	1519	5.2	1127	104	46761	7064	39697	NW	Chinle lot
11-7-16	0815	5.3	1130	107	49792	8843	40949	NW	Claim 28
11-7-16	1821	5.2	1120	100	47318	6436	40882	NW	Chinle lot
11-16-16	0821	5.4	1158	132	50609	11976	38633	NW	Standing Rock
11-16-16	1507	5.2	1125	106	49562	10942	38620	NW	Gallup lot

NW 12-6-16

Reviewed by:

Review Date: 11/29/16

(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:	2221
Serial No.:	282966
Cal. Due Date:	10-31-17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR150507
Cal. Due Date:	10-31-17

Comments:
NNEAT

Source: Cs-137

Serial No.: 333-94

Activity: 5.12 uCi

Emission Rate: NA cpm/emissions

Source Date: 6-6-94

Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project Reference Points
11-12-16	0827	5.7	1010	102	48550	9744	38806	NW	Hoskie Tso
11-12-16	1351	5.6	1000	101	47089	8725	38364	NW	Hoskie Tso
11-16-16	0826	5.7	1011	102	50569	12266	38303	NW	Standing Rock
11-16-16	1516	5.6	1006	103	50039	11202	38837	NW	Gallup lot
11-18-16	0836	5.7	1017	104	52221	13620	38601	NW	Standing Rock
11-18-16	1530	5.6	1009	103	48820	10831	37989	NW	Gallup lot
11-19-16	0812	5.6	1016	104	44700	4940	39760	NW	Eunice Becenti
11-19-16	1407	5.5	1004	102	44961	4975	39986	NW	Eunice Becenti
					12-6-16				

Reviewed by: MNC

Review Date: 11/29/16

ERG Form ITC.201.A

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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.:	254772
Cal. Due Date:	2-28-18

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR303727
Cal. Due Date:	2-28-18

Comments:
NNGRT

Source: Cs-137
Serial No.: 544-96
Activity: 4 uCi
Emission Rate: N/a cpm/emissions
Source Date: 4-18-96
Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
3-22-17	0658	5.9	948	100	37553	5150	32403	NW	Goulding's lot
3-22-17	1432	5.7	944	100	35555	4865	30690	NW	Charles Keith shooting range
3-23-17	0903	5.8	949	100	35647	5062	30585	NW	NA-0928
3-23-17	1918	5.7	950	101	41998	10371	31627	NW	Gallup lot
3-24-17	0812	5.7	953	100	36633	4660	31973	NW	Eunice Becenti
3-24-17	1740	5.6	947	100	42350	11142	31208	NW	Gallup lot
3-27-17	0830	5.6	952	100	36518	4677	31841	NW	Eunice Becenti
3-27-17	1230	5.5	949	100	36189	4090	32099	NW	Eunice Becenti
						4-2-17			

Reviewed by:

Review Date: 11/06/17

ERG Form ITC.201.A

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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.:	196086
Cal. Due Date:	2-28-18

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR 295014
Cal. Due Date:	2-28-18

Comments:

NNZRT

Source: Cs-137

Serial No.: 544-96

Activity: 4 uCi

Emission Rate: NA cpm/emissions

Source Date: 4-18-96

Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
3-20-17	0905	5.7	1003	101	40471	8507	31964	NW	Claim 28
3-20-17	1547	5.6	996	101	36470	5494	30976	NW	chinle lot
3-21-17	0641	5.7	1004	101	37904	5597	32307	NW	chinle lot
3-21-17	1654	5.6	999	101	36212	4929	31283	NW	Goulding's lot
3-22-17	0702	5.6	1001	101	35714	5119	30595	NW	Goulding's lot
3-22-17	1937	5.4	995	101	35087	4539	30548	NW	Charles Keith shooting range
3-23-17	0907	5.6	1004	101	36031	4879	31152	NW	NA-0928
3-23-17	1922	5.5	1004	101	41793	9955	31838	NW	Gallup lot
3-24-17	0810	5.5	1007	101	35608	4282	31326	NW	Eunice Becenti
3-24-17	1785	5.5	1000	101	41923	10785	31138	NW	Gallup lot
3-27-17	0833	5.5	1005	101	36943	4282	32661	NW	Eunice Becenti
3-27-17	1235	5.4	1000	101	35141	4013	31128	NW	Eunice Becenti

Reviewed by:

Review Date: 10/19/17

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.:	271435
Cal. Due Date:	3-13-18

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR295017
Cal. Due Date:	3-13-18

Comments:

NNERT

Source: Cs-137

Serial No.: 544-96

Activity: 4 uCi

Emission Rate: NA cpm/emissions

Source Date: 4-18-96

Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
3-22-17	0705	5.6	1050	100	35820	5210	30610	NW	Goulding's lot
3-22-17	1425	5.5	1049	101	36169	4648	31521	NW	Charles Keith shooting range
3-23-17	0908	5.6	1056	102	35972	4828	31144	NW	NA-0928
3-23-17	1915	5.5	1055	102	41686	10757	30929	NW	Gallup lot
3-24-17	0805	5.5	1060	102	36151	4442	31709	NW	Eunice Becenti
3-24-17	1744	5.4	1051	101	41975	10993	31002	NW	Gallup lot
3-25-17	0908	5.5	1057	102	37581	5827	31754		Section 26
3-25-17				DID	NOT USE				
					4-2-17				

Reviewed by:

Review Date: ~~9~~ 10/9/17

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.:	196086
Cal. Due Date:	2-28-18

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR295614
Cal. Due Date:	2-28-18

Comments:
NNERT

Source: Cs-137
Serial No.: 544-96
Activity: 4 uCi
Emission Rate: NA cpm/emissions
Source Date: 4-18-96
Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
6-26-17	0900	6.2	1109	101	38088	6806	31282	NW	Tsosie 1
6-26-17	1619	6.0	1095	99	38337	6166	32171	NW	Tsosie 1
6-27-17	1247	6.1	1108	100	36994	5161	31833	NW	Eunice Becenti
6-27-17	1358	6.0	1102	101	36293	5017	31276	NW	Eunice Becenti
6-28-17	0730	6.1	1111	101	36814	5111	31703	NW	Eunice Becenti
6-28-17	1752	5.9	1101	100	37391	5304	32087	NW	Gallup Garden Inn lot
6-29-17	0908	5.9	1106	100	35972	6002	29970	NW	Section 26
6-30-17	0855	5.9	1107	100	40749	9057	31692	NW	ERG office
						7-5-17			

Reviewed by:

Review Date: 10/9/17

ERG Form ITC.201.A

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Single-Channel Function Check Log

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

METER	
Manufacturer:	GE
Model:	RSJ-131
Serial No.:	07JOUKMI
Cal. Due Date:	6-29-17

DETECTOR	
Manufacturer:	SAME AS METER
Model:	
Serial No.:	
Cal. Due Date:	

Comments:
NWEAT

Source: Cs-137
Serial No. 333-94
Activity: 5.12 uCi
Emission Rate: NA cpm/emissions
Source Date: 6-6-94
Distance to Source: Contact - housing

Date	Time	Battery	High Voltage	Threshhold	mR/h Source Counts	mR/h BKG Counts	Net Counts	Initials	Note(s): Project reference points
11-14-16	0530	~6.3	~400	NA	~27	~10	~17	NW	DoubleTree Flagstaff - room
11-14-16	2005	~6.3	~400	NA	~29	~11	~18	NW	Best Western Holbrook - room
11-18-16	0623	~6.3	~400	NA	~27	~11	~16	NW	Best Western Gallup - room
11-18-16	1532	~6.2	~400	NA	~27	~11	~16	NW	Best Western Gallup - room

NW
12-6-16

Reviewed by:

Review Date: 11-29-16

Appendix B Exposure Rate Measurements

Date and Time	Exposure Rate (mR/h)	Location
11/18/2016 10:22	0.0549	Correlation Location 1
11/18/2016 10:22	0.0967	Correlation Location 1
11/18/2016 10:22	0.0855	Correlation Location 1
11/18/2016 10:22	0.0603	Correlation Location 1
11/18/2016 10:22	0.0413	Correlation Location 1
11/18/2016 10:22	0.0297	Correlation Location 1
11/18/2016 10:22	0.0235	Correlation Location 1
11/18/2016 10:22	0.0204	Correlation Location 1
11/18/2016 10:22	0.0189	Correlation Location 1
11/18/2016 10:22	0.0182	Correlation Location 1
11/18/2016 10:23	0.018	Correlation Location 1
11/18/2016 10:23	0.0179	Correlation Location 1
11/18/2016 10:23	0.0182	Correlation Location 1
11/18/2016 10:23	0.0182	Correlation Location 1
11/18/2016 10:23	0.0179	Correlation Location 1
11/18/2016 10:23	0.0177	Correlation Location 1
11/18/2016 10:23	0.0173	Correlation Location 1
11/18/2016 10:23	0.017	Correlation Location 1
11/18/2016 10:23	0.0168	Correlation Location 1
11/18/2016 10:23	0.017	Correlation Location 1
11/18/2016 10:24	0.017	Correlation Location 1
11/18/2016 10:24	0.0168	Correlation Location 1
11/18/2016 10:24	0.0166	Correlation Location 1
11/18/2016 10:24	0.0167	Correlation Location 1
11/18/2016 10:24	0.017	Correlation Location 1
11/18/2016 10:24	0.017	Correlation Location 1
11/18/2016 10:24	0.017	Correlation Location 1
11/18/2016 10:24	0.0174	Correlation Location 1
11/18/2016 10:24	0.0176	Correlation Location 1
11/18/2016 10:24	0.0177	Correlation Location 1
11/18/2016 10:25	0.0177	Correlation Location 1
11/18/2016 10:25	0.0173	Correlation Location 1
11/18/2016 10:25	0.0173	Correlation Location 1
11/18/2016 10:25	0.0178	Correlation Location 1
11/18/2016 10:25	0.0175	Correlation Location 1
11/18/2016 10:25	0.0172	Correlation Location 1
11/18/2016 10:25	0.0172	Correlation Location 1
11/18/2016 10:25	0.017	Correlation Location 1
11/18/2016 10:25	0.017	Correlation Location 1
11/18/2016 10:25	0.0172	Correlation Location 1
11/18/2016 10:26	0.0179	Correlation Location 1
11/18/2016 10:26	0.0177	Correlation Location 1
11/18/2016 10:26	0.0169	Correlation Location 1
11/18/2016 10:26	0.0163	Correlation Location 1
11/18/2016 10:26	0.0165	Correlation Location 1
11/18/2016 10:26	0.0166	Correlation Location 1
11/18/2016 10:26	0.0166	Correlation Location 1
11/18/2016 10:26	0.0168	Correlation Location 1
11/18/2016 10:26	0.0173	Correlation Location 1
11/18/2016 10:26	0.0173	Correlation Location 1
11/18/2016 10:27	0.0169	Correlation Location 1
11/18/2016 10:27	0.017	Correlation Location 1
11/18/2016 10:27	0.0177	Correlation Location 1
11/18/2016 10:27	0.018	Correlation Location 1
11/18/2016 10:27	0.018	Correlation Location 1
11/18/2016 10:27	0.018	Correlation Location 1
11/18/2016 10:27	0.0182	Correlation Location 1
11/18/2016 10:27	0.0179	Correlation Location 1
11/18/2016 10:27	0.0176	Correlation Location 1
11/18/2016 10:27	0.0176	Correlation Location 1
11/18/2016 10:28	0.018	Correlation Location 1
11/18/2016 10:28	0.018	Correlation Location 1
11/18/2016 10:28	0.0176	Correlation Location 1
11/18/2016 10:28	0.018	Correlation Location 1
11/18/2016 10:28	0.0182	Correlation Location 1
11/18/2016 10:28	0.0178	Correlation Location 1
11/18/2016 10:28	0.0168	Correlation Location 1
11/18/2016 10:28	0.0162	Correlation Location 1
11/18/2016 10:28	0.0158	Correlation Location 1
11/18/2016 10:28	0.0164	Correlation Location 1
11/18/2016 10:29	0.0168	Correlation Location 1
11/18/2016 10:29	0.0169	Correlation Location 1
11/18/2016 10:29	0.017	Correlation Location 1
11/18/2016 10:29	0.0175	Correlation Location 1
11/18/2016 10:29	0.0178	Correlation Location 1
11/18/2016 10:29	0.0178	Correlation Location 1
11/18/2016 10:29	0.0175	Correlation Location 1
11/18/2016 10:29	0.0173	Correlation Location 1
11/18/2016 10:29	0.0169	Correlation Location 1
11/18/2016 10:29	0.0168	Correlation Location 1
11/18/2016 10:30	0.017	Correlation Location 1
11/18/2016 10:30	0.017	Correlation Location 1
11/18/2016 10:30	0.0176	Correlation Location 1
11/18/2016 10:30	0.0177	Correlation Location 1
11/18/2016 10:30	0.0172	Correlation Location 1
11/18/2016 10:30	0.0168	Correlation Location 1
11/18/2016 10:30	0.0166	Correlation Location 1
11/18/2016 10:30	0.0169	Correlation Location 1
11/18/2016 10:30	0.0176	Correlation Location 1
11/18/2016 10:30	0.0177	Correlation Location 1
11/18/2016 10:31	0.0179	Correlation Location 1
11/18/2016 10:31	0.0177	Correlation Location 1
11/18/2016 10:31	0.0174	Correlation Location 1
11/18/2016 10:31	0.0178	Correlation Location 1
11/18/2016 10:31	0.018	Correlation Location 1
11/18/2016 10:31	0.0179	Correlation Location 1
11/18/2016 10:31	0.0176	Correlation Location 1
11/18/2016 10:31	0.0173	Correlation Location 1
11/18/2016 10:31	0.0172	Correlation Location 1
11/18/2016 10:31	0.017	Correlation Location 1
11/18/2016 10:32	0.017	Correlation Location 1
11/18/2016 10:32	0.017	Correlation Location 1
11/18/2016 10:32	0.0168	Correlation Location 1
11/18/2016 10:32	0.017	Correlation Location 1
11/18/2016 10:32	0.017	Correlation Location 1
11/18/2016 10:32	0.017	Correlation Location 1
11/18/2016 10:32	0.0173	Correlation Location 1
11/18/2016 10:32	0.0173	Correlation Location 1
11/18/2016 10:32	0.0173	Correlation Location 1
11/18/2016 10:53	0.0564	Correlation Location 2
11/18/2016 10:54	0.0998	Correlation Location 2
11/18/2016 10:54	0.09	Correlation Location 2

Standing Rock Exposure Rate Measurements for Correlation

Date and Time	Exposure Rate (mR/h)	Location
11/18/2016 10:54	0.0653	Correlation Location 2
11/18/2016 10:54	0.0461	Correlation Location 2
11/18/2016 10:54	0.0346	Correlation Location 2
11/18/2016 10:54	0.0284	Correlation Location 2
11/18/2016 10:54	0.0256	Correlation Location 2
11/18/2016 10:54	0.0244	Correlation Location 2
11/18/2016 10:54	0.0234	Correlation Location 2
11/18/2016 10:54	0.0223	Correlation Location 2
11/18/2016 10:55	0.0213	Correlation Location 2
11/18/2016 10:55	0.0206	Correlation Location 2
11/18/2016 10:55	0.0202	Correlation Location 2
11/18/2016 10:55	0.0208	Correlation Location 2
11/18/2016 10:55	0.0211	Correlation Location 2
11/18/2016 10:55	0.0216	Correlation Location 2
11/18/2016 10:55	0.0217	Correlation Location 2
11/18/2016 10:55	0.0221	Correlation Location 2
11/18/2016 10:55	0.0223	Correlation Location 2
11/18/2016 10:55	0.0223	Correlation Location 2
11/18/2016 10:56	0.0217	Correlation Location 2
11/18/2016 10:56	0.0211	Correlation Location 2
11/18/2016 10:56	0.021	Correlation Location 2
11/18/2016 10:56	0.0213	Correlation Location 2
11/18/2016 10:56	0.0211	Correlation Location 2
11/18/2016 10:56	0.0211	Correlation Location 2
11/18/2016 10:56	0.0215	Correlation Location 2
11/18/2016 10:56	0.0215	Correlation Location 2
11/18/2016 10:56	0.0213	Correlation Location 2
11/18/2016 10:56	0.021	Correlation Location 2
11/18/2016 10:57	0.0208	Correlation Location 2
11/18/2016 10:57	0.0207	Correlation Location 2
11/18/2016 10:57	0.021	Correlation Location 2
11/18/2016 10:57	0.0213	Correlation Location 2
11/18/2016 10:57	0.0211	Correlation Location 2
11/18/2016 10:57	0.0209	Correlation Location 2
11/18/2016 10:57	0.021	Correlation Location 2
11/18/2016 10:57	0.0211	Correlation Location 2
11/18/2016 10:57	0.0213	Correlation Location 2
11/18/2016 10:57	0.0216	Correlation Location 2
11/18/2016 10:58	0.0217	Correlation Location 2
11/18/2016 10:58	0.0222	Correlation Location 2
11/18/2016 10:58	0.0219	Correlation Location 2
11/18/2016 10:58	0.022	Correlation Location 2
11/18/2016 10:58	0.023	Correlation Location 2
11/18/2016 10:58	0.0229	Correlation Location 2
11/18/2016 10:58	0.0227	Correlation Location 2
11/18/2016 10:58	0.0225	Correlation Location 2
11/18/2016 10:58	0.0223	Correlation Location 2
11/18/2016 10:58	0.0223	Correlation Location 2
11/18/2016 10:59	0.022	Correlation Location 2
11/18/2016 10:59	0.0217	Correlation Location 2
11/18/2016 10:59	0.0218	Correlation Location 2
11/18/2016 10:59	0.0219	Correlation Location 2
11/18/2016 10:59	0.0221	Correlation Location 2
11/18/2016 10:59	0.0218	Correlation Location 2
11/18/2016 10:59	0.0219	Correlation Location 2
11/18/2016 10:59	0.0225	Correlation Location 2
11/18/2016 10:59	0.0227	Correlation Location 2
11/18/2016 10:59	0.0223	Correlation Location 2
11/18/2016 11:00	0.0217	Correlation Location 2
11/18/2016 11:00	0.0217	Correlation Location 2
11/18/2016 11:00	0.0222	Correlation Location 2
11/18/2016 11:00	0.0223	Correlation Location 2
11/18/2016 11:00	0.0221	Correlation Location 2
11/18/2016 11:00	0.0219	Correlation Location 2
11/18/2016 11:00	0.0219	Correlation Location 2
11/18/2016 11:00	0.0223	Correlation Location 2
11/18/2016 11:00	0.0221	Correlation Location 2
11/18/2016 11:00	0.0213	Correlation Location 2
11/18/2016 11:01	0.021	Correlation Location 2
11/18/2016 11:01	0.0211	Correlation Location 2
11/18/2016 11:01	0.0213	Correlation Location 2
11/18/2016 11:01	0.0211	Correlation Location 2
11/18/2016 11:01	0.021	Correlation Location 2
11/18/2016 11:01	0.0211	Correlation Location 2
11/18/2016 11:01	0.0216	Correlation Location 2
11/18/2016 11:01	0.0219	Correlation Location 2
11/18/2016 11:01	0.0216	Correlation Location 2
11/18/2016 11:01	0.0211	Correlation Location 2
11/18/2016 11:02	0.0211	Correlation Location 2
11/18/2016 11:02	0.0216	Correlation Location 2
11/18/2016 11:02	0.0218	Correlation Location 2
11/18/2016 11:02	0.022	Correlation Location 2
11/18/2016 11:02	0.0216	Correlation Location 2
11/18/2016 11:02	0.0216	Correlation Location 2
11/18/2016 11:02	0.0216	Correlation Location 2
11/18/2016 11:02	0.0218	Correlation Location 2
11/18/2016 11:02	0.0216	Correlation Location 2
11/18/2016 11:02	0.0216	Correlation Location 2
11/18/2016 11:03	0.0213	Correlation Location 2
11/18/2016 11:03	0.0219	Correlation Location 2
11/18/2016 11:03	0.0221	Correlation Location 2
11/18/2016 11:03	0.0219	Correlation Location 2
11/18/2016 11:03	0.0218	Correlation Location 2
11/18/2016 11:03	0.0218	Correlation Location 2
11/18/2016 11:03	0.0213	Correlation Location 2
11/18/2016 11:03	0.0213	Correlation Location 2
11/18/2016 11:03	0.0215	Correlation Location 2
11/18/2016 11:03	0.0213	Correlation Location 2
11/18/2016 11:04	0.0217	Correlation Location 2
11/18/2016 11:04	0.0219	Correlation Location 2
11/18/2016 11:04	0.0219	Correlation Location 2
11/18/2016 11:04	0.0218	Correlation Location 2
11/18/2016 11:04	0.0219	Correlation Location 2
11/18/2016 11:04	0.022	Correlation Location 2
11/18/2016 11:04	0.0223	Correlation Location 2
11/18/2016 11:22	0.058	Correlation Location 3
11/18/2016 11:22	0.104	Correlation Location 3
11/18/2016 11:22	0.0965	Correlation Location 3
11/18/2016 11:22	0.0727	Correlation Location 3
11/18/2016 11:22	0.0545	Correlation Location 3
11/18/2016 11:23	0.0433	Correlation Location 3
11/18/2016 11:23	0.0375	Correlation Location 3

Date and Time	Exposure Rate (mR/h)	Location
11/18/2016 11:23	0.0341	Correlation Location 3
11/18/2016 11:23	0.0326	Correlation Location 3
11/18/2016 11:23	0.0317	Correlation Location 3
11/18/2016 11:23	0.0313	Correlation Location 3
11/18/2016 11:23	0.0312	Correlation Location 3
11/18/2016 11:23	0.0311	Correlation Location 3
11/18/2016 11:23	0.0309	Correlation Location 3
11/18/2016 11:23	0.0306	Correlation Location 3
11/18/2016 11:24	0.0304	Correlation Location 3
11/18/2016 11:24	0.0305	Correlation Location 3
11/18/2016 11:24	0.0312	Correlation Location 3
11/18/2016 11:24	0.0317	Correlation Location 3
11/18/2016 11:24	0.0322	Correlation Location 3
11/18/2016 11:24	0.0322	Correlation Location 3
11/18/2016 11:24	0.0319	Correlation Location 3
11/18/2016 11:24	0.0319	Correlation Location 3
11/18/2016 11:24	0.0322	Correlation Location 3
11/18/2016 11:24	0.0319	Correlation Location 3
11/18/2016 11:25	0.0313	Correlation Location 3
11/18/2016 11:25	0.031	Correlation Location 3
11/18/2016 11:25	0.0308	Correlation Location 3
11/18/2016 11:25	0.0308	Correlation Location 3
11/18/2016 11:25	0.0306	Correlation Location 3
11/18/2016 11:25	0.0308	Correlation Location 3
11/18/2016 11:25	0.0309	Correlation Location 3
11/18/2016 11:25	0.0309	Correlation Location 3
11/18/2016 11:25	0.0311	Correlation Location 3
11/18/2016 11:25	0.031	Correlation Location 3
11/18/2016 11:26	0.031	Correlation Location 3
11/18/2016 11:26	0.0312	Correlation Location 3
11/18/2016 11:26	0.0316	Correlation Location 3
11/18/2016 11:26	0.0316	Correlation Location 3
11/18/2016 11:26	0.0312	Correlation Location 3
11/18/2016 11:26	0.0312	Correlation Location 3
11/18/2016 11:26	0.0309	Correlation Location 3
11/18/2016 11:26	0.031	Correlation Location 3
11/18/2016 11:26	0.031	Correlation Location 3
11/18/2016 11:26	0.0309	Correlation Location 3
11/18/2016 11:27	0.0305	Correlation Location 3
11/18/2016 11:27	0.0302	Correlation Location 3
11/18/2016 11:27	0.0304	Correlation Location 3
11/18/2016 11:27	0.0306	Correlation Location 3
11/18/2016 11:27	0.0305	Correlation Location 3
11/18/2016 11:27	0.0305	Correlation Location 3
11/18/2016 11:27	0.0308	Correlation Location 3
11/18/2016 11:27	0.0317	Correlation Location 3
11/18/2016 11:27	0.0317	Correlation Location 3
11/18/2016 11:27	0.031	Correlation Location 3
11/18/2016 11:28	0.0307	Correlation Location 3
11/18/2016 11:28	0.0306	Correlation Location 3
11/18/2016 11:28	0.0308	Correlation Location 3
11/18/2016 11:28	0.0307	Correlation Location 3
11/18/2016 11:28	0.0306	Correlation Location 3
11/18/2016 11:28	0.0306	Correlation Location 3
11/18/2016 11:28	0.0309	Correlation Location 3
11/18/2016 11:28	0.0312	Correlation Location 3
11/18/2016 11:28	0.0312	Correlation Location 3
11/18/2016 11:28	0.031	Correlation Location 3
11/18/2016 11:29	0.0315	Correlation Location 3
11/18/2016 11:29	0.032	Correlation Location 3
11/18/2016 11:29	0.032	Correlation Location 3
11/18/2016 11:29	0.0317	Correlation Location 3
11/18/2016 11:29	0.031	Correlation Location 3
11/18/2016 11:29	0.0312	Correlation Location 3
11/18/2016 11:29	0.0319	Correlation Location 3
11/18/2016 11:29	0.0319	Correlation Location 3
11/18/2016 11:29	0.0316	Correlation Location 3
11/18/2016 11:29	0.0311	Correlation Location 3
11/18/2016 11:30	0.0305	Correlation Location 3
11/18/2016 11:30	0.0302	Correlation Location 3
11/18/2016 11:30	0.0302	Correlation Location 3
11/18/2016 11:30	0.03	Correlation Location 3
11/18/2016 11:30	0.0302	Correlation Location 3
11/18/2016 11:30	0.0304	Correlation Location 3
11/18/2016 11:30	0.0309	Correlation Location 3
11/18/2016 11:30	0.0304	Correlation Location 3
11/18/2016 11:30	0.0298	Correlation Location 3
11/18/2016 11:30	0.0297	Correlation Location 3
11/18/2016 11:31	0.0299	Correlation Location 3
11/18/2016 11:31	0.03	Correlation Location 3
11/18/2016 11:31	0.0306	Correlation Location 3
11/18/2016 11:31	0.0306	Correlation Location 3
11/18/2016 11:31	0.0311	Correlation Location 3
11/18/2016 11:31	0.0312	Correlation Location 3
11/18/2016 11:31	0.0309	Correlation Location 3
11/18/2016 11:31	0.0306	Correlation Location 3
11/18/2016 11:31	0.031	Correlation Location 3
11/18/2016 11:31	0.0315	Correlation Location 3
11/18/2016 11:32	0.0316	Correlation Location 3
11/18/2016 11:32	0.0313	Correlation Location 3
11/18/2016 11:32	0.0313	Correlation Location 3
11/18/2016 11:32	0.0317	Correlation Location 3
11/18/2016 11:32	0.0316	Correlation Location 3
11/18/2016 11:32	0.0312	Correlation Location 3
11/18/2016 11:32	0.0305	Correlation Location 3
11/18/2016 11:32	0.03	Correlation Location 3
11/18/2016 11:32	0.0302	Correlation Location 3
11/18/2016 11:32	0.0316	Correlation Location 3
11/18/2016 11:33	0.0317	Correlation Location 3
11/18/2016 11:33	0.0312	Correlation Location 3
11/18/2016 11:33	0.0313	Correlation Location 3
11/18/2016 11:33	0.0313	Correlation Location 3
11/18/2016 11:57	0.0547	Correlation Location 4
11/18/2016 11:57	0.0962	Correlation Location 4
11/18/2016 11:57	0.0847	Correlation Location 4
11/18/2016 11:57	0.059	Correlation Location 4
11/18/2016 11:57	0.0398	Correlation Location 4
11/18/2016 11:57	0.0282	Correlation Location 4
11/18/2016 11:58	0.0216	Correlation Location 4
11/18/2016 11:58	0.018	Correlation Location 4
11/18/2016 11:58	0.0169	Correlation Location 4
11/18/2016 11:58	0.0164	Correlation Location 4

Date and Time	Exposure Rate (mR/h)	Location
11/18/2016 11:58	0.0161	Correlation Location 4
11/18/2016 11:58	0.0155	Correlation Location 4
11/18/2016 11:58	0.015	Correlation Location 4
11/18/2016 11:58	0.015	Correlation Location 4
11/18/2016 11:58	0.015	Correlation Location 4
11/18/2016 11:58	0.0148	Correlation Location 4
11/18/2016 11:59	0.0146	Correlation Location 4
11/18/2016 11:59	0.0147	Correlation Location 4
11/18/2016 11:59	0.0149	Correlation Location 4
11/18/2016 11:59	0.0151	Correlation Location 4
11/18/2016 11:59	0.0152	Correlation Location 4
11/18/2016 11:59	0.0155	Correlation Location 4
11/18/2016 11:59	0.0154	Correlation Location 4
11/18/2016 11:59	0.0152	Correlation Location 4
11/18/2016 11:59	0.0151	Correlation Location 4
11/18/2016 11:59	0.0151	Correlation Location 4
11/18/2016 12:00	0.0156	Correlation Location 4
11/18/2016 12:00	0.0155	Correlation Location 4
11/18/2016 12:00	0.0156	Correlation Location 4
11/18/2016 12:00	0.0156	Correlation Location 4
11/18/2016 12:00	0.0155	Correlation Location 4
11/18/2016 12:00	0.0155	Correlation Location 4
11/18/2016 12:00	0.0155	Correlation Location 4
11/18/2016 12:00	0.0151	Correlation Location 4
11/18/2016 12:00	0.015	Correlation Location 4
11/18/2016 12:00	0.0149	Correlation Location 4
11/18/2016 12:01	0.0145	Correlation Location 4
11/18/2016 12:01	0.0142	Correlation Location 4
11/18/2016 12:01	0.0142	Correlation Location 4
11/18/2016 12:01	0.0143	Correlation Location 4
11/18/2016 12:01	0.0145	Correlation Location 4
11/18/2016 12:01	0.0151	Correlation Location 4
11/18/2016 12:01	0.0153	Correlation Location 4
11/18/2016 12:01	0.0151	Correlation Location 4
11/18/2016 12:01	0.0151	Correlation Location 4
11/18/2016 12:01	0.0153	Correlation Location 4
11/18/2016 12:02	0.0154	Correlation Location 4
11/18/2016 12:02	0.0154	Correlation Location 4
11/18/2016 12:02	0.0154	Correlation Location 4
11/18/2016 12:02	0.0158	Correlation Location 4
11/18/2016 12:02	0.0161	Correlation Location 4
11/18/2016 12:02	0.0158	Correlation Location 4
11/18/2016 12:02	0.0156	Correlation Location 4
11/18/2016 12:02	0.0153	Correlation Location 4
11/18/2016 12:02	0.0155	Correlation Location 4
11/18/2016 12:02	0.0153	Correlation Location 4
11/18/2016 12:03	0.015	Correlation Location 4
11/18/2016 12:03	0.0151	Correlation Location 4
11/18/2016 12:03	0.0151	Correlation Location 4
11/18/2016 12:03	0.0156	Correlation Location 4
11/18/2016 12:03	0.0158	Correlation Location 4
11/18/2016 12:03	0.0158	Correlation Location 4
11/18/2016 12:03	0.0152	Correlation Location 4
11/18/2016 12:03	0.015	Correlation Location 4
11/18/2016 12:03	0.0154	Correlation Location 4
11/18/2016 12:03	0.0156	Correlation Location 4
11/18/2016 12:04	0.0156	Correlation Location 4
11/18/2016 12:04	0.0153	Correlation Location 4
11/18/2016 12:04	0.0149	Correlation Location 4
11/18/2016 12:04	0.0149	Correlation Location 4
11/18/2016 12:04	0.0147	Correlation Location 4
11/18/2016 12:04	0.0152	Correlation Location 4
11/18/2016 12:04	0.0155	Correlation Location 4
11/18/2016 12:04	0.0153	Correlation Location 4
11/18/2016 12:04	0.0147	Correlation Location 4
11/18/2016 12:04	0.0149	Correlation Location 4
11/18/2016 12:05	0.0151	Correlation Location 4
11/18/2016 12:05	0.0148	Correlation Location 4
11/18/2016 12:05	0.0146	Correlation Location 4
11/18/2016 12:05	0.0146	Correlation Location 4
11/18/2016 12:05	0.015	Correlation Location 4
11/18/2016 12:05	0.0158	Correlation Location 4
11/18/2016 12:05	0.0154	Correlation Location 4
11/18/2016 12:05	0.0147	Correlation Location 4
11/18/2016 12:05	0.0146	Correlation Location 4
11/18/2016 12:05	0.0148	Correlation Location 4
11/18/2016 12:06	0.015	Correlation Location 4
11/18/2016 12:06	0.0152	Correlation Location 4
11/18/2016 12:06	0.0153	Correlation Location 4
11/18/2016 12:06	0.0155	Correlation Location 4
11/18/2016 12:06	0.0155	Correlation Location 4
11/18/2016 12:06	0.0156	Correlation Location 4
11/18/2016 12:06	0.0154	Correlation Location 4
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11/18/2016 12:32	0.0265	Correlation Location 5
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11/18/2016 12:32	0.0139	Correlation Location 5
11/18/2016 12:32	0.0136	Correlation Location 5
11/18/2016 12:32	0.0133	Correlation Location 5

Date and Time	Exposure Rate (mR/h)	Location
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11/18/2016 12:32	0.0132	Correlation Location 5
11/18/2016 12:33	0.0137	Correlation Location 5
11/18/2016 12:33	0.0138	Correlation Location 5
11/18/2016 12:33	0.0137	Correlation Location 5
11/18/2016 12:33	0.0141	Correlation Location 5
11/18/2016 12:33	0.014	Correlation Location 5
11/18/2016 12:33	0.0135	Correlation Location 5
11/18/2016 12:33	0.0132	Correlation Location 5
11/18/2016 12:33	0.0132	Correlation Location 5
11/18/2016 12:33	0.0136	Correlation Location 5
11/18/2016 12:33	0.0133	Correlation Location 5
11/18/2016 12:34	0.0131	Correlation Location 5
11/18/2016 12:34	0.0129	Correlation Location 5
11/18/2016 12:34	0.0127	Correlation Location 5
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11/18/2016 12:34	0.0137	Correlation Location 5
11/18/2016 12:34	0.0141	Correlation Location 5
11/18/2016 12:34	0.0137	Correlation Location 5
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11/18/2016 12:34	0.0126	Correlation Location 5
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11/18/2016 12:35	0.0136	Correlation Location 5
11/18/2016 12:35	0.0137	Correlation Location 5
11/18/2016 12:35	0.0133	Correlation Location 5
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11/18/2016 12:40	0.0136	Correlation Location 5
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11/18/2016 12:41	0.0131	Correlation Location 5
11/18/2016 12:41	0.0131	Correlation Location 5
11/18/2016 12:41	0.0129	Correlation Location 5
11/18/2016 12:42	0.0131	Correlation Location 5
11/18/2016 12:42	0.0136	Correlation Location 5
11/18/2016 12:42	0.0135	Correlation Location 5

Appendix C Technical Memo from ERG to Stantec. "Statistical Analysis of the Navajo Trustee Mines Dataset: Multivariate Linear Regression for Evaluation of Gamma Correlation with Ra-226 and Evaluation of Secular Equilibrium Between Ra-226 and Th-230"

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Memo

To: Kirsty Woods, Program Director, Stantec

From: Liz Ruedig, PhD, CHP, and Mike Schierman, CHP, Environmental Restoration Group

Date: 7/31/2018

Re: Statistical Analysis of the Navajo Trustee Mines Dataset: Multivariate Linear Regression for Evaluation of Gamma Correlation with Ra-226 and Evaluation of Secular Equilibrium Between Ra-226 and Th-230

Multivariate Linear Regression for Evaluation of Gamma Count Rate with Ra-226 Concentrations in Surface Soil

Due to a large number of reviewer comments at the sixteen Navajo Trust Abandoned Uranium Mines (AUMs) concerning the influence of gamma-emitting radionuclides not within the uranium-238 decay series on the correlation between dynamic gamma count rate and soil concentration of radium-226, Environmental Restoration Group has performed multivariate linear regression (MLR), relating gamma count rate to multiple soil radionuclides simultaneously. MLR models the influence of a set of predictor variables (in this case, soil concentrations of several gamma-emitting radionuclides, or surrogates for these radionuclides) on a single response variable (in this case, dynamic gamma count rate), accounting for the influence of each predictor variable upon the response variable independently of the other predictor variables within the set.

In a MLR, it is possible to distinguish from a large set of variables the subset that significantly predicts a response variable. This is done by evaluating potential models on a number of criteria:

1. **The multi-collinearity of predictor variables.**

   Predictor variables that are linearly related to each other (i.e., variables y and x, where y may also be mathematically expressed as some multiple of x) produce a condition known as multicollinearity, where the matrix math used to solve the multivariate linear regression becomes irreducible. A physical example of multicollinearity occurs when modelling the influence of two radionuclides in equilibrium with each other (e.g., Th-230 and Ra-226) on a single response variable (e.g., gamma count rate). In order to compute a mathematical solution to the regression model, one of the multicollinear variables must be removed from the regression matrix. The multicollinear variables are identifiable by a large variance inflation factor (VIF), typically greater than 7, but in cases of near-perfect multicollinearity, often much greater than this value (e.g., > 100).

   It is also possible to identify multicollinear predictor variables by regressing two suspect variables upon each other. A high degree of correlation (i.e., $p < 0.05$ and high adjusted R^2) between the two variables suggests that the predictor variables are multicollinear, and that one variable should be eliminated from the multivariate regression prior to analysis.

2. **The p-value of predictor variables**

   For a variable to be considered a significant predictor of the response variable, the p-value of its slope (as calculated in an ANOVA table) must be significant (i.e., $p < 0.05$). In a MLR, the adjusted R^2 value for individual predictor variables is not indicative of overall model quality.

For the Navajo Trust AUMs there are three potential gamma-contributing radionuclides (defined as radionuclides that emit gamma radiation, or whose short-lived decay products emit gamma radiation) present in soil: thorium-232, radium-226 and, thorium-228. Thorium-230, which does not emit gamma radiation, was excluded as a potentially significant gamma-contributing radionuclide.

A MLR model: gamma = radium-226 + thorium-228 + thorium-232 was run for each AUM. For 15 of the 16 mines, thorium-232 and thorium-228 were multicollinear. On this basis, thorium-228 was excluded from the MLR. No multicollinearity was detected at Barton 3. However, none of the predictor variables was a significant predictor of gamma count rate ($p > 0.05$) for the complete model. As such, analysis for all 16 AUMs proceeded by removing thorium-228 from the set of predictor variables and running a new MLR model: gamma = radium-226 + thorium-232. None of the 16 models exhibited multicollinearity with the reduced model. After accounting for the effect of radium-226, thorium-232 was not a significant predictor of gamma count rate at any of the 16 AUMs. Radium-226 was a significant predictor ($p < 0.05$) of gamma count rate (after accounting for the influence of thorium-232 and thorium-228) at some of the AUMs (six of 16 AUMs).

Since neither predictor variable (thorium-232 or radium-226) was unambiguously a predictor in the MLR, two univariate regression models were performed as a final step: gamma = radium-226 and gamma = thorium-232. Thorium-232 was a significant predictor of gamma count rate ($p < 0.05$) only at Standing Rock, which is not unexpected given the geological conditions at this AUM. At all other sites, thorium-232 (and thorium-228 by association) were not significant predictors of gamma count rate ($p > 0.05$). By way of contrast, radium-226 was a significant predictor of the gamma count rate ($p < 0.05$) at 13 of the 16 AUMs. At three AUMs (Mitten, NA-0928, and Tsosie 1) none of the measured radionuclides significantly predicted the gamma count rate. Additionally, the adjusted R^2 values for the correlation models at the three AUMs, plus Claim 28, fail to meet the specified data quality objective (DQO) of greater than 0.8.

The failure to construct statistically defensible correlation models at four AUMs has been identified as a data gap in the relevant AUM report. The unsatisfactory correlation result at these locations is likely due to the small number of correlation locations, or environmental conditions at the AUMs (e.g., spatial heterogeneity in radionuclide concentration in soil, topographic features influencing gamma count rate, etc.), or some combination thereof.

Note that while the statistical measures (i.e., conformance with the study DQO of $R^2 > 0.8$) associated with these regressions can be improved by fitting a power curve to the data, and reporting unadjusted R^2 values, with only five data points at each AUM, ERG does not believe that any statistical correlation model is sufficiently robust to make meaningful inferences concerning soil radium-226 concentration from the gamma scanning data. ERG believes that linear functions – not power curves – best mimic the conceptual model for the physical processes governing the observed data. Fitting any other function in an effort to achieve the study DQO for R^2 is not a statistically rigorous approach, and improving R^2 does not commensurately improve a statistical model's predictive ability. Figure *1* compares the result of fitting a linear versus a power function to the available correlation data for one AUM (Hoskie Tso); the other AUM results are similar.

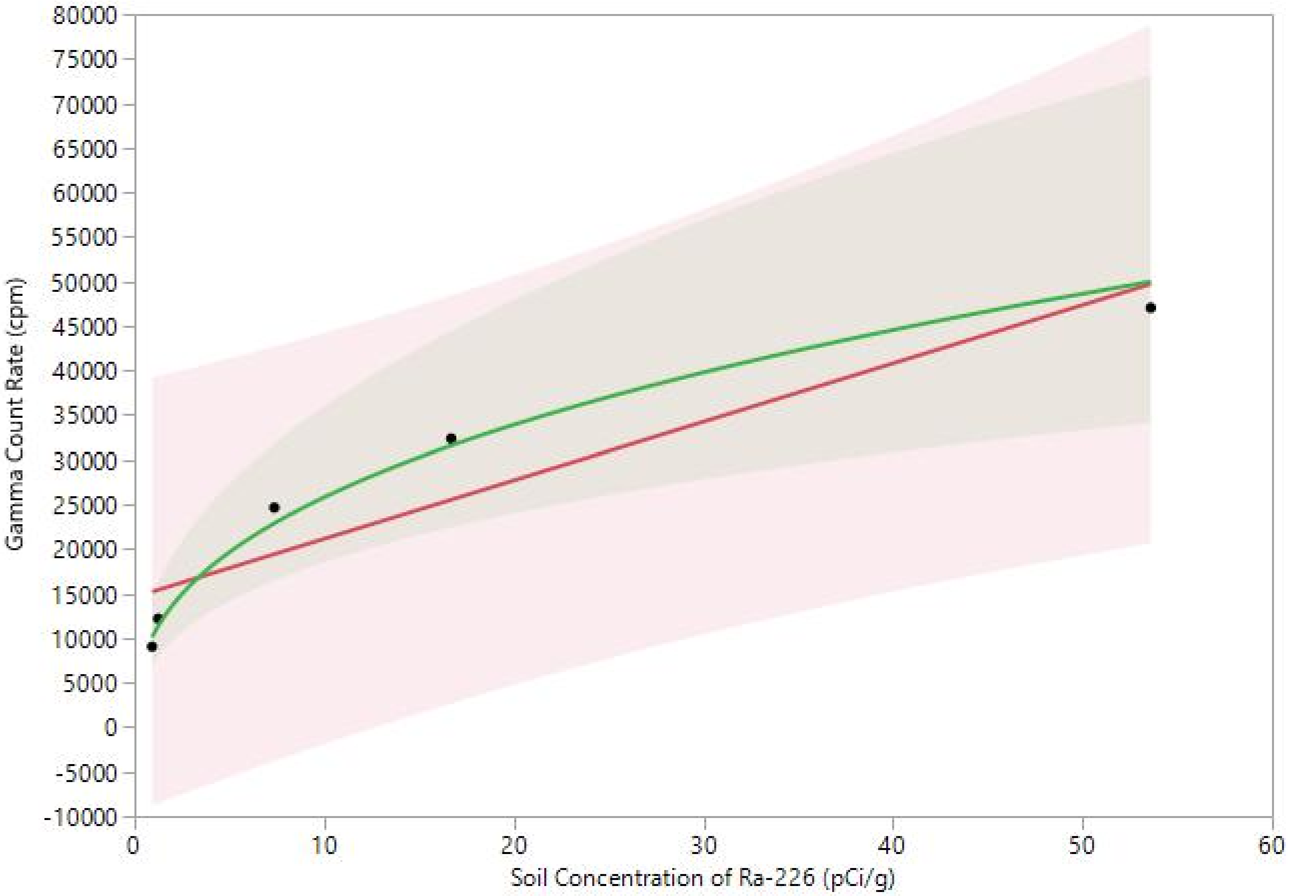

Figure 1. Regression models (linear versus power curve) for gamma count rate regressed on radium-226 showing 95% UPLs (upper prediction limits). Both models meet the study DQO for adjusted R^2 (greater than 0.8). Gamma count rate is not an especially strong predictor of soil concentration of radium-226 for either function.

ERG has updated the individual AUM reports with linear correlation functions and reported the more robust measures of statistical performance described in this memo.

Evaluation of Secular Equilibrium Between Ra-226 and Th-230

Secular equilibrium is a condition that occurs when the half-life of a decay-product nuclide is significantly shorter than that of its parent nuclide. After a period of ingrowth equal to approximately seven times the half-life of the decay product, the two nuclides effectively decay with the half-life of the parent. When two radionuclides are in secular equilibrium, their activities are equal.

Equilibrium, for the purpose of this report, is defined as a condition whereby a parent nuclide and its decay product are present in the environment at a fixed ratio, but this ratio – for whatever reason – is not a one-to-one relationship indicative of secular equilibrium. Most commonly, an equilibrium condition results from an environmental process which chemically selects for and transports one nuclide (parent or decay product) away from the other nuclide. Because a consistent fraction of one nuclide has been removed, the two nuclides are present at a fixed ratio other than one-to-one.

Determination of secular equilibrium for an AUM can be an important part of the risk assessment process, as the assumed fraction of radium-226 decay products present in the environment greatly influences a hypothetical receptor's radiation dose and mortality risk. However, it is also acceptable and conservative to assume secular equilibrium between radium-226 and its decay products for the purpose of risk assessment, and therefore to avoid the need to conclusively determine the secular equilibrium status of an AUM. Thus, an inconclusive result regarding secular equilibrium is not a study data gap, as the risk assessment phase may still proceed, provided that conservative assumptions are included regarding equilibrium concentrations of radium-226 decay products.

Regardless, the Navajo Nation AUM Environmental Response Trust RSE workplan specified that an evaluation of secular equilibrium would be made at each of the 16 Trust AUMs, and so a robust statistical examination of secular equilibrium status for radium-226 and its decay products at each AUM was conducted. One method of evaluating equilibrium between Ra-226 and Th-230 is to calculate the ratio (φ) between the two nuclides for each soil sample location, i.e.,

$$\varphi = \frac{\left[{}^{226}Ra\right]}{\left[{}^{230}Th\right]}$$

When φ is unity, the two nuclides may be said to be in secular equilibrium. Sometimes, φ is averaged over a number of locations, and if the average is unity, the population of measurement locations is said to be in secular equilibrium. Similarly, if φ is consistently some number other than one, it may be concluded that the measured population is in equilibrium. This approach does not account for the statistical uncertainty associated with making inferences across a population, nor the bias introduced into the measurement by averaging a potentially large number of ratios. It is also difficult to establish defensible cutoffs for whether Ra-226 and Th-230 are in secular equilibrium at a particular site using a ratio approach, as there is no objective basis for concluding, e.g., that φ must be between 0.8 and 1.2 (versus any other range of values for φ) for secular equilibrium to occur.

Due to a large number of reviewer comments concerning secular equilibrium within the RSE reports, Environmental Restoration Group opted to re-evaluate equilibrium at each mine site using a more robust statistical method: simple linear regression. This was done after confirming the methods to analyze Ra-226 (EPA Method 901.1) and Th-230 (alpha spectroscopy following sample digestion with hydrofluoric acid) are both total-activity methods with comparable results (L. Steere, ALS personal email communication, July 25, 2018). Evaluation of secular equilibrium for each mine site proceeded as follows:

1. Construction of a figure that depicts soil concentrations of Th-230 plotted against soil concentrations of Ra-226.

2. Simple linear regression is performed on the dataset; the p-value and the adjusted R^2 are recorded. The resulting linear model and the 95% UCL (upper confidence limit) bands are plotted on the figure generated in step 1.

3. The line y=x is added to the figure generated in step 2 (this line represents a perfect 1:1 ratio between Th-230 to Ra-226, indicative of secular equilibrium).

4. An examination of the model and the figure is made sequentially:

    a. If the p-value for the regression slope is insignificant (i.e., $p > 0.05$) or the adjusted R^2 does not meet the study's data quality objective (Adjusted $R^2 > 0.8$), ERG concludes that there is insufficient evidence to conclude that Ra-226 and Th-230 are in equilibrium (secular or otherwise) therefore, it is listed as inconclusive (no equilibrium). Figure *2* depicts the regression result for an AUM (Mitten) that failed to meet the p-value and adjusted R^2 criteria.

    b. If the p-value for the regression slope is significant (i.e., $p < 0.05$) and the adjusted R^2 meets the DQO (Adjusted $R^2 > 0.8$) there are two possible conditions, which are evaluated via visual examination of the figure generated in step 3.

        i. If the y=x line falls fully within the bounds of the 95% UCL bands on the regression, ERG concludes that there is evidence that Ra-226 and Th-230 are in secular equilibrium at the site. Figure *3* depicts the regression result for an AUM (Harvey Blackwater) where there is evidence that Ra-226 and Th-230 are in secular equilibrium.

        ii. If the y=x line falls partially or completely outside the bounds of the 95% UCL bands on the regression, ERG concludes that there is evidence that Ra-226 and Th-230 are in equilibrium, but not secular equilibrium at the site. Figure *4* depicts the regression result for an AUM (Alongo Mines) where there is evidence that Ra-226 and Th-230 are in equilibrium, but not secular equilibrium.

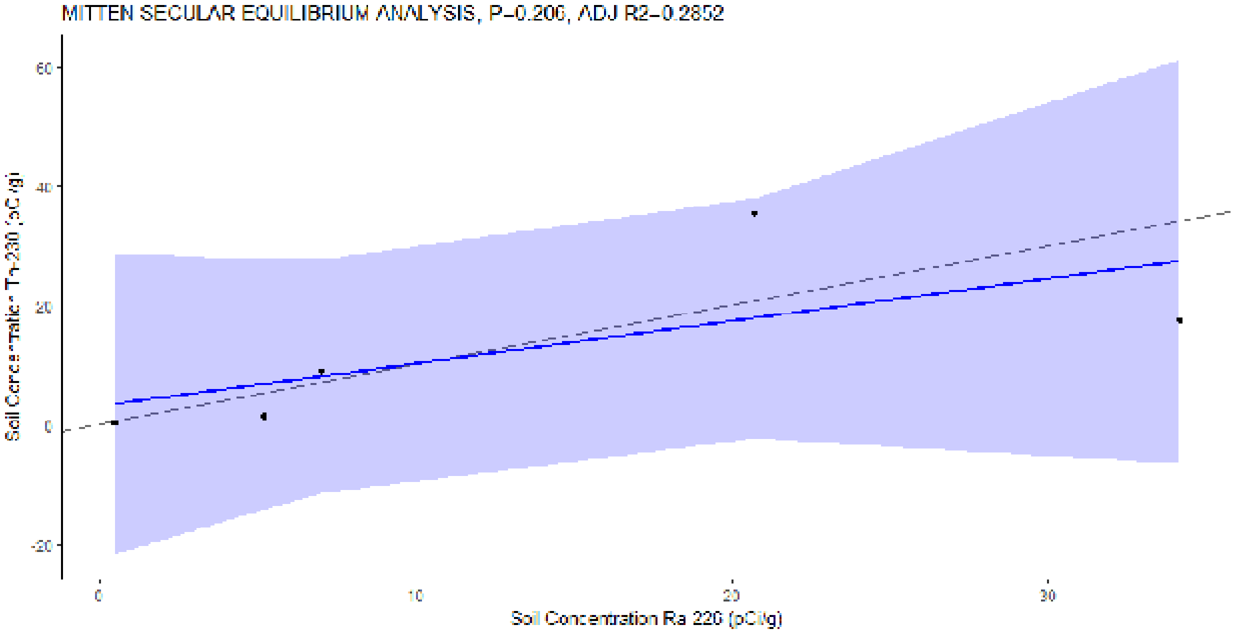

Figure 2. Result for Mitten secular equilibrium analysis, showing failure to meet p-value and adjusted R^2 criteria, i.e., the data are poorly correlated.

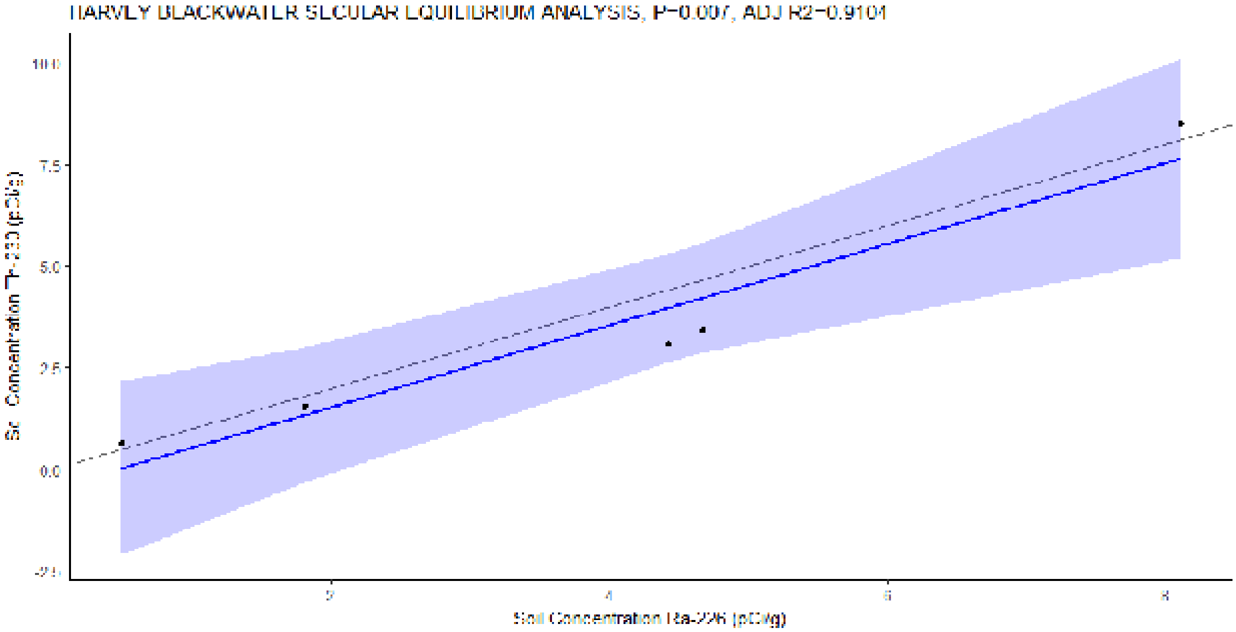

Figure 3. Result for Harvey Blackwater secular equilibrium analysis, showing excellent correlation between the data and the y=x line, i.e., Th-230 and Ra-226 are in secular equilibrium.

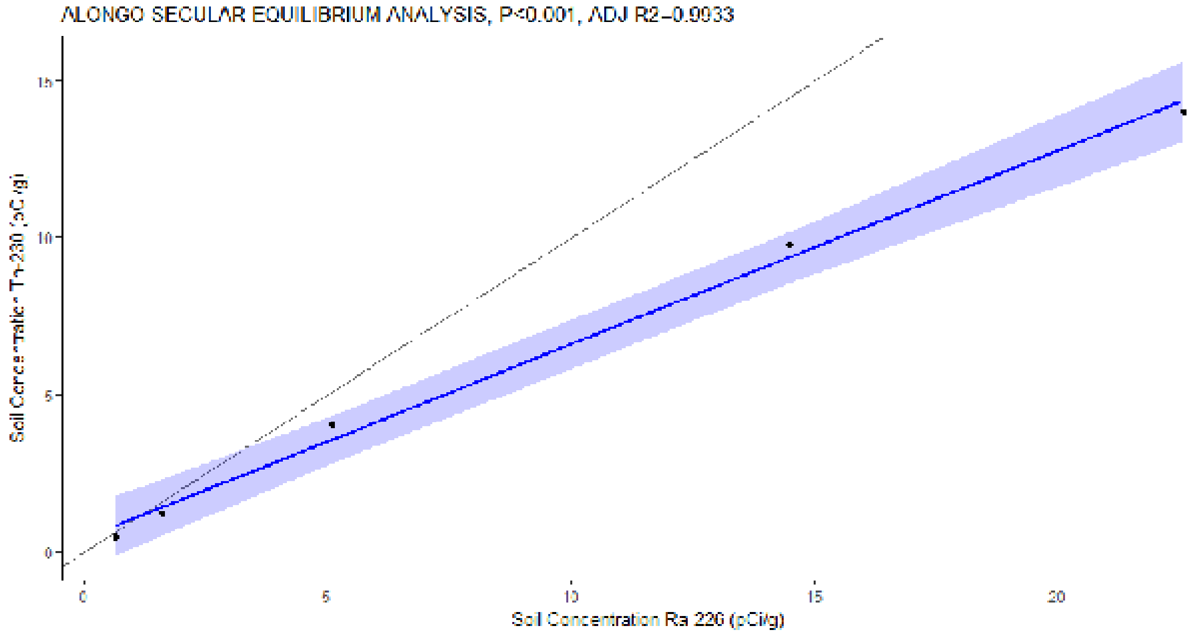

Figure 4. Result for Alongo Mines secular equilibrium analysis, showing excellent correlation between the data, but poor agreement with the y=x line, i.e., Th-230 and Ra-226 are in equilibrium, but not secular equilibrium.

ERG tested for secular equilibrium at each of the 16 Navajo AUMs using the process described above. The results are summarized in Table 1 and in the RSE report for each AUM, respectively. ERG concluded that the data provide evidence that that Ra-226 and Th-230 are in secular equilibrium in soils at two mines (Harvey Blackwater and NA-0928). At one mine (Mitten) there was insufficient evidence to draw any conclusions regarding equilibrium. At the remaining sites, there is evidence that Ra-226 and Th-230 are in equilibrium.

Table 1. Results of secular equilibrium analysis for each of the 16 Navajo Trust AUMs.

Mine	p-value	Adjusted R^2	Conclusion
Alongo Mine	<0.001	0.99	Equilibrium
Barton 3	<0.001	0.98	Equilibrium
Boyd Tisi	<0.001	0.99	Equilibrium
Charles Keith	<0.001	0.99	Equilibrium
Claim 28	<0.001	0.99	Equilibrium
Eunice Becenti	<0.001	0.99	Equilibrium
Harvey Blackwater	0.008	0.91	Secular Equilibrium
Hoskie Tso	<0.001	0.99	Equilibrium
Mitten	0.2	0.29	No Equilibrium
NA-0904	0.001	0.98	Equilibrium
NA-0928	0.002	0.97	Secular Equilibrium
Oak 124-125	<0.001	0.99	Equilibrium
Occurrence B	<0.001	0.98	Equilibrium
Section 26	0.002	0.96	Equilibrium
Standing Rock	0.008	0.91	Equilibrium
Tsosie 1	0.02	0.86	Equilibrium

Appendix D Preliminary Report “Alongo Mines Abandoned Uranium Mine”

Disclaimer: Data and analytical methods used in this Preliminary Report are superseded by the Final Report.

Radiological Characterization of the Alongo Mines Abandoned Uranium Mine

Preliminary

February 19, 2018

prepared for:

Stantec Consulting Services Inc.

2130 Resort Drive, Suite 350
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prepared by:

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Figure 2 Gamma count rates in the potential Background Reference Areas

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Figure 9 Predicted concentrations of radium-226 in the Survey Area

Figure 10 Correlation of gamma count rates and exposure rates

Figure 11 Predicted exposure rates in the Survey Area

Appendices

Appendix A Instrument calibration and completed function check forms

Appendix B Exposure Rate Measurements

Acronyms

ANSI	American National Standards Institute
AUM	abandoned uranium mine
BG2	Background Reference Area 2
BG3	Background Reference Area 3
cpm	counts per minute
DQOs	data quality objectives
ERG	Environmental Restoration Group, Inc.
ft	foot
GPS	global positioning system
MDL	method detection limit
µR/h	microRoentgens per hour
pCi/g	picocuries per gram
R^2	Pearson's Correlation Coefficient
RSE	removal site evaluation
σ	standard deviation
Stantec	Stantec Consulting Services Inc.

Executive Summary

This report addresses the radiological characterization of the Alongo Mines abandoned uranium mine (AUM) located in the Red Valley Chapter of the Navajo Nation in Red Rock Valley, New Mexico. It documents part of the implementation of the Navajo Nation AUM Environmental Response Trust, First Phase, Removal Site Evaluation Work Plan (RSE Work Plan: MWH, 2016). The work was performed by Environmental Restoration Group, Inc of Albuquerque, New Mexico and MWH, now part of Stantec Consulting Services Inc. (Stantec) on behalf of the Navajo Nation AUM Environmental Response Trust – First Phase.

This report provides the results of a 1) Global Positioning System (GPS)-based gamma radiation (gamma) survey and 2) comparisons of the gamma count rates at this AUM to exposure rates and concentrations of radium-226 in surface soils. The field activities addressed in this report were conducted on May 3, 2016; October 1, 8, and 13, 2016; May 18, 2017; and September 13, 2017. They included a GPS-based radiological survey of land surfaces over a Survey Area consisting of the mine claim area out to a 100-foot (ft) buffer; roads and drainages within a 0.25-mile radius of the 100-ft buffer; and areas where the survey was extended; and correlation studies.

The discussion of the results of soil sampling in this report is limited to concentrations of radium-226 and isotopes of thorium in samples taken from surface soils, as part of correlation studies. The objective of the analysis of thorium isotopes was to 1) assess the potential effects of thorium-232 and thorium-228 on the correlation of gamma count rates to concentrations of radium-226 in surface soils; and 2) evaluate thorium-230 and radium-226 activities to indicate the status of equilibrium in the uranium decay series. These and additional results for the RSE are addressed in "Alongo Mines Removal Site Evaluation Report" (Stantec, 2018).

The findings of the RSE pertaining to these activities are:

- The horizontal extent and magnitude of mining-related materials were delineated sufficiently to support additional characterization of the subsurface.
- Elevated gamma count rates observed along the southern edge of the mine claim were associated with waste rock.
- Two potential Background Reference Areas were established.
- The relationship between gamma count rates and concentrations of radium-226 in surface soils (0 to 0.5 ft below ground surface) is described by a power regression model:

$$\text{Radium-226 concentration (in picocuries per gram [pCi/g])} = \\ 1 \text{ x } 10^{-10} \text{ x Gamma Count Rate (in counts per minute [cpm])}^{2.428}$$

- The distribution of concentrations of radium-226 in surface soils predicted using this model resembles a lognormal distribution. The values in the Survey Area range from 0.2 to 194, with a central tendency (median) of 0.6 pCi/g.

- The thorium series radionuclides do not appear to affect the prediction of concentrations of radium-226 from gamma count rates.

- The uranium series radionuclides appear not to be in secular equilibrium.

- The relationship between gamma count rates and exposure rates is described by a linear regression model:

$$\text{Exposure Rate (in microRoentgens per hour [}\mu\text{R/h]) =} \\ \text{Gamma Count Rate (cpm) x } 5\text{x}10^{-4} + 6.7336$$

- The distribution of exposure rates predicted using this model resembles a lognormal distribution. The values in the Survey Area range from 10.3 to 64.3, with a central tendency (median) of 12.0 µR/h.

1.0 Introduction

This report addresses the radiological characterization of the Alongo Mines abandoned uranium mine (AUM) located in the Red Valley Chapter of the Navajo Nation in Red Rock Valley, New Mexico. It documents part of the implementation of the Navajo Nation AUM Environmental Response Trust, First Phase, Removal Site Evaluation Work Plan (RSE Work Plan: MWH, 2016). The work was performed by Environmental Restoration Group, Inc of Albuquerque, New Mexico and MWH, now part of Stantec Consulting Services Inc. (Stantec) on behalf of the Navajo Nation AUM Environmental Response Trust – First Phase.

The activities described here focus on the characterization of gamma radiation (gamma) emitted by uranium series radionuclides in surface soils at the AUM. This report provides the results of a 1) Global Positioning System (GPS)-based gamma radiation (gamma) survey and 2) comparisons of gamma count rates to exposure rates and concentrations of radium-226 in surface soils.

The field activities were conducted on May 3, 2016; October 1, 8, and 13, 2016; May 18, 2017; and September 13, 2017 in accordance with the methods described in the RSE Work Plan. They included a GPS-based radiological survey of land surfaces over an approximately 18-acre Survey Area consisting of the mine claim area out to a 100-foot (ft) buffer, roads and drainages within a 0.25-mile radius of the 100-ft buffer, and areas where the survey was extended; and correlation studies.

The discussion of the results of soil sampling in this report is limited to concentrations of radium-226 and isotopes of thorium in samples taken from surface soils, as part of correlation studies. The objective of the analysis of thorium isotopes was to 1) assess the potential effects of thorium-232 and thorium-228 on the correlation of gamma count rates to concentrations of radium-226 in surface soils; and 2) evaluate thorium-230 and radium-226 activities to indicate the status of equilibrium in the uranium decay series. These and additional results for the RSE are addressed in "Alongo Mines Removal Site Evaluation Report" (Stantec, 2018).

Figure 1 shows the location of the AUM. Background information that is pertinent to the characterization of this AUM is presented in "Alongo Mines Removal Site Evaluation Report" (Stantec, 2018).

2.0 GPS-Based Gamma Surveys

This section addresses the GPS-based surveys conducted in two potential Background Reference Areas and the Survey Area. Table 1 lists the detection systems used in the survey, which were function-checked before and after each day of use and within calibration, in accordance with American National Standards Institute (ANSI) Standard N232A (ANSI, 1997). Appendix A presents the completed function check forms and calibration certificates for the instruments.

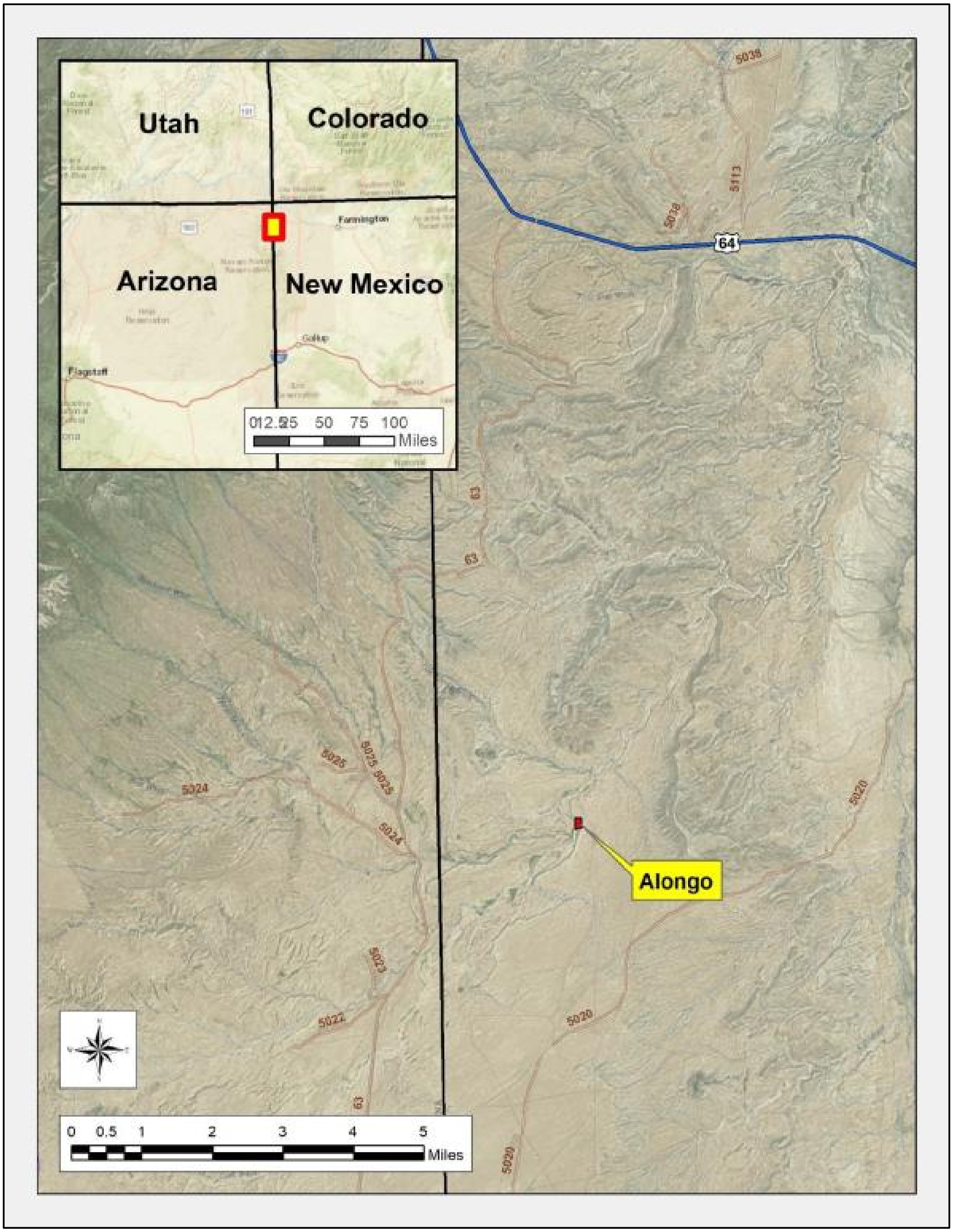


Figure 1. Location of the Alongo Mines Abandoned Uranium Mine

Table 1. Detection systems used in the GPS-based gamma surveys.

Survey Area	Ludlum Model 44-10	Ludlum Model 2221 Ratemeter/Scaler
Potential Background Reference Areas	PR303727[a]	254772[a]
Survey Area	PR295014	196086
	PR303727[a]	254772[a]
	PR320678	282971
	PR355763	138368

Notes:

[a]Detection system used in the correlation studies described in Section 3.0.

2.1 Potential Background Reference Areas

Two potential Background Reference Areas were surveyed, the locations and results of which are depicted on Figure 2. BG2 in the figure is Background Reference Area 2. BG3 is Background Reference Area 3.

Table 2 lists a summary of the gamma count rates, which in BG2 ranged from 7,889 to 15,166 counts per minute (cpm), with a mean and median of 10,851 and 10,616 cpm, respectively. The gamma count rates in BG3 ranged from 7,147 to 14,331 cpm, with a mean and median of 9,675 and 9,472 cpm, respectively.

Figure 3 depicts histograms of the gamma count rates in in BG2 (Figure 3a) and BG3 (Figure 3b). The red and green lines on the figure are theoretical normal and lognormal distributions, respectively. They are presented to show what could be expected if the distributions were normal or lognormal.

Table 2. Summary statistics for gamma count rates in the potential Background Reference Areas.

	Gamma Count Rate (cpm)					
Potential Background Reference Area	n	Minimum	Maximum	Mean	Median	Standard Deviation
2	199	7,889	15,166	10,851	10,616	1,218
3	444	7,147	14,331	9,675	9,472	1,136

Notes:

cpm = counts per minute

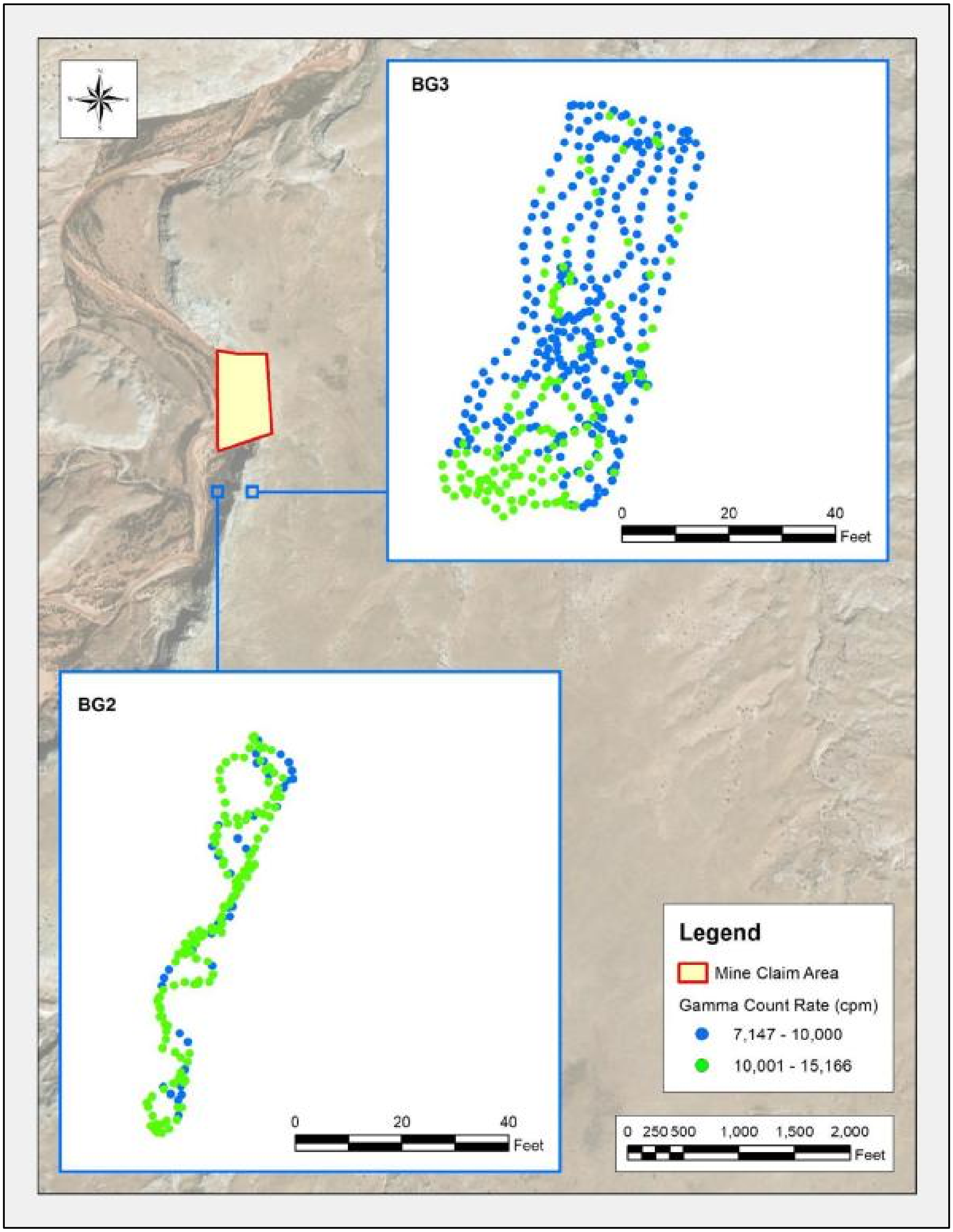
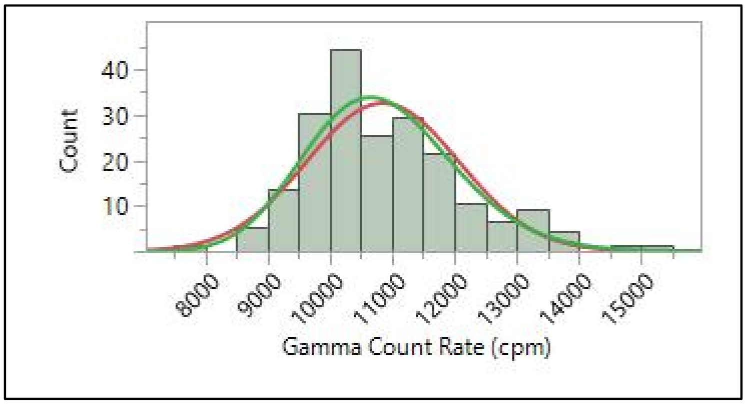
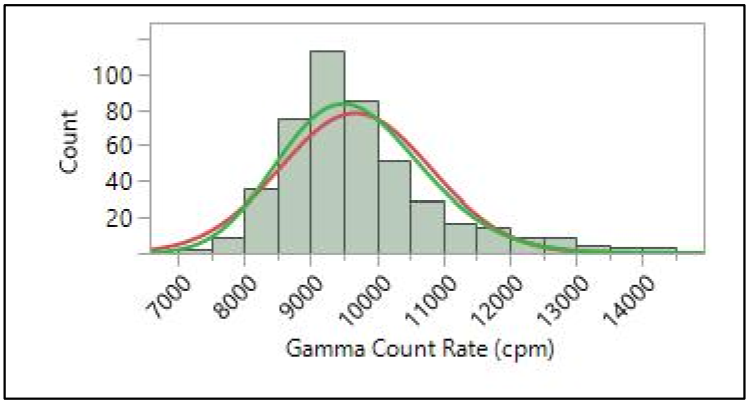


Figure 2. Gamma count rates in the potential Background Reference Areas.



a. Background Reference Area 2



b. Background Reference Area 3

Figure 3. Histograms of gamma count rates in the Background Reference Areas.

2.2 Survey Area

The gamma count rates observed in the Survey Area are depicted in Figure 4. The highest count rates, observed on the south end the mine claim, were associated with waste rock.

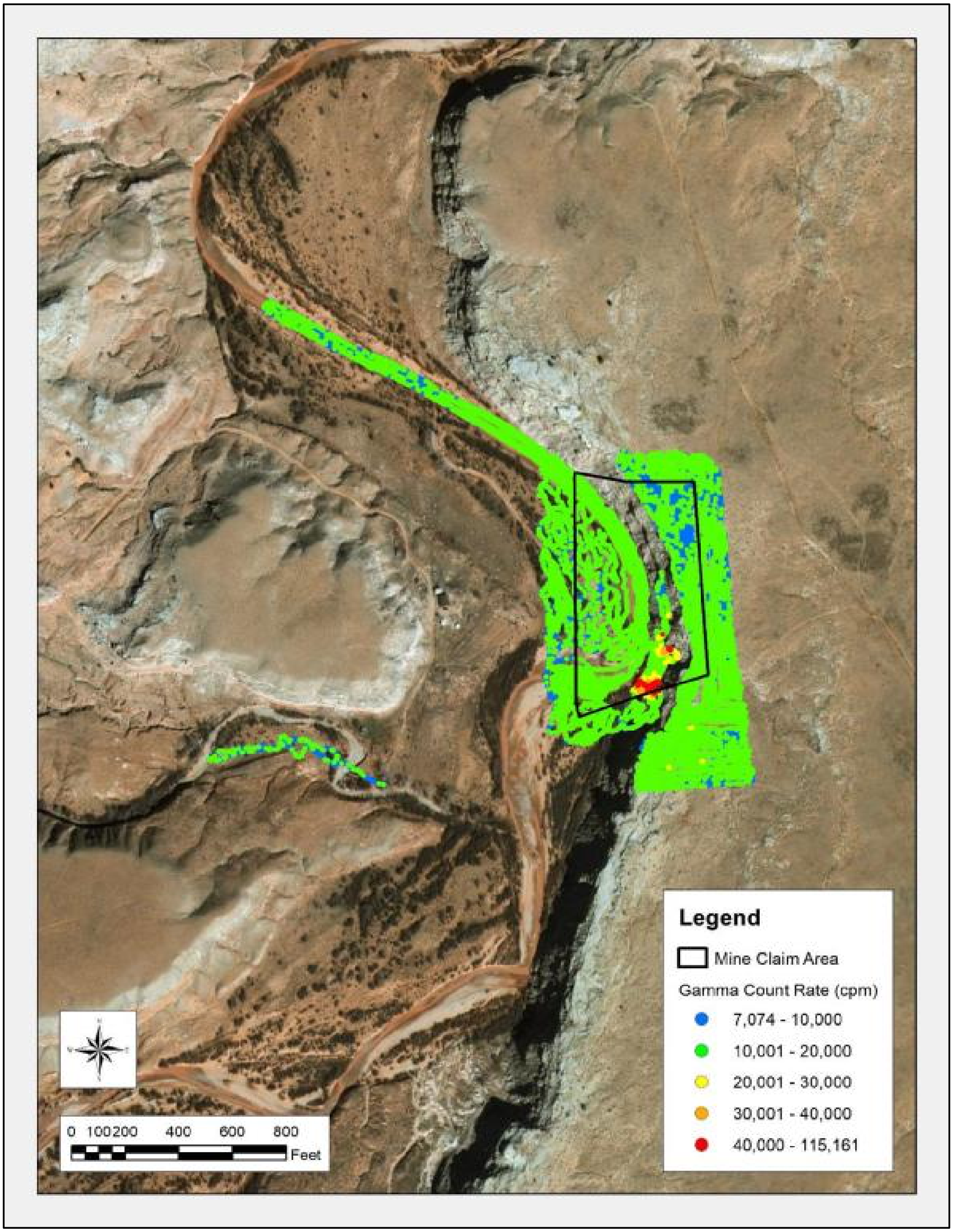


Figure 4. Gamma count rates in the Survey Area.

Figure 5 is a histogram of the gamma count rate measurements made in the Survey Area. The red and green lines on the figure are theoretical normal and lognormal distributions, respectively. They are presented to show what could be expected if the distributions were normal or lognormal. The distribution of the right-tailed set of measurements, evaluated using U.S. Environmental Protection Agency software ProUCL, is not defined; i.e., neither normal or logarithmic. The box plot in Figure 6 depicts cutoffs as horizontal bars, from bottom to top, for the following values or percentiles: minimum, 0.5, 2.5, 10, 25, 50, 75, 90, 97.5, 99.5, and maximum. The 25th, 50th, and 75th percentiles (the three horizontal lines of the box inside the box plot) are 9,882, 10,605, and 11,511 cpm, respectively.

Table 3 is a statistical summary of the measurements, which range from 7,074 to 115,161 cpm and have a central tendency (median) of 10,605 cpm.

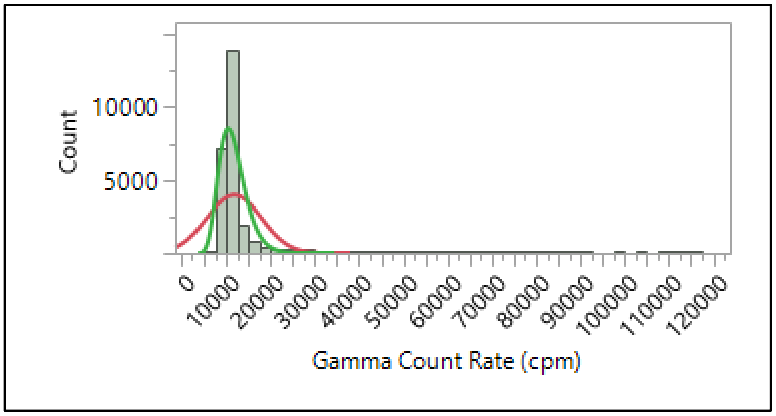


Figure 5. Histogram of gamma count rates in the Survey Area.

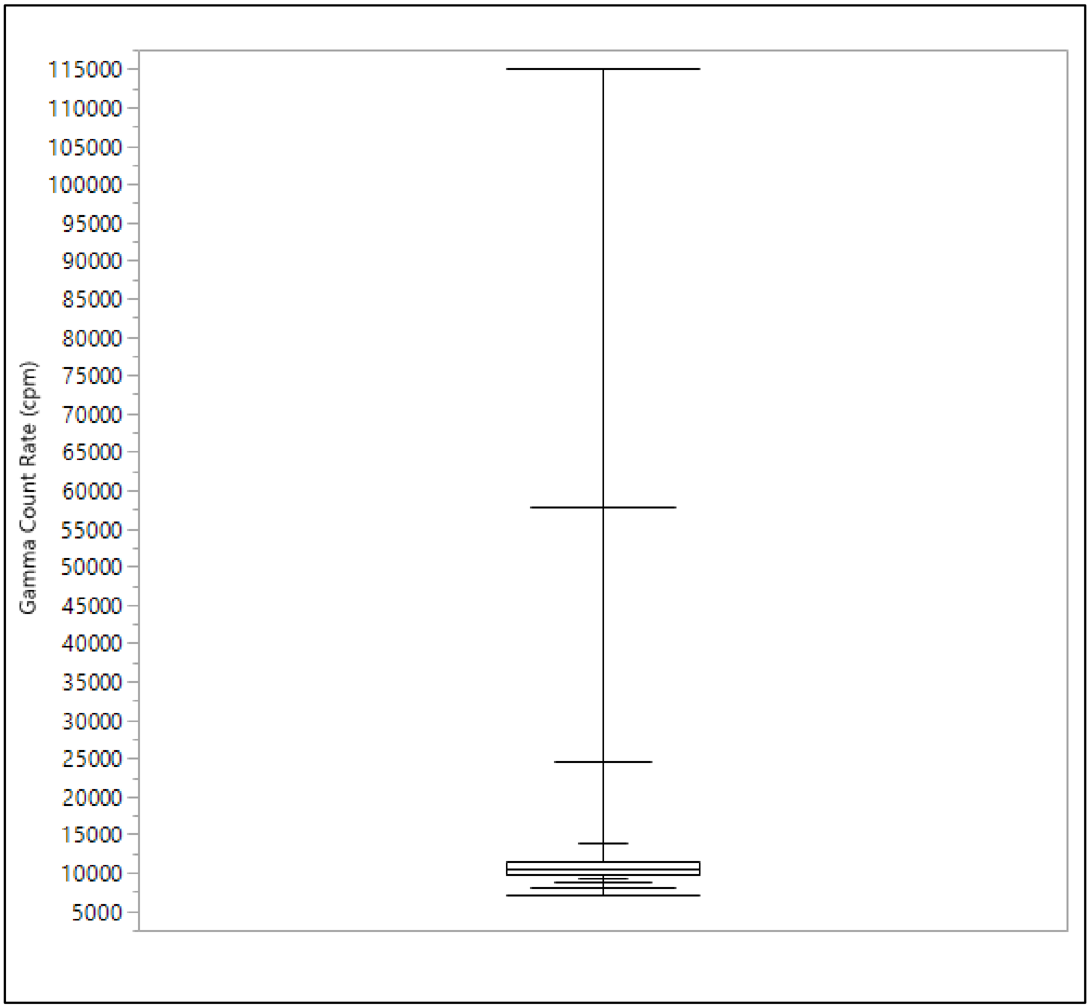


Figure 6. Box plot of gamma count rates in the Survey Area.

Table 3. Summary statistics for gamma count rates in the Survey Area.

Parameter	Gamma Count Rate (cpm)
n	24,442
Minimum	7,074
Maximum	115,161
Mean	11,813
Median	10,605
Standard Deviation	6,125

Notes:
cpm = counts per minute

3.0 Correlation Studies

The following sections address the activities under two types of correlation studies outlined in the RSE Work Plan: comparisons of 1) radium-226 concentrations in surface soils and gamma count rates and 2) exposure rates and gamma count rates. GPS-based gamma count rate measurements were made over small areas for the former study. The means of the measurements were used in this case. Static gamma count rate measurements, co-located with exposure rate measurements, were used in the latter study.

3.1 Radium-226 concentrations in surface soils and gamma count rates

On October 13, 2016, field personnel made GPS-based gamma count rates measurements and collected five-point composite samples of surface soils in each of five areas at the AUM. The activities were performed contemporaneously, by area and all on the same day, such that variations in the gamma count rate measurements could be limited largely to those posed by the soils and rocks at the locations. Figure 7 shows the GPS-based gamma count rate measurements in the five areas (labeled with location identifiers).

The soil samples were analyzed by ALS Laboratories in Ft Collins, CO for radium-226 and isotopic thorium. The latter analysis was included to assess the potential effects of thorium series isotopes on the correlation and evaluate thorium-230 and radium-226 activities to indicate the status of equilibrium in the uranium decay series. Table 4 lists the results of the measurements and radium-226 concentrations in the soil samples. The means of the gamma count rate measurements range from 11,318 to 46,805 cpm. The concentrations of radium-226 range from 0.64 to 22.6 picocuries per gram (pCi/g).

Table 5 lists the concentrations of isotopes of thorium (thorium-228, -230, and -232) in the same soil samples.

Laboratory analyses are presented in Appendix D, Laboratory Analytical Data and Data Usability Report, in “Alongo Mines Removal Site Evaluation Report” (Stantec, 2018).

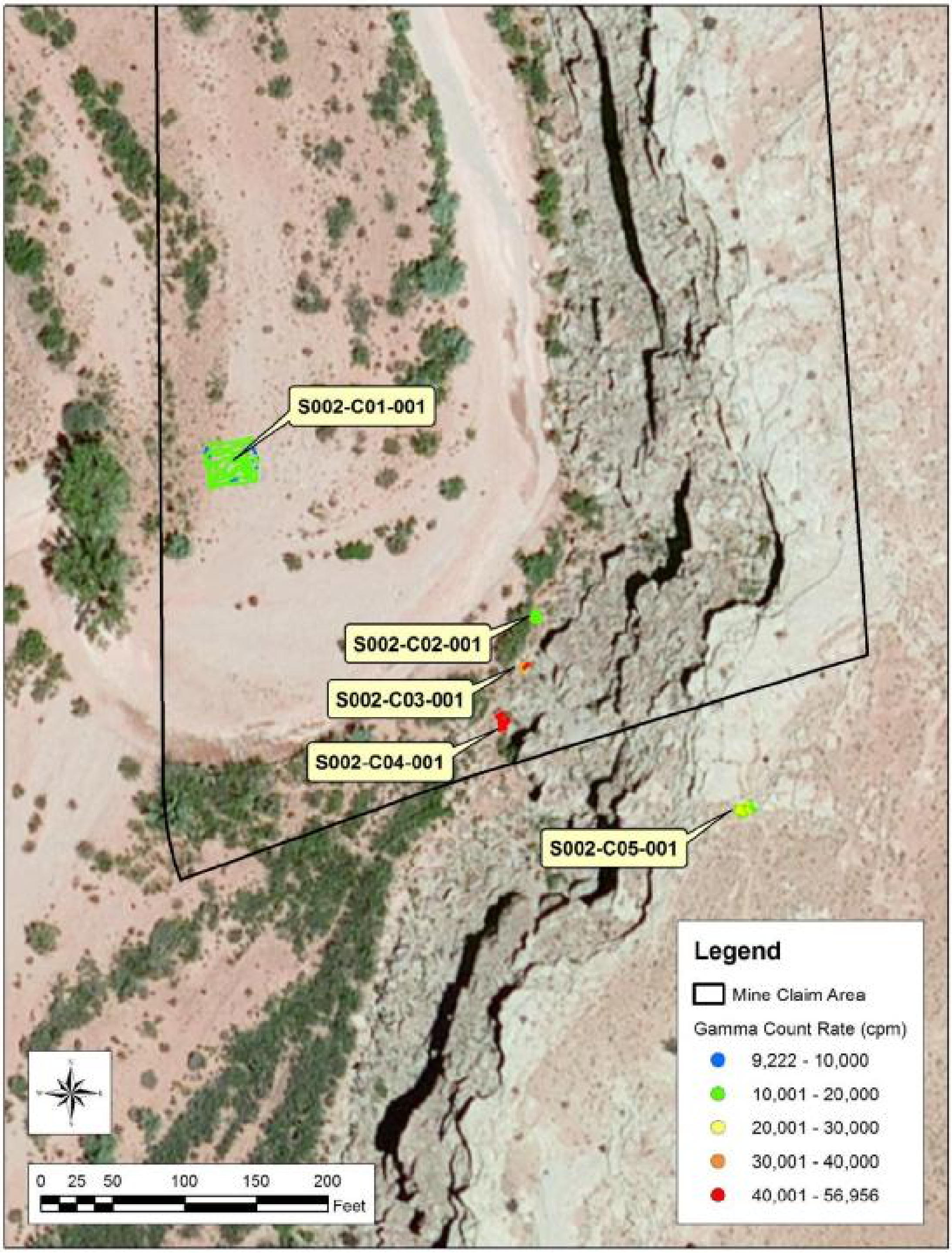


Figure 7. GPS-based gamma count rate measurements made for the correlation study.

Table 4. Gamma count rates and associated concentrations of radium-226 in samples of surface soils obtained in the correlation study.

	Gamma Count Rate (cpm)				Ra-226 (pCi/g)		
Location	Mean	Minimum	Maximum	σ	Result	Error ±1σ	MDL
S002-C01-001	11,319	9,222	16,947	1,229	0.64	0.2	0.37
S002-C02-001	15,488	13,152	18,270	1,149	1.52	0.295	0.395
S002-C03-001	36,691	30,768	45,295	3,866	14.5	1.9	0.65
S002-C04-001	46,805	35,480	56,956	3,745	22.6	2.8	0.8
S002-C05-001	18,267	14,947	22,684	1,321	5.1	0.69	0.43

Notes:
cpm = counts per minute
MDL = method detection limit
pCi/g = picocuries per gram
σ = standard deviation

Table 5. Concentrations of isotopes of thorium in samples of surface soils obtained in the correlation study.

	Thorium-228 (pCi/g)			Thorium-230 (pCi/g)			Thorium-232 (pCi/g)		
Sample ID	Result	Error ± 1 σ	MDL	Result	Error ± 1 σ	MDL	Result	Error ± 1 σ	MDL
S002-C01-001	0.56	0.11	0.03	0.49	0.1	0.07	0.63	0.12	0
S002-C02-001	0.486	0.1145	0.079	1.165	0.22	0.09	0.506	0.112	0.025
S002-C03-001	0.3825	0.0845	0.052	9.95	1.55	0.1	0.4255	0.0865	0.015
S002-C04-001	0.446	0.095	0.058	14	2.2	0.1	0.471	0.093	0.017
S002-C05-001	0.56	0.11	0.05	4.04	0.65	0.08	0.55	0.11	0.02

Notes:
MDL = method detection limit
pCi/g = picocuries per gram
σ = standard deviation

A model was made of the results in Table 4, predicting the concentrations of radium-226 in surface soils from the mean gamma count rate in each area. The best predictive relationship between the measurements, shown in Figure 8, is a strong, power function with a Pearson's Correlation Coefficient (R^2) of 0.9401, as expressed in the equation:

$$\text{Radium-226 concentration (pCi/g)} = 1 \times 10^{-10} \times \text{Gamma Count Rate (cpm)}^{2.428}$$

R^2 is a measure of the dependence between two variables and is expressed as a value between -1 and +1 where +1 is a positive correlation, 0 is no correlation, and -1 is a negative correlation. The root mean square error and p-value for the model are 0.423222 and 0.0063, respectively; these parameters are not data quality objectives (DQOs) and are included only as information.

The concentrations of thorium-232 and thorium-228, isotopes in the thorium series, in the correlation samples are similar and at most 0.63 pCi/g. Given these low concentrations and the high R^2 of the power function, the thorium series radionuclides do not appear to affect the prediction of concentrations of radium-226, using gamma count rates.

This equation was used to convert the gamma count rate measurements observed in the gamma surveys to predicted concentrations of radium-226. **Table 6** presents summary statistics for the predicted concentrations of radium-226 in the Survey Area. The range of the predicted concentrations of radium-226 in the Survey Area is 0.2 to 194 pCi/g, with a mean and median of 1.3 and 0.6 pCi/g, respectively. Note that the radium-226 concentrations predicted from gamma count rate measurements exceeding approximately 47,000 cpm are extrapolated from the regression model and are uncertain.

Figure 9 shows the predicted concentrations of radium-226, the spatial and numerical distribution of which mirror those depicted in Figure 4.

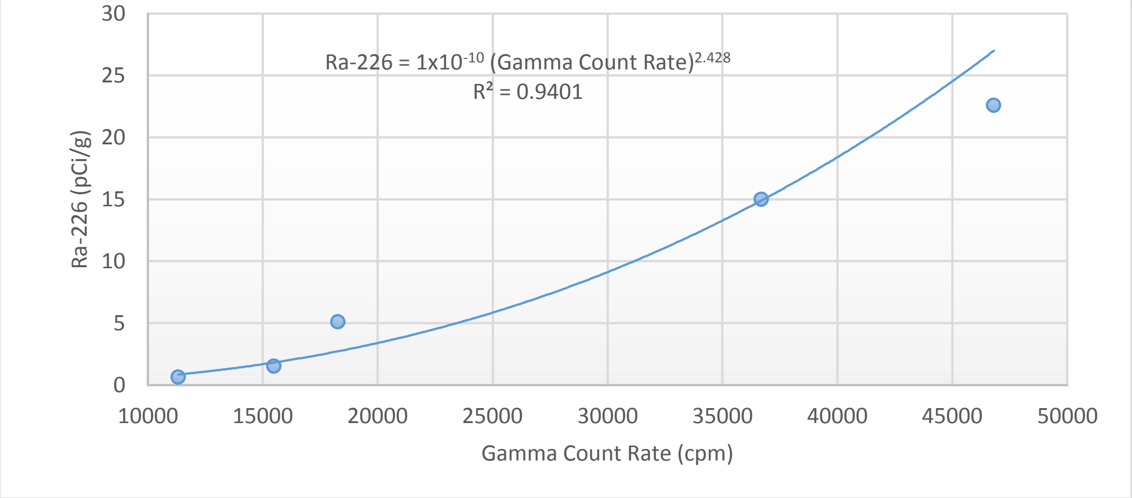


Figure 8. Correlation of gamma count rates and concentrations of radium-226 in surface soils.

Table 6. Predicted concentrations of radium-226 in the Survey Area.

Parameter	Radium-226 (pCi/g)
n	24,442
Minimum	0.2
Maximum	194
Mean	1.3
Median	0.6
Standard Deviation	5.8

Notes:
pCi/g = picocuries per gram

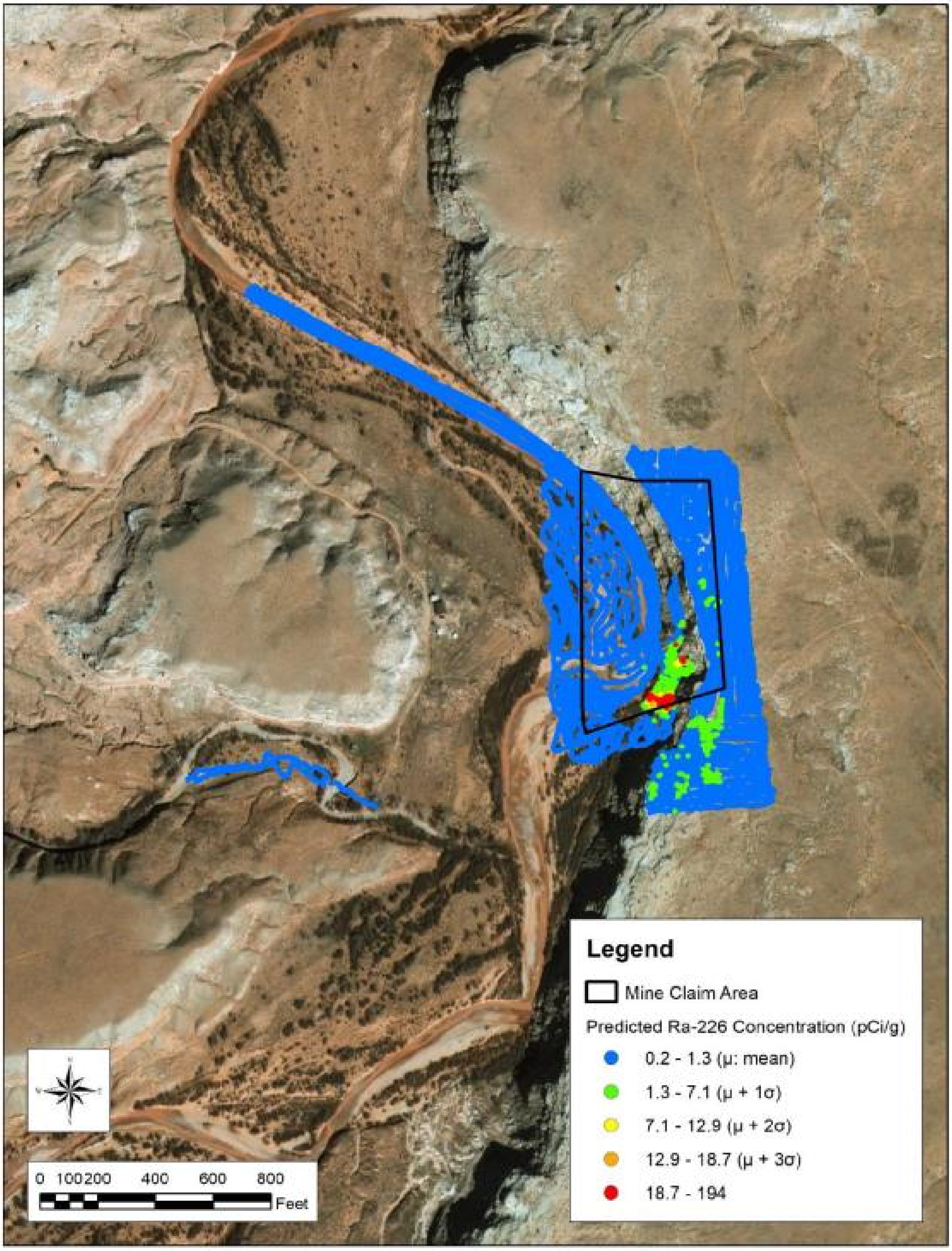


Figure 9. Predicted concentrations of radium-226 in the Survey Area.

3.2 Equilibrium in the uranium series

Secular equilibrium occurs when the activities of a parent radionuclide and its decay products are equal. This can occur in a closed system, when the half-life of the parent radionuclide is much larger than that of the decay product.

The ratio of the concentrations of radium-226 to thorium-230 can be used as an indicator of the status of equilibrium in the uranium series. The half-lives of thorium-230 and radium-226 are 77,000 and 1,600 years, respectively. The ratios in the five correlation samples are 1.3 (Sample S002-C01-001), 1.3 (Sample S002-C02-001), 1.5 (Sample S002-C03-001), 1.6 (Sample S002-C04-001), and 1.3 (Sample S002-C05-001), indicating that thorium-230 is depleted in relation to radium-226 and, by extrapolation, the uranium series itself is not in secular equilibrium.

Note this observation is based on the results of five samples, subject to differing analytical methods. Gamma spectroscopy, the method used to determine the concentration of radium-226, assesses an intact portion of the whole sample as it was collected. The concentration of thorium-230 was determined by alpha spectroscopy of an acid-leached aliquot of the sample.

This evaluation is not related to the correlation of radium-226 concentrations in surface soils and gamma count rates. It may be used for a future risk assessment.

3.3 Exposure rates and gamma count rates

Field personnel made co-located one-minute static count rate and exposure rate measurements at the five locations within the Survey Area, representing the range of gamma count rates obtained in the GPS-based gamma survey. Figure 7 shows the locations of the co-located measurements, which were made in the centers of the areas.

The gamma count rate and exposure rate measurements were made on October 13, 2016 at 0.5 m and 1 m above the ground surface, respectively. The gamma count rate measurements were made using one of the four sodium iodide detection systems used in the GPS-based gamma survey of the AUM (Serial Number PR303727/254772). The exposure rate measurements were made using a Reuter Stokes Model RSS-131 (Serial Number 07J00KM1) high pressure ionization chamber (HPIC) at six-second intervals for about 10 minutes. The exposure rate used in the comparison was the mean of these measurements, less those occurring in initial instrument spikes. The HPIC was in current calibration and function checked before and after use. Calibration forms for the HPIC are provided in Appendix A.

Table 7 presents the results for the two types of measurements made at each of the five locations. Appendix C presents the individual (one second) exposure rate measurements.

The Pearson's Correlation Coefficient (R^2) is a measure of the dependence between two variables, and is expressed as a value between -1 and +1 where +1 is a positive correlation, 0 is no correlation, and -1 is a negative correlation. The best predictive relationship between the measurements is linear with a R^2 of 0.9896, indicating a strong, positive correlation. The root mean square error and p-value for the model are 0.921829 and 0.0004, respectively; these parameters are not DQOs and are included only as information.

The following equation is the linear regression (shown in **Figure 10**) between the mean exposure rate and gamma count rate results in Table 7 that was generated using MS Excel:

Exposure Rate (microRoentgens per hour [µR/h]) = $5\text{x}10^{-4}$ x Gamma Count Rate (cpm) + 6.7336

Figure 11 presents the exposure rates predicted from the gamma count rate measurements, the spatial and numerical distribution of which mirror those depicted in **Figure 4**.

Tables 8 and 9 present summary statistics for the predicted exposure rates in the two potential Background Reference Areas and Survey Area, respectively. The range of predicted exposure rates at BG2 is 10.7 to 14.3 µR/h, with a mean and median of 12.2 and 12.0 µR/h, respectively. The range of predicted exposure rates at BG3 is 10.3 to 13.9 µR/h, with a mean and median of 11.6 and 11.5 µR/h, respectively. The range of predicted exposure rates at the Survey Area is 10.3 to 64.3 µR/h, with a mean and median of 12.6 and 12.0 µR/h, respectively.

Table 7. Co-located gamma count rate and exposure rate measurements.

Location	Gamma Count Rate (cpm)	Exposure Rate (µR/h)
S002-C01-001	10,974	12.1
S002-C02-001	15,169	14.3
S002-C03-001	38,471	23.8
S002-C04-001	48,839	30.9
S002-C05-001	18,658	15.5

Notes:
cpm = counts per minute
µR/h = microRoentgens per hour

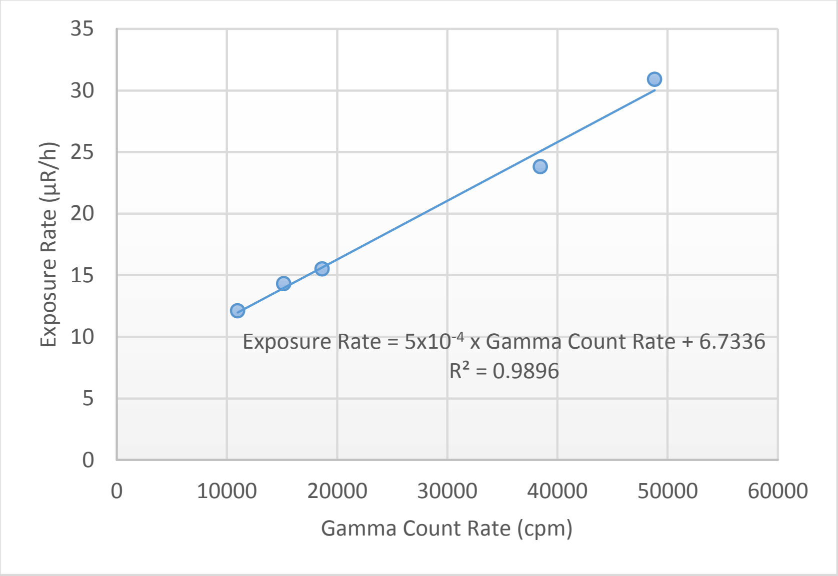


Figure 10. Correlation of gamma count rates and exposure rates.

Table 8. Predicted exposure rates in the potential Background Reference Areas.

Potential Background Reference Area	BG2	BG3
Parameter	**Exposure Rate (µR/h)**	
n	199	444
Minimum	10.7	10.3
Maximum	14.3	13.9
Mean	12.2	11.6
Median	12.0	11.5
Standard Deviation	0.6	0.6

Notes:
µR/h = microRoentgens per hour

Table 9. Predicted exposure rates in the Survey Area.

Parameter	Exposure Rate (µR/h)
n	24,442
Minimum	10.3
Maximum	64.3
Mean	12.6
Median	12.0
Standard Deviation	3.1

Notes:
µR/h = microRoentgens per hour

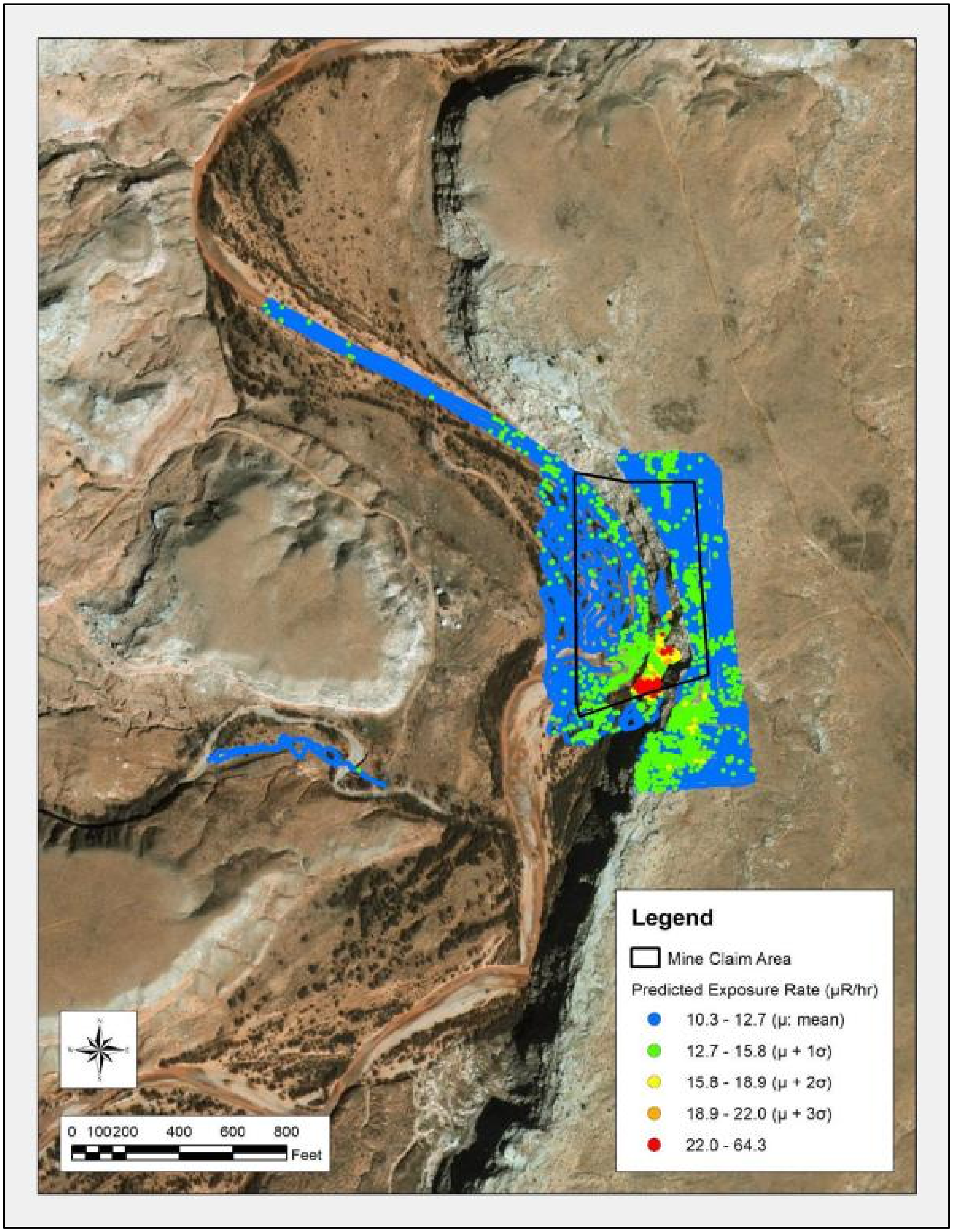


Figure 11. Predicted exposure rates in the Survey Area.

4.0 Deviations to RSE Work Plan

The RSE Work Plan specifies that the comparison of gamma count rates and radium concentrations in surface soils was to occur in 900 square foot areas. Field personnel adjusted the areas as necessary, to minimize the variability of gamma count rates observed, particularly where the spatial distribution of waste rock was heterogeneous.

5.0 Conclusions

The findings of the RSE pertaining to these activities are:

- The horizontal extent and magnitude of mining-related materials were delineated sufficiently to support additional characterization of the subsurface.

- Elevated gamma count rates observed along the southern edge of the mine claim were associated with waste rock.

- Two potential Background Reference Areas were established.

- The relationship between gamma count rates and concentrations of radium-226 in surface soils (0 to 0.5 ft below ground surface) is described by a power regression model:

  Radium-226 concentration (pCi/g) = 1×10^{-10} x Gamma Count Rate (cpm)$^{2.428}$

- The distribution of concentrations of radium-226 in surface soils predicted using this model resembles a lognormal distribution. The values in the Survey Area range from 0.2 to 194, with a central tendency (median) of 0.6 pCi/g.

- The thorium series radionuclides do not appear to affect the prediction of concentrations of radium-226 from gamma count rates.

- The uranium series radionuclides appear not to be in secular equilibrium.

- The relationship between gamma count rates and exposure rates is described by a linear regression model:

  Exposure Rate (μR/h) = Gamma Count Rate (cpm) x 5×10^{-4} + 6.7336

- The distribution of exposure rates predicted using this model resembles a lognormal distribution. The values in the Survey Area range from 10.3 to 64.3, with a central tendency (median) of 12.0 μR/h.

6.0 References

ANSI, 1997. Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments, American National Standards Institute (ANSI) Standard N232A. June 20, 2014.

MWH, 2016. Navajo Nation AUM Environmental Response Trust, First Phase, Removal Site Evaluation Work Plan, October 24, 2016.

Stantec, 2018. Alongo Mines Removal Site Evaluation Report, January 2018.

Appendix A Instrument calibration and completed function check forms

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: 254772

Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR303727

✔ 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:

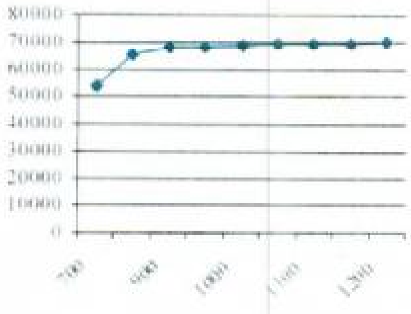
Barometric Pressure: 24.75 inches Hg
Temperature: 74 °F
Relative Humidity: 20 %

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	398857	400
x 1000	100	100	100		100
x 100	400	400	400	39913	400
x 100	100	100	100		100
x 10	400	400	400	3992	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	53620	
800	64979	
900	67955	
950	67795	
1000	68536	9542
1050	69153	
1100	69331	
1150	69346	
1200	69492	

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: 87490128
✔ Gamma Source: Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03
Other Source:

Calibrated By:
Calibration Date: 7 15 16
Calibration Due: 7-15-17

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: 254772

Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR303727

✓ 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:

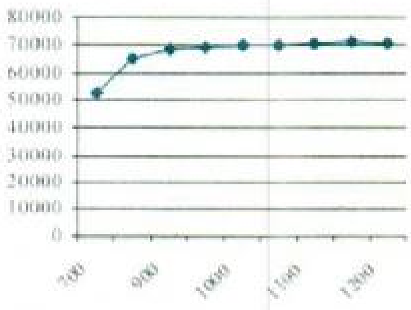
Barometric Pressure: 24.24 inches Hg
Source Distance: ☐ Contact ✓ 6 inches ☐ Other: Threshold: 10 mV Temperature: 78 °F
Source Geometry: ✓ Side ☐ Below ☐ Other: Window: Relative Humidity: 20 %

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	399859	400
x 1000	100	100	100		100
x 100	400	400	400	39991	400
x 100	100	100	100		100
x 10	400	400	400	4001	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	52821	
800	65213	
900	68644	
950	69245	
1000	69492	9111
1050	69792	
1100	70472	
1150	71183	
1200	70571	

Voltage Plateau



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

Reference Instruments and/or Sources:

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

Calibrated By: Calibration Date: 2/28/17 ~~2 March 17~~ Calibration Due: 2/28/18 ~~2 March~~ 18

Reviewed By: Date: 3-1-17

ERG Form HC 101A

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: 196086

Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR295014

✓ 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:

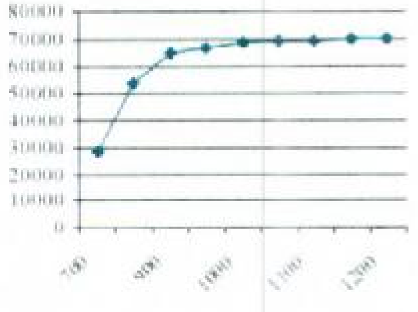
Barometric Pressure: 24.78 inches Hg
Source Distance: Contact ✓ 6 inches Other: Threshold: 10 mV Temperature: 74 °F
Source Geometry: ✓ Side Below Other: Window: Relative Humidity: 20 %

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	39989	400
x 100	100	100	100		100
x 10	400	400	400	3999	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	28456	
800	53330	
900	64430	
950	66209	
1000	68333	
1050	69077	
1100	69121	8924
1150	69973	
1200	70155	

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: Calibration Date: 7 [illegible] 16 Calibration Due: 7 [illegible] 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:	282971
Detector:	Manufacturer:	Ludlum	Model Number:	44-10	Serial Number:	PR320678

☑ 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:

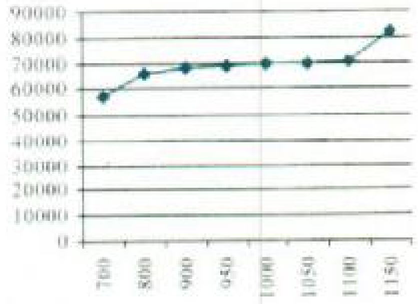
Barometric Pressure: 24.63 inches Hg
Temperature: 75 °F
Relative Humidity: 20 %

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	399936	400
x 1000	100	100	100		100
x 100	400	400	400	39984	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	57641	
800	65850	
900	68414	
950	68639	
1000	69410	9773
1050	69358	
1100	70301	
1150	81822	

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 sn: 4098-03 @ 12,800dpm/6,520 cpm (1/4/1
☐ 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: 3-13-17
Calibration Due: 3-13-18

Reviewed By:
Date: 14 March 2017

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:	PR355763

☑ 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:

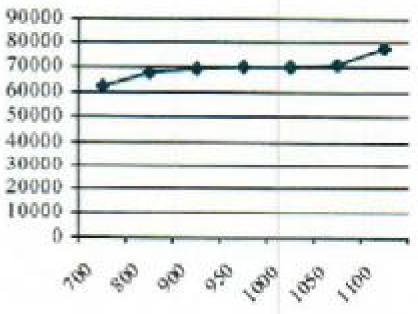
Barometric Pressure: 24.75 inches Hg
Temperature: 76 °F
Relative Humidity: 20 %

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	398875	400
x 1000	100	100	100		100
x 100	400	400	400	39883	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	398	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	62275	
800	68049	
900	69726	
950	70112	9509
1000	70068	
1050	71042	
1100	77619	

Voltage Plateau



Comments: Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV = 950

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: 9/7-17
Calibration Due: 9-7-18

Reviewed By:
Date: 09/08/17

ERG Form ITC. 101.A

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

K&S Associates, Inc.
1926 Elm Tree Drive
Nashville, Tennessee 37210-3718
Phone 800-522-2325 Fax 615-871-0856

ACCREDITED
CALIBRATION CERT #1856.01

CALIBRATION REPORT

SUBMITTED BY:
ERG
8809 Washington Street Northeast
Suite 150
Albuquerque, NM 87113

INSTRUMENT: Reuter Stokes RSS-131, #07J00KM1

REPORT NUMBER: 161866
TEST NUMBER(S) M161588
REPORT DATE: June 29, 2016

The CALIBRATION COEFFICIENTS contained in this report were obtained by intercomparison with instruments calibrated by, or directly traceable to, the National Institute of Standards and Technology (NIST). K• S Associates, Inc. is licensed by the State of Tennessee (R-19075-G97, R-19136-B00) to perform calibrations, and is recognized by the Health Physics Society (HPS) as an ACCREDITED INSTRUMENT CALIBRATION LABORATORY. As part of the accreditation K • S participates in a measurement assurance program conducted by the HPS and NIST. K • S also certifies that the calibration was performed using quality policies, methods and procedures that meet or exceed the requirements of ISO/IEC 17025:2005.

This laboratory is accredited by the American Association for Laboratory Accreditation (A2LA) and the results shown in this report have been determined in accordance with the laboratory's terms of accreditation unless stated otherwise in this report

The CALIBRATION COEFFICIENTS stated herein are valid under the conditions specified. It is the instrument user's responsibility to perform the appropriate constancy tests prior to shipment and after return from calibration. It is also the responsibility of the user to assure that the interpretation of the information in this report is consistent with that intended by K • S Associates, Inc.

K&S Associates, Inc
Nashville, Tennessee 37210-3718

ACCREDITED

CALIBRATION CERTIFICATE

Calibration Date: 6/27/2016 Report Number: 161866 Test Number: M161588

K&S certifies that the environmental radiation monitor identified below has been calibrated for radiation measurement using collimated radiation sources whose output has been calibrated with instruments calibrated by or directly traceable to the National Institute of Standards and Technology. K&S is accredited by the American Association for Laboratory Accreditation to perform environmental level calibrations and further certifies that the calibration was performed using accredited policies and procedures (SI 25) that meet or exceed the requirements of ISO/IEC 17025:2005.

Sensor Type: 100 mR/h

Serial Number: 07J00KM1

Average Calibration Coefficient for the range of 0.012 mR/h – 0.220 mR/h*:
1.02 mR/"mR" reading
(Measured at 4 points)

Calibration Coefficient for the 50.0 mR/h point*:
1.12 mR/"mR" reading

Calibration Coefficient for the 80.0 mR/h point*:
1.10 mR/"mR" reading

Found RAC: 2.169e-8

*Multiply the reading in **mR/h** by the Calibration Coefficient to obtain true **mR/h**.

Calibrated By: Richard Hardison
Richard Hardison
Title: Calibration Technician

Reviewed By: Angela Roper
Angela Roper
Title: Calibration Physicist

Log: M-53 Page: 73

K&S Associates, Inc
Nashville, Tennessee 37210-3718

ACCREDITED
CALIBRATION CERT #

AS FOUND DATA

Reuter-Stokes Chamber Calibration

June 27, 2016

Test Number *M161588*

CHAMBER:

Mfgr: Reuter Stokes
Model: RSS-131
Serial: 07J00KM1

SUBMITTED BY:

ERG

Albuquerque, NM

ORIENTATION/CONDITIONS:

Serial number away from source

"True" background exposure rate of 6.7 uR/h, instrument reading was 0.0076 mR/h

ATMOSPHERIC COMMUNICATION: SEALED

POLARIZING POTENTIAL 401V

LEAKAGE: negligible

BEAM QUALITY				**CALIBRATION**		
BEAM		**EXPOSURE RATE**		**COEFFICIENT**	**UNCERT**	**LOG**
CsEn220	(11mCi)	0.22mR/h	N_x=	1.00 mR/h/rdg	11%	M-53 73
CsEn80	(11mCi)	0.08mR/h	N_x=	1.03 mR/h/rdg	11%	
CsEnv12	(1mCi)	0.012mR/h	N_x=	1.01 mR/h/rdg	11%	
CsEnv15	(1mCi)	0.015mR/h	N_x=	1.02 mR/h/rdg	11%	
Cs199m	(20 Ci)	50mR/h	N_x=	1.12 mR/h/rdg	8%	
Cs252m	(20 Ci)	80mR/h	N_x=	1.10 mR/h/rdg	8%	

Comments Batt: 6.1V, Temp: 24.6 deg C, K&S Environment: Temp:21 deg C , RH 59%, Press: 752 mmHg;
Report Number: 161866
Refer to Appendix I of this report for details on PIC ionization chamber calibrations. Procedure: SI 25
RAC Found: 2.169e-8

Calibrated By Richard Hardison
Title: Calibration Technician
Reviewed By:
Title: Calibration Physicist
Checked By:
Prepared By: REH

Form RSS

①

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.:	254772
Cal. Due Date:	7-19-17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR303727
Cal. Due Date:	7-19-17

Comments:
NNERT

Source: Cs-137 Activity: 5.12 uCi Source Date: 6-16-94 Distance to Source: 6 Inches

Serial No.: 333-94 Emission Rate: NA cpm/emissions

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project Reference Point,
9-27-16	1126	6.1	1002	99	45988	6844	39144	NW	NA-0904
9-27-16	1619	5.9	997	99	44136	6788	37348	NW	NA-0904
9-28-16	1027	5.9	1001	99	44612	6242	38370	NW	Comfort Suites Parking lot
9-28-16	1754	5.9	1000	99	43583	6742	36841	NW	NA-0928
9-29-16	0936	5.9	1001	100	44695	5574	39121	NW	Comfort Suites Parking Lot
9-29-16	1600	5.8	1002	99	46024	6760	39264	NW	NA-0928
9-30-16	0920	5.8	1002	99	44958	5748	39210	NW	NA-0904
9-30-16	1436	5.7	998	99	44138	6240	37898	NW	NA-0904
10-1-16	0913	5.7	1002	100	43656	5047	38609	NW	Oak 124/125
10-1-16	1605	5.6	995	99	43105	6275	36830	NW	Alonzo
10-3-16	0950	5.7	1001	99	44914	5611	39303	NW	Barton 3
10-3-16	1220	5.6	996	99	45823	5678	40105	NW	Barton 3

Reviewed by:

Review Date: 11-29-16

ERG Form ITC.201.A

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.:	254772
Cal. Due Date:	7-19-17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR303727
Cal. Due Date:	7-19-17

Comments:
NNERT

Source: Cs-137

Serial No.: 333-94

Activity: 5.12 uCi

Emission Rate: NA cpm/emissions

Source Date: 6-6-94

Distance to Source: 6 Inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project reference points
10-4-16	0925	5.7	1003	99	45635	6378	39254	NW	Tsosie 1
10-4-16	1720	5.6	1008	99	46987	6720	40267	NW	Comfort Suites Parking lot
10-5-16	0620	5.7	1007	99	47335	6804	40531	NW	Comfort Suites Parking lot
10-5-16	1542	5.5	999	99	45375	6342	39033	NW	Tsosie 1
10-6-16	0900	5.5	1003	99	43705	6364	37341	NW	Tsosie 1
10-6-16	1713	5.5	1000	99	44279	6053	38226	NW	Comfort Suites Parking Lot
10-7-16	0902	5.5	1006	99	44457	6003	38,404	NW	Oak 124/125
10-7-16	1627	5.5	999	99	46103	6751	39352	NW	Comfort Suites Parking Lot
10-8-16	0903	5.6	1003	99	45434	6365	39069	NW	Red Valley Intersection
10-8-16	1653	5.5	999	99	45185	6467	38718	NW	Comfort Suites Parking Lot
10-10-16	0958	5.5	1004	100	42755	5579	37176	NW	Oak 124/125
10-10-16	1919	5.5	999	99	51651	6930	44721	NW	Oak 124/125

Reviewed by:

Review Date: 11/29/16

②

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
Serial No.:	196086
Cal. Due Date:	7-9-17

DETECTOR	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	PR295014
Cal. Due Date:	7-9-17

Comments:
NNSRT

Source: Cs-137
Serial No.: 333-94
Activity: 5.12 uCi
Emission Rate: NA cpm/emissions
Source Date: 6-16-94
Distance to Source: 6 Inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project Reference Points
9-27-16	1121	5.7	1100	100	45851	6762	39089	NW	NA-0904
9-27-16	1619	5.6	1094	99	45492	6313	39179	NW	NA-0904
9-28-16	1026	5.7	1100	100	44929	6287	38642	NW	NA-0904
9-28-16	1754	5.6	1098	100	44643	6434	38209	NW	Comfort Suites Parking Lot
9-29-16	0940	5.6	1100	99	43453	5654	37799	NW	NA-0928
9-29-16	1603	5.5	1101	100	44586	6525	38061	NW	Comfort Suites Parking Lot
9-30-16	0415	5.5	1102	100	44975	5236	39739	NW	NA-0928
9-30-16	1433	5.4	1096	100	44003	5827	38176	NW	NA-0904
10-1-16	0925	5.5	1102	100	42929	5140	37789	NW	Oak 124/125
10-1-16	1605	5.3	1092	100	44650	6271	38379	NW	Mongo
10-3-16	0946	5.5	1100	100	43679	4995	38684	NW	Barton 3
10-3-16	1225	5.4	1099	100	45921	5361	40560	NW	Barton 3

Reviewed by:

Review Date: 11/29/16

ERG Form ITC.201.A

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.:	254772
Cal. Due Date:	7-19-17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR303727
Cal. Due Date:	7-19-17

Comments:
NNERT

Source: Cs-137

Serial No.: 333-94

Activity: 5.12 uCi

Emission Rate: NA cpm/emissions

Source Date: 6-6-94

Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project reference points
10-11-16	0927	5.5	1002	99	45999	6141	39858	NW	NA-0504
10-11-16	1720	5.5	998	99	48630	6576	42054	NW	Comfort Suites Parking Lot
10-12-16	0858	5.5	1003	99	44780	5306	39474	NW	NA-0928
10-12-16	1618	5.5	998	99	43779	6289	37490	NW	Comfort Suites Parking Lot
10-13-16	0911	5.5	1003	99	46726	7375	39351	NW	Alongo
10-13-16	1910	5.5	990	99	45235	6618	38617	NW	Comfort Suites Parking Lot
10-14-16	0926	5.5	1004	99	45657	7242	38415	NW	Barton 3
10-14-16	1540	5.4	998	99	44751	6480	38271	NW	Comfort Suites Parking Lot
10-15-16	0927	5.5	1001	99	45697	6933	38764	NW	Harvey Blackwater
10-15-16	1324	5.4	996	99	42528	4945	37583	NW	Hat Rock Inn Parking Lot
* 10-24-16	0800	6.2	1005	100	48507	9268	39239	NW	Boyd Tisi
10-24-16	1207	6.0	1001	99	46290	8126	38164	NW	Boyd Tisi

* changed battery

Reviewed by: MM

Review Date: 11/29/16

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
Serial No.:	196086
Cal. Due Date:	7-9-17

↔

DETECTOR	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	PR295014
Cal. Due Date:	7-9-17

Comments:
NNERT

Source: Cs-137
Activity: 5.12 uCi
Source Date: 6-16-94
Distance to Source: 6 Inches
Serial No.: 333-94
Emission Rate: NA cpm/emissions

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project Reference Points
10-4-16	0936	5.5	1102	100	46804	6042	40762	NW	Tsosie 1
10-4-16	1710	5.4	1106	100	46032	6898	39134	NW	Comfort Suites Parking Lot
10-5-16	0622	5.4	1109	101	45794	6834	38960	NW	Comfort Suites Parking Lot
10-5-16	1548	5.3	1097	99	46608	6021	40587	NW	Tsosie 1
10-6-16	0904	5.4	1103	100	44521	6273	38248	NW	Comfort Suites Parking Lot
10-6-16	1718	5.3	1099	100	45178	6311	38867	NW	Comfort Suites Parking Lot
10-7-16	0859	5.4	1104	100	44101	5226	38875	NW	Oak 124/125
10-7-16	1633	5.4	1098	99	44930	6832	38098	NW	Comfort Suites Parking Lot
10-8-16	0908	5.4	1104	100	45110	6201	38909	NW	Red Valley Intersection
10-8-16	1658	5.3	1098	99	45810	6196	39614	NW	Comfort Suites Parking Lot
10-12-16	1331	5.4	1099	99	46496	6519	39977	NW	Barton 3
10-12-16	1614	5.4	1097	100	44509	6060	38449	NW	Comfort Suites Parking Lot

Reviewed by: MHP

Review Date: 11/29/16

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.:	254772
Cal. Due Date:	2-28-18

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR303727
Cal. Due Date:	2-28-18

Comments:

NNMRT

Source: Cs-137

Serial No.: 544-96

Activity: 4 uCi

Emission Rate: NA cpm/emissions

Source Date: 4-18-96

Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
5-18-17	1032	5.5	1001	100	38206	6536	31670	NW	Alongo upper
5-18-17	1206	5.5	1001	100	39193	6515	32678	NW	Alongo upper
5-19-17	0643	5.6	1003	101	36123	4837	31286	NW	Oak 124/125
5-19-17	1456	5.5	999	101	38056	6003	32053	NW	Alongo lower
5-22-17	0729	5.5	1000	100	36624	4799	31825	NW	Mitten
5-22-17	1542	5.4	992	100	35431	4841	30590	NW	Mitten
5-23-17	0733	5.5	995	100	36519	5067	31452	NW	Mitten
5-23-17	1426	5.4	994	100	35848	4830	31018	NW	Gouldings lodge
5-24-17	0757	5.4	997	100	36605	5123	31482	NW	Charles Keith
5-24-17	1143	5.3	993	100	36113	4844	31269	NW	Charles Keith
					5-25-17				

Reviewed by:

Review Date: 11/08/17

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.:	282971
Cal. Due Date:	3-13-18

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR320678
Cal. Due Date:	3-13-18

Comments:

NNERT

Source: Cs-137

Serial No.: 544-96

Activity: 4 uCi

Emission Rate: NA cpm/emissions

Source Date: 4-18-96

Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
5-16-17	0747	5.6	1051	100	37255	5170	32085	NW	Eunice Brent.
5-16-17	1332	5.6	1052	100	36609	5251	31358	NW	Eunice Becenti
5-17-17	0808	5.6	1053	101	37256	5821	31435	NW	Eunice Becenti
5-17-17	1417	5.6	1047	100	36737	5441	31296	NW	Eunice Becenti
5-18-17	1029	5.5	1032	100	38435	7070	31365	NW	Alonzo upper
5-18-17	1202	5.5	1052	101	38935	6986	31949	NW	Alonzo upper
5-20-17	0924	5.6	1051	101	38316	7201	31115	NW	Alonzo lower
5-20-17	1352	5.5	1047	99	39498	6654	32844	NW	Alonzo lower
5-23-17	0737	5.6	1050	100	36693	5557	31136	NW	Mitten
5-23-17	1430	5.5	1046	100	37575	5371	32204	NW	Fowldings lodge
5-24-17	0803	5.6	1048	100	37282	5725	31557	NW	Charles Keith
5-24-17	1143	5.5	1044	100	36054	5552	30502	NW	Charles Keith

Reviewed by:

Review Date: 10/9/17

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.:	138368
Cal. Due Date:	9-7-18

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR355763
Cal. Due Date:	9-7-18

Comments:

NNERT

Source: Cs-137
Activity: 4 uCi
Source Date: 4-18-96
Distance to Source: 6 Inches
Serial No.: 544-96
Emission Rate: NA cpm/emissions

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
9-12-17	0914	5.4	950	101	36935	6331	30604	NW	Barton 3
9-12-17	1432	5.3	944	99	38043	6468	31575	NW	Tsosie 1
9-13-17	0906	5.4	951	99	37146	6538	30608	NW	Alonzo
9-13-17	1600	5.3	944	99	35587	5991	29596	NW	Barton 3
9-14-17	0909	5.4	950	100	36080	6176	29904	NW	NA-0904
9-14-17	1255	5.3	948	100	36099	5764	30335	NW	NA-0904
9-15-17	0920	5.4	954	101	35208	5551	29657	NW	Eunice Becenti
9-15-17	1729	5.3	957	109	35937	5261	30676	NW	Eunice Becenti
9-19-17	0831	5.4	958	105	36467	6034	30433	NW	Section 26 @ trailer
9-19-17	1453	5.3	946	98	44454	14748	29706	NW	Section 26 @ corral
9-20-17	0736	5.3	953	102	37676	6987	30689	NW	Mexican Hat
9-20-17	1611	5.2	947	100	36842	6252	30590	NW	Mexican Hat

Reviewed by:

Review Date: 10/19/17

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	GE
Model:	RSS-131
Serial No.:	07J00km1
Cal. Due Date:	6-29-17

DETECTOR	
Manufacturer:	SAME AS METER
Model:	
Serial No.:	
Cal. Due Date:	

Comments:
NNERT

Source: Cs-137
Serial No.: 333-94
Activity: 5.12 uCi
Emission Rate: NA cpm/emissions
Source Date: 6-16-94
Distance to Source: Contact - housing

mR/h

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project reference points,
10-7-16	0545	~6.16	~400	~ NA ~	~26.7	~9.5	~17.2	NW	Comfort Suites Room - Farmingt
10-7-16	2040	~6.16	~400	NA	~26.5	~8.7	~17.8	NW	Comfort Suites Room - Farmington
10-11-16	0634	~6.2	~400	NA	~25	~10.5	~14.5	NW	Comfort Suites Room - Farmington
10-11-16	1801	~6.3	~400	NA	~25.5	~10.1	~14.4	NW	Comfort Suites Room - Farmington
10-12-16	0548	~6.3	~400	NA	~26.5	~10	~16.5	NW	Comfort Suites Room - Farmington
10-12-16	1640	~6.3	~400	NA	~26.4	~10	~16.4	NW	Comfort Suites Room - Farmington
10-13-16	0608	~6.3	~400	NA	~27	~9.8	~17.2	NW	Comfort Suites Room - Farmington
10-13-16	1950	~6.3	~400	NA	~26.3	~9.5	~16.8	NW	Comfort Suites Room - Farmington
10-14-16	0630	~6.4	~400	NA	~26.4	~9.5	~16.9	NW	Comfort Suites Room - Farmington
10-14-16	1547	~6.2	~400	NA	~30	~12	~18	NW	Comfort Suites Room - Farmington
10-25-16	0539	~6.3	~400	NA	~29	~11	~18	NW	Best Western Room - Flagstaff
10-29-16	1255				DID	NOT USE			

Reviewed by:

Review Date: 11-29-16

Appendix B Exposure Rate Measurements

Date and Time	Exposure Rate (mR/h)	Location
10/13/2016 10:19	0.0536	Correlation Location 1
10/13/2016 10:19	0.0939	Correlation Location 1
10/13/2016 10:19	0.082	Correlation Location 1
10/13/2016 10:19	0.0564	Correlation Location 1
10/13/2016 10:19	0.0375	Correlation Location 1
10/13/2016 10:19	0.0258	Correlation Location 1
10/13/2016 10:19	0.0196	Correlation Location 1
10/13/2016 10:19	0.0163	Correlation Location 1
10/13/2016 10:20	0.0145	Correlation Location 1
10/13/2016 10:20	0.0136	Correlation Location 1
10/13/2016 10:20	0.0131	Correlation Location 1
10/13/2016 10:20	0.0126	Correlation Location 1
10/13/2016 10:20	0.0123	Correlation Location 1
10/13/2016 10:20	0.0122	Correlation Location 1
10/13/2016 10:20	0.0122	Correlation Location 1
10/13/2016 10:20	0.0128	Correlation Location 1
10/13/2016 10:20	0.0126	Correlation Location 1
10/13/2016 10:20	0.0121	Correlation Location 1
10/13/2016 10:21	0.0118	Correlation Location 1
10/13/2016 10:21	0.0118	Correlation Location 1
10/13/2016 10:21	0.0122	Correlation Location 1
10/13/2016 10:21	0.0122	Correlation Location 1
10/13/2016 10:21	0.0122	Correlation Location 1
10/13/2016 10:21	0.0124	Correlation Location 1
10/13/2016 10:21	0.0122	Correlation Location 1
10/13/2016 10:21	0.0121	Correlation Location 1
10/13/2016 10:21	0.0122	Correlation Location 1
10/13/2016 10:21	0.0122	Correlation Location 1
10/13/2016 10:22	0.0122	Correlation Location 1
10/13/2016 10:22	0.012	Correlation Location 1
10/13/2016 10:22	0.0118	Correlation Location 1
10/13/2016 10:22	0.0118	Correlation Location 1
10/13/2016 10:22	0.0116	Correlation Location 1
10/13/2016 10:22	0.0117	Correlation Location 1
10/13/2016 10:22	0.0118	Correlation Location 1
10/13/2016 10:22	0.0117	Correlation Location 1
10/13/2016 10:22	0.0117	Correlation Location 1
10/13/2016 10:22	0.012	Correlation Location 1
10/13/2016 10:23	0.0121	Correlation Location 1
10/13/2016 10:23	0.0124	Correlation Location 1
10/13/2016 10:23	0.0126	Correlation Location 1
10/13/2016 10:23	0.0124	Correlation Location 1
10/13/2016 10:23	0.0122	Correlation Location 1
10/13/2016 10:23	0.012	Correlation Location 1
10/13/2016 10:23	0.012	Correlation Location 1
10/13/2016 10:23	0.012	Correlation Location 1
10/13/2016 10:23	0.0121	Correlation Location 1
10/13/2016 10:23	0.0118	Correlation Location 1
10/13/2016 10:24	0.0117	Correlation Location 1
10/13/2016 10:24	0.0121	Correlation Location 1
10/13/2016 10:24	0.0124	Correlation Location 1
10/13/2016 10:24	0.0129	Correlation Location 1
10/13/2016 10:24	0.0126	Correlation Location 1
10/13/2016 10:24	0.0124	Correlation Location 1
10/13/2016 10:24	0.0124	Correlation Location 1
10/13/2016 10:24	0.0127	Correlation Location 1
10/13/2016 10:24	0.0124	Correlation Location 1
10/13/2016 10:24	0.0123	Correlation Location 1
10/13/2016 10:25	0.0122	Correlation Location 1
10/13/2016 10:25	0.0117	Correlation Location 1
10/13/2016 10:25	0.0115	Correlation Location 1
10/13/2016 10:25	0.0117	Correlation Location 1
10/13/2016 10:25	0.0117	Correlation Location 1
10/13/2016 10:25	0.0117	Correlation Location 1
10/13/2016 10:25	0.0118	Correlation Location 1
10/13/2016 10:25	0.0121	Correlation Location 1
10/13/2016 10:25	0.0118	Correlation Location 1
10/13/2016 10:25	0.0117	Correlation Location 1
10/13/2016 10:26	0.0118	Correlation Location 1
10/13/2016 10:26	0.0117	Correlation Location 1
10/13/2016 10:26	0.0117	Correlation Location 1
10/13/2016 10:26	0.0117	Correlation Location 1
10/13/2016 10:26	0.0118	Correlation Location 1
10/13/2016 10:26	0.0123	Correlation Location 1
10/13/2016 10:26	0.0126	Correlation Location 1
10/13/2016 10:26	0.0127	Correlation Location 1
10/13/2016 10:26	0.0129	Correlation Location 1
10/13/2016 10:26	0.0124	Correlation Location 1
10/13/2016 10:27	0.0122	Correlation Location 1
10/13/2016 10:27	0.0122	Correlation Location 1
10/13/2016 10:27	0.0122	Correlation Location 1
10/13/2016 10:27	0.0122	Correlation Location 1
10/13/2016 10:27	0.0122	Correlation Location 1
10/13/2016 10:27	0.012	Correlation Location 1
10/13/2016 10:27	0.012	Correlation Location 1
10/13/2016 10:27	0.0117	Correlation Location 1
10/13/2016 10:27	0.0115	Correlation Location 1
10/13/2016 10:27	0.0117	Correlation Location 1
10/13/2016 10:28	0.012	Correlation Location 1
10/13/2016 10:28	0.0122	Correlation Location 1
10/13/2016 10:28	0.012	Correlation Location 1
10/13/2016 10:28	0.0117	Correlation Location 1
10/13/2016 10:28	0.0121	Correlation Location 1
10/13/2016 10:28	0.012	Correlation Location 1
10/13/2016 10:28	0.0117	Correlation Location 1
10/13/2016 10:28	0.012	Correlation Location 1
10/13/2016 10:28	0.012	Correlation Location 1
10/13/2016 10:28	0.0117	Correlation Location 1
10/13/2016 10:29	0.0117	Correlation Location 1
10/13/2016 10:29	0.012	Correlation Location 1
10/13/2016 10:29	0.0121	Correlation Location 1
10/13/2016 10:29	0.0123	Correlation Location 1
10/13/2016 10:29	0.0126	Correlation Location 1
10/13/2016 10:29	0.0122	Correlation Location 1
10/13/2016 10:29	0.0122	Correlation Location 1
10/13/2016 10:29	0.0123	Correlation Location 1
10/13/2016 10:29	0.0123	Correlation Location 1
10/13/2016 10:29	0.0124	Correlation Location 1
10/13/2016 10:30	0.0128	Correlation Location 1
10/13/2016 10:30	0.0128	Correlation Location 1
10/13/2016 10:30	0.0123	Correlation Location 1
10/13/2016 10:30	0.012	Correlation Location 1
10/13/2016 10:30	0.012	Correlation Location 1
10/13/2016 10:30	0.0121	Correlation Location 1

Date and Time	Exposure Rate (mR/h)	Location
10/13/2016 10:30	0.0122	Correlation Location 1
10/13/2016 11:18	0.054	Correlation Location 2
10/13/2016 11:18	0.0947	Correlation Location 2
10/13/2016 11:18	0.0827	Correlation Location 2
10/13/2016 11:19	0.0573	Correlation Location 2
10/13/2016 11:19	0.0381	Correlation Location 2
10/13/2016 11:19	0.0267	Correlation Location 2
10/13/2016 11:19	0.02	Correlation Location 2
10/13/2016 11:19	0.0169	Correlation Location 2
10/13/2016 11:19	0.0158	Correlation Location 2
10/13/2016 11:19	0.0153	Correlation Location 2
10/13/2016 11:19	0.0154	Correlation Location 2
10/13/2016 11:19	0.0156	Correlation Location 2
10/13/2016 11:19	0.0152	Correlation Location 2
10/13/2016 11:20	0.0151	Correlation Location 2
10/13/2016 11:20	0.015	Correlation Location 2
10/13/2016 11:20	0.0148	Correlation Location 2
10/13/2016 11:20	0.0146	Correlation Location 2
10/13/2016 11:20	0.0141	Correlation Location 2
10/13/2016 11:20	0.0141	Correlation Location 2
10/13/2016 11:20	0.0143	Correlation Location 2
10/13/2016 11:20	0.0142	Correlation Location 2
10/13/2016 11:20	0.0142	Correlation Location 2
10/13/2016 11:20	0.0139	Correlation Location 2
10/13/2016 11:21	0.0136	Correlation Location 2
10/13/2016 11:21	0.0139	Correlation Location 2
10/13/2016 11:21	0.0141	Correlation Location 2
10/13/2016 11:21	0.0146	Correlation Location 2
10/13/2016 11:21	0.0145	Correlation Location 2
10/13/2016 11:21	0.0141	Correlation Location 2
10/13/2016 11:21	0.0142	Correlation Location 2
10/13/2016 11:21	0.0145	Correlation Location 2
10/13/2016 11:21	0.0146	Correlation Location 2
10/13/2016 11:21	0.0144	Correlation Location 2
10/13/2016 11:22	0.0143	Correlation Location 2
10/13/2016 11:22	0.0145	Correlation Location 2
10/13/2016 11:22	0.0145	Correlation Location 2
10/13/2016 11:22	0.014	Correlation Location 2
10/13/2016 11:22	0.0139	Correlation Location 2
10/13/2016 11:22	0.014	Correlation Location 2
10/13/2016 11:22	0.0142	Correlation Location 2
10/13/2016 11:22	0.0145	Correlation Location 2
10/13/2016 11:22	0.0147	Correlation Location 2
10/13/2016 11:22	0.0149	Correlation Location 2
10/13/2016 11:23	0.015	Correlation Location 2
10/13/2016 11:23	0.0151	Correlation Location 2
10/13/2016 11:23	0.015	Correlation Location 2
10/13/2016 11:23	0.0151	Correlation Location 2
10/13/2016 11:23	0.0153	Correlation Location 2
10/13/2016 11:23	0.0153	Correlation Location 2
10/13/2016 11:23	0.0149	Correlation Location 2
10/13/2016 11:23	0.0145	Correlation Location 2
10/13/2016 11:23	0.0144	Correlation Location 2
10/13/2016 11:23	0.0142	Correlation Location 2
10/13/2016 11:24	0.014	Correlation Location 2
10/13/2016 11:24	0.0139	Correlation Location 2
10/13/2016 11:24	0.0138	Correlation Location 2
10/13/2016 11:24	0.0137	Correlation Location 2
10/13/2016 11:24	0.0143	Correlation Location 2
10/13/2016 11:24	0.0145	Correlation Location 2
10/13/2016 11:24	0.0146	Correlation Location 2
10/13/2016 11:24	0.0145	Correlation Location 2
10/13/2016 11:24	0.0142	Correlation Location 2
10/13/2016 11:24	0.0141	Correlation Location 2
10/13/2016 11:25	0.014	Correlation Location 2
10/13/2016 11:25	0.014	Correlation Location 2
10/13/2016 11:25	0.014	Correlation Location 2
10/13/2016 11:25	0.014	Correlation Location 2
10/13/2016 11:25	0.0141	Correlation Location 2
10/13/2016 11:25	0.014	Correlation Location 2
10/13/2016 11:25	0.0145	Correlation Location 2
10/13/2016 11:25	0.0149	Correlation Location 2
10/13/2016 11:25	0.0148	Correlation Location 2
10/13/2016 11:25	0.0144	Correlation Location 2
10/13/2016 11:26	0.0141	Correlation Location 2
10/13/2016 11:26	0.0138	Correlation Location 2
10/13/2016 11:26	0.0139	Correlation Location 2
10/13/2016 11:26	0.0139	Correlation Location 2
10/13/2016 11:26	0.014	Correlation Location 2
10/13/2016 11:26	0.0142	Correlation Location 2
10/13/2016 11:26	0.0142	Correlation Location 2
10/13/2016 11:26	0.0144	Correlation Location 2
10/13/2016 11:26	0.0144	Correlation Location 2
10/13/2016 11:26	0.0147	Correlation Location 2
10/13/2016 11:27	0.0147	Correlation Location 2
10/13/2016 11:27	0.0145	Correlation Location 2
10/13/2016 11:27	0.0144	Correlation Location 2
10/13/2016 11:27	0.0142	Correlation Location 2
10/13/2016 11:27	0.0143	Correlation Location 2
10/13/2016 11:27	0.0144	Correlation Location 2
10/13/2016 11:27	0.014	Correlation Location 2
10/13/2016 11:27	0.0136	Correlation Location 2
10/13/2016 11:27	0.0139	Correlation Location 2
10/13/2016 11:27	0.0142	Correlation Location 2
10/13/2016 11:28	0.0144	Correlation Location 2
10/13/2016 11:28	0.0141	Correlation Location 2
10/13/2016 11:28	0.0135	Correlation Location 2
10/13/2016 11:28	0.0132	Correlation Location 2
10/13/2016 11:28	0.0135	Correlation Location 2
10/13/2016 11:28	0.0135	Correlation Location 2
10/13/2016 11:28	0.0137	Correlation Location 2
10/13/2016 11:28	0.0141	Correlation Location 2
10/13/2016 11:28	0.0141	Correlation Location 2
10/13/2016 11:28	0.0142	Correlation Location 2
10/13/2016 11:29	0.0142	Correlation Location 2
10/13/2016 11:29	0.0142	Correlation Location 2
10/13/2016 11:29	0.0144	Correlation Location 2
10/13/2016 11:29	0.0143	Correlation Location 2
10/13/2016 11:29	0.0144	Correlation Location 2
10/13/2016 11:29	0.0145	Correlation Location 2
10/13/2016 11:29	0.0146	Correlation Location 2
10/13/2016 11:51	0.056	Correlation Location 3
10/13/2016 11:51	0.0994	Correlation Location 3
10/13/2016 11:51	0.0903	Correlation Location 3

Date and Time	Exposure Rate (mR/h)	Location
10/13/2016 11:51	0.066	Correlation Location 3
10/13/2016 11:51	0.0475	Correlation Location 3
10/13/2016 11:51	0.0365	Correlation Location 3
10/13/2016 11:51	0.0305	Correlation Location 3
10/13/2016 11:51	0.0271	Correlation Location 3
10/13/2016 11:51	0.0254	Correlation Location 3
10/13/2016 11:51	0.0242	Correlation Location 3
10/13/2016 11:52	0.0233	Correlation Location 3
10/13/2016 11:52	0.023	Correlation Location 3
10/13/2016 11:52	0.0231	Correlation Location 3
10/13/2016 11:52	0.0234	Correlation Location 3
10/13/2016 11:52	0.0235	Correlation Location 3
10/13/2016 11:52	0.0237	Correlation Location 3
10/13/2016 11:52	0.0239	Correlation Location 3
10/13/2016 11:52	0.0235	Correlation Location 3
10/13/2016 11:52	0.0234	Correlation Location 3
10/13/2016 11:52	0.0235	Correlation Location 3
10/13/2016 11:53	0.0237	Correlation Location 3
10/13/2016 11:53	0.0237	Correlation Location 3
10/13/2016 11:53	0.0237	Correlation Location 3
10/13/2016 11:53	0.0237	Correlation Location 3
10/13/2016 11:53	0.0241	Correlation Location 3
10/13/2016 11:53	0.0249	Correlation Location 3
10/13/2016 11:53	0.0249	Correlation Location 3
10/13/2016 11:53	0.0244	Correlation Location 3
10/13/2016 11:53	0.0237	Correlation Location 3
10/13/2016 11:53	0.0235	Correlation Location 3
10/13/2016 11:54	0.0241	Correlation Location 3
10/13/2016 11:54	0.0244	Correlation Location 3
10/13/2016 11:54	0.0247	Correlation Location 3
10/13/2016 11:54	0.0245	Correlation Location 3
10/13/2016 11:54	0.0243	Correlation Location 3
10/13/2016 11:54	0.0241	Correlation Location 3
10/13/2016 11:54	0.0237	Correlation Location 3
10/13/2016 11:54	0.0237	Correlation Location 3
10/13/2016 11:54	0.0235	Correlation Location 3
10/13/2016 11:54	0.0235	Correlation Location 3
10/13/2016 11:55	0.0234	Correlation Location 3
10/13/2016 11:55	0.0231	Correlation Location 3
10/13/2016 11:55	0.0232	Correlation Location 3
10/13/2016 11:55	0.0233	Correlation Location 3
10/13/2016 11:55	0.0235	Correlation Location 3
10/13/2016 11:55	0.024	Correlation Location 3
10/13/2016 11:55	0.0242	Correlation Location 3
10/13/2016 11:55	0.0244	Correlation Location 3
10/13/2016 11:55	0.0247	Correlation Location 3
10/13/2016 11:55	0.0247	Correlation Location 3
10/13/2016 11:56	0.0244	Correlation Location 3
10/13/2016 11:56	0.0237	Correlation Location 3
10/13/2016 11:56	0.0239	Correlation Location 3
10/13/2016 11:56	0.0241	Correlation Location 3
10/13/2016 11:56	0.0241	Correlation Location 3
10/13/2016 11:56	0.0239	Correlation Location 3
10/13/2016 11:56	0.024	Correlation Location 3
10/13/2016 11:56	0.0239	Correlation Location 3
10/13/2016 11:56	0.0235	Correlation Location 3
10/13/2016 11:56	0.0235	Correlation Location 3
10/13/2016 11:57	0.0237	Correlation Location 3
10/13/2016 11:57	0.0235	Correlation Location 3
10/13/2016 11:57	0.0235	Correlation Location 3
10/13/2016 11:57	0.0237	Correlation Location 3
10/13/2016 11:57	0.0237	Correlation Location 3
10/13/2016 11:57	0.0237	Correlation Location 3
10/13/2016 11:57	0.0235	Correlation Location 3
10/13/2016 11:57	0.0235	Correlation Location 3
10/13/2016 11:57	0.0237	Correlation Location 3
10/13/2016 11:57	0.0235	Correlation Location 3
10/13/2016 11:58	0.0233	Correlation Location 3
10/13/2016 11:58	0.0235	Correlation Location 3
10/13/2016 11:58	0.024	Correlation Location 3
10/13/2016 11:58	0.0243	Correlation Location 3
10/13/2016 11:58	0.0241	Correlation Location 3
10/13/2016 11:58	0.0239	Correlation Location 3
10/13/2016 11:58	0.0237	Correlation Location 3
10/13/2016 11:58	0.0239	Correlation Location 3
10/13/2016 11:58	0.0239	Correlation Location 3
10/13/2016 11:58	0.0237	Correlation Location 3
10/13/2016 11:59	0.024	Correlation Location 3
10/13/2016 11:59	0.0244	Correlation Location 3
10/13/2016 11:59	0.0245	Correlation Location 3
10/13/2016 11:59	0.024	Correlation Location 3
10/13/2016 11:59	0.0241	Correlation Location 3
10/13/2016 11:59	0.0239	Correlation Location 3
10/13/2016 11:59	0.0242	Correlation Location 3
10/13/2016 11:59	0.0245	Correlation Location 3
10/13/2016 11:59	0.0244	Correlation Location 3
10/13/2016 11:59	0.0239	Correlation Location 3
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10/13/2016 12:00	0.024	Correlation Location 3
10/13/2016 12:00	0.0241	Correlation Location 3
10/13/2016 12:00	0.0239	Correlation Location 3
10/13/2016 12:00	0.0239	Correlation Location 3
10/13/2016 12:00	0.0237	Correlation Location 3
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10/13/2016 12:00	0.0225	Correlation Location 3
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10/13/2016 12:01	0.0235	Correlation Location 3
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10/13/2016 12:01	0.0241	Correlation Location 3
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10/13/2016 12:46	0.0954	Correlation Location 4
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10/13/2016 12:47	0.0429	Correlation Location 4
10/13/2016 12:47	0.0365	Correlation Location 4
10/13/2016 12:47	0.0334	Correlation Location 4

Date and Time	Exposure Rate (mR/h)	Location
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10/13/2016 12:47	0.0311	Correlation Location 4
10/13/2016 12:47	0.0309	Correlation Location 4
10/13/2016 12:47	0.0308	Correlation Location 4
10/13/2016 12:47	0.0305	Correlation Location 4
10/13/2016 12:48	0.0306	Correlation Location 4
10/13/2016 12:48	0.0305	Correlation Location 4
10/13/2016 12:48	0.0302	Correlation Location 4
10/13/2016 12:48	0.0306	Correlation Location 4
10/13/2016 12:48	0.031	Correlation Location 4
10/13/2016 12:48	0.0312	Correlation Location 4
10/13/2016 12:48	0.0312	Correlation Location 4
10/13/2016 12:48	0.0312	Correlation Location 4
10/13/2016 12:48	0.0312	Correlation Location 4
10/13/2016 12:48	0.0308	Correlation Location 4
10/13/2016 12:49	0.03	Correlation Location 4
10/13/2016 12:49	0.0299	Correlation Location 4
10/13/2016 12:49	0.0308	Correlation Location 4
10/13/2016 12:49	0.0312	Correlation Location 4
10/13/2016 12:49	0.0312	Correlation Location 4
10/13/2016 12:49	0.0312	Correlation Location 4
10/13/2016 12:49	0.0312	Correlation Location 4
10/13/2016 12:49	0.0312	Correlation Location 4
10/13/2016 12:49	0.0306	Correlation Location 4
10/13/2016 12:49	0.0307	Correlation Location 4
10/13/2016 12:50	0.0302	Correlation Location 4
10/13/2016 12:50	0.0302	Correlation Location 4
10/13/2016 12:50	0.0304	Correlation Location 4
10/13/2016 12:50	0.0311	Correlation Location 4
10/13/2016 12:50	0.0313	Correlation Location 4
10/13/2016 12:50	0.0311	Correlation Location 4
10/13/2016 12:50	0.0308	Correlation Location 4
10/13/2016 12:50	0.0307	Correlation Location 4
10/13/2016 12:50	0.0307	Correlation Location 4
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10/13/2016 12:51	0.0308	Correlation Location 4
10/13/2016 12:51	0.0308	Correlation Location 4
10/13/2016 12:51	0.0309	Correlation Location 4
10/13/2016 12:51	0.0307	Correlation Location 4
10/13/2016 12:51	0.0306	Correlation Location 4
10/13/2016 12:51	0.0309	Correlation Location 4
10/13/2016 12:51	0.0308	Correlation Location 4
10/13/2016 12:51	0.0305	Correlation Location 4
10/13/2016 12:51	0.0305	Correlation Location 4
10/13/2016 12:51	0.0306	Correlation Location 4
10/13/2016 12:52	0.0307	Correlation Location 4
10/13/2016 12:52	0.0308	Correlation Location 4
10/13/2016 12:52	0.0308	Correlation Location 4
10/13/2016 12:52	0.0307	Correlation Location 4
10/13/2016 12:52	0.0309	Correlation Location 4
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10/13/2016 12:52	0.0312	Correlation Location 4
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10/13/2016 12:53	0.0305	Correlation Location 4
10/13/2016 12:53	0.0311	Correlation Location 4
10/13/2016 12:53	0.0312	Correlation Location 4
10/13/2016 12:53	0.0309	Correlation Location 4
10/13/2016 12:53	0.0308	Correlation Location 4
10/13/2016 12:53	0.0307	Correlation Location 4
10/13/2016 12:53	0.0311	Correlation Location 4
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10/13/2016 12:53	0.0311	Correlation Location 4
10/13/2016 12:54	0.0312	Correlation Location 4
10/13/2016 12:54	0.0309	Correlation Location 4
10/13/2016 12:54	0.0308	Correlation Location 4
10/13/2016 12:54	0.0309	Correlation Location 4
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10/13/2016 12:55	0.0308	Correlation Location 4
10/13/2016 12:55	0.031	Correlation Location 4
10/13/2016 12:55	0.0309	Correlation Location 4
10/13/2016 12:55	0.0309	Correlation Location 4
10/13/2016 12:55	0.0309	Correlation Location 4
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10/13/2016 12:56	0.031	Correlation Location 4
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10/13/2016 12:57	0.0313	Correlation Location 4
10/13/2016 12:57	0.0313	Correlation Location 4
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10/13/2016 12:57	0.0311	Correlation Location 4
10/13/2016 12:57	0.0312	Correlation Location 4
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Date and Time	Exposure Rate (mR/h)	Location
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10/13/2016 16:45	0.0156	Correlation Location 5
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10/13/2016 16:45	0.0156	Correlation Location 5
10/13/2016 16:45	0.0156	Correlation Location 5
10/13/2016 16:45	0.0156	Correlation Location 5
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10/13/2016 16:45	0.015	Correlation Location 5
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10/13/2016 16:45	0.0152	Correlation Location 5
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10/13/2016 16:46	0.0154	Correlation Location 5
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10/13/2016 16:46	0.0153	Correlation Location 5
10/13/2016 16:46	0.0151	Correlation Location 5
10/13/2016 16:46	0.0151	Correlation Location 5
10/13/2016 16:46	0.0156	Correlation Location 5
10/13/2016 16:46	0.0158	Correlation Location 5
10/13/2016 16:47	0.0158	Correlation Location 5
10/13/2016 16:47	0.0156	Correlation Location 5
10/13/2016 16:47	0.0155	Correlation Location 5
10/13/2016 16:47	0.0156	Correlation Location 5
10/13/2016 16:47	0.0158	Correlation Location 5
10/13/2016 16:47	0.0154	Correlation Location 5
10/13/2016 16:47	0.0156	Correlation Location 5
10/13/2016 16:47	0.0161	Correlation Location 5
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10/13/2016 16:47	0.0158	Correlation Location 5
10/13/2016 16:48	0.0158	Correlation Location 5
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10/13/2016 16:48	0.0158	Correlation Location 5
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10/13/2016 16:48	0.0158	Correlation Location 5
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10/13/2016 16:51	0.0156	Correlation Location 5
10/13/2016 16:51	0.0158	Correlation Location 5
10/13/2016 16:51	0.0155	Correlation Location 5
10/13/2016 16:51	0.0153	Correlation Location 5
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10/13/2016 16:51	0.015	Correlation Location 5
10/13/2016 16:51	0.015	Correlation Location 5
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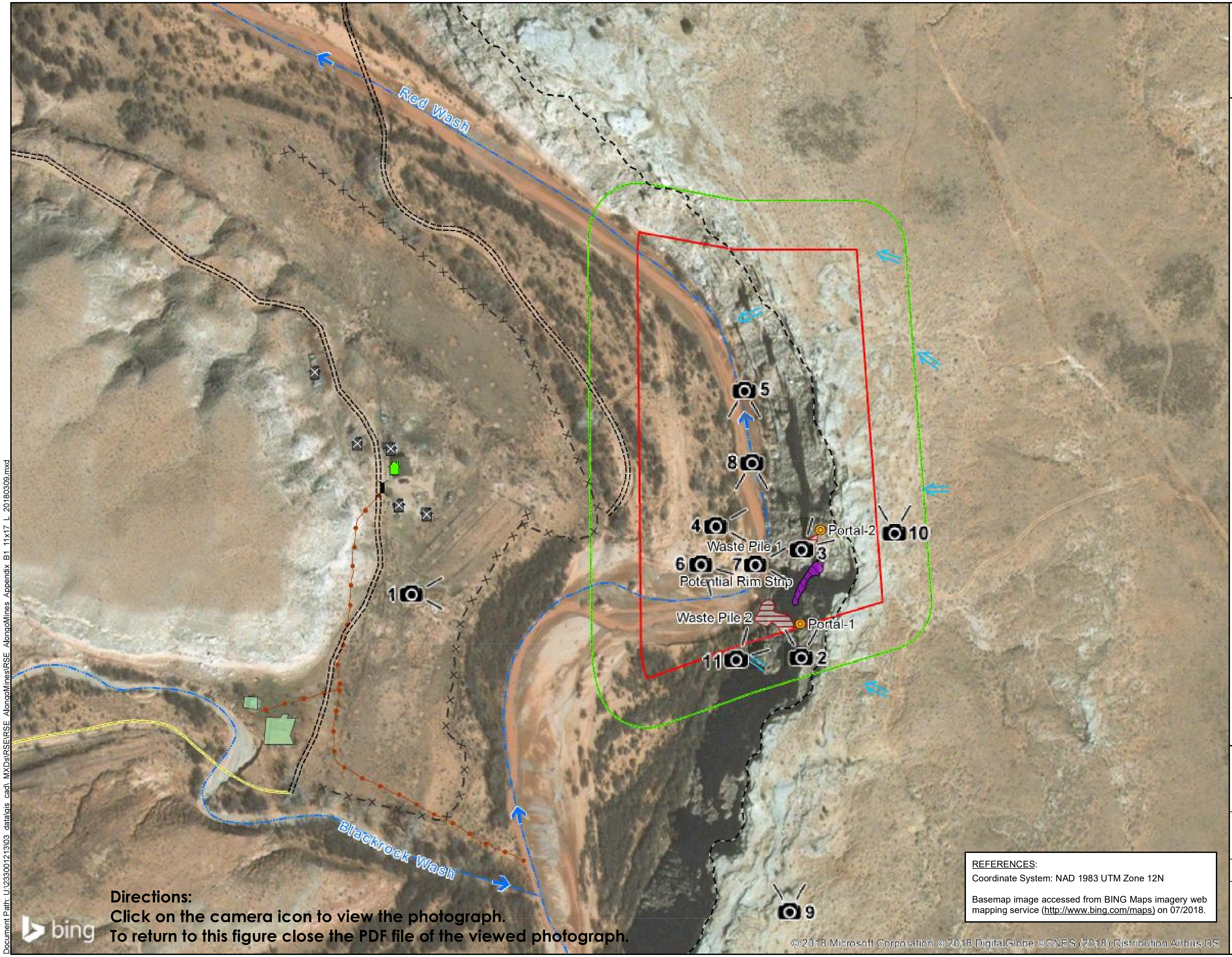
10/13/2016 16:51	0.0158	Correlation Location 5
10/13/2016 16:51	0.0158	Correlation Location 5
10/13/2016 16:52	0.016	Correlation Location 5
10/13/2016 16:52	0.016	Correlation Location 5
10/13/2016 16:52	0.0158	Correlation Location 5
10/13/2016 16:52	0.0158	Correlation Location 5
10/13/2016 16:52	0.0156	Correlation Location 5
10/13/2016 16:52	0.0158	Correlation Location 5
10/13/2016 16:52	0.0158	Correlation Location 5
10/13/2016 16:52	0.0158	Correlation Location 5
10/13/2016 16:52	0.0158	Correlation Location 5
10/13/2016 16:52	0.0158	Correlation Location 5
10/13/2016 16:53	0.0155	Correlation Location 5
10/13/2016 16:53	0.0156	Correlation Location 5
10/13/2016 16:53	0.0156	Correlation Location 5
10/13/2016 16:53	0.0155	Correlation Location 5
10/13/2016 16:53	0.0155	Correlation Location 5
10/13/2016 16:53	0.0154	Correlation Location 5
10/13/2016 16:53	0.0153	Correlation Location 5
10/13/2016 16:53	0.0152	Correlation Location 5
10/13/2016 16:53	0.0152	Correlation Location 5
10/13/2016 16:53	0.0152	Correlation Location 5
10/13/2016 16:54	0.0156	Correlation Location 5
10/13/2016 16:54	0.0156	Correlation Location 5
10/13/2016 16:54	0.0156	Correlation Location 5

Appendix B Site Photographs



Directions:
Click on the camera icon to view the photograph.
To return to this figure close the PDF file of the viewed photograph.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 07/2018.

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

- Photograph Taken Indicating Direction
- Gate
- Habitable Building
- Portal
- Uninhabitable Building
- Flow Direction
- Approximate Overland Water Flow Direction
- Drainage
- Fence
- Potential Haul Road
- Power Line
- Road
- Approximate Edge of Mesa
- Corral
- Potential Rim Strip
- Waste Pile
- Claim Boundary
- 100-Foot Claim Buffer

N
W E
S

0 200 400
Feet

TITLE:
Site Photographs

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 7/18/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ
REVIEWER: CBB

FIGURE: Appendix B

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_AlongoMines\RSE_AlongoMines_Appendix_B1_11x17_L_20180309.mxd

Appendix C Field Activity Forms

C.1 Soil Sample Field Forms

C.2 Hand Auger Borehole Logs

C.1 Soil Sample Field Forms

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alongo)

SAMPLE I.D. S002 - ~~BG2~~ BG1 -001

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1401

SAMPLE COLLECTED BY Chen

WEATHER CONDITIONS Sunny, 70's

FIELD USCS DESCRIPTIONS Fine red sand, moist

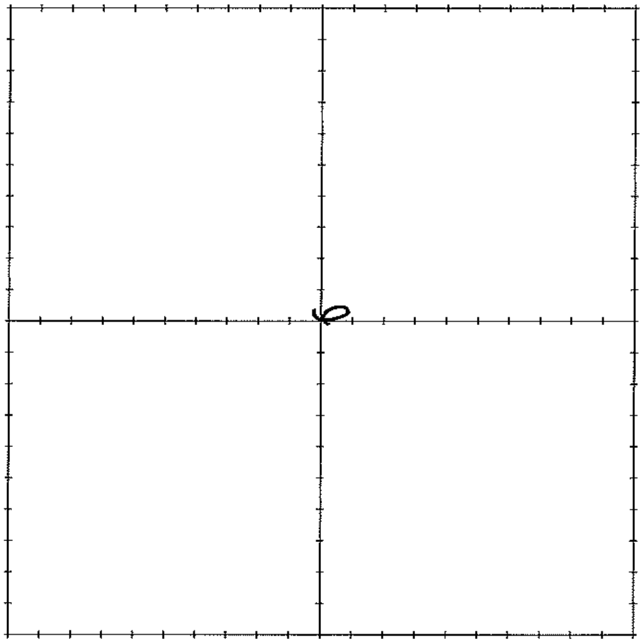
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☐ DRY ☑ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alongo)

SAMPLE I.D. S002 - BG1-002 (202, Dup)

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1415

SAMPLE COLLECTED BY C Lee

WEATHER CONDITIONS Sunny, 70's

FIELD USCS DESCRIPTIONS Fine red sand, moist, some coarse gravel

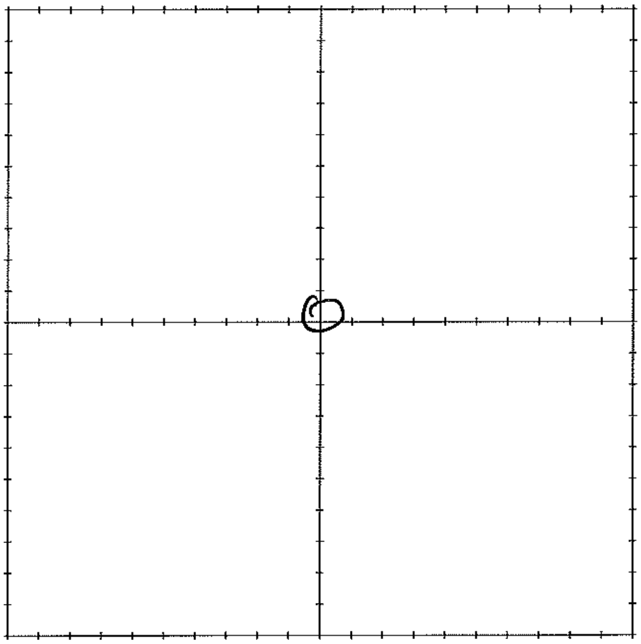
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☑ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☐ DRY ☑ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, Ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Aloyo)

SAMPLE I.D. S002-BG1-003, MS, MSD

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1430

SAMPLE COLLECTED BY C Lee

WEATHER CONDITIONS Sunny, 70's

FIELD USCS DESCRIPTIONS Fine w/ sand, moist

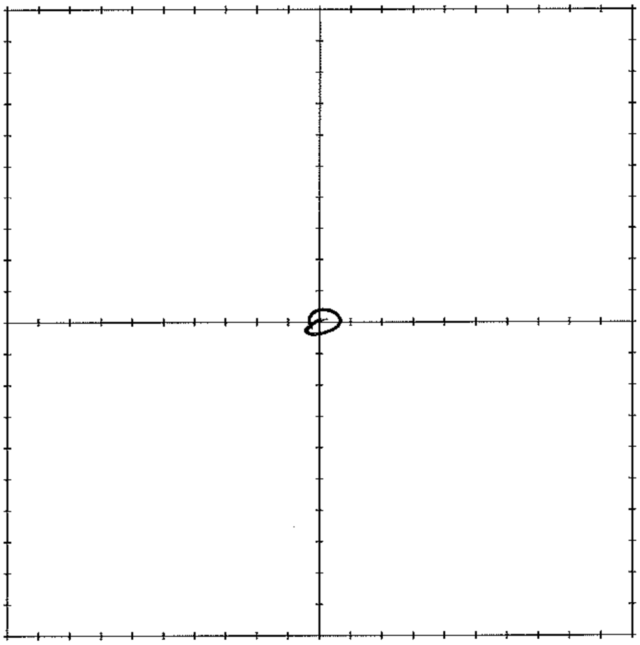
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☐ DRY ☑ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alongo)

SAMPLE I.D. S002-BG1_004

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1445

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS Sunny, 70's

FIELD USCS DESCRIPTIONS Fine red sand, very clean, moist

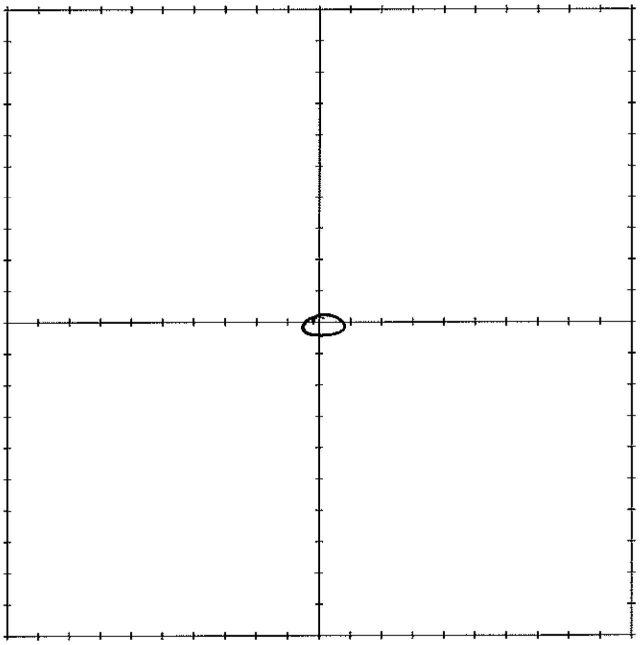
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☐ DRY ☑ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alonzo)

SAMPLE I.D. S002-BG1-005

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1452

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS Sunny, 70's

FIELD USCS DESCRIPTIONS Fine red sand

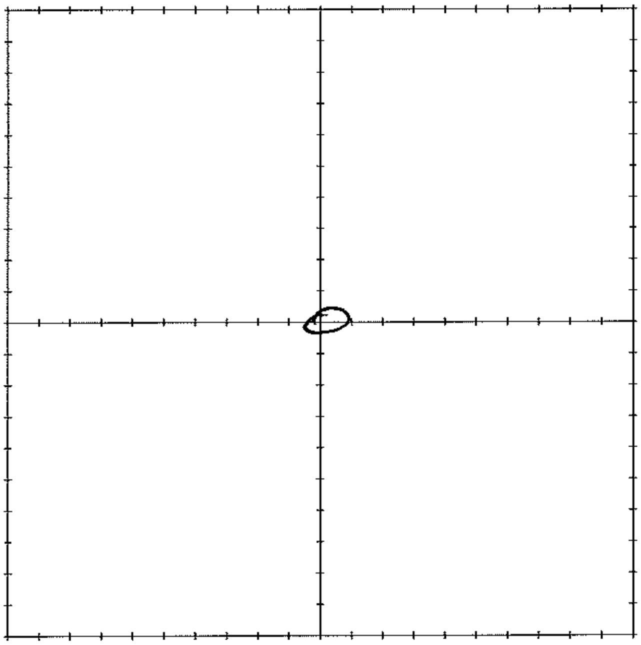
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alonzo)

SAMPLE I.D. S002 - 361 - 006

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1500

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS Sunny, 70's

FIELD USCS DESCRIPTIONS Fine red sand, very clean

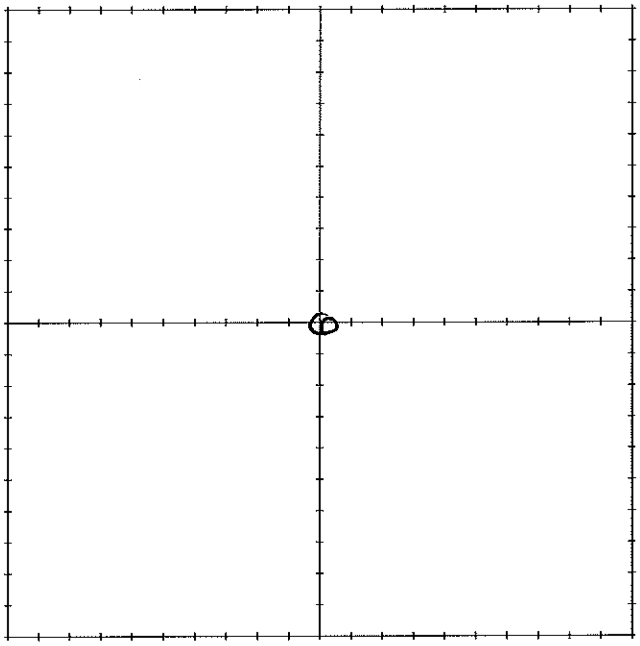
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, Ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alogo)

SAMPLE I.D. S002-BG1-007

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1510

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, Sunny

FIELD USCS DESCRIPTIONS Fine red sand

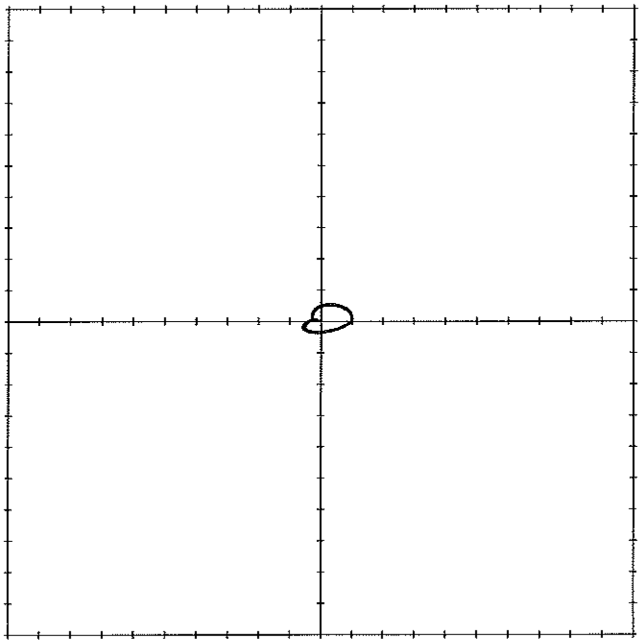
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alongo)

SAMPLE I.D. S002-BG1-008

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1515

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, Sunny

FIELD USCS DESCRIPTIONS Fine red sand, some gravels

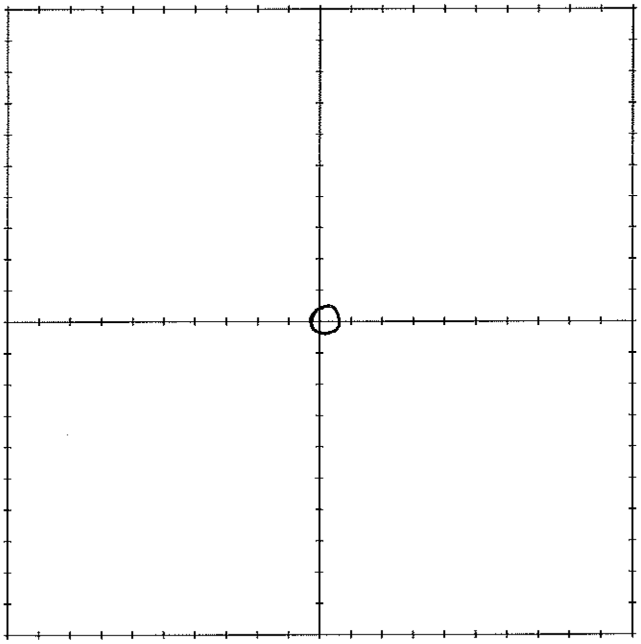
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☑ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, Ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alongo)

SAMPLE I.D. S002-BG1-009

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1520

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine red silty sand

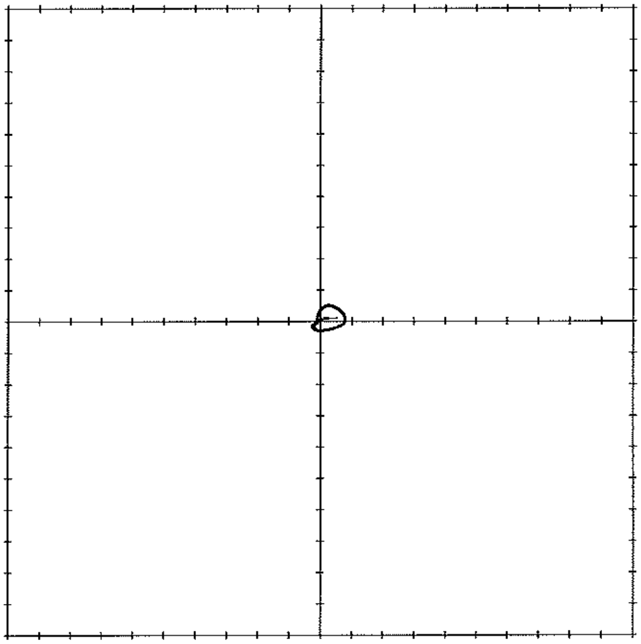
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☐ DRY ☑ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Aloyo)

SAMPLE I.D. S002-BG1-010

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1530

SAMPLE COLLECTED BY C Lee

WEATHER CONDITIONS 70's, Sunny

FIELD USCS DESCRIPTIONS Fine red sand, some gravel's

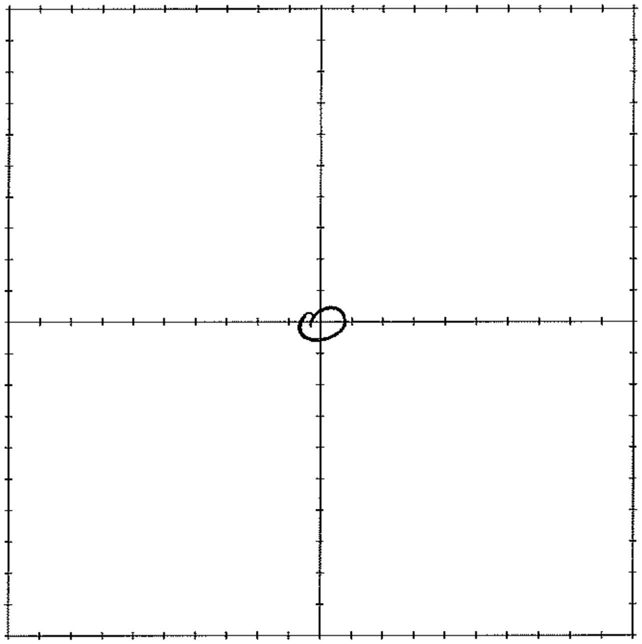
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☑ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals.



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alojo)

SAMPLE I.D. S002-BG2-001

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1540

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine red sand

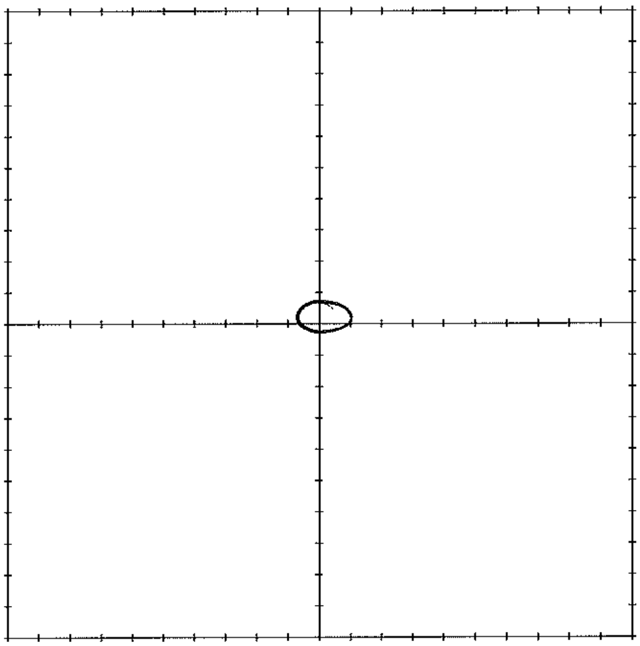
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alongo)

SAMPLE I.D. S002-BG2-002 (202, dup)

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1545

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, Sunny

FIELD USCS DESCRIPTIONS Fine red sand

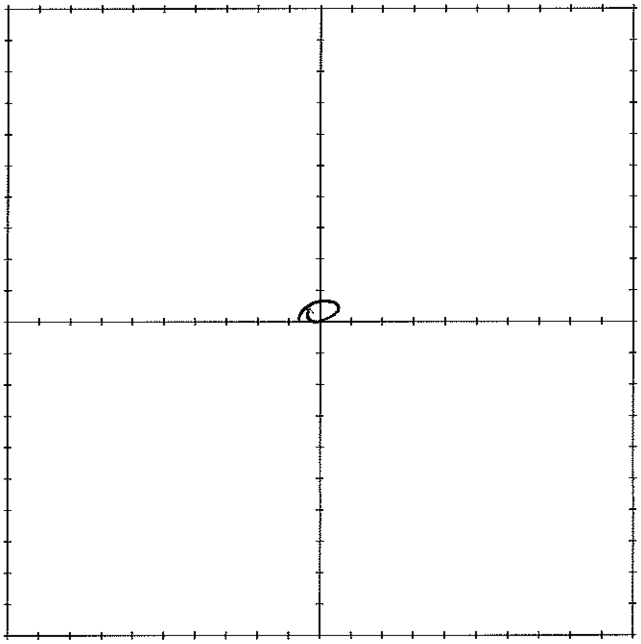
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alonzo)

SAMPLE I.D. S002-BG2-003

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1555

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine red sand

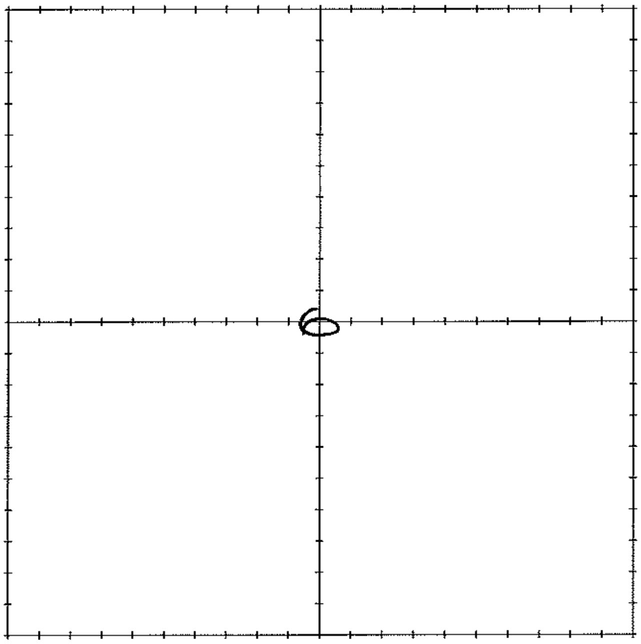
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alkyd)

SAMPLE I.D. S002-BG2-004

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1600

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, Sunny

FIELD USCS DESCRIPTIONS Fine red sand

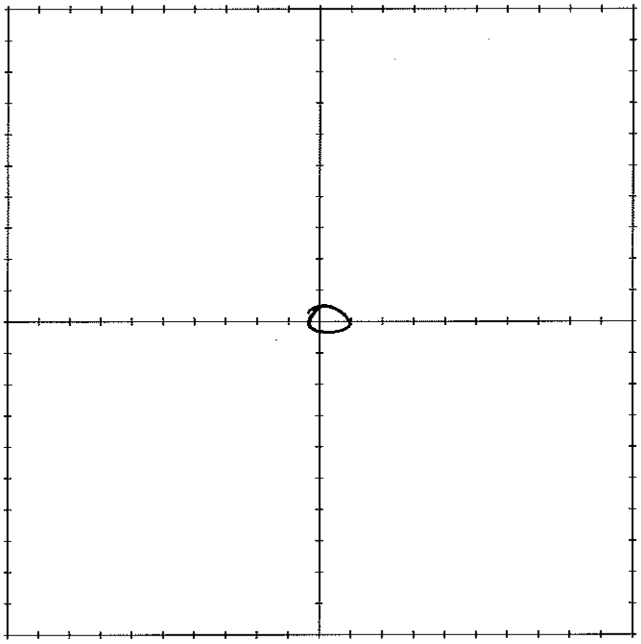
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, zip-lo

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alongo)

SAMPLE I.D. S002-BG2-005

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1610

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine red sand

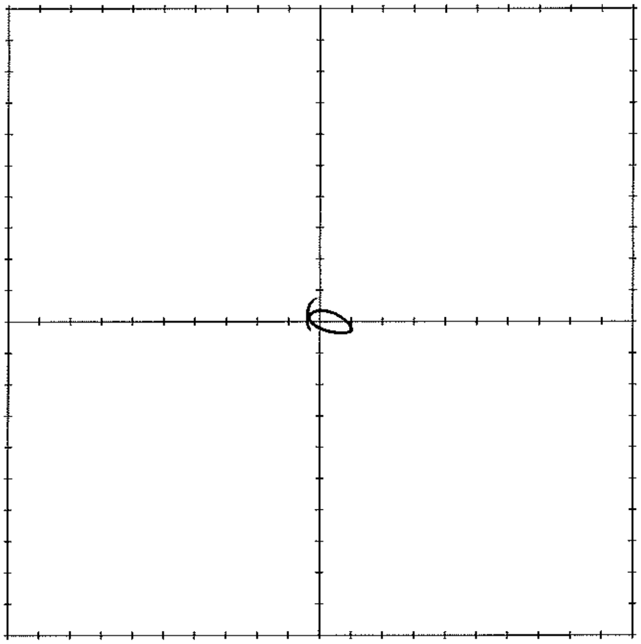
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alongo)

SAMPLE I.D. S002-BG2-006

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1615

SAMPLE COLLECTED BY C Lee

WEATHER CONDITIONS 70's, Sunny

FIELD USCS DESCRIPTIONS Fine red sand

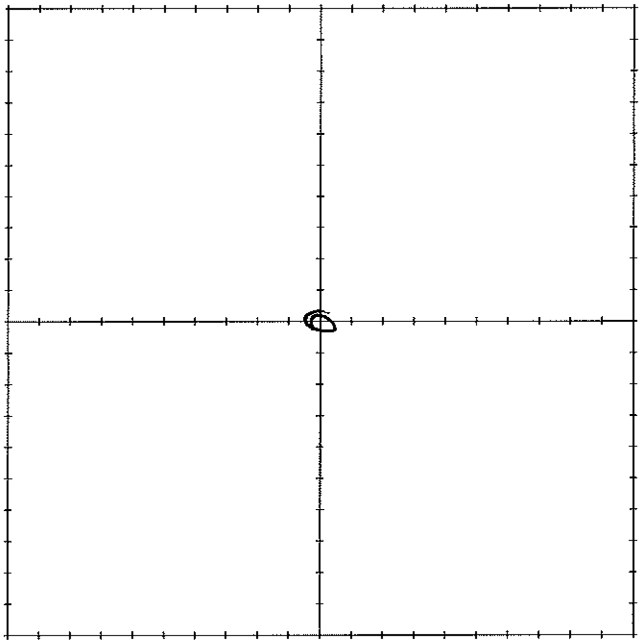
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alayo)

SAMPLE I.D. S002-BG2-007

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1620

SAMPLE COLLECTED BY C Lee

WEATHER CONDITIONS 70's, Sunny

FIELD USCS DESCRIPTIONS Fine red sand

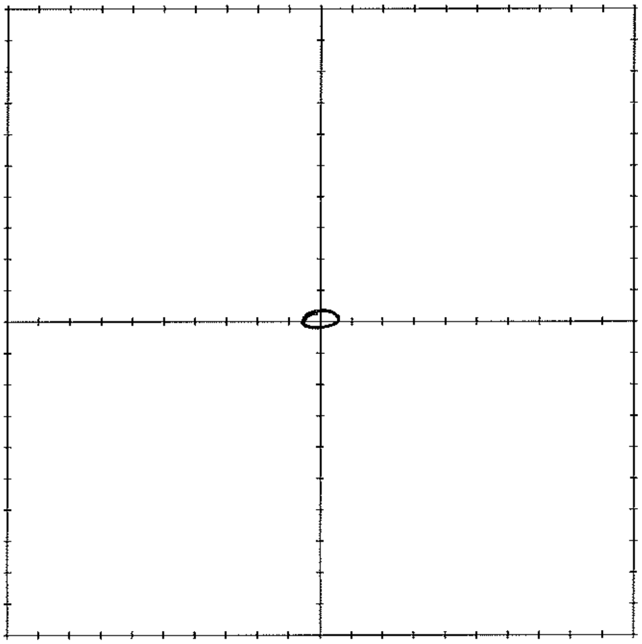
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alongo)

SAMPLE I.D. S002-BG2-008

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1625

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, Sunny

FIELD USCS DESCRIPTIONS Fine red sand

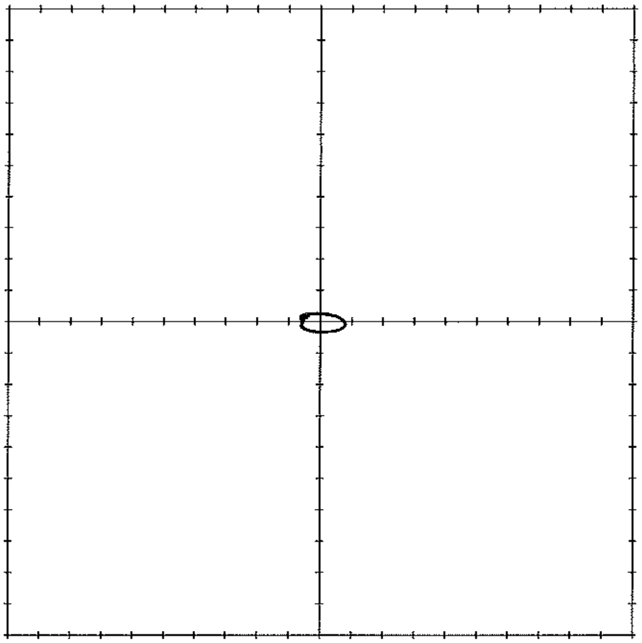
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alonzo)

SAMPLE I.D. S002-BG2-009

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1630

SAMPLE COLLECTED BY C Lee

WEATHER CONDITIONS 70's, Sunny

FIELD USCS DESCRIPTIONS Fine red sand

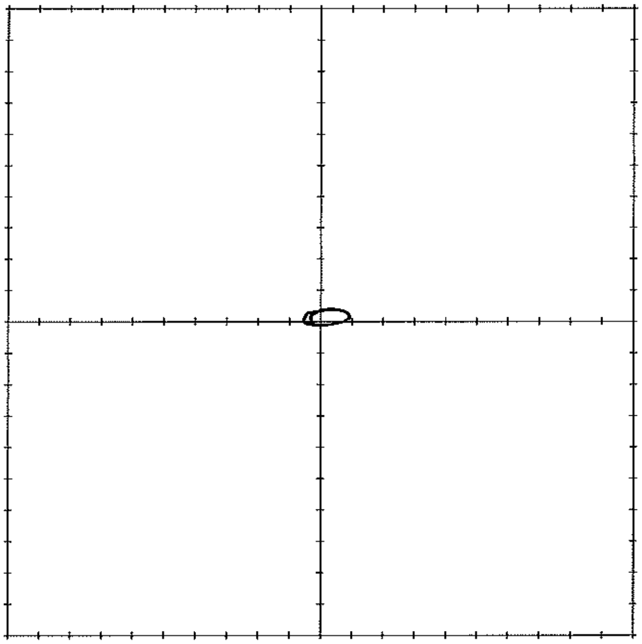
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 (Alonzo)

SAMPLE I.D. S002-BG2-010

SAMPLE COLLECTION DATE 10/1/16

SAMPLE COLLECTION TIME 1635

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 20's, Sunny

FIELD USCS DESCRIPTIONS Fine red sand

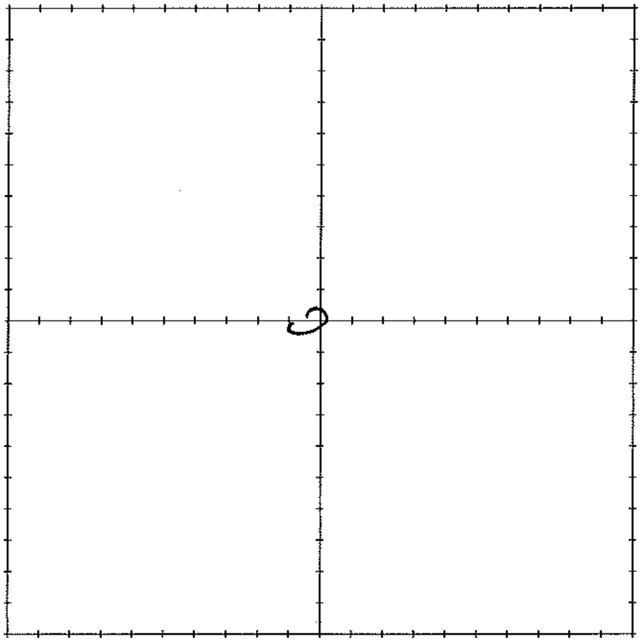
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

Alongo

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Alongo

SAMPLE I.D. S002-B63-001

SAMPLE COLLECTION DATE 8/28/17

SAMPLE COLLECTION TIME 10:00

SAMPLE COLLECTED BY CL

WEATHER CONDITIONS Sunny 90°F

FIELD USCS DESCRIPTIONS (SW) well graded sand with gravel, Brown, Dry, loose sand (75%) fine to coarse gravels (25%) angular to subangular weathered Sandstone bedrock

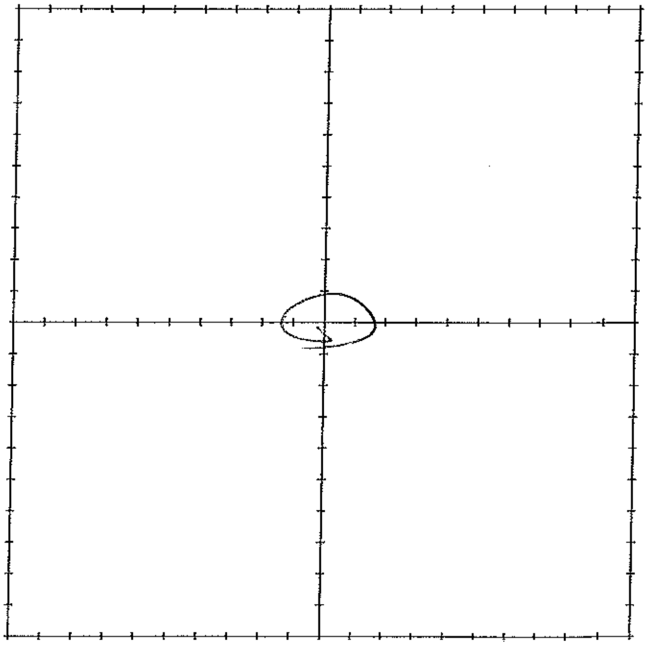
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 Ziplocks

ANALYSES: Ra-226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Alonzo

SAMPLE I.D. S002-BG3-002

SAMPLE COLLECTION DATE 8/28/17

SAMPLE COLLECTION TIME 1010

SAMPLE COLLECTED BY CL

WEATHER CONDITIONS Sunny 90°F

FIELD USCS DESCRIPTIONS (SW) Well graded Sands and gravels. Brown, Dry, Medium D. Fine to medium sand (60%) Gravel (40%) Subangular weathered Sandstone 1/2"-4 weathered bedrock

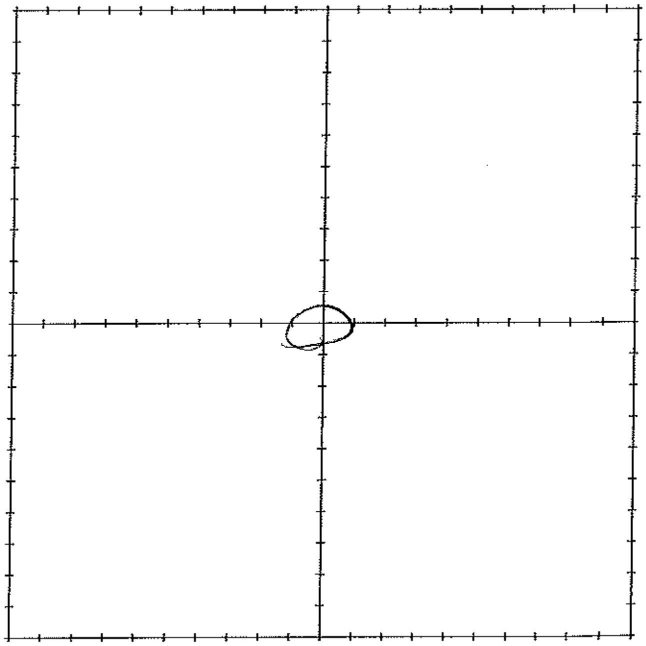
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 Ziplocks

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Alongo

SAMPLE I.D. S002-BG3-003

SAMPLE COLLECTION DATE 8/28/17

SAMPLE COLLECTION TIME 1015

SAMPLE COLLECTED BY CL

WEATHER CONDITIONS Sonny 90°F

FIELD USCS DESCRIPTIONS (SW) well graded sand with some gravel, Brown Sand (80%) fine to medium Gravel (20%) Sandstone ½"-3" bedrock. Dry, lo Subang weathe

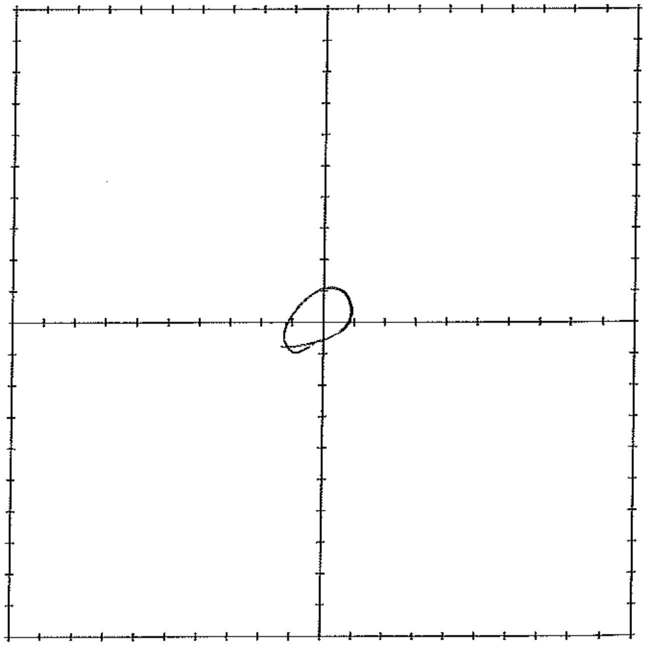
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 Ziplocks

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Nongo

SAMPLE I.D. S002 - BG3 - 004

SAMPLE COLLECTION DATE 8/28/17

SAMPLE COLLECTION TIME 1020

SAMPLE COLLECTED BY CL

WEATHER CONDITIONS Sunny 90°F

FIELD USCS DESCRIPTIONS (SW) Well graded sand and gravels. Brown, Dry, loose sand (70%) fine to coarse Gravel (30%) subangular ½"-4" weathered Sandsto bedrock

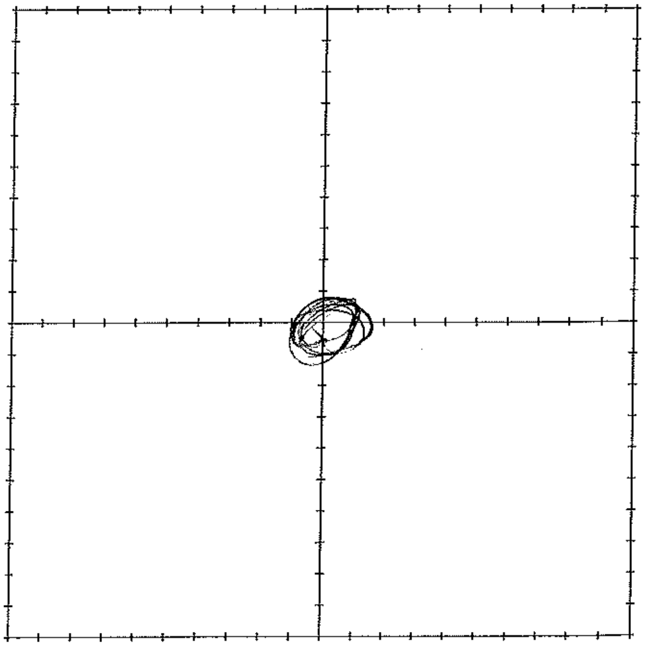
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 Ziplocks

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Alongo.

SAMPLE I.D. S002-BG3-005

SAMPLE COLLECTION DATE 8/28/17

SAMPLE COLLECTION TIME 1026

SAMPLE COLLECTED BY LL

WEATHER CONDITIONS SUNNY 90°F

FIELD USCS DESCRIPTIONS (GW) Well graded gravel with sand. Dry, loose, Bro
gravel (70%) is subangular ½"-4" weathered bedro
Soil color is very sh

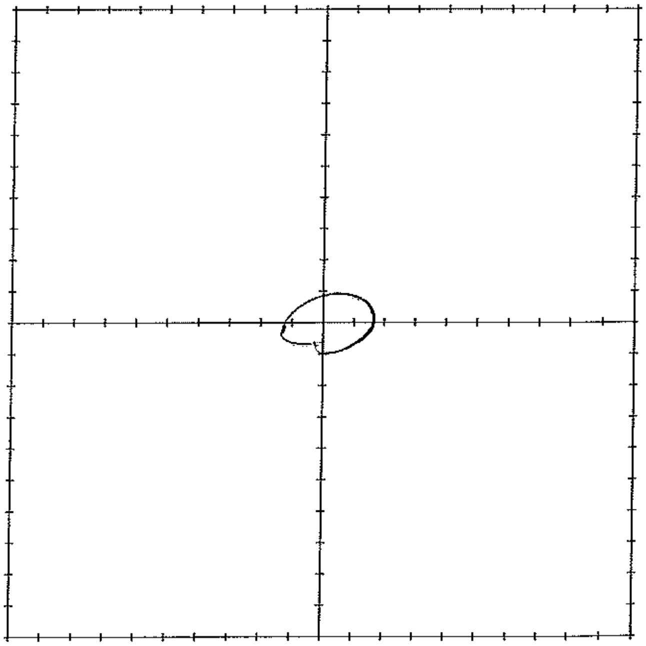
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☒ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 Ziplocks

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Alongo

SAMPLE I.D. S002-BG3-006

SAMPLE COLLECTION DATE 8/28/17

SAMPLE COLLECTION TIME 1030

SAMPLE COLLECTED BY CL

WEATHER CONDITIONS Sunny, 90°F

FIELD USCS DESCRIPTIONS (SW) well graded Sand with gravel, Brown, Dry, loose Sand (70%) fine to coarse gravel (30%) subangular weathered sandstone bedro.

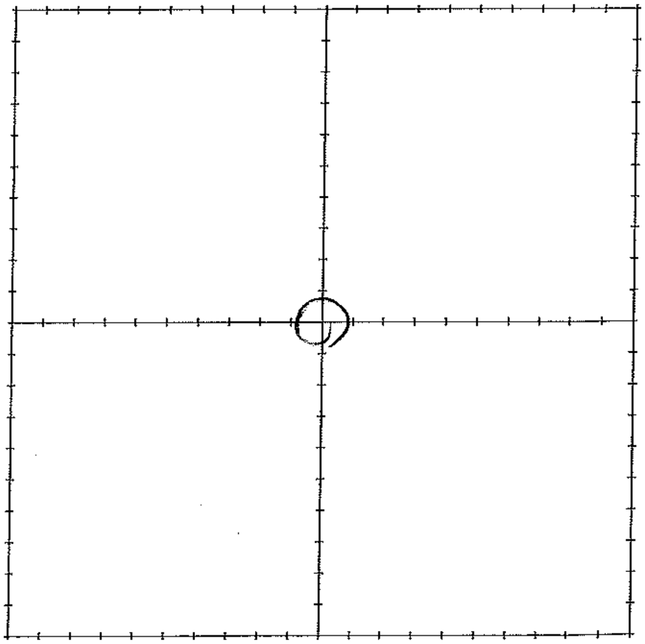
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☑ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 Ziplocks

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Alongo

SAMPLE I.D. S002 - BG3-007 + Duplicate

SAMPLE COLLECTION DATE 8/28/17

SAMPLE COLLECTION TIME 10:37

SAMPLE COLLECTED BY CL

WEATHER CONDITIONS Sunny 90°F

FIELD USCS DESCRIPTIONS (SW) well graded sand with some gravel. Brown, Dry, lo Sand (90%) fine to coarse, gravel (10%) subangular weathered bedrock ½"-1"

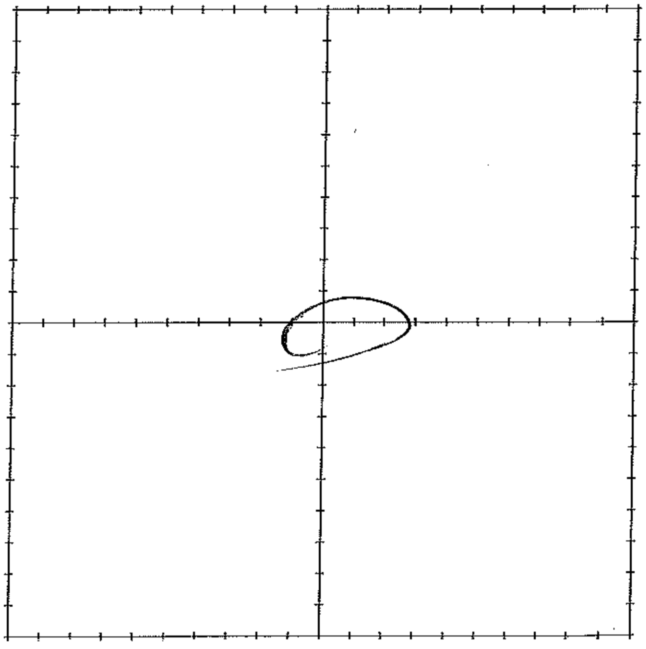
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 Ziplocks

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Alewgo

SAMPLE I.D. S002-B63-008

SAMPLE COLLECTION DATE 8/28/17

SAMPLE COLLECTION TIME 10:40

SAMPLE COLLECTED BY CL

WEATHER CONDITIONS Sunny 90°F

FIELD USCS DESCRIPTIONS (SW) well graded sand, Brown, Dry, loose, (100%) Sand fine (40%) medium (30%) coarse (30%)

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC ☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

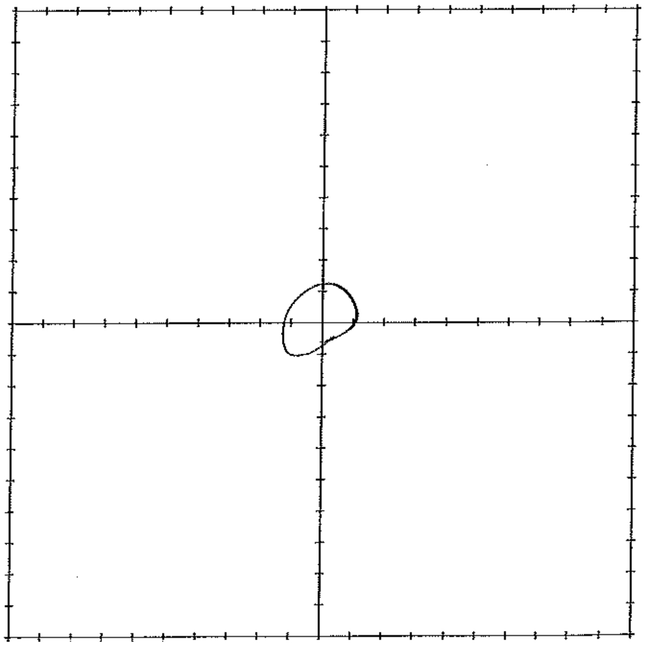
grains are rounded Brown, white, green red.

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 Ziplocks

ANALYSES: Ra-226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Alongo

SAMPLE I.D. S002-BG3-009

SAMPLE COLLECTION DATE 8/28/17

SAMPLE COLLECTION TIME 10:59

SAMPLE COLLECTED BY CL

WEATHER CONDITIONS Sunny 90°F

FIELD USCS DESCRIPTIONS (SW) (well graded sand with gravel. Dry, loose, Brown sand: Fine to coarse (70%) gravel (30%) subrou 1/2"-1"

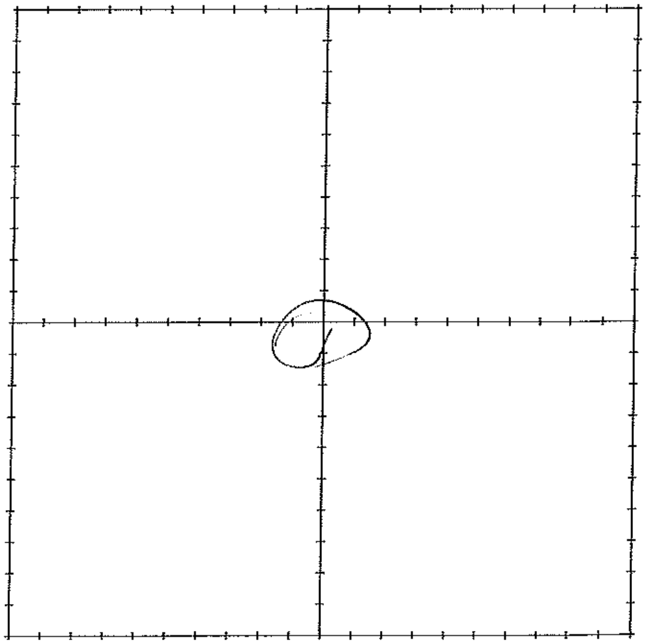
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 Ziplocks

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Alonzo

SAMPLE I.D. S002-BG3-010

SAMPLE COLLECTION DATE 8/28/17

SAMPLE COLLECTION TIME 1105

SAMPLE COLLECTED BY CL

WEATHER CONDITIONS Sunny 90°F

FIELD USCS DESCRIPTIONS (SP) poorly graded Fine Sand with trace medium sand, Brown, Dry, loose, (100%) Sand

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC

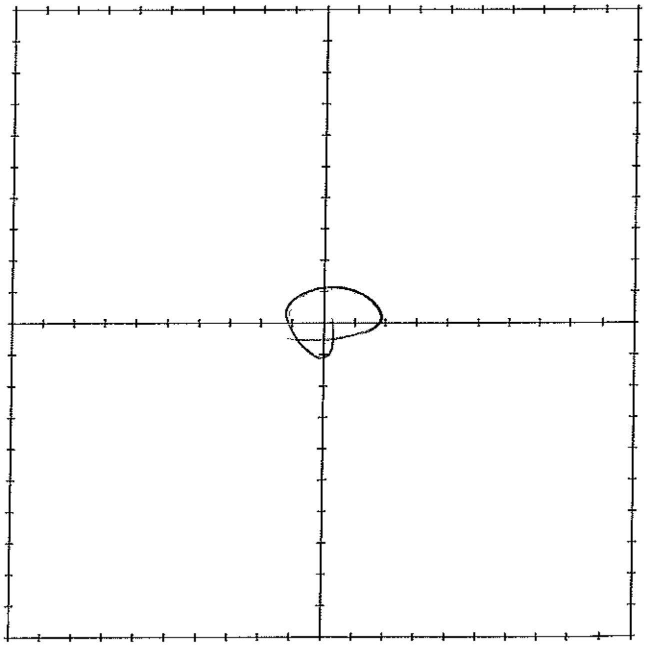
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 Ziplocks

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-C01-001 (Aloyo)

SAMPLE I.D. S002-C01-001

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1020

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 80's, sunny

FIELD USCS DESCRIPTIONS Brown clean silt

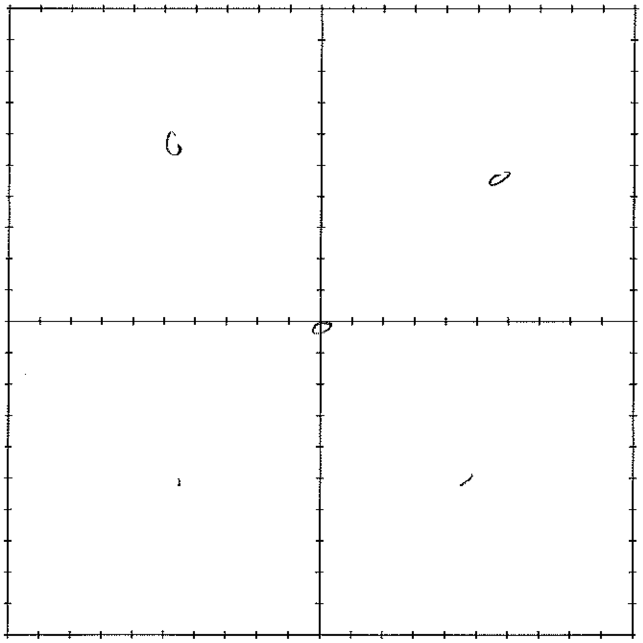
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziploc

ANALYSES: Ra-226, Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-602-201 (Alongo)

SAMPLE I.D. S002-602-201

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1115

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 80's, Sunny

FIELD USCS DESCRIPTIONS Brown silt, trace sandy black frags

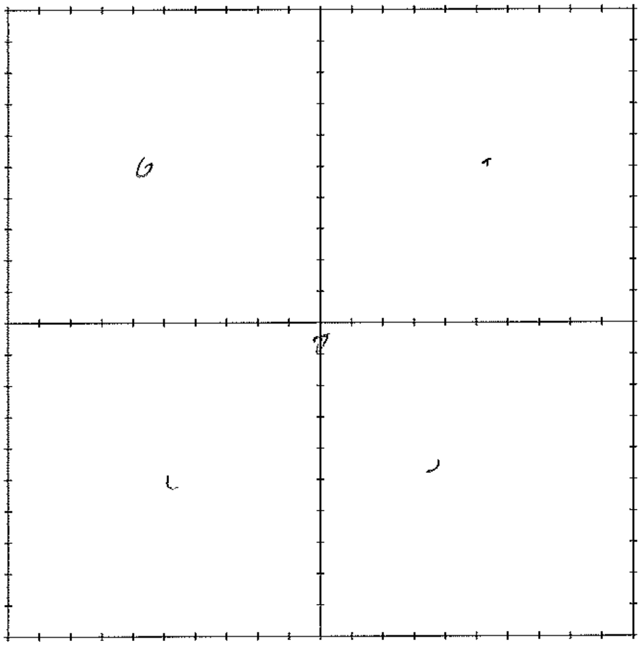
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziploc

ANALYSES: Ra-226, Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-C02-001 (Alongo)

SAMPLE I.D. S002-C02-001

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1115

SAMPLE COLLECTED BY C.Lee

WEATHER CONDITIONS 80's, sunny

FIELD USCS DESCRIPTIONS Brown silt, minor sand(black)

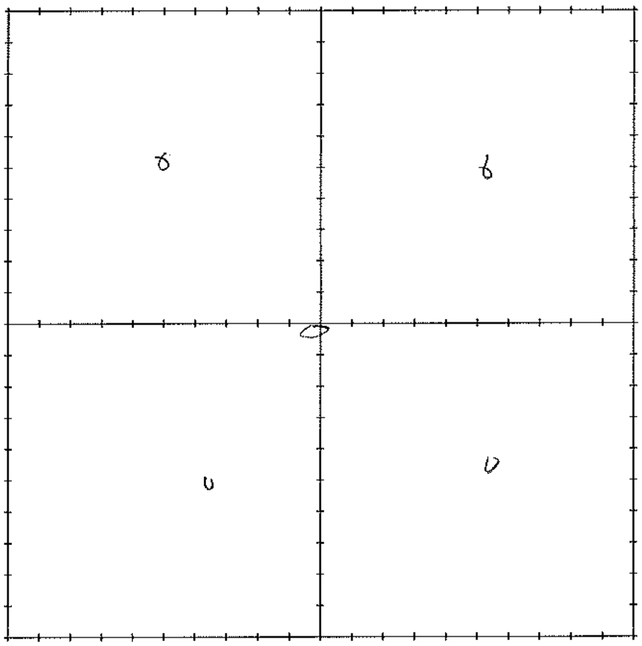
MAJOR DIVISIONS: ☐ OH ☐ CH ☑ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☒ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 ziploc

ANALYSES: Ra-226, Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-C03-001 (Alongo)

SAMPLE I.D. S002-C03-001

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1148

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 80's, Sunny

FIELD USCS DESCRIPTIONS Silts, Brown, some black sand frags

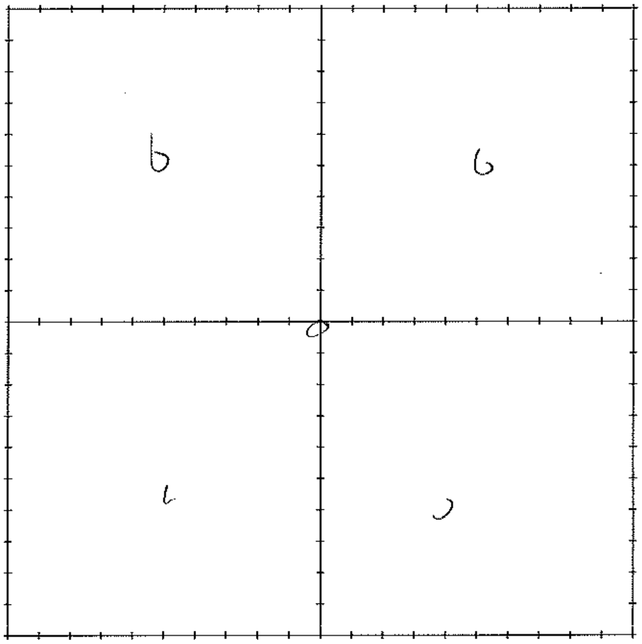
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☒ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziplock

ANALYSES: Ra-226, Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-C03-001 (Alayo)

SAMPLE I.D. S002-C03-001 MS

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1148

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 80's Sunny

FIELD USCS DESCRIPTIONS Brown sandy silt

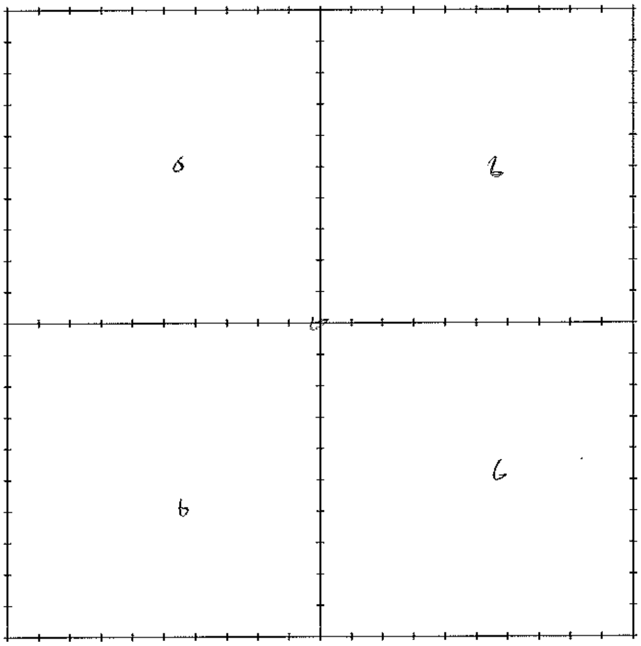
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☒ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, Ziploc

ANALYSES: Ra-226, Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-L03-001 (Alongo)

SAMPLE I.D. S002-L03-001 MSD

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1140

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 80's, clear

FIELD USCS DESCRIPTIONS Brown-gray silt, some sand

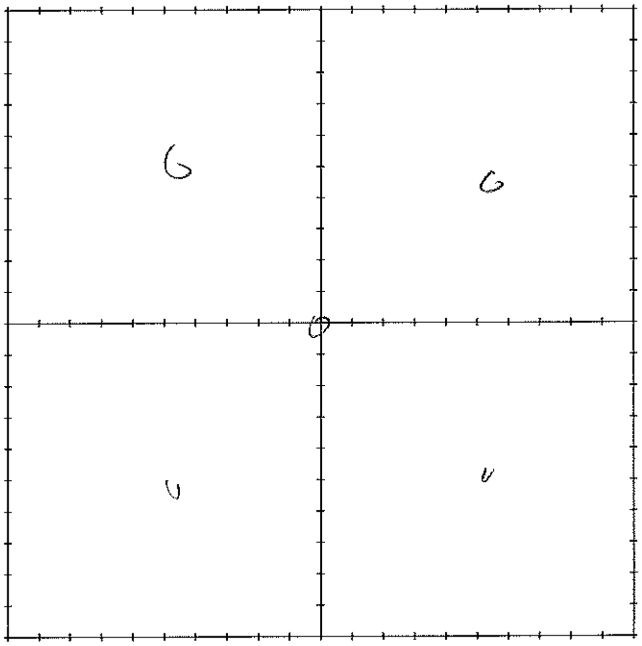
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, Ziploc

ANALYSES: Ra-226, Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-C04-001 (Alonzo)

SAMPLE I.D. S002-C04-001

SAMPLE COLLECTION DATE 10/13/06

SAMPLE COLLECTION TIME 1240

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 86's, clear

FIELD USCS DESCRIPTIONS Brown sandy silt

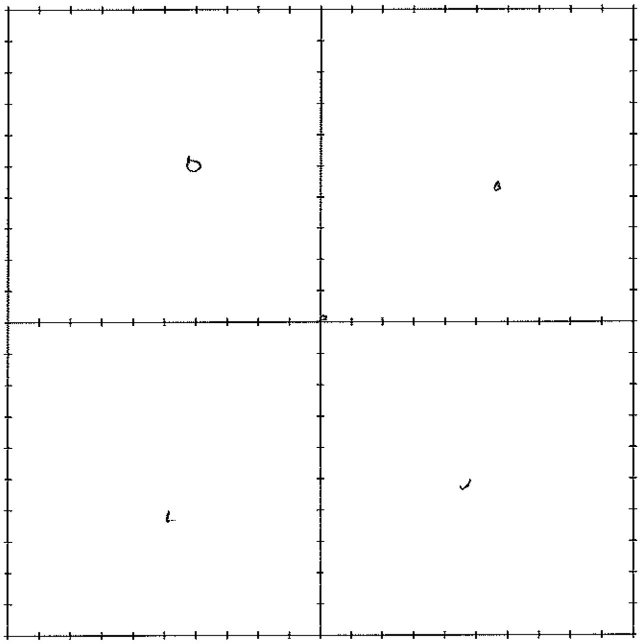
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☒ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziplock

ANALYSES: Ra-226, Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-L05-001 (Alogo)

SAMPLE I.D. S002-L05-601

SAMPLE COLLECTION DATE 10/13/06

SAMPLE COLLECTION TIME 1640

SAMPLE COLLECTED BY L. Lee

WEATHER CONDITIONS 80's, clear

FIELD USCS DESCRIPTIONS Brown sandy silt

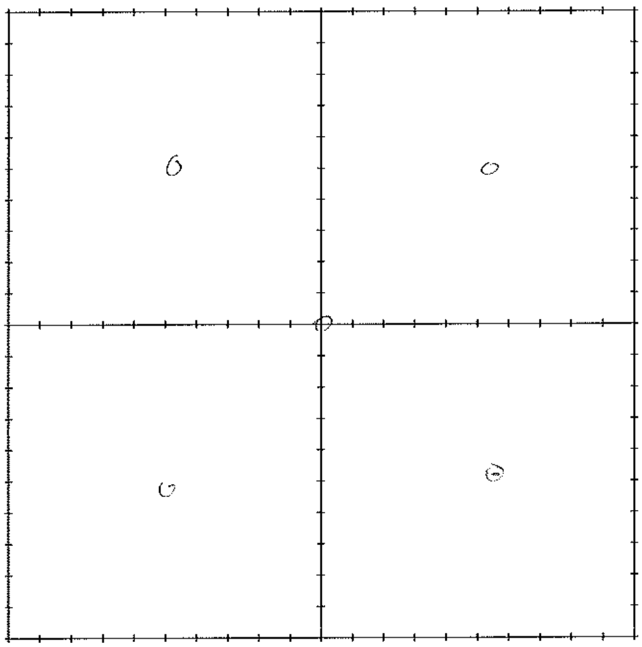
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☑ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, Ziploc

ANALYSES: Ra-226, Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-CX-001 (Alonzo)

SAMPLE I.D. 8002-CX-001

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1024

SAMPLE COLLECTED BY L. Rodriguez

WEATHER CONDITIONS 80's, clear

FIELD USCS DESCRIPTIONS Brown sandy silt, fine sand

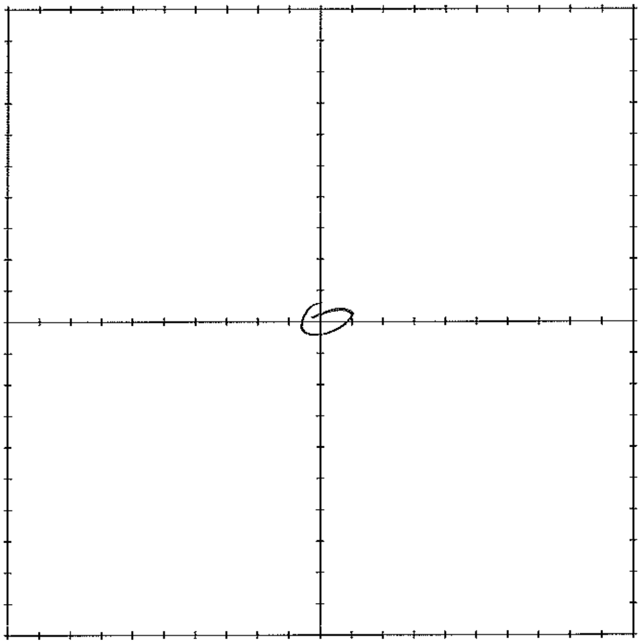
MAJOR DIVISIONS: ☐ OH ☐ CH ☑ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☑ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME 8002-CX-002 (Alluys)

SAMPLE I.D. 8002-CX-002

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1126

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 80's, clear

FIELD USCS DESCRIPTIONS Brown very fine sand/silt

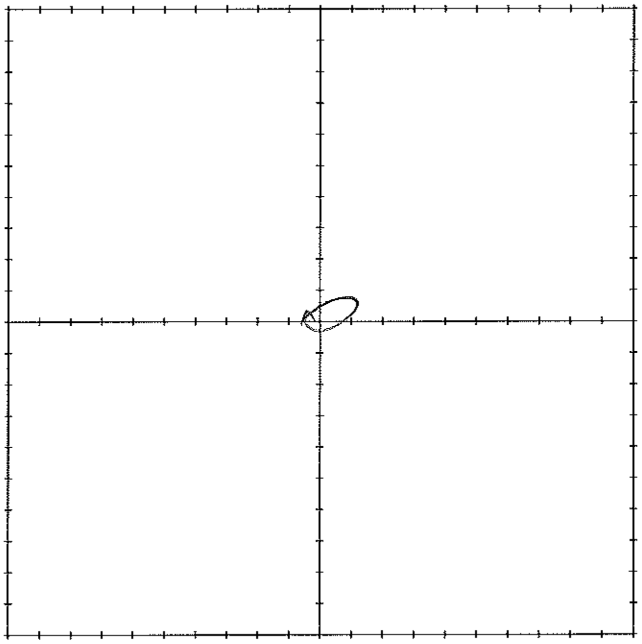
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002 - CX - 003 (Alonzo)

SAMPLE I.D. S002-CX-003

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1240

SAMPLE COLLECTED BY L. Rodriguez

WEATHER CONDITIONS 80's, clear

FIELD USCS DESCRIPTIONS Brown sandy silt

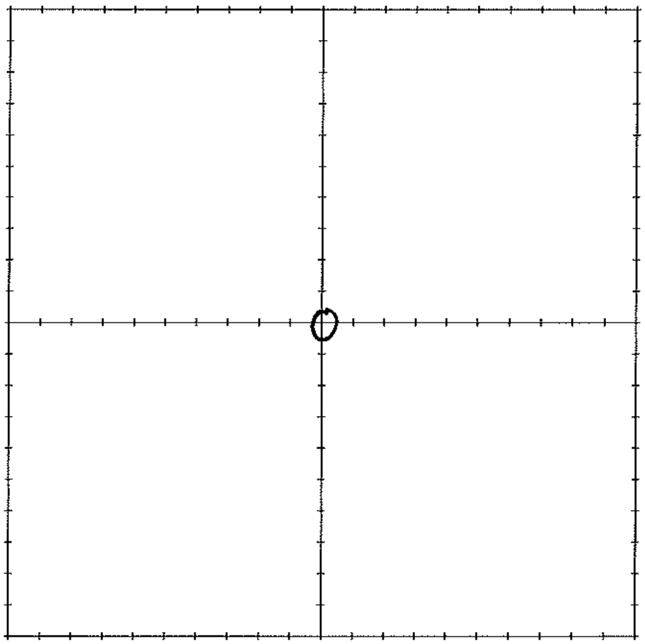
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-CX-004 (Alongo)

SAMPLE I.D. S002-CX-004

SAMPLE COLLECTION DATE 10/17/16

SAMPLE COLLECTION TIME 1235

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 80's, Sunny

FIELD USCS DESCRIPTIONS Brown silt

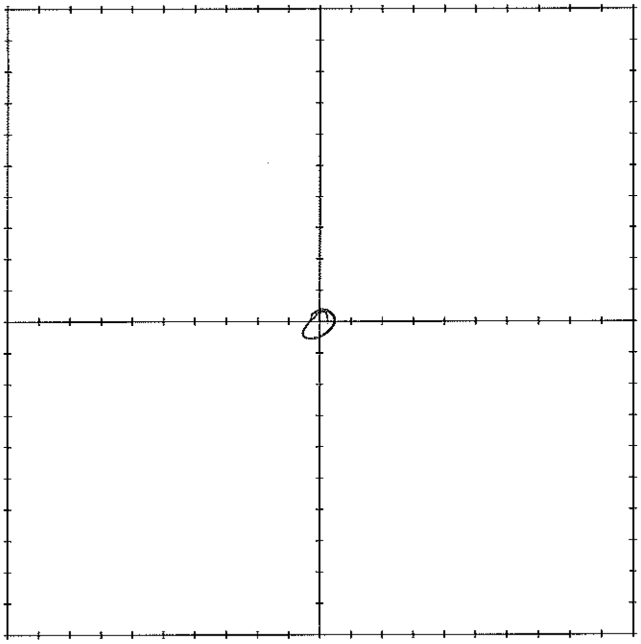
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☐ DRY ☒ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziplock

ANALYSES: Ra-226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-CX-005 (Alayo)

SAMPLE I.D. S002-CX-005

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1320

SAMPLE COLLECTED BY C Lee

WEATHER CONDITIONS 80's, clear

FIELD USCS DESCRIPTIONS Brownish red sand

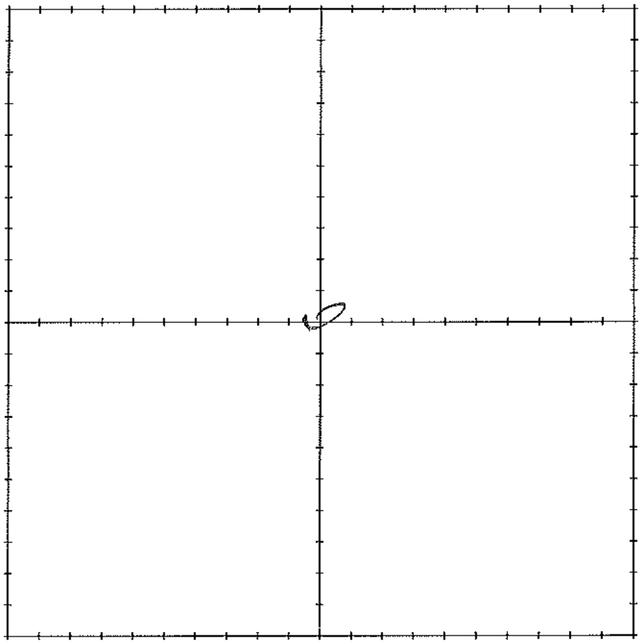
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☒ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 ziploc

ANALYSES: Ra-226, Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-GX-006 (Arroyo)

SAMPLE I.D. S002-GX-006

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1345

SAMPLE COLLECTED BY C Lee

WEATHER CONDITIONS 80's, clear

FIELD USCS DESCRIPTIONS Coarse brown sand

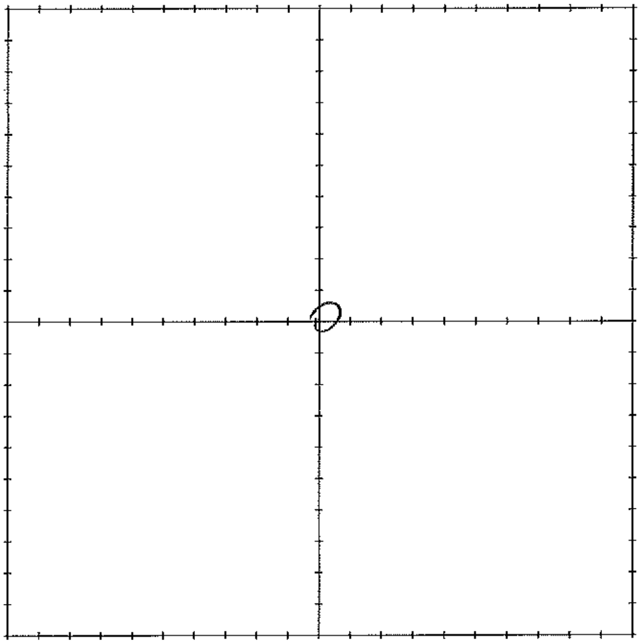
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☐ DRY ☒ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-CX-006 (Algod)

SAMPLE I.D. S002-CX-006MS

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1345

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 80's, clear

FIELD USCS DESCRIPTIONS Brown-red sand

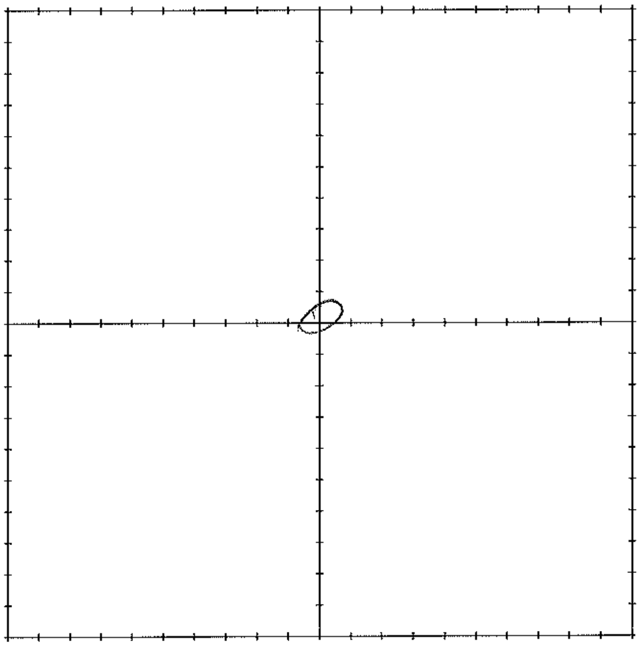
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☒ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☐ DRY ☒ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziplock

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-LX-006 (Along)

SAMPLE I.D. S002-LX-006 MSD

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1345

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 80's, clear

FIELD USCS DESCRIPTIONS Brown fine sand

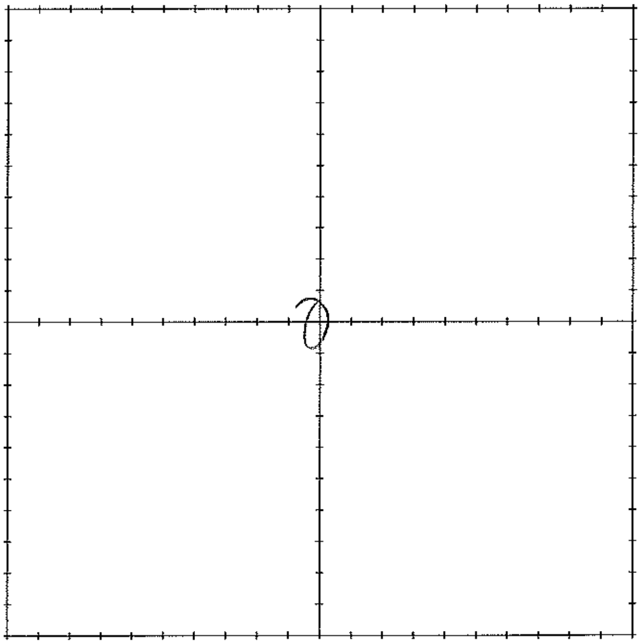
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☒ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☐ DRY ☒ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-LX-206 (Alonzo)

SAMPLE I.D. S002-LX-206

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1345

SAMPLE COLLECTED BY C Lee

WEATHER CONDITIONS 80's, clear

FIELD USCS DESCRIPTIONS Brown fine sand

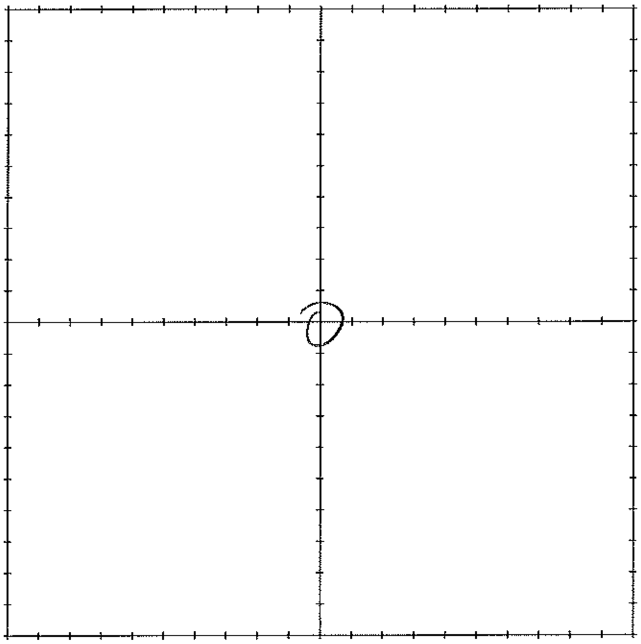
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☒ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☐ DRY ☒ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-LX-007 (Algo)

SAMPLE I.D. S002-LX-007

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1335

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 80's, Clear

FIELD USCS DESCRIPTIONS Brown sandy silt

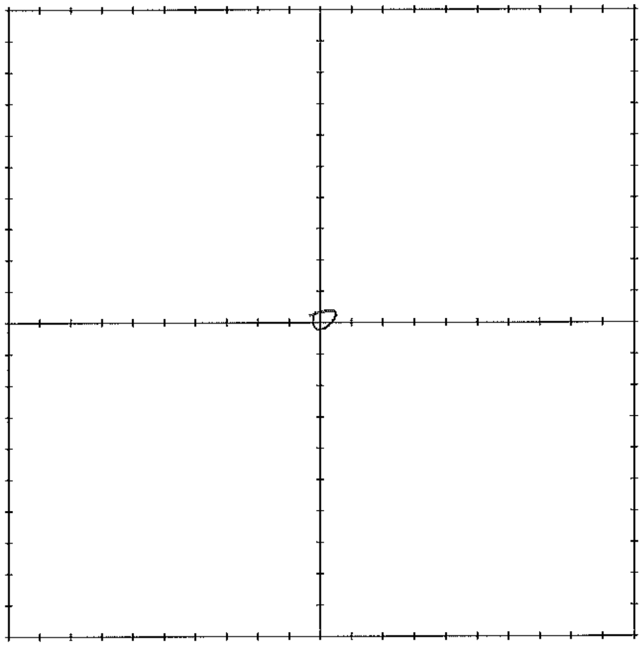
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☒ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziploc

ANALYSES: Ra-226; Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-LX-008 (Alonzo

SAMPLE I.D. S002-LX-008

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1034

SAMPLE COLLECTED BY J, Garvey

WEATHER CONDITIONS 80's, clear

FIELD USCS DESCRIPTIONS Red fine sand

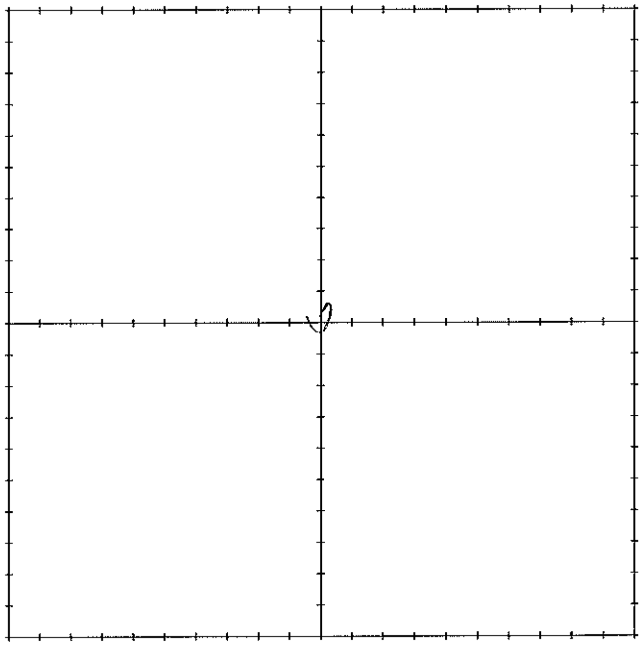
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☒ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S002-CX-009 (Alugo)

SAMPLE I.D. S002-CX-009

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1647

SAMPLE COLLECTED BY J. Garvey

WEATHER CONDITIONS 80's, clear

FIELD USCS DESCRIPTIONS Brown silt

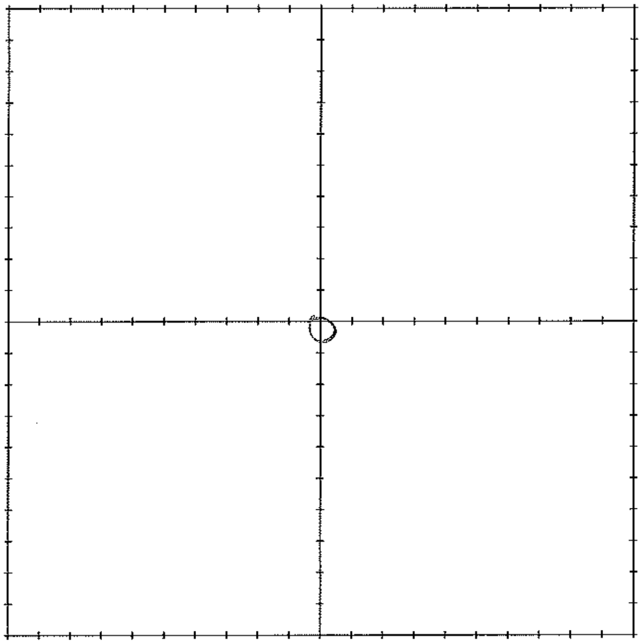
MAJOR DIVISIONS: ☐ OH ☐ CH ☑ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME 5002-LX-010 (Alamo)

SAMPLE I.D. 5002-LX-010

SAMPLE COLLECTION DATE 10/13/16

SAMPLE COLLECTION TIME 1706

SAMPLE COLLECTED BY J. Gorney

WEATHER CONDITIONS 80's, clear

FIELD USCS DESCRIPTIONS Brown silt, minor gray coarse particles (agg. frags)

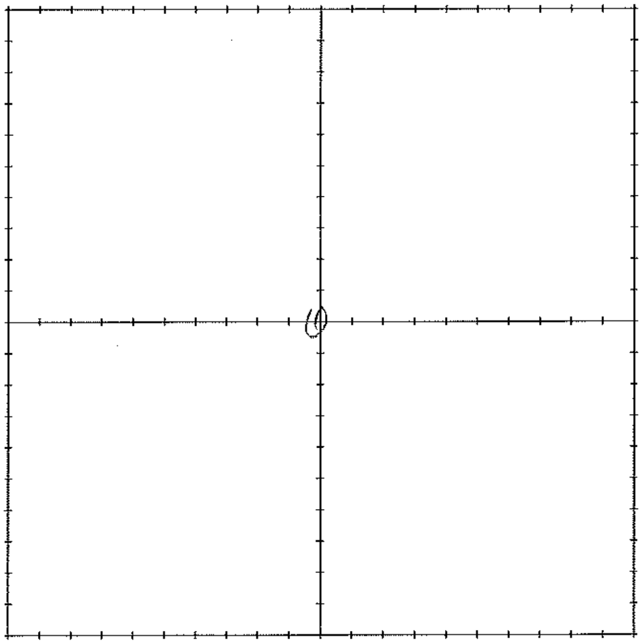
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☑ MINOR ☐ SOME; SAND SIZE ☐ FINE ☑ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziplock

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Alonzo (S002)

SAMPLE I.D. S002-CX-011, 211

SAMPLE COLLECTION DATE 5/19/17

SAMPLE COLLECTION TIME 1227

SAMPLE COLLECTED BY MW/CL

WEATHER CONDITIONS 80's, sunny

FIELD USCS DESCRIPTIONS Fine light brown sand

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

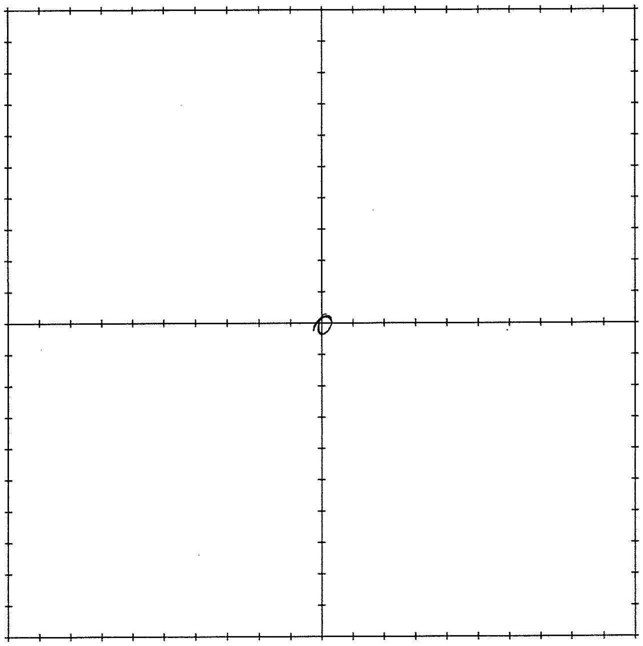
QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

MUNSELL COLOR —

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziplocs

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME [illegible] Alonzo (S220)

SAMPLE I.D. S220 - LX-012

SAMPLE COLLECTION DATE 5/20/17

SAMPLE COLLECTION TIME 1005

SAMPLE COLLECTED BY MW/CL

WEATHER CONDITIONS [illegible] 60's, sunny

FIELD USCS DESCRIPTIONS Fine red sand

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

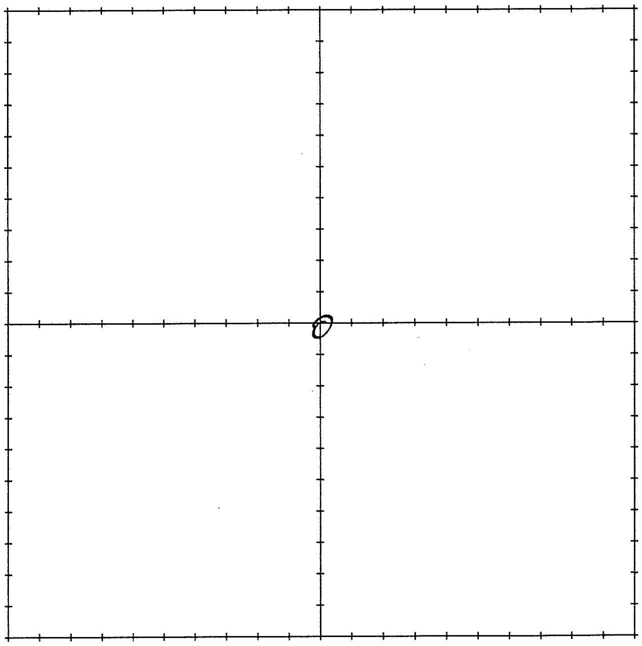
QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

MUNSELL COLOR —

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Alonzo (S002)

SAMPLE I.D. S002 - CX-013

SAMPLE COLLECTION DATE 5/20/17

SAMPLE COLLECTION TIME 1012

SAMPLE COLLECTED BY MW/CL

WEATHER CONDITIONS 60's, sunny

FIELD USCS DESCRIPTIONS Fine red sand

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

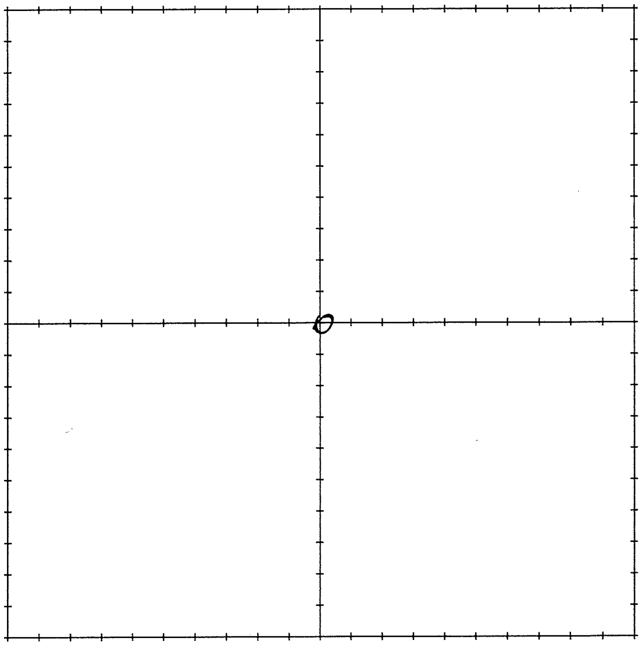
QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

MUNSELL COLOR —

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

C.2 Hand Auger Borehole Logs

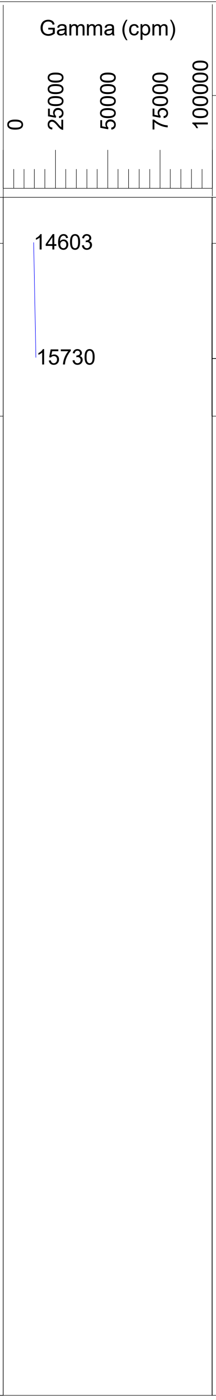
Stantec

NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S002-SCX-003 (BG-1)**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Alongo Mines

DRILLING CONTRACTOR: Stantec
DRILLING METHOD: Hand auger
DRILLING EQUIPMENT: Hand auger
SAMPLING METHOD: Regular hand auger, 3 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 677725.79
NORTHING: 4063987.4
DATE STARTED: 10/13/2016
DATE STARTED: 10/13/2016
TOTAL DEPTH (ft.): 0.75
BOREHOLE ANGLE: 90 degrees
LOGGED BY: Luis Rodriguez



DEPTH (feet)	LITHOLOGICAL DESCRIPTION	SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	SILTY SAND WITH GRAVEL (SM): gray.	S002-SCX-003-1	0-0.5	grab	1.54
		S002-SCX-003-2	0.5-0.75	grab	1.43
0.75	Terminated hand auger borehole at 0.75 ft. below ground surface. Refusal on bedrock.				
1					
2					
3					
4					
5					

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

Stantec

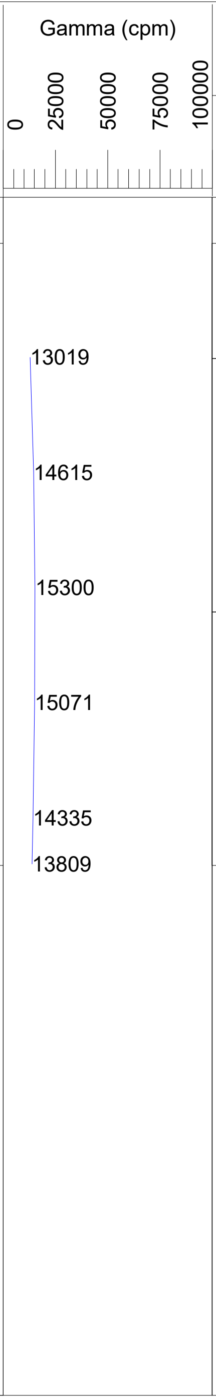
NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S002-SCX-004 (BG-2)**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Alongo Mines

DRILLING CONTRACTOR: Stantec
DRILLING METHOD: Hand auger
DRILLING EQUIPMENT: Hand auger
SAMPLING METHOD: Regular hand auger, 3 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 677694.67 NORTHING: 4063996.73
DATE STARTED: 10/13/2016 DATE STARTED: 10/13/2016
TOTAL DEPTH (ft.): 2.7 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Luis Rodriguez

DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION
0		POORLY GRADED SAND (SP): fine grained sand.
		Terminated hand auger borehole at 2.7 ft. below ground surface because gamma measurements were below initial background level. No refusal.



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S002-SCX-004-1	0-0.5	grab	0.52
S002-SCX-004-2	0.5-1.6	comp	0.96
S002-SCX-004-3	1.6-2.7	comp	0.77

Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

Stantec

NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S002-BG3-011**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Alongo Mines

DRILLING CONTRACTOR: Stantec
DRILLING METHOD: Hand auger
DRILLING EQUIPMENT: Hand auger
SAMPLING METHOD: Regular hand auger, 3 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 677795.18
NORTHING: 4064005.83
DATE STARTED: 8/28/2017
DATE STARTED: 8/28/2017
TOTAL DEPTH (ft.): 0.25
BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn

DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION	Gamma (cpm) 0 25000 50000 75000 100000	SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	▨	WELL GRADED SAND (SW): fine to coarse sand, brown, dry, loose.	9329 10370	S002-BG3-011	0-0.25	grab	2.89
		Terminated hand auger borehole at 0.25 ft. below ground surface. Refusal on hard sandstone.					
1							
2							
3							
4							
5							

Notes: cpm = counts per minute
pCi/g = picocuries per gram

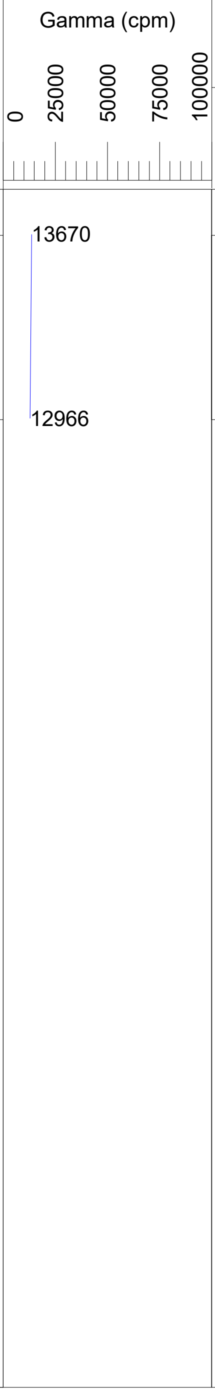
grab = grab sample
comp = composite sample

- - - - = approximate contact

BOREHOLE ID: **S002-SCX-001**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Alongo Mines

DRILLING CONTRACTOR: Stantec
DRILLING METHOD: Hand auger
DRILLING EQUIPMENT: Hand auger
SAMPLING METHOD: Regular hand auger, 3 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 677788.95 NORTHING: 4064192.62
DATE STARTED: 10/13/2016 DATE STARTED: 10/13/2016
TOTAL DEPTH (ft.): 0.8 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Luis Rodriguez



DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION	SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	▨	POORLY GRADED SAND (SP): fine grained sand.	S002-SCX-001	0-0.8	grab	0.95
		Terminated hand auger borehole at 0.8 ft. below ground surface. Refusal on hard surface.				
1						
2						
3						
4						
5						

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

Stantec

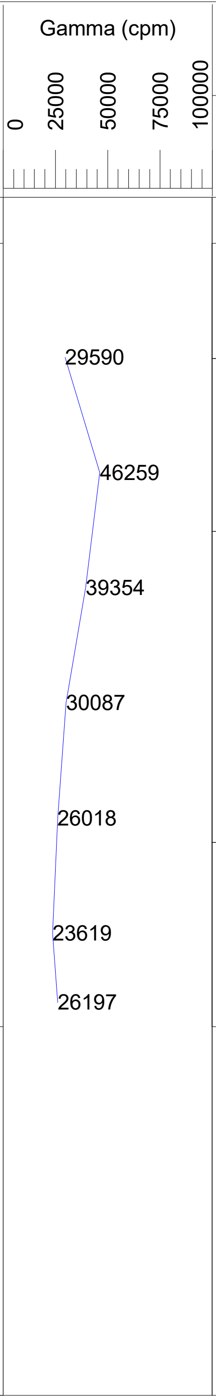
NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S002-SCX-002**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Alongo Mines

DRILLING CONTRACTOR: Stantec
DRILLING METHOD: Hand auger
DRILLING EQUIPMENT: Hand auger
SAMPLING METHOD: Regular hand auger, 3 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 677770.72 NORTHING: 4064149.39
DATE STARTED: 10/13/2016 DATE STARTED: 10/13/2016
TOTAL DEPTH (ft.): 3.4 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Luis Rodriguez

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0 – 3.4	POORLY GRADED SAND (SP): fine grained sand, trace silts.
3.4	Terminated hand auger borehole at 3.4 ft. below ground surface because gamma measurements were below initial background level. No refusal.



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE		LAB RESULTS RA-226 (pCi/g)
S002-SCX-002-1	0-0.5	grab	🟨	3.03
S002-SCX-002-2	0.5-1.25	grab	🟨	16.00
S002-SCX-002-3	1.25-2.6	comp	🟧	4.85
S002-SCX-002-4	2.6-3.4	grab	🟨	1.23

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

Stantec

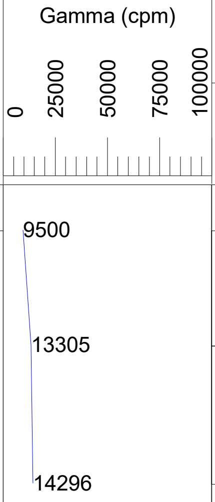
NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S002-SCX-005**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Alongo Mines

DRILLING CONTRACTOR: Stantec
DRILLING METHOD: Hand auger
DRILLING EQUIPMENT: Hand auger
SAMPLING METHOD: Regular hand auger, 3 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 677862.05
NORTHING: 4064314.17
DATE STARTED: 5/19/2017
DATE STARTED: 5/19/2017
TOTAL DEPTH (ft.): 1.25
BOREHOLE ANGLE: 90 degrees
LOGGED BY: Michael Ward

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0–1.25	POORLY GRADED SAND WITH GRAVEL (SP): brown and trace white, medium to coarse grained sand, subrounded to angular gravels, loose, moist, unconsolidated, with organics and roots.
1.25	Terminated hand auger borehole at 1.25 ft. below ground surface. Refusal on hard surface or rock.



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S002-SCX-005-1	0-0.5	grab	1.38
S002-SCX-005-2	0.5-1.1	grab	1.65

Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

Stantec

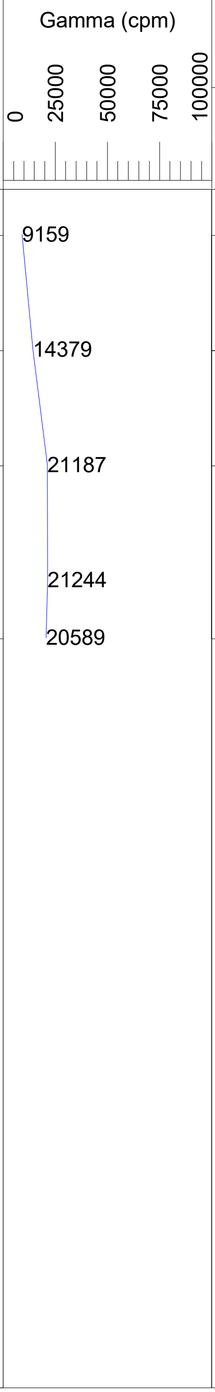
NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S002-SCX-006**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Alongo Mines

DRILLING CONTRACTOR: Stantec
DRILLING METHOD: Hand auger
DRILLING EQUIPMENT: Hand auger
SAMPLING METHOD: Regular hand auger, 3 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 677845.54
NORTHING: 4064368.23
DATE STARTED: 5/19/2017
DATE STARTED: 5/19/2017
TOTAL DEPTH (ft.): 1.75
BOREHOLE ANGLE: 90 degrees
LOGGED BY: Michael Ward

DEPTH (feet)	LITHOLOGICAL DESCRIPTION	SUBSURFACE SAMPLE INFORMATION			
		SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	POORLY GRADED SAND (SP): brown, medium grained, loose, unconsolidated, dry.	S002-SCX-006-1	0-0.5	grab	1.32
	moist.	S002-SCX-006-2	0.5-1	grab	4.46
1	with light gray.	S002-SCX-006-3	1-1.75	grab	3.20
	Terminated hand auger borehole at 1.75 ft. below ground surface. Refusal on hard rock.				
2					
3					
4					
5					



Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

Stantec

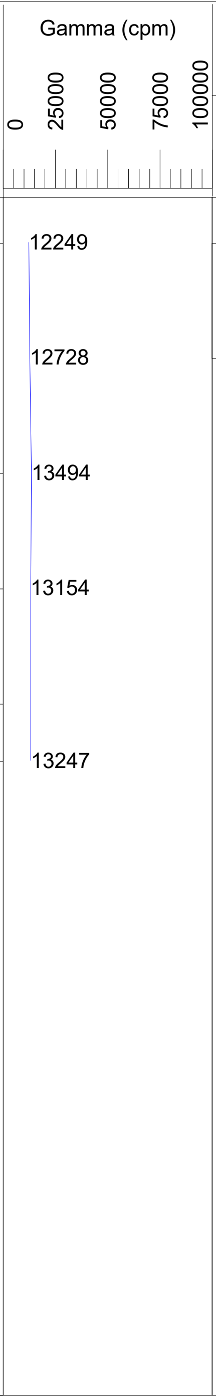
NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID:	**S002-SCX-007**
CLIENT:	NNAUMERT
PROJECT:	Removal Site Evaluation
SITE LOCATION:	Alongo Mines

DRILLING CONTRACTOR:	Stantec
DRILLING METHOD:	Hand auger
DRILLING EQUIPMENT:	Hand auger
SAMPLING METHOD:	Regular hand auger, 3 inch diameter

COORDINATE SYSTEM:		NAD 1983 UTM Zone 12N	
EASTING:	677770.99	NORTHING:	4064155.25
DATE STARTED:	5/20/2017	DATE STARTED:	5/20/2017
TOTAL DEPTH (ft.):	2.25	BOREHOLE ANGLE:	90 degrees
LOGGED BY:	Michael Ward		

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED SAND (SP): brown, medium grained, loose, soft, unconsolidated. Fluvial deposition environment on bank of Red Wash creek.
1	with few gravels.
1.5	medium grained sand, 100%
2	with gravels, rounded to subangular.
2.25	Terminated hand auger borehole at 2.25 ft. below ground surface due to consistently low gamma measurements.



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S002-SCX-007-1	0-0.5	grab	0.92

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

Stantec

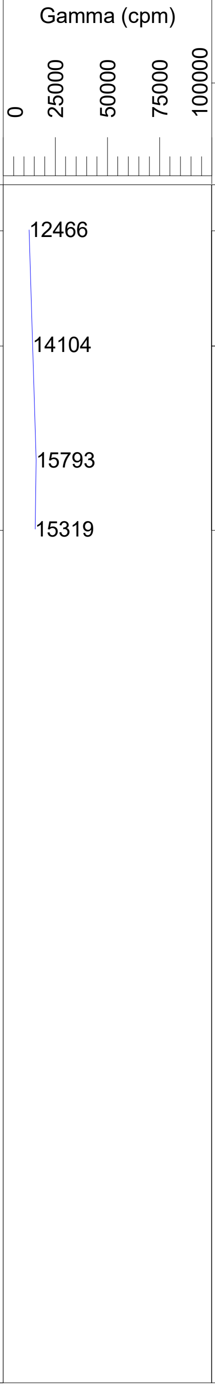
NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S002-SCX-008**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Alongo Mines

DRILLING CONTRACTOR: Stantec
DRILLING METHOD: Hand auger
DRILLING EQUIPMENT: Hand auger
SAMPLING METHOD: Regular hand auger, 3 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 677769.49
NORTHING: 4064177.27
DATE STARTED: 5/20/2017
DATE STARTED: 5/20/2017
TOTAL DEPTH (ft.): 1.3
BOREHOLE ANGLE: 90 degrees
LOGGED BY: Michael Ward

DEPTH (feet)	LITHOLOGICAL DESCRIPTION	SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	SAND WITH GRAVEL AND SILT (SP-SM): brown, gray, sands, gravels are assorted colors including white, gray green, loose, unconsolidated. Fluvial deposition in creek bed.	S002-SCX-008-1	0-0.5	grab	0.71
	increasing gravel gradation.	S002-SCX-008-2	0.5-1.3	grab	0.85
1					
	Terminated hand auger borehole at 1.3 ft. below ground surface. Refusal on hard rock.				
2					
3					
4					
5					



Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

Stantec

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

BOREHOLE ID: **S002-SCX-009**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Alongo Mines

DRILLING CONTRACTOR: Stantec
DRILLING METHOD: Hand auger
DRILLING EQUIPMENT: Hand auger
SAMPLING METHOD: Regular hand auger, 3 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 677778.77 NORTHING: 4064204.87
DATE STARTED: 5/20/2017 DATE STARTED: 5/20/2017
TOTAL DEPTH (ft.): 0.5 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Michael Ward

DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION	Gamma (cpm) 0 25000 50000 75000 100000	SUBSURFACE SAMPLE INFORMATION SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	▒	SILTY SAND (SM): dark red, brown, fine to medium grained sand, loose, soft, unconsolidated, wet. Borehole location in creek bed of Red Wash Creek.		No Sample	0-0.5		No sample collected. No results.
		Terminated hand auger borehole at 0.5 ft. below ground surface. Borehole terminated due to saturated caving sands.	11465				
1							
2							
3							
4							
5							

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

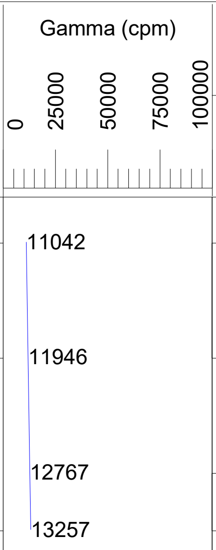
Stantec

NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID:	**S002-SCX-010**
CLIENT:	NNAUMERT
PROJECT:	Removal Site Evaluation
SITE LOCATION:	Alongo Mines

DRILLING CONTRACTOR:	Stantec
DRILLING METHOD:	Hand auger
DRILLING EQUIPMENT:	Hand auger
SAMPLING METHOD:	Regular hand auger, 3 inch diameter

COORDINATE SYSTEM:		NAD 1983 UTM Zone 12N	
EASTING:	677782.62	NORTHING:	4064240.83
DATE STARTED:	5/20/2017	DATE STARTED:	5/20/2017
TOTAL DEPTH (ft.):	1.25	BOREHOLE ANGLE:	90 degrees
LOGGED BY:	Michael Ward		



DEPTH (feet)	LITHOLOGICAL DESCRIPTION	Gamma (cpm)	SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	SILTY SAND (SM): medium grained sand, loose, soft, unconsolidated, moist to wet. Fluvial environment adjacent to Red Wash creek.	11042	S002-SCX-010-1	0-0.5	grab	0.60
	- - - - increasing gravel gradation, gravels 30%, assorted colors red, green, white, well rounded to subangular.	11946				
1		12767	S002-SCX-010-2	1-1.25	grab	0.74
		13257				
	Terminated hand auger borehole at 1.25 ft. below ground surface. Refusal on hard rock.					
2						
3						
4						
5						

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

BOREHOLE ID: **S002-SCX-011**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Alongo Mines

DRILLING CONTRACTOR:	Stantec	COORDINATE SYSTEM:	NAD 1983 UTM Zone 12N
DRILLING METHOD:	Hand auger	EASTING: 677773.97	NORTHING: 4064284.65
DRILLING EQUIPMENT:	Hand auger	DATE STARTED: 5/20/2017	DATE STARTED: 5/20/2017
SAMPLING METHOD:	Regular hand auger, 3 inch diameter	TOTAL DEPTH (ft.): 0.75	BOREHOLE ANGLE: 90 degrees
		LOGGED BY: Michael Ward	

DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION	Gamma (cpm) 0 25000 50000 75000 100000	SUBSURFACE SAMPLE INFORMATION SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	⁙	SILTY SAND (SM): brown, medium grained sand, loose, soft, unconsolidated, moist to wet. Fluvial depositional environment adjacent to Red Wash creek.	10344				
			12156	S002-SCX-011-1	0-0.5	grab	1.12
		increasing gravel gradation, well rounded to subangular.	15730				
			12476				
		Terminated hand auger borehole at 0.75 ft. below ground surface. Refusal on hard rock.					
1							
2							
3							
4							
5							

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

Stantec

NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S002-SCX-012**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Alongo Mines

DRILLING CONTRACTOR: Stantec
DRILLING METHOD: Hand auger
DRILLING EQUIPMENT: Hand auger
SAMPLING METHOD: Regular hand auger, 3 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 677879.03
NORTHING: 4064196.64
DATE STARTED: 9/13/2017
DATE STARTED: 9/13/2017
TOTAL DEPTH (ft.): 0.5
BOREHOLE ANGLE: 90 degrees
LOGGED BY: Michael Ward

DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION	Gamma (cpm) 0 25000 50000 75000 100000	SUBSURFACE SAMPLE INFORMATION SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	▨	POORLY GRADED SAND WITH GRAVEL (SP): very pale brown (10 YR 7/4), fine to medium grained sand 85%, loose, unconsolidated, gravels are fine to coarse, subangular to angular, white, dry.	9622 9682	S002-SCX-012	0-0.5	grab 🟨	1.29
		Terminated hand auger borehole at 0.5 ft. below ground surface. Refusal on hard rock.					
1							
2							
3							
4							
5							

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

Stantec

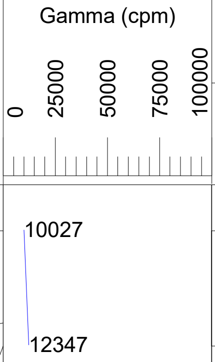
NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID:	**S002-SCX-013**
CLIENT:	NNAUMERT
PROJECT:	Removal Site Evaluation
SITE LOCATION:	Alongo Mines

DRILLING CONTRACTOR:	Stantec
DRILLING METHOD:	Hand auger
DRILLING EQUIPMENT:	Hand auger
SAMPLING METHOD:	Regular hand auger, 3 inch diameter

COORDINATE SYSTEM:		NAD 1983 UTM Zone 12N	
EASTING:	677855.09	NORTHING:	4064191.53
DATE STARTED:	9/13/2017	DATE STARTED:	9/13/2017
TOTAL DEPTH (ft.):	0.5	BOREHOLE ANGLE:	90 degrees
LOGGED BY:	Michael Ward		

DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION	Gamma (cpm)	SUBSURFACE SAMPLE INFORMATION			
				SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0		POORLY GRADED SAND WITH GRAVEL (SP): very pale brown (10 YR 7/4), fine to medium grained sand 90%, loose, unconsolidated, gravels 10% are subangular to angular, white, dry.	10027	S002-SCX-013	0-0.5	grab	1.86
		POORLY GRADED GRAVEL (GP): Sand become trace, color change to very pale brown (10 YR 8/3), possible weak calcium carbonate cementation.	12347				
		Terminated hand auger borehole at 0.5 ft. below ground surface. Refusal on hard sandstone.					
1							
2							
3							
4							
5							



Notes: cpm = counts per minute
pCi/g = picocuries per gram

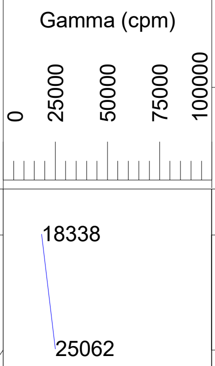
grab = grab sample
comp = composite sample

- - - - = approximate contact

BOREHOLE ID:	**S002-SCX-014**
CLIENT:	NNAUMERT
PROJECT:	Removal Site Evaluation
SITE LOCATION:	Alongo Mines

DRILLING CONTRACTOR:	Stantec
DRILLING METHOD:	Hand auger
DRILLING EQUIPMENT:	Hand auger
SAMPLING METHOD:	Regular hand auger, 3 inch diameter

COORDINATE SYSTEM:		NAD 1983 UTM Zone 12N	
EASTING:	677828.61	NORTHING:	4064098.9
DATE STARTED:	9/13/2017	DATE STARTED:	9/13/2017
TOTAL DEPTH (ft.):	0.5	BOREHOLE ANGLE:	90 degrees
LOGGED BY:	Michael Ward		



DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION	Gamma (cpm)	SUBSURFACE SAMPLE INFORMATION			
				SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0		POORLY GRADED SAND (SP) very pale brown (10 YR 7/4) and some light greenish gray (1 GLEY 7/1), fine to medium grained sand, 98% sands, 2% gravels, some roots, dry, loose. Some mixed greenish gray sand eroded from base of sandstone outcrops to the north of borehole.	18338	S002-SCX-014	0-0.5	grab	4.92
		Terminated hand auger borehole at 0.5 ft. below ground surface. Refusal on hard sandstone.	25062				
1							
2							
3							
4							
5							

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

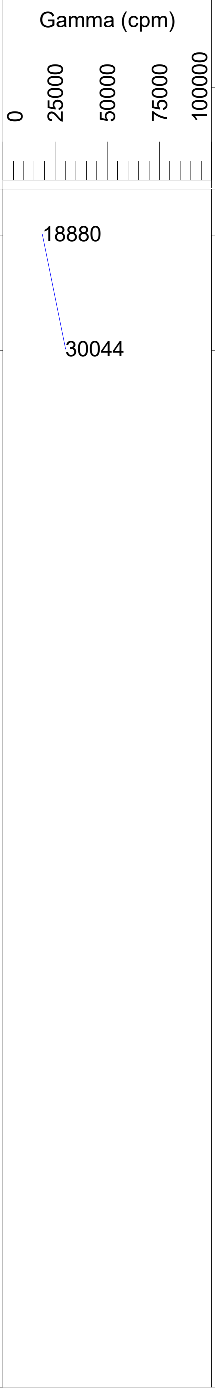
- - - - = approximate contact

BOREHOLE ID:	**S002-SCX-015**
CLIENT:	NNAUMERT
PROJECT:	Removal Site Evaluation
SITE LOCATION:	Alongo Mines

DRILLING CONTRACTOR:	Stantec
DRILLING METHOD:	Hand auger
DRILLING EQUIPMENT:	Hand auger
SAMPLING METHOD:	Regular hand auger, 3 inch diameter

COORDINATE SYSTEM:		NAD 1983 UTM Zone 12N	
EASTING:	677833.15	NORTHING:	4064071.86
DATE STARTED:	9/13/2017	DATE STARTED:	9/13/2017
TOTAL DEPTH (ft.):	0.5	BOREHOLE ANGLE:	90 degrees
LOGGED BY:	Michael Ward		

DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION
0	▨	POORLY GRADED SAND (SP) very pale brown (10 YR 7/4) with trace white and light greenish gray (1 GLEY 8/1) fine to medium grained 98%, loose, dry. Mixture of Eolian and Alluvial sand.
0.5		Terminated hand auger borehole at 0.5 ft. below ground surface. Refusal on hard sandstone.
1		
2		
3		
4		
5		



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S002-SCX-015	0-0.5	grab	6.99

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

Appendix D Evaluation of RSE Data

D.1 Background Reference Area Selection

D.2 Statistical Evaluation

BACKGROUND REFERENCE AREA SELECTION

1.0 INTRODUCTION

This appendix presents the rationale for selection of the background reference areas for the Alongo Mines Site (Site). To select the background reference areas for the Site, personnel considered geology, predominant wind direction, distance from the Site, hydrologic influence, similarities of vegetation and ground cover, and visual evidence of impacts due to mining (or other anthropogenic sources) in accordance with the *Multi-Agency Radiation Survey and Site Investigation Manual – Appendix A* ([MARSSIM] USEPA, 2000).

2.0 POTENTIAL BACKGROUND REFERENCE AREAS

The potential background reference area study was initiated during the Site Clearance desktop study and field investigations. Two potential background reference areas (BG-1 and BG-2) were initially identified to represent the two geologic formations at the Site where mining-impacted material was assumed to be present, the Salt Wash Member of the Morrison Formation (the Morrison Formation) on the mesa sidewall (BG-1) and the Quaternary deposits in Red Wash (BG-2), as shown on Figure D.1-1. Bluff Sandstone is present at the base of the mesa sidewall within the Site with approximately five to 10 feet (ft) of exposure between the Morrison Formation and the Quaternary deposits; colluvial material from the Morrison Formation covers a majority of the Bluff Sandstone. A potential background reference area was not identified to represent the Bluff Sandstone due to the limited outcropping of the unit. The surface gamma surveys at BG-1 and BG-2 were completed in May 2016 and the soil/sediment samples were collected in October 2016.

Following review of data collected at BG-1 and the Site, it was determined that mining-related disturbance may also be present on the mesa top where the ground appears disturbed on the mesa top directly above the locations of the portals on the mesa sidewall. It was also identified that surface gamma survey measurements collected at BG-1 were potentially not representative of the mesa top. Therefore, one additional potential background reference area (BG-3) was identified within the Morrison Formation on the mesa top; a gamma survey was conducted in May 2017 and soil samples were collected in August 2017. It was determined that BG-1 would not be used to represent the Site, but it would be included in the RSE for comparison purposes, as described in Section 3.0 below.

The locations of the three potential background reference areas (BG-1, BG-2, and BG-3) are shown along with the site geology, locations of the mine portals, and predominant wind direction in Figure D.1-1. The potential background reference areas are described below.

- BG-1 encompasses an area of 644 ft^2 (approximately 0.01 acres), is located 380 ft south of the claim boundary, and is cross-wind and hydrologically cross-gradient from the Site. The colluvium-covered slopes and bedrock outcrops represent the mesa sidewall area of the Site where mining occurred, and are the same geologic unit, the Morrison Formation. The vegetation and ground cover at BG-1 are similar to the Site.

- BG-2 encompasses an area of 838 ft^2 (approximately 0.02 acres), is located 330 ft south of the claim boundary, and is cross-wind and hydrologically upgradient from the Site. The alluvial sediments and valley bottom Quaternary deposits represent the areas downslope of the mine portals on the mesa sidewall and the area within the wash. The vegetation and ground cover at BG-2 are similar to the Site.

- BG-3 encompasses an area of 2,755 ft^2 (approximately 0.06 acres), is located 410 ft south of the claim boundary, and is cross-wind and hydrologically cross-gradient from the Site. The thin soils and bedrock outcrops represent the mesa top and mesa sidewall portions of the Site, and are the same geologic unit, the Morrison Formation. The vegetation and ground cover at BG-3 are similar to the Site.

The potential background reference area evaluation included surface gamma surveys, surface static gamma measurements, subsurface static gamma measurements, and collecting surface soil/sediment samples and subsurface soil/sediment samples, as described below.

- BG-1: 11 surface soil grab samples were collected from 11 locations; one subsurface soil grab sample and surface and subsurface static gamma measurements were collected from borehole location S002-SCX-003

- BG-2: 11 surface sediment grab samples were collected from 11 locations; two subsurface composite sediment samples and subsurface static gamma measurements were collected from borehole location S002-SCX-004

- BG-3: 11 surface soil grab samples were collected from 11 locations; a borehole could not be advanced beyond 0.5 ft at S002-BG3-011 due to refusal on bedrock, so no subsurface samples were collected at BG-3; surface and subsurface static gamma measurements were collected from borehole location S002-BG3-011

The sample locations and surface gamma survey data for BG-1, BG-2, and BG-3 are shown in Figure D.1-2. Samples were categorized as surface soil/sediment samples where sample depths were up to 0.5 ft bgs and as subsurface samples where sample depths were greater than 0.5 ft bgs, and static gamma measurements were categorized as subsurface where static gamma was measured at or greater than 0.1 ft bgs. Table 4-1 in the RSE report provides the results of the sample analyses, and Tables D.1-1 and D.1-2 provide descriptive statistics for the metals/Ra-226 concentrations and the surface gamma measurements, respectively. Field forms, including borehole logs, are provided in Appendix C of the RSE report.

The equipment used for the surface gamma survey were also used for static one-minute gamma measurements at the ground surface and for subsurface gamma measurements at borehole locations. Soil samples, sediment samples, and gamma measurements were collected according to the methods described in the *Removal Site Evaluation Work Plan* (MWH, 2016).

3.0 SELECTION OF BACKGROUND REFERENCE AREA

Background reference areas were needed to represent the two major formations present at the Site where disturbances may have occurred: BG-1 and BG-3 were representative of the Morrison Formation, and BG-2 was representative of the Quaternary deposits. BG-3 was selected over BG-1 to represent the Morrison Formation because radiological conditions in BG-1 were not representative of some areas of the Site (e.g., on the mesa top). However, BG-1 does provide a valuable comparison to BG-3 regarding the variation in gamma measurements that may occur in background areas and the heterogeneity present within the Morrison Formation. As a result, BG-1 is included in the RSE report for discussion purposes. Gamma survey measurements, soil and sediment sample results, and subsurface static gamma measurements collected from BG-2 and BG-3 were used for the remainder of the Removal Site Evaluation of the Site.

4.0 REFERENCES

MWH, 2016. *Navajo Nation AUM Environmental Response Trust – First Phase Removal Site Evaluation Work Plan*. October.

USEPA, 2000. *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM), EPA 402-R-97-016, Rev. 1.

Table D.1-1
Soil and Sediment Sampling Summary
Alongo Mines
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 2

Statistic	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Uranium (mg/kg)	Vanadium (mg/kg)	Radium-226 (pCi/g)
Background Reference Area Study - Background Area 1 - Morrison Formation						
Total Number of Observations	10	10	10	10	10	10
Percent Non-Detects	--	20%	100%	--	--	--
Minimum[1]	1.50	--	--	1.60	7.20	1.50
Minimum Detect[2]	--	0.210	--	--	--	--
Mean[1]	1.95	--	--	1.97	9.43	1.95
Mean Detects[2]	--	0.295	--	--	--	--
Median[1]	1.70	--	--	1.85	8.70	2.04
Median Detects[2]	--	0.295	--	--	--	--
Maximum[1]	3.00	--	--	2.70	12.0	2.23
Maximum Detect[2]	--	0.360	--	--	--	--
Distribution	Normal	Normal	Not Calculated	Normal	Normal	Normal
Coefficient of Variation[1]	0.277	--	--	0.207	0.181	0.117
CV Detects[2]	--	0.147	--	--	--	--
UCL Type	95% Student's-t UCL	95% KM (t) UCL	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL
UCL Result	2.26	0.311	Not Calculated	2.21	10.4	2.08
UTL Type	UTL Normal	UTL KM Normal	Not Calculated	UTL Normal	UTL Normal	UTL Normal
UTL Result	3.52	0.559	Not Calculated	3.16	14.4	2.61
Background Reference Area Study - Background Area 2 - Quaternary Deposit						
Total Number of Observations	11	11	11	11	11	11
Percent Non-Detects	--	100%	100%	--	--	--
Minimum[1]	0.740	--	--	0.240	4.20	0.420
Minimum Detect[2]	--	--	--	--	--	--
Mean[1]	0.908	--	--	0.311	5.30	0.605
Mean Detects[2]	--	--	--	--	--	--
Median[1]	0.860	--	--	0.290	5.10	0.590
Maximum[1]	1.20	--	--	0.470	7.60	0.810
Maximum Detect[2]	--	--	--	--	--	--
Distribution	Normal	Not Calculated	Not Calculated	Normal	Normal	Normal
Coefficient of Variation[1]	0.163	--	--	0.258	0.206	0.200
UCL Type	95% Student's-t UCL	Not Calculated	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL
UCL Result	0.989	Not Calculated	Not Calculated	0.355	5.90	0.671
UTL Type	UTL Normal	Not Calculated	Not Calculated	UTL Normal	UTL Normal	UTL Normal
UTL Result	1.33	Not Calculated	Not Calculated	0.537	8.37	0.944

Table D.1-1
Soil and Sediment Sampling Summary
Alongo Mines
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase

Statistic	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Uranium (mg/kg)	Vanadium (mg/kg)	Radium-226 (pCi/g)
Background Reference Area Study - Background Area 3 - Morrison Formation						
Total Number of Observations	11	11	11	11	11	11
Percent Non-Detects	--	91%	100%	--	--	--
Minimum[1]	1.60	--	--	1.40	4.70	0.840
Minimum Detect[2]	--	0.380	--	--	--	--
Mean[1]	2.33	--	--	2.41	7.26	1.82
Mean Detects[2]	--	0.380	--	--	--	--
Median[1]	2.00	--	--	2.10	7.10	1.63
Maximum[1]	3.70	--	--	4.70	10.0	3.58
Maximum Detect[2]	--	0.380	--	--	--	--
Distribution	Normal	Not Calculated	Not Calculated	Normal	Normal	Gamma
Coefficient of Variation[1]	0.305	--	--	0.449	0.224	0.425
UCL Type	95% Student's-t UCL	Not Calculated	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% Adjusted Gamma UCL
UCL Result	2.72	Not Calculated	Not Calculated	3.00	8.15	2.37
UTL Type	UTL Normal	Not Calculated	Not Calculated	UTL Normal	UTL Normal	UTL Gamma WH
UTL Result	4.33	Not Calculated	Not Calculated	5.460	11.8	4.48

Notes

CV	Coefficient of variation
KM	Kaplan Meier
mg/kg	Milligrams per kilogram
--	Not applicable
pCi/g	Picocuries per gram
WH	Wilson Hilferty

[1] This statistic is reported by ProUCL when the dataset contains 100 percent detections.

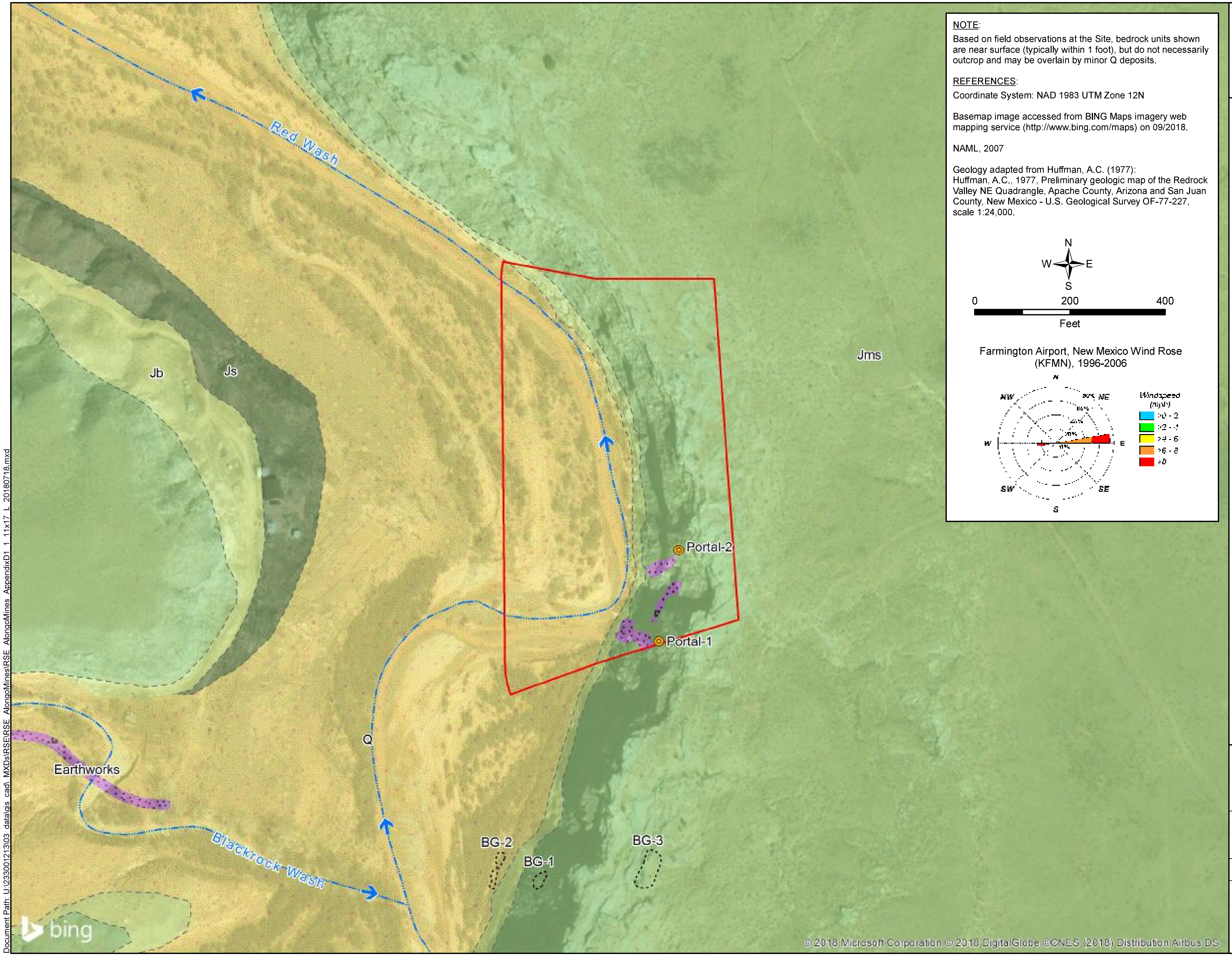
[2] This statistic is reported by ProUCL when non-detect values exist in the dataset. The value reported is calculated using detections only.

Table D.1-2
Surface Gamma Survey Summary
Alongo Mines
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 1

Geologic Formation	Background Reference Area 1 (BG-1) Morrison Formation	Background Reference Area 2 (BG-2) Quaternary Deposit	Background Reference Area 3 (BG-3) Morrison Formation
Statistic			
Total Number of Observations	874	199	444
Minimum	9,261	7,889	7,147
Mean	13,050	10,851	9,675
Median	12,706	10,616	9,472
Maximum	22,114	15,166	14,331
Distribution	Normal	Normal	Normal
Coefficient of Variation	0.141	0.112	0.117
UCL Type	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL
UCL Result	13,152	10,994	9,764
UTL Type	UTL Normal	UTL Normal	UTL Normal
UTL Result	16,235	13,088	11,686

Notes

cpm	Counts per minute
UCL	Upper confidence limit
UTL	Upper tolerance limit



NOTE:
Based on field observations at the Site, bedrock units shown are near surface (typically within 1 foot), but do not necessarily outcrop and may be overlain by minor Q deposits.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

NAML, 2007

Geology adapted from Huffman, A.C. (1977):
Huffman, A.C., 1977, Preliminary geologic map of the Redrock Valley NE Quadrangle, Apache County, Arizona and San Juan County, New Mexico - U.S. Geological Survey OF-77-227, scale 1:24,000.

Farmington Airport, New Mexico Wind Rose (KFMN), 1996-2006

NAVAJO NATION
AUM Environmental Response Trust

LEGEND

◉	Portal
↑	Flow Direction
⌇	Drainage
⬚	Potential Background Reference Area
🟥	Claim Boundary
╌	Geologic Contact (Inferred)

Site Geology

HOLOCENE

▨	Earthworks: Human-caused disturbance of the land surface
▨	Q: Quaternary Deposits – Undifferentiated (Pleistocene and Holocene) – includes sandy to gravelly colluvial and alluvial deposits, and eolian sand deposits.

JURASSIC

🟩	Jms: Salt Wash Member of the Morrison Formation (Upper Jurassic) – Yellowish gray to greenish-gray cross-bedded very fine to medium-grained calcareous sandstone inter-bedded with greenish-gray and reddish-brown claystone.
🟩	Jb: Bluff Sandstone (Upper Jurassic)- Moderate reddish-orange to light-brown, fine to medium grained laminated sandstone.
🟩	Js: Summerville Formation (Upper Jurassic) – Reddish-brown to light-orange very fine- to fine-grained flat bedded silty sandstone and thin-bedded silty sandstone, claystone, and siltstone; forms banded steep slopes and cliffs.

TITLE:

Geologic Map and Potential Background Reference Areas

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/24/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: EDZ
REVIEWER: CBB
FIGURE: D.1-1

Stantec

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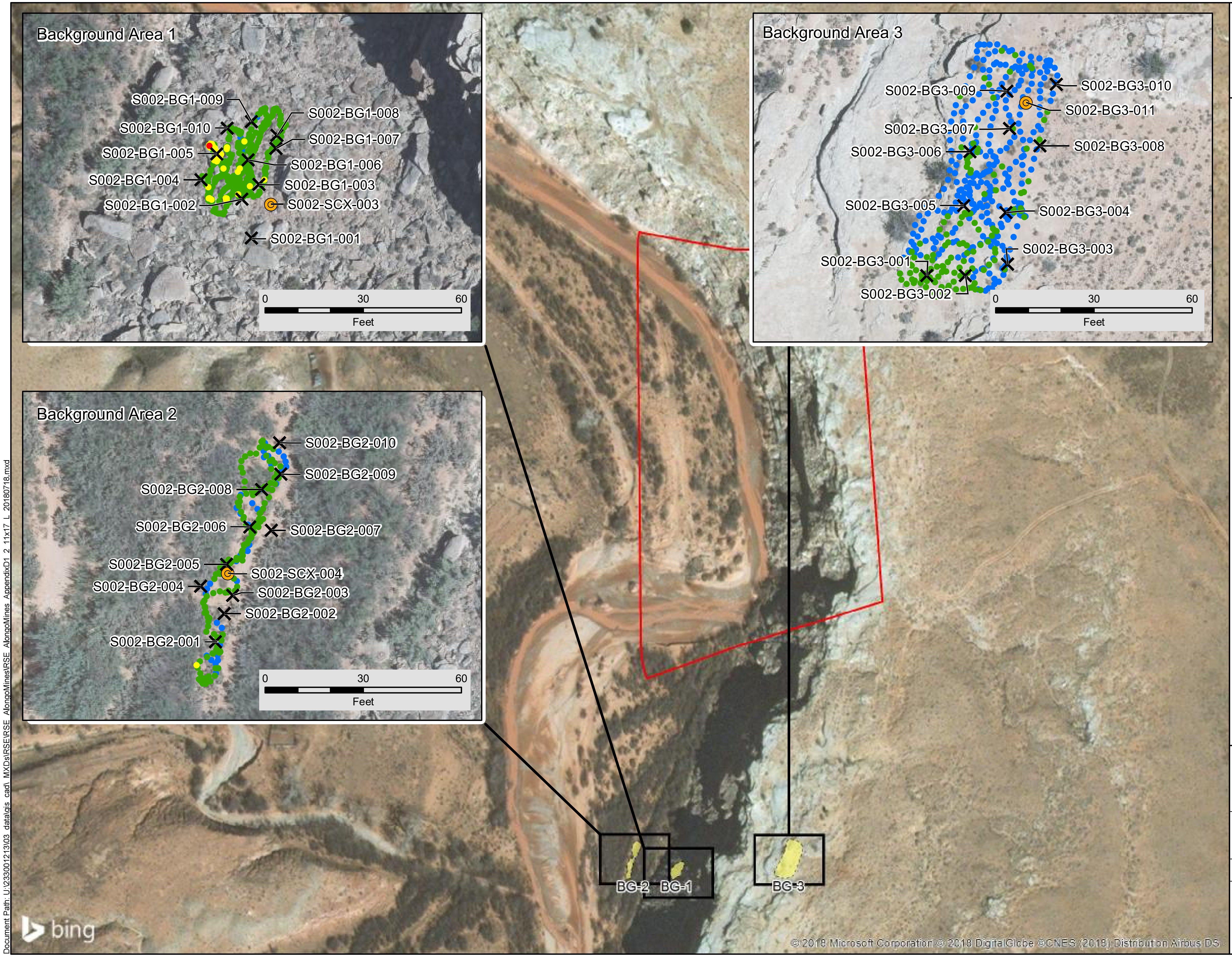


NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Subsurface Borehole Location for Background Reference
▨	Potential Background Reference Area
▭	Claim Boundary

Gamma Survey Area

Counts per Minute (CPM)

●	7,147 - 10,000
●	10,001 - 15,000
●	15,001 - 20,000
●	20,001 - 22,114

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Main display basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 09/2018.

Basemap image insets flown by Cooper Aerial Surveys Co. on June 16, 2017.

N
W E
S

0 200 400
Feet

TITLE:
Potential Background Reference Area
Gamma Radiation Survey Results and
Soil Sample Locations

PROJECT:
Removal Site Evaluation
Alongo Mines Site

DATE: 9/24/2018

DOCUMENT NAME: Removal Site Evaluation Report

AUTHOR: EDZ

REVIEWER: CBB

Stantec

FIGURE: D.1-2

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE AlongoMines\RSE AlongoMines AppendixD1 2 11x17 L 20180718.mxd

STATISTICAL EVALUATION

1.0 INTRODUCTION

This statistical evaluation presents the methods used in, and results of, statistical analyses performed on gamma radiation survey results and soil sample analytical results collected from the Alongo Mines Site (Site). The evaluation includes comparing background reference area and Survey Area data distributions, and documents the decision process followed to select site-specific investigation levels (ILs). The ILs are used to confirm contaminants of potential concern (COPCs) listed in the *RSE Work Plan*, and to support identification of technologically enhanced naturally occurring radioactive materials (TENORM) at the Site.

2.0 EVALUATIONS

The evaluation process included compiling the results for gamma radiation surveys and soil sample analytical results from three potential background reference areas and two Survey Areas. These areas are designated Background Reference Area 1 (BG-1), Background Reference Area 2 (BG-2), Background Reference Area 3 (BG-3), Survey Area A, and Survey Area B. The Background Reference Areas BG-1, BG-2 and BG-3 were selected to represent the Site’s natural conditions as described in Appendix D.1. The gamma radiation survey data and soil sample analytical results for the background reference areas and Survey Areas were evaluated to determine the appropriate ILs for the Site as follows:

1. Identify and examine potential outlier values. Potential outlier values were identified statistically and, if justified upon further examination, removed from a dataset prior to further evaluation and calculations. No data were removed from the dataset for the calculations presented in this appendix.

2. Compare data populations between Survey Area A and BG-2, and between Survey Area B and both BG-1 and BG-3 (box plots, probability plots, hypothesis testing with Wilcoxon Mann-Whitney test). Soil sample and gamma radiation survey results were compared between Survey Area A and BG-2 and Survey Area B and both BG-1 and BG-3 qualitatively and quantitatively to evaluate similarity or difference in data distributions between the areas, and as a component of evaluating background area adequacy and representativeness.

3. Develop descriptive statistics. Descriptive statistics for gamma survey results and soil sample analytical results (e.g., number of observations, mean, maximum, median, etc.) were generated to facilitate qualitative comparisons of soil sample and gamma radiation survey results from one area to another.

4. Select ILs for the Site based on the results of the statistical evaluations.

3.0 RESULTS

The following sections present the evaluation of potential outlier values in the dataset, calculated descriptive statistics, and comparison of data populations between groups in support of determining ILs for use at the Site.

3.1 POTENTIAL OUTLIER VALUES

A potential outlier is a data point within a random sample of a population that is different enough from the majority of other values in the sample as to be considered potentially unrepresentative of the population, and therefore requires further inspection and evaluation. Unrepresentative values in a dataset have potential to yield distorted estimates of population parameters of interest (e.g., means, upper confidence limits, upper percentiles). Therefore, potential outliers in the Site data were evaluated further prior to performing data comparisons (Section 3.2) and developing the descriptive statistics (Section 3.3). In the context of this statistical evaluation, extreme values and statistical outliers are referred to as potential outliers.

A potential outlier value in a sample may be a true representative value in the test population (not a ‘discrepant’ value), simply representing a degree of inherent variation present in the population. Furthermore, a statistical determination of one or more potential outliers does not indicate that the measurements are actually discrepant from the rest of the data set. Therefore, general statistical guidance does not recommend that extreme values (potential outliers) be removed solely on a statistical basis. Statistical outlier tests can provide supportive information, but a reasonable scientific rationale needs to be identified for removal of any potential outlier values (e.g., sampling error, records error, or the potential outlier is determined to violate underlying assumptions of the sampling design, such as the targeted geology).

In the background reference areas, soil samples were collected randomly. Potential outliers in the BG-1, BG-2, and BG-3 datasets were examined using box plots, probability plots, and statistical testing. Descriptive statistics were then calculated with and without the potential outliers, as applicable. Finally, the potential outlier values were evaluated to determine if a reason could be found to remove the data points before calculating the final statistics. The results of these evaluations are described in the following sections.

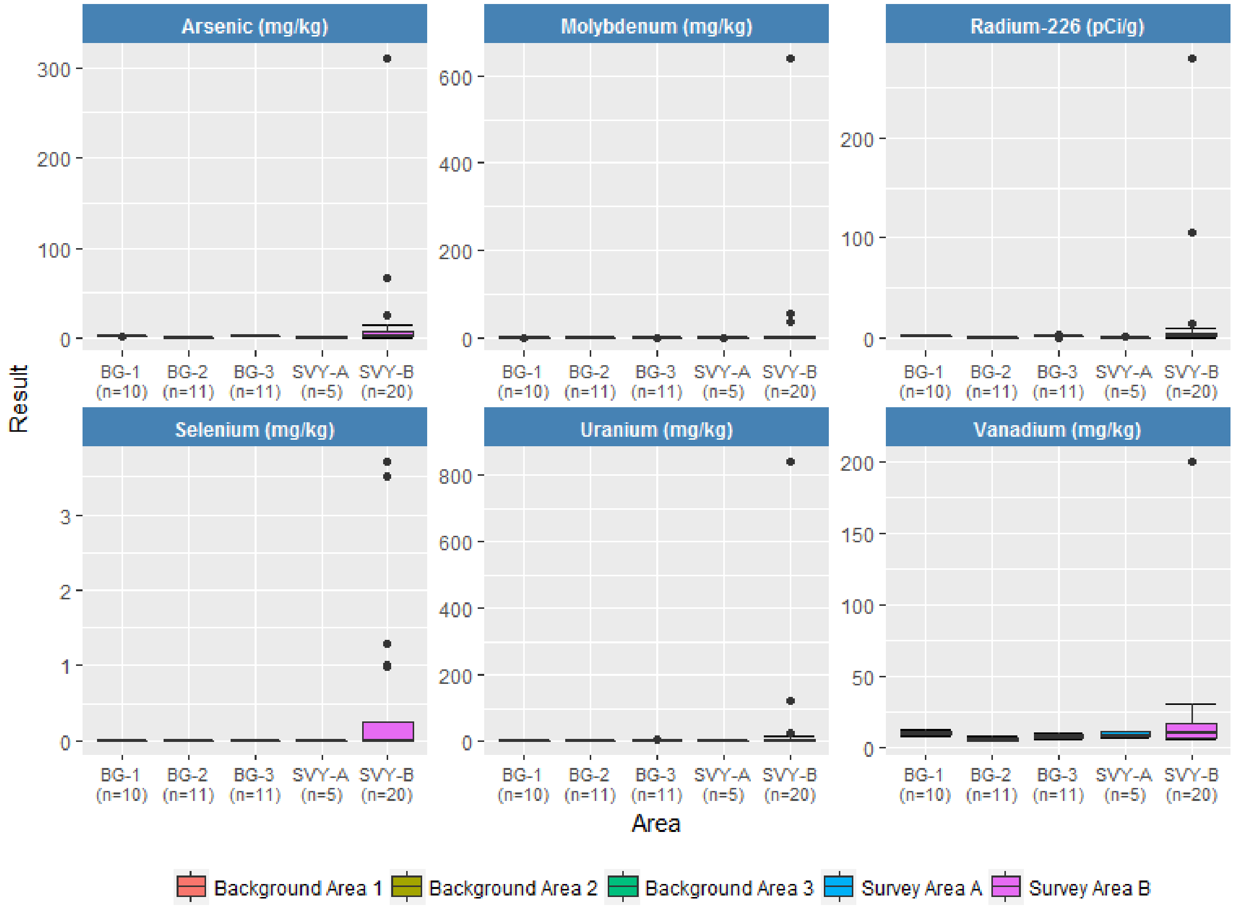
In the Survey Areas at Alongo Mines, soil samples were collected using a judgmental sampling approach. Specifically, some sample locations were selected to characterize areas of higher gamma radiation and, as a result, potential outlier values are not unexpected in the Survey Area sample statistics. Potential outliers in this context mean values that are well-separated from the majority of the data set coming from the far/extreme tails of the data distribution (USEPA, 2016a). Descriptive statistics for the Survey Areas and some comparisons to background reference areas are still presented for qualitative assessment. However, potential outlier values in the Survey Areas are not evaluated further nor removed from the dataset.

3.1.1 Box Plots

Box plots depict descriptive statistics from a group of data (Figure 1A). The interquartile range is represented by the bounds of the box, the minimum and maximum values, not including potential outlier values (extreme values), are depicted by the whiskers (vertical lines), and any potential outliers are identified as singular dots. Potential outliers in this context are defined as values outside 1.5 times the interquartile range above or below the box.

3.1.1.1 Soil Sample Results Box Plots

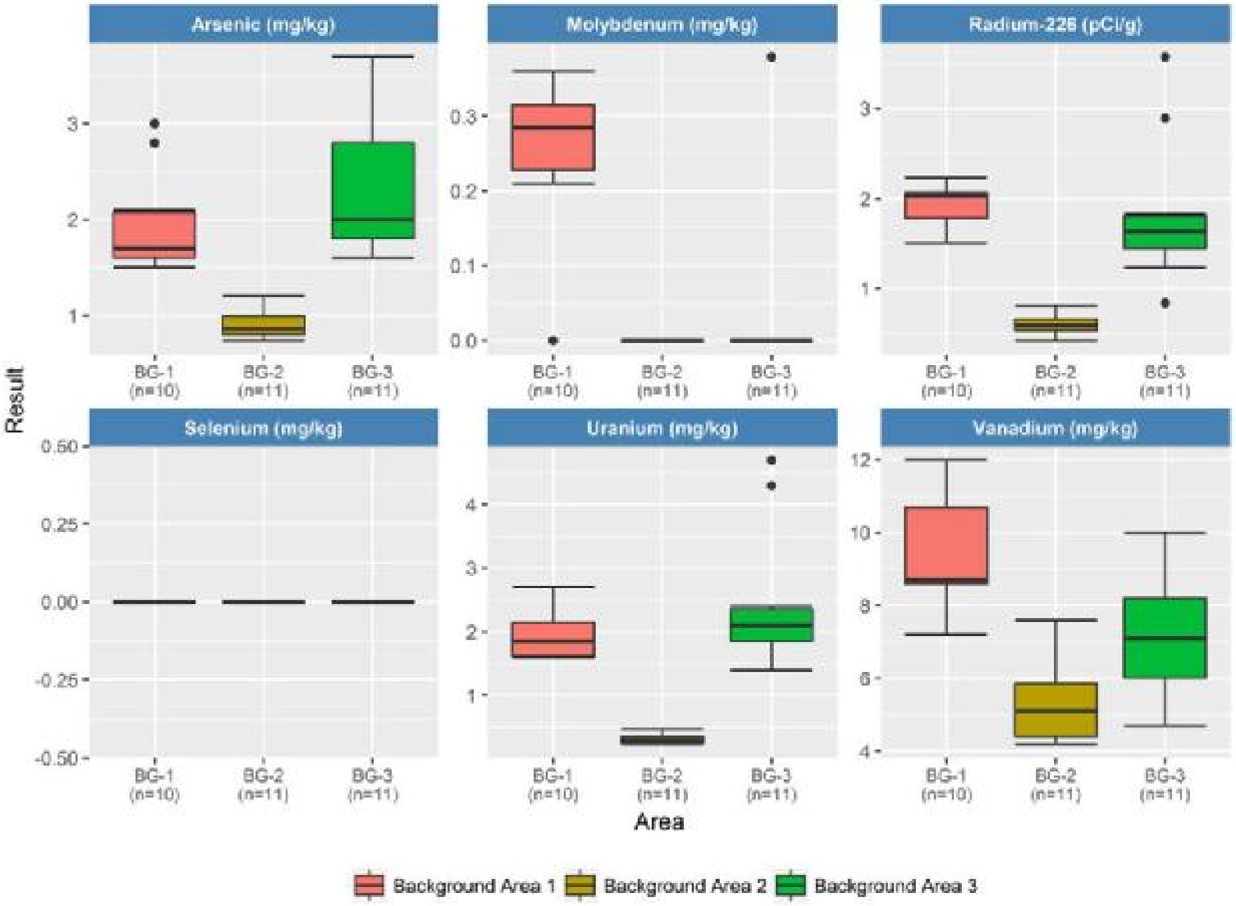
Figure 1A. Survey Areas A and B, and Background Reference Areas 1 (BG-1), 2 (BG-2), and 3 (BG-3) Soil Sample Box Plots



The soil sample box plots shown on Figure 1A depict differences in the data distribution for analytical constituent concentrations between the BG-1, BG-2, BG-3, and Survey Areas A and B. Some potential high and low outlier values are shown for BG-1, BG-3, Survey Area A, and Survey Area B.

Potential outlier values are of greatest concern in the background reference area datasets, as these data are used to determine the ILs. Background reference area data are presented alone in Figure 1B.

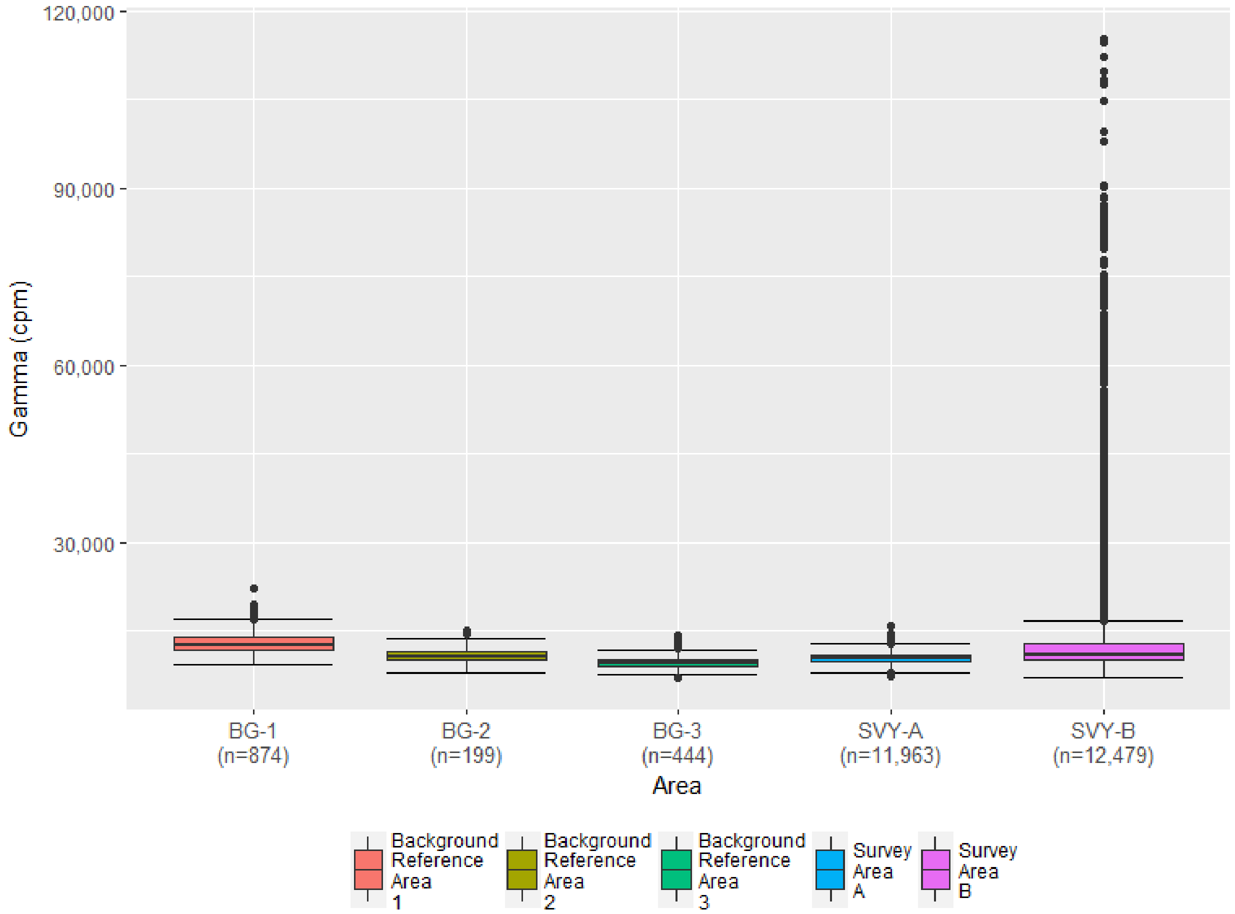
Figure 1B. Background Reference Areas 1 (BG-1), 2 (BG-2), and 3 (BG-3) Soil Sample Box Plots



Four potential outliers (i.e., outside 1.5 times the interquartile range) are identified in the box plot in Figure 1B for BG-1: two high values for arsenic (As) and two low value for molybdenum (Mo). For BG-3, six potential outliers are identified in Figure 1B: one value for Mo, three values for Ra-226, and two values for uranium (U). These observations are further evaluated with the use of probability plots in Section 3.1.2 and statistical outlier testing in Section 3.1.3. No potential outliers were identified for the BG-2 dataset.

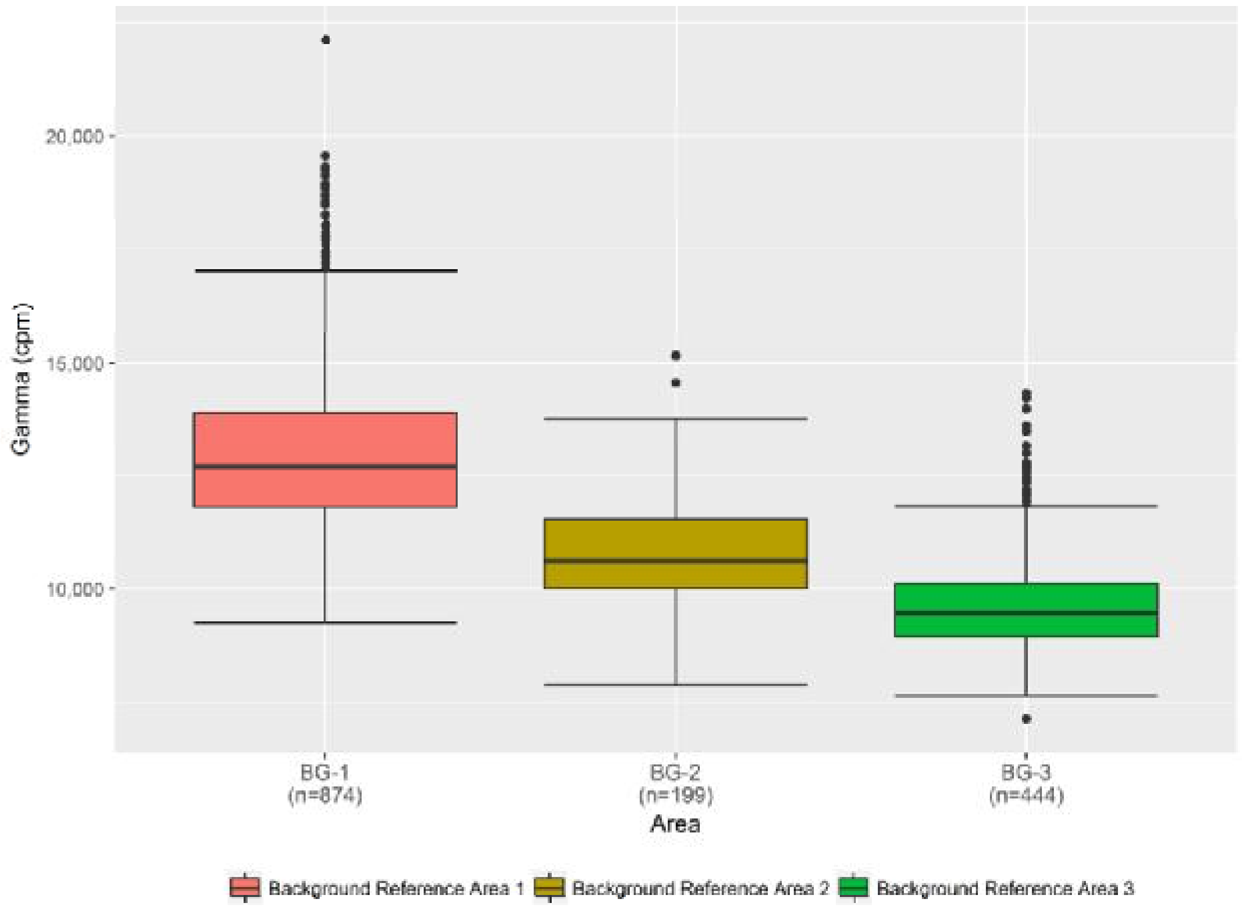
3.1.1.2 Gamma Radiation Results Box Plots

Figure 2A. Survey Area and Background Reference Area Gamma Radiation Box plots



The gamma radiation survey results box plots shown on Figure 2A depict differences in the data distribution for gamma measurements between BG-1, BG-2, BG-3 and Survey Areas A and B. The large number of potential outlier values in the Survey Area box plots indicate high skewness or possibly non-normally distributed data, instead of outlier values. Based on Site geology, the potential gamma radiation outlier values observed for the Survey Areas data on Figure 2A represent localized areas of higher gamma radiation with respect to other parts of each of the Survey Areas, as would be expected in areas with varying levels of mineralization, naturally occurring radioactive material (NORM), and potential TENORM. Background area data are presented alone in Figure 2B.

Figure 2B. Background Reference Area Gamma Radiation Box plots



There are 36 potential high outlier values shown for gamma data in the BG-1 dataset; two potential high outlier values in the BG-2 dataset; and 24 potentially high outlier values and one potentially low outlier value in the BG-3 dataset. These potential outlier values do not represent skewed data as do the Survey Area results.

The potential outlier values shown for BG-1, BG-2, and BG-3 are most likely representative of natural variation of gamma in these areas. These observations are further evaluated with the use of probability plots in Section 3.1.2 and statistical outlier testing in Section 3.1.4.

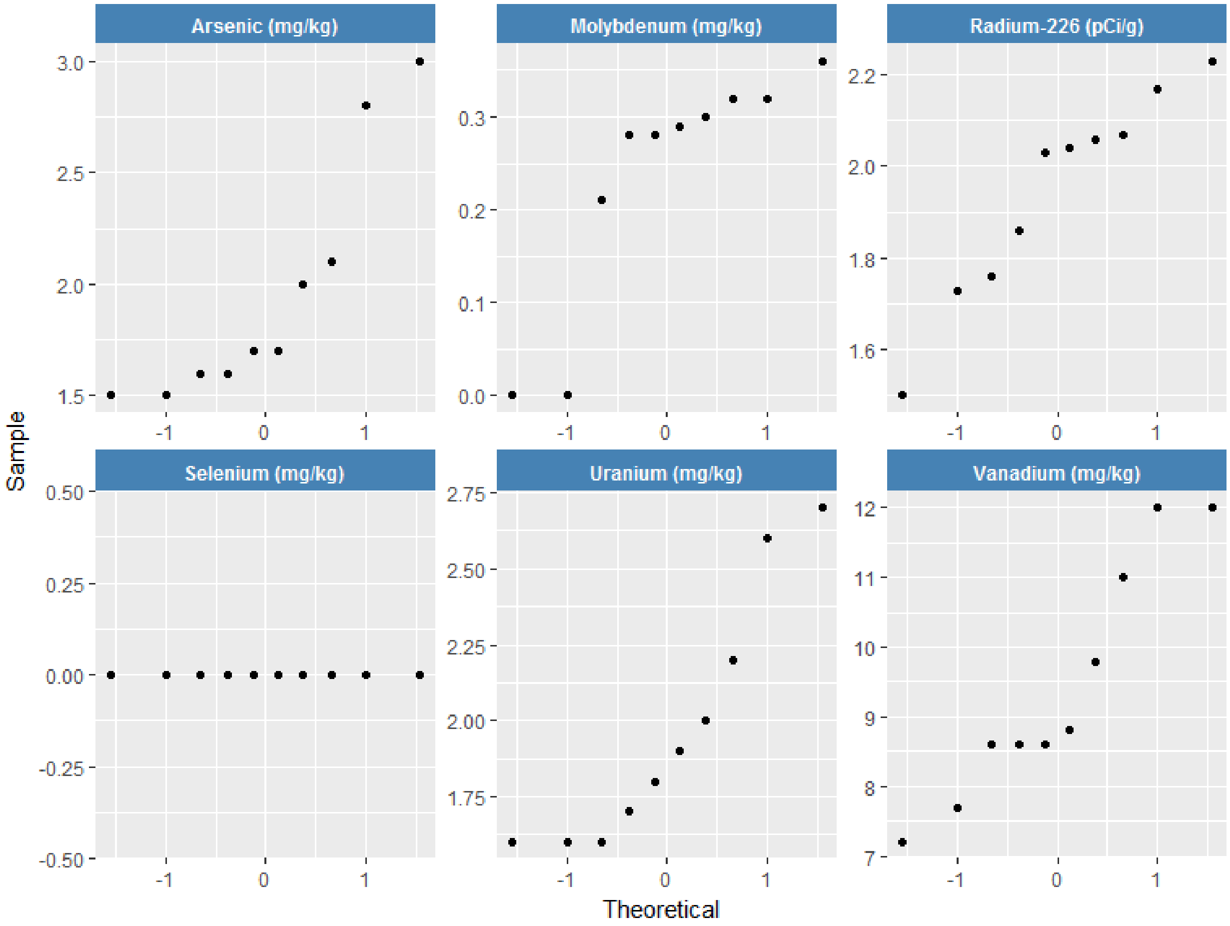
3.1.2 Probability Plots

The normal probability plot is a graphical technique for assessing whether or not a data set is approximately normally distributed, and where there may be potential outlier values. The data are plotted against a theoretical normal distribution in such a way that the points, if normally distributed, should form an approximate straight line. Curved lines may indicate non-normally or log-normally distributed data, and ‘S” shaped lines may indicate two distinct groups within the dataset.

3.1.2.1 Soil Sample Results Probability Plots

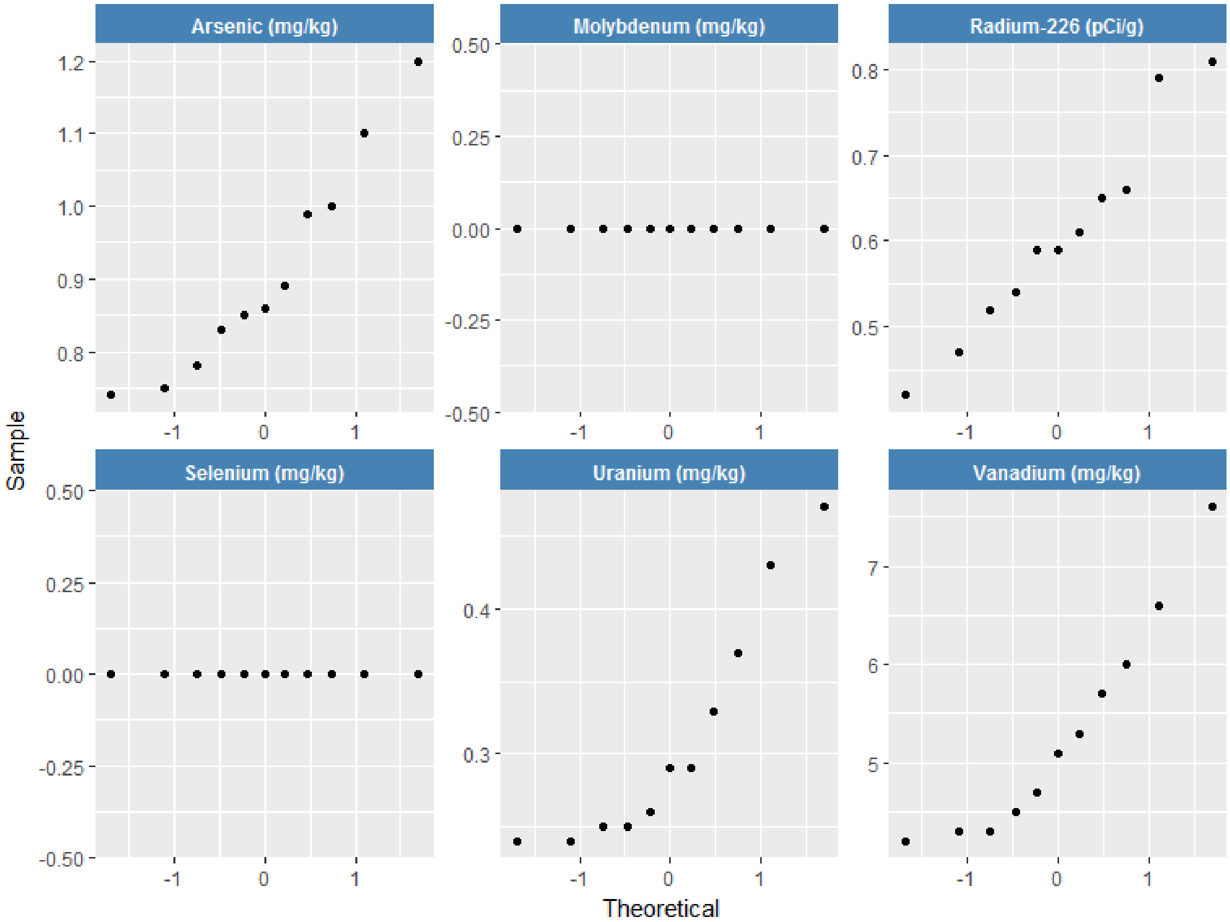
Figures 3, 4, and 5 depict the probability plots for metals and Ra-226 results at BG-1, BG-2 and BG-3, respectively.

Figure 3. Background Reference Area 1 (BG-1) Soil Sample Probability Plots



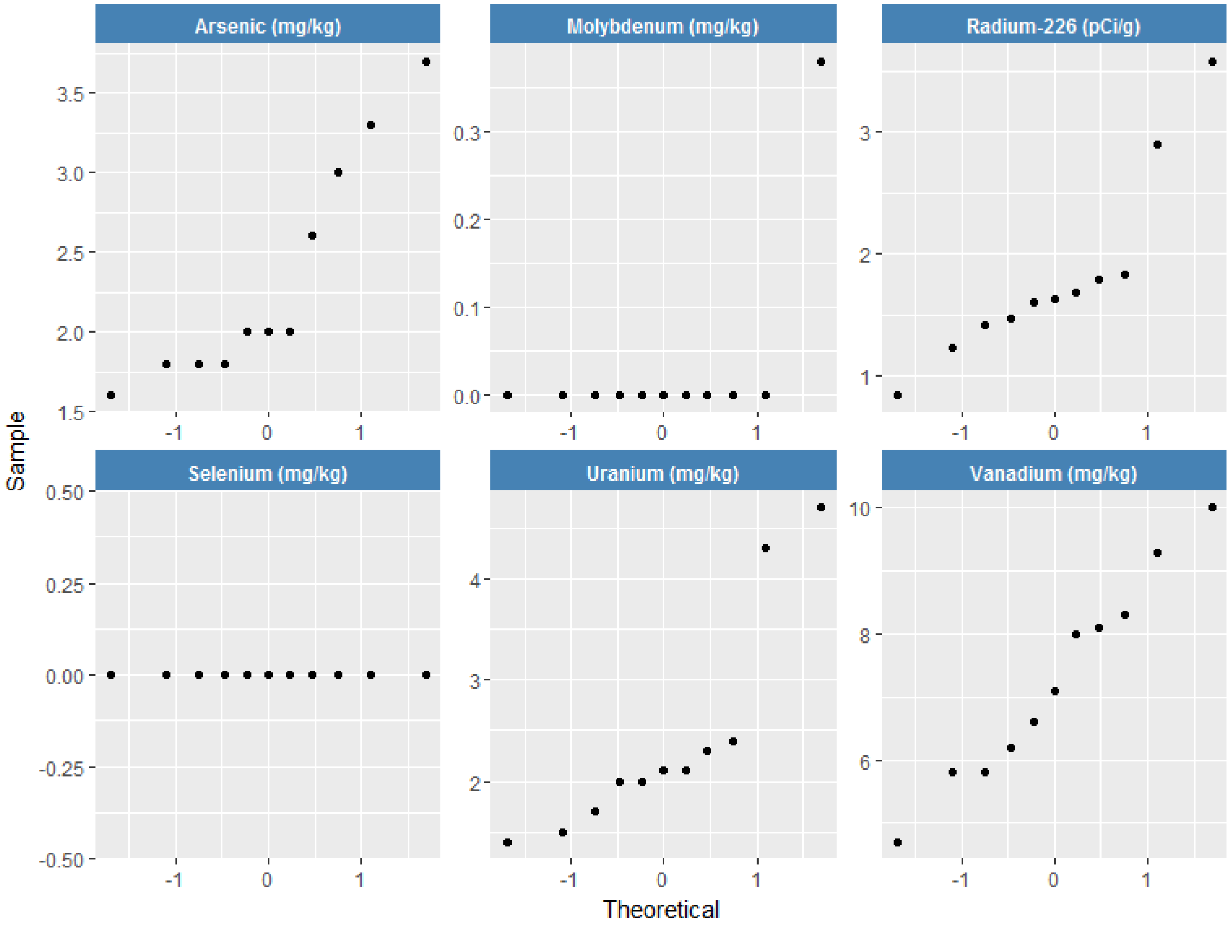
Two high values for arsenic and two low values for molybdenum were identified as potential outliers (i.e., outside 1.5 times the interquartile range) in the BG-1 box plots in Figure 1B. When viewed in the probability plots in Figure 3, the arsenic values do appear to be substantially higher than, and out of line with, the rest of the dataset. The two molybdenum potential outlier values are non-detect values, plotted at a value of 0 in Figure 3. The remainder of the molybdenum data appear to be normally distributed. These four potential outliers are tested further for statistical significance as potential outliers, as described in Section 3.1.3.

Figure 4. Background Reference Area 2 (BG-2) Soil Sample Probability Plots



No potential outliers (i.e., outside 1.5 times the interquartile range) were identified in the BG-2 box plots in Figure 1B. Although there are two high values for Ra-226 and one high value for vanadium in the probability plots in Figure 4, these values are in line with the rest of their respective datasets. Because these values, which appear elevated in Figure 4, are within 1.5 times the interquartile range for their respective datasets (Figure 1B), they are considered to be representative of the natural variation in concentrations of Ra-226 and vanadium in soil at BG-2.

Figure 5. Background Reference Area 3 (BG-3) Soil Sample Probability Plots

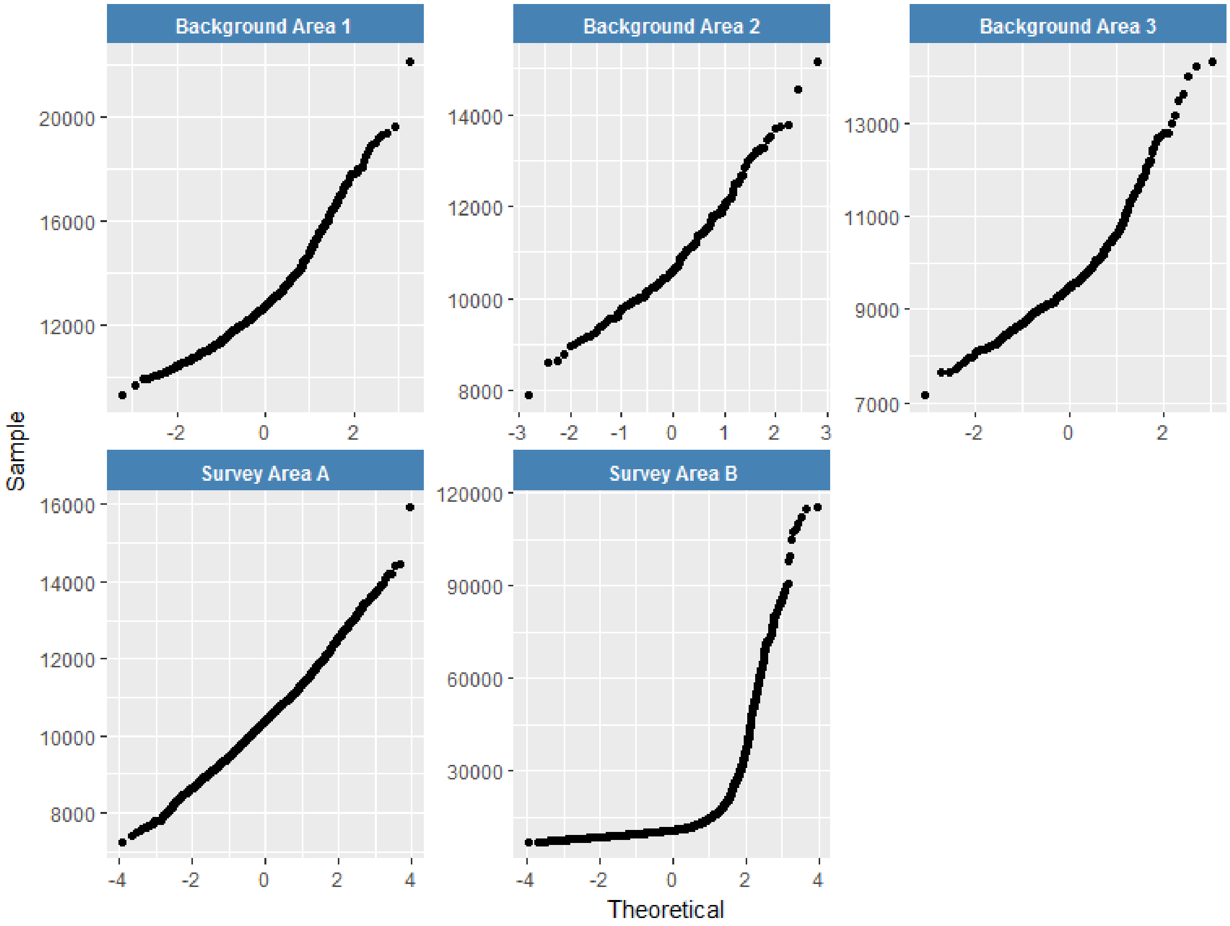


One value for molybdenum, three values for Ra-226 (one low value and two high values), and two values for uranium were identified as potential outliers (i.e., outside 1.5 times the interquartile range) in the box plots in Figure 1B. When viewed in the probability plots in Figure 5, it is apparent that the high value for molybdenum is the only detected value in the BG-3 dataset. The single detect in the molybdenum dataset is anomalous, but as the remaining non-detect values cannot be evaluated statistically it is not considered further as a potential outlier. The low value for Ra-226 is lower than, but not out of line with, the remainder of the Ra-226 dataset for BG-3. The remaining four potential outlier values are higher than and out of line with the rest of their respective datasets. These potential outlier values are further tested for statistical significance as potential outliers in Section 3.1.3.

3.1.2.2 Gamma Survey Results Probability Plots

Figure 6 depicts the probability plots for gamma radiation results at background reference areas and the Survey Areas.

Figure 6. Survey Area and Background Reference Area Gamma Probability Plots



The BG-1, BG-2 and BG-3 gamma probability plots in Figure 6 are approximately linear, indicating normal distributions. The single highest value in the BG-1 dataset and the two highest values in the BG-2 dataset, identified as potential outliers in the box plot in Figure 2B, appear to be higher than, and out of line with, the distribution of the rest of the dataset, indicating that they are potential outliers. The highest values in the BG-3 dataset also appear out of line with the distribution of the rest of the dataset, indicating that they are potential outliers. The low value in the BG-3 dataset also appears to be out of line with the distribution of the rest of the dataset, indicating that it is a potential outlier. These values are further evaluated for statistical significance in Section 3.1.4.

The gamma probability plot in Figure 6 for Survey Area A is approximately linear, indicating normal distributions. The gamma probability plot for Survey Area B is non-linear or S-shaped. The Survey Area B gamma probability plot in Figure 6 indicates a sub-group of higher gamma radiation values which may be distinct from the rest of the dataset, and non-normal distribution. Additionally, the shape and smoothness of the probability plot for the Survey Area B gamma results confirms that the gamma radiation data are more log-normally distributed than the BG-1, BG-2, and BG-3, and Survey Area A gamma results. This suggests that these higher values in Survey Area B are not outliers, but rather are representative of the spatial variability of gamma radiation in Survey Area B.

3.1.3 Potential Soil Sample Data Outliers

Two high and two low results are identified as potential outlier values for BG-1 in the box plots in Figure 1B and probability plots in Figure 3. Four high results and one low result are identified as potential outlier values for BG-3 in the box plots in Figure 1B and probability plots in Figure 5. These values are:

Background Reference Area 1 (BG-1)

- Arsenic: 3.00 mg/kg, 2.80 mg/kg
- Molybdenum: ND, ND mg/kg

Background Reference Area 3 (BG-3)

- Radium 226: 0.840 pCi/g (low); 2.89 pCi/g, 3.58 (high) pCi/g
- Uranium: 4.30 mg/kg, 4.70 mg/kg

Dixon’s Test (Dixon, 1953) is designed to be used for datasets containing only one or two potential outlier values. Therefore, Dixon's Test was performed to the 95% confidence level on each of the potential soil sample outlier values. The non-detect results for molybdenum at BG-1 that were identified as potential outliers were evaluated at the method detection limit (MDL) of 0.04 mg/kg reported by the laboratory for these samples. The results of Dixon’s Test are summarized in Table 1.

The test confirms that six of the nine potential outliers tested are statistically significant (p value <0.05). The statistically significant potential outlier values for molybdenum at BG-1 and Ra-226 and uranium at BG-3 were further investigated by reviewing sample forms, notes and laboratory reports. Field staff and field notes indicate nothing abnormal about the locations where the samples were collected, and the laboratory datasets show no data quality flags were applied to these values that would call their accuracy in to question. Therefore, while these values are: 1) outside the interquartile range of their respective datasets (Figure 1B), 2) may not conform linearly with the respective dataset distributions in the probability plots (Figures 3 and 5), and 3) are deemed potential statistical outliers by Dixon's Test, they were not removed from the BG-1 and BG-3 datasets because no scientific reason was found to justify disqualifying these values. These values are considered representative of the natural variation at BG-1 and BG-3. However, descriptive statistics were calculated with and without these values for comparison (Section 3.3.1).

Table 1. Summary of Dixon's Test on Maximum Values

Area	Constituent	Location ID	Method	Hypothesis	p_Value	Conclusion
Background Reference Area 1 (BG-1)	As	S002-BG1-001	Dixon test for potential outliers	high value 2.80 is a potential outlier	> 0.05	Hypothesis rejected
	As	S002-BG1-006	Dixon test for potential outliers	high value 3.00 is a potential outlier	> 0.05	Hypothesis rejected
	Mo	S002-BG1-008	Dixon test for potential outliers	low value ND is a potential outlier	< 0.05	Hypothesis accepted
	Mo	S002-BG1-009	Dixon test for potential outliers	low value ND is a potential outlier	< 0.05	Hypothesis accepted
Background Reference Area 3 (BG-3)	Ra-226	S002-BG3-004	Dixon test for potential outliers	low value 0.840 is a potential outlier	> 0.05	Hypothesis rejected
	Ra-226	S002-BG3-001	Dixon test for potential outliers	high value 2.89 is a potential outlier	< 0.05	Hypothesis accepted
	Ra-226	S002-BG3-002	Dixon test for potential outliers	high value 3.58 is a potential outlier	< 0.05	Hypothesis accepted
	U	S002-BG3-001	Dixon test for potential outliers	high value 4.30 is a potential outlier	< 0.05	Hypothesis accepted
	U	S002-BG3-002	Dixon test for potential outliers	high value 4.70 is a potential outlier	< 0.05	Hypothesis accepted

As = Arsenic Mo = Molybdenum Ra-226 = Radium 226 U = Uranium

3.1.4 Potential Gamma Data Outliers

Potential gamma survey outlier values are observed for the BG-1, BG-2, and BG-3 gamma datasets shown in the boxplot in Figure 2B. When viewed in the probability plots in Figure 6, the BG-1, BG-2, and BG-3 gamma probability plots are approximately linear, indicating normal distribution. A total of 36 values in the BG-1 dataset were identified as higher than, and out of line with the distribution of the rest of the dataset. The two highest values in BG-2 appear to be higher than, and out of line with, the distribution of the rest of the dataset. A total of 25 values in the BG-3 dataset (24 high values and one low value) were identified as being out of line with the distribution of the rest of the dataset. Because the number of values in the BG-1, BG-2, and BG-3 gamma datasets is >30, Dixon’s Test was not appropriate for potential outlier testing. Instead, because the values appear to be generally normally distributed, it was appropriate to identify potential outliers using Z, t and chi squared scoring methods at the 95% confidence level. These tests were performed in the 'Outliers' package in R (Lukasz Komsta, 2011), and the results are summarized in Table 2. The R programming language complements ProUCL in its ability to provide more meaningful and useful graphics and summarizes the results equivalent to ProUCL. Because ProUCL and R packages follow similar statistical procedures, the results are comparable. The interquartile range evaluation (values outside 1.5 times the interquartile range) results are also provided in Table 2.

Table 2. Potential Gamma Outlier Interquartile Range, Z Score, t Score and Chi Squared Score Results

Area	Value (cpm)	Interquartile Range Result	Z Score Result	t Score Result	Chi Sq Score Result
Background Reference Area 1 (BG-1)	22,114	High	Potential Outlier	Potential Outlier	Potential Outlier
	19,572	High	Potential Outlier	Potential Outlier	Potential Outlier
	19,338	High	Potential Outlier	Potential Outlier	Potential Outlier
	19,268	High	Potential Outlier	Potential Outlier	Potential Outlier
	19,148	High	Potential Outlier	Potential Outlier	Potential Outlier
	18,965	High	Potential Outlier	Potential Outlier	Potential Outlier
	18,926	High	Potential Outlier	Potential Outlier	Potential Outlier
	18,846	High	Potential Outlier	Potential Outlier	Potential Outlier
	18,703	High	Potential Outlier	Potential Outlier	Potential Outlier
	18,573	High	Potential Outlier	Potential Outlier	Potential Outlier
	18,497	High	Potential Outlier	Potential Outlier	Potential Outlier
	18,277	High	Potential Outlier	Potential Outlier	Potential Outlier
	18,031	High	Potential Outlier	Potential Outlier	Potential Outlier
	18,007	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,978	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,974	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,867	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,817	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,811	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,791	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,781	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,771	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,770	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,714	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,675	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,588	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,448	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,426	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,419	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,394	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,351	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,319	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,311	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,212	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,168	High	Potential Outlier	Potential Outlier	Potential Outlier
	17,074	High	Potential Outlier	Potential Outlier	Potential Outlier
Background Reference Area 2 (BG-2)	15,166	High	Potential Outlier	Potential Outlier	Potential Outlier
	14,567	High	Potential Outlier	Potential Outlier	Potential Outlier
Background Reference Area 3 (BG-3)	14,331	High	Potential Outlier	Potential Outlier	Potential Outlier
	14,223	High	Potential Outlier	Potential Outlier	Potential Outlier
	13,992	High	Potential Outlier	Potential Outlier	Potential Outlier
	13,619	High	Potential Outlier	Potential Outlier	Potential Outlier
	13,488	High	Potential Outlier	Potential Outlier	Potential Outlier
	13,175	High	Potential Outlier	Potential Outlier	Potential Outlier
	13,005	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,793	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,793	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,768	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,741	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,703	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,680	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,672	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,585	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,466	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,432	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,351	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,206	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,195	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,115	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,079	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,065	High	Potential Outlier	Potential Outlier	Potential Outlier
	11,938	High	Potential Outlier	Potential Outlier	Potential Outlier
	7,147	Low	Potential Outlier	Potential Outlier	Potential Outlier

cpm Counts per minute

The values in Table 2 are deemed potential statistical outliers and represent 63 out of 1,517 data points (4.2 percent). One possible reason for the number/percentage of potential outliers in the gamma radiation dataset may be the presence of a localized source of radiation within a background reference area. This was evaluated by viewing the relative position of the potential outlier values relative to each other in BG-1, BG-2, and BG-3.

In the BG-1 dataset, the 36 potential outliers are located across the background reference area, but there is a higher concentration of potential outliers in the southwestern portion. This observation suggests that BG-1 comprises a degree of geologic variation which is causing this effect; however, the gamma results at BG-1 appear to include elevated gamma measurements that are not representative of some areas of the Site (e.g., on the mesa top).

In the BG-2 dataset, there are only two potential outlier values, located in two random locations in the background reference area.

In the BG-3 dataset, the 24 high potential outliers are indeed collocated, grouped within the southwestern portion of the background reference area. This observation suggests that BG-3 comprises a degree of geologic variation which is causing this effect, and makes it a representative area of Survey Area B, which has a similar geologic makeup.

While these observations may explain the presence of these values in the dataset, nothing in field notes or the gamma data records indicates a scientific reason for these values to be excluded from the dataset (e.g., data handling error, equipment malfunction), and there is no record of anomalous soil or other material in the background reference areas. Therefore, the values are considered representative of the natural variation present, and there is no basis to remove them from the gamma dataset. However, descriptive statistics were calculated with and without these values for comparison (Section 3.3.2).

Potential outlier values in the gamma dataset for the Survey Areas appear in the Figure 2A boxplots, particularly Survey Area B. However, because of the non-linear shape and continuous distribution of gamma results shown in the probability plot in Figure 6, these values are thought to be representative of the heterogeneous nature of radioactive materials within the Survey Areas and are not outlier values. Indeed, Figure 4-1 of the RSE Report shows that while gamma results for the majority of each of the Survey Areas are within the range of background, localized areas of elevated gamma results associated with mineralized areas are also present.

3.2 COMPARE DATA POPULATIONS

Group comparison analyses provide insight into the relative concentrations of constituents between background reference areas and the Survey Areas. Observations made during these analyses may indicate the need for further evaluation or discussion regarding the influence of potential outlier values, and the use of background data. For instance, if two or more background reference areas were determined to be statistically similar to each other, these data could be combined to calculate more robust statistics (not a factor in this evaluation, as one background reference area was selected to represent each Survey Area). Alternatively, testing of this kind may reveal background concentrations statistically higher than corresponding Survey Area concentrations, requiring additional interpretation or modifications in the use of background reference area datasets. Finally, results of these evaluations are a component of determining background reference area representativeness, though statistical comparisons are not the only factors to be considered in judging representativeness. Factors such as geologic materials, predominant wind direction, distance from the Site, visual evidence of impacts due to mining (or other anthropogenic sources) and soil depth are all important to the selection of background reference areas.

Group comparisons, therefore, are considered instructive as a component of the overall evaluation of soil sample and gamma radiation survey results collected from background reference areas and Survey Areas. Relative data distributions were investigated by evaluating the boxplots and probability plots in Figures 1A through 6, and by hypothesis testing with the non-parametric Mann-Whitney test, as applicable.

3.2.1 Evaluation of Box Plots

3.2.1.1 Soil Sample Box Plots

The box plot comparison in Figures 1A and 1B suggests that mean metals and Ra-226 values may differ between the background reference areas and the Survey Areas. As shown in Figures 1A and 1B, concentrations of all analytical constituents were significantly elevated at Survey Area B compared with Survey Area A and the background reference areas. Concentrations of analytical constituents appear similar between background reference areas. When interpreting the soil sample box plots in Figures 1A and 1B, it is important to note that samples at background reference areas were collected randomly, while samples in the Survey Areas were collected judgmentally from areas of suspected contamination. Analytical constituent-specific observations from the boxplots in Figures 1A and 1B indicate:

BG-1 and Survey Area B, BG-2 and Survey Area A, and BG-3 and Survey Area B

- Arsenic. Arsenic concentrations are similar between Survey Area A and BG-2, and significantly elevated at Survey Area B compared with BG-1 and BG-3. Concentrations at BG-1 and BG-3 are elevated relative to BG-2, and at Survey Area B relative to Survey Area A.

- Molybdenum. Molybdenum concentrations are elevated at Survey Area B compared with BG-1 and BG-3. Concentrations are elevated at Survey Area B relative to Survey Area A and are similar between BG-1 and BG-3. Molybdenum was not detected at BG-2.

- Ra-226. Ra-226 concentrations are elevated at Survey Area A relative to BG-2, and maximum detected concentrations are significantly elevated at Survey Area B relative to BG-1 and BG-3. The median concentration of Ra-226 is similar between Survey Area B and BG-1 and BG-3. Ra-226 concentrations are significantly elevated at Survey Area B compared with Survey Area A and similar between BG-1, BG-2, and BG-3.

- Selenium. Selenium was detected at Survey Area B only.
- Uranium. The maximum uranium concentration detected is significantly elevated at Survey Area B compared with BG-1 and BG-3, while the median concentration is similar between Survey Area B and both BG-1 and BG-3. Uranium concentrations are similar between Survey Area A and BG-2. Concentrations are similar between the background reference areas, and elevated at Survey Area B relative to Survey Area A.
- Vanadium. Vanadium concentrations are elevated at Survey Area A relative to BG-2 and maximum detected concentrations significantly elevated at Survey Area B compared with BG-1 and BG-3. The median vanadium concentration at Survey Area B is only slightly elevated relative to median concentrations at BG-1 and BG-2. The concentrations are elevated at BG-1 and BG-3 compared with BG-2 and significantly elevated at Survey Area B compared with Survey Area A.

3.2.1.2 Gamma Radiation Box Plots and Probability Plots

The box plot comparison in Figures 2A and 2B suggests that interquartile ranges are similar between BG-2 and Survey Area A, and significantly elevated in Survey Area B compared with BG-1 and BG-3. Gamma values in BG-1 and Survey Area B are higher than those in BG-2, BG-3, and Survey Area A. These observations are verified in Section 3.2.2 using the non-parametric Mann-Whitney test. Gamma radiation data distributions at BG-1, BG-2, BG-3, and Survey Area A are approximately normal, while gamma radiation distributions at Survey Area B are non-normal (Figure 6). These observations are further evaluated in Section 3.2.2 using the non-parametric Mann-Whitney test.

3.2.2 Mann-Whitney Testing

The Mann-Whitney test (Bain and Engelhardt, 1992) is a nonparametric test used for determining whether a difference exists between two or more population distributions. This test is also known as the Wilcoxon Rank Sum (WRS) test. This test evaluates whether measurements from one population consistently tend to be larger (or smaller) than those from another population. This test was selected over other comparative tests such as the Student's t test and analysis of variance (ANOVA) because it remains robust in the absence of required assumptions that these two tests require, such as normally distributed data and equality of variances.

Soil samples at the background reference areas were collected randomly, while soil samples in the Survey Areas were collected judgmentally (see Section 3.1). Mann-Whitney testing is not appropriate for comparative analysis if one or both groups contain data collected using a judgmental approach. Therefore, the Mann-Whitney test was not performed for soil sample data between background reference areas and Survey Areas. Gamma radiation data, however, do represent non-judgmental sampling, and so the Mann-Whitney test was appropriate for comparison between background reference areas and Survey Areas (Table 3). Therefore, the test was performed two-sided on the background reference area and Survey Area gamma radiation data. The two-sided test accounts for results from one group being lower or higher than any other group (i.e., the hypothesis tested whether the two groups differ, independent of which group is higher). A test result p-value of 0.05 or smaller indicates that a significant difference exists between any two groups that are compared. Results of Mann-Whitney testing are presented in Table 3.

Table 3. Summary of Gamma Survey Mann-Whitney Test Results

Comparison	p_Value	Description
Background Reference Area 1 (BG-1) vs Survey Area B	<0.05	Significant Difference
Background Reference Area 1 (BG-1) vs Background Reference Area 1 (BG-1) Potential Outliers Excluded	0.140	No Significant Difference
Background Reference Area 1 (BG-1) Potential Outliers Excluded vs Survey Area B	<0.05	Significant Difference
Background Reference Area 2 (BG-2) vs Survey Area A	<0.05	Significant Difference
Background Reference Area 3 (BG-3) vs Survey Area B	<0.05	Significant Difference
Background Reference Area 3 (BG-3) vs Background Reference Area 3 (BG-3) Potential Outliers Excluded	0.188	No Significant Difference
Background Reference Area 3 (BG-3) Potential Outliers Excluded vs Survey Area B	<0.05	Significant Difference
Background Reference Area 1 (BG-1) vs Background Reference Area 2 (BG-2)	<0.05	Significant Difference
Background Reference Area 1 (BG-1) vs Background Reference Area 3 (BG-3)	<0.05	Significant Difference
Background Reference Area 2 (BG-2) vs Background Reference Area 3 (BG-3)	<0.05	Significant Difference
Survey Area A vs Survey Area B	<0.05	Significant Difference

The results of the Mann-Whitney testing on gamma radiation survey results in Table 3 indicate the following:

- Gamma results are statistically elevated in Survey Area A and Survey Area B with respect to their respective background reference areas; this observation is valid for Survey Area B, BG-1 both with and without inclusion of potential outliers in the BG-1 dataset, and BG-3 both with and without inclusion of potential outliers in the BG-3 dataset.

- Additionally, gamma results are statistically elevated at Survey Area B relative to Survey Area A. Gamma results at BG-2 are statistically similar with BG-3, but gamma results at BG-1 are statistically elevated at BG-1 relative to BG-2 and BG-3.

- The observation that gamma results at Survey Area A and Survey Area B are statistically elevated relative to their respective background reference areas is likely attributable to the fact that background reference areas may not fully represent the degree of natural mineralization present at the Survey Areas (see RSE Report Section 3.2.2.2). This latter point does not prohibit the use of the gamma ILs calculated from these background reference areas, but this observation should be considered, as Site conditions are further evaluated for remediation.

- The inclusion or removal of potential outlier values has no effect on the results of the Mann-Whitney test between BG-1 and Survey Area B, and BG-3 and Survey Area B (i.e., there is a statistically significant difference in gamma results between BG-1 and Survey Area B, and BG-3 and Survey Area B with and without potential outlier values included).

3.3 DESCRIPTIVE STATISTICS

Descriptive statistics, including the upper confidence limit (UCL) of the mean and the 95-95 upper tolerance limit (UTL), were calculated from gamma survey data and soil sample results. Descriptive statistics are important for any data evaluation to present the basic statistics of a data set with regards to its limits (maximum and minimum), central tendencies (mean and median) as well as data dispersion (coefficient of variance). The ILs for the Site are taken from the descriptive statistics, namely the 95-95 UTL. The UTL value is selected by ProUCL as the maximum value in the dataset when the data are determined to be non-parametric. The parameters and constituents evaluated include gamma radiation, arsenic, molybdenum, selenium, uranium, vanadium, and Ra-226. Molybdenum and selenium results for BG-2 were 100 percent non-detect, as were the selenium results for BG-1 and BG-3; therefore, no statistics were calculated for these groups.

Statistics were calculated using Environmental Protection Agency (EPA) ProUCL version 5.1 software. Statistical methodology employed by the software is documented in the *ProUCL Version 5.1 Technical Guide Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations* (EPA, 2015). In the case of non-detect results, ProUCL does not recommend detection limit substitution methods (e.g., 1/2 the detection limit), considering these methods to be imprecise and out of date (EPA, 2015). The software instead calculates descriptive statistics for the detected results only, and follows various methods accordingly to calculate UCL and UTL values based on the percentage of non-detect results present in the dataset and on the distribution of the data (i.e., normal, lognormal, gamma, or unknown distribution).

Descriptive statistics for soil samples and gamma radiation survey results have been calculated with and without the potential outlier values previously identified, as applicable. Select descriptive statistics for these constituents are presented in Tables 4 and 5.

3.3.1 Soil Sample Analytical Results Summary

Table 4 presents the descriptive statistics output from the ProUCL software for the soil sample results.

Table 4. Summary of Soil Sampling Results

Area	Statistic	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Uranium (mg/kg)	Vanadium (mg/kg)	Radium-226 (pCi/g)
Background Reference Area 1 (BG-1) All Data	Total Number of Observations	10	10	10	10	10	10
	Percent Non-Detects	--	20%	100%	--	--	--
	Minimum[1]	1.50	--	--	1.60	7.20	1.50
	Minimum Detect[2]	--	0.210	--	--	--	--
	Mean[1]	1.95	--	--	1.97	9.43	1.95
	Mean Detects[2]	--	0.295	--	--	--	--
	Median[1]	1.70	--	--	1.85	8.70	2.04
	Median Detects[2]	--	0.295	--	--	--	--
	Maximum[1]	3.00	--	--	2.70	12.0	2.23
	Maximum Detect[2]	--	0.360	--	--	--	--
	Distribution	Normal	Normal	Not Calculated	Normal	Normal	Normal
	Coefficient of Variation[1]	0.277	--	--	0.207	0.181	0.117
	CV Detects[2]	--	0.147	--	--	--	--
	UCL Type	95% Student's-t UCL	95% KM (t) UCL	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL
	UCL Result	2.26	0.311	Not Calculated	2.21	10.4	2.08
	UTL Type	UTL Normal	UTL KM Normal	Not Calculated	UTL Normal	UTL Normal	UTL Normal
	UTL Result	3.52	0.559	Not Calculated	3.16	14.4	2.61
Background Reference Area 1 (BG-1) Excluding Potential Outliers [3]	Total Number of Observations	--	8	--	--	--	--
	Minimum[1]	--	0.210	--	--	--	--
	Mean[1]	--	0.295	--	--	--	--
	Median[1]	--	0.295	--	--	--	--
	Maximum[1]	--	0.360	--	--	--	--
	Distribution	--	Normal	--	--	--	--
	Coefficient of Variation[1]	--	0.147	--	--	--	--
	UCL Type	--	95% Student's-t UCL	--	--	--	--
	UCL Result	--	0.324	--	--	--	--
	UTL Type	--	UTL Normal	--	--	--	--
	UTL Result	--	0.433	--	--	--	--
Background Reference Area 2 (BG-2) All Data	Total Number of Observations	11	11	11	11	11	11
	Percent Non-Detects	--	100%	100%	--	--	--
	Minimum[1]	0.740	--	--	0.240	4.20	0.420
	Minimum Detect[2]	--	--	--	--	--	--
	Mean[1]	0.908	--	--	0.311	5.30	0.605
	Mean Detects[2]	--	--	--	--	--	--
	Median[1]	0.860	--	--	0.290	5.10	0.590
	Maximum[1]	1.20	--	--	0.470	7.60	0.810
	Maximum Detect[2]	--	--	--	--	--	--
	Distribution	Normal	Not Calculated	Not Calculated	Normal	Normal	Normal
	Coefficient of Variation[1]	0.163	--	--	0.258	0.206	0.200
	UCL Type	95% Student's-t UCL	Not Calculated	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL
	UCL Result	0.989	Not Calculated	Not Calculated	0.355	5.90	0.671
	UTL Type	UTL Normal	Not Calculated	Not Calculated	UTL Normal	UTL Normal	UTL Normal
	UTL Result	1.33	Not Calculated	Not Calculated	0.537	8.37	0.944

Area	Statistic	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Uranium (mg/kg)	Vanadium (mg/kg)	Radium-226 (pCi/g)
Background Reference Area 3 (BG-3) All Data	Total Number of Observations	11	11	11	11	11	11
	Percent Non-Detects	--	91%	100%	--	--	--
	Minimum[1]	1.60	--	--	1.40	4.70	0.840
	Minimum Detect[2]	--	0.380	--	--	--	--
	Mean[1]	2.33	--	--	2.41	7.26	1.82
	Mean Detects[2]	--	0.380	--	--	--	--
	Median[1]	2.00	--	--	2.10	7.10	1.63
	Maximum[1]	3.70	--	--	4.70	10.0	3.58
	Maximum Detect[2]	--	0.380	--	--	--	--
	Distribution	Normal	Not Calculated	Not Calculated	Normal	Normal	Gamma
	Coefficient of Variation[1]	0.305	--	--	0.449	0.224	0.425
	UCL Type	95% Student's-t UCL	Not Calculated	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% Adjusted Gamma UCL
	UCL Result	2.72	Not Calculated	Not Calculated	3.00	8.15	2.37
	UTL Type	UTL Normal	Not Calculated	Not Calculated	UTL Normal	UTL Normal	UTL Gamma WH
	UTL Result	4.33	Not Calculated	Not Calculated	5.46	11.8	4.48
Background Reference Area 3 (BG-3) Excluding Potential Outliers [3]	Total Number of Observations	--	10	--	9	--	9
	Percent Non-Detects	--	100%	--	--	--	--
	Minimum[1]	--	--	--	1.40	--	0.840
	Minimum Detect[2]	--	--	--	--	--	--
	Mean[1]	--	--	--	1.94	--	1.50
	Mean Detects[2]	--	--	--	--	--	--
	Median[1]	--	--	--	2.00	--	1.60
	Maximum[1]	--	--	--	2.40	--	1.83
	Maximum Detect[2]	--	--	--	--	--	--
	Distribution	--	Not Calculated	--	Normal	--	Normal
	Coefficient of Variation[1]	--	--	--	0.176	--	0.207
	UCL Type	--	Not Calculated	--	95% Student's-t UCL	--	95% Student's-t UCL
	UCL Result	--	Not Calculated	--	2.16	--	1.69
	UTL Type	--	Not Calculated	--	UTL Normal	--	UTL Normal
	UTL Result	--	Not Calculated	--	2.99	--	2.44
Survey Area A	Total Number of Observations	5	5	5	5	5	5
	Percent Non-Detects	--	80%	100%	--	--	--
	Minimum[1]	1.10	--	--	0.270	6.20	0.650
	Minimum Detect[2]	--	0.520	--	--	--	--
	Mean[1]	1.44	--	--	0.424	8.52	0.794
	Mean Detects[2]	--	0.520	--	--	--	--
	Median[1]	1.40	--	--	0.310	7.20	0.730
	Maximum[1]	1.70	--	--	0.700	11.0	1.12
	Maximum Detect[2]	--	0.520	--	--	--	--
	Distribution	Normal	Not Calculated	Not Calculated	Normal	Normal	Gamma
	Coefficient of Variation[1]	0.181	--	--	0.452	0.270	0.235
	UCL Type	95% Student's-t UCL	Not Calculated	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% Adjusted Gamma UCL
	UCL Result	1.69	Not Calculated	Not Calculated	0.607	10.7	1.13
	UTL Type	UTL Normal	Not Calculated	Not Calculated	UTL Normal	UTL Normal	UTL Gamma WH
	UTL Result	2.54	Not Calculated	Not Calculated	1.23	18.2	1.75

Area	Statistic	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Uranium (mg/kg)	Vanadium (mg/kg)	Radium-226 (pCi/g)
Survey Area B	Total Number of Observations	20	20	20	20	20	20
	Percent Non-Detects	--	35%	75%	--	--	--
	Minimum[1]	1.00	--	--	0.340	4.90	0.600
	Minimum Detect[2]	--	0.250	0.990	--	--	--
	Mean[1]	23.9	--	--	52.0	21.5	22.2
	Mean Detects[2]	--	57.8	2.10	--	--	--
	Median[1]	2.55	--	--	1.75	9.75	1.83
	Median Detects[2]	--	2.10	1.30	--	--	--
	Maximum[1]	310	--	--	840	200	279
	Maximum Detect[2]	--	640	3.70	--	--	--
	Distribution	Unknown	Not Calculated	Normal	Unknown	Lognormal	Unknown
	Coefficient of Variation[1]	2.90	--	--	3.61	1.98	2.91
	CV Detects[2]	--	3.04	0.657	--	--	--
	UCL Type	95% Chebyshev (Mean, Sd) UCL	97.5% KM (Chebyshev) UCL	95% KM (t) UCL	95% Chebyshev (Mean, Sd) UCL	95% H-UCL	95% Chebyshev (Mean, Sd) UCL
	UCL Result	91.2	240	1.09	235	27.3	85.3
	UTL Type	UTL Non-Parametric	UTL Non-Parametric	UTL KM Normal	UTL Non-Parametric	UTL Lognormal	UTL Non-Parametric
	UTL Result	310	640	3.19	840	90.0	279

[1] This statistic is reported by ProUCL when the dataset contains 100 percent detections.

[2] This statistic is reported by ProUCL when non-detect values exist in the dataset. The value reported is calculated using detections only.

[3] Statistics shown are for the constituents where potential statistical outliers were identified, calculated with the potential outliers removed.

CV	Coefficient of variation
KM	Kapplan Meier
mg/kg	Milligrams per kilogram
--	Not applicable
pCi/g	Picocuries per gram
WH	Wilson Hilferty
Note	The UTL result that is shown on the table is based on the output from ProUCL. ProUCL evaluates the data and provides all possible UCLs from its UCL module for three possible data distributions, then identifies a recommended UCL value. ProUCL does not identify a recommended UTL value. The UTLs are therefore based on the distribution of the recommended UCL. Please refer to *ProUCL Version 5.1 Technical Guide Statistical Software for Environmental Applications for Data Sets with and without Non-detect Observations* (EPA, 2015) for further information

As described in Section 3.2.1.1, arsenic, molybdenum, uranium, and Ra-226 results appear similar between BG-1, BG-2, BG-3, and Survey Area A. Arsenic, molybdenum, uranium, and Ra-226 results are significantly higher for Survey Area B when compared to BG-1, BG-2, BG-3, and Survey Area A. Selenium was only detected in Survey Area B. An important consideration when comparing concentrations of metals and Ra-226 between background reference areas and Survey Areas is that the background reference areas were selected to be representative of the geology present in the region around the Site, whereas the Site was selected as a mine claim because it is in an area of mineralized bedrock likely to have localized, naturally elevated uranium concentrations (see RSE Report Section 3.2.2.2). It should be noted that concentrations of several of the metals measured in the Survey Area are within the range of metals concentrations typically observed in Western U.S. soils (United States Geological Survey [USGS], 1984):

- Arsenic (mean = 5.5 mg/kg; range <0.10 – 97 mg/kg)
- Molybdenum (mean = 0.85 mg/kg; range <3 – 7 mg/kg)
- Selenium (mean = 0.23 mg/kg; range <0.1 – 4.3 mg/kg)
- Uranium (mean = 2.5 mg/kg; range 0.68 – 7.9 mg/kg)
- Vanadium (mean = 70 mg/kg; range 7 – 500 mg/kg)

As shown in Table 4, maximum detected concentrations of selenium and vanadium in the Survey Areas are within typical ranges reported for Western U.S soils, and may not be related to the uranium mineralization. Exceptions to the above are arsenic, molybdenum, Ra-226, and uranium in Survey Area B; elevated concentrations of these constituents in Survey Area B are likely attributable to the mineralized and/or disturbed portions of the Site (see RSE Report Section 4.6).

3.3.2 Gamma Radiation Results Summary

Table 5 presents the descriptive statistics output from the ProUCL software for the gamma radiation survey results.

Table 5. Summary of Walk-over Gamma Results

Area	Statistic	Gamma (cpm)
Background Reference Area 1 (BG-1) All Data	Total Number of Observations	874
	Minimum	9,261
	Mean	13,050
	Median	12,706
	Maximum	22,114
	Distribution	Normal
	Coefficient of Variation	0.141
	UCL Type	95% Student's-t UCL
	UCL Result	13,152
	UTL Type	UTL Normal
	UTL Result	16,235
Background Reference Area 1 (BG-1) Excluding Potential Outliers	Total Number of Observations	838
	Minimum	9,261
	Mean	12,831
	Median	12,631
	Maximum	17,004
	Distribution	Normal
	Coefficient of Variation	0.119
	UCL Type	95% Student's-t UCL
	UCL Result	12,918
	UTL Type	UTL Normal
	UTL Result	15,476
Background Reference Area 2 (BG-2) All Data	Total Number of Observations	199
	Minimum	7,889
	Mean	10,851
	Median	10,616
	Maximum	15,166
	Distribution	Normal
	Coefficient of Variation	0.112
	UCL Type	95% Student's-t UCL
	UCL Result	10,994
	UTL Type	UTL Normal
	UTL Result	13,088
Background Reference Area 2 (BG-2) Excluding Potential Outliers	Total Number of Observations	197
	Minimum	7,889
	Mean	10,810
	Median	10,590
	Maximum	13,773
	Distribution	Normal
	Coefficient of Variation	0.107
	UCL Type	95% Student's-t UCL
	UCL Result	10,946
	UTL Type	UTL Normal
	UTL Result	12,931
Background Reference Area 3 (BG-3) All Data	Total Number of Observations	444
	Minimum	7,147
	Mean	9,675
	Median	9,472
	Maximum	14,331
	Distribution	Normal
	Coefficient of Variation	0.117
	UCL Type	95% Student's-t UCL
	UCL Result	9,764
	UTL Type	UTL Normal
	UTL Result	11,686
Background Reference Area 3 (BG-3) Excluding Potential Outliers	Total Number of Observations	419
	Minimum	7,650
	Mean	9,502
	Median	9,408
	Maximum	11,840
	Distribution	Normal
	Coefficient of Variation	0.090
	UCL Type	95% Student's-t UCL
	UCL Result	9,571
	UTL Type	UTL Normal
	UTL Result	11,020
Survey Area A	Total Number of Observations	11,963
	Minimum	7,233
	Mean	10,410
	Median	10,388
	Maximum	15,920
	Distribution	Gamma
	Coefficient of Variation	0.092
	UCL Type	95% Approximate Gamma UCL
	UCL Result	10,424
	UTL Type	UTL Gamma WH
	UTL Result	12,059
Survey Area B	Total Number of Observations	12,479
	Minimum	7,074
	Mean	13,158
	Median	10,896
	Maximum	115,161
	Distribution	Normal
	Coefficient of Variation	0.631
	UCL Type	95% Student's-t UCL
	UCL Result	13,281
	UTL Type	UTL Normal
	UTL Result	26,999

As noted for metals and Ra-226 in Section 3.3.1, gamma results measured within Survey Areas A and B appeared to be elevated relative to gamma results measured in background reference areas because background reference areas were selected to represent the geology present in the region around the Site, whereas the Site was selected as a mine claim because it is in an area of mineralized bedrock likely to have localized naturally elevated uranium concentrations. Therefore, it’s not surprising that gamma results within the Survey Areas are somewhat higher than the gamma results at the background reference areas. Elevated gamma results in portions of the Survey Areas are likely attributable to historic waste piles, as well as a higher degree of natural mineralization within the Survey Areas relative to the background reference areas.

4.0 INVESTIGATION LEVELS

The calculated 95-95 UTL values described in Section 3.3 are used as the ILs for gamma measurement results and soil sampling results because they reflect the natural variability in the background data, and provide an upper limit from background data to be used for single-point comparisons to Survey Area data. The ILs for analytical results of soil samples and gamma radiation results in Survey Areas A and B are based on Background Reference Areas BG-2 and BG-3, respectively. The ILs derived from BG-1 were not used for Survey Area B as BG-1 contained elevated gamma measurements that were not representative of some areas of the Site (refer to Appendix D.1). The ILs based on BG-1 are presented for comparison, only.

4.1 SURVEY AREA A INVESTIGATION LEVELS

- Arsenic (mg/kg): 1.33
- Molybdenum (mg/kg): None (All results non-detect)
- Selenium (mg/kg): None (All results non-detect)
- Uranium (mg/kg): 0.537
- Vanadium (mg/kg): 8.37
- Ra-226 (pCi/g): 0.944
- Gamma radiation measurements (cpm): 13,088

4.2 SURVEY AREA B INVESTIGATION LEVELS

4.2.1 Based on Background Reference Area 3 (BG-3)

- Arsenic (mg/kg): 4.33
- Molybdenum (mg/kg): None. (Only one detection. One detection is insufficient to calculate IL)
- Selenium (mg/kg): None (All results non-detect)
- Uranium (mg/kg): 5.46
- Vanadium (mg/kg): 11.8
- Ra-226 (pCi/g): 4.48
- Gamma radiation measurements (cpm): 11,686

4.2.2 Based on Background Reference Area 1 (BG-1)

- Arsenic (mg/kg): 3.52
- Molybdenum (mg/kg): 0.559
- Selenium (mg/kg): None (All results non-detect)
- Uranium (mg/kg): 3.16
- Vanadium (mg/kg): 14.4
- Ra-226 (pCi/g): 2.61
- Gamma radiation measurements (cpm): 16,235

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Appendix E Cultural and Biological Resource Clearance Documents

BIOLOGICAL EVALUATION

For the Proposed:

Alongo Mines
Abandon Uranium Mine Project

Sponsored by:

MWH Global / Stantec

Prepared by:

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1. INTRODUCTION AND PROJECT BACKGROUND

The federal Endangered Species Act (ESA) of 1973, 16 U.S.C. §1531 et seq., requires all federal departments and agencies to conserve threatened, endangered, and critical and sensitive species and the habitats on which they depend, and to consult with the U.S. Fish and Wildlife Service (USFWS) on all actions authorized, funded, or carried out by each agency to ensure that the action will not likely jeopardize the continued existence of any threatened and endangered species or adversely modify critical habitat [USFWS 1998]. This report describes the potential for federal ESA-listed species and Navajo Nation Endangered Species List (NESL) endangered, threatened, candidate, or otherwise designated sensitive flora and fauna to occur in the proposed action area. The action area with regard to the ESA is defined as any area that may be directly or indirectly impacted by the proposed action [50 CFR §402.02]. This report is intended to provide the responsible official with information to make determinations of effect on species with special conservation status.

As the result of settlement by the United States, the US established funding to address certain abandoned uranium mines located across Navajo lands. For this funding, scientific investigation of these sites is required prior to potential remediation activities in the future. MWH Global, a division of Stantec (MWH), will conduct exploratory activities at the Alongo Mines abandoned uranium mine (AUM) such as pedestrian gamma surveys, mapping, well sampling, and surface soil sampling within the mine claim boundaries and surrounding buffer zone. Subsequent earthwork and long term monitoring may be involved after final approval by the Navajo Nation Environmental Protection Agency (NNEPA) in conjunction with the U. S. Environmental Protection Agency (USEPA).

In support of this project, MWH contracted Adkins Consulting, Inc. (ACI) to conduct surveys for ESA-listed fauna and Navajo Nation Endangered Species List (NESL) endangered, threatened, candidate, or otherwise designated sensitive fauna. MWH contracted Redente Ecological Consultants (Redente) to conduct surveys for NESL and ESA-listed plant species. The results of the 2016 Redente biological investigations will be incorporated in Sections 4.2 and 4.3 of this report and can be found in entirety attached as Appendix C.

The objectives of the biological surveys were as follows:

- To compile a list of ESA-listed or NESL species potentially occurring in the proposed action area.
- To provide a physical and biological description of the proposed action area.
- To determine the presence of ESA-listed or NESL species in the proposed action area.
- To assess potential impacts the proposed action may have on any ESA-listed or NESL species present in the area.
- To assess potential impacts to species protected under the Migratory Bird Treaty Act (MBTA).

2. PROJECT DESCRIPTION

2.1. Location

The Alongo Mines site is located in San Juan County New Mexico, approximately 20 miles west-southwest of Shiprock, NM at an elevation of approximately 5,400 feet. Global Positioning System coordinates are 36°42'26” N by 109°0'34” W NAD 83. The site is located on Navajo Tribal Trust Lands within the Bureau of Indian Affairs (BIA) Shiprock Agency. The legal description of the project surface location is as follows: Section 36, Township 29 North, Range 21 West, New Mexico Principal Meridian. Project area maps are provided in Appendix A.

2.2. Estimated Disturbance

MWH proposes a phased approach to scientific investigations at the Alongo Mines AUM. The study area encompasses the claim boundary and a 100-foot perimeter buffer zone for a total of approximately 15.3 acres. Please refer to Appendix A for maps delineating the mine claim boundary and buffer zone.

The project will also include a walkover survey for gamma radiation across a small area known as the “background area”. Please refer to Appendix A for a map of the background sample areas. A few soil samples approximately 3 inches in diameter and up to 6 inches deep will be collected by hand in these areas.

- Phase I: Spring of 2016 activity would entail pedestrian biological surveys and land surveying. Fall of 2016 work would entail pedestrian activity including gamma surveys, mapping, well sampling, and surface soil sampling. In 2016 there will be a maximum of 5 people onsite for no more than 5 to 7 days. Surface disturbance would be minimal and noise would be light.

- Phase II: Beginning in 2017, equipment including an excavator or small mobile drilling unit may be used to collect one or more soil samples. Up to 8 people may be onsite all day for a period of one week. Equipment travel would be confined to a temporary travel corridor approximately 20 feet in width. Within the travel corridor, vegetation and surface soil would sustain some disturbance but would not be bladed or bulldozed. During Phase II, noise may be moderate for a short duration, and surface disturbance will be light to moderate but confined to a minimal footprint within the study area. No permanent structures will be left on site.

3. AFFECTED ENVIRONMENT

3.1. Proposed Project Area (PPA)

The proposed project area (PPA) at Alongo Mines includes the mine boundary and a 100-foot perimeter buffer zone for a total of approximately 15.3 acres. The affected environment or action area includes any area that may be directly or indirectly impacted by the proposed activities. Project area maps are provided in Appendix A.

3.1.1. Environmental Setting

Project activities would occur in northwestern New Mexico within the USEPA designated Arizona/New Mexico Plateau Level III Ecoregion. The Arizona/New Mexico Plateau occurs primarily in Arizona, Colorado, and New Mexico, with a small portion in Nevada. This ecoregion is approximately 45,870,500 acres, and the elevation ranges from 2,165 to 11,949 feet. The ecoregion’s landscapes include low mountains, hills, mesas, foothills, irregular plains, alkaline basins, some sand dunes, and wetlands. This ecoregion is a large transitional region between the semiarid grasslands to the east, the drier shrublands and woodlands to the north, and the lower, hotter, less vegetated areas to the west and south.

The Alongo Mines PPA is located on the eastern bank of Red Wash and approximately 0.5 mile northeast of Horse Mesa. Terrain within the PPA includes intermittent stream terrace, a deep cut bank on the east side of the wash, and a relatively flat area above the wash to the east.

Flora

Vegetation communities found within the region include shrublands with big sagebrush, rabbitbrush, winterfat, shadscale saltbush, and greasewood; and grasslands of blue grama, Western wheatgrass, green needlegrass, and needle-and-thread grass. Higher elevations may support piñon pine and juniper woodlands.

Within the floodplain of the Alongo Mines site are small tracks of arid riparian vegetation mainly comprised of discontinuous saltcedar (*Tamarix ramosissima*), rubber rabbitbrush (*Ericameria nauseosa*) and sporadic Russian olive (*Elaeagnus angustifolia*). The area outside of the wash floodplain is mainly scattered shrubs and grasses including blue grama (*Bouteloua gracilis*), alkali sacaton (*Sporobolus airoides*), Indian ricegrass (*Achnatherum hymenoides*), broom snakeweed (*Gutierrizia sarathrae*), shadscale saltbush (*Atriplex confertifolia*), and sagebrush.

Fauna

Wildlife or evidence of wildlife observed within or near the PPA included turkey vulture (*Cathartes aura*), common raven (*Corvus corax*), American kestrel (*Falco sparverius*), prairie falcon (*Falco mexicanus)*, and cottontail rabbit (S*ylvilagus* sp.). No prairie dog (*Cynomys* sp.) burrows were recorded within the PPA or immediate vicinity. A prairie falcon flew into the canyon from the north and perched along the eastern cliff ledge and remained in the area for 20 minutes then flew down the canyon to the south. Surveyors observed a pair of American kestrels perched toward the southwest corner of the site. They were perched on a series of ledges and periodically flew around the area and returned to the perch site; light whitewash was seen around the perch site. Further analysis of sensitive species can be found in Section 4 of this document.

Hydrology/Wetlands

Under Executive Orders 11988 and 11990, Federal agencies are required to minimize the destruction, loss, or degradation of wetlands and floodplains, and preserve and enhance their natural and beneficial values. These habitats should be conserved through avoidance, or mitigated to ensure that there would be no net loss of wetlands function and value.

There is a small strip of arid riparian vegetation in the PPA. The area is dominated by stunted woody vegetation, discontinuous saltcedar (*Tamarix ramosissima*) and scattered willows (*Salix* sp.). The water regime is characterized by intermittent flooding.

Run-off from precipitation in the project area drains west into Red Wash. Red Wash joins the San Juan River approximately 15 miles north of the project area. The proposed project activities would contribute to a negligible increase in sedimentation down gradient of the project area. This increase is not anticipated to be a factor due to the distance from perennial waters. There is no suitable habitat for ESA-listed fish, nor critical habitats thereof, within 15 miles of the PPA.

Cumulative impacts to surface waters would be negligible. Surface-disturbing activities other than the proposed action that may cause accelerated erosion include, but are not limited to, construction of roads, other facilities, and installation of trenches for utilities; road maintenance such as grading or ditch-cleaning; public recreational activities; vegetation manipulation and management activities; natural and prescribed fires; and livestock grazing. Because the proposed action would have a negligible impact to downstream surface water quality, the cumulative impact also would be negligible when added to other past, present, and reasonably foreseeable activities.

4. THREATENED, ENDANGERED, AND SENSITIVE SPECIES EVALUATION

The Endangered Species Act (ESA) of 1973 requires all federal departments and agencies to conserve threatened, endangered, and critical and sensitive species and the habitats on which they depend, and to consult with the U.S. Fish and Wildlife Service (USFWS) on all actions authorized, funded, or carried out by the agency to ensure that the action will not likely jeopardize the continued existence of any threatened and endangered species or adversely modify critical habitat.

4.1. Methods

4.1.1. *Off-site Methods*

Prior to conducting fieldwork, ACI compiled data on animal species listed under the ESA. Informal consultation was initiated by requesting an Official Species List from the USFWS Information, Planning, and Conservation System (IPaC) website (http://ecos.fws.gov/ipac/). ACI received the Official Species List (02ENNM00-2016-SLI-0465) on April 20, 2016. See Table 1 for USFWS-listed threatened, endangered, or candidate species with potential to occur in the PPA.

The Navajo Nation Department of Fish and Wildlife (NNDFW), Navajo Natural Heritage Program (File # 15mwh101) sent MWH a NESL information letter dated 29 December, 2015. The letter suggests biologists determine habitat suitability within the project area for the provided list of species of concern with potential to occur on the 7.5-minute quadrangles containing the project boundaries. The Navajo species of concern listed in the NESL information letter are included in Table 2.a below.

In addition to the above listed species, ACI reviewed species protected under the MBTA with potential to occur in the proposed project and action area (Table 3).

4.1.2. *On-site Survey Methods*

An on-site pedestrian survey was conducted in April 2016 by ACI personnel under a permit issued by NNDFW. The purpose of the survey was to assess habitat potential for ESA-listed or NESL animal species. Field biologists with considerable experience identifying local wildlife species lead survey crews. The survey consisted of walking transects ten feet apart throughout the PPA including a survey buffer of approximately 50 feet beyond the PPA edge of disturbance. The surrounding areas were visually inspected with binoculars for nests, raptors, or past signs of raptor use. Weather conditions were clear and visibility was good.

Follow up surveys were conducted at the site specifically targeting Golden eagle (*Aquila chrysaetos*), Ferruginous hawk (*Buteo regalis*), and American peregrine falcon (*Falco peregrinus*) following Navajo Natural Heritage Program (NNHP) guidelines. All wildlife species observed in the action area were recorded, and digital photos were taken (Appendix B). Follow up survey details including date, site conditions and methods can be found on summary sheets attached as Appendix E.

Redente conducted surveys for plant species of concern. The results of the 2016 Redente biological investigations will be incorporated in Sections 4.2 and 4.3 of this report and can be found in entirety attached as Appendix C.

4.2. ESA-Listed Species Analysis and Results

4.2.1. *Species from the USFWS IPaC Official Species List*

Table 1 includes ESA-listed species that have the potential to occur in the project area based on the USFWS IPaC Official Species List. Biologists evaluated habitat suitability within and surrounding the PPA for the species in Table 1.

Table 1: USFWS IPaC Official Species List for the Alongo Mines Project

Species	Status	Occurrence Within Region	Habitat	Potential to Occur within Action Area
BIRDS				
Southwestern Willow Flycatcher (*Empidonax traillii extimus*)	Endangered with Designated Critical Habitat	Summer/breeding range.[2]	Breeds in dense riparian habitat.[2]	No potential. Action area does not provide appropriate dense riparian habitat for species to occur.

Table 1: USFWS IPaC Official Species List for the Alongo Mines Project

Species	Status	Occurrence Within Region	Habitat	Potential to Occur within Action Area
Western yellow-billed cuckoo (*Coccyzus americanus*)	Threatened	Possible rare summer/breeding occurrences.[2]	In the southwestern U.S., associated with riparian woodlands dominated by cottonwood or willow trees. In New Mexico, native or exotic species may be used.[2]	No potential. Action area does not provide appropriate woodland riparian habitat for species to occur.
FISHES				
Colorado pikeminnow *(Ptychocheilus lucius)*	Endangered	Upper Colorado River from WY to NM. On the Navajo Nation documented throughout the San Juan River (SJR), from Shiprock to Lake Powell; mouth of the Mancos River used during spring runoff.[3]	Backwaters and flooded riparian areas during spring runoff, and migrate large distances (15-64 km in the SJR) to spawn in riffle-run areas with cobble/gravel substrates. Young-of-year use warm backwaters along shorelines. Irrigation canals and ponds connected to SJR may be potential habitat.[3]	No potential. No perennial waters in or near the PPA. Action area is within the San Juan River watershed; however, negligible effects from the project to any drainage system are expected.
Razorback sucker (*Xyrauchen texanus*)	Endangered with Designated Critical Habitat	Restricted to the Colorado River and a few warm-water tributaries; rare in Colorado River in Marble Canyon and the mouth of the Little Colorado River, and San Juan arm of Lake Powell.	Pre- and post-spawning suckers mostly use low-flow areas (backwaters over sand and silt substrate, deep eddies, and impoundments). Young-of-year use warm backwaters along shorelines. Irrigation canals and ponds connected to San Juan River may be potential habitat.[3]	No potential. No perennial waters in or near the PPA. Action area is within the San Juan River watershed; however, negligible effects from the project to any drainage system are expected.
Zuni bluehead sucker (*Catostomus discobolus yarrowi*)	Endangered	Native to headwater streams of the Little Colorado River in east-central AZ and west-central NM; current range in NM is limited to the upper Río Nutria drainage.[2]	Low-velocity pools and pool-runs with seasonally dense perilithic and periphytic algae, particularly shady, cobble/boulder/bedrock substrates in streams with frequent runs and pools.[2]	No potential. Action area does not provide suitable habitat for species to occur.
MAMMALS				
Canada lynx (*Lynx canadensis*)	Threatened	Rocky Mountains	Moist boreal (spruce-fir) forests and in the western US, subalpine forests that have cold, snowy winters and a high-density snowshoe hare prey base.[1,2]	Project area does not provide suitable habitat for species to occur.

Table 1: USFWS IPaC Official Species List for the Alongo Mines Project

Species	Status	Occurrence Within Region	Habitat	Potential to Occur within Action Area
New Mexico meadow jumping mouse (*Zapus hudsonius luteus*)	Endangered	Endemic to New Mexico, Arizona, and a small area of southern Colorado.[1]	Nests in dry soils, but requires moist, streamside, dense riparian/wetland vegetation up to an elevation of about 8,000 feet; appears to only utilize two riparian community types: 1) persistent emergent herbaceous wetlands (i.e., beaked sedge and reed canary grass alliances); and 2) scrub-shrub wetlands (i.e., riparian areas along perennial streams that are composed of willows and alders). It especially uses microhabitats of patches or stringers of tall dense sedges on moist soil along the edge of permanent water.[1]	No potential. Action area does not provide appropriate dense riparian habitat for species to occur.
PLANTS				
Knowlton's Cactus (*Pediocactus knowltonii*)	Endangered	One viable population along Los Piños River in San Juan County.[2]	Occurs on tertiary alluvial deposits that have formed gravelly, dark, sandy loams on slopes or hills. It is found under the shade of trees and shrubs and in open areas in dry piñon-juniper woodlands at 1800-2000 m elevation. [2]	No potential. Action area does not provide suitable habitat for species to occur. No individuals found during Redente plant investigations.[4]
Mancos Milk-Vetch (*Astragalus humillimus*)	Endangered	Known from 20-square mile area in San Juan County.[2]	Occurs on Point Lookout and Cliff House sandstones, and tan Cretaceous sandstones of the Mesa Verde series.[2]	No potential. Action area does not provide suitable habitat for species to occur. No individuals found during Redente plant investigations.[4]
Mesa Verde Cactus (*Sclerocactus mesae-verdae*)	Threatened	Known from Hogback ACEC area and Navajo Nation in San Juan County.[2]	Dry low exposed hills and mesas in full sun of Mancos or Fruitland clays in the desert at about 1200-2000 m elevation.[2]	No potential. Action area does not provide suitable habitat for species to occur. No individuals found during Redente plant investigations.[4]

[1]USFWS; [2]NatureServe Explorer; [3]Navajo Endangered Species List, Species Accounts 2008; [4]Redente 2016

4.2.2. ESA-Listed Species Eliminated From Further Consideration

Table 1 includes ten (10) ESA-listed species that have the potential to occur in the project area based on the USFWS IPaC Official Species List. All ten (10) species have been eliminated from further discussion in this report because the action area does not provide suitable habitat for them to occur. None of the species in Table 1 were observed during surveys of the proposed project area or immediate surroundings. No species in Table 1, or critical habitats thereof, exist within or adjacent to the proposed project area. There would be no direct, indirect or cumulative impacts to the species in Table 1.

4.3. NESL Species Analysis and Results

4.3.1. Navajo Endangered Species List (NESL) and Species of Concern

Table 2.a lists species of concern with potential to occur on the 7.5-minute quadrangle(s) containing the project boundaries. According to the NESL information letter received from the NNFWD found in Appendix D, the golden eagle (*Aquila chrysaetos*) is known to occur within three miles of project site. Biologists evaluated the potential for the species of concern listed in the table below to occur within and surrounding the project area.

Additionally, the NESL information letter requested that the potential for black-footed ferret (*Mustela nigripes*) be evaluated if prairie dog towns of sufficient size (per NFWD guidelines) occur in the project area, and that potential for Parish's alkali grass (*Puccinellia parishii*) be evaluated if wetland conditions exist that contain white alkaline crusts. Species listed by the USFWS in Table 1 are not reiterated here.

Table 2.a: Navajo Endangered Species List (NESL) and Species of Concern

Species	Status	Habitat Associations	Potential to Occur in Project or Action Area
ANIMALS			
Black-footed ferret (*Mustela nigripes*)	USFWS Endangered	Open habitat, including grasslands, steppe, and shrub steppe. Closely associated with prairie dog colonies. At least 40 hectares of prairie dog colony required to support one ferret.[1]	No potential. Action area does not provide suitable habitat for species to occur. Action area does not provide prairie dog colonies of sufficient size
Northern Leopard Frog (*Lithobates pipiens*)	NESL G2	Breeds in wetlands usually with permanent water and aquatic vegetation (especially cattails), ranging from irrigation ditches and small streams to rivers, and small ponds and marshes to lakes or reservoirs. In summer, commonly inhabits wet meadows and fields. Takes cover underwater, in damp niches, or in caves when inactive. Over winters usually underwater. Eggs are laid and larvae develop in shallow, still, permanent water (typically), generally in areas well exposed to sunlight.[3,4]	No potential. Action area does not provide suitable habitat for species to occur. Intermittent wash does not provide permanent and still water for breeding or egg development. No individuals observed during pedestrian surveys.
Mountain plover *(Charadrius montanus)*	NESL G4	Typically nests in flat (<2% slope) to slightly rolling expanses of grassland, semi-desert, or badland, in an area with short, sparse vegetation, large bare areas (often >1/3 of total area), and that is typically disturbed (e.g. grazed); may also nest in plowed or fallow cultivation fields. Nest is a scrape in dirt often next to a grass clump or old cow manure pile. Migration habitat is similar to breeding habitat.[2,3]	No potential. Action area does not provide suitable habitat for species to occur.
American peregrine falcon (*Falco peregrinus*)	NESL G4 NM-T	Nests on steep cliffs >30 m tall (typically >45 m) in a scrape on sheltered ledges or potholes. Foraging	Action area provides potential foraging habitat for species to occur.

Species	Status	Habitat Associations	Potential to Occur in Project or Action Area
		habitat quality is an important factor; often, but not always, extensive wetland and/or forest habitat is within the falcon's hunting range of <=12 km. Nest in ledges or potholes on cliffs in wooded/forested habitats; Forage over riparian woodlands, coniferous & deciduous forests, shrublands, prairies. [3]	
Golden eagle (*Aquila chrysaetos*)	NESL G3	In the west, mostly open habitats in mountainous, canyon terrain. Nests primarily on cliffs. [3]	Action area provides potential foraging habitat for species to occur.
Ferruginous hawk (*Buteo regalis*)	NESL G3	Breed in open country, usually prairies, plains and badlands; semi- desert grass-shrub, sagebrush-grass & piñon-juniper plant associations. [3]	Action area provides potential foraging habitat for species to occur.
PLANTS			
Parish's alkali grass (*Puccinellia parishii*)	NESL G4 NM-E	Alkaline springs, seeps, and seasonally wet areas that occur at the heads of drainages or on gentle slopes. Elevation: 2600-7200 feet.[2,3]	No potential. Action area does not provide suitable habitat for species to occur. No individuals found during Redente plant investigations.[5]
Rydberg's Thistle (*Cirsium rydbergii*)	NESL G4	Hanging gardens, seeps and sometimes stream banks below hanging gardens, 3300-6500 ft. [3]	No potential. Action area does not provide suitable habitat for species to occur. No individuals found during Redente plant investigations.[5]
Alcove Bog-orchid (*Platanthera zothecina*)	NESL G3	Seeps, hanging gardens, and moist stream areas from the desert shrub to pinion-juniper & Ponderosa pine/mixed conifer communities. Known populations occur between 4000 and 7200ft elevation. [3]	No potential. Action area does not provide suitable habitat for species to occur. No individuals found during Redente plant investigations.[5]
Alcove Death Camass (*Zigadenus vaginatus*)	NESL G3	Hanging gardens in seeps and alcoves, mostly on Navajo Sandstone, 3700 – 6700ft. [3]	No potential. Action area does not provide suitable habitat for species to occur. No individuals found during Redente plant investigations.[5]
Navajo sedge *(Carex specuicola)*	USFWS Threatened	Typically found in seeps and hanging gardens, on vertical sandstone cliffs and alcoves. Known populations occur from 4600ft to 7200ft.[3]	No potential. Action area does not provide suitable habitat for species to occur. No individuals found during Redente plant investigations.[5]

Species are listed by the NESL as; Group 2: Endangered (survival or recruitment in jeopardy); Group 3: Endangered (survival or recruitment in jeopardy in foreseeable future); and Group 4: Species of Consideration. NESL Species with New Mexico State Endangered or Threatened status are labeled as NM-T or NM-E.

Sources: Sources: [1]New Mexico Natural Heritage Program 2010, [2]NatureServe Explorer; [3]Navajo Endangered Species List, Species Accounts 2008, [4] IUCN Red List, [5]Redente 2016, [6] Hammerson et al 2004.

4.3.2. NESL Species Eliminated From Further Consideration

Table 2.a includes eleven (11) NESL and Navajo Species of Concern that have the potential to occur in the project area based on the general geographical association. The following species have been eliminated from further discussion in this report because the action area does not provide suitable habitat for them to occur: Northern leopard frog (*Lithobates pipiens*), mountain plover *(Charadrius montanus),* black-footed ferret (*Mustela nigripes*), Parish's alkali grass *(Puccinellia parishii)*, Rydberg's thistle (*Cirsium rydbergii*), Navajo sedge (*Carex specuicola*), Alcove death camass (*Zigadenus vaginatus*), and Alcove bog orchid (*Platanthera zothecina*). None of these species were observed during surveys of the proposed project area or immediate surroundings. There would be no direct, indirect or cumulative impacts to these species.

4.3.3. NESL Species Warranting Further Analysis

Table 2.b lists NESL and Navajo Species of Concern with potential to occur within the proposed project area based on habitat suitability or actual record of observation.

Table 2.b: NESL and Navajo Species of Concern Warranting Further Analysis

Species	Status	Habitat Associations	Potential to Occur in Project or Action Area
ANIMALS			
Golden eagle (*Aquila chrysaetos*)	NESL G3	In the west, mostly open habitats in mountainous, canyon terrain. Nests primarily on cliffs.[3]	Action area provides potential foraging habitat for species to occur.
Ferruginous hawk (*Buteo regalis*)	NESL G3	Breed in open country, usually prairies, plains and badlands; semi-desert grass-shrub, sagebrush-grass & piñon-juniper plant associations. [3]	Action area provides potential foraging habitat for species to occur.
American peregrine falcon (*Falco peregrinus*)	NESL G4 NM-T	Nests on steep cliffs >30 m tall (typically >45 m) in a scrape on sheltered ledges or potholes. Foraging habitat quality is an important factor; often, but not always, extensive wetland and/or forest habitat is within the falcon's hunting range of <=12 km. Nest in ledges or potholes on cliffs in wooded/forested habitats; Forage over riparian woodlands, coniferous & deciduous forests, shrublands, prairies. [3]	Action area provides potential foraging habitat for species to occur.

Species are listed by the NESL as; Group 2: Endangered (survival or recruitment in jeopardy); Group 3: Endangered (survival or recruitment in jeopardy in foreseeable future); and Group 4: Species of Consideration. NESL Species with New Mexico State Endangered or Threatened status are labeled as NM-T or NM-E.

Sources: [1]New Mexico Natural Heritage Program 2010, [2]NatureServe Explorer; [3]Navajo Endangered Species List, Species Accounts 2008, [4] IUCN Red List, [5]Redente 2016, [6] Hammerson et al 2004.

4.4. Migratory Bird Species

The Migratory Bird Treaty Act (MBTA) implements various treaties and conventions between the U.S. and Canada, Japan, Mexico and the former Soviet Union for the protection of migratory birds. Under the Act, taking, killing or possessing migratory birds is unlawful.

The bald eagle (*Haliaeetus leucocephalus*) was delisted under the ESA on August 9, 2007. Both the bald eagle and golden eagle (*Aquila chrysaetos*) are still protected under the MBTA and Bald and Golden

Eagle Protection Act (BGEPA). The BGEPA affords both eagles protection in addition to that provided by the MBTA, in particular, by making it unlawful to "disturb" eagles.

In preparation for conducting the migratory bird survey, information from the New Mexico Partners In Flight website (http://www.hawksaloft.org/pif.shtml), the New Mexico PIF highest priority list of species of concern by vegetation type, the USFWS's Division of Migratory Bird Management website (http://www.fws.gov/migratorybirds/), and the 2002 Birds of Conservation Concern Report for the Southern Rockies/Colorado Plateau Bird Conservation Region (BCR) No. 16, were used to develop a list of high priority migratory bird species with potential to occur in the area of the proposed action. Species addressed previously will not be reiterated here.

Table 3: Priority Birds of Conservation Concern with Potential to Occur in the Project Area

Species Name	**Habitat Associations**	**Potential to Occur in the Project Area**
Black-throated sparrow (*Amphispiza bilineata*)	Xeric habitats dominated by open shrubs with areas of bare ground.	Suitable habitat is present within the action area for species to occur.
Brewer's sparrow (*Spizella breweri*)	Closely associated with sagebrush, preferring dense stands broken up with grassy areas.	No suitable habitat is present within the action area for species to occur.
Gray vireo (*Vireo vicinior*)	Open stands of piñon pine and Utah juniper (5,800 – 7,200 ft) with a shrub component and mostly bare ground; antelope bitterbrush, mountain mahogany, Utah serviceberry and big sagebrush often present. Broad, flat or gently sloped canyons, in areas with rock outcroppings, or near ridge-tops.	No suitable habitat is present within the action area for species to occur.
Loggerhead shrike (*Lanius ludovicianus*)	Open country interspersed with improved pastures, grasslands, and hayfields. Nests in sagebrush areas, desert scrub, and woodland edges.	No suitable habitat is present within the action area for species to occur.
Mountain bluebird (*Sialia currucoides*)	Open piñon-juniper woodlands, mountain meadows, and sagebrush shrublands; requires larger trees and snags for cavity nesting.	No suitable habitat is present within the action area for species to occur.
Mourning dove (*Zenaida macroura*)	Open country, scattered trees, and woodland edges. Feeds on ground in grasslands and agricultural fields. Roost in woodlands in the winter. Nests in trees or on ground.	No suitable habitat is present within the action area for species to occur.
Sage sparrow (*Amphispiza belli*)	Large and contiguous areas of tall and dense sagebrush. Negatively associated with seral mosaics and patchy shrublands and abundance of greasewood.	No suitable habitat is present within the action area for species to occur.
Sage thrasher (*Oreoscoptes montanus*)	Shrub-steppe dominated by big sagebrush.	Marginal habitat is present within the action area for species to occur. Lack of significant sagebrush shrubland likely a limiting factor.
Scaled quail (*Callipepla squamata*)	Brushy arroyos, cactus flats, sagebrush or mesquite plains, desert grasslands, Plains grasslands, and agricultural areas. Good breeding habitat has a diverse grass composition, with varied forbs and scattered shrubs.	No suitable habitat present within the action area for species to occur. Lack of diverse grass composition with varied forbs likely a limiting factor.
Swainson's hawk (*Buteo swainsoni*)	A mixture of grassland, cropland, and shrub vegetation; nests on utility poles and in isolated trees in rangeland. Nest densities higher in agricultural areas.	Marginal habitat is present within the action area for species to occur.

Vesper sparrow (*Pooecetes gramineus*)	Dry montane meadows, grasslands, prairie, and sagebrush steppe with grass component; nests on ground at base of grass clumps.	No suitable habitat present within the action area for species to occur. Lack of significant grassland/prairie component a limiting factor.
Bald eagle (*Haliaeetus leucocephalus*)	Near lakes, rivers and cottonwood galleries. Nests near surface water in large trees. May forage terrestrially in winter	No suitable habitat present within the action area for species to occur.
Bendire's thrasher (*Toxostoma bendirei*)	Typically inhabits sparse desert shrubland & open woodland with scattered shrubs; breeds in scattered locations in AZ, central & western portions of NM; most common in southwest NM.	No suitable habitat is present within the action area for species to occur.
Piñon jay (*Gymnorhinus cyanocephalus*)	Foothills throughout CO and NM wherever large blocks of piñon-juniper woodland habitat occurs.	No suitable habitat present within the action area for species to occur.
Prairie falcon (*Falco mexicanus*)	Arid, open country, grasslands or desert scrub, rangeland; nests on cliff ledges, trees, power structures.	Action area provides potential foraging and nesting habitat for species to occur. Individual seen perched in action area.
Western burrowing owl (*Athene cunicularia*)	Open grasslands and sometimes other open areas (such as vacant lots). Nests in abandoned burrows, such as those dug by prairie dogs.	No suitable habitat present within the action area for species to occur.

5. EFFECTS ANALYSIS

Effects or impacts can be either long term (permanent or residual) or short term (incidental or temporary). Short-term impacts affect the environment for only a limited period and then the environment reverts rapidly back to pre-action conditions. Long-term impacts are substantial and permanent alterations to the pre-existing environmental condition. Direct effects are those effects that are caused by the action and occur in the same time and place as the action. Indirect effects are those effects that are caused by or will result from the proposed action and are later in time but still reasonably certain to occur [USFWS 1998].

5.1. Direct and Indirect Effects

The PPA at Alongo Mines includes the ERT mine boundary and a 100-foot perimeter buffer zone for a total of approximately 15.3 acres. The project will also include a walkover survey for gamma radiation across a small area known as the "background area" (see Appendix A for map). A few soil samples approximately 3 inches in diameter and up to 6 inches deep will be collected by hand in these areas. The proposed action would result in a short term increase in human activity within the PPA at varying degrees depending on the project phase:

- Phase I: Spring of 2016 activity would entail pedestrian biological surveys and land surveying. During 2016, work would entail pedestrian activity including gamma surveys, mapping, well sampling, and surface soil sampling. For this phase, there will be a maximum of 5 people onsite for no more than 5 to 7 days. Surface disturbance would be minimal and noise would be light.

- Phase II: Beginning in 2017, equipment including an excavator or small mobile drilling unit may be used to collect one or more soil samples. Up to 8 people may be onsite all day for a period of one week. Equipment travel would be confined to a temporary travel corridor approximately 20 feet in width. Within the travel corridor, vegetation and surface soil would sustain some disturbance but would not be bladed or bulldozed. During Phase II, noise may be moderate for a short duration, and surface disturbance will be light to moderate but confined to a minimal footprint within the study area. No permanent structures will be left on site.

Best Management Practices (BMPs) incorporated into project design will reduce potential impacts including: confining equipment travel to PPA boundary, minimizing travel corridors as much as practicable, limiting truck and equipment travel within the PPA when surfaces are wet and soil may become deeply rutted, and using previously disturbed areas for travel when possible. Additionally, precautions to preserve the integrity of the watercourse and vegetation such as the use of platforms if equipment must enter the wash will minimize potential impacts.

5.1.1. Golden eagle, Ferruginous hawk, American peregrine falcon

Due to the mobility of adult raptors and the lack of appropriate nesting sites in the vicinity of the proposed project area, it is unlikely that the proposed project would result in 1) injury to a raptor, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior. Short term audial and visual disturbances associated with the Phase II activity could cause minor indirect habitat loss by temporarily deterring raptors from using available habitat adjacent to the proposed project area.

5.1.2. Migratory Birds

The PPA encompasses approximately 15.3 acres of potential migratory bird habitat in the form of Great Basin Desert scrub, rocky ledges arid riparian vegetation. No trees would be removed as a result of the proposed project.

<u>Phase I:</u>
Noise and surface disturbance will be low during pedestrian survey activity. Adult migratory birds would not be directly impacted by Phase I because of their mobility and ability to avoid areas of human activity. Minor human presence during project activities within the breeding season may indirectly disturb or displace adults from nests and foraging habitats for a short period of time. Direct and indirect effects are expected to be short term and minor.

<u>Phase II:</u>
Adult migratory birds would not be directly harmed by the activities because of their mobility and ability to avoid areas of human activity. During Phase II, noise may be moderate but for a short duration, and surface disturbance will be light to moderate but confined to a minimal footprint within the study area. No permanent structures will be left on site. Direct impacts are more likely if surface disturbing activities occur during the breeding season (April 1 through August 15); however, surface disturbance will be confined to a minimal footprint (likely less than one acre) within the study area. The increased human presence during project activities within the breeding season may indirectly disturb or displace adults from nests and foraging habitats for a short period of time.

5.2. Cumulative Effects

Cumulative impacts of an action include the total effects on a resource or ecosystem. Cumulative effects in the context of the Endangered Species Act pertain to non-Federal actions, and are reasonably certain to occur in the action area [USFWS 1998].

5.2.1. Golden eagle, Ferruginous hawk, American peregrine falcon

Additional existing surface disturbances within the action area include unimproved access roads to the residences nearby, all-terrain vehicle use and active wildlife and livestock grazing. Local plant and animal pest control are also activities that may occur in the vicinity. These foreseeable actions would cumulatively impact raptors through habitat loss or contamination. Human activity may also increase available prey base if the activity leads to an increase in rodent population numbers. The intensity of indirect effects would be dependent upon the species, its life history, time of year and/or day and the type and level of human and vehicular activity is occurring.

5.2.2. Migratory Birds

With the implementation of BMPs discussed in Section 5.1, the cumulative impact of the proposed action on migratory birds would be low based on the minimal surface disturbance involved.

6. CONCLUSIONS

U.S. Fish and Wildlife Service Listed Species (USFWS)

ACI conducted informal consultation with the USFWS and received an Official Species List for the proposed project area. Qualified ACI biologists evaluated habitat suitability within and surrounding the PPA for these species and concluded the potential does not exist for USFWS-listed species to occur within the proposed project area. No further consultation with the USFWS is required.

Migratory Birds

The proposed action phases would result in varying degrees of noise and surface disturbance within approximately 15.3 acres of potential migratory bird habitat in the form of Great Basin Desert scrub, rocky ledges and arid riparian vegetation. During Phase I, noise and surface disturbance will be low during pedestrian survey activity. Direct and indirect effects are expected to be short term and negligible. For Phase II, the total surface disturbance is unknown at this point; however equipment movement would be confined to only a few temporary travel corridors. Within the travel corridors, vegetation and surface soil would sustain some disturbance but would not be bladed or bulldozed. Possible direct impacts would be short term and are more likely if surface disturbing activities occur during the breeding season (April 1 through August 15). Effects to potential habitat for migratory birds are anticipated to be minor and short term; however, precautions should be taken to preserve the integrity of the watercourse and vegetation.

Wetlands

Under Executive Orders 11988 and 11990, Federal agencies are required to minimize the destruction, loss, or degradation of wetlands and floodplains, and preserve and enhance their natural and beneficial values. These habitats should be conserved through avoidance, or mitigated to ensure that there would be no net loss of wetlands function and value. There is a small strip of arid riparian vegetation in the PPA. The area is dominated by stunted woody vegetation, discontinuous saltcedar (*Tamarix ramosissima*) and scattered willows (*Salix* sp.). The water regime is characterized by intermittent flooding.

The proposed project activities would contribute to a negligible increase in sedimentation down gradient of the project area. This increase is not anticipated to be a factor due to the distance from perennial waters. There is no suitable habitat for ESA-listed fish, nor critical habitats thereof, within 15 miles of the PPA.

Navajo Endangered Species List (NESL) and Species of Concern

Three (3) NESL and Navajo species of concern have potential to occur within of near the PPA based on habitat suitability or actual record of observation. Based on site surveys, ACI determined the PPA contains potential foraging habitat for the following: American peregrine falcon, golden eagle and ferruginous hawk.

Potential effects to these species are discussed in detail in Section 5 above. The short term increased human activity and ground disturbance associated with Phase II of the project may have some impact on these species; however, with the implementation of recommendations discussed in Section 7 below, it is unlikely that the proposed action would result in detriment to the three (3) NESL and Navajo species of concern.

7. RECOMMENDATIONS FOR AVOIDANCE

ACI recommends that the proponent implement Best Management Practices (BMPs) designed to protect vegetation and sensitive wildlife species during project activities including: confining equipment travel to PPA boundary, minimizing travel corridors as much as practicable, limiting truck and equipment travel within the PPA when surfaces are wet and soil may become deeply rutted, and using previously disturbed areas for travel when possible.

Additionally, precautions to preserve the integrity of the watercourse and vegetation such as the use of platforms if equipment must enter the wash will minimize potential impacts.

8. SUPPORTING INFORMATION

8.1. Consultation and Coordination

John Nystedt, Fish and Wildlife Biologist/AESO Tribal Coordinator
USFWS AZ Ecological Services Office - Flagstaff Suboffice
Southwest Forest Science Complex, 2500 S Pine Knoll Dr, Rm 232
Flagstaff, AZ 86001

Pam Kyselka, Project Reviewer and
Chad Smith, Zoologist
Navajo Nation Department of Fish and Wildlife
Natural Heritage Program
PO Box 1480
Window Rock, AZ 86515

8.2. Report Preparers and Certification

Adkins Consulting, Inc.
180 E. 12th Street, Unit 5
Durango, Colorado 81301
Lori Gregory, Biologist; Sarah McCloskey, Field Biologist; Arnold Clifford, Lead Field Biologist

It is believed by Adkins Consulting that the proposed action would not violate any of the provisions of the Endangered Species Act of 1973, as amended. Conclusions are based on actual field examination and are correct to the best of my knowledge.

1 August 2016

Lori Gregory
Wildlife Biologist
Adkins Consulting
505.787.4088

Date

8.3. References

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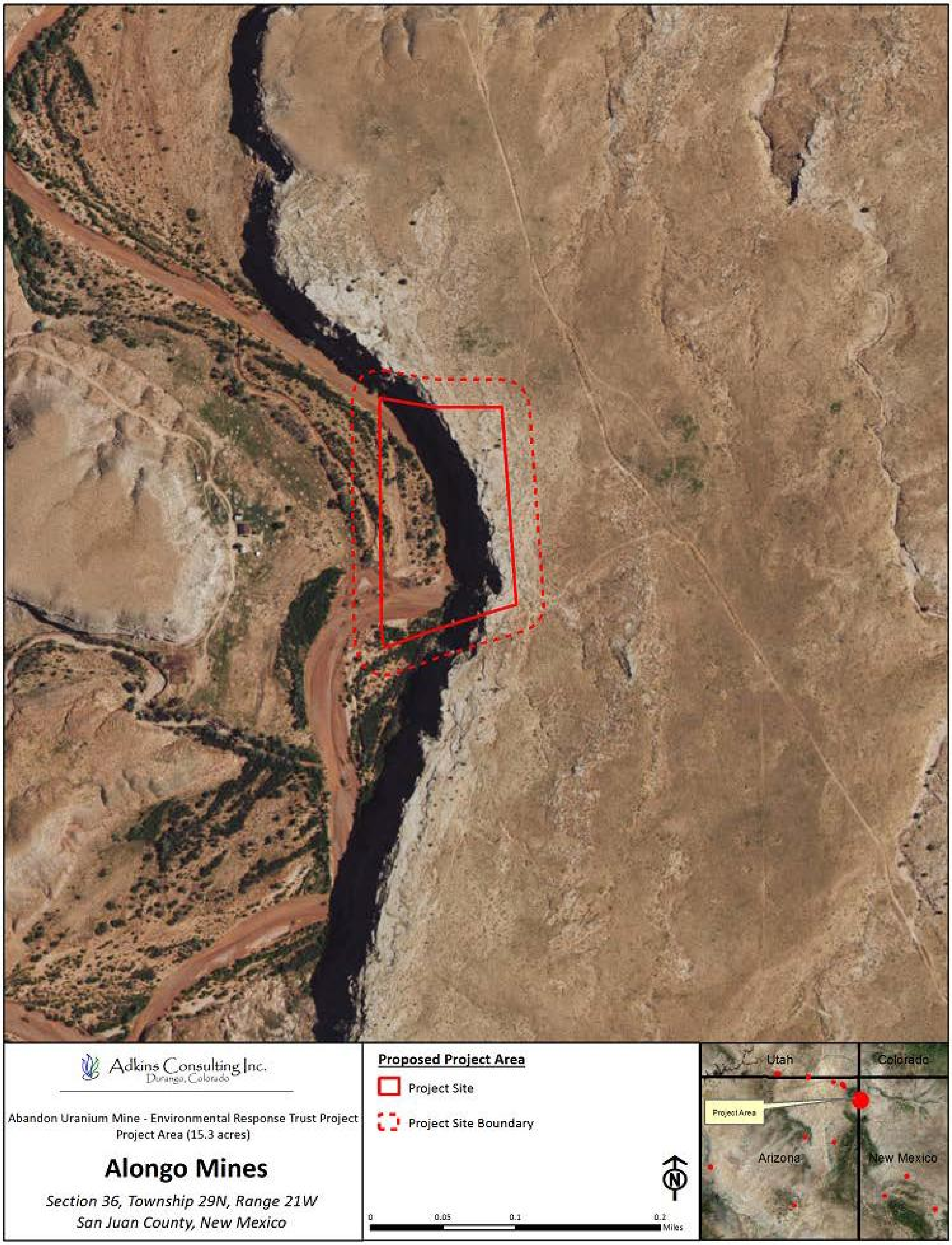
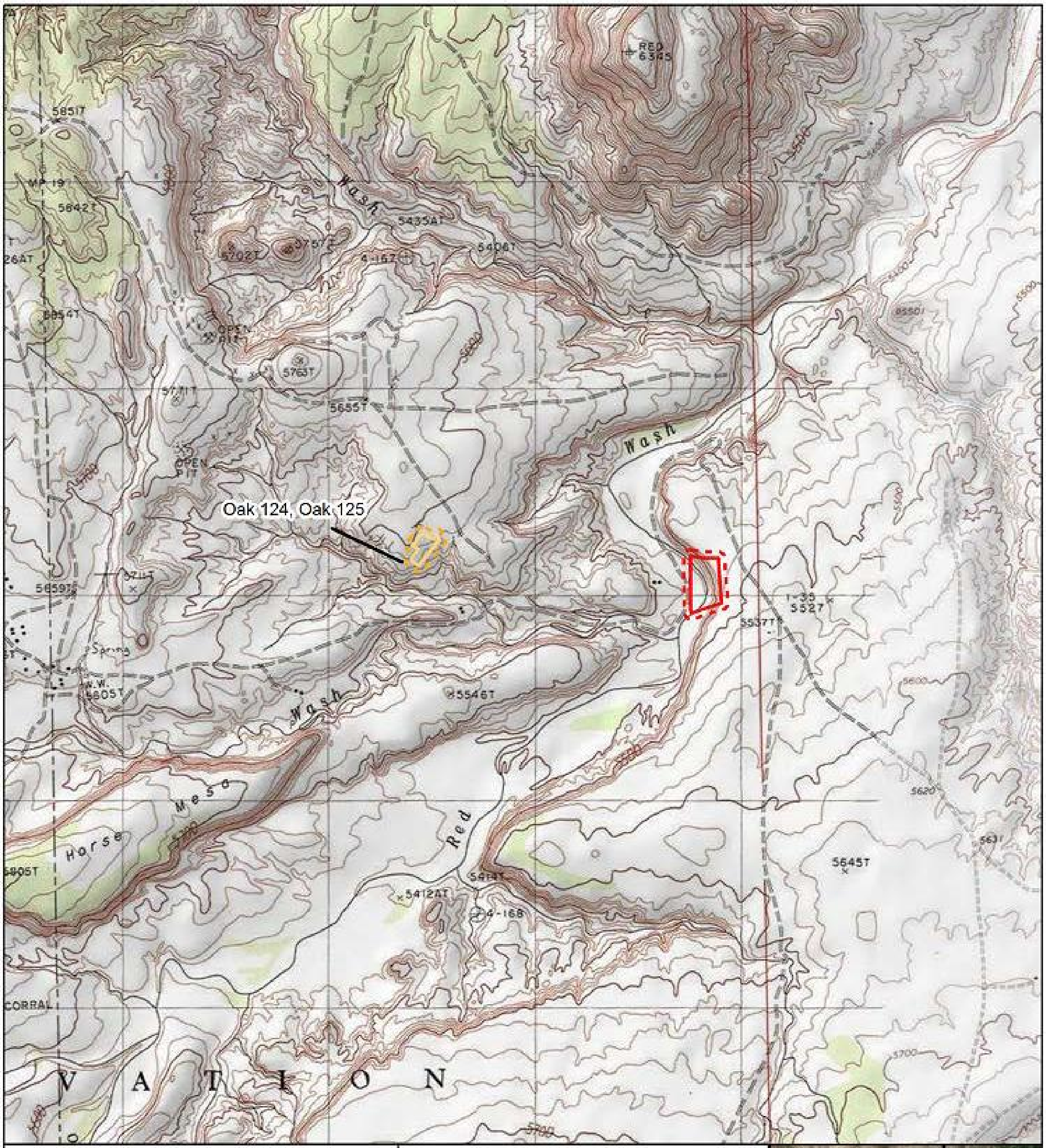
APPENDIX A. MAPS





Adkins Consulting Inc.
Durango, Colorado

Abandon Uranium Mine - Environmental Response Trust Project
Project Area (15.3 acres)

Alongo Mines

Sections 36, Township 29N, Range 21W
San Juan County, New Mexico

Proposed Project Area

- 🟥 Project Site
- ⬚ Project Site Boundary

N

0 0.25 0.5 1 Miles

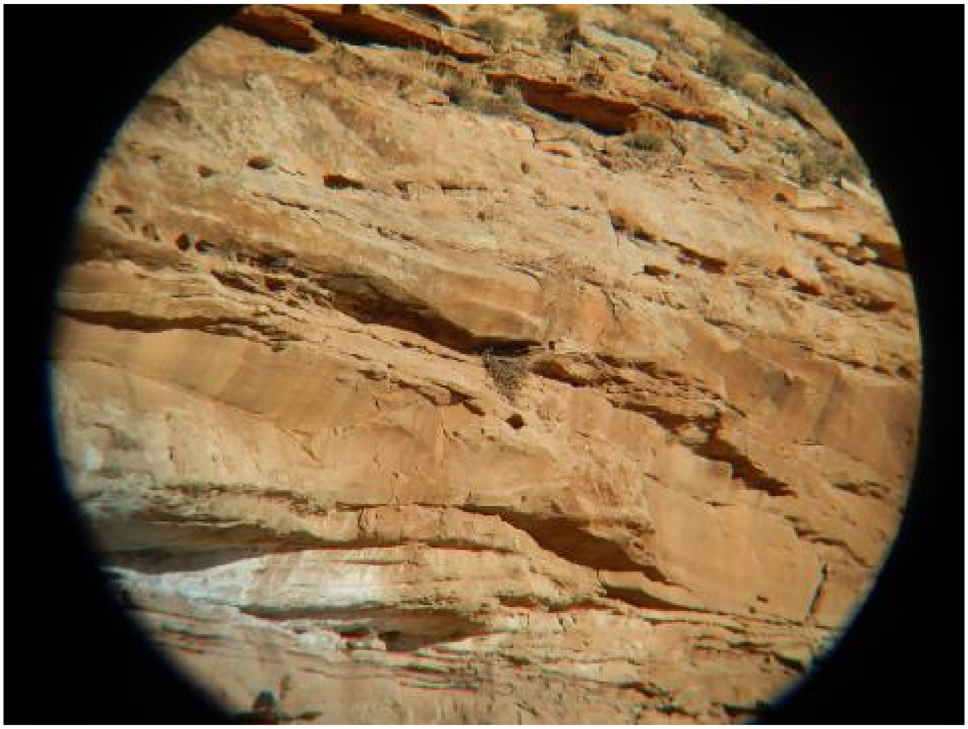
APPENDIX B. PHOTOGRAPHS

View from west of wash looking east

View from bottom of wash looking east

View north from the south-overview

View east from west side of wash



Raven nest

APPENDIX C. REDENTE PLANT SURVEY REPORT

Navajo Nation AUM Environmental Response Trust

Plant Survey Report for Species of Concern At Alongo Mines Project Site San Juan County, New Mexico August 2016

Prepared by:
Redente Ecological Consultants
1322 Alene Circle
Fort Collins, CO 80525

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    Land Use 2
REGULATORY SETTING 2
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INTRODUCTION

Purpose of Report

A biological survey was conducted at the Alongo Mines site as part of the Navajo Nation AUM Environmental Response Trust Project. The purpose of the survey is to determine if plant species of concern are present within the claim boundary and extending 100 feet around the site. Biological clearance is required at each site prior to any site investigation to determine if the project may affect potential species-of-concern or potential federal threatened and endangered (T&Es) species and/or critical habitat.

Site Location

Alongo Mines is located in San Juan County New Mexico, approximately 32 km (20 miles) west of Shiprock, New Mexico at an elevation of approximately 1,638 m (5,374 ft). Global Positioning System coordinates are 36° 42' 26" N by 109° 00' 35" W (North American Datum of 1983). The site is located on Tribal Trust Land (TTL).

Environmental Setting

Climate

The climate of the Alongo Mines site is classified as semi-arid, with an average annual precipitation of 200 mm (7.8 in) with the greatest precipitation months occurring in July and August (USDA 2001). Average annual temperature is 12.7° C (55° F).

Soils

The U.S. Department of Agriculture (USDA) Soil Survey for San Juan County was published in 2001 in cooperation with the Bureau of Indian Affairs and the Navajo Nation. This area of San Juan County is mainly escarpments separated by major riverwashes, with slopes that range from 8 to 45%. The general mapping unit for the area is Shalet-Rock Outcrop Complex and the soil type is Shalet; an eolian soil formed on eolian-mantled structural benches (USDA 2001). Typical features include escarpments of mesas with outcrops consisting of cliffs, spires and slickrock (USDA 2001).

Plant Community Type

The vegetation on the Alongo Mines site is part of the Colorado Plateau Shrub-Grassland type (USDA 2001). The most common species on the relatively flat upper portion of the site include blue grama (*Bouteloua gracilis*), alkali sacaton (*Sporobolus airoides*), galleta (*Pleuraphis jamesii*), Indian ricegrass (*Achnatherum hymenoides*), broom snakeweed (*Gutierrizia sarathrae*), shadscale saltbush (Atriplex confertifolia), Bigelow sagebrush (*Artemisia bigelovii*), and Mormon tea (*Ephedra viridis*), The most common species on the bottom portion of the cliff face and riverwash areas include blue grama, salt cedar (*Tamarix ramosissima*), big sagebrush (*Artemisia tridentata*), rubber rabbitbrush (*Ericameria nauseosa*), and Russian olive (*Elaeagnus angustifolia*).

Land Use

The land type on the Alongo Mines site is rangeland and the principal land use is livestock grazing.

REGULATORY SETTING

The survey for vegetation species-of-concern was conducted according to the Navajo Natural Heritage Program (NNHP) guidelines and the Endangered Species Act (ESA), including the procedures set forth in the *Biological Resource Land Use Clearance Policies and Procedures* (RCP), RCS-44-08 (NNDFW 2008), the Species Accounts document (NNHP 2008), and the USFWS survey protocols and recommendations. Data requests for species of concern were submitted to the NNHP and for federal T&E species to the USFWS. NNHP responded to the request for species of concern with a letter to MWH dated 19 November 2015. The letter provided a list of species of concern known to occur within the proximity of the project area. The list of species included their status as either NESL (Navajo Endangered Species List), Federally Endangered, Federally Threatened, or Federal Candidate. Species were further classified as G2, G3 or G4. G2 includes endangered species or subspecies whose prospects of survival or recruitment are in jeopardy. G3 includes endangered species or subspecies whose prospects of survival or recruitment are likely to be in jeopardy in the foreseeable future. G4 are “candidates” and includes those species or subspecies which may be endangered but for which we lack sufficient information to support being listed.

The Navajo Natural Heritage Program identified five plant species of concern that may occur in the project area—Alcove death camas (*Zigadenus vaginatus*), Parish's alkaligrass (*Puccinellia parishii*), Alcove bog-orchid (*Platanthera zothecina*), Rydberg's thistle (*Cirsium rydbergii*), and Navajo sedge (*Carex specuicola*). The USFWS listed Knowlton's cactus (*Pediocactus knowltonii*), Manco's milkvetch (*Astragalus humillimus*), and Mesa Verde cactus (*Sclerocactus mesae-verdae*) as additional threatened species that may occur in the area.

METHODS

Study Area

The area evaluated for plant species of concern was defined by the claim boundary, with an additional 100 foot buffer around all sides.

Database Queries and Literature Review

Prior to initiating field surveys, a target list of all potentially occurring species of concern identified by NNHP and the USFWS was compiled. Ecologic and taxonomic information was reviewed for each species prior to initiating field work to better understand ecological characteristics of the species, habitat requirements and key taxonomic indicators for proper identification (ANPS 2000).

Rare Plant Survey Protocols

The plant survey followed currently accepted resource agency protocols and guidelines, for conducting and reporting botanical inventories for special status plant species (USFWS 1996). According to these protocols, rare plant surveys were conducted by botanists with considerable experience with the local flora. All species observed during the surveys were identified to the degree necessary to correctly identify the species and determine if the plant had special status. The survey was conducted in the spring (May) and summer (July) of 2016 during the appropriate season to observe the phenological characteristics of the special status plant species that were necessary for identification (Table 1).

Table 1. Species of Concern and Survey Period

Species of Concern	Survey Period
Rydberg's thistle (*Cirsium rydbergii*)	May
Knowlton's cactus (*Pediocactus knowltonii*)	May
Manco's milkvetch (*Astragalus humillimus*)	May
Mesa Verde cactus (*Sclerocactus mesae-verdae*)	May
Parish's alkaligrass (*Puccinellia parishii*)	May
Alcove death camas (*Zigadenus vaginatus*)	July
Alcove bog-orchid (*Platanthera zothecina*)	July
Navajo sedge (*Carex specuicola*)	July

The botanical survey team was assisted during the survey by GIS trained staff from MWH with training specifically in the use of the Trimble GeoExplorer 6000 Series and the Garmin Montana 600. The GPS operator was also instructed in sight identification of species of concern to help delineate points or polygons and other data collection and data management tasks. GPS units were preloaded for the plant team with background and data files that showed the aerial photographic base map, the site boundaries, and the study area, so team members could clearly identify their exact location in the field at all times.

2016 Field Survey

The project site was surveyed by a field botanist. The botanist walked meandering "transect" lines through each area and looked for suitable habitat for these species, such as alkali seeps for *Puccinellia parishii,* seeps and hanging gardens for *Cirsium rydbergii, Platanthera zothecina, Zigadenus vaginatus* and *Carex specuicola*, rolling-gravelly hills for *Pediocactus knowltonii*, small depressions and sand-filled cracks in light colored sandstone on or near ledges and mesa tops for *Astragalus humillimus*, and clay–rich soils for *Sclerocactus mesae-verdae*. The most emphasis was placed in areas with suitable habitat for the species of concern. If a species of concern was identified, the location would be recorded using the point or polygon feature in the GPS units. Further, the population size was planned to be obtained either by direct counts, estimations, or by sampling the population.

Field botanists documented every field visit on field forms, by area, and took photographs of field conditions and species of concern, if found on site. The botanist also recorded all plant communities and plant species observed during each field visit. Plant community types were also photographed to document site conditions (Photos #1 and #2).

RESULTS

A total of 8 plant species of concern were identified as potentially occurring within the proximity of the project area. These species included *Zigadenus vaginatus*, *Puccinellia parishii*, *Platanthera zothecina*, *Cirsium rydbergii*, *Carex specuicola Pediocactus knowltonii*, *Astragalus humillimus*, and *Sclerocactus mesae-verdae*.

Zigadenus vaginatus is a native perennial forb that grows in hanging gardens in seeps and alcoves, mostly on Navajo sandstone. This species is endemic to the Colorado Plateau in southern Utah and northern Arizona at elevations between 1,127 and 2,042 m (3,698 and 6,999 ft). *Puccinellia parishii* is a native annual grass that grows in a series of widely disjunct populations ranging from southern California to eastern Arizona and western New Mexico in alkaline seeps, springs and seasonally wet areas and washes at elevations between 1,525 and 2,195 m (5,003 and 7,201 ft). *Platanthera zothecina* is a native perennial forb that grows in seeps, hanging gardens and moist stream areas from the desert shrub to the Pinyon-Juniper communities. This species is found in New Mexico, Utah and Arizona at elevations between 1,220 and 2,195 m (4,003 and 7,201 ft). *Cirsium rydbergii* is a native perennial forb that occurs in hanging gardens, seeps and stream banks below hanging gardens at elevations between 1,005 and 1,980 m (3,297 and 6,946 ft). Its distribution includes southern San Juan County along with Coconino and Apache Counties in Arizona. *Carex specuicola* is a native perennial grass-like plant that grows in seeps and hanging gardens primarily on sandstone cliffs and alcoves. Known populations occur at elevations between 1,402 and 2,195 m (4,600 and 7,201 ft) in San Juan County and northern Arizona. *Pediocactus knowltonii* is one of the rarest cacti in the U.S. and is known to occur only in a very limited area in San Juan County, New Mexico. Its habitat occurs on alluvial deposits that form rolling-gravelly hills dominated by pinyon, juniper and black sagebrush. *Astragalus humillimus* is a native perennial forb that grows in small depressions and sand-filled cracks in light colored sandstone on or near ledges and mesa tops in San Juan County New Mexico and Montezuma County Colorado between 1,500 and 1,800 m (4,921 and 5,905 ft). *Sclerocactus mesae-verdae* is a native cacti that grows in clay-rich soils on the tops of hills, on benches and slopes mostly in saltbush communities with low plant cover. It occurs in San Juan County in New Mexico and Montezuma County in Colorado at elevations between 1,493 and 1,675 m (4,898 and 5,945 ft).

The survey at Alongo Mines on May 7 and July 20, 2016 did not identify any of the eight species that have been listed as potential species of concern for this site. Many of the species occur in seeps, alcoves or hanging gardens (i.e. *Zigadenus vaginatus*, (*Puccinellia parishii*, *Platanthera zothecina*, *Cirsium rydbergii*, and *Carex specuicola*) that were not found on the site. There were seasonally wet areas, but there was no evidence of alkalinity on the soil surface from salt accumulation, a characteristic important for *Puccinellia parishii*. Habitat for *Pediocactus knowltonii*, *Astragalus humillimus*, and *Sclerocactus mesae-verdae* was not identified at Alongo Mines.

Photo #1—Overview of general landscape and plant community at Alongo Mines.

Photo #2—Overview of general landscape and plant community at Alongo Mines.

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Navajo Nation Department of Fish and Wildlife (NNDFW), 2008. Biological Resource Land Use Clearance Policies and Procedures, RCS-44-08. September 10.

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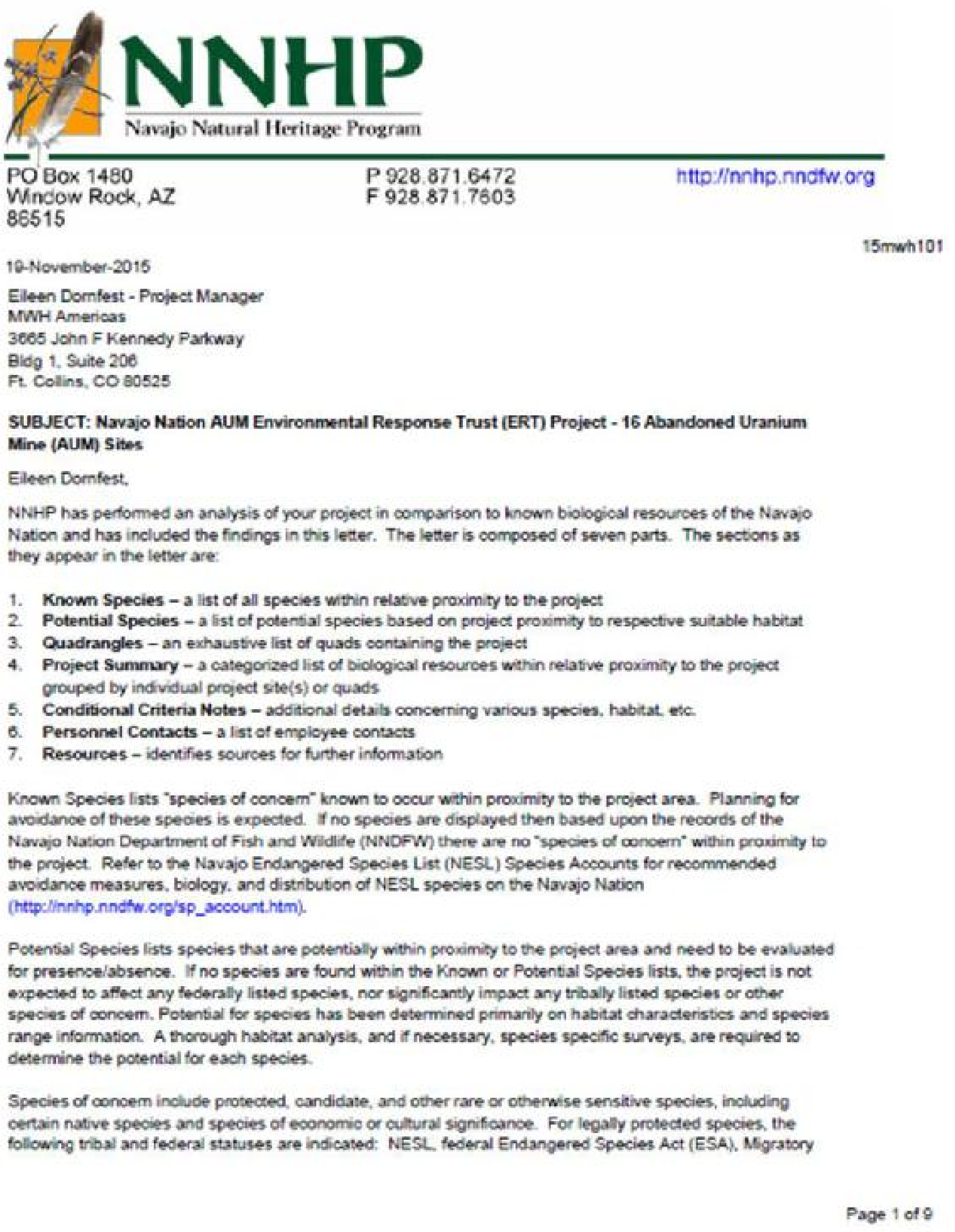
LIST OF PREPARERS

Redente, Edward F. Plant Ecologist. B.A., M.S. and Ph.D. Over 40 years of experience in plant ecology and plant survey studies throughout the semi-arid and arid western U.S. Author or Co-author of over 200 publications.

APPENDIX D. NESL LETTER



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Navajo Natural Heritage Program

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http://nnhp.nndfw.org

15mwh101

19-November-2015

Eileen Dornfest - Project Manager
MWH Americas
3665 John F Kennedy Parkway
Bldg 1, Suite 206
Ft. Collins, CO 80525

SUBJECT: Navajo Nation AUM Environmental Response Trust (ERT) Project - 16 Abandoned Uranium Mine (AUM) Sites

Eileen Dornfest,

NNHP has performed an analysis of your project in comparison to known biological resources of the Navajo Nation and has included the findings in this letter. The letter is composed of seven parts. The sections as they appear in the letter are:

1. **Known Species** – a list of all species within relative proximity to the project
2. **Potential Species** – a list of potential species based on project proximity to respective suitable habitat
3. **Quadrangles** – an exhaustive list of quads containing the project
4. **Project Summary** – a categorized list of biological resources within relative proximity to the project grouped by individual project site(s) or quads
5. **Conditional Criteria Notes** – additional details concerning various species, habitat, etc.
6. **Personnel Contacts** – a list of employee contacts
7. **Resources** – identifies sources for further information

Known Species lists "species of concern" known to occur within proximity to the project area. Planning for avoidance of these species is expected. If no species are displayed then based upon the records of the Navajo Nation Department of Fish and Wildlife (NNDFW) there are no "species of concern" within proximity to the project. Refer to the Navajo Endangered Species List (NESL) Species Accounts for recommended avoidance measures, biology, and distribution of NESL species on the Navajo Nation (http://nnhp.nndfw.org/sp_account.htm).

Potential Species lists species that are potentially within proximity to the project area and need to be evaluated for presence/absence. If no species are found within the Known or Potential Species lists, the project is not expected to affect any federally listed species, nor significantly impact any tribally listed species or other species of concern. Potential for species has been determined primarily on habitat characteristics and species range information. A thorough habitat analysis, and if necessary, species specific surveys, are required to determine the potential for each species.

Species of concern include protected, candidate, and other rare or otherwise sensitive species, including certain native species and species of economic or cultural significance. For legally protected species, the following tribal and federal statuses are indicated: NESL, federal Endangered Species Act (ESA), Migratory

Bird Treaty Act (MBTA), and Eagle Protection Act (EPA). No legal protection is afforded species with only ESA candidate, NESL group 4 status, and species listed on the Sensitive Species List. Please be aware of these species during surveys and inform the NNDFW of observations. Reported observations of these species and documenting them in project planning and management is important for conservation and may contribute to ensuring they will not be up listed in the future.

In any and all correspondence with NNDFW or NNHP concerning this project please cite the Data Request Code associated with this document. It can be found in this report on the top right corner of the every page. Additionally please cite this code in any biological evaluation documents returned to our office.

1. Known Species

(NESL=Navajo Endangered Species List, FE=Federally Endangered, FT=Federally Threatened, FC=Federal Candidate)

Species

AMPE = Amsonia peeblesii / Peebles' Blue-star NESL G4
AQCH = Aquila chrysaetos / Golden Eagle NESL G3
CASP = Carex specuicola / Navajo Sedge NESL G3 FT
LIPI = Lithobates pipiens / Northern Leopard Frog NESL G2
PEAMCI = Perognathus amplus cineris / Wupatki Pocket Mouse NESL G4
PUPA = Puccinellia parishii / Parish's Alkali Grass NESL G4

**All or parts of this project currently are within areas protected by the Golden and Bald Eagle Nest Protection Regulations; consult with NNDFW zoologist or EA Reviewer for more information and recommendations.

2. Potential Species

Species

ALGO = Allium gooddingii / Gooding's Onion NESL G3
AMPE = Amsonia peeblesii / Peebles' Blue-star NESL G4
AQCH = Aquila chrysaetos / Golden Eagle NESL G3
ASBE = Astragalus beathii / Beath Milk-vetch NESL G4
ASNA = Astragalus naturitensis / Naturita Milk-vetch NESL G3
ASWE = Asclepias welshii / Welsh's Milkweed NESL G3 FT
ATCU = Athene cunicularia / Burrowing Owl NESL G4
BURE = Buteo regalis / Ferruginous Hawk NESL G3
CASP = Carex specuicola / Navajo Sedge NESL G3 FT
CHMO = Charadrius montanus / Mountain Plover NESL G4
CIME = Cinclus mexicanus / American Dipper NESL G3
CIRY = Cirsium rydbergii / Rydberg's Thistle NESL G4
CYUT = Cystopteris utahensis / Utah Bladder-fern NESL G4
EMTREX = Empidonax traillii extimus / Southwestern Willow Flycatcher NESL G2 FE
ERAC = Erigeron acomanus / Acoma Fleabane NESL G3
ERRH = Erigeron rhizomatus / Rhizome Fleabane/zuni Fleabane NESL G2 FT
ERRO = Errazurizia rotundata / Round Dunebroom NESL G3
ERSI = Erigeron sivinskii / Sivinski's Fleabane NESL G4
FAPE = Falco peregrinus / Peregrine Falcon NESL G4
GIRO = Gila robusta / Roundtail Chub NESL G2
LENA = Lesquerella navajoensis / Navajo Bladderpod NESL G3
LIPI = Lithobates pipiens / Northern Leopard Frog NESL G2
MUNI = Mustela nigripes / Black-footed Ferret NESL G2 FE

PEAMCI = Perognathus amplus cineris / Wupatki Pocket Mouse NESL G4
PLZO = Platanthera zothecina / Alcove Bog-orchid NESL G3
PRSP = Primula specuicola / Cave Primrose NESL G4
PTLU = Ptchocheilus lucius / Colorado Pikeminnow NESL G2
PUPA = Puccinellia parishii / Parish's Alkali Grass NESL G4
SAPAER = Salvia pachyphylla ssp eremopictus / Arizona Rose Sage NESL G4
STOCLU = Strix occidentalis lucida / Mexican Spotted Owl NESL G3 FT
VUMA = Vulpes macrotis / Kit Fox NESL G4
ZIVA = Zigadenus vaginatus / Alcove Death Camass NESL G3

3. Quadrangles (7.5 Minute)

Quadrangles

Cameron SE (35111-G3) / AZ
Dalton Pass (35108-F3) / NM
Del Muerto (36109-B4) / AZ
Dos Lomas (35107-C7) / NM
Gallup East (35108-E6) / NM
Garnet Ridge (36109-H7) / AZ, UT
Horse Mesa (36109-F1) / AZ, NM
Indian Wells (35110-D1) / AZ
Mexican Hat SE (37109-A7) / UT, AZ
Oljeto (37110-A3) / UT, AZ
Toh Atin Mesa East (36109-H3) / AZ, UT
Toh Atin Mesa West (36109-H4) / AZ, UT

4. Project Summary *(EO1 Mile/EO 3 Miles=elements occuring within 1 & 3 miles., MSO=mexican spotted owl PACs, POTS=potential species, RCP=Biological Areas)*

SITE	EO1MI	EO3MI	QUAD	MSO	POTS	AREAS
Alongo Mines	None	AQCH	Horse Mesa (36109-F1) / AZ, NM	None	LIPI, FAPE, EMTREX, CHMO, BURE, ATCU, AQCH, ZIVA, PUPA, PLZO, CIRY, CASP	Area 3
Barton 3	None	None	Toh Atin Mesa West (36109-H4) / AZ, UT	None	PTLU, GIRO, EMTREX, CHMO, BURE, ATCU, AQCH, ZIVA, PLZO, CIRY, CASP	Area 3
Boyd Tisi No. 2 Western	None	AMPE, PEAMCI, LIPI	Cameron SE (35111-G3) / AZ	None	LIPI, PEAMCI, FAPE, EMTREX, BURE, AQCH, ERRO, ASBE, AMPE	Area 3
Charles Keith	None	None	Oljeto (37110-A3) / UT, AZ	None	LIPI, FAPE, EMTREX, CHMO, BURE, AQCH	Area 1, Area 3

SITE	EO1MI	EO3MI	QUAD	MSO	POTS	AREAS
Eunice Becenti	None	None	Gallup East (35108-E6) / NM	None	FAPE, EMTREX, ATCU, AQCH, LENA, ERSI, ERRH, ERAC	Area 3
Harvey Blackwater No. 3	AQCH	AQCH, PUPA	Garnet Ridge (36109-H7) / AZ, UT	None	VUMA, LIPI, FAPE, EMTREX, CIME, BURE, ATCU, AQCH, ZIVA, PUPA, PRSP, PLZO, CIRY, CASP, ASWE	Area 3
Harvey Blackwater No. 3	AQCH	AQCH, PUPA	Mexican Hat SE (37109-A7) / UT, AZ	None	VUMA, FAPE, EMTREX, ATCU, AQCH, ZIVA, PLZO, CIRY, CASP, ASWE	Area 1
Hoskie Tso No. 1	AQCH	AQCH	Indian Wells (35110-D1) / AZ	None	FAPE, CHMO, BURE, ATCU, AQCH, SAPAER	Area 3
Mitten No. 3	None	AQCH	Oljeto (37110-A3) / UT, AZ	None	LIPI, FAPE, EMTREX, CHMO, BURE, AQCH	Area 3
NA-0904	None	AQCH	Toh Atin Mesa East (36109-H3) / AZ, UT	None	STOCLU, LIPI, PTLU, GIRO, FAPE, EMTREX, CHMO, ATCU, AQCH, PUPA	Area 3
NA-0928	None	None	Toh Atin Mesa East (36109-H3) / AZ, UT	None	STOCLU, LIPI, PTLU, GIRO, FAPE, EMTREX, CHMO, ATCU, AQCH, PUPA	Area 3
Oak124, Oak125	AQCH	AQCH	Horse Mesa (36109-F1) / AZ, NM	None	LIPI, FAPE, EMTREX, CHMO, BURE, AQCH, ZIVA, PUPA, PLZO, CIRY, CASP	Area 3
Occurrence B	None	AQCH, CASP	Del Muerto (36109-B4) / AZ	None	LIPI, FAPE, EMTREX, CIME, AQCH, ZIVA, PLZO, CYUT, CIRY, CASP, ALGO	Area 3
Section 26 (Desiddero Group)	None	None	Dos Lomas (35107-C7) / NM	None	FAPE, CHMO, ATCU, AQCH	Area 3
Standing Rock	None	None	Dalton Pass (35108-F3) / NM	None	VUMA, MUNI, FAPE, CHMO, BURE, ATCU, AQCH, ERSI, ASNA	Area 3

SITE	EO1MI	EO3MI	QUAD	MSO	POTS	AREAS
Tsosie 1	AQCH	AQCH	Toh Atin Mesa East (36109-H3) / AZ, UT	None	STOCLU, LIPI, PTLU, GIRO, FAPE, EMTREX, CHMO, AQCH, PUPA	Area 1, Area 3

5. Conditional Criteria Notes *(Recent revisions made please read thoroughly. For certain species, and/or circumstances, please read and comply)*

A. **Biological Resource Land Use Clearance Policies and Procedures (RCP)** - The purpose of the RCP is to assist the Navajo Nation government and chapters ensure compliance with federal and Navajo laws which protect, wildlife resources, including plants, and their habitat resulting in an expedited land use clearance process. After years of research and study, the NNDFW has identified and mapped wildlife habitat and sensitive areas that cover the entire Navajo Nation.
The following is a brief summary of six (6) wildlife areas:
1.***Highly Sensitive Area*** – recommended no development with few exceptions.
2.***Moderately Sensitive Area*** – moderate restrictions on development to avoid sensitive species/habitats.
3.***Less Sensitive Area*** – fewest restrictions on development.
4.*Community Development Area* – areas in and around towns with few or no restrictions on development.
5.***Biological Preserve*** – no development unless compatible with the purpose of this area.
6.***Recreation Area*** – no development unless compatible with the purpose of this area.
None - outside the boundaries of the Navajo Nation
This is not intended to be a full description of the RCP please refer to the our website for additional information at http://www.nndfw.org/clup.htm.

B. **Raptors** – If raptors are known to occur within 1 mile of project location: Contact Chad Smith at 871-7070 regarding your evaluation of potential impacts and mitigation.
  - o **Golden and Bald Eagles**- If Golden or Bald Eagle are known to occur within 1 mile of the project, decision makers need to ensure that they are not in violation of the Golden and Bald Eagle Nest Protection Regulations found at http://nnhp.nndfw.org/docs_reps/gben.pdf.
  - o **Ferruginous Hawks** – Refer to "Navajo Nation Department of Fish and Wildlife's Ferruginous Hawk Management Guidelines for Nest Protection" http://nnhp.nndfw.org/docs_reps.htm for relevant information on avoiding impacts to Ferruginous Hawks within 1 mile of project location.
  - o **Mexican Spotted Owl** - Please refer to the Navajo Nation Mexican Spotted Owl Management Plan http://nnhp.nndfw.org/docs_reps.htm for relevant information on proper project planning near/within spotted owl protected activity centers and habitat.

C. **Surveys** – Biological surveys need to be conducted during the appropriate season to ensure they are complete and accurate please refer to NN Species Accounts http://nnhp.nndfw.org/sp_account.htm. Surveyors on the Navajo Nation must be permitted by the Director, NNDFW. Contact Jeff Cole at (928) 871-7068 for permitting procedures. Questions pertaining to surveys should be directed to the NNDFW Zoologist (Chad Smith) for animals at 871-7070, and Botanist (Andrea Hazelton) for plants at (928)523-3221. Questions regarding biological evaluation should be directed to Jeff Cole at 871-7068.

D. **Oil/Gas Lease Sales** – Any settling or evaporation pits that could hold contaminants should be lined and covered. Covering pits, with a net or other material, will deter waterfowl and other migratory bird use. Lining pits will protect ground water quality.

E. **Power line Projects** – These projects need to ensure that they do not violate the regulations set forth in the Navajo Nation Raptor Electrocution Prevention Regulations found at http://nnhp.nndfw.org/docs_reps/repr.pdf.

F. **Guy Wires** – Does the project design include guy wires for structural support? If so, and if bird species may occur in relatively high concentrations in the project area, then guy wires should be equipped with highly visual markers to reduce the potential mortality due to bird-guy wire collisions. Examples of visual markers include aviation balls and bird flight diverters. Birds can be expected to occur in relatively high concentrations along migration routes (e.g., rivers, ridges or other distinctive linear topographic features) or where important habitat for breeding, feeding, roosting, etc. occurs. The U.S. Fish and Wildlife Service recommends marking guy wires with at least one marker per 100 meters of wire.

G. **San Juan River** – On 21 March 1994 (Federal Register, Vol. 59, No. 54), the U.S. Fish and Wildlife Service designated portions of the San Juan River (SJR) as critical habitat for Ptychocheilus lucius (Colorado pikeminnow) and Xyrauchen texanus (Razorback sucker). Colorado pikeminnow critical habitat includes the SJR and its 100-year floodplain from the State Route 371 Bridge in T29N, R13W, sec. 17 (New Mexico Meridian) to Neskahai Canyon in the San Juan arm of Lake Powell in T41S, R11E, sec. 26 (Salt Lake Meridian) up to the full pool elevation. Razorback sucker critical habitat includes the SJR and its 100-year floodplain from the Hogback Diversion in T29N, R16W, sec. 9 (New Mexico Meridian) to the full pool elevation at the mouth of Neskahai Canyon on the San Juan arm of Lake Powell in T41S, R11E, sec. 26 (Salt Lake Meridian). All actions carried out, funded or authorized by a federal agency which may alter the constituent elements of critical habitat must undergo section 7 consultation under the Endangered Species Act of 1973, as amended. Constituent elements are those physical and biological attributes essential to a species conservation and include, but are not limited to, water, physical habitat, and biological environment as required for each particular life stage of a species.

H. **Little Colorado River** - On 21 March 1994 (Federal Register, Vol. 59, No. 54) the U.S. Fish and Wildlife Service designated Critical Habitat along portions of the Colorado and Little Colorado Rivers (LCR) for Gila cypha (humpback chub). Within or adjacent to the Navajo Nation this critical habitat includes the LCR and its 100-year floodplain from river mile 8 in T32N R6E, sec. 12 (Salt and Gila River Meridian) to its confluence with the Colorado River in T32N R5E sec. 1 (S&GRM) and the Colorado River and 100-year floodplain from Nautuloid Canyon (River Mile 34) T36N R5E sec. 35 (S&GRM) to its confluence with the LCR. All actions carried out, funded or authorized by a federal agency which may alter the constituent elements of Critical Habitat must undergo section 7 consultation under the Endangered Species Act of 1973, as amended. Constituent elements are those physical and biological attributes essential to a species conservation and include, but are not limited to, water, physical habitat, and biological environment as required for each particular life stage of a species.

I. **Wetlands** – In Arizona and New Mexico, potential impacts to wetlands should also be evaluated. The U.S. Fish & Wildlife Service's National Wetlands Inventory (NWI) maps should be examined to determine whether areas classified as wetlands are located close enough to the project site(s) to be impacted. In cases where the maps are inconclusive (e.g., due to their small scale), field surveys must be completed. For field surveys, wetlands identification and delineation methodology contained in the "Corps of Engineers Wetlands Delineation Manual" (Technical Report Y-87-1) should be used. When wetlands are present, potential impacts must be addressed in an environmental assessment and the Army Corps of Engineers, Phoenix office, must be contacted. NWI maps are available for examination at the Navajo Natural Heritage Program (NNHP) office, or may be purchased through the U.S. Geological Survey (order forms are available through the NNHP). The NNHP has complete coverage of the Navajo Nation, excluding Utah, at 1:100,000 scale; and coverage at 1:24,000 scale in the southwestern portion of the Navajo Nation. In Utah, the U.S. Fish & Wildlife Service's National Wetlands Inventory maps are not yet available for the Utah portion of the Navajo Nation, therefore, field surveys should be completed to determine whether wetlands are located close enough to the project site(s) to be impacted. For field surveys, wetlands identification and delineation methodology contained in the "Corps of Engineers Wetlands Delineation Manual" (Technical Report Y-87-1) should be used. When wetlands are present, potential impacts must be addressed in an environmental assessment and the Army Corps of Engineers, Phoenix office, must be contacted. For more information contact the Navajo Environmental Protection Agency's Water Quality Program.

J. **Life Length of Data Request** – The information in this report was identified by the NNHP and NNDFW's biologists and computerized database, and is based on data available at the time of this response. If project planning takes more than two (02) years from the date of this response, verification of the information provided herein is necessary. It should not be regarded as the final statement on the occurrence of any species, nor should it substitute for on-site surveys. Also, because the NNDFW information is continually updated, any given information response is only wholly appropriate for its respective request.

K. **Ground Water Pumping** - Projects involving the ground water pumping for mining operations, agricultural projects or commercial wells (including municipal wells) will have to provide an analysis on the effects to surface water and address potential impacts on all aquatic and/or wetlands species listed below. NESL Species potentially impacted by ground water pumping: Carex specuicola (Navajo Sedge), Cirsium rydbergii (Rydberg's Thistle), Primula specuicola (Cave Primrose), Platanthera zothecina (Alcove Bog Orchid), Puccinellia parishii (Parish Alkali Grass), Zigadenus vaginatus (Alcove Death Camas), Perityle specuicola (Alcove Rock Daisy), Symphyotrichum welshii (Welsh's American-aster), Coccyzus americanus (Yellow-billed Cuckoo), Empidonax traillii extimus (Southwestern Willow Flycatcher), Rana pipiens (Northern Leopard Frog), Gila cypha (Humpback Chub), Gila robusta (Roundtail Chub), Ptychocheilus lucius (Colorado Pikeminnow), Xyrauchen texanus (Razorback Sucker), Cinclus mexicanus (American Dipper), Speyeria nokomis (Western Seep Fritillary), Aechmophorus clarkia (Clark's Grebe), Ceryle alcyon (Belted Kingfisher), Dendroica petechia (Yellow Warbler), Porzana carolina (Sora), Catostomus discobolus (Bluehead Sucker), Cottus bairdi (Mottled Sculpin), Oxyloma kanabense (Kanab Ambersnail)

6. Personnel Contacts

Wildlife Manager
Sam Diswood
928.871.7062
sdiswood@nndfw.org

Zoologist
Chad Smith
928.871.7070
csmith@nndfw.org

Botanist
Vacant

Biological Reviewer
Pamela Kyselka
928.871.7065
pkyselka@nndfw.org

GIS Supervisor
Dexter D Prall
928.645.2898
prall@nndfw.org

Wildlife Tech
Sonja Detsoi
928.871.6472
sdetsoi@nndfw.org

7. Resources

National Environmental Policy Act

Navajo Endangered Species List:
http://nnhp.nndfw.org/endangered.htm

Species Accounts:
http://nnhp.nndfw.org/sp_account.htm

Biological Investigation Permit Application
http://nnhp.nndfw.org/study_permit.htm

Navajo Nation Sensitive Species List
http://nnhp.nndfw.org/study_permit.htm

Various Species Management and/or Document and Reports
http://nnhp.nndfw.org/docs_reps.htm

Consultant List
(Coming Soon)

Dexter D Prall

Digitally signed by Dexter D Prall
DN: cn=Dexter D Prall, o=Navajo Nation
Department of Fish and Wildlife, ou=Navajo
Natural Heritage Program,
email=prall@nndfw.org, c=US
Date: 2015.11.19 15:56:30 -07'00'

Dexter D Prall, GIS Supervisor - Natural Heritage Program
Navajo Nation Department of Fish and Wildlife

MWH
BUILDING A BETTER WORLD

November 18, 2015

TO:
Navajo Natural Heritage Program
Navajo Nation Dept. of Fish and Wildlife
ATTN: Sonja Detsoi and Dexter Prall
P.O. Box 1480
Window Rock, AZ 86515

FROM:
MWH Americas
ATTN: Eileen Dornfest, Project Manager
3665 John F Kennedy Parkway
Bldg 1, Suite 206
Ft. Collins, CO 80525
Phone: (970) 377-9410
Fax: (970) 377-9406
E-mail: Eileen.Dornfest@mwhglobal.com

SUBJECT: Request for T and E Information for 16 Abandoned Uranium Mine (AUM) Sites

PROJECT NAME:
Navajo Nation AUM Environmental Response Trust (ERT) Project

LOCATION:
16 AUM Sites (attached in GIS shape files and USGS topographic maps)

SUMMARY DESCRIPTION OF PROJECT:

The work is to be conducted at 16 Abandoned Uranium Mines (AUMs) and includes Removal Site Evaluations (RSEs) according to CERCLA at each of the Sites. The RSEs are site investigations that include the following activities:

- conducting background soil studies
- conducting gamma radiation scans of surface soils
- sampling surface and subsurface soils and sediments related to historic mining operations
- assessing radiation exposure inside mine operations buildings, homes, or other nearby structures (if present at the Sites)
- sampling existing and accessible groundwater wells
- mitigating physical hazards and other interim response actions
- preparing a final written report documenting the work performed and information obtained for each of the Sites

MWH

BUILDING A BETTER WORLD

TOPOGRAPHIC MAPS ATTACHED:

- Blue Gap Quadrangle, Arizona-Apache Co.
- Cameron SE Quadrangle, Arizona-Coconino Co.
- Cameron South Quadrangle, Arizona-Coconino Co.
- Del Muerto Quadrangel, Arizona-Apache Co.
- Five Buttes Quadrangle, Arizona-Navajo Co.
- Garnet Ridge Quadrangle, Arizona-Utah
- Horse Mesa Quadrangle, Arizona-New Mexico
- Indian Wells Quadrangle, Arizona-Navajo Co.
- Tah Chee Wash Quadrangle, Arizona-Apache Co.
- Toh Atin Mesa East Quadrangle, Arizona-Utah
- Toh Atin Mesa West Quadrangle, Arizona-Utah
- Bluewater Quadrangle, New Mexico
- Bread Springs Quadrangle, New Mexico-McKinley Co.
- Dalton Pass Quadrangle, New Mexico-McKinley Co.
- Dos Lomas Quadrangle, New Mexico
- Gallup East Quadrangle, New Mexico-McKinley Co.
- Sand Spring Quadrangle, New Mexico-San Juan Co.
- Standing Rock Quadrangle, New Mexico-McKinley Co.
- Mexican Hat SE Quadrangle, Utah-San Juan Co.
- Oljato Quadrangle, Utah-San Juan Co.

APPENDIX E. NOTES FROM SPECIES SPECIFIC SURVEYS

Adkins Consulting Inc.
Environmental Permitting Services

180 East 12 Street Suite #5
Durango, CO 81301
Phone: 505-793-1140

DAILY REPORT

Field Surveys

PROJECT NAME: NN AUM SITE: Alongo Mines

DATE: 4/21/16

WEATHER: Sunny, calm, temps mid 60’s

PERSONNEL ONSITE: Arnold Cifford (Principal Biologist), Sarah McCloskey (Field Assistant)

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CONTRACTORS ONSITE NOTES:

Background: During the previous habitat assessment survey, habitat was documented for Golden Eagles, Peregrine Falcons, Ferruginous Hawk and Burrowing Owls.

Purpose: In areas where suitable habitat occurs, a formal survey of the species is to be performed following Navajo Nation survey protocols[1] outlined below:

Golden Eagle – A single pedestrian survey with high-power optics for nest sites or breeding adults from 1 MAR-15 JUN.

Ferruginous Hawk – A single pedestrian survey with high-power optics for nest sites or breeding adults from 1 MAR-15 JUN.

Burrowing Owls - Survey during hours of first light to 11 am, and 3 hours before sunset to dusk; no surveys during excessive rain or above 32°C (90°F) ambient temperature. Conduct =2 diurnal transect surveys (transects spaced 10 m) in suitable habitat with high-powered optics during 15 MAR-31 JUL; record locations of all burrows with sign of recent owl use (presence of muting, pellets, and/or feathers at suitable burrow); scan area for owls every 100 m with binoculars; remove owl sign at potentially active burrows on first visit; check all potentially active burrows for fresh sign on second visit 2-8 days later.

Peregrine Falcons - Two 8 hours surveys (4 hours before sunset and 4 hours after sunrise the following day) during each period: 1 FEB-30 APR (surveys during egg-laying/incubation discouraged) & 1 MAY-31 JUL (2 survey preferably prior to JUL). Productivity surveys require >=1 additional visits.

Methods: Surveys were performed for Peregrine Falcon and Golden Eagle. It was determined upon re-evaluation that the site did not provide suitable habitat for Burrowing Owls, so no additional surveys for the species are necessary. Surveyors arrived at the project site at 4:25 p.m. and conducted a thorough survey of the project area. Surveys included establishing appropriate vantage points, remaining at those points for 20 to 30 minutes listening for calls and using high powered binoculars to examine cliff faces for signs of nesting (ex. whitewash, nests, single or pairs of adults remaining in the area, etc.) and continuing father down the canyon until dark. Surveyors left the site at 8:25 p.m.

Additional Information: This concludes the required surveys for the Golden Eagle and Ferruginous Hawk at the Alongo Mines site. Surveyors will revisit site tomorrow (4/22/16) to complete the morning portion of the Peregrine Falcon survey. One more complete Peregrine Falcon survey (evening and following morning) will be needed at the site before April 30th.

Findings: Observers located a raven nest with hatchlings along the eastern side of the site along a cliff ledge.

Adkins Consulting Inc.
Environmental Permitting Services

180 East 12 Street Suite #5
Durango, CO 81301
Phone: 505-793-1140

DAILY REPORT
Field Surveys

PROJECT NAME: NN AUM SITE: Alongo Mines

DATE: 4/22/16

WEATHER: Sunny, light winds, occasional gusts from 5- 10 mph, temps mid 60’s

PERSONNEL ONSITE: Arnold Clifford (Principal Biologist), Sarah McCloskey (Field Assistant)

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CONTRACTORS ONSITE NOTES:

Background: During the previous habitat assessment survey, habitat was documented for Golden Eagles, Peregrine Falcons, and Ferruginous Hawk. Surveys were completed for Golden Eagle and Ferruginous Hawk last night (4/21/16). The first of two Peregrine Falcon surveys was also completed this morning.

Purpose: In areas where suitable habitat occurs, a formal survey of the species is to be performed following Navajo Nation survey protocols[1] outlined below:

Peregrine Falcons - Two 8 hours surveys (4 hours before sunset and 4 hours after sunrise the following day) during each period: 1 FEB-30 APR (surveys during egg-laying/incubation discouraged) & 1 MAY-31 JUL (2 survey preferably prior to JUL). Productivity surveys require >=1 additional visits.

Methods: Surveyors arrived at the project site at 4:20 p.m. and conducted a thorough survey of the project area. Surveys included establishing appropriate vantage points, remaining at those points for 20 to 30 minutes listening for calls and using high powered binoculars to examine cliff faces for signs of nesting (ex. whitewash, nests, single or pairs of adults remaining in the area, etc.) and continuing father down the canyon until dark. Surveyors left the site at 8:20 p.m.

Additional Information: Tomorrow’s morning survey will complete the second of two required surveys before April 30th.

Findings: The raven nest located yesterday was still active. A Prairie Falcon flew into the canyon from the north and perched along the eastern cliff ledge and remained in the area for 20 minutes then flew farther down the canyon to the south. A pair of American Kestrels was seen towards the southwest corner of the site. They were perched on a series of ledges and periodically flew around the area and returned to the perch site, light whitewash was seen around the perch site.

Adkins Consulting Inc.
Environmental Permitting Services

180 East 12 Street Suite #5
Durango, CO 81301
Phone: 505-793-1140

DAILY REPORT
Field Surveys

PROJECT NAME: NN AUM SITE: Alongo Mines

DATE: 4/23/16

WEATHER: Overcast to sunny, light winds gusts 5-10 mph, temps low 50's

PERSONNEL ONSITE: Arnold Clifford (Principal Biologist), Sarah McCloskey (Field Assistant)

==

CONTRACTORS ONSITE NOTES:

Background: During the previous habitat assessment survey, habitat was documented for Golden Eagles, Peregrine Falcons, and Ferruginous Hawk. Surveys were completed for Golden Eagle and Ferruginous Hawk last night (4/21/16). The pm survey for Peregrine Falcons was also completed last night

Purpose: In areas where suitable habitat occurs, a formal survey of the species is to be performed following Navajo Nation survey protocols[1] outlined below:

Peregrine Falcons - Two 8 hours surveys (4 hours before sunset and 4 hours after sunrise the following day) during each period: 1 FEB-30 APR (surveys during egg-laying/incubation discouraged) & 1 MAY-31 JUL (2 survey preferably prior to JUL). Productivity surveys require >=1 additional visits.

Methods: Surveyors arrived at the project site at 6:10 a.m. and conducted a thorough survey of the project area. Surveys included establishing appropriate vantage points, remaining at those points for 20 to 30 minutes listening for calls and using high powered binoculars to examine cliff faces for signs of nesting (ex. whitewash, nests, single or pairs of adults remaining in the area, etc.) and continuing father down the canyon until 10:10 a.m.

Additional Information: This completes the second of two required surveys before April 30th for the Alongo Mines site.

Findings: The raven nest located yesterday remained active. The American Kestrel pair was seen in the same location as yesterday and remained perched in the area for a majority of the survey. No other species of interest were observed.

THE NAVAJO NATION
HISTORIC PRESERVATION DEPARTMENT
PO Box 4950, Window Rock, Arizona 86515
TEL: (928) 871-7198 **FAX:** (928) 871-7886

CULTURAL RESOURCE COMPLIANCE FORM

ROUTE COPIES TO:	**NNHPD NO.:** **HPD-16-588**
☑ DCRM	**OTHER PROJECT NO.:** **DCRM 2016-06**

PROJECT TITLE: A Cultural Resource Inventory of Eight Abandoned Uranium Mines (Northern Region) for MWH Americas, Inc. in the Western and Shiprock Agencies of the Navajo Nation, in Utah, Arizona, and New Mexico.

LEAD AGENCY: BIA/NR

SPONSOR: Sadie Hoskie, Trustee, Navajo National AUM, Environmental Response Trust, P.O. Box 3330, Window Rock, AZ 86515

PROJECT DESCRIPTION: The proposed undertaking will involve proposing to complete Removal Site Evaluations to define the horizontal extent of contamination in surface soils and sediments at the eight former uranium mine areas. The proposed undertaking may involve intensive ground disturbance with the use of heavy equipment and hand tools. The area of potential effect is 54.4-acres.

LAND STATUS:	Navajo Tribal Trust
CHAPTER:	Oljato, Dennehotso, Mexican Water, Sweetwater, and Red Valley

LOCATION:	T.	43	S.,	R.	24&14	E-	Sec.	14&24;	Oljato	Quadrangle,	San Juan	County	UT	SLPM
	T.	43	S.,	R.	14	E-	Sec.	13;	Oljato	Quadrangle,	San Juan	County	UT	SLPM
	T.	43	S.,	R.	19&23	E-	Sec.	UP;	Garnet Ridge	Quadrangle,	Apache	County	AZ	G&SRP
	T.	43	N.,	R.	19	E-	Sec.	UP;	Mexican Hat	Quadrangle,	Apache	County	AZ	G&SRP
	T.	41&40	N.,	R.	27. 28& 23	E-	Sec.	UP;	Toh Atin Mesa West	Quadrangle,	Apache	County	AZ	G&SRP
	T	29	N.,	R.	21	W-	Sec.	UP;	Horse Mesa	Quadrangle,	San Juan	County	NM	NMPM

PROJECT ARCHAEOLOGIST:	Rena Martin
NAVAJO ANTIQUITIES PERMIT NO.:	B16728
DATE INSPECTED:	4/16/2016, 5/18/2016
DATE OF REPORT:	7/15/2016
TOTAL ACREAGE INSPECTED:	105.2 – ac
METHOD OF INVESTIGATION:	Class III pedestrian inventory with transects spaced 10 m apart.
LIST OF CULTURAL RESOURCES FOUND:	**(8) sites (UT-B-59-8, UT-C-63-12, AZ-I-5-25, AZ- I 7-72, AZ-I-6-79, NM-I-24-87, NM-I-24-88, NM-I-24-89)** **(1) In Use Area** **(23) Isolated Occurrences (IOs)**
LIST OF ELIGIBLE PROPERTIES:	**(8) sites (UT-B-59-8, UT-C-63-12, AZ-I-5-25, AZ-I-7-72, AZ-I-6-79, NM-I-24-87, NM-I-24-88, NM-I-24-89)**
LIST OF NON-ELIGIBLE PROPERTIES:	**(1) In Use Area, (23) IOs**
LIST OF ARCHAEOLOGICAL RESOURCES:	**(5) sites (UT-B-59-8, UT-C-63-12, AZ-I-7-72, AZ-I-6-79, NM-I-24-89)**

EFFECT/CONDITIONS OF COMPLIANCE: No historic properties affected with the following conditions:

Sites: UT-B-59-8, UT-C-63-12, AZ-I-5-25, AZ- I-7-72, AZ-I-6-79, NM-I-24-87, NM-I-24-89:

1. **Prior to any construction, the site boundaries will be flagged and/or temporarily fenced under the direction of a qualified archaeologist & shown to the construction foreman.**
2. **All ground disturbance within the 50 ft. of the site boundaries will be monitored by a qualified archaeologist.**
3. **No construction, equipment or vehicular traffic will be allowed within the site boundaries.**
4. **A brief letter/report documenting the result of the monitoring will be submitted to NNHPD within 30 days of monitoring activities.**
5. **All future maintenance activities shall avoid the site by a minimum of 50 ft. from the site boundaries.**

Site NM-I-24-88:

Given the environmental hazards the mine possesses, and the thorough extent of the ethnographic information, all research potential has been exhausted. No further work is warranted.

TCPs.

No effect by proposed undertaking.

In the event of a discovery [*"discovery"* means any previously unidentified or incorrectly identified cultural resources including but not limited to archaeological deposits, human remains, or locations reportedly associated with Native American religious/traditional beliefs or practices], all operations in the immediate vicinity of the discovery must cease, and the Navajo Nation Historic Preservation Department must be notified at (928) 871-7198.

FORM PREPARED BY: **Tamara Billie**
FINALIZED: September 9, 2016

Notification to Proceed Recommended ☑ Yes ☐ No Tamara Billie 9/9/16
Conditions: ☑ Yes ☐ No
The Navajo Nation Historic Preservation Office Date

b 11/21/16 Navajo Region Approval ☑ Yes ☐ No SEP 28 2016
~~BIA~~ Navajo Regional Office Date
Acting

NNDFW Review No. <u>15mwh101-am</u>

BIOLOGICAL RESOURCES COMPLIANCE FORM
NAVAJO NATION DEPARTMENT OF FISH AND WILDLIFE
P.O. BOX 1480, WINDOW ROCK, ARIZONA 86515-1480

It is the Department's opinion the project described below, with applicable conditions, is in compliance with Tribal and Federal laws protecting biological resources including the Navajo Endangered Species and Environmental Policy Codes, U.S. Endangered Species, Migratory Bird Treaty, Eagle Protection and National Environmental Policy Acts. This form does not preclude or replace consultation with the U.S. Fish and Wildlife Service if a Federally-listed species is affected.

PROJECT NAME & NO.: Alongo Mines - Abandoned Uranium Mine Project

DESCRIPTION: Proposed Phase I & II scientific investigations at an abandoned mine site. Phase I would entail biological and land surveying with a maximum of 5 people onsite for no more than 5-7 days. Disturbance would be light. Phase II would require the use of an excavator or a small mobile drilling unit to collect one or more soil samples with up to 8 people onsite for a period of one week. A temporary travel corridor 20 f. in width would be necessary to move equipment to the site. Disturbance would be light to moderate. No permanent structures would be left onsite. Total land use would be approximately 15.3 acres.

LOCATION: 36°42'26"N 109°0'34"W, Red Valley Chapter, San Juan County, New Mexico

REPRESENTATIVE: Lori Gregory, Adkins Consulting, Inc. for MWH Global/Stantec

ACTION AGENCY: U.S. Environmental Protection Agency and Navajo Nation

B.R. REPORT TITLE / DATE / PREPARER: BE-Alongo Mines Abandoned Uranium Mine Project/AUG 2016/Lori Gregory, Plant Survey Report for Species of Concern At Alongo Mines Project Site/AUG 2016/Redente Ecological Consultants

SIGNIFICANT BIOLOGICAL RESOURCES FOUND: Area 3. Suitable nesting habitat is present in the project area for Migratory Birds not listed under the NESL or ESA. Migratory Birds and their habitats are protected under the Migratory Bird Treaty Act (16 USC §703-712) and Executive Order 13186. Under the EO, all federal agencies are required to consider management impacts to protect migratory non-game birds.

<u>POTENTIAL IMPACTS</u>

NESL SPECIES POTENTIALLY IMPACTED: NA

FEDERALLY-LISTED SPECIES AFFECTED: NA

OTHER SIGNIFICANT IMPACTS TO BIOLOGICAL RESOURCES: NA

AVOIDANCE / MITIGATION MEASURES: Mitigation measures will be implemented to ensure that there are no impacts to migratory birds that could potentially nest in the project area.

CONDITIONS OF COMPLIANCE*: NA

FORM PREPARED BY / DATE: Pamela A. Kyselka/10 NOV 2016

COPIES TO: (add categories as necessary)

☐ ______________________ ☐ ______________________

2 NTC § 164 Recommendation:	Signature	Date
☒Approval		
☐Conditional Approval (with memo)		11/16/16
☐Disapproval (with memo)	Gloria M. Tom, Director, Navajo Nation Department of Fish and Wildlife	
☐Categorical Exclusion (with request letter)		
☐None (with memo)		

*I understand and accept the conditions of compliance, and acknowledge that lack of signature may be grounds for the Department not recommending the above described project for approval to the Tribal Decision-maker.

Representative's signature Date

From: Nystedt, John
To: Justin Peterson
Cc: Lori Gregory; Pam Kyselka; tbillie@navajo-nsn.gov; Harrilene Yazzie; Melissa Mata
Subject: Navajo Nation AUM Environmental Response Trust - -First Phase
Date: Monday, November 07, 2016 4:08:30 PM
Attachments: image001.png

Justin,

Thank you for your November 6, 2016, email. This email documents our response regarding the subject project, in compliance with section 7 of the Endangered Species Act of 1973 (ESA) as amended (16 U.S.C. 1531 et seq.). Based on the information you provided, we believe no endangered or threatened species or critical habitat will be affected by this project; nor is this project likely to jeopardize the continued existence of any proposed species or adversely modify any proposed critical habitat. No further review is required for this project at this time. Should project plans change or if new information on the distribution of listed or proposed species becomes available, this determination may need to be reconsidered. In all future communication on this project, please refer to consultation numbers given below.

In keeping with our trust responsibilities to American Indian Tribes, by copy of this email, we will notify the Navajo Nation, which may be affected by the proposed action and encourage you to invite the Bureau of Indian Affairs to participate in the review of your proposed action.

Should you require further assistance or if you have any questions, please contact me as indicated below, or my supervisor, Brenda Smith, at 556-2157. Thank you for your continued efforts to conserve endangered species.

Claim 28	02EAAZ00-2016-SLI-0358
Section 26 (Desiddero Group)	02ENNM00-2016-SLI-0447
Mitten #3	06E23000-2016-SLI-0210
NA-0904	02EAAZ00-2016-SLI-0363
Occurrence B	02EAAZ00-2016-SLI-0361
Standing Rock	02ENNM00-2016-SLI-0448
Alongo Mines	02ENNM00-2016-SLI-0465
Tsosie 1*	02EAAZ00-2016-SLI-0364
Boyd Tisi No. 2 Western	02EAAZ00-2016-SLI-0355
Harvey Blackwater #3	02EAAZ00-2016-SLI-0356 / 06E23000-2016-SLI-0207
Oak 124/125	02ENNM00-2016-SLI-0466
NA-0928	02EAAZ00-2016-SLI-0360
Hoskie Tso #1	02EAAZ00-2016-SLI-0362
Charles Keith	06E23000-2016-SLI-0208
Barton 3	02EAAZ00-2016-SLI-0354
Eunice Becenti	02ENNM00-2016-SLI-0444

* It is our understanding that the Tsosie No. 1 site has been put on hold indefinitely due to access issues. However, provided the results of the survey were negative (i.e., no potential for

any ESA-listed species) then we would come to the same conclusion, above, as for the other 15 projects.

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Fish and Wildlife Biologist/AESO Tribal Coordinator
USFWS AZ Ecological Services Office - Flagstaff Suboffice
Southwest Forest Science Complex, 2500 S Pine Knoll Dr, Rm 232
Flagstaff, AZ 86001-6381 (928) 556-2160 Fax-2121 Cell:(602) 478-3797
http://www.fws.gov/southwest/es/arizona/

Appendix F Data Usability Report, Laboratory Analytical Data, and Data Validation Reports

F.1 Data Usability Report

F.2 Laboratory Analytical Data and Data Validation Reports

(provided in a separate electronic file due to its file size and length)

F.1 Data Usability Report

DATA USABILITY REPORT

1.0 INTRODUCTION

This data usability report presents a summary of the validation results for the sample data collected from the Alongo Mines Site (the Site) as part of the Removal Site Evaluation (RSE) performed for the Navajo Nation AUM Environmental Response Trust—First Phase. The purpose of the validation was to ascertain the data usability measured against the data quality objectives (DQOs) and confirm that results obtained are scientifically defensible.

Samples were collected between October 1, 2016 and September 13, 2017 and were analyzed by ALS Environmental of Ft. Collins, Colorado, for all methods. Samples were analyzed for one or more of the following:

- Radium-226 in soil by United States Environmental Protection Agency (USEPA) Method 901.1
- Metals in soil by USEPA Method SW6020
- Isotopic thorium in soil by USDOEAS-06/EMSL/LV

Samples were collected and analyzed according to the procedures and specific criteria presented in the *Quality Assurance Project Plan, Navajo Nation AUM Environmental Response Trust (QAPP)* (MWH, 2016).

Project data were validated as follows:

- Laboratory Data Consultants, Inc. (LDC) of Carlsbad, California, performed validation of all radiological soil data, plus ten percent of the non-radiological data (Level IV only)
- All non-radiological soil data were validated by the Stantec Consulting Services Inc. (Stantec; formerly MWH) Project Chemist (Level III only)
- All samples received Level III data validation
- Ten percent of the sample results for all methods received a more detailed Level IV validation

The analytical data were validated based on the results of the following data evaluation parameters or quality control (QC) samples:

- Compliance with the QAPP
- Sample preservation
- Sample extraction and analytical holding times

- Initial calibration (ICAL), initial calibration verification (ICV), and continuing calibration verification (CCV) results
- Method and initial/continuing calibration blank (ICB/CCB) sample results
- Matrix spike/matrix spike duplicate (MS/MSD) sample results
- Laboratory duplicate results
- Serial dilution (metals analysis only)
- Interference check samples (ICS) (metals analysis only)
- Laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) results
- Field duplicate sample results
- Minimum detectable concentration (radiological analyses only)
- Reporting limits
- Sample result verification
- Completeness evaluation
- Comparability evaluation

Sample results that were qualified due to quality control parameters outside of acceptance criteria are listed on Table F.1-1.

2.0 DATA VALIDATION RESULTS

Stantec reviewed the data validation reports and assessed the qualified data against the DQOs for the project. The following summarizes the data validation findings for each of the data evaluation parameters.

2.1 QUALITY ASSURANCE PROJECT PLAN COMPLIANCE EVALUATION

Based on the data validation, all samples were analyzed following the quality control criteria specified in the QAPP, with the following exception: ALS routinely dilutes all metals samples by a factor of 10 times in order to protect their ICP-MS instrument from the adverse effects of running samples with high total dissolved solids. This also includes running a long series of samples (as is common in a production laboratory) with intermediate dissolved solids. The vulnerable parts of the instrument are the nebulizer, which produces an aerosol, and the cones, which disperse the aerosol. These areas form scaly deposits from the samples in the sample solution, despite the nitric acid and other acids present in the digestate. These parts of the instrument periodically need to be taken apart and cleaned, but in a production setting the laboratory wants to avoid any downtime as much as possible. As an ameliorating factor, the laboratory also takes account of this dilution factor up front in the project planning stages. The laboratory will not quote a reporting limit for this instrument that cannot be achieved after the 10 times dilution required for the instrument. Not all of the requested reporting limits can be met using the laboratory's routine protocol. The dilution is narrated by the laboratory merely as a matter of transparency, as well as for the validator's information. The dilution should have no impact on the project's sensitivity goals.

Sample Preservation Evaluation. All samples were preserved as specified in the QAPP.

Holding Time Evaluation. All analytical holding times were met.

Initial Calibration, Initial Calibration Verification, and Continuing Calibration Verification Evaluation. All ICAL, ICV, and CCV results were within acceptance criteria.

Method Blank Evaluation. No sample data were qualified due to method blank results.

Initial and Continuing Calibration Blank Evaluation. No sample data were qualified due to ICB/CCB data.

Matrix Spike/Matrix Spike Duplicate Samples Evaluation. All MS/MSD recoveries were within acceptance criteria with the exception of two MS recoveries and three MSD recoveries for the analysis of metals. The sample results were qualified with a "J+" flag to indicate the data were estimated and potentially biased high. Two MS/MSD RPDs were outside the acceptance criteria. The results were qualified with a "J" flag if not otherwise qualified.

Laboratory Duplicate Sample Evaluation. For some analyses, the laboratory prepared and analyzed a duplicate sample. RPD results were evaluated between the parent and laboratory duplicate samples. All RPDs were within acceptance criteria except one sample for the analysis of vanadium. The result was qualified with a "J" flag to indicate an estimated result.

Serial Dilution Evaluation. All serial dilution percent differences were within acceptance criteria except for one sample analyzed for uranium. The sample result was already qualified with a "J+" flag.

Interference Check Sample Evaluation. All interference check samples were within acceptance criteria.

Laboratory Control Sample/Laboratory Control Sample Duplicate Evaluation. All LCS and LCSD recoveries were within acceptance criteria. All LCS/LCSD RPDs were within acceptance criteria.

Field Duplicate Evaluation. The RPDs were less than the guidance RPD of 30 percent established in the QAPP for all field duplicate pairs, with the exception of results for three metals and one radium-226. The primary cause for RPDs exceeding 30 percent for some duplicate pairs is assumed to be the heterogeneity/variability of soil samples. The sample IDs, sample results, and RPDs for those results that did not meet the guidance RPD are listed in Table F.1-2. Sample results were not qualified due to RPDs exceeding the guidance criteria, as described in the QAPP.

Minimum Detectable Concentration Evaluation. All minimum detectable concentrations met reporting limits with the exception of three samples for the analysis of radium-226. However, the reported activity for each of these samples was greater than the achieved minimum detectable concentration and no qualification was needed.

Reporting Limit Evaluation. All sample data were reported to the reporting limit established in the QAPP, with the exception of the metals, as discussed at the beginning of this section related to dilution.

Sample Result Verification. All sample result verifications were acceptable with the exception of nine samples analyzed for radium-226. The sample density exceeded the limit of +/- 15% of the density of the calibration standard. In all cases the results were qualified with a "J-" flag as estimated, potentially biased low (see Table F.1-1).

Completeness Evaluation. All samples and QC samples were collected as scheduled, resulting in 100 percent sampling completeness for this project. Based on the results of the data validation described in the previous sections, all data are considered valid as qualified. No data were rejected; consequently, analytical completeness was 100 percent, which met the 95 percent analytical completeness goal established in the QAPP.

Comparability Evaluation. Comparability is a qualitative parameter that expresses the confidence that one data set may be compared to another. For this project, sample collection and analysis followed standard methods and the data were reported using standard units of measure as specified in the QAPP. In addition, QC data for this project indicate the data are comparable. As a result, the data from this project should be comparable to other data collected at this Site using similar sample collection and analytical methodology.

3.0 DATA VALIDATION SUMMARY

Precision. Based on the MS/MSD sample, LCS/LCSD sample, laboratory duplicate sample, and field duplicate results, the data are precise as qualified.

Accuracy. Based on the ICAL, ICV, CCV, MS/MSD, and LCS, the data are accurate as qualified.

Representativeness. Based on the results of the sample preservation and holding time evaluation; the method and ICB/CCB blank sample results; the field duplicate sample evaluation; and the RL evaluation the data are considered representative of the Site as reported.

Completeness. All media and QC sample results were valid and collected as scheduled; therefore, completeness for this RSE is 100 percent.

Comparability. Standard methods of sample collection and standard units of measure were used during this project. The analysis performed by the laboratory was in accordance with current USEPA methodology and the QAPP.

Based on the results of the data validation, all data are considered valid as qualified.

Table F.1-1
Summary of Qualified Data
Alongo Mines
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Field Sample Identification	Sample Date	Analysis Code	Analyte	Sample Result	Units	QC Type	QC Result	QC Limit	Added Flag	Comment
S002-BG2-001	10/1/16	SW6020	Uranium	0.26	mg/kg	MS Serial Dilution	136% 14%	75% - 125% 10%	J+	Result is estimated, potentially biased high. MS recovery above acceptance criteria. Serial dilution %D greater than
S002-BG2-001	10/1/16	SW6020	Vanadium	4.3	mg/kg	MS	133%	75% - 125%	J+	Result is estimated, potentially biased high. MS recovery above acceptance criteria.
S002-BG2-010	10/1/16	E901.1	Radium-226	0.42	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S002-BG2-004	10/1/16	E901.1	Radium-226	0.54	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S002-BG1-006	10/1/16	E901.1	Radium-226	2.03	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S002-BG1-009	10/1/16	E901.1	Radium-226	1.5	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S002-CX-006	10/13/16	SW6020	Vanadium	11	mg/kg	LR	30%	20%	J	Result is estimated, bias unknown. LR RPD outside acceptance criteria.
S002-CX-006	10/13/16	E901.1	Radium-226	0.76	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S002-CX-206	10/13/16	E901.1	Radium-226	0.67	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S002-SCX-001	10/13/16	SW6020	Uranium	0.39	mg/kg	MSD	142%	75% - 125%	J+	Result is estimated, potentially biased high. MSD recovery above acceptance criteria.
S002-SCX-001	10/13/16	SW6020	Vanadium	8	mg/kg	MSD	134%	75% - 125%	J+	Result is estimated, potentially biased high. MSD recovery above acceptance criteria.
S002-SCX-003-2	10/13/16	E901.1	Radium-226	1.43	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S002-SCX-003-1	10/13/16	E901.1	Radium-226	1.54	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S002-BG3-009	8/28/17	E901.1	Radium-226	1.68	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S002-SCX-014-01	9/13/17	SW6020	Arsenic	4.5	mg/kg	MSD MS/MSD RPD	141% 22%	75% - 125% 20%	J+	Result is estimated, potentially biased high. MSD recovery above acceptance criteria. MS/MSD RPD outside acceptance
S002-SCX-014-01	9/13/17	SW6020	Molybdenum	0.56	mg/kg	MS/MSD RPD	28%	20%	J	Result is estimated, bias unknown. MS/MSD RPD outside acceptance criteria.

Notes
mg/kg milligrams per kilogram
pCi/g picocuries per gram
LCS laboratory control sample
LR laboratory replicate (duplicate)
MS matrix spike
MSD matrix spike duplicate
RPD relative percent difference

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AUM Environmental Response Trust-First Phase

Table F.1-2
Results that did not Meet the Relative Percent Difference Guidance
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Primary Sample / Duplicate Indentification	Sample Date	Parameter	Primary Result	Duplicate Result	Units	RPD (%)
S002-BG2-002/S002-BG2-202	10/1/2016	Radium-226	0.79	0.51	pCi/g	43
S002-BG1-002/S002-BG1-202	10/1/2016	Uranium	1.9	2.7	mg/kg	35
S002-CX-006/S002-CX-206	10/13/2016	Arsenic	1.7	2.4	mg/kg	34
S002-CX-006/S002-CX-206	10/13/2016	Molybdenum	0.52	0.22	mg/kg	81

Notes
mg/kg milligrams per kilogram
pCi/g picocuries per gram
RPD relative percent difference