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Mitten No. 3 (#260)

Removal Site Evaluation Report

Final | October 7, 2018

Stantec

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

Mitten No.3 (#260) Removal Site Evaluation Report - Final

October 7, 2018

Prepared for:

Navajo Nation AUM Environmental Response Trust
– First Phase

Prepared by:

Stantec Consulting Services Inc.

Title and Approval Sheet

Title: Mitten No.3 Removal Site Evaluation Report - Final

Approvals

This Removal Site Evaluation Report is approved for implementation without conditions.

10/15/18

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Navajo Nation Environmental Protection Agency
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10/16/18

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Revision Log

Revision No.	Date	Description
0	March 30, 2018	Submission of Draft RSE report to Agencies for review
1	October 7, 2018	Submission of Final RSE report to Agencies

Sign-off Sheet

This document entitled *Mitten No.3 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."

Prepared by Emily Yeager

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

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

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)
    - Chenoweth, 1991 – The Geology and Production History of the Uranium-Vanadium Deposits in Monument Valley San Juan County, Utah
    - Hendricks, 2001 – An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation
    - NAML, 1997 – Monument Valley 3 AML Reclamation Project Proposal Documents
    - USEPA, 2007a – Abandoned Uranium Mines and the Navajo Nation. Navajo Nation AUM Screening Assessment Report and Atlas with Geospatial Data
    - Weston Solutions, 2012 - Navajo Abandoned Uranium Mine Site Screen Report – Mitten No.3

Executive Summary

Introduction

The Mitten No.3 site (the Site) is located within the Navajo Nation, Tuba City Bureau of Indian Affairs (BIA) Agency, Oljato Chapter in southeastern Utah. 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 July 2015 and August 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. The Site is located in the Monument Valley mining area in the west-central portion of the Colorado Plateau. Bedrock outcrops on or adjacent to the Site consist of the Shinarump member of the Chinle Formation, the Moenkopi Formation, and the De Chelly Sandstone Member and Organ Rock Tongue of the Cutler Formation. 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 downgradient of a mesa top, along the mesa sidewall and colluvium-covered bedrock slopes, at an elevation range of approximately 5,080 to 5,380 ft above mean sea level. On-site overland surface water flow, when present either terminates within the unconsolidated deposits or drains south toward an un-named drainage tha drains east toward Oljeto Wash, which joins into the San Juan River approximately 17 miles north of the Site.

Mine workings on-site consisted of a portal with an approximately 320-ft-long mining adit (Chenoweth, 1991). Ore production in the US Atomic Energy Commission (USAEC) records showed one shipment sent from the Site in January 1955. This shipment contained 9.6 tons of ore that contained 61.43 pounds of 0.31 percent U_3O_8 (uranium oxide) and 136.31 pounds of | 0.71 percent V_2O_5 (vanadium oxide).

In 1997 the Site was included in a reclamation bid document (NAML, 1997). Closeout reports for the bid document could not be located. While historical documents were not found confirming that these activities were completed at the site, the *2007 AUM Atlas* listed the Site as reclaimed by NAML. In 2012, Weston Solutions (Weston) performed a site screening on behalf of the USEPA. The screening included: (1) recording site observations (i.e., number of homes, water sources, and sensitive environments[2] around the Site); (2) recording the type, number, and reclamation status of mine features; and (3) performing a surface gamma survey.

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:

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[2] Weston defined sensitive environments as "all sensitive environments located within visible range of the mine site, including: wetlands, endangered species, habitats and approximate locations of sites that may be under protection of the government of the Navajo Nation"

- **Site Clearance activities** consisted of a desktop study of historical information, site mapping, potential background reference area(s) 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, and surface water and well water 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. The results of the surface water and well water analyses were used to evaluate mining impacts to surface water and well water.

In addition, during the RSE work, the Trust performed an "Interim Action" to close an open portal to prevent human and livestock (animal) access.

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. Arsenic, molybdenum, uranium, vanadium, and Ra-226 concentrations and gamma radiation measurements in soil/sediment exceeded their respective ILs and are confirmed constituents of potential concern (COPCs) for the Site. In addition, selenium was also confirmed as a COPC because it was detected in soil samples from the Site, but was non-detect in all but one background reference area sample. Based on the data analyses performed for this report along with the multiple lines of evidence, approximately 2.7 acres, out of the 9.1 acres of the Survey Area (i.e., the full areal extent of the Site surface gamma survey), were estimated to contain TENORM. Of the 2.7 acres that contain TENORM, 2.2 acres contain TENORM exceeding the surface gamma ILs. The volume of TENORM in excess of ILs was estimated to be 5,927 yd^3 (4,532 cubic meters).

Gamma Correlation Study results. Results of the Gamma Correlation Study indicated that surface gamma survey results do not 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. Therefore, users of the regression equation should be aware of the limitations of the dataset and be cautious when estimating Ra-226 concentrations. Additional correlation studies may be needed to identify the relationship between gamma and Ra-226.

Water sample results. Water samples were collected from two surface water seeps and one water well. No ILs were exceeded in either of the seep samples, so further characterization may not be needed at these seeps. Analytical results indicated that the sample from the water well had total and dissolved concentrations of selenium, total dissolved solids (TDS), and sulfate above their respective ILs, but not any IL exceedances of radionuclides. Based on these results, selenium, TDS, and sulfate are confirmed COPCs for the water well and additional characterization may be considered in the future.

Based on the Site Clearance and RSE data collection and analyses for the Site, potential data gaps were identified and are presented in Section 4.9 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
byd^3	bank cubic yards
e.g.	exempli gratia
etc.	et cetera
ft	feet
ft^2	square feet
i.e.	id est
mg/kg	milligram per kilogram
µg/L	micrograms per liter
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
BIA	Bureau of Indian Affairs
CCV	continuing calibration verification
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
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

LCS/LCSD	laboratory control sample/laboratory control sample duplicate
MARSSIM	Multi-agency Radiation Survey and Site Investigation Manual
MBTA	Migratory Bird Treaty Act
MCL	maximum contaminant level
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
NNPDWR	Navajo National Primary Drinking Water Regulation
NORM	Naturally Occurring Radioactive Material
NSDWR	National Secondary Drinking Water Regulation
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
R^2	Pearson’s Correlation Coefficient
Ra-226	Radium-226
Ra-228	Radium-228
Redente	Redente Ecological Consultants
RSE	Removal Site Evaluation
SOP	standard operating procedure
Stantec	Stantec Consulting Services Inc.
T&E	threatened and endangered
Th-230	thorium-230
Th-232	thorium-232
TDS	total dissolved solids
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 nearly horizontal entry leading into a mine.

Alluvium – material deposited by flowing water.

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

Bank yd^3 – a unit designating one cubic yard of earth or rock, measured or calculated before removal from the bank (Dictionary of Construction, 2018).

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.

Bulkhead – an engineered wall placed inside a mine portal/adit to close the portal/adit.

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).

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.

Pediment – gently sloping erosional surface of low relief developed on bedrock (Dohrenwend and Parsons, 2009)

Portal – The surface entrance to a drift, tunnel, adit, or entry (US Bureau of Mines, 2017).

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

Radium-228 (Ra-228) – 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 July 2015 and August 2017 at the Mitten No.3 site (the Site) located in southeastern Utah, 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 #260 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 2.4 acres (104,544 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[3]: (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 Federal Regulations (CFR) Section 300.5 of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; USEPA, 1992).

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

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)(2012) 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 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.

- Characterization of perennial surface water and well water – surface water and well water sampling and laboratory analyses. Investigation of groundwater is not included in the scope of this RSE.

Details regarding the Site Clearance activities are provided in the *Mitten No.3 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 *Mitten No.3 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, in southeastern Utah, and approximately 1.15 miles northwest of Oljato, Utah, as shown in Figure 2-1. The Site is located in the Monument Valley mining area, along the southern rim of Holiday Mesa, as shown in Figure 2-2. A summary of historical mining on the Site is presented below, based on reports by Chenoweth (1991).

In 1949, the US Atomic Energy Commission (USAEC) began uranium mining in the Monument Valley area. In 1952, the USAEC explored Holiday Mesa and found uranium-bearing minerals on the west end of the mesa. Between 1952 and 1954, the US Geological Survey (USGS) further explored Holiday Mesa by performing seismic work to trace the buried uranium-bearing zones. Based on its findings, the USGS recommended to the USAEC that the uranium-bearing zone on Holiday Mesa should be drilled.

According to Chenoweth (1991), in 1954, the USAEC began a drilling program on Holiday Mesa. A total of 200 boreholes were drilled with a total footage of approximately 32,620 ft, including approximately 5,838 ft of core drilling. The drilling program discovered significant uranium ore deposits on the Holiday Mesa. Based on the exploration findings, Cecil Parrish Jr. claimed a 17.6 acre parcel of Holiday Mesa. The 17.6 acre claim included the area of the Mitten No. 3 mine, and was inclusive of a portion of mining permit 15 (MP-15). Mine workings at the Site consisted of a portal with an approximately 320-ft-long mining adit. Ore production in the USAEC records showed one shipment was sent from the Site in January 1955, to the ore-buying station in Shiprock, New Mexico. This shipment contained 9.6 tons of ore that contained 61.43 pounds of 0.31 percent U_3O_8 (uranium oxide) and 136.31 pounds of 0.71 percent V_2O_5 (vanadium oxide). By 1966 mines in the Monument Valley mining area were inactive.

2.1.2 Ownership and Surrounding Land Use

The Site is located within the Navajo Nation, Tuba City Bureau of Indian Affairs (BIA) Agency in Section 14 of Township 43 South, Range 14 East, Salt Lake Principal Meridian. Land ownership where the Site is located falls under Navajo Trust lands. The Site is located within the Oljato Chapter of the Navajo Nation, as shown in Figure 1-1, and is in Grazing Unit 8, as designated by the Navajo Nation Division of Natural Resources (NNDNR, 2006). The Site is currently uninhabited, but one home-site is located approximately 0.25 miles southeast of the Site, as shown in Figure 2-1. The Site is also located approximately 1.15 miles northwest of the town of Oljato, Utah (refer to Figure 2-1). The 2010 US Census reported that the population of Oljato, Utah was 674 (US Census Bureau, 2017).

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 Oljato Chapter officials and nearby residents and notified them of the work.

2.1.4 Previous Work at the Site

2.1.4.1 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 Oljato 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 Oljato area covered approximately 113.59 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 4 µR/hr to 6 µR/hr and excess bismuth (i.e., bismuth activity greater than approximately 3.5 µR/hr) present in approximately 0.00005 square miles (0.03 acres) of the area (*2007 AUM Atlas*). The aerial radiological survey results for the Oljato area indicated a gross exposure rate range of 1.66 µR/hr to 57.95 µR/hr and excess bismuth (i.e., bismuth activity greater than approximately 3.5 µR/hr) present in approximately 0.40 square miles of the 113.59 square miles of the Oljato flight area (Hendricks, 2001).

2.1.4.2 1997 Monument Valley 3 Project Invitation for Reclamation Bids

In 1997, NAML issued an invitation for bids for the reclamation of 25 AUMs, referred to as the Monument Valley 3 Project (NAML, 1997). The Site was included in the Monument Valley 3 Project bid document, and is referred to in the bid document as either Mitten #3 or NA-0211. The bid document stated that the Site contained one portal and one waste pile. The bid document included a historical drawing of the Site showing the location of the portal and the waste pile. The bid document listed the following reclamation activities that were needed for the Site:

- Excavate, stabilize, and backfill one portal using part of the waste pile.
- Close the portal by constructing a bulkhead out of 16-inch-thick reinforced concrete blocks.

- Excavate 175 bank cubic yards (byd[3]) of the waste pile and backfill the exterior of the bulkhead at a slope of 2h:1v (horizontal to vertical). During excavation of the waste pile approximately 50 linear ft of the access road was to be eliminated.

- Eliminate two (2) 100 linear feet long sections of the access road leaving the project area, locations were to be discussed with the project manager. The sections were to be sloped leading to the portal using a cut and fill technique to a slope of 2h:1v.

While historical documents were not found confirming that these activities were completed at the site, the *2007 AUM Atlas* listed the Site as reclaimed by NAML.

2.1.4.3 2012 Site Screening

In 2012, Weston performed a site screening on behalf of the USEPA (Weston, 2012). The screening included: (1) recording site observations (i.e., number of homes, water sources, and sensitive environments[4] around the Site); (2) recording the type, number, and reclamation status of mine features; and (3) performing a surface gamma survey. Weston reported a residential compound with multiple structures located southeast of and within 0.25 miles of the Site, one pond and one livestock well within a one-mile radius of the Site, and no sensitive environments were identified. Weston also reported the Site was reclaimed and it identified a waste rock pile located on the eastern claim boundary border. Based on Weston's performance of a surface gamma survey, it determined that the highest gamma measurements were greater than 31 times the site-specific background level used for its gamma screening.

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

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[4] Weston defined sensitive environments as "all sensitive environments located within visible range of the mine site, including: wetlands, endangered species, habitats and approximate locations of sites that may be under protection of the government of the Navajo Nation"

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 Monument Valley mining area in the west-central portion of the Colorado Plateau. Figure 2-3 presents the regional USGS topographic map of a portion of the Colorado Plateau in the vicinity of the Site. The Site is located downgradient of a mesa top, along the mesa sidewall and colluvium-covered bedrock slopes at an elevation range of approximately 5,080 to 5,380 ft above mean sea level (amsl), as shown in 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. 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.

The portion of the Monument Valley mining area where the Site is located consists of the Shinarump member of the Triassic Chinle Formation, the Triassic Moenkopi Formation, and the Permian De Chelly Sandstone Member of the Cutler Formation and Permian Organ Rock Tongue of the Cutler Formation. Figure 2-5 depicts a regional geology map showing the Site in relation to the regional extent of the Chinle, Moenkopi, and Cutler Formations. Regionally, the Chinle Formation caps most mesas, ranges in thickness from 800 ft to 1,500 ft, and uranium ore has been found within channel sediments of the Shinarump member (Lewis and Trimble, 1959). Regionally, the Moenkopi Formation ranges from 80 ft to 300 ft thick and forms steep slopes in-between the resistant Shinarump member and the cliff forming De Chelly Sandstone Member. Regionally the De Chelly Sandstone is a massive sandstone unit that ranges from 0 to 450 ft thick, and the Organ Rock Tongue can be up to 700 ft thick.

2.2.2.2 Site Geology

Bedrock outcrops on or adjacent to the Site consist of the Shinarump member of the Chinle Formation, the Moenkopi Formation, and the De Chelly Sandstone Member and Organ Rock Tongue of the Cutler Formation, as shown in Figure 2-6a. In addition, a significant portion of the Site is exposed bedrock, as shown in Figure 2-6b. A geologic profile of the geologic formations forming the mesa top, mesa sidewall, and pediment is shown in Figure 2-6a. Site-specific geology consists of the following as provided by Hackman and Wyant (1973):

- Shinarump Member of the Chinle Formation (mesa top and vertical cliffs) – moderate-orange and yellowish-gray sandstone, siltstone, conglomerate, and sandy shale

- Moenkopi Formation (weathered bedrock slopes) – reddish-brown, platy to slabby, ripple-marked siltstone, thin marine limestones, and thick beds of brown, fine-grained calcareous sandstone

- De Chelly Sandstone Member of the Cutler Formation (colluvium-covered bedrock slopes and pediment) – reddish-orange to pale-reddish-brown, fine to medium-grained eolian sandstone that erodes to cliffs and domes

- Organ Rock Tongue of the Cutler Formation (pediment) – reddish brown, evenly thin bedded siltstone and fine-grained sandstone

Unconsolidated deposits on-site are alluvium, colluvium, and eolian deposits consisting of poorly graded sand with gravel and silt. During the Site Characterization field activities, boreholes were advanced through the unconsolidated deposits using a hand auger until termination due to stable low gamma measurements or refusal at either bedrock or a hard surface (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 2.2 ft below ground surface (bgs).

According to the US Department of Agriculture (USDA) Soil Survey for the Navajo Nation – San Juan County, Utah, soils on-site that have not been disturbed are classified as Moenkopi soils consisting of well drained soils formed from sandstone and shale (USDA, 1980).

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 425812 Monument Valley Mission, Utah (Western Regional Climate Center, 2017) located approximately 6 miles southeast of the Site, ranges between 41.2 degrees Fahrenheit (°F) in January to 92.3°F in July. Daily temperature extremes reach as high as 106°F in summer and as low as -11°F in winter. Monument Valley Mission receives an average annual precipitation of 7.4 inches, with July and August being the wettest months, averaging 0.97 inches, and June being the driest month, averaging 0.25 inches.

Potential evaporation in the area is greater than the area’s average annual precipitation. The potential evaporation noted at the Mexican Hat, Utah weather station, located approximately 26 miles northeast of the Site, averages 86 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 Page, Arizona airport, located approximately 63 miles to the west of the Site, had the most complete record of wind conditions. A wind rose for the Page 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 west (refer to the wind rose on Figure 1-1). The Site is surrounded by mesas which may influence wind direction at the Site so that it differs from the available regional wind data.

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. On-site surface water flow (i.e., overland flow) is controlled along the watershed divide line (refer to Figure 2-7) by a decrease in elevation to the south (refer to Figure 2-4). Along the pediment, two parallel patterned ephemeral drainages drain south (refer to Figure 2-7) toward an un-named drainage (refer to Figure 2-1). Overland water flow direction arrows and the approximate extent of watershed divide line are shown in Figure 2-7. Precipitation run-off on-site either terminates within the unconsolidated deposits or drains south toward the un-named drainage. The un-named drainage drains east toward Oljeto Wash (refer to Figure 2-1). Oljeto Wash joins the San Juan River approximately 17 miles north of the Site.

Adkins Consulting Inc. (Adkins), under contract to Stantec, performed a wildlife evaluation as part of the Site Clearance field investigations and did not identify any wetlands, seeps, springs, or riparian areas within the Site that would be attractive to wildlife (refer to Appendix E).

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 July 2016, Redente Ecological Consultants (Redente), under contract to Stantec, 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. The Site is predominantly rocky with very little vegetation (refer to Appendix E). During the surveys, Stantec and/or its subcontractors observed on-site wildlife including common raven 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 (Dinétahdóó, 2016). Based on historical and ethnographic data reviews, Dinétahdóó did not identify any mining history information for the Site (Dinétahdóó, 2016).

During the cultural resource survey, Dinétahdóó did not identify any isolated occurrences or archaeological or structural remains at the Site. 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 and Potential Exploration

During RSE activities, Stantec field personnel (field personnel) observed the following features indicative of potential mining or exploration activities at the Site: the approximate location of a reclaimed portal, a prospect portal location, historical boreholes, historical rock core/drill cuttings, exploration area, a potential haul road, mining disturbed area, and a waste pile. 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 July 2015 and August 2017. Site Clearance activities were conducted initially to obtain information necessary to develop the *RSE Work Plan*. 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[5] 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).

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[5] (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).

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:

1. Background reference area soil/sediment 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, Appendix C.2 includes borehole logs, and Appendix C.3 includes water sample field forms.

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 1951, 1979, and 1993 for comparison against a current 2017 image (Cooper, 2017). The selected historical photographs are shown in Figure 3-1a. The potential haul road and waste pile were not visible in the 1951 photograph but were visible in the 1979 and 2017 photographs. Figure 3-1b compares the aerial photograph from 1979 and a current 2017 image. The 1979 historical photograph is presented because it provides the best resolution of what the Site looked like after mining occurred on-site.

- The current aerial photograph review confirmed that the Site was uninhabited, but one home-site was located approximately 0.25 miles southeast of the Site, as shown in Figure 2-1. The Site was also located approximately 1.15 miles northwest of the town of Oljato, Utah. 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).

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

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

Previous studies and information related to past mining/exploration 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).
- Drainages – Two parallel patterned ephemeral drainages were mapped as shown in Figure 2-7. The drainages drained south toward an un-named drainage (refer to- Figure 2-1).
- Topographic features – The mapped area can be divided into four topographic areas, as shown in Figure 2-4: (1) the mesa top; (2) the mesa bench; (3) the mesa sidewall (i.e., the vertical cliffs and steep colluvium-covered bedrock slope); and (4) the pediment area (i.e., the area in-between the base of the steep bedrock slope and the un-named drainage).
- Historical boreholes – Three historical boreholes were mapped, as shown in Figure 2-7. The historical boreholes were located on the mesa top, and two of them were within the exploration area. The third borehole was located to the east of the 100-foot buffer. Two of the historical boreholes were approximately two inches in diameter and a metal rod was left inside the boreholes. The third borehole was approximately five inches in diameter and was un-sealed. These boreholes appeared to be related to exploration and not related to mining at the Site. Photographs of the historical boreholes are shown in Appendix B-1 photograph numbers 1, 2, and 3.
- Historical rock core/drill cuttings – Historical rock core/drill cuttings were mapped, as shown in Figure 2-7. The historical rock core/drill cuttings were scattered on the ground near the historical boreholes, as shown in Appendix B-1 photograph number 3 and 4.
- Reclaimed portal – The approximate location of one buried reclaimed portal was mapped, as shown in Figure 2-7. Field personnel observed that the material used to bury the reclaimed portal appeared to be similar to soil/rock material from the surrounding areas and not material from the waste pile; refer to Section 2.1.4. The reclaimed portal was observed along the potential haul road and above the mapped waste pile. The exact location of the portal was not observed because it was buried under soil and rock. However, NAML confirmed the location of the reclaimed portal to field personnel in the field. The reclaimed portal is shown in Appendix B-1 photograph numbers 6 and 8.
- Waste pile – A waste pile was mapped, as shown in Figure 2-7. Field personnel observed that the waste pile did not appear to have had material excavated (e.g., there were no visible cuts into the pile) from it for use in the reclamation activities described in Section 2.1.4. The waste pile was located downgradient of the reclaimed portal, consisted of fine-grained unconsolidated material, and fanned downslope on the mesa sidewall, as shown in Appendix B-1 photograph numbers 8 through 10 and Appendix B-2 photograph number 11.
- Prospect portal – An open prospect portal was mapped northeast of the reclaimed portal, as shown in Figure 2-7. The prospect portal was approximately 8 ft to 10 ft wide, 6 ft tall, and

20 ft deep, as shown in Appendix B-1 photograph number 5. Because the prospect portal was open, the Agencies and Trustee decided this posed a safety risk. To mitigate the safety hazard, in April 2018 the Trust conducted an interim closure, pursuant to the Trust provisions for interim actions, and installed of a steel cable mesh over the prospect portal. The steel cable mesh was designed to limit access by humans or large animals. The constructed mesh grate was of sufficient quality that access to the interior of the prospect portal was only possible by cutting and removing materials with heavy tools. Because this work was completed separately from the RSE, it is not reported herein, and instead was reported to the Agencies in an interim action summary letter (Stantec, 2018).

- Potential haul road – One potential haul road was mapped that ran from Chicago Rd, through two other claim boundaries, east-west through the Site, and then connected with the mapped road along the eastern arm of Holiday Mesa, as shown in Figure 2-1. On-site the potential haul road ran along the mesa sidewall and to the reclaimed portal and waste pile, as shown in Figure 2-7 and Appendix B-1 photograph numbers 7 and 8. Field personnel observed that portions of the potential haul road were impassable to vehicles. However, field personnel were unable to determine if these portions were impassable due to erosion or due to reclamation activities that occurred on-site (refer to Section 2.1.4). The impassable portions of the potential haul road were located greater than 0.5 miles from the Site.

- Road – One road was mapped that connected to the potential haul road, as shown in Figure 2-7. The road ran east-west along the mesa bench located on the eastern arm of Holiday Mesa, to radio antennas located approximately 0.4 miles east of the claim boundary, as shown in Figure 2.1. Field personnel did not observe a route from the mesa bench to the surrounding plains; therefore, this road was not considered to have been used as a potential haul road.

- Corral – Three corral areas were mapped within 0.25 miles of the Site, as shown in Figure 2-7. During RSE activities field personnel observed sheep, horses, and goats in the corrals.

- Structures – One home-site was located approximately 0.25 miles southeast of the Site and the town of Oljato, Utah was located approximately 1.15 miles southeast of the Site, as shown in Figure 2-1. It is unknown if the one home-site Stantec field personnel observed was the residential compound with multiple structures, identified by Weston (2012).

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

- Water features – Field personnel assessed the four water features identified from the desktop study, as shown in Figure 2-1. The water features and field personnel observations are included in Table 3-1a. NNDWR provided the water well specifications listed in Table 3-1b.

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 Oljato 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 analysis, 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 five potential background reference areas (BG-1, BG-2, BG-3, BG-4, and CK-BG-2) for the Site, as shown in Figures 3-2a and 3-2b, and described in Appendix D.1. BG-1, BG-2, and CK-BG-2 were selected as suitable background reference areas for the Site for the following reasons:

- BG-1 encompassed an area of 2,074 ft^2 (approximately 0.05 acres), was located approximately 400 ft northeast of the Site, and was crosswind and hydrologically cross-gradient from the Site. BG-1 was on the opposite side of the mesa from the Site and was sheltered from wind and water transport from the Site. The colluvium-covered slope, and bedrock outcrops at BG-1 represent the upper mesa sidewall at the Site and the Moenkopi

Formation. While BG-1 did overlap the Cutler Formation, soil material present in BG-1 consisted of colluvium from the Moenkopi Formation because the Cutler Formation is composed of smooth sandstone bedrock that does not generate soil or colluvium in that area. The limited vegetation and ground cover at BG-1 were similar to the Site.

- BG-2 encompassed an area of 785 ft^2 (approximately 0.02 acres), was located approximately 850 ft southwest of the Site, and was crosswind and hydrologically cross-gradient of the Site. Geologically, BG-2 represented the Quaternary deposits (alluvium) found in the drainages downgradient from the Site. The vegetation and ground cover at BG-2 were similar to the drainages downgradient from the Site.

- CK-BG-2 encompassed an area of 2,615 ft^2 (approximately 0.06 acres), was located 1.6 miles east of the Site and was cross-gradient of the Site. CK-BG-2 was downwind from the Site but was sheltered from the Site by a large valley and a mesa. Geologically, CK-BG-2 represented the Cutler Formation areas on the mesa sidewall and pediment and includes limited Quaternary deposits.

BG-3 and BG-4 were not selected as background reference areas for the Site for the reasons described in Appendix D.1.

In addition, the selected background reference areas were located outside of the mining-related impacted areas associated with the Sites as described below:

- BG-1 was located at a lower elevation (5,053 ft amsl) than the reclaimed portal (5,237 ft amsl) and the prospect portal (5,280 ft amsl); however, BG-1 is located across a watershed divide from these features and impacted areas at the Site (refer to Figure 3-2a). While BG-1 was potentially located downgradient from exploration activities on the mesa top, the mesa top is relatively flat and there would be little to no runoff from the areas of exploration on the mesa top.

- BG-2 was located crosswind and cross-gradient from the Site.

- CK-BG-2 was located near the Charles Keith Site; however, it was located cross-gradient of mining-related impacted areas that occurred at the Site and downwind from the Site but was sheltered from the Site by a large valley and a mesa as shown on Figure 3-3b.

A background area for the Chinle Formation was not selected; data collected within the Moenkopi Formation background area (BG-1) are used for comparison purposes only and do not directly apply to the area of the Site within the Chinle Formation. Further background investigation of the Moenkopi Formations may be warranted because a portion of the current background reference area extends into the Cutler Formation. A background investigation of the Chinle Formation may be warranted to identify a background reference area to represent portions of the mesa top that were disturbed during exploration activities. The Agencies have suggested that due to the variation in statistics for the surface gamma surveys at CK-BG-2, BG-3, and BG-4 (refer to Table D.1-2 in Appendix D.1), further investigation for a background area to represent the Cutler Formation is warranted as part of future work at the Site. The need for further investigations of these background reference areas are included as data gaps in Section 4.9.

Stantec evaluated the need for a separate background reference area for the mesa top (i.e., Shinarump member of the Chinle Formation), but determined that it was not necessary (refer to Appendix D.1). While there were historical boreholes, metal rods, and rock core/drill cuttings on the mesa top, they appeared to be related to the exploration drilling, and not the mining activities that occurred at the Site (refer to Section 2.1.1). In addition, field personnel did not observe any mining related disturbances on the mesa top.

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 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[6]. A copy of this letter is included in Appendix E. A spring vegetation survey was not required for the Site because the species of concern data provided by NNDFW-NNHP did not include listed potential plant species that require a spring survey.

The NNDFW listed one T&E plant species that may occur on-site; Parish's alkali grass (G4). The USFWS also listed one T&E plant species that may occur on-site: Navajo sedge. Parish's alkali grass 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 springs, seeps, and seasonally wet areas that occur at the heads of drainages or on gentle slopes at elevations from 2,600 ft to 7,200 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. Parish's alkali grass was eliminated from further evaluation because there was no potential for the species to occur on the Site due to lack of suitable habitat. Navajo sedge was the only T&E species evaluated during the Site vegetation survey.

Before beginning the Site vegetation survey, 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 Navajo sedge, specifically seeps and hanging gardens.

The Redente botanist did not identify Navajo sedge at the Site, based on observations he made during the on-site survey. The botanist concluded he did not identify Navajo sedge at the Site because the Site was not a likely habitat for the T&E species. The Site is predominantly rocky with very little vegetation (refer to Appendix E).

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

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[6] 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).

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 eight ESA-species with the potential to occur in the area of the Site; five birds (southwestern willow flycatcher, Mexican spotted owl, western yellow-billed cuckoo, California condor, and Gunnison sage-grouse) and three fish (Colorado pikeminnow, greenback cutthroat trout, and razorback sucker). 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 and ferruginous hawk, 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, two birds (golden eagle and ferruginous hawk) remained as species of concern warranting further analysis during the Site survey.

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 15 bird species in addition to those listed above, known as "Priority Birds of Conservation Concern with the Potential to Occur"[7] 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, and prairie falcon. These 15 MBTA bird species were added for further analysis during the survey for effects to potential habitat.

The wildlife survey revealed two NNESL species of concern that have the potential to occur within or near the Site based on habitat suitability or actual recorded observation: golden eagle and ferruginous hawk. 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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[7] 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[8]).

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 did not identify any isolated occurrences or archaeological or structural remains at the Site. Navajo Nation Historic Preservation Department (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 archaeological clearance for the Site. 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, and surface water and well water 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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[8] 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 Figures 3-3a and 3-3b. Field personnel performed the Background Reference Area Study in accordance with the *RSE Work Plan,* Sections 4.2, 4.4, and 4.5.

The background reference area surface gamma surveys were completed in May 2016 at BG-1 and CK-BG-2, and in May 2017 at BG-2. 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 S260-BG1-011 (BG-1), S260-BG2-011 (BG-2), and S225-SCX-001 (CK-BG-2). 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 Figures 3-3a and 3-3b. 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. Field personnel collected the following samples from the background reference areas:

- BG-1 – In October 2016, 11 surface soil grab samples were collected from 11 locations and one subsurface borehole S260-SCX-001 was advanced to 1.0 ft bgs and samples were collected (refer to Appendix C). However, prior to shipping samples to the laboratory for analyses, the samples collected from borehole S260-SCX-001 were accidently misplaced by field personnel. Therefore, field personnel returned to BG-1 in May 2017, during a later sampling event, and advanced a second borehole S260-BG1-011 (located near where S260-SCX-001 was advanced) and collected a sample. A grab sample was collected at S260-BG1-011 from 0.0 to 0.5 ft bgs, but this is categorized as a surface sample. Therefore, no subsurface soil sample was collected from BG-1.
- BG-2 – In August 2017, 11 surface sediment grab samples were collected from 11 locations and one subsurface sediment composite sample was collected from borehole S260-BG2-011.
- CK-BG-2 – In October and November 2017, 11 surface soil grab samples were collected from 11 locations and one subsurface soil grab sample was collected from borehole S225-SCX-001.

The lack of a subsurface soil sample from BG-1 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/sediment samples (refer to Section 4.1).

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 0.2 acres located within the 100-ft buffer and on the mesa top were mistakenly omitted from the surface gamma survey due to field personnel oversight (refer to Figure 3-4). The shoulders of the potential haul road were surveyed, but the approximate centerline was not surveyed, due to miscommunication with the field personnel. These are identified as data gaps in Section 4.9. In addition, approximately 0.7 acres on the cliff face and some overly steep areas near the waste pile were not surveyed because field personnel were unable to safely access these areas. The area not surveyed due to access issues is shown in Figure 3-4 and is considered a potential data gap in Section 4.9.

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, and surface water and well water samples were also collected and used to evaluate mining-related impacts (refer to Section 3.3.2).

In October 2016, 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. Refer to Appendix B-1 photograph numbers 8 and 10 showing topography encountered during the surface gamma survey. 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.

In addition, the Agencies requested field personnel also conduct a surface gamma survey at an approximately 12 acre exploration area which was included in the *2007 AUM Atlas*. The exploration area was located adjacent to the claim boundary on the mesa top, as shown in Figures 2-1, 2-7, and 3-4. Results of the exploration area surface gamma survey are included in Section 4.2.

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 does not include the 12 acres surveyed within the exploration area. The Survey Area was 9.1 acres and was subdivided into three 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 Moenkopi Formation and Chinle Formation (based on BG-1), Survey Area B is within the Quaternary deposits (based on BG-2), and Survey Area C is within bedrock and sediment in the drainages of the Cutler Formation (based on CK-BG-2).

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 soils 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, the study area soils 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 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 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, 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 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 taken into account. 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 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 May 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-three surface soil/sediment grab samples were collected from 23 locations in the Survey Area (12 from Survey Area A, two from Survey Area B, and nine from Survey Area C). 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). 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.

Twelve boreholes were advanced in the Survey Area (seven in Survey Area A, one in Survey Area B, and 4 in Survey Area C). The boreholes were advanced through the unconsolidated deposits (from 0.5 ft to greater than 2.2 ft bgs; refer to Table 3-2 and Appendix C.2) until refusal at either bedrock or a hard surface or termination due to stable low gamma measurements (the use of this criterion was a field error and has been identified as a potential data gap in Section 4.9). 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 poorly graded sand with gravel and silt (refer to Appendix C.2 for borehole information). Subsurface sampling was limited in some areas on the cliff face and some overly steep areas near the waste pile due to unsafe terrain. A drill rig was not employed at the Site because of the steepness and instability of the terrain at the Site, especially where the bulk of the mining-related impacts were identified (i.e., the waste pile), a drill rig could not safely access or operate at the Site.

In May 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. Eight subsurface soil/sediment samples were collected from seven borehole locations in the Survey Area (two subsurface samples were collected from borehole S260-SCX-012). Five subsurface samples were collected from Survey Area A, two from Survey Area B, and one from Survey Area C.

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 Surface Water and Well Water Sampling

Four potential water features were identified during the Site Clearance desktop study, as shown in Figure 2-1 and Table 3-1a. One of the four water features was not sampled, identified as 08-0908 in the *2007 AUM Atlas*, because a water well and/or surface water feature was not observed by field personnel at this location. The other three water features were sampled as described below.

On October 18, 2016, a surface water sample (S260-WS-001) was collected from a seep identified in the *2007 AUM Atlas* as 08GS-12-10. The seep is also known as Holiday Mesa Spring. The seep was located 0.70 miles northwest of the Site and day-lighted on a bedrock wall. Historically a hole was drilled into the bedrock and a polyvinyl chloride (PVC) pipe was cemented into the hole to capture flow from the seep. The PVC pipe ran from the bedrock wall to a sediment-settling tank and then from the tank to an enclosed 8 ft tall water tank. A second pipe ran underground and carried the discharge from the tank to a water spigot. The seep water sample was collected at the water spigot. A galvanized water trough was also present under the spigot to collect water when the spigot was turned on. Seep 08GS-12-10 is shown in Appendix B-2 photograph number 13.

On October 18, 2016, a surface water sample (S260-WS-002) was collected from a seep identified in the *2007 AUM Atlas* as 08A-213. The seep was located 0.75 miles northwest of the Site and day-lighted on a bedrock wall. Historically a hole was drilled into the bedrock and a PVC pipe was cemented into the hole to capture flow from the seep. The PVC pipe ran to a water trough and the water sample was collected from the pipe at the water trough. Seep 08A-213 is shown in Appendix B-2 photograph number 12.

On October 18, 2016, a well water sample (S260-WL-001) was collected from the water well identified as 08K-432 in the *2007 AUM Atlas*. Water well 08K-432 was completed in May1955 at a total depth of 451 ft bgs, and was screened from 41 ft to 451 ft bgs (refer to Table 3-1b for additional well build specifications). Water well 08K-432 was a livestock windmill well located 0.92 miles west of the Site. The well water sample was collected from a spigot associated with the water well. Water well 08K-432 is shown in Appendix B-2 photograph number 14.

The water samples collected for dissolved metals analyses were sampled and field filtered using a peristaltic pump, Teflon® tubing, and 0.45-micron inline filter in the field at the time of sample collection per the *RSE Work Plan*, Section 4.6.1. All other analyses did not require in-field filtering. The samples were collected, packaged, and shipped in accordance with the *RSE Work Plan,* Sections 4.6, 4.9, 4.11, and Appendix E. ACZ Laboratories, Inc. in Steamboat Springs, Colorado conducted the mercury analysis and ALS Environmental Laboratories in Fort Collins, Colorado conducted all other analyses including Ra-226 and Radium-228 (Ra-228), adjusted gross alpha, and the following total and dissolved metals: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, selenium, silver, thallium, uranium, vanadium, and zinc.

Additional general water quality analyses or field measurements included: total dissolved solids (TDS), anions (carbonate, bicarbonate, chloride, and sulfate), cations (sodium and calcium), and field measurements (pH, salinity, conductivity, turbidity, temperature, and oxidation reduction potential). Table 3-4 provides a summary of the water analyses. 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. Surface water and well water analytical results are presented in Section 4.8. Field forms are provided in Appendix C.3 and the laboratory analytical data and Data Usability Report for the analyses are provided in Appendix F. Investigation of groundwater is not included in the scope of this RSE.

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, 2002b) 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 qualified.

    - **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 4-1d with sample locations in the background reference areas shown for BG-1, BG-2, and CK-BG-2 on Figures 4-1b, 4-1c, and 4-1d, respectively. The surface gamma survey in BG-2 did not cover the areal extent of the sample locations because field personnel stepped one sample (S260-BG2-001) out past vegetation that was present in the drainage. Analytical results of the samples collected from BG-1, BG-2, and CK-BG-2 are summarized in Table 4-1. The gamma measurements and surface soil sample analytical results collected from BG-1, BG-2, and CK-BG-2 were evaluated statistically to calculate ILs (refer to Appendix D.2) for each corresponding Survey Area (i.e., Survey Area A, Survey Area B, and Survey Area C, respectively). As previously discussed in Section 3.3.1.2, the Site was subdivided into three 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, 2016c).

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 Moenkopi; refer to Figure 2-6a) were established using statistical analysis of background data from BG-1(refer to Figures 3-2a and 3-3a) and are as follows:

- Arsenic – 3.31 milligrams per kilogram (mg/kg)
- Molybdenum – 0.312 mg/kg
- Selenium – an IL for selenium was not identified because selenium detections were not sufficient to calculate an IL.
- Uranium – 0.877 mg/kg
- Vanadium – 17.2 mg/kg
- Ra-226 – 0.872 pCi/g
- Surface gamma measurements – 12,847 cpm

The ILs for Survey Area B (i.e., the Quaternary deposits; refer to Figure 2-6a) were established using statistical analysis of background data from BG-2 (refer to Figures 3-2a and 3-3a) and are as follows:

- Arsenic – 6.43 mg/kg
- Molybdenum – 0.447 mg/kg
- Selenium – an IL for selenium was not identified because selenium sample results in BG-2 were all non-detect.
- Uranium – 0.619 mg/kg
- Vanadium – 8.38 mg/kg
- Ra-226 – 0.922 pCi/g
- Surface gamma measurements – 9,172 cpm

The ILs for Survey Area C (i.e., the Cutler Formation; refer to Figure 3-2b) were established using statistical analysis of background data from CK-BG-2 (refer to Figures 3-2b and 3-3b) and are as follows:

- Arsenic – 2.36 mg/kg
- Molybdenum – 0.786 mg/kg
- Selenium – an IL for selenium was not identified because selenium sample results in BG-3 were all non-detect.
- Uranium – 0.482 mg/kg
- Vanadium – 9.45 mg/kg
- Ra-226 – 0.909 pCi/g
- Surface gamma measurements – 11,220 cpm

ILs for the Chinle Formation were not developed; ILs developed for the Moenkopi Formation are used for comparison purposes only and do not directly apply to the area of the Site within the Chinle Formation. Further background investigation of the Chinle and Moenkopi Formations may be warranted as part of future work at the Site. The Agencies have suggested that due to the variation in statistics for the surface gamma surveys at CK-BG-2, BG-3, and BG-4 (refer to Table D.1-2 in Appendix D.1), further investigation for a background area to represent the Cutler Formation is warranted as part of future work at the Site. The need for further investigations of these background reference areas are included as data gaps in Section 4.9.

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 background reference areas, subsurface static gamma measurements were collected in the boreholes completed in the BG-2 and CK-BG-2. A borehole was completed in BG-1 (S260-BG1-011) to the refusal depth of 0.5 ft bgs (refer to Appendix C.2); however, the borehole location was not within the Moenkopi portion of the background reference area (refer to Section 3.2.2.2 and Figures 2-6a and 3-3a), but instead, within the Cutler Formation. Because refusal was on bedrock (Cutler Formation), the subsurface static gamma measurement from this borehole was not considered representative of the Moenkopi, and a subsurface static gamma measurement IL was not established for Survey Area A. This is considered a minor data gap for the Site (refer to Section 4.9). The measurements collected from BG-2 and CK-BG-2 were used to establish a subsurface static gamma screening level for Survey Areas B and C. Where possible, the selected subsurface static gamma screening level 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. The subsurface static gamma screening levels provide a comparison and assessment tool for Survey Areas B and C 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. Three subsurface static gamma measurements of 12,198, 11,694, and 11,490 cpm were collected from BG-2 borehole S260-BG2-011, at down-hole depths of 1.0, 2.0, and 3.0 ft bgs, respectively. The lowest measured value (11,490 cpm) was measured at the borehole termination depth (3.0 ft bgs); however, because the borehole termination was on bedrock, the 2.0-ft measurement of 11,694 cpm was selected as the subsurface static gamma IL for Survey Area B. Three subsurface static gamma measurements of 9,424, 10,849, and 8,623 cpm were collected from CK-BG-2 borehole S225-SCX-001 at down-hole depths of 0.5, 1.0, and 1.5 ft bgs, respectively. The lowest measured value (8,623 cpm) was measured at the borehole termination depth (1.5 ft bgs); because the borehole termination was not on bedrock, 8,623 cpm was selected as the subsurface static gamma IL for Survey Area C.

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 bins ranges were based on the minimum site gamma measurement, the background reference area ILs, and the maximum site gamma measurement. The maximum survey measurement was 129,220 cpm, which was more than 10 times the maximum IL (i.e. BG-1 IL of 12,847 cpm), and occurred within Survey Area A, in an area adjacent to the prospect portal (refer to Figure 2-7).

Surface gamma measurements were generally highest in the vicinity of the portal area and within the waste pile. The portal area is inclusive of the reclaimed portal, the prospect portal, and the area northeast of the prospect portal. A description and photographs of these areas are provided in Section 3.2.2.1 and Appendix B-1 photograph numbers 7, 9, 10, 11, 12, and 13.

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

- Survey Area A (refer to Figure 4-1b) – Surface gamma IL exceedances (greater than 12,847 cpm) occurred primarily in areas associated with mining-related disturbances, including the portal area and portions of the potential haul road located beneath the portal area, in the waste pile, and in areas immediately surrounding and/or downgradient of the waste pile.

- Survey Area B (refer Figure 4-1c) – Surface gamma IL exceedances (greater than 9,172 cpm) occurred in sediments located within the eastern drainage. The maximum measurement of 13,241 cpm was less than two times the IL.

- Survey Area C (refer to Figure 4-1d) – Surface gamma IL exceedances (greater than 11,220 cpm) occurred immediately downgradient of the waste pile and in sediments located in the eastern drainage. The maximum measurement of 20,919 cpm was measured just downgradient of the waste pile.

The extent of IL exceedances outside the eastern drainage channel was not surveyed. However, the IL exceedances appeared to be related to the alluvial sediments in the channel within the drainage from the waste pile area.

A surface gamma survey was also conducted in the exploration area located on the mesa top (refer to Section 3.3.1.2). The spatial patterns of surface gamma measurements in the exploration area are shown in Figure 4-1e. Surface gamma measurements within the exploration area ranged from 3,950 cpm to 13,806 cpm. As shown in Figures 4-1a and 4-1e, gamma measurements were less than 9,172 cpm in the areas around the mapped historical boreholes, rock core/drill cuttings, and historical metal rods.

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

1. Approximately 0.7 acres on the cliff face and some overly steep areas near the waste pile were not surveyed because field personnel were unable to safely access these areas (refer to Figure 3-4).

2. The shoulders of the potential haul road were surveyed, but the approximate centerline was not surveyed, due to miscommunication with the field personnel.

3. Approximately 0.2 acres located within the 100-ft buffer and on the mesa top were mistakenly omitted from the surface gamma survey due to an oversight by field personnel (refer to Figure 3-4).

4. The survey was not extended laterally from the potential haul road or the eastern drainage where gamma measurements were greater than the IL, as the result of an oversight.

5. The survey was not extended to include the eastern historical borehole and metal rod because the features are outside of the 100 ft buffer, and it was initially assumed the features were related to exploration activities and not related to mining at the Site. However, the features are being included in TENORM at the request of the Agencies (NNEPA, 2018)

4.2.1.2 Subsurface Gamma Survey

Surface and subsurface static gamma measurements were collected at all but 12 borehole locations. Surface and subsurface static gamma measurement locations are shown in Figures 4-1b through 4-1d. 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 (refer to Figure 4-1b) – A subsurface static gamma IL was not established for Survey Area A (refer to Sections 3.3.1.1 and 4.1) and findings of the subsurface static gamma survey are not considered with respect to an IL. Because the subsurface static gamma measurement in this location was directly on Cutler Formation bedrock (0.5 ft bgs), the static gamma measurement (8,053 cpm) was not considered representative of the Moenkopi Formation. The maximum subsurface measurement (145,025 cpm) was measured at 0.8 ft bgs in borehole S225-SCX-007, which was located in the waste pile. The remaining six boreholes were located along the potential haul road, and with the exception of one borehole (S260-SCX-005), all had subsurface static gamma measurements greater than 20,000 cpm. Excluding surface static gamma measurements (refer to Section 4.1), subsurface static gamma measurements increased with depth in the two boreholes where more than one subsurface static gamma measurement was collected (S260-SCX-007 and -SCX-008). When comparing the static gamma measurements collected at the surface to the first measurement collected down-hole (generally 0.5 ft bgs), static gamma measurements also increased with depth (potentially from geometric effects), with the exception of borehole S225-SCX-004, located on the haul road at the top of the waste pile, where measurements decreased from 41,122 to 37,296 cpm.

- Survey Area B (refer to Figure 4-1c) – One borehole was completed in Survey Area B (S260-SCX-012) in the southern extent of the eastern drainage. All three subsurface static gamma measurements exceeded the IL (11,694 cpm) in this borehole, and the maximum measurement (17,206 cpm) occurred at 0.5 ft bgs. Excluding surface static gamma measurements (refer to Section 4.1), the subsurface static gamma measurements decreased with depth. When comparing the static gamma measurements collected at the surface to the first measurement collected down-hole (0.5 ft bgs), the static gamma measurement increased (potentially from geometric effects).
- Survey Area C (refer to Figure 4-1d) – The subsurface static gamma IL (8,623 cpm) was exceeded in all four boreholes in Survey Area C. The maximum subsurface static gamma measurement (24,215 cpm) occurred at 0.5 ft bgs in borehole S260-SCX-011, which was located in the eastern drainage, near the base of the mesa sidewall. Excluding surface static gamma measurements (refer to Section 4.1), subsurface static gamma measurements increased with depth in two boreholes (S260-SCX-010 and -SCX-013), and decreased with depth for one borehole (S260-SCX-011). When comparing the static gamma measurements collected at the surface to the first measurement collected down-hole (0.5 ft bgs), static gamma measurements increased with depth in all four Survey Area C borehole locations (potentially from geometric effects).

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.

The correlation was developed as a potential field screening tool for future Removal or Remedial Action evaluations. 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 0.41 which is not within the acceptance criterion of 0.8 to 1.0 described in the *RSE Work Plan* and indicates that surface gamma results do not correlate with Ra-226 concentrations in soil. The R^2

value is likely lower because the correlation location with the highest mean gamma count rate (48,808 cpm at correlation location S260-C04-001) had the second highest Ra-226 laboratory concentration of 20.7 pCi/g, and the correlation location with the second highest mean gamma count rate (32,533 cpm at correlation location S260-C03-001) had the highest Ra-226 laboratory concentration (34.2 pCi/g). These results were possibly due to the presence of gamma radiation heterogeneity at correlation location S260-C04-001(in comparison to more homogenous measurements at correlation location S260-C03-001), that was not captured in the five-point composite soil sample. The Agencies have also suggested that the high-density surface gamma measurements are over-weighted because measurement results at two of the five areas used for the Gamma Correlation Study are at the middle-to-high end of the range of gamma measurements collected from the Survey Area (refer to Figure 3-5 and 4-1a). Conversely, the lower ranges of gamma measurements may also be underrepresented, and those gamma measurements would be the more significant range if lower ILs were imposed (NNEPA, 2018). However, it is also notable that the maximum correlation gamma survey measurement was 66,226 cpm (Figure 3-5) when the maximum from the Site is more than two-times that value (129,220 cpm). The correlation model may have also 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 Ra-226 concentrations. The inability to construct a statistically defensible correlation model is identified as a data gap. The correlation equation to convert gamma measurements in cpm to predicted surface soil Ra-226 concentrations in pCi/g for the Site is:

$$\text{Gamma (cpm)} = 879 \times \text{Surface Soil Ra-226 (pCi/g)} + 12{,}867$$

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 (8,354 cpm) and greater than the maximum (48,808 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 -5.1 pCi/g and the concentration associated with the maximum mean gamma measurement is 40.9 pCi/g. Therefore, predicted Ra-226 concentrations less than -5.1 pCi/g and greater than 40.9 pCi/g should be limited to qualitative use only. Negative values for Ra-226 are a function of the linear regression equation and are not physically possible. 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 8,354 to 48,808 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 12,867 cpm. The predicted concentrations are shown in Figure 4-2a and the values less than zero are prevalent throughout the majority of the Site, except for in areas associated with the Waste Pile, Prospect Bench and potential haul road. 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 -9.8 to 132.4 pCi/g, with a mean of -1.1 pCi/g, and a standard deviation, of 10.4 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. With the exception of 12 (out of 23) sample locations, the measured Ra-226 laboratory concentrations were within the applicable predicted Ra-226 bin ranges. Eleven of the 12 sample locations that did not fall within the applicable predicted Ra-226 bin range had Ra-226 laboratory concentrations that were higher than the predicted Ra-226 values and the remaining sample location had a Ra-226 laboratory concentration that was lower than the predicted Ra-226 value. The majority of the sample locations had Ra-226 laboratory concentrations that were within one standard deviation (10.4 pCi/g) of each other, however, one sample location (S260-CX-007) had a notable difference between the predicted and laboratory Ra-226 concentrations; this sample was downgradient from the waste pile. 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 exceeded the Ra-226 ILs in the area of the potential haul road, prospect bench, and waste pile and in a small area of the drainage downgradient from the waste pile. Within Survey Area A, surface sample locations that exceeded the Ra-226 IL were co-located with predicted Ra-226 concentrations that exceeded the IL. However, in Survey Areas B and C, surface samples where Ra-226 concentrations exceeded the IL were generally not co-located with predicted Ra-226 concentrations that exceeded the IL. 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 not significant (i.e., $p > 0.05$) and the adjusted R2 does not meet the study DQO (adjusted R2 > 0.8), indicating that Ra-226 and Th-230 are not in equilibrium (secular or otherwise). 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 23 surface soil/sediment grab samples (17 soil and 6 sediment) from 23 locations, and eight subsurface soil/sediment grab samples (five soil and three sediment) from seven borehole locations were collected at the Site (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 through 4-4c. 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 two surface soil/sediment samples (S260-CX-005 and -SCX-013, both in Survey Area C) and in all eight subsurface samples. The maximum Ra-226 and metals concentrations were detected in Survey Area A and were associated with the portal area, the portion of the haul road immediately downgradient from the portal area, and the waste pile. The maximum concentrations for molybdenum, uranium, vanadium, and Ra-226 were detected in surface soil samples collected from the waste pile (S260-CX-004 and -SCX-007). The maximum concentrations of arsenic and selenium were detected in surface soil sample S260-CX-001, which was collected in the portal area, north of the haul road. Surface and subsurface soil/sediment IL exceedances for each analyte, within each Survey Area, are shown on Figures 4-3, 4-4a, 4-4b, 4-4c, 4-4d, and 4-5, and described below:

- Ra-226
  - Survey Area A – the Ra-226 IL (0.872 pCi/g) was exceeded in all surface and subsurface soil samples. Survey Area A Ra-226 concentrations ranged from 1.03 to 77.4 pCi/g. The highest Ra-226 concentrations (greater than ten-times the IL) for the Survey Area and the Site were detected in surface and subsurface soil samples collected from the waste pile and along the potential haul road in the vicinity of the portal area. The maximum concentration (77.4 pCi/g) was detected in a surface soil sample that was collected from the waste pile (S260-CX-004). With the exception of borehole S260-SCX-007 located in the waste pile, Ra-226 concentrations decreased with depth.
  - Survey Area B – the Ra-226 IL (0.922 pCi/g) was exceeded in all surface and subsurface sediment samples. Ra-226 concentrations in Survey Area B ranged from 1.4 to 2.15 pCi/g, and the maximum concentration (2.15 pCi/g) occurred in a subsurface sediment sample that was collected in the eastern drainage (S260-SCX-012; 0.5–1 ft bgs). Overall, the Ra-226 concentration in borehole S260-SCX-012 decreased with depth.
  - Survey Area C – the Ra-226 IL (0.909 pCi/g) was exceeded in six out of nine surface soil/sediment samples and in the one subsurface sediment sample. Survey Area C Ra-226 concentrations ranged from 0.45 to 12 pCi/g and the maximum detection was from surface sediment sample S260-CX-008, located on the mesa sidewall and downgradient from the waste pile. In general, Ra-226 concentrations decreased with distance downgradient from the waste pile and with depth.

A majority of the Ra-226 results presented in Tables 4-4a through 4-4c are flagged to indicate the data are estimated and may be potentially biased (i.e., influenced) due to associated quality control data. The majority of the associated quality control issues are related to the (natural) sample density differing by more than 15% from the laboratory control sample (refer to Appendix F.1 for additional information).

- Uranium
  - Survey Area A – the uranium IL (0.877 mg/kg) was exceeded in ten out of 12 surface soil samples and all five subsurface samples. The two surface soil samples that did not exceed the IL (S260-CX-006 and SCX-008) were located on the mesa sidewall, southwest and southeast of the waste pile, respectively. Survey Area A uranium concentrations ranged from 0.77 to 130 mg/kg. The maximum concentration (130 mg/kg) for Survey Area A and the Site, occurred in a surface soil sample that was collected from the waste pile (S260-CX-004). In general, the highest concentrations (greater than ten times the IL) detected in surface and subsurface soil samples were from the waste pile and along the haul road, and in the vicinity of the portal area. Uranium concentrations increased with depth in borehole S260-SCX-008, and decreased with depth in boreholes S260-SCX-002, -SCX -003, -SCX-006, and SCX-007. The most notable uranium concentration change with depth for Survey Area A and the Site occurred in borehole S260-SCX-007, where the uranium concentration decreased from 120 mg/kg in the surface sample (0 to 0.5 ft bgs) to 100 mg/kg at 0.5 to 0.8 ft bgs.
  - Survey Area B – the uranium IL (0.619 mg/kg) was exceeded in all surface and subsurface sediment samples. Survey Area B uranium concentrations ranged from 1.2 to 2.8 mg/kg,

and the maximum concentration occurred in a surface sediment sample that was collected in the eastern drainage (S260-SCX-012). Uranium concentrations in samples collected in the western drainage did not exceed the IL. The uranium concentration decreased with depth in borehole S260-SCX-012.

- Survey Area C – the uranium IL (0.482 mg/kg) was exceeded in six out of nine surface soil/sediment samples, and in the one subsurface sediment sample. Survey Area C uranium concentrations ranged from 0.3 to 18 mg/kg, and the maximum concentration occurred in a surface soil sample that was collected just downgradient from the waste pile (S260-CX-007). Uranium IL exceedances were not observed in three soil/sediment samples: one collected southwest of the waste pile (S260-CX-005), and two collected in the western drainage (S260-CX-011 and -SCX-013). In general, uranium concentrations decreased with distance downgradient from the waste pile, and increased with depth in borehole S260-SCX-011.

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 the four Survey Area B sediment samples, but exceeded the maximum regional value in seven (out of 17) Survey Area A soil samples, and four (out of 9) Survey Area B soil/sediment samples. All samples that exceeded the regional value were associated with, or downgradient from the waste pile.

- Arsenic
  - Survey Area A – the arsenic IL (3.31 mg/kg) was exceeded in 11 out of 12 surface soil samples and four out of five subsurface soil samples. Survey Area A arsenic concentrations ranged from 3 to 24 mg/kg. The surface and subsurface soil samples that did not exceed the arsenic IL were both collected from borehole location S260-SCX-006, which was located on the potential haul road and west of the reclaimed portal. The maximum concentration (24 mg/kg) for Survey Area A and the Site was measured in a surface soil sample collected northeast of the prospect portal (S260-CX-001). In general, the highest concentrations (greater than two-times the IL) were measured in soil samples collected from the waste pile and in the portal area. Arsenic concentrations increased with depth in borehole S260-SCX-006, decreased with depth in boreholes S260-SCX-002, and -SCX-008, and were unchanged with depth in boreholes S260-SCX-003 and -SCX-007.
  - Survey Area B – the arsenic IL (6.43 mg/kg) was not exceeded in any surface or subsurface sediment samples. Survey Area B arsenic concentrations ranged from 1.8 to 3.1 mg/kg, and the maximum detection occurred in a subsurface sediment that was collected in the eastern drainage (S260-SCX-012; 1-1.5 ft bgs). Overall, the arsenic concentration in borehole S260-SCX-012 increased with depth, although there was an initial decrease of 0.4 mg/kg between the surface sample and the sample collected from 0.5 to 1.0 ft bgs.
  - Survey Area C – the arsenic IL (2.36 mg/kg) was exceeded in six out of nine surface soil/sediment samples and was not exceeded in the subsurface sediment sample. Survey Area C arsenic concentrations ranged from 1.4 to 5.8 mg/kg and the maximum detection was from surface sediment sample S260-CX-008, located in the eastern drainage, near the base of the mesa sidewall. The majority of the arsenic IL

exceedances in Survey Area C were in samples located downgradient of the waste pile. The arsenic concentration in borehole S260-SCX-011 decreased with depth.

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). All arsenic concentrations were within the typical range of regional values in the soil/sediment samples from Survey Areas A, B, and C.

- Molybdenum
  - Survey Area A – the molybdenum IL (0.312 mg/kg) was exceeded in nine out of 12 surface soil samples, and in all five subsurface soil samples. Survey Area A molybdenum concentrations ranged from 0.26 to 4.3 mg/kg, and the maximum concentration (4.3 mg/kg) for Survey Area A and the Site, was detected in a surface soil sample collected from the waste pile (S260-SCX-007). Molybdenum concentrations decreased with depth in boreholes located in the waste pile, or in the vicinity of the portal area (S260-SCX-002, -SCX-003, and -SCX-007), but increased with depth in the other two boreholes S260-SCX-006 and -SCX-008 not associated with the waste pile or portals.
  - Survey Area B – the molybdenum IL (0.447 mg/kg) was not exceeded in any surface (two locations) or subsurface sediment (two locations) samples. Survey Area B molybdenum concentrations were non-detect at one surface location (S260-CX-010) and one subsurface location (S260-SCX-012; 0.5 to 1 ft bgs). Two detections occurred at borehole S260-SCX-012 in the surface sample (0.24 mg/kg) and at 1.0-1.5 ft bgs (0.38 mg/kg).
  - Survey Area C – the molybdenum IL (0.786 mg/kg) was exceeded in two out of nine surface soil/sediment samples and was not exceeded in the subsurface sediment sample. Survey Area C molybdenum concentrations were non-detect in two surface samples and one subsurface sample, concentrations in samples where there were molybdenum detections ranged from 0.21 to 1.4 mg/kg. The two surface soil/sediment samples that exceeded the Survey Area C molybdenum IL (S260-CX-007, and -SCX-008) were located on the mesa sidewall and in the eastern drainage downgradient from the waste pile. Molybdenum concentrations decreased with depth in borehole S260-SCX-011.

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). All molybdenum concentrations were within the typical range of regional values in soil/sediment samples from Survey Areas A, B, and C.

- Selenium – ILs for selenium were not identified because selenium sample results in the background reference areas were non-detect (BG-2 and CK-BG-2) or there were not enough detections to establish an IL (one detection in BG-1)
  - Survey Area A – selenium was detected in three, out of 12 surface samples, and in two out of five subsurface samples. Measurable Survey Area A selenium concentrations ranged from 0.98 to 2.1 mg/kg. The maximum detection (2.1 mg/kg) was in surface soil sample S260-CX-001, which was located northeast of the prospect portal. Selenium

concentrations increased with depth in boreholes S260-SCX-002 and -SCX-007, and decreased with depth in borehole S260-SCX-003.

- Survey Area B – selenium was below detection limits in all surface and subsurface sediment samples collected from Survey Area B

- Survey Area C – selenium was below detection limits in all surface and subsurface soil/sediment samples in Survey Area C.

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). All selenium concentrations were within the typical range of regional values in all Survey Areas A, B, and C.

- Vanadium

  - Survey Area A – the vanadium IL (17.2 mg/kg) was exceeded in all 12 surface soil samples, and four out of five subsurface samples. Survey Area A vanadium concentrations ranged from 17 to 120 mg/kg. The maximum vanadium concentration (120 mg/kg) for the Survey Area and the Site occurred in a surface soil sample that was collected from the waste pile (S260-SCX-007). The one subsurface soil sample that did not exceed the IL (S260-SCX-008) had a concentration that was 0.2 mg/kg lower than the IL. With the exception of borehole S260-SCX-006, vanadium concentrations decreased with depth. The most notable vanadium concentration change with depth occurred in borehole S260-SCX-007, where the concentration decreased from 120 mg/kg at the surface to 97 mg/kg at 0.5 to 0.8 ft bgs.

  - Survey Area B – the vanadium IL (8.38 mg/kg) was exceeded in all surface and subsurface sediment samples. The Survey Area B vanadium concentrations ranged from 9.2 to 13 mg/kg, and the maximum concentration occurred in a subsurface sediment sample that was collected in the eastern drainage (S260-SCX-012; 0.5-1.0 ft bgs). Overall, the vanadium concentration in borehole S260-SCX-012 decreased with depth (there was an initial increase of 1.0 mg/kg between the surface sample and the sample collected from 0.5 to 1.0 ft bgs).

  - Survey Area C – the vanadium IL (9.45 mg/kg) was exceeded in six out of nine surface soil samples and in the one subsurface sediment sample. The Survey Area C vanadium concentrations ranged from 6.7 to 25 mg/kg, and the maximum concentration was in a surface soil sample collected just downgradient from the waste pile (S260-CX-007). Vanadium IL exceedances were not observed in three soil/sediment samples: one collected southwest of the waste pile (S260-CX-005) and two collected in the western drainage (S260-CX-011 and -SCX-013). The vanadium concentration decreased with depth in borehole S260-SCX-011.

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 all Survey Areas (A, B, and C).

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, molybdenum, uranium, and vanadium in soil/sediment exceeded their respective ILs in Survey Areas A, B, and C. Therefore, these constituents were confirmed COPCs for the Site. In addition, selenium was also confirmed as a COPC because it was detected in soil samples from Survey Area A, but was non-detect in all but one background reference area sample.

4.5 AREAS THAT EXCEED THE INVESTIGATION LEVELS

The approximate lateral extent of surface gamma IL exceedances in soil/sediment is 2.4 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 through 4-4d show larger scale views of each of the three Survey Areas to better display those areas with multiple, contiguous surface gamma IL exceedances. Seven sample locations were located in areas that were not included in the 2.4 acres, as follows:

- Two sample locations in the eastern drainage (S260-CX-009 and -CX-010) with Ra-226 or metals concentrations that were generally less than two times the ILs. This stretch of the drainage is included in the TENORM volume estimate in Section 4.7.

- Two sample locations on the mesa sidewall, downgradient from the waste pile (S260-CX-007, and -SCX-010), with uranium and Ra-226 concentrations up to 10 times the ILs, but low gamma measurements. The area on the mesa sidewall inclusive of sample locations S260-CX-007 and -SCX-010 is included in TENORM volume estimate in Section 4.7.

- Three sample locations in areas that were cross-gradient from the waste pile (S260-CX-006, -CX-011, and -SCX-008) with Ra-226 or metals approximately two times their respective ILs.

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 similar area of the Site as the surface gamma measurements exceeded the surface gamma IL. The primary exception is that predicted Ra-226 concentrations in Survey Area B did not exceed the IL while surface gamma measurements exceeded the surface gamma IL. The inconsistency between the predicted Ra-226 exceedances and the surface gamma exceedances within Survey Area C 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 concentration is lower than the actual concentration.

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, 2.7 acres, out of the 9.1acres of the Survey Area, were estimated to contain TENORM at the Site. This estimate is inclusive of four areas: the portal area, the waste pile, areas downgradient of the waste pile (including the eastern drainage), and the potential haul road. 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 Conclusions
    - Historical document review showed that one mining portal (with an approximately 320 ft long mining adit) and one waste pile were present on-site.
    - USAEC records show one shipment of ore was sent from the Site in 1955.
    - Historical document review suggested that reclamation activities were proposed for the Site that included: (1) excavation, stabilization, and closure of the portal using material from the waste pile and concrete blocks; (2) excavation and backfilling of the waste pile; and (3) elimination of two sections of the access road, with one of those sections being a 50-ft section near the waste pile. Stantec field personnel observed the approximate location of the reclaimed portal; however, the waste pile appeared to be undisturbed and portions of the haul roads that were impassable were greater than 0.5 miles from the Site.
- Geology/geomorphology
    - Bedrock at the Site consisted of four geologic units from three geologic Formations: (1) the Shinarump Member of the Chinle Formation; (2) the Moenkopi Formation; and (3) the De Chelly Sandstone Member and Organ Rock Tongue of the Cutler Formation. The Shinarump member of the Chinle Formation commonly contains natural 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.

  - Two ephemeral drainages drain the Site and join into an unnamed drainage located in the pediment that could transport NORM/TENORM to the southeast. The eastern drainage is located downgradient from the waste pile, and the western drainage is offset to the west of the waste pile.

- Disturbance Mapping – Stantec field personnel observed the following features:

  - The approximate location of one reclaimed portal was mapped by Stantec field personnel. The exact location of the portal was not observed because it was buried under soil and rock; however, NAML confirmed the location to Stantec personnel in the field. The portal was located just upgradient from the waste pile, and north of the potential haul road. Historical documentation indicated that approximately 175 yd^3 of material from the waste pile would be used to stabilize and close the portal; however, Stantec field personnel were unable to confirm whether any material had been borrowed from the waste pile (i.e., there were no areas of the waste pile where material appeared to be removed).

  - A prospect portal was observed approximately 50 feet northeast of the reclaimed portal. The prospect portal was approximately eight feet wide, six feet tall, and 20 feet deep.

  - One waste pile was located immediately downgradient of the reclaimed portal. The waste pile fanned downslope on the mesa sidewall, and consisted primarily of fine-grained unconsolidated material.

  - One potential haul road was observed on-site that provided access to the historical portals. The potential haul road ran along the mesa sidewall, near the geologic contact between the Moenkopi Formation and Chinle Formations. However, there were no indications of disturbance due to historical mining-related activities along the section of the road that runs to the east of the portal area, which is therefore considered NORM (it appears to provide access to a radio tower at the end of the mesa). Given the presence of an antenna at the far southeast end of the mesa bench, and that there was no viable route to haul materials down from the mesa bench, this portion of the road was likely used to access the antenna, and was not related to historical mining activities.

  - Historical boreholes, rock cores, drill cuttings, and metal rods were mapped on the mesa top within the 100-foot buffer area of the mine and within the exploration area mapped in the *2007 AUM Atlas*. The features on the mesa top were included in TENORM by including ten ft diameter polygons at the location of the mapped feature (refer to Figure 4-6). It is unknown whether these features were associated with mining-related disturbances at the Site.

- Site Characterization

  - Waste rock was observed in Waste Pile 1based on a gray color and finer grained soil than surrounding material at the ground surface; can be seen on aerial photographs of the Site (gray color); and was observed in borehole S260-SCX-007 (variable color including gray).

  - The portal area and waste pile are located on the mesa sidewall in Survey Area A. These areas were characterized by the highest surface gamma measurements, subsurface static gamma measurements, and metals and Ra-226 concentrations at the Site. With the exception of arsenic and molybdenum in one borehole located west of the portal area, every sample location exceeded the IL for each COPC, and selenium was detected in several samples. The lateral extent of TENORM along the edges of the waste pile was defined based on IL exceedances. The potential haul road, which crosses beneath the portal area, is also located within Survey Area A.

- TENORM downgradient from the waste pile on the mesa sidewall and in the eastern drainage is within Survey Areas A, B, and C. Three or more ILs were exceeded in every surface or subsurface soil/sediment sample location within this area. Portions of this area were characterized by contiguous surface gamma IL exceedances that were generally less than two times the ILs. Colluvium on the mesa sidewall just downgradient from the waste pile was identified as TENORM based on uranium and Ra-226 concentrations more than ten times the ILs. Other portions of this area contained contiguous surface gamma IL exceedances that were generally less than two times the ILs.

- Sample locations S260-CX-006, -CX-011, and –SCX-008 in Survey Area A had Ra-226 and metals that exceeded the ILs by less than two times, and some gamma measurements exceed the IL in a small area just west of the southwest corner of the claim boundary, next to sample S260-CX-006. These areas were not likely to have been mine impacted because they are not downgradient or downwind of the mine features (waste pile or portal area) and appeared undisturbed based on historical and current information (e.g., aerial photographs) and field observations. These results suggest that these areas are un-impacted and contain NORM.

- Sediment in the western drainage did not exceed any ILs, except arsenic in one sample that narrowly exceeded the IL (by 0.04 mg/kg), even though it is downgradient of the waste pile. Therefore, this drainage is considered to contain NORM.

- Metals concentrations in samples collected outside the area of TENORM (five locations) were less than or within the regional concentration values.

- 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 IL in borehole locations 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 2.7 acres, as shown on Figure 4-8a. Portions of the TENORM exceeded one or more IL, where approximately 2.2 acres contained TENORM that exceeded the surface gamma IL and the 11 out of the 13 sample locations where TENORM exceeded the ILs. TENORM exceeding the ILs was observed at two sample locations in Survey Area B that were not coincident with areas of the Site that exceeded the surface gamma IL. TENORM that exceeded the ILs in Survey Areas A, B, and C is shown on Figures 4-8b through 4-8d, respectively, and is compared to mining-related features in Figure 4-8e.

4.7 TENORM VOLUME ESTIMATE

The volume estimate of TENORM that exceeded one or more ILs is approximately 5,927 yd^3, as shown in Figure 4-9a. The volume and area of TENORM associated with specific mine features is listed in Table 3-3. This estimate was calculated using 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 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.

A separate volume estimate is provided for potential TENORM on the mesa top (Group 6). While the gamma survey measurements were less than 9,172 cpm in the areas of the features that were surveyed, it is uncertain whether the TENORM would exceed an IL because a background reference area was not established for the mesa top. The TENORM was estimated to be 9 yd^3.

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 4-9a. The waste pile is also shown on Figure 4-9a for reference, and the volume and area of the waste pile is listed in Table 3-3. The assumptions that were 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.
- For areas of TENORM at the Site containing large cobble- or boulder-sized rocks at the surface whose heights exceeded the assumed depth of TENORM in that area (e.g., a 5-ft-tall boulder in an area where TENORM was assumed to extend 1 ft bgs), the additional volume of the boulders was assumed to be accounted for by the TENORM depth estimates.
- The subsurface static gamma ILs were not used as the only evidence to delineate the vertical extent of TENORM that exceeded the IL in borehole locations at the Site.

Group Assumptions

- Group 1 (2,013 yd^3) – the waste pile and the area surrounding it (referred to as Waste Pile Area) was estimated to contain 347 yd^3 of TENORM. Contours of the depth of the waste pile area were created to support these volume calculations (refer to Figure 4-9b). The contours were based on: (1) elevation profiles of the waste pile area; (2) the assumption that bedrock beneath the waste pile area was a planar surface; (3) the assumption that all material within the footprint of the waste pile area exceeded the ILs; and (4) review of oblique imagery in Google Earth (Google Earth, 2018). The elevation profiles were created by cutting a series of cross-sections along the topographic contours (Cooper, 2017) of the waste pile area. Each profile visually depicted the depth of the waste pile area relative to the assumed depth of bedrock and/or exposed bedrock adjacent to the waste pile area. Depth information from each profile, in conjunction with the orthophotographs, were then used to create the depth contours that supported the volume calculations. The waste pile area contours ranged from 0 to 5 ft bgs (refer to Figure 4-9b). Note that the surface extent of the waste pile area depicted on Figure 4-9a differ from what was depicted on Figure 2-7. This is because the extent of the waste pile in Figure 2-7 was based on field mapping alone, whereas the extent in Figure 4-9a was based on a more comprehensive integration of multiple lines of evidence including field mapping, gamma measurements, soil sampling results (surface and subsurface), and critical review of aerial imagery (Cooper, 2017 and Google Earth, 2018).

- Group 2 (230 yd^3) – TENORM in the area of the eastern drainage on the pediment (referred to as eastern drainage) was estimated based on field mapping of sediment thicknesses within the drainage (ranging from 0.1 to 1.5 ft bgs), sediment sampling results (surface and subsurface), and gamma measurements. The entire drainage was assumed to contain TENORM above the ILs based on sediment sampling results (i.e., samples S260CX-009, -CX-010, and -SCX-010), though surface gamma measurements indicated that some portions of the drainage did not contain TENORM above the ILs.

- Group 3 (2,910 yd^3) – based on field observations, TENORM in the area of the potential haul road was assumed to extend to 2.0 ft bgs. Portions of the road that are located closest to the adjacent mesa sidewall contain cut surfaces where bedrock is exposed at the surface, while other portions on the road contain unconsolidated material that was used to create a level road base surface.

- Group 4 (211 yd^3) – a polygon was best fit around the area of TENORM in the area of the reclaimed portal and prospect portal (referred to collectively as the Portal Area). Cut and fill work was performed in this area to create a relatively flat working platform near the prospect portal, and during reclamation activities at the reclaimed portal. TENORM in the area of the portal area was assumed to extend to 2.0 ft bgs based on field personnel observations and measurements.

- Group 5 (563 yd^3) – a polygon was fit around the area on the mesa sidewall that was downgradient from the waste pile (identified as Upper Drainage). Surface gamma survey measurements exceeded the IL in the northwest corner of the polygon and IL exceedances were present in sample locations (S260-CX-007, -SCX-009, and -SCX-010). The polygon was fit to the lateral extent of TENORM, and TENORM was assumed to extend to 1.0 ft bgs based field personnel observations and bedrock being encountered in the boreholes at 0.8 ft bgs in this area.

- Group 6 - historical boreholes, cuttings/rock core, and metal rods were present on the mesa top. A background reference area was not established to represent the Chinle Formation on the mesa top, so gamma survey measurements could not be compared to a representative surface gamma IL. While the gamma survey measurements were less than 9,172 cpm in the areas of the features that were surveyed, it is uncertain whether the TENORM would exceed an IL. Therefore, a volume estimate of the approximate TENORM surrounding the features is provided as Group 6 on Figure 4-9a. The TENORM was estimated by placing a circle with a 10 ft radius in the area of each of the features and TENORM was assumed to extend to 0.5 ft bgs based on the field observation that the mesa top is generally comprised of a mix of shallow soils and exposed bedrock. The TENORM was estimated be approximately 9 yd^3.

4.8 SURFACE WATER AND WELL WATER ANALYTICAL RESULTS

The surface water and well water samples collected as part of the Site Characterization activities were analyzed for the constituents listed in Section 3.3.2.3. Three of the four identified water features were sampled. The locations of these water features are shown in Figure 2-1 and included the following:

- 08GS-12-10 seep (sample S260-WS-001) located 0.70 miles northwest of the Site
- 08A-213 seep (sample S260-WS-002) located 0.75 miles northwest of the Site
- 08K-432 windmill well (sample S260-WL-001) located 0.92 miles west of the Site

The analytical results from the samples were compared to the water ILs, which are defined as the lowest value from the following regulations/standards: the National Secondary Drinking Water Regulations (NSDWR), the Navajo Nation Surface Water Quality Standards, the Navajo Drinking Water maximum contaminant levels (MCLs), and/or the National Primary Drinking Water Regulations. The water ILs are shown in Table 4-6a and the analytical results compared to the water ILs are shown in Table 4-6b.

Analytical results indicated that the sample from the 08K-432 windmill well (S260-WL-001) had total and dissolved selenium concentrations of 130 micrograms per liter (µg/L), which were more than two-times the selenium IL (50 µg/L). Based on these results, selenium is confirmed a COPC for the water well. All other metals and radionuclides were below their respective ILs in the three samples. Results of general chemistry parameters indicated that TDS and sulfate were also above their respective ILs in the sample from the 08K-432 windmill well (S260-WL-001). All other general chemistry parameters were below their respective ILs in the three samples. Based on these results, TDS and sulfate are also confirmed COPCs for the water well. Because selenium, TDS, and sulfate exceeded their respective ILs for the water well (08K-432) additional characterization may be considered in the future. No ILs were exceeded for seep samples S260-WS-001 and S260–WS-002; therefore, further characterization may not be needed at seeps 08GS-12-10 and 08A-213. The laboratory analytical data and Data Usability Report are provided in Appendix F.

4.9 POTENTIAL DATA GAPS AND SUPPLEMENTAL STUDIES

4.9.1 Data Gaps

Ten 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. Approximately 0.2 acres located within the 100-ft buffer and on the mesa top were mistakenly omitted from the surface gamma survey due to an oversight by field personnel. This is considered a minor data gap that does not affect the results of the RSE, because there

was no evidence of mining impacts on the mesa top, elevated gamma radiation measurements were not detected in the areas that were surveyed on the mesa top, and there was no evidence of mineralization on the mesa top.

2. The shoulders of the potential haul road were surveyed, but the approximate centerline was not surveyed, due to miscommunication with the field personnel. This is not considered a significant data gap because the road was approximately 15 to 20 ft wide and the shoulder transects were sufficient to detect elevated gamma near the center-line of the road.
3. Approximately 0.7 acres (out of the 9.1 acres of the Survey Area) on the cliff face and some overly steep areas near the waste pile were not surveyed because field personnel were unable to safely access these areas.
4. The surface gamma survey was not extended laterally from the potential haul road or the eastern drainage where gamma measurements were greater than the IL because of an oversight.
5. A subsurface static gamma IL was not established for Survey Area A; however, one or more ILs (e.g., Ra-226 and metals) were exceeded in every subsurface sample and so the lack of a subsurface static gamma IL did not affect the TENORM volume estimate.
6. The survey was not extended to include the eastern historical borehole and metal rod because the features are outside of the 100 ft buffer and it was initially assumed the features were related to exploration activities and not related to mining at the Site. However, the features are being included in TENORM at the request of the Agencies (NNEPA, 2018).
7. Field personnel terminated one borehole due to consistently low static gamma measurements; the use of this criterion was a field error.
8. Further background investigation of the Cutler Formation may be warranted as part of future work at the Site due to the variability observed between the surface gamma survey statistics between CK-BG-2, BG-3, and BG-4.
9. Further background investigation of the Moenkopi Formation may be warranted because a portion of the current background reference area extends into the Cutler Formation.
10. A background reference investigation of the Chinle Formations may be warranted to identify a background reference area to represent the portions of the mesa top that were disturbed during exploration activities.

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

2. The USEPA identified that there were potential discrepancies between the NNDWR database used for this study (received from NNDWR in 2016) and a 2018 version of the NNDWR database that the USEPA reviewed. It is recommended that the two databases be compared (with additional field work, if necessary) to confirm the locations of water features.

3. Large 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 prior to future Removal or Remedial Actions.

4. Further characterization and investigation of the upper drainage may be warranted as part of future work at the Site.

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 July 2015 and August 2017. The Site is known as the Mitten No.3 site and is also identified by the USEPA as AUM identification #260 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. Surface water and well water samples were also collected as part of the RSE to evaluate potential mining-related impacts. 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 is located in the Monument Valley mining area. Mine workings on-site consisted of a portal with an approximately 320-ft-long mining adit. Ore production in the USAEC records showed one shipment sent from the Site in January 1955. This shipment contained 9.6 tons of ore that contained 61.43 pounds of 0.31 percent U_3O_8 and 136.31 pounds of 0.71 percent V_2O_5.

Five potential background reference areas were considered. Three background reference areas (BG-1, BG-2, and CK-BG-2) were selected to develop surface gamma, subsurface gamma, Ra-226, and metals ILs for the three Survey Areas (Survey Areas A through C) at the Site.

Arsenic, molybdenum, uranium, vanadium, and Ra-226 concentrations and gamma radiation measurements in soil/sediment exceeded their respective ILs and are COPCs for the Site. In addition, selenium was also confirmed as a COPC because it was detected in soil samples from the Survey Area A, but was non-detect in all but one background reference area sample.

Surface gamma measurements and Ra-226 and metals concentrations were generally highest in areas that were coincident with the portal area and the waste pile. The maximum gamma survey measurement was 129,220 cpm, which was greater than 10 times the maximum IL (i.e.

BG-1 IL of 12,847 cpm), and occurred in the area just below the prospect portal. The highest Ra-226 and metals concentrations, and subsurface static gamma measurements were also detected in surface/subsurface soil samples collected from the waste pile, and in the vicinity of the portal area.

Results of the Gamma Correlation Study indicated that surface gamma survey results do not correlate with Ra-226 concentrations in soil. Therefore, users of the regression equation should be aware of the limitations of the dataset and be cautious when estimating Ra-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 multiple lines of evidence, approximately 2.7 acres out of the 9.1 acres of the Survey Area were estimated to contain TENORM. This estimate is inclusive of four areas: the portal area, the waste pile, areas downgradient of the waste pile (including the eastern drainage), and the potential haul road. The areas outside of the TENORM boundary showed no signs of disturbance related to mining and, therefore, are considered NORM (i.e., naturally occurring). Of the 2.7 acres that contain TENORM, 2.2 acres contain TENORM exceeding the surface gamma ILs and TENORM that exceeded the ILs at all but two of the soil/sediment sample locations. The volume of TENORM in excess of ILs was estimated to be 5,927 yd^3 (4,532 cubic meters). It should be noted that the COPC measurements and concentrations in the area that contains TENORM that exceeded the ILs are generally higher than the COPC measurements and concentrations in the area of NORM located outside the TENORM boundary.

Surface water samples were collected from two seeps (08GS-12-10 and 08A-213) and one water well (08K-432). No ILs were exceeded in either of the seep samples, so further characterization may not be needed at these seeps. Analytical results indicated that the sample from the water well (S260-WL-001) had total and dissolved selenium concentrations of 130 micrograms per liter (µg/L), which were more than two-times the selenium IL (50 µg/L), and TDS and sulfate were also above their respective ILs. Based on these results, selenium, TDS, and sulfate are confirmed COPCs for the water well and additional characterization may be considered in the future.

In addition, during the RSE work, the Trust performed an "Interim Action" to close an open portal to prevent human and livestock (animal) access.

Ten potential data gaps were identified based on the Site Clearance and RSE data collection and analyses for the Site, as listed in Section 4.9. 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 Mitten No. 3 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 Mitten No. 3 RSE were $631,337. Stantec's costs associated with interim actions (portal closure and sign installation) were $86,500. In addition, Administrative costs provided by the Trust were estimated currently at $191,500[9,10]. Administrative costs will change due to continued community outreach and close out activities.

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

[10] Administrative costs were averaged across all Sites.

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TABLES

Table 3-1a
Identified Water Features
Mitten No. 3
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 Sample Identification	Field Personnel Observations
Seep	2007 AUM Atlas[1]	08A-213	S260-WS-002	This location was a seep that daylighted on a bedrock wall. Historically, a hole was drilled into the bedrock and a polyvinyl chloride (PVC) pipe was cemented into the hole to capture the seep flow. The PVC pipe ran to a water trough, and water sample ID S260-WS-002 was collected from the pipe at the water trough on October 18, 2016.
Drainage Channel	2007 AUM Atlas[1]	08-0608	NA	No surface water or water well observed at this location during Removal Site Evaluation (RSE) activities. Historical water samples may have been potentially collected from a nearby drainage .
Seep	2007 AUM Atlas[1]	08GS-12-10	S260-WS-001	This location was a seep that daylighted on a bedrock wall. Historically, a hole was drilled into the bedrock and a PVC pipe was cemented into the hole to capture the seep flow. The PVC pipe ran from the bedrock wall to a sediment-settling tank and then from the tank to an enclosed 8ft tall water tank. A second pipe ran underground and carried the water from the tank to a water spigot. Water sample ID S260-WS-001 was collected from the water spigot on October 18, 2016. A galvanized water trough was also present under the spigot to collect water when the spigot was turned on.
Windmill Well	2007 AUM Atlas[1]	08K-432	S260-WL-001	Windmill well, water tank, and water trough were observed at this location. Water sample ID S260-WL-001 was collected from the spigot at the trough on October 18, 2016.

Notes
NA - Water feature not sampled
ID - identification
PVC - polyvinyl chloride
RSE - Removal Site Evaluation
[1] USEPA, 2007a

Table 3-1b
Water Well Specifications for 08K-432
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase

Description	Water Well Information
Tribal Well Number	08K-432
Easting[1]	557435.00
Northing[1]	4099691.00
Operator	Tribe Operations and Maintenance
Well Completed Date	5/11/1955
Elevation (ft amsl)	4,976
Well Depth (ft bgs)	451
Well Type	Water Well
Well Status	Active
Well Use	Livestock
Well Borehole Diameter (inches)	unknown
Well Casing Diameter (inches)	8.62 inches from1.4 ft ags to 41 ft bgs, unknown from 41 to 451 ft bgs
Top of Well Casing (ft ags)	1.4
Bottom of Well Casing (ft bgs)	451
Well Build Material	Steel
Top of Well Screen Perforation (ft bgs)	41
Bottom of Well Screen Perforation (ft bgs)	451

Notes
ft - feet
ft ags - feet above ground surface
ft amsl - feet above mean sea level
ft bgs - feet below ground surface
[1] Coordinate System: NAD 1983 UTM Zone 12N

Table 3-2
Soil and Sediment Sampling Summary
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 2

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
Background Reference Area Study - Background Area 1											
S260-BG1-001	0 - 0.5	soil	SF	grab	NA	10/28/2016	559062.91	4099868.81	N	N	--
S260-BG1-002	0 - 0.5	soil	SF	grab	NA	10/28/2016	559065.25	4099868.83	N	N	--
S260-BG1-003	0 - 0.5	soil	SF	grab	NA	10/28/2016	559069.55	4099867.95	N	N	--
S260-BG1-004	0 - 0.5	soil	SF	grab	NA	10/28/2016	559072.20	4099868.67	N	N	--
S260-BG1-005	0 - 0.5	soil	SF	grab	NA	10/28/2016	559074.76	4099869.98	N	N	--
S260-BG1-006	0 - 0.5	soil	SF	grab	NA	10/28/2016	559077.07	4099869.93	N;FD	N;FD	--
S260-BG1-007	0 - 0.5	soil	SF	grab	NA	10/28/2016	559081.04	4099870.80	N	N	--
S260-BG1-008	0 - 0.5	soil	SF	grab	NA	10/28/2016	559080.37	4099871.93	N	N	--
S260-BG1-009	0 - 0.5	soil	SF	grab	NA	10/28/2016	559086.59	4099869.65	N;MS;MSD	N	--
S260-BG1-010	0 - 0.5	soil	SF	grab	NA	10/28/2016	559085.75	4099873.27	N	N	--
S260-BG1-011	0 - 0.5	soil	SF	grab	NA	5/22/2017	559086.98	4099871.59	N	N	--
Background Reference Area Study - Background Area 2											
S260-BG2-001	0 - 0.5	sediment	SF	grab	NA	8/24/2017	558740.79	4099451.15	N	N	--
S260-BG2-002	0 - 0.5	sediment	SF	grab	NA	8/24/2017	558737.92	4099453.35	N	N	--
S260-BG2-003	0 - 0.5	sediment	SF	grab	NA	8/24/2017	558737.75	4099456.20	N	N	--
S260-BG2-004	0 - 0.5	sediment	SF	grab	NA	8/24/2017	558735.99	4099458.83	N	N	--
S260-BG2-005	0 - 0.5	sediment	SF	grab	NA	8/24/2017	558735.46	4099461.22	N;FD	N;FD	--
S260-BG2-006	0 - 0.5	sediment	SF	grab	NA	8/24/2017	558733.19	4099463.20	N	N	--
S260-BG2-007	0 - 0.5	sediment	SF	grab	NA	8/24/2017	558732.65	4099465.07	N	N	--
S260-BG2-008	0 - 0.5	sediment	SF	grab	NA	8/24/2017	558730.77	4099470.00	N;MS;MSD	N	--
S260-BG2-009	0 - 0.5	sediment	SF	grab	NA	8/24/2017	558731.10	4099473.02	N	N	--
S260-BG2-010	0 - 0.5	sediment	SF	grab	NA	8/24/2017	558729.06	4099476.73	N	N	--
S260-BG2-011	0 - 0.5	sediment	SF	grab	NA	8/24/2017	558734.18	4099462.08	N	N	--
S260-BG2-011	0.3 - 3.0	sediment	SB	composite	NA	8/24/2017	558734.18	4099462.08	N	N	--
Background Reference Area Study - Background Area CK-BG-2*											
S225-BG2-001	0 - 0.5	soil	SF	grab	NA	10/17/2016	561648.64	4100057.74	N	N	--
S225-BG2-002	0 - 0.5	soil	SF	grab	NA	10/17/2016	561646.64	4100062.02	N	N	--
S225-BG2-003	0 - 0.5	soil	SF	grab	NA	10/17/2016	561641.83	4100060.87	N	N	--
S225-BG2-004	0 - 0.5	soil	SF	grab	NA	10/17/2016	561636.50	4100059.58	N	N	--
S225-BG2-005	0 - 0.5	soil	SF	grab	NA	10/17/2016	561638.48	4100061.41	N	N	--
S225-BG2-006	0 - 0.5	soil	SF	grab	NA	10/17/2016	561638.85	4100066.10	N;FD	N;FD	--
S225-BG2-007	0 - 0.5	soil	SF	grab	NA	10/17/2016	561635.49	4100067.80	N	N	--
S225-BG2-008	0 - 0.5	soil	SF	grab	NA	10/17/2016	561635.82	4100071.36	N	N	--
S225-BG2-009	0 - 0.5	soil	SF	grab	NA	10/17/2016	561632.81	4100064.84	N	N	--
S225-BG2-010	0 - 0.5	soil	SF	grab	NA	10/17/2016	561632.52	4100060.50	N	N	--
S225-SCX-001	0 - 0.5	soil	SF	grab	NA	11/2/2016	561637.32	4100067.76	N	N	--
S225-SCX-001	0.5 - 1.5	soil	SB	grab	NA	11/2/2016	561637.32	4100067.76	N	N	--
Correlation											
S260-C01-001	0 - 0.5	soil	SF	5-point composite	NA	10/31/2016	559037.39	4099780.27	--	N	N
S260-C02-001	0 - 0.5	soil	SF	5-point composite	NA	10/31/2016	558980.55	4099797.69	--	N	N
S260-C03-001	0 - 0.5	soil	SF	5-point composite	NA	10/31/2016	558968.45	4099799.56	--	N	N
S260-C04-001	0 - 0.5	soil	SF	5-point composite	NA	10/31/2016	558938.86	4099796.69	--	N	N
S260-C05-001	0 - 0.5	soil	SF	5-point composite	NA	10/31/2016	559015.49	4099611.59	--	N	N

Notes

--	Not Sampled
*	Background reference area used from the Charles Keith Site, referred to in the RSE report as CK-BG-2
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 3-2
Soil and Sediment Sampling Summary
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 2 of 2

									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
Characterization											
S260-CX-001	0 - 0.5	soil	SF	grab	A	5/22/2017	558976.30	4099816.34	N	N	--
S260-CX-002	0 - 0.5	soil	SF	grab	A	5/22/2017	559028.39	4099787.06	N;MS;MSD	N	--
S260-CX-003	0 - 0.5	soil	SF	grab	A	5/22/2017	558863.27	4099761.23	N	N	--
S260-CX-004	0 - 0.5	soil	SF	grab	A	5/22/2017	558951.12	4099758.41	N	N	--
S260-CX-005	0 - 0.5	soil	SF	grab	C	5/22/2017	558923.21	4099689.89	N	N	--
S260-CX-006	0 - 0.5	soil	SF	grab	A	5/22/2017	558835.76	4099703.15	N	N	--
S260-CX-007	0 - 0.5	soil	SF	grab	C	5/22/2017	558983.24	4099669.03	N	N	--
S260-CX-008	0 - 0.5	sediment	SF	grab	C	5/22/2017	559009.30	4099618.19	N;FD	N;FD	--
S260-CX-009	0 - 0.5	sediment	SF	grab	C	5/22/2017	559074.45	4099485.39	N	N	--
S260-CX-010	0 - 0.5	sediment	SF	grab	B	5/22/2017	559089.69	4099335.90	N	N	--
S260-CX-011	0 - 0.5	sediment	SF	grab	C	5/22/2017	558938.13	4099594.18	N;FD	N;FD	--
S260-SCX-002	0 - 0.5	soil	SF	grab	A	5/22/2017	558994.45	4099798.01	N;FD	N;FD	--
S260-SCX-002	0.5 - 0.8	soil	SB	grab	A	5/22/2017	558994.45	4099798.01	N	N	--
S260-SCX-003	0 - 0.5	soil	SF	grab	A	5/22/2017	558952.61	4099800.90	N	N	--
S260-SCX-003	0.5 - 0.8	soil	SB	grab	A	5/22/2017	558952.61	4099800.90	N	N	--
S260-SCX-004	0 - 0.5	soil	SF	grab	A	5/22/2017	558938.22	4099795.06	N	N	--
S260-SCX-005	0 - 0.5	soil	SF	grab	A	5/22/2017	558918.75	4099790.63	N	N	--
S260-SCX-006	0 - 0.5	soil	SF	grab	A	5/22/2017	558887.26	4099771.78	N	N	--
S260-SCX-006	0.5 - 0.8	soil	SB	grab	A	5/22/2017	558887.26	4099771.78	N	N	--
S260-SCX-007	0 - 0.5	soil	SF	grab	A	5/22/2017	558953.39	4099747.01	N	N	--
S260-SCX-007	0.5 - 0.8	soil	SB	grab	A	5/22/2017	558953.39	4099747.01	N	N	--
S260-SCX-008	0 - 0.5	soil	SF	grab	A	5/22/2017	559000.64	4099744.88	N	N	--
S260-SCX-008	0.5 - 0.8	soil	SB	grab	A	5/22/2017	559000.64	4099744.88	N	N	--
S260-SCX-009	0 - 0.5	soil	SF	grab	C	5/22/2017	558962.74	4099706.72	N	N	--
S260-SCX-010	0 - 0.5	soil	SF	grab	C	5/22/2017	558986.02	4099695.12	N	N	--
S260-SCX-011	0 - 0.5	sediment	SF	grab	C	5/22/2017	559030.25	4099573.04	N;MS;MSD	N	--
S260-SCX-011	0.5 - 1.0	sediment	SB	grab	C	5/22/2017	559030.25	4099573.04	N	N	--
S260-SCX-012	0 - 0.5	sediment	SF	grab	B	5/22/2017	559088.46	4099359.62	N;FD	N;FD	--
S260-SCX-012	0.5 - 1.0	sediment	SB	grab	B	5/22/2017	559088.46	4099359.62	N	N	--
S260-SCX-012	1.0 - 1.5	sediment	SB	grab	B	5/22/2017	559088.46	4099359.62	N	N	--
S260-SCX-013	0 - 0.5	sediment	SF	grab	C	5/22/2017	558921.08	4099437.57	N	N	--

Notes

--	Not Sampled
*	Background reference area used from the Charles Keith Site, referred to in the RSE report as CK-BG-2
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
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 1

Mine Feature	Surface Samples	Subsurface Samples	Area (sq. ft)	Volume of TENORM exceeding ILs (yd^3)
Waste Pile	2	1	8,884	1,272
Upper Drainage	3	0	15,208	563
Eastern Drainage	5	3	24,062	230
Potential Haul Road	6	3	39,284	2,910
Exploration Area	0	0	552,674	3
Mining Disturbed Area	2	1	2,844	211

Notes

sq.ft - square feet

yd^3 - cubic yards

ILs - investigation levels

TENORM - technologically enhanced naturally occurring radioactive material

Table 3-4
Water Sampling Summary
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 1

					Sample Types							
Field Sample Location	Water Feature Identification	Sample Date	Easting [1]	Northing [1]	Ra-226	Ra-228	Gross Alpha	Metals, Dissolved [2]	Metals, Total	TDS	Anions	Cations
Surface Water												
S260-WS-001	08GS-12-10	10/18/2016	558036.02	4100648.41	N	N	N	N;MS;MSD	N	N	N	N
S260-WS-002	08A-213	10/18/2016	558447.95	4100933.77	N	N	N	N	N	N	N	N
Well Water												
S260-WL-001	08K-432	10/18/2016	557372.85	4099876.34	N	N	N	N;MS;MSD	N	N	N	N

Notes

--	Not Sampled
N	Normal
FD	Field Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
Ra-226	Radium 226
Ra-228	Radium 228
TDS	Total Dissolved Solids

[1] Coordinate System: NAD 1983 UTM Zone 12N

[2] Mercury analysis also included laboratory MS/MSD, all other metals analyses did not include laboratory MS/MDS

Table 4-1
Background Reference Area Soil and Sediment Sample Analytical Results
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 4

Location Identification	S260-BG1-001	S260-BG1-002	S260-BG1-003	S260-BG1-004	S260-BG1-005	S260-BG1-006	S260-BG1-006 Dup	S260-BG1-007	S260-BG1-008	S260-BG1-009	S260-BG1-010
Date Collected	10/28/2016	10/28/2016	10/28/2016	10/28/2016	10/28/2016	10/28/2016	10/28/2016	10/28/2016	10/28/2016	10/28/2016	10/28/2016
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
Analyte (Units)											
Metals[1] (mg/kg)											
Arsenic	2.5	2.9	2.5	1.8	1.9	1.4	1.4	1.7	1.8	1.6	1.4
Molybdenum	0.23	0.21	0.21	<0.18	<0.2	<0.19	<0.19	<0.2	<0.2	<0.18	<0.18
Selenium	<0.93	<0.91	<0.98	<0.92	<1	<0.96	<0.93	1.2	<0.99	<0.9	<0.91
Uranium	0.57	0.55	0.57	0.39	0.31	0.74	0.35	0.38	0.44	0.27	0.37
Vanadium	14	15	12	9	11	9.4	8.5	10	9.5	8.3	7.5
Radionuclides (pCi/g)											
Radium-226	0.65 ± 0.18 J-	0.71 ± 0.19 J-	0.51 ± 0.2 J-	0.66 ± 0.21 J-	0.46 ± 0.21 J-	0.62 ± 0.17 J-	0.57 ± 0.19 J-	0.53 ± 0.17 J-	0.58 ± 0.18 J-	0 ± 0.18 UJ	0.68 ± 0.2 J-

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
RSE	Removal Site Evaluation
¹	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
*	Background reference area used from the Charles Keith Site, referred to in the RSE report as CK-BG-2
<	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.
UJ	Potential low bias, possible false negative.

Table 4-1
Background Reference Area Soil and Sediment Sample Analytical Results
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 2 of 4

Location Identification	S260-BG1-011	S260-BG2-001	S260-BG2-002	S260-BG2-003	S260-BG2-004	S260-BG2-005	S260-BG2-005 Dup	S260-BG2-006	S260-BG2-007	S260-BG2-008	S260-BG2-009
Date Collected	5/22/2017	8/24/2017	8/24/2017	8/24/2017	8/24/2017	8/24/2017	8/24/2017	8/24/2017	8/24/2017	8/24/2017	8/24/2017
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
Analyte (Units)											
Metals[1] (mg/kg)											
Arsenic	1.6	1.4	2	2.8	3.6	3.4	3	2.2	2.1	3.2 J	1.8
Molybdenum	<0.2	<0.2	<0.2	0.22	0.29	0.25	<0.19	<0.19	<0.19	0.23	<0.2
Selenium	<0.98	<0.98	<0.99	<0.94	<0.93	<1	<0.97	<0.94	<0.94	<0.98	<0.99
Uranium	0.21	0.22	0.31	0.44	0.35	0.47	0.38	0.35	0.34	0.37 J	0.32
Vanadium	8	5.4	6.9	6.5	6.5	7	6.3	5.1	5.4	5.8	5.8
Radionuclides (pCi/g)											
Radium-226	0.45 ± 0.15 J-	0.36 ± 0.14	0.76 ± 0.2 J-	0.5 ± 0.21 J-	0.7 ± 0.21 J-	0.59 ± 0.19	0.44 ± 0.16	0.57 ± 0.23 J-	0.49 ± 0.14 J-	0.63 ± 0.2 J-	0.61 ± 0.2

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
RSE	Removal Site Evaluation
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
*	Background reference area used from the Charles Keith Site, referred to in the RSE report as CK-BG-2
<	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.
UJ	Potential low bias, possible false negative.

Table 4-1
Background Reference Area Soil and Sediment Sample Analytical Results
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 3 of 4

Location Identification	S260-BG2-010	S260-BG2-011	S260-BG2-011	S225-BG2-001*	S225-BG2-002*	S225-BG2-003*	S225-BG2-004*	S225-BG2-005*	S225-BG2-006*	S225-BG2-006 Dup*	S225-BG2-007*
Date Collected	8/24/2017	8/24/2017	8/24/2017	10/17/2016	10/17/2016	10/17/2016	10/17/2016	10/17/2016	10/17/2016	10/17/2016	10/17/2016
Depth (feet)	0 - 0.5	0 - 0.5	0.3 - 3	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	4.7	5.3	1.8	2.1	0.99	1.1	1.4	0.81	1	1.2	0.71
Molybdenum	0.41	0.35	<0.21	0.62	0.47	0.46	0.4	0.29	0.31	0.28	0.17
Selenium	<0.98	<0.94	<1	<0.92	<0.88	<0.89	<0.96	<0.84	<1	<0.91	<0.85
Uranium	0.54	0.41	0.4	0.43	0.26	0.38	0.3	0.24	0.26	0.25	0.22
Vanadium	6.5	7.5	6.9	6.7	7.1	6	6.9	7	6.4	7.2	4.4
Radionuclides (pCi/g)											
Radium-226	0.73 ± 0.2 J-	0.49 ± 0.19 J-	0.44 ± 0.21	0.75 ± 0.21	0.65 ± 0.19	0.6 ± 0.2	0.7 ± 0.25	0.46 ± 0.16	0.67 ± 0.3	0.52 ± 0.17	0.49 ± 0.16

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
RSE	Removal Site Evaluation
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
*	Background reference area used from the Charles Keith Site, referred to in the RSE report as CK-BG-2
<	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.
UJ	Potential low bias, possible false negative.

Table 4-1
Background Reference Area Soil and Sediment Sample Analytical Results
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 4 of 4

Location Identification	S225-BG2-008*	S225-BG2-009*	S225-BG2-010*	S225-SCX-001*	S225-SCX-001*
Date Collected	10/17/2016	10/17/2016	10/17/2016	11/2/2016	11/2/2016
Depth (feet)	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0.5 - 1.5
Analyte (Units)					
Metals[1] (mg/kg)					
Arsenic	0.98	0.95	0.75	0.64	0.69
Molybdenum	<0.19	0.24	0.18	<0.19	<0.19
Selenium	<0.97	<0.92	<0.86	<0.96	<0.96
Uranium	0.2	0.23	0.22	0.18	0.2
Vanadium	7.2	5.6	5.6	3.4	3.8
Radionuclides (pCi/g)					
Radium-226	0.47 ± 0.22 J-	0.36 ± 0.21	0.44 ± 0.15	0.55 ± 0.19	0.45 ± 0.2

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
RSE	Removal Site Evaluation
[1]	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
*	Background reference area used from the Charles Keith Site, referred to in the RSE report as CK-BG-2
<	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.
UJ	Potential low bias, possible false negative.

Table 4-2
Static Gamma Measurement Summary
Mitten No 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 1

Sample Location	Survey Area	Subsurface Static Gamma Investigation Level (cpm)	Sample Depth (ft bgs)	Media	Static Gamma Measurement (cpm)
S260-BG1-011	Background Area 1	*	0.0	soil	9,004
S260-BG1-011	Background Area 1	*	0.5	soil	8,053**
S260-BG2-011	Background Area 2	*	0.0	sediment	7,753
S260-BG2-011	Background Area 2	*	1.0	sediment	12,198
S260-BG2-011	Background Area 2	*	2.0	sediment	11,694
S260-BG2-011	Background Area 2	*	3.0	sediment	11,490**
S225-SCX-001	Background Area CK-BG-2	*	0.0	soil	8,285
S225-SCX-001	Background Area CK-BG-2	*	0.5	soil	9,424
S225-SCX-001	Background Area CK-BG-2	*	1.0	soil	8,623
S225-SCX-001	Background Area CK-BG-2	*	1.5	soil	8,623
S260-SCX-002	A	--	0.0	soil	17,288
S260-SCX-002	A	NA	0.5	soil	20,642**
S260-SCX-003	A	--	0.0	soil	36,140
S260-SCX-003	A	NA	0.5	soil	50,662**
S260-SCX-004	A	--	0.0	soil	41,122
S260-SCX-004	A	NA	0.5	soil	37,296**
S260-SCX-005	A	--	0.0	soil	13,751
S260-SCX-005	A	NA	0.5	soil	17,095**
S260-SCX-006	A	--	0.0	soil	14,585
S260-SCX-006	A	NA	0.8	soil	22,360**
S260-SCX-007	A	--	0.0	soil	90,478
S260-SCX-007	A	NA	0.5	soil	144,652
S260-SCX-007	A	NA	0.8	soil	145,025**
S260-SCX-008	A	--	0.0	soil	14,028
S260-SCX-008	A	NA	0.5	soil	18,510
S260-SCX-008	A	NA	0.8	soil	20,803**
S260-SCX-012	B	--	0.0	sediment	12,468
S260-SCX-012	B	11,694	0.5	sediment	17,206
S260-SCX-012	B	11,694	1.0	sediment	16,189
S260-SCX-012	B	11,694	1.5	sediment	13,337**
S260-SCX-009	C	--	0.0	soil	20,955
S260-SCX-009	C	8,623	0.5	soil	21,501**
S260-SCX-010	C	--	0.0	soil	12,011
S260-SCX-010	C	8,623	0.5	soil	14,097
S260-SCX-010	C	8,623	0.8	soil	14,888**
S260-SCX-011	C	--	0.0	sediment	18,100
S260-SCX-011	C	8,623	0.5	sediment	24,215
S260-SCX-011	C	8,623	1.0	sediment	18,104**
S260-SCX-013	C	--	0.0	sediment	6,414
S260-SCX-013	C	8,623	0.5	sediment	8,064
S260-SCX-013	C	8,623	1.0	sediment	8,506
S260-SCX-013	C	8,623	1.5	sediment	9,355
S260-SCX-013	C	8,623	2.1	sediment	10,812

Notes

Bold	Bolded result indicates measurement exceeds subsurface static gamma investigation level
*	The subsurface static 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 static gamma investigation level does not apply to surface static gamma measurements
NA	A subsurface static gamma investigation level was not established for Survey Area A, refer to Section 4.1 of the RSE report
RSE	Removal Site Investigation
cpm	counts per minute
ft bgs	feet below ground surface

Table 4-3
Gamma Correlation Study Soil Sample Analytical Results
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase

Location Identification	S260-C01-001	S260-C02-001	S260-C03-001	S260-C04-001	S260-C05-001
Date Collected	10/31/2016	10/31/2016	10/31/2016	10/31/2016	10/31/2016
Depth (feet)	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Analyte (Units)					
Radionuclides (pCi/g)					
Radium-226	5.18 ± 0.73	7.02 ± 0.93 J-	34.2 ± 4.2 J-	20.7 ± 2.5 J-	0.49 ± 0.2
Thorium-228	0.94 ± 0.17	0.93 ± 0.17	0.84 ± 0.16	0.72 ± 0.13	0.443 ± 0.091
Thorium-230	1.42 ± 0.24	8.8 ± 1.4	17.5 ± 2.7	35.4 ± 5.4	0.405 ± 0.089
Thorium-232	0.96 ± 0.17	0.99 ± 0.17	0.76 ± 0.14	0.66 ± 0.12	0.468 ± 0.091

Notes

Bold	Bolded result indicates positively identified compound
pCi/g	picocuries per gram
J-	Data are estimated and are potentially biased low due to associated quality control data

Table 4-4a
Site Characterization Soil Sample Analytical Results for Survey Area A
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase

Location Identification		S260-CX-001	S260-CX-002	S260-CX-003	S260-CX-004	S260-CX-006	S260-SCX-002	S260-SCX-002	S260-SCX-002 Dup	S260-SCX-003	S260-SCX-003	S260-SCX-004	S260-SCX-005
Date Collected		5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017
Depth (feet)		0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0.5 - 0.8	0 - 0.5	0 - 0.5	0.5 - 0.8	0 - 0.5	0 - 0.5
Sample Category		surface	surface	surface	surface	surface	surface	subsurface	surface	surface	subsurface	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	3.31	24	3.4	3.6	19	5.3	4	3.9	3.7	7.8	7.8	8.3	4.9
Molybdenum	0.312	3.5	0.39	0.33	3	0.26	0.48	0.45	0.46	1.5	1.4	1.1	0.49
Selenium	NA	2.1	<1	<1	1.1	<0.95	<1	0.98	<0.98	1.2	<1	<1	<1
Uranium	0.877	35	3.7 J-	1.2	130 D	0.77	5.1	4.5	5.1	28	21	36	2.6
Vanadium	17.2	22	35 J-	22	69	25	26	23	26	49	46	38	26
Radionuclides (pCi/g)													
Radium-226	0.872	31.5 ± 3.8	2.58 ± 0.41	1.29 ± 0.26 J-	77.4 ± 9.2	1.03 ± 0.22	3.17 ± 0.47 J-	2.97 ± 0.47 J-	2.91 ± 0.46 J-	13.6 ± 1.7 J-	10.7 ± 1.3 J-	14.4 ± 1.8 J-	1.34 ± 0.25 J-

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 the background areas were all non-detect, with the exception of a single detection in BG-1
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 and are potentially biased low due to associated quality control data

Table 4-4a
Site Characterization Soil Sample Analytical Results for Survey Area A
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 2 of 2

	Location Identification	S260-SCX-006	S260-SCX-006	S260-SCX-007	S260-SCX-007	S260-SCX-008	S260-SCX-008
	Date Collected	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017
	Depth (feet)	0 - 0.5	0.5 - 0.8	0 - 0.5	0.5 - 0.8	0 - 0.5	0.5 - 0.8
	Sample Category	surface	subsurface	surface	subsurface	surface	subsurface
	Sample Collection Method	grab	grab	grab	grab	grab	grab
	Media	soil	soil	soil	soil	soil	soil
Analyte (Units)							
Metals[1] (mg/kg)	Investigation Level						
Arsenic	3.31	3	3.3	16	16	5.9	5.6
Molybdenum	0.312	0.31	0.33	4.3	3.8	0.27	0.33
Selenium	NA	<1	<0.97	<1	1.1	<1	<1
Uranium	0.877	1.9	1.7	120 D	100 D	0.87	1
Vanadium	17.2	22	23	120	97	19	17
Radionuclides (pCi/g)							
Radium-226	0.872	1.51 ± 0.31 J-	1.45 ± 0.3 J-	65.7 ± 7.8	67.1 ± 7.9	1.37 ± 0.27	1.04 ± 0.23

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 the background areas were all non-detect, with the exception of a single detection in BG-1
[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 and are potentially biased low due to associated quality control data

Table 4-4b
Site Characterization Sediment Sample Analytical Results for Survey Area B
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 1

Location Identification		S260-CX-010	S260-SCX-012	S260-SCX-012 Dup	S260-SCX-012	S260-SCX-012
Date Collected		5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017
Depth (feet)		0 - 0.5	0 - 0.5	0 - 0.5	0.5 - 1	1 - 1.5
Sample Category		surface	surface	surface	subsurface	subsurface
Sample Collection Method		grab	grab	grab	grab	grab
Media		sediment	sediment	sediment	sediment	sediment
Analyte (Units)						
Metals[1] (mg/kg)	Investigation Level					
Arsenic	6.43	1.8	2.7 J	2.2	2.3	3.1
Molybdenum	0.447	<0.21	0.24	0.21	<0.21	0.38
Selenium	NA	<1	<1	<1	<1	<1
Uranium	0.619	1.6	2.8 J	17	2.1	1.2
Vanadium	8.38	11	12	12	13	9.2
Radionuclides (pCi/g)						
Radium-226	0.922	1.6 ± 0.29	2 ± 0.35 J-	2.79 ± 0.42 J-	2.15 ± 0.34 J-	1.4 ± 0.28 J-

Notes

Bold	Bolded result indicates positively identified compound
Shaded	Shaded result indicates result greater than or equal to the investigation level
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
NA	An investigation level is not identified because selenium sample results in the background areas were all non-detect, with the exception of a single detection in BG-1
[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 4-4c
Site Characterization Soil and Sediment Sample Analytical Results for Survey Area C
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 1

Location Identification		S260-CX-005	S260-CX-007	S260-CX-008	S260-CX-008 Dup	S260-CX-009	S260-CX-011	S260-CX-011 Dup	S260-SCX-009	S260-SCX-010	S260-SCX-011	S260-SCX-011	S260-SCX-013
Date Collected		5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017	5/22/2017
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	0.5 - 1	0 - 0.5
Sample Category		surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	subsurface	surface
Sample Collection Method		grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab
Media		soil	soil	sediment	sediment	sediment	sediment	sediment	soil	soil	sediment	sediment	sediment
Analyte (Units)													
Metals[1] (mg/kg)	Investigation Level												
Arsenic	2.36	1.6	5.3	5.8	5.1	2	2.4	2.1	4.3	5.3	3.2	2.3	1.4
Molybdenum	0.786	<0.2	0.98	1.4	0.77	0.34	0.2	<0.2	0.69	0.26	0.59	<0.21	<0.21
Selenium	NA	<0.98	<0.99	<1	<0.96	<1	<0.98	<0.98	<0.95	<1	<1	<1.1	<1
Uranium	0.482	0.37	18	16	11	5	0.43	0.61	10	1.5	7.8	15	0.3
Vanadium	9.45	8.8	25	19	28	11	8.2	8.4	15	17	21	12	6.7
Radionuclides (pCi/g)													
Radium-226	0.909	0.55 ± 0.24	11.5 ± 1.5 J-	12 ± 1.5	8.2 ± 1.1 J-	6.65 ± 0.89	0.7 ± 0.2 J-	0.7 ± 0.22 J-	6.78 ± 0.9 J-	1.34 ± 0.29 J-	6.9 ± 0.93	2.37 ± 0.41	0.45 ± 0.19 J-

Notes

Bold	Bolded result indicates positively identified compound
Shaded	Shaded result indicates result greater than or equal to the investigation level
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
NA	An investigation level is not identified because selenium sample results in the background areas were all non-detect, with the exception of a single detection in BG-1
[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 and are potentially biased low due to associated quality control data

Table 4-5
Summary of Investigation Level Exceedances in Soil at Borehole Locations
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase

Sample Location	Survey Area	Investigation Level Exceedances
S260-SCX-002[1]	A	As, Mo, Se, U, V, Ra-226, Static Gamma
S260-SCX-003[1]	A	As, Mo, Se, U, V, Ra-226, Static Gamma
S260-SCX-004	A	As, Mo, U, V, Ra-226, Static Gamma
S260-SCX-005	A	As, Mo, U, V, Ra-226, Static Gamma
S260-SCX-006	A	Mo, U, V, Ra-226, Static Gamma
S260-SCX-007[1]	A	As, Mo, Se, U, V, Ra-226, Static Gamma
S260-SCX-008	A	As, Mo, U, V, Ra-226, Static Gamma
S260-SCX-009	C	As, U, V, Ra-226, Static Gamma
S260-SCX-010	C	As, U, V, Ra-226, Static Gamma
S260-SCX-011	C	As , U, V, Ra-226, Static Gamma
S260-SCX-012	B	U, V, Ra-226, Static Gamma
S260-SCX-013	C	Static Gamma

Notes

[1] Detections of Se included for reference, no IL is established for Se

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

Table 4-6a
Water Sampling Investigation Level Derivation
Mitten No.3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 1

Analyte (Units)	USEPA		Navajo Nation		Investigation Level
	MCL (a)	Secondary Standard (b)	Surface Water Quality Standards (c)	Primary Drinking Water MCL(d)	
Radionuclides (pCi/L)					
Ra-226 (e)	5	*	5	5	5
Ra-228 (e)	5	*	5	5	5
Gross Alpha	15	*	15	15	15
Metals (ng/L)					
Mercury	2000	*	2000	2000	2000
Metals (µg/L)					
Antimony	6	*	5.6	6	5.6
Arsenic	10	*	10	10	10
Barium	2000	*	2000	2000	2000
Beryllium	4	*	4	4	4
Cadmium	5	*	5	5	5
Chromium, Total	100	*	100	100	100
Cobalt	*	*	*	*	*
Copper	1300	*	1300	*	1300
Lead	15	*	15	15	15
Molybdenum	*	*	*	*	*
Nickel	*	*	610	*	610
Selenium	50	*	50	50	50
Silver	*	100	35	*	35
Thallium	2	*	2	2	2
Uranium	30	*	30	30	30
Vanadium	*	*	*	*	*
Zinc	*	5000	2100	*	2100
General Chemistry Parameters (mg/L) (f)					
Bicarbonate	*	*	*	*	*
Calcium	*	*	*	*	*
Carbonate	*	*	*	*	*
Chloride	*	250	*	*	250
Sodium	*	*	*	*	*
Sulfate	*	250	*	*	250
TDS	*	500	*	*	500

Notes

Bold – indicates the most conservative value to be used for comparison.

(a) “Table of Regulated Drinking Water Contaminants”, Groundwater and Drinking Water (USEPA, 2016a).

(b) “Table of Secondary Drinking Water Standards”, Secondary Drinking Water Standards: Guidance for Nuisance Chemicals (USEPA, 2016b).

(c) Navajo Nation Surface Water Quality Standards (NNEPA, 2015)

(d) Maximum Contaminant Levels Navajo Nation Primary Drinking Water Regulations (NNPDWR, 2015)

(e) The MCL for Ra-226 and Ra-228 have a combined limit of 5 pCi/L, and are not individually 5pCi/L

(f) Collected data will be used for water quality analysis purposes

* USEPA primary (MCL), secondary standard, Navajo Nation Surface Water Quality Standards, or Navajo Drinking Water MCLs are not established for these analytes.

MCL - maximum contaminant level
µg/L - micrograms per liter
mg/L - milligrams per liter
ng/L - nanograms per liter
pCi/L - picocuries per liter
TDS - Total Dissolved Solids
Ra-226 - Radium 226
Ra-228 - Radium 228
USEPA - Unites States Environmental Protection Agency

Table 4-6b
Water Sampling Analytical Results
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 1

Water Feature Identification		08K-432	08K-432	08GS-12-10	08GS-12-10	08A-213	08A-213
Field Sample Identification		S260-WL-001	S260-WL-001	S260-WS-001	S260-WS-001	S260-WS-002	S260-WS-002
Date Collected		10/18/2016	10/18/2016	10/18/2016	10/18/2016	10/18/2016	10/18/2016
Matrix		Water Well	Water Well	Surface Water	Surface Water	Surface Water	Surface Water
Preparation		Dissolved	Total	Dissolved	Total	Dissolved	Total
Analyte (Units)							
Radionuclides (pCi/L)	Investigation Level						
Ra-226	5 [1]	NS	0.2 ± 0.12	NS	0.28 ± 0.14	NS	0.27 ± 0.13
Ra-228	5 [1]	NS	0 ± 0.28	NS	0 ± 0.26	NS	0 ± 0.26
Gross Alpha	--	NS	8.9 ± 3.1	NS	0 ± 1.1	NS	0 ± 0.83
Adjusted Gross Alpha [2]	15	NS	NA	NS	NA	NS	NA
Gross Beta	--	NS	12.2 ± 3.1	NS	0 ± 1.4	NS	3.4 ± 1.5
Mercury (ng/L)							
Mercury	2000	0.6	0.5	<0.5	<0.5	<0.5	0.6
Metals [3] (µg/L)							
Antimony	5.6	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Arsenic	10	<2	<2	<2	<2	<2	<2
Barium	2000	24	27	120	130	270	260
Beryllium	4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cadmium	5	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium, Total	100	<10	<10	<10	<10	<10	<10
Cobalt	--	<1	<1	<1	<1	<1	<1
Copper	1300	<10	11	12	<10	<10	<10
Lead	15	<0.5	0.64	1.1	0.55	<0.5	<0.5
Molybdenum	--	8.2	8.2	<1	<1	<1	<1
Nickel	610	<5	<5	<5	<5	<5	<5
Selenium	50	130	130	1.5	1.7	1.6	1.2
Silver	35	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Thallium	2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Uranium	30	17	18	1.2	1.2	1.5	1.4
Vanadium	--	5.5	6.5	3.2	3.1	13	12
Zinc	2100	<20	32	<20	<20	<20	<20
General Chemistry Parameters (mg/L)							
TDS	500	NS	1000	NS	120	NS	130
Carbonate	--	NS	<20	NS	<20	NS	<20
Bicarbonate	--	NS	220	NS	83	NS	89
Chloride	250	NS	140 D	NS	8.4	NS	4.8
Sulfate	250	NS	410 D	NS	14	NS	6.7
Calcium	--	54000	55000	13000	14000	14000	13000
Sodium	--	240000	240000	10000	10000	4400	4300
Field Parameters							
Oxidation Reduction Potential(millivolts)	--	NS	89.7	NS	66.5	NS	77.7
pH(pH units)	--	NS	8.31	NS	7.91	NS	8.19
Salinity(PPTV)	--	NS	0.81	NS	0.1	NS	0.1
Specific Conductivity(µS/cm)	--	NS	1612	NS	216.7	NS	202.9
Temperature(°C)	--	NS	20.9	NS	20.7	NS	17.4
Turbidity(NTU)	--	NS	2.69	NS	5.12	NS	0.13
Flow Rate(L/HR)	--	NS	NS	NS	NS	NS	7.2

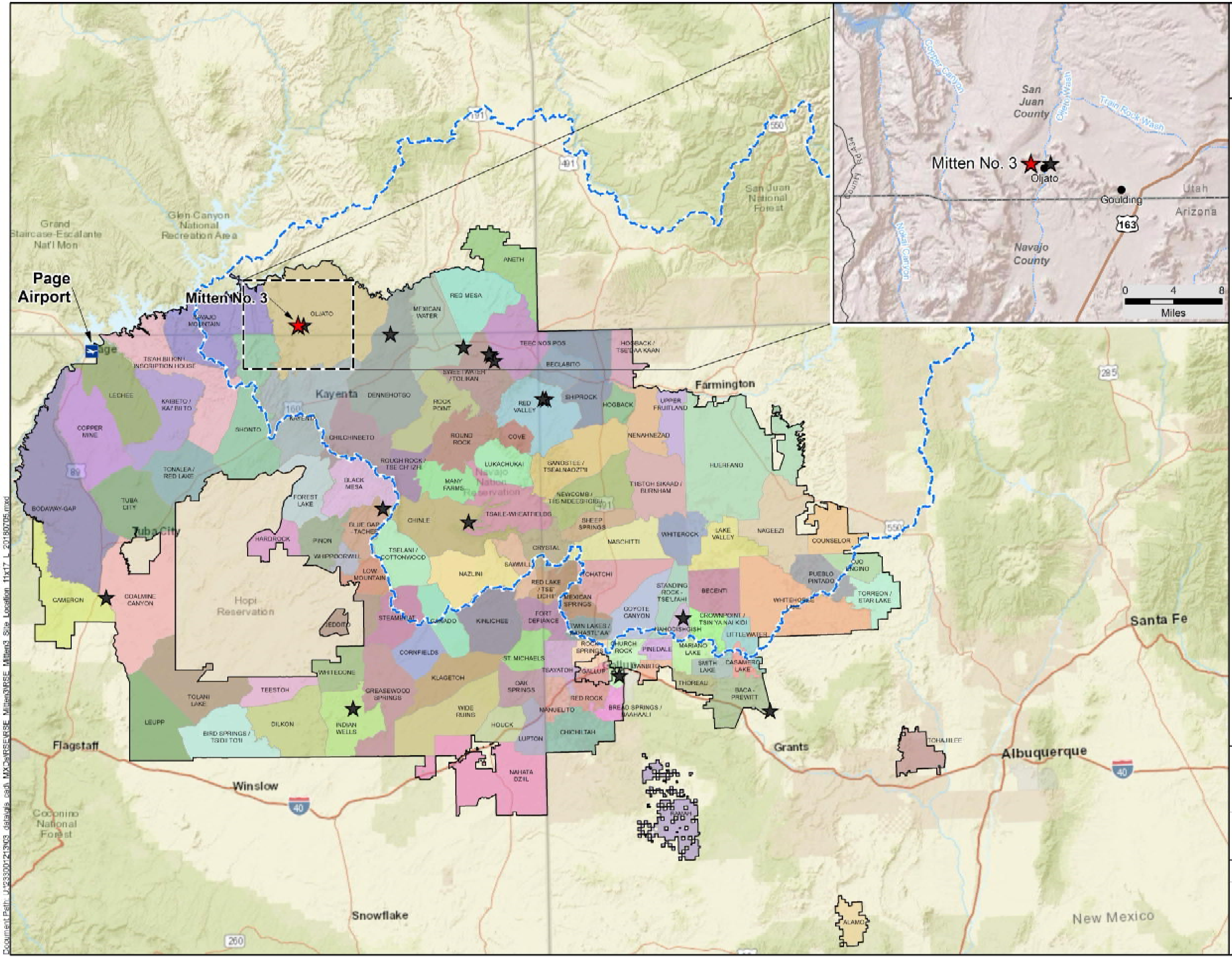
Notes

Bold	Bolded result indicates positively identified compound
Shaded	Shaded result indicates result or reporting limit greater than or equal to the investigation action level
°C	Degrees Celsius
L/HR	liters per hour
µg/L	micrograms per liter
µS/cm	microSiemens per centimeter
mg/L	milligrams per liter
ng/L	nanograms per liter
NTU	nephelometric turbidity unit
pCi/L	picocuries per liter
PPTV	parts per trillion volume
--	Not established
NA	Adjusted Gross Alpha result is not applicable because it was negative, refer to note [2]
NS	Not scheduled
Ra-226	Radium 226
Ra-228	Radium 228
TDS	Total Dissolved Solids
<	Result not detected above associated laboratory reporting limit
1	The Investigation Level for Ra-226 and Ra-228 have a combined limit of 5 pCi/L, and are not individually 5pCi/L
2	Adjusted Gross Alpha = Gross alpha concentration - uranium concentration, using the conversion factor of 0.6757 to convert uranium µg/L to pCi/L (U.S. Department of Energy, 2011)
3	Analysis required sample dilution of 10 times; reported values have been converted to non-diluted value

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
NAD	North American Datum
pCi/g	picocuries per gram
Ra	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

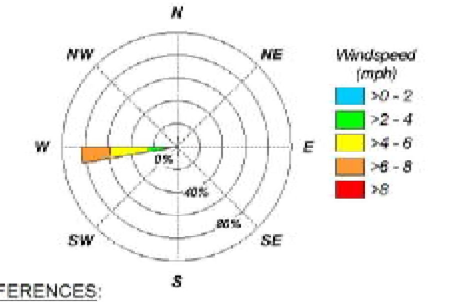


NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

- ★ Mitten No. 3 Mine 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

Page Airport, Arizona Wind Rose (KPGA), 1996-2006



REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

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

Wind Rose: USEPA, 2007a

TITLE:

Site Location

PROJECT:

Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 7/5/2018

DOCUMENT NAME: Removal Site Evaluation Report

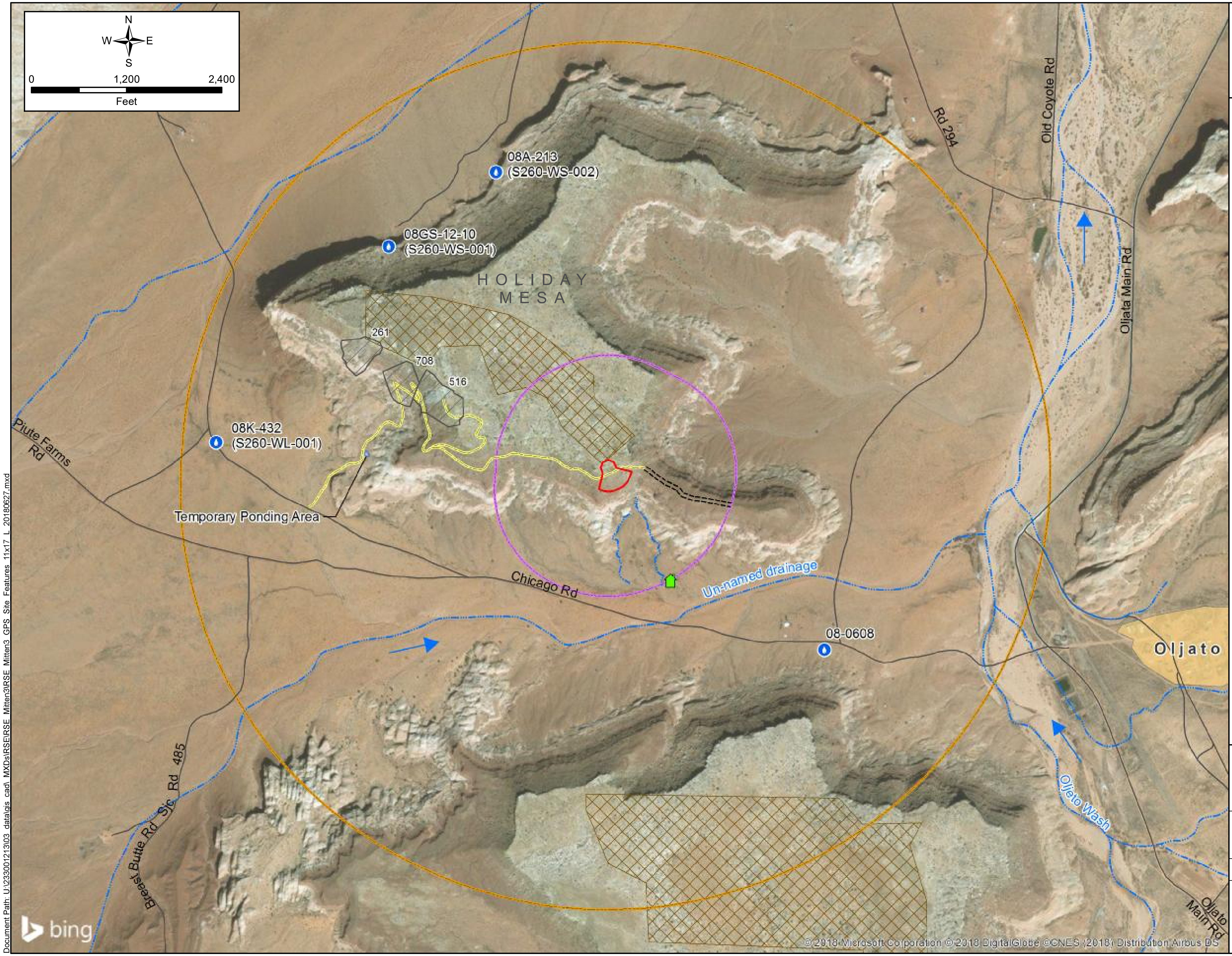
Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 1-1

Document Path: U:\233001213\03_data\gis_cad\MXDs\RSE\RSE_Mitten3\RSE_Mitten3_Site_Location_11x17_L_20180705.mxd



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

⌂	Habitable Building
●	Site Clearance Identified Water Feature[1]
↑	Flow Direction
-··-··-	Intermittent Stream/River
------	Potential Haul Road
========	Road
——	Local Road
▨	Exploration Area
▭	Temporary Ponding Area
▭	Residential Area
▭	Claim Boundary
○	1/4-Mile Claim Boundary Buffer
▭	1-Mile Claim Boundary Buffer
▱	Other Claim Boundary

NOTE:

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

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
Mitten No. 3 Mine Site

DATE: 7/5/2018

DOCUMENT NAME: Removal Site Evaluation Report

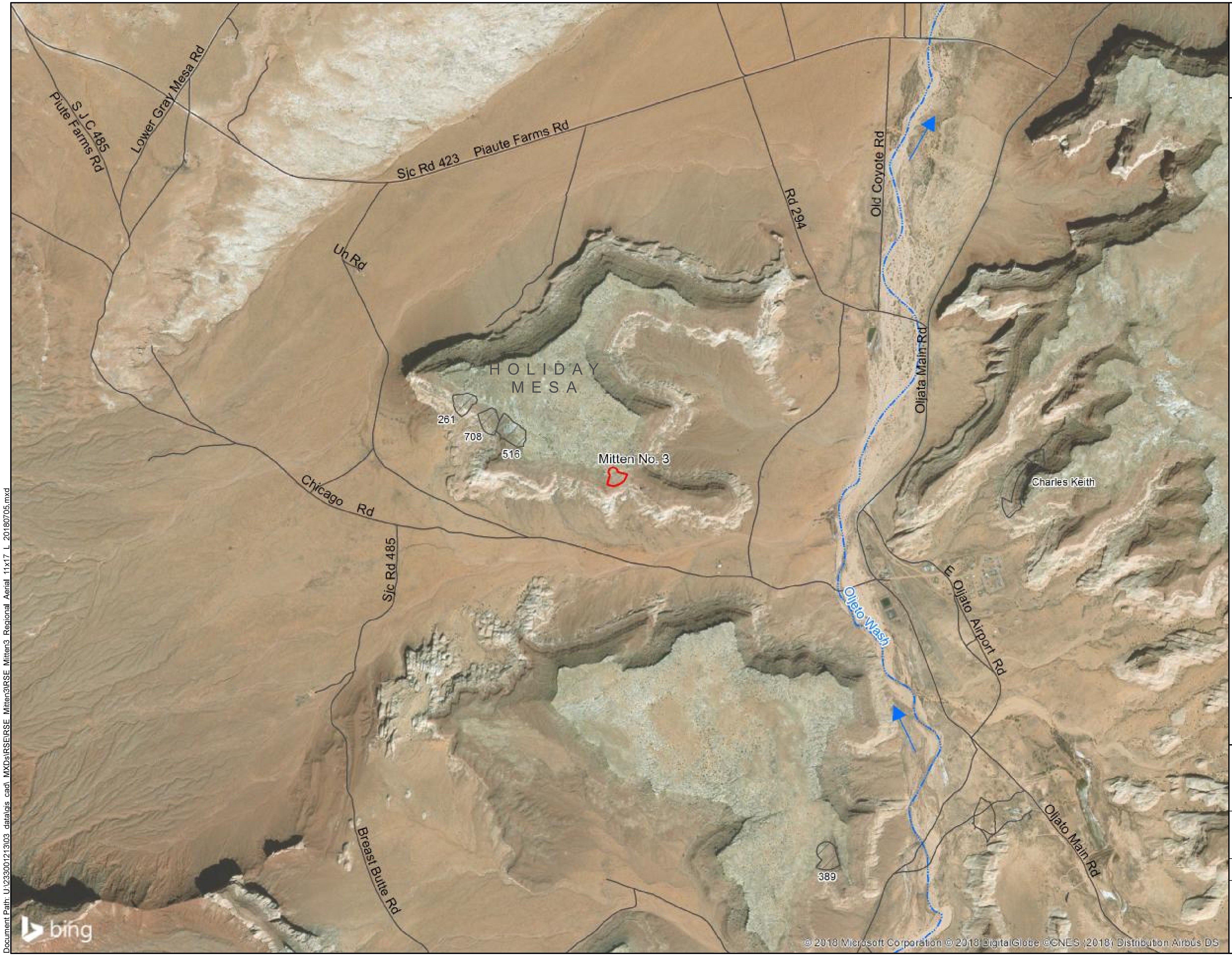
Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 2-1

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\RSE Mitten3 GPS Site Features 11x17 L 20180627.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

↑	Flow Direction
—	Road
-·-·-	Intermittent Stream/River
🟥	Claim Boundary
▨	Other Claim 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
Mitten No. 3 Mine Site

DATE: 7/5/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 2-2

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\RSE Mitten3 Regional Aerial 11x17 L 20180705.mxd

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

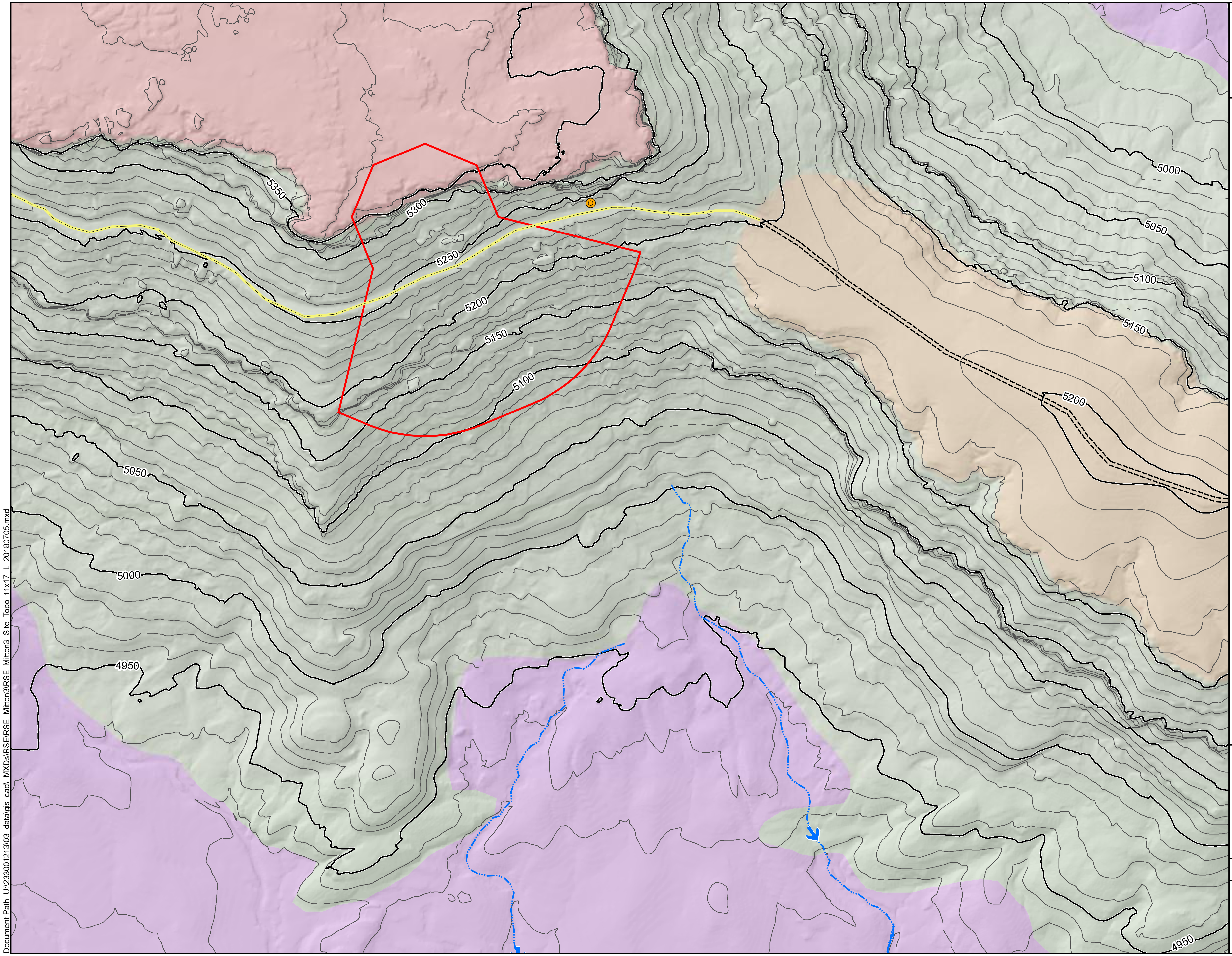
PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 7/5/2018
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ
REVIEWER: CBB
FIGURE: 2-3

Document Path: U:\233001213\03_data\gis_cad\MXDs\RSE\RSE_Mitten3\RSE_Mitten3_Regional_Topo_11x17_L_20180705.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

- ↑ Flow Direction
- ● Approximate Reclaimed Portal Location
- Drainage
- Potential Haul Road
- Road
- Index Contour (50 ft Interval)
- Intermediate Contour (10 ft Interval)
- Claim Boundary

Geomorphology Features

- 🟥 Mesa Top
- 🟧 Mesa Bench
- 🟩 Mesa Sidewall
- 🟪 Pediment

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

Coordinate System: NAD 1983 UTM Zone 12N

N
W E
S

0 130 260
Feet

TITLE:
Site Topography

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 7/5/2018

DOCUMENT NAME: Removal Site Evaluation Report

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 2-4

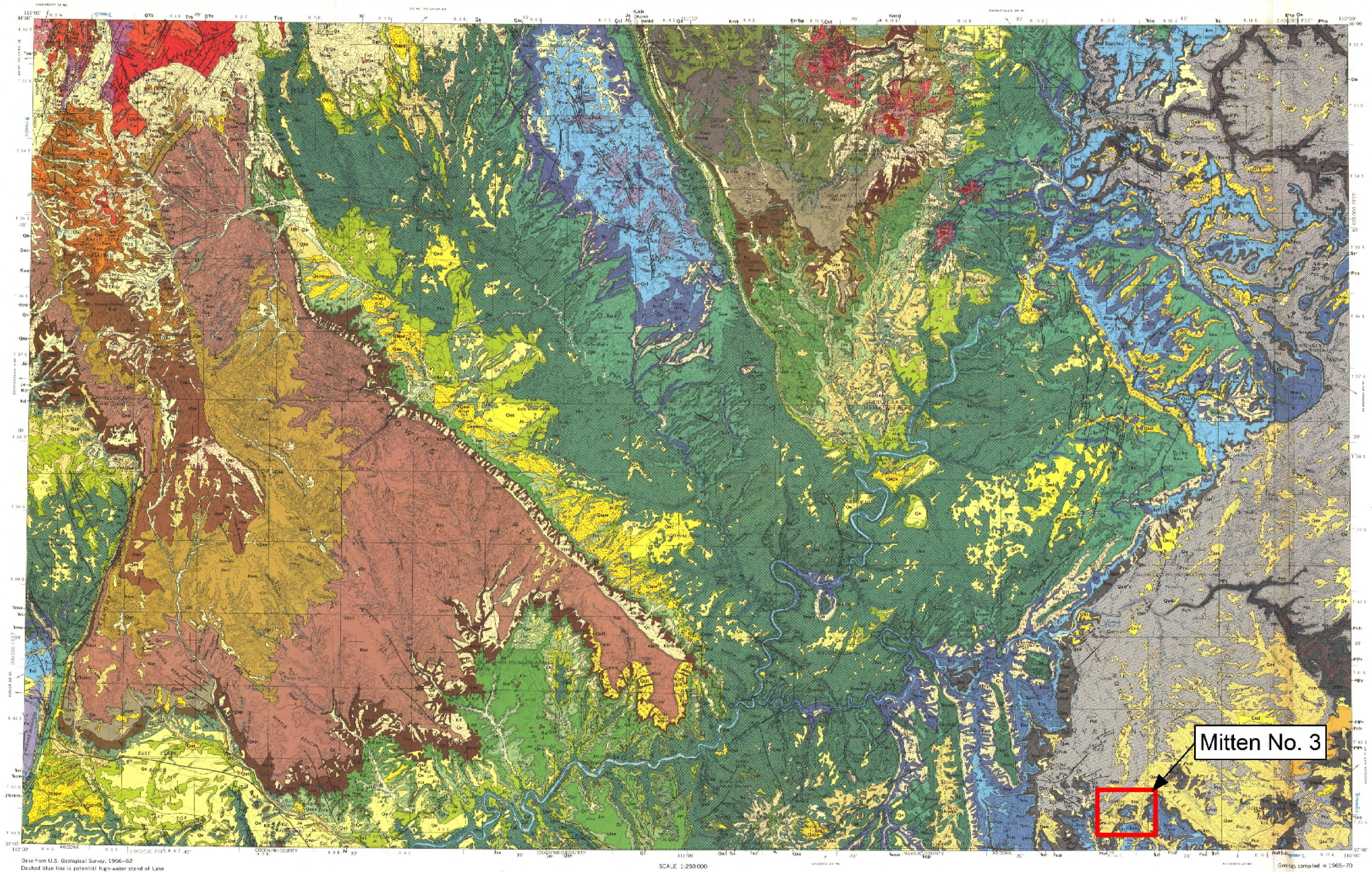
Stantec

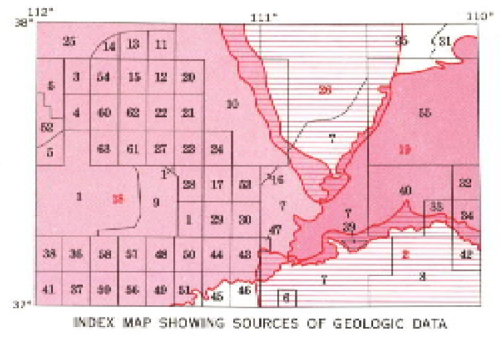
Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\RSE Mitten3 Site Topo 11x17 L 20180705.mxd

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

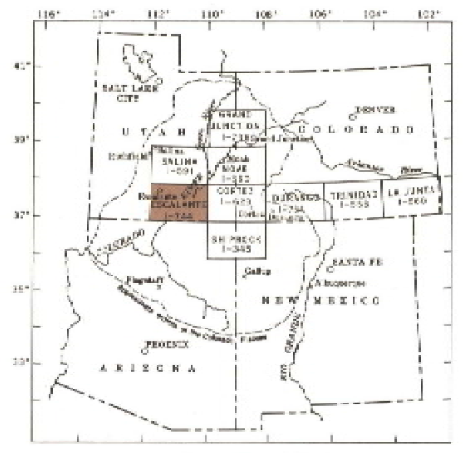
PREPARED IN COOPERATION WITH THE
U.S. ATOMIC ENERGY COMMISSION

MISCELLANEOUS GEOLOGIC INVESTIGATIONS
MAP I-744 (SHEET 1 OF 2)




INDEX MAP SHOWING SOURCES OF GEOLOGIC DATA

GEOLOGIC SOURCES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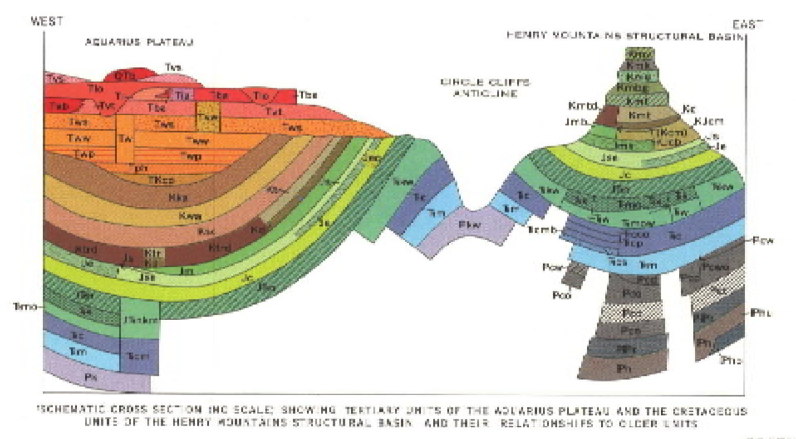
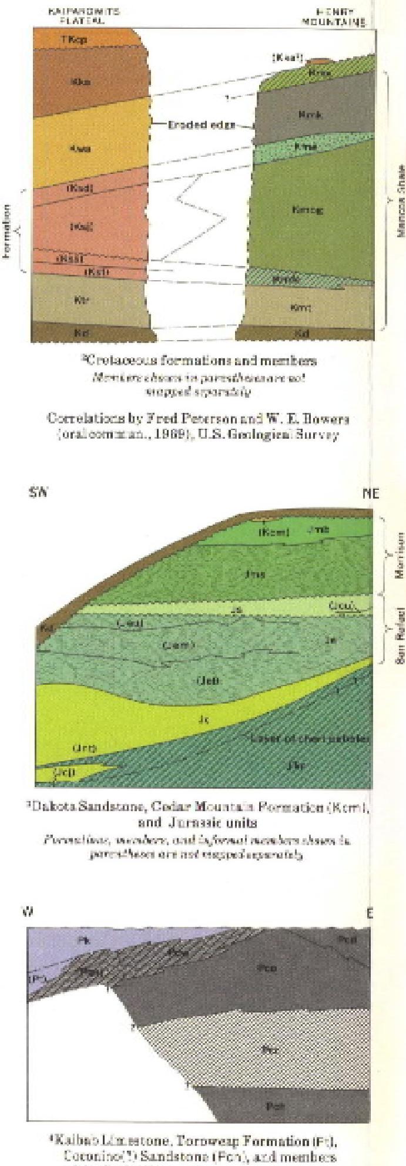
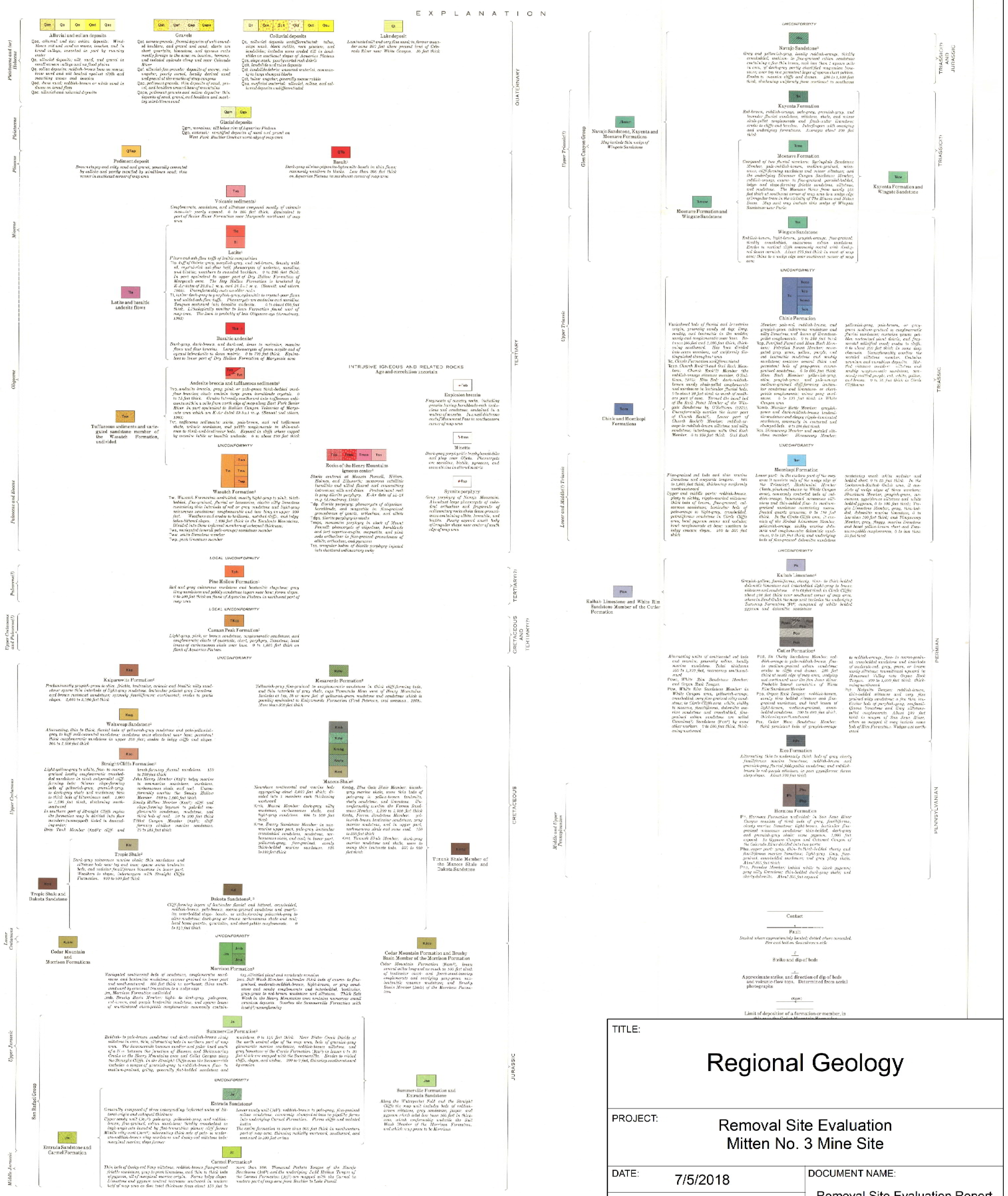


FOOTNOTES FOR EXPLANATION


E X P L A N A T I O N

Geology

GEOLOGY, STRUCTURE, AND URANIUM DEPOSITS OF THE ESCALANTE QUADRANGLE, UTAH AND ARIZONA

Compiled By
Robert J. Hackman and Donald G. Wyant
1973

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

TITLE:
Regional Geology

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 7/5/2018

DOCUMENT NAME:
Removal Site Evaluation Report

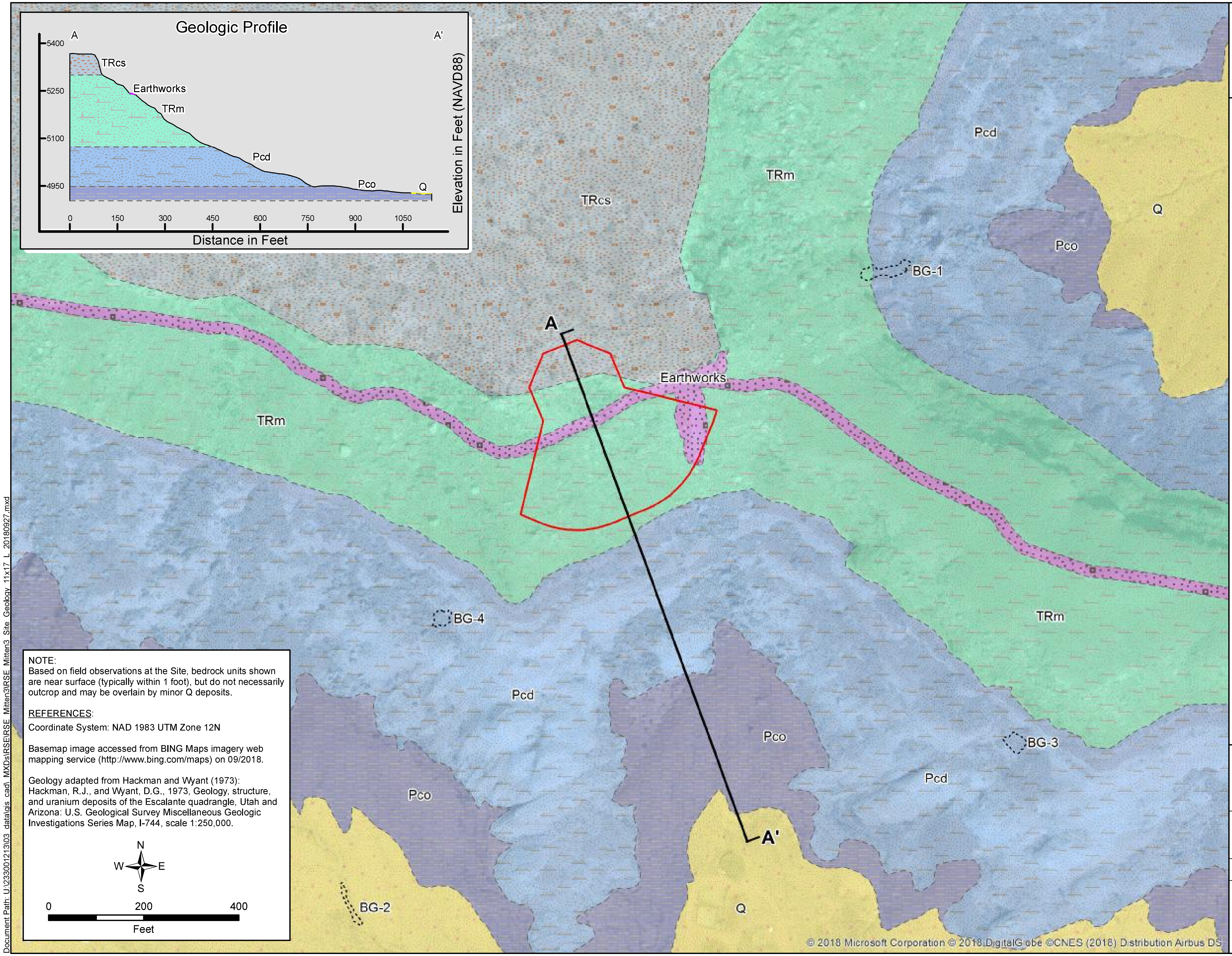
Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE:
2-5

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_Mitten3\RSE_Mitten3_Geology_22x34_L_20180627.mxd



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.

Geology adapted from Hackman and Wyant (1973):
Hackman, R.J., and Wyant, D.G., 1973, Geology, structure, and uranium deposits of the Escalante quadrangle, Utah and Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Series Map, I-744, scale 1:250,000.

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

⊔	Geologic Profile
╌	Geologic Contact (Inferred)
⬚	Potential Background Reference Area
🟥	Claim Boundary

Site Geology

HOLOCENE

▨	Earthworks: Human-caused disturbance of the land surface potentially related to mining.
▨	Q: Quaternary Deposits – Undifferentiated (Pleistocene and Holocene) – includes sandy to gravelly colluvial and alluvial deposits, and eolian sand deposits.

TRIASSIC

▨	TRcs: Shinarump member of the Chinle Formation (Upper Triassic) – moderate-orange and yellowish-gray sandstone, siltstone, conglomerate and sandy shale.
▨	TRm: Moenkopi Formation (Triassic) – reddish-brown, platy to slabby, ripple-marked siltstone, thin marine limestones, and thick beds of brown, fine-grained calcareous sandstone.

PERMIAN

▨	Pcd: De Chelly Sandstone Member of the Cutler Formation (Permian) – reddish-orange to pale-reddish-brown, fine to medium-grained eolian sandstone; erodes to cliffs and domes.
▨	Pco: Organ Rock Tongue of the Cutler Formation (Permian) – reddish brown, evenly thin bedded siltstone and fine-grained sandstone.

TITLE:

Site Geology

PROJECT:

Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

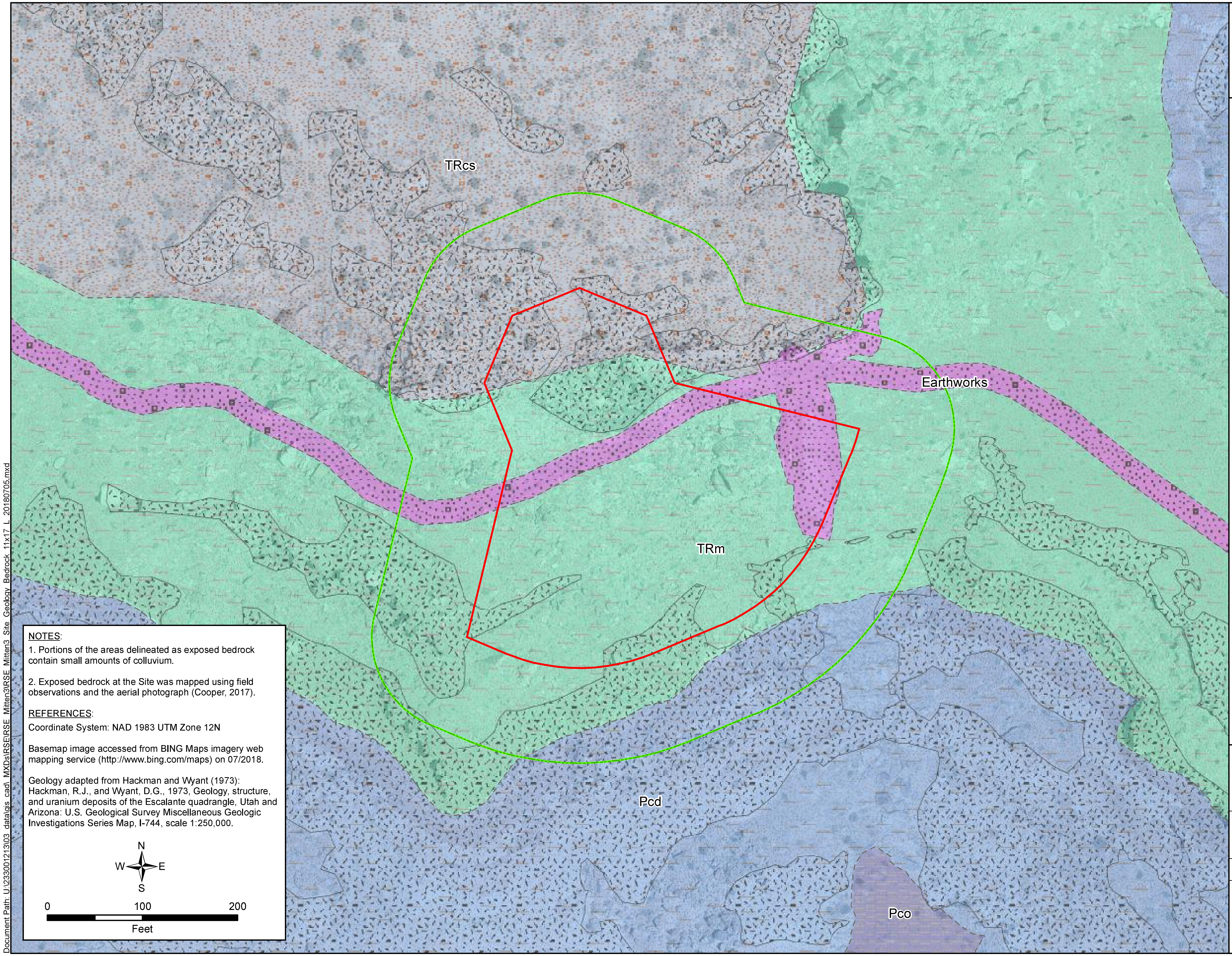
Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 2-6a

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\RSE Mitten3 Site Geology 11x17 L 20180927.mxd



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 Hackman and Wyant (1973): Hackman, R.J., and Wyant, D.G., 1973, Geology, structure, and uranium deposits of the Escalante quadrangle, Utah and Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Series Map, I-744, scale 1:250,000.

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

- Claim Boundary
- 100-Foot Claim Buffer
- Geologic Contact (Inferred)
- Exposed Bedrock[1]

Site Geology

HOLOCENE

- Earthworks: Human-caused disturbance of the land surface potentially related to mining.

TRIASSIC

- TRcs: Shinarump member of the Chinle Formation (Upper Triassic) – moderate-orange and yellowish-gray sandstone, siltstone, conglomerate and sandy shale.
- TRm: Moenkopi Formation (Triassic) – reddish-brown, platy to slabby, ripple-marked siltstone, thin marine limestones, and thick beds of brown, fine-grained calcareous sandstone.

PERMIAN

- Pcd: De Chelly Sandstone Member of the Cutler Formation (Permian) – reddish-orange to pale-reddish-brown, fine to medium-grained eolian sandstone; erodes to cliffs and domes.
- Pco: Organ Rock Tongue of the Cutler Formation (Permian) – reddish brown, evenly thin bedded siltstone and fine-grained sandstone.

TITLE:

Site Exposed Bedrock

PROJECT:

Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 7/5/2018

DOCUMENT NAME: Removal Site Evaluation Report

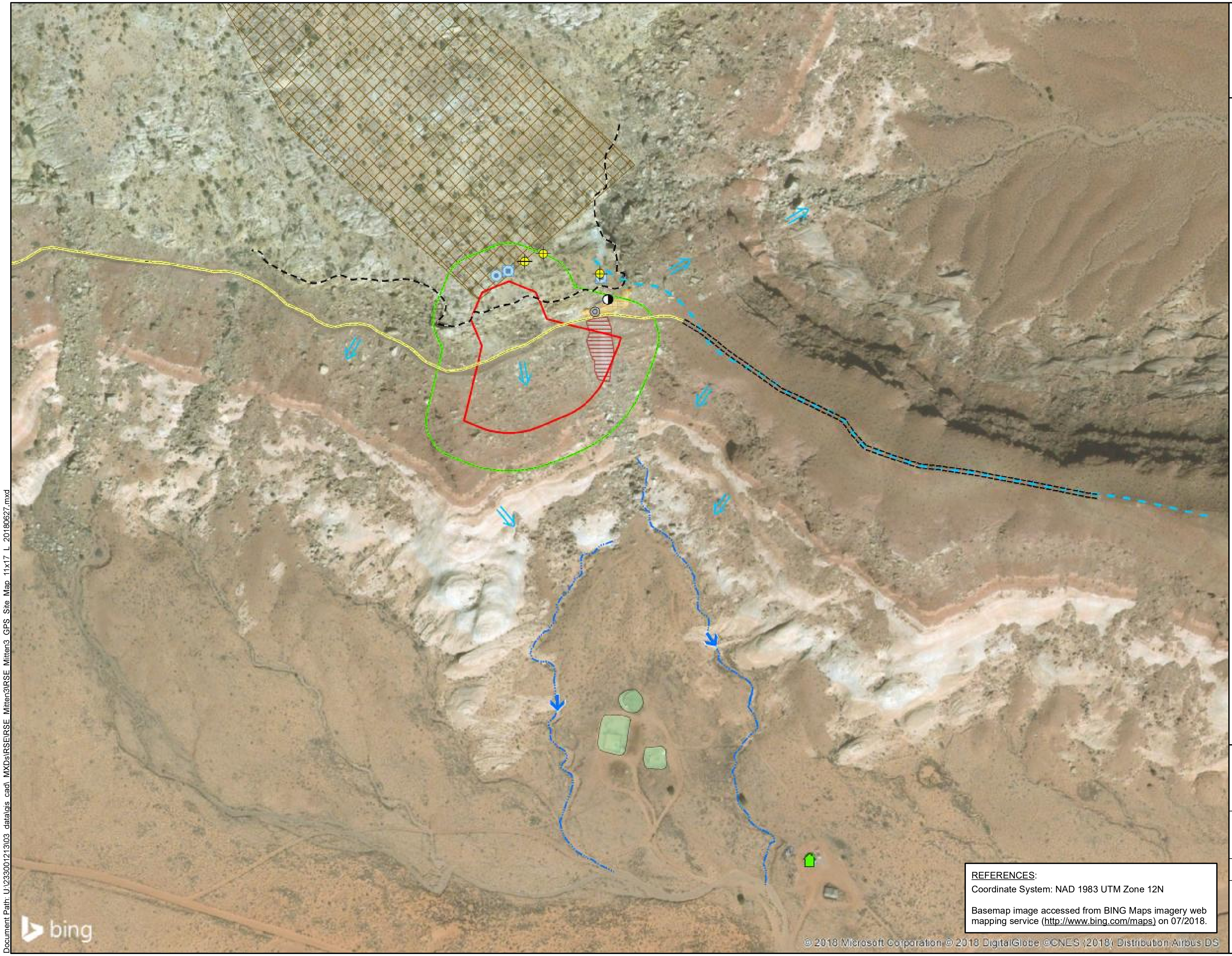
Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 2-6b

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\RSE Mitten3 Site Geology Bedrock 11x17 L 20180705.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.

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

⊕	Historical Borehole
◉	Historical Rock Core / Drill Cuttings
▣	Historical Metal Rods
⌂	Habitable Building
◎	Approximate Reclaimed Portal Location
◑	Prospect Portal
↑	Flow Direction
⇑	Approximate Overland Water Flow Direction
-·-·-·	Drainage
-------	Potential Haul Road
========	Road
- - - -	Approximate Edge of Mesa
- - -	Approximate Watershed Divide Line
▨	Exploration Area
🟩	Corral
▦	Mining Disturbed Area
▤	Waste Pile
🟥	Claim Boundary
▢	100-Foot Claim Buffer

N
W E
S

0 250 500
Feet

TITLE:
Site Features

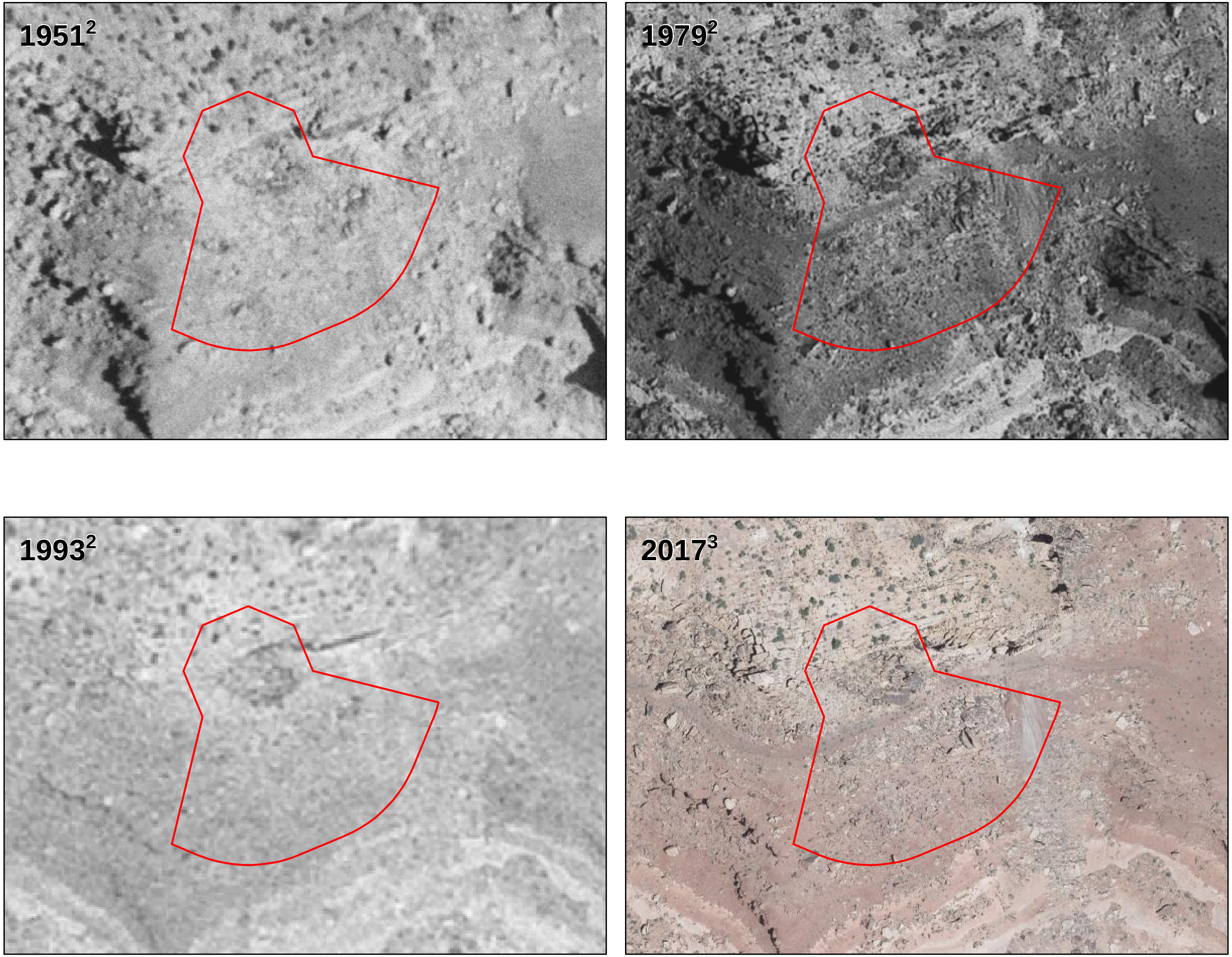
PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 7/5/2018
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ
REVIEWER: CBB
FIGURE: 2-7

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\RSE Mitten3 GPS Site Map 11x17 L 20180627.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

🟥 Mitten No. 3 Claim Boundary

REFERENCES:

1. Coordinate System: NAD 1983 UTM Zone 12N
2. Historical aerial imagery downloaded from https://earthexplorer.usgs.gov/ on (01/2016)
3. Site-specific imagery flown by Cooper Aerial Surveys Co. on June 16, 2017.

N
W E
S

0 150 300
Feet

TITLE:

Historical Aerial Photograph Comparison

PROJECT:

Removal Site Evaluation
Hoskie Tso No. 1 Mine Site

DATE: 7/5/2018

DOCUMENT NAME: Removal Site Evaluation Report

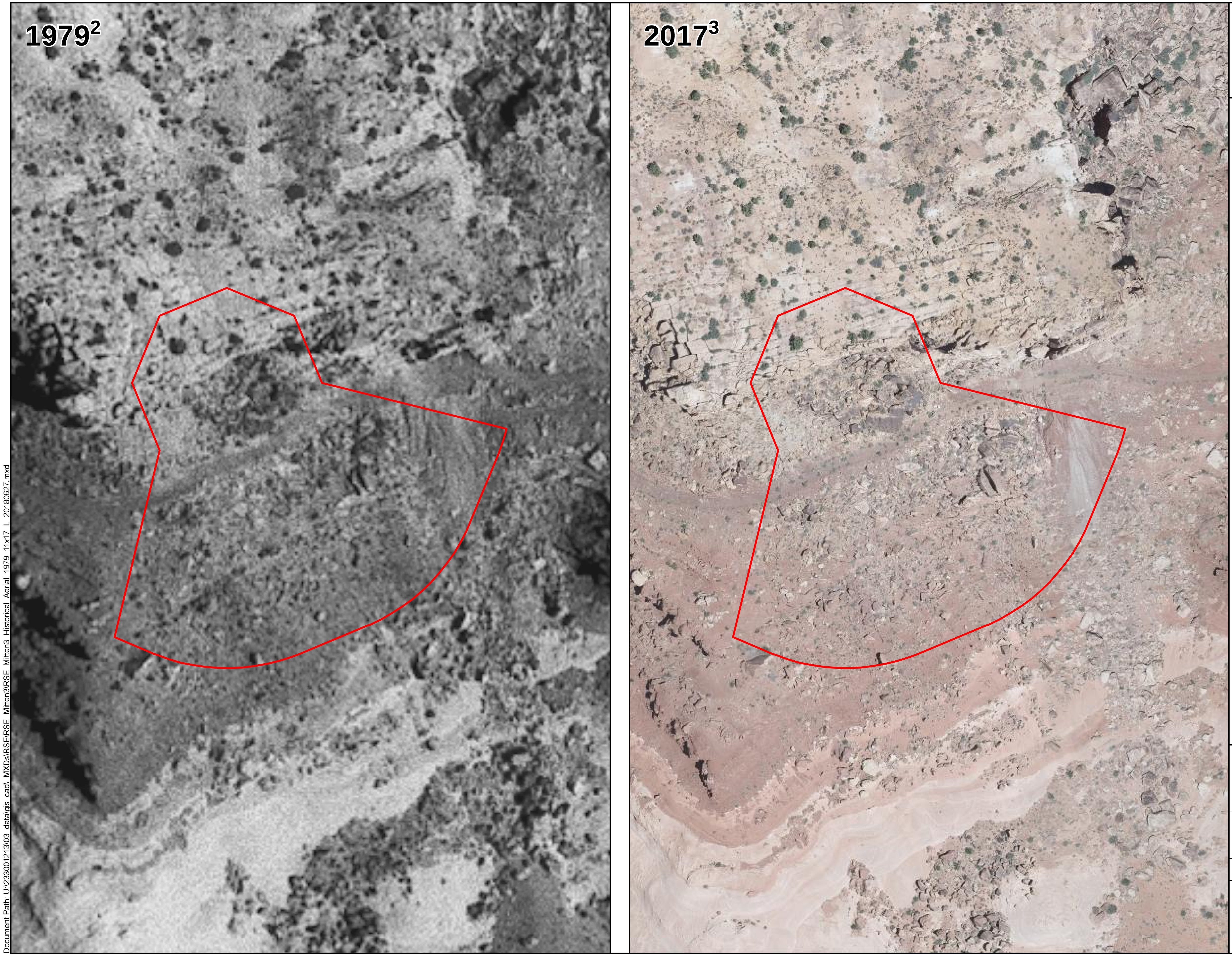
Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 3-1a

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\RSE Mitten3 Historical Aerial Compilation 11x17 L 20180627.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

🟥 Mitten No. 3 Claim Boundary

REFERENCES:

1. Coordinate System: NAD 1983 UTM Zone 12N

2. 1979 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

0 100 200
Feet

TITLE:
1979 Historical Aerial
Photograph Comparison

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 7/5/2018

DOCUMENT NAME: Removal Site Evaluation Report

AUTHOR: CBB

REVIEWER: EDZ

Stantec

3-1b

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_Mitten3\RSE_Mitten3_Historical_Aerial_1979_11x17_L_20180627.mxd

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

- - - Approximate Watershed Divide Line

🟨 Potential Background Reference Area

☐ Claim Boundary

NOTE:
Additional potential background reference area shown on Figure 3-2b.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image flown specifically for the project by Cooper Aerial Surveys Co. on June 16, 2017.

N
W E
S

0 150 300
Feet

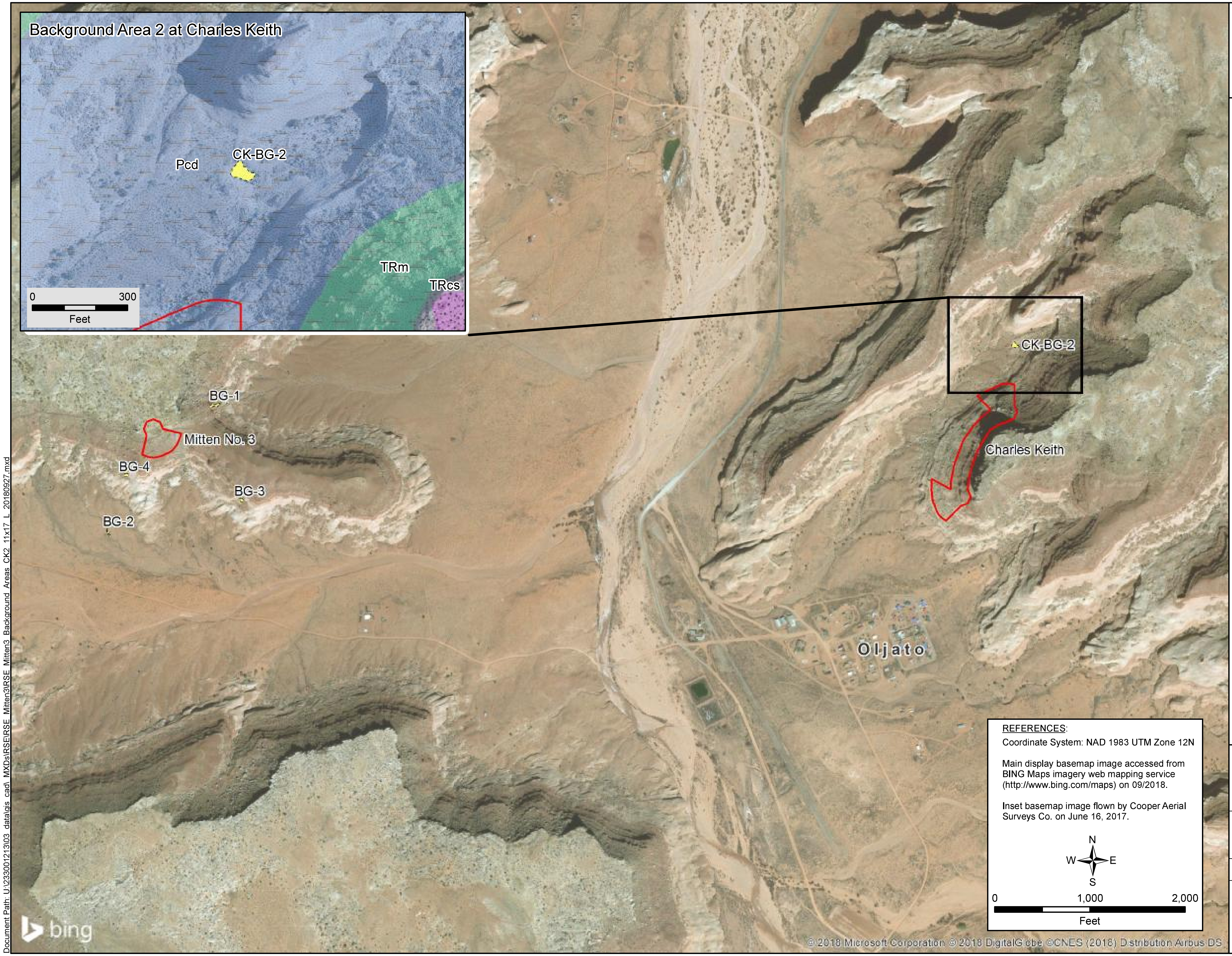
TITLE:
Potential Background Reference Areas

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 9/27/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: CBB
REVIEWER: EDZ
FIGURE: 3-2a

Stantec

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\RSE Mitten3 Background Areas 11x17 L 20180627.mxd



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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.

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

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

- 🟨 Potential Background Reference Area
- 🟥 Claim Boundary

Site Geology

HOLOCENE

- ▨ Earthworks: Human-caused disturbance of the land surface potentially related to mining.

TRIASSIC

- ▨ TRcs: Shinarump member of the Chinle Formation (Upper Triassic) – moderate-orange and yellowish-gray sandstone, siltstone, conglomerate and sandy shale.
- ▨ TRm: Moenkopi Formation (Triassic) – reddish-brown, platy to slabby, ripple-marked siltstone, thin marine limestones, and thick beds of brown, fine-grained calcareous sandstone.

PERMIAN

- ▨ Pcd: De Chelly Sandstone Member of the Cutler Formation (Permian) – reddish-orange to pale-reddish-brown, fine to medium-grained eolian sandstone; erodes to cliffs and domes.

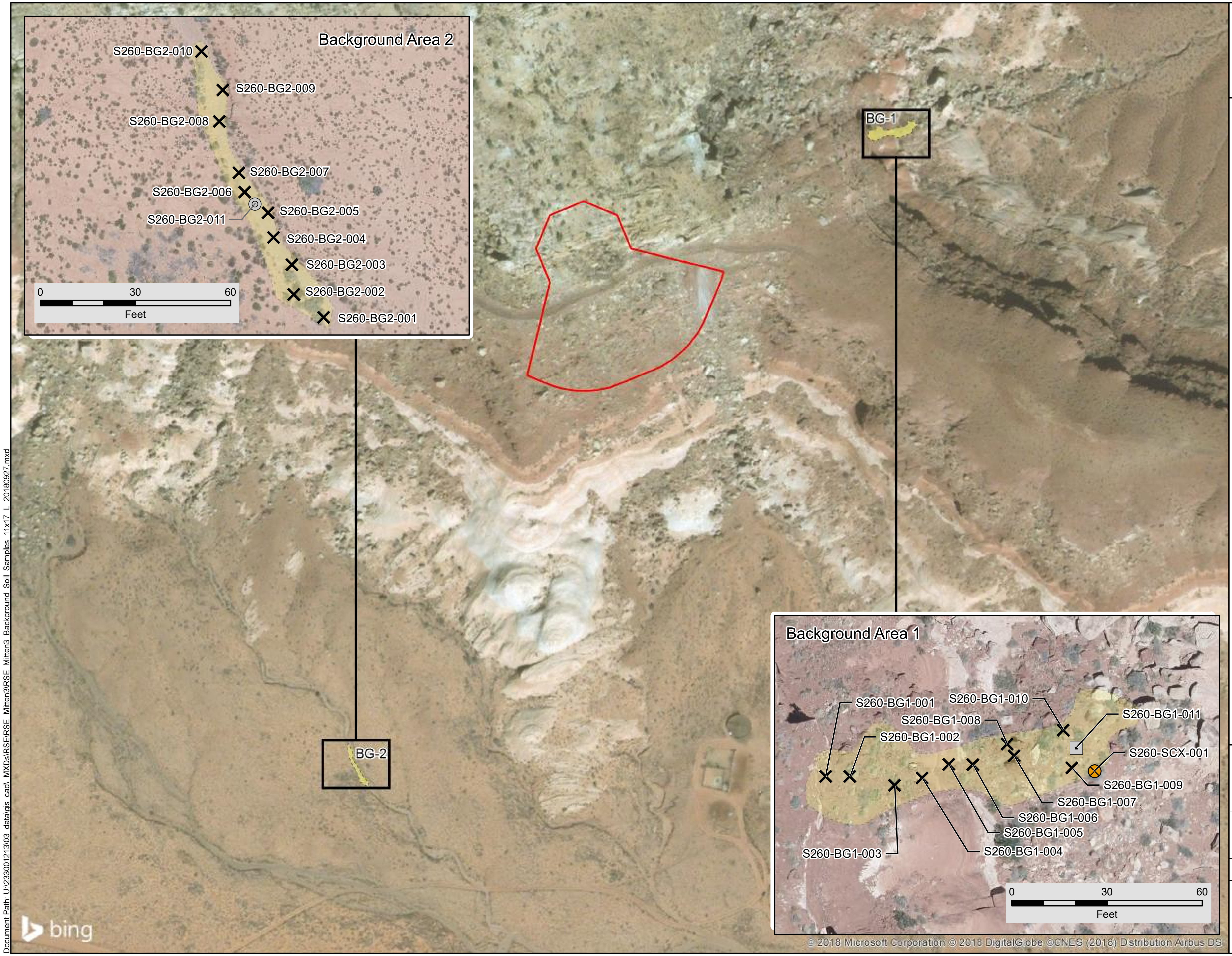
TITLE:
Additional Background Reference Area

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 9/27/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: CBB
REVIEWER: EDZ
FIGURE: 3-2b

Stantec

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\RSE Mitten3 Background Areas CK2 11x17 L 20180927.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
⊗	Attempted Borehole Location¹
▨	Background Reference Area
▭	Claim Boundary

NOTES:

1. Samples from initial borehole in BG-1 were misplaced prior to shipping.

2. Sample locations at additional potential background reference area are shown on 3-3b.

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.

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

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Feet

TITLE:
Background Reference Areas - Sample Locations

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

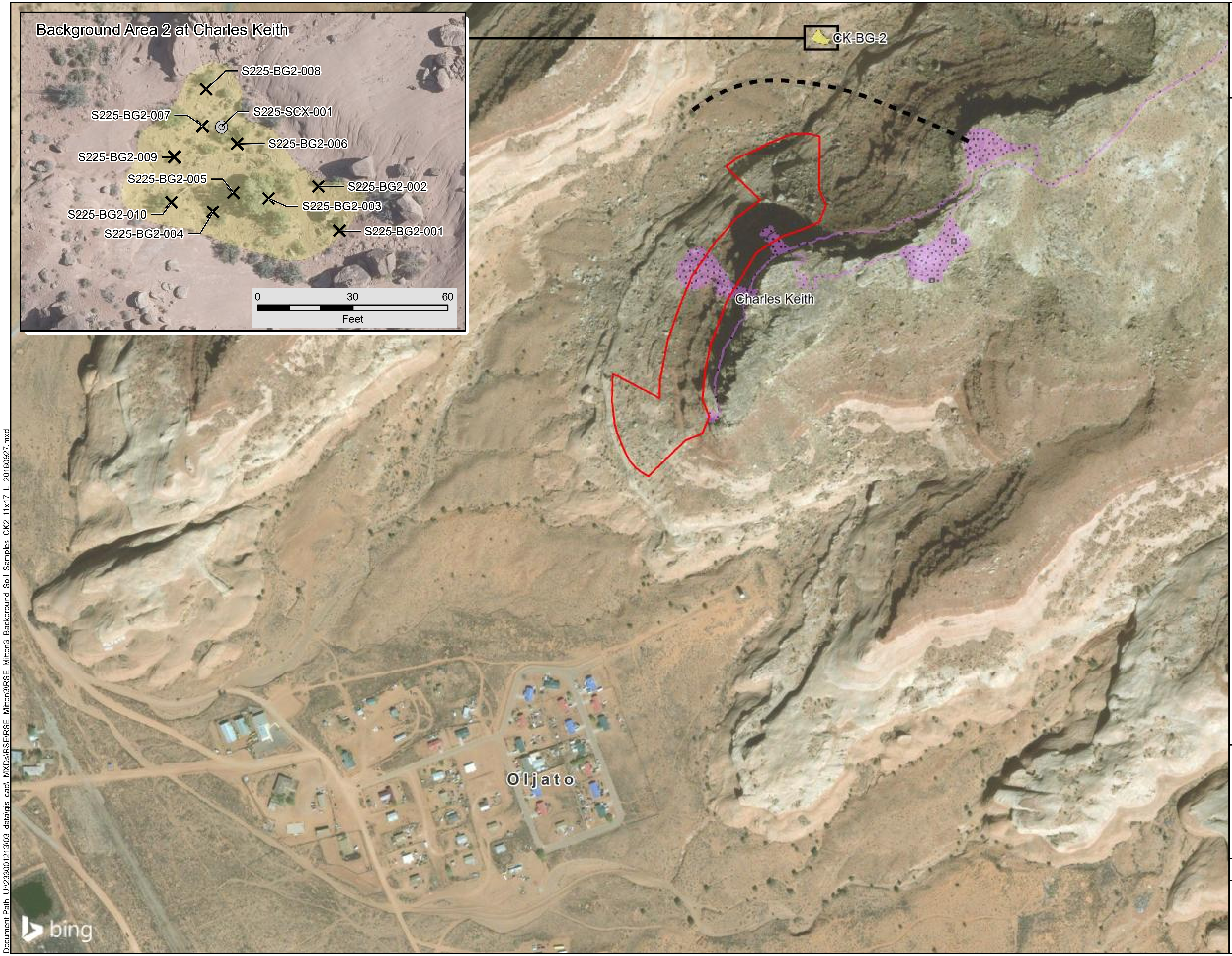
Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 3-3a

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_Mitten3\RSE_Mitten3_Background_Soil Samples_11x17_L_20180927.mxd



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

✕ Surface Sample Location

◎ Borehole Location - Surface and Subsurface Samples

⋯ Approximate Northern Range of (Hydrologic or Mass Wasting) Impact from Earthworks at the Site

🟨 Background Reference Area

▨ Earthworks: Human-caused disturbance of the land surface potentially related to mining.

☐ 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 09/2018.

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

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TITLE:
Additional Background
Reference Area - Sample Locations

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

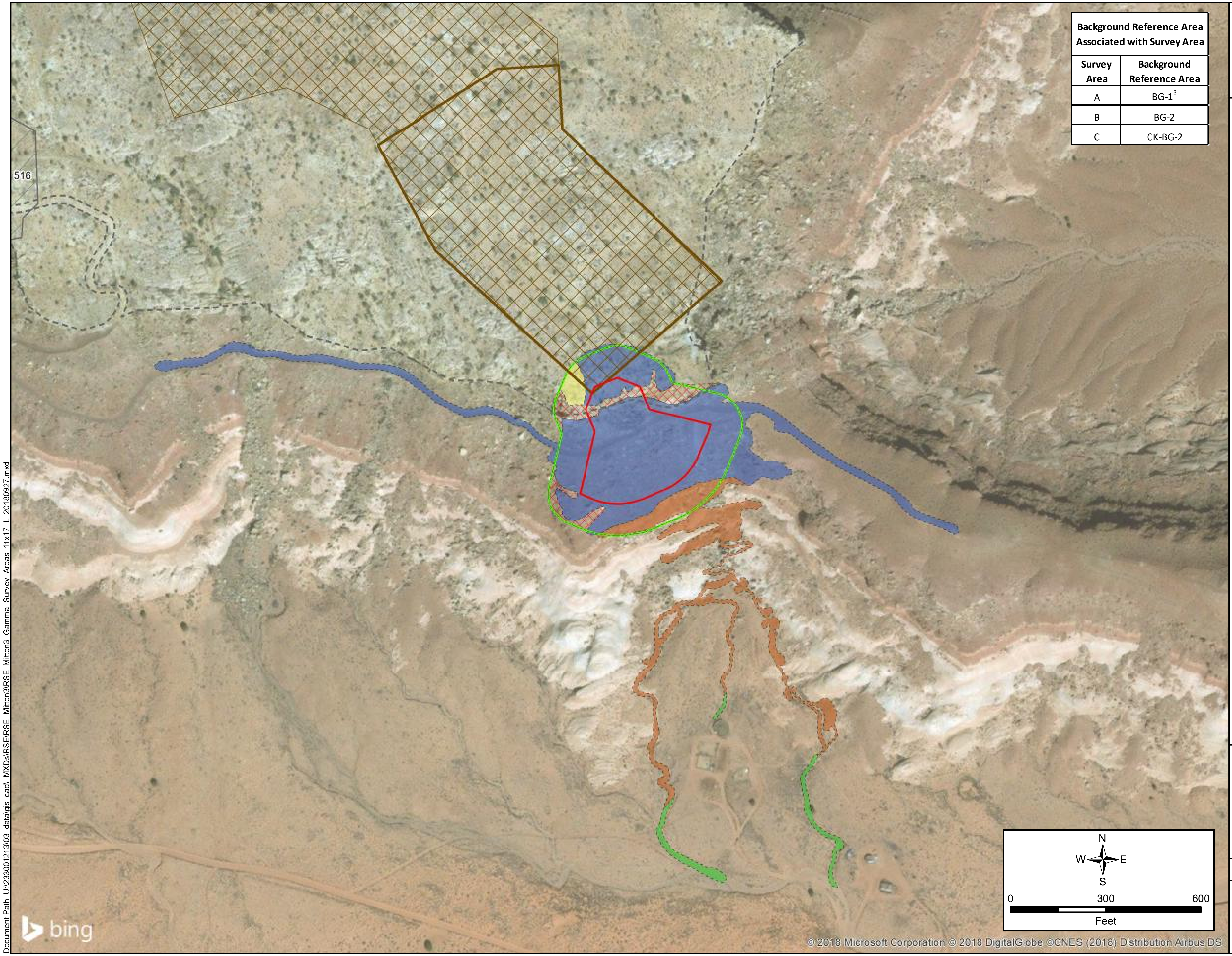
Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 3-3b

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_Mitten3\RSE_Mitten3_Background_Soil_Samples_CK2_11x17_L_20180927.mxd



Background Reference Area Associated with Survey Area	
Survey Area	Background Reference Area
A	BG-1[3]
B	BG-2
C	CK-BG-2

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NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

- 🟦 Survey Area A
- 🟩 Survey Area B
- 🟧 Survey Area C
- ▨ Unsurveyed Area - Steep/Unsafe Terrain[1]
- 🟨 Unsurveyed Area - Data Gap[2]
- ☐ Surveyed Exploration Area
- ▨ Exploration Area
- ☐ Chinle Formation / Moenkopi Formation Geologic Contact (Inferred)[3]
- 🟥 Claim Boundary
- ☐ Other Claim Boundary
- 🟩 100-Foot Claim Buffer

NOTES:

1. Areas within Survey Areas (0.7 acres) that were not surveyed due to steep/unsafe terrain.

2. A small portion of the mesa top was omitted from the surface gamma survey within the northwestern 100-ft buffer (approximately 0.2 acres).

3. A background reference area was not identified to represent the Chinle Formation area of the Site.

4. Site gamma survey area is approximately 9.1 acres, exploration area survey area is approximately 12 acres.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

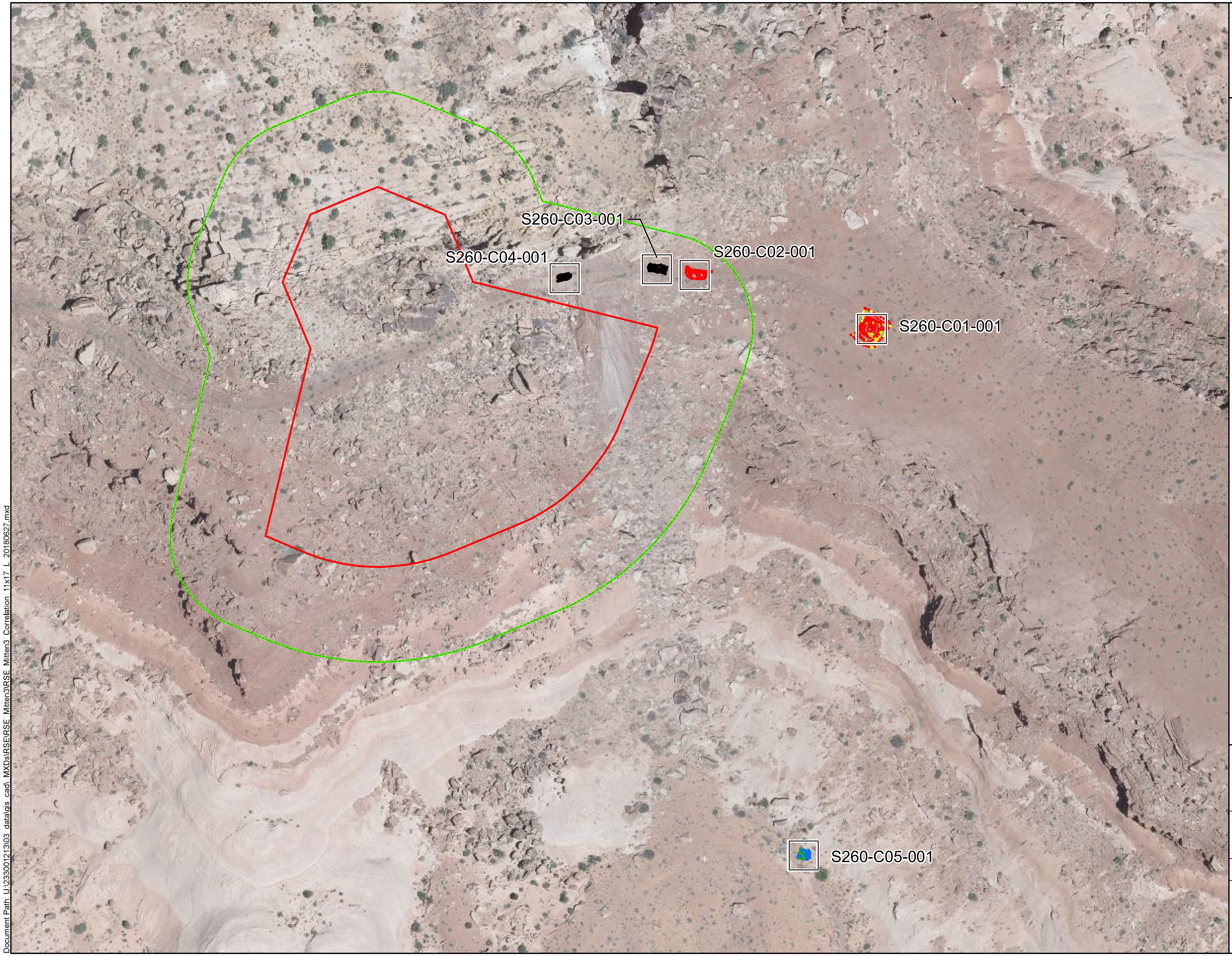
Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 10/2018.

TITLE:
Gamma Radiation
Survey Areas

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/3/2018	DOCUMENT NAME: Removal Site Evaluation Report
Stantec	AUTHOR: CBB
	REVIEWER: EDZ
	FIGURE: 3-4

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_Mitten3\RSE_Mitten3_Gamma_Survey_Areas_11x17_L_20180927.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

☐ S260-C01-001 Correlation Location (30' x 30')

🟥 Claim Boundary

🟩 100-Foot Claim Buffer

Gamma Survey

Counts per Minute (CPM)

- ● 6,195 - 9,172 (Minimum to BG-2 UTL)
- ● 9,173 - 11,220 (>BG-2 UTL to CK BG-2 UTL)
- ● 11,221 - 12,847 (>CK BG-2 UTL to BG-1 UTL)
- ● 12,848 - 25,696 (>BG-1 UTL to 2x BG-1 UTL)
- ● 25,697 - 66,226 (>2x BG-1 UTL to Maximum)

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 specifically for the project by Cooper Aerial Surveys Co. on June 16, 2017.

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Feet

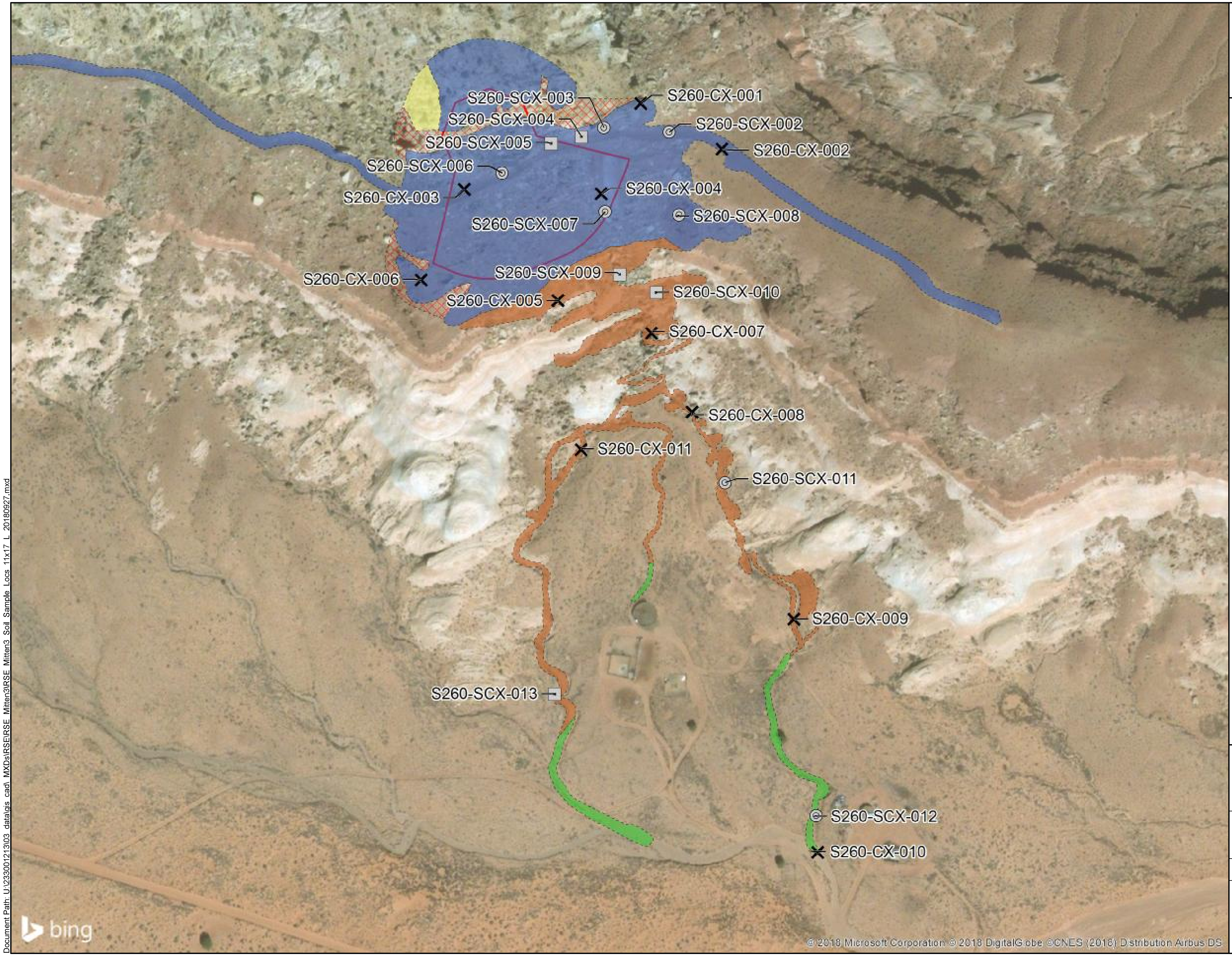
TITLE:
Gamma Correlation
Study Locations

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 7/5/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: EDZ
REVIEWER: CBB
FIGURE: 3-5

Stantec

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\RSE Mitten3 Correlation 11x17 L 20180627.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
▣	Borehole Location - Surface Samples Only
🟦	Survey Area A
🟩	Survey Area B
🟧	Survey Area C
▨	Unsurveyed Area - Steep/Unsafe Terrain
🟨	Unsurveyed Area - Data Gap
🟥	Claim Boundary

NOTES:

Surface and subsurface static gamma measurements were collected at all borehole locations.

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

Subsurface samples range from 0.5 - 1.5 ft bgs

Static gamma measurements range from 0.0 - 2.1 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.

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Feet

TITLE:
Site Characterization Surface and Subsurface Sample Locations

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

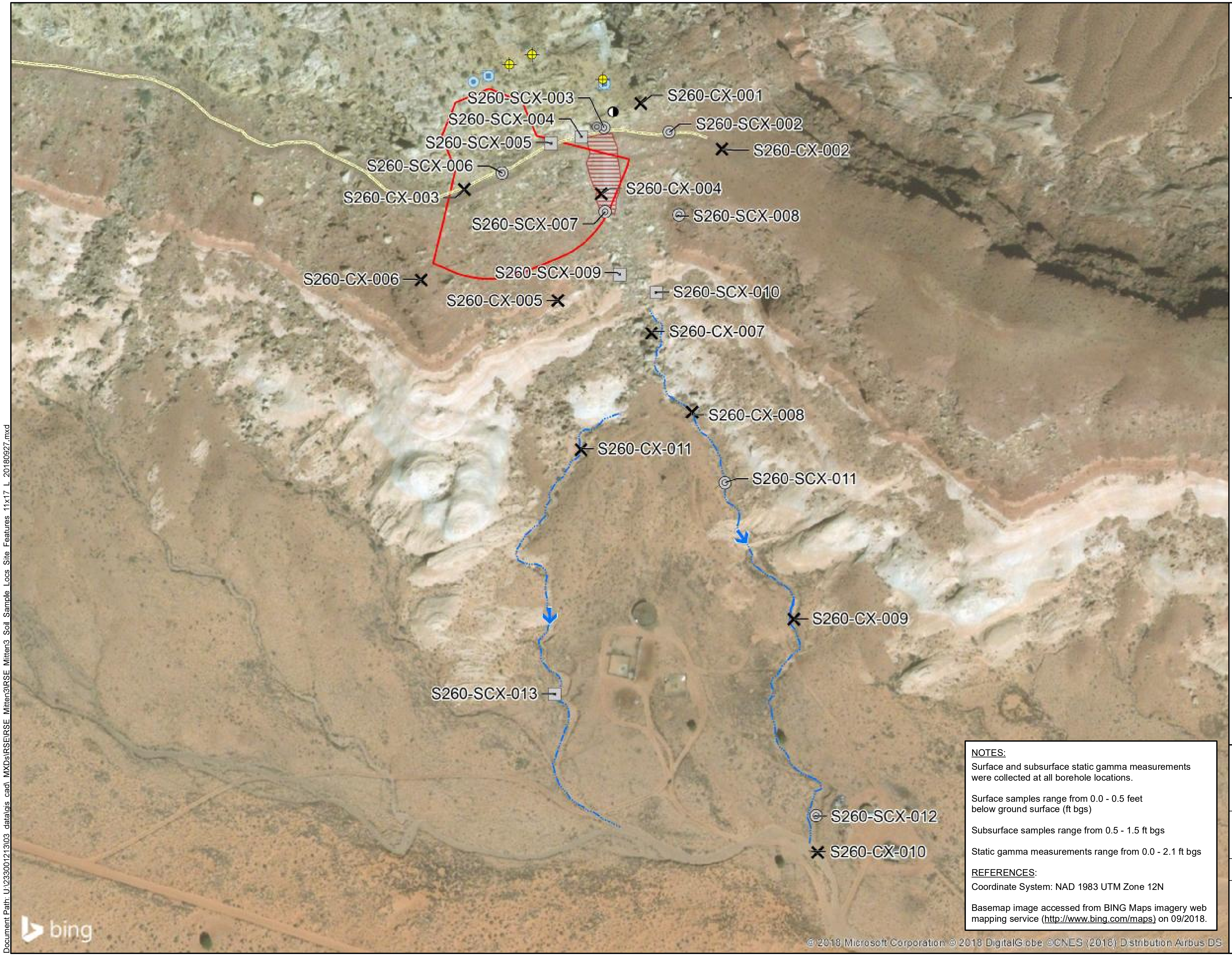
AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 3-6a

Stantec

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_Mitten3\RSE_Mitten3_Soil_Sample_Locs_11x17_L_20180927.mxd



NOTES:

Surface and subsurface static gamma measurements were collected at all borehole locations.

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

Subsurface samples range from 0.5 - 1.5 ft bgs

Static gamma measurements range from 0.0 - 2.1 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.

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

⊕	Historical Borehole
◉	Historical Rock Core / Drill Cuttings
▣	Historical Metal Rods
◎	Approximate Reclaimed Portal Location
◑	Prospect Portal
✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
▪	Borehole Location - Surface Samples Only
↑	Flow Direction
-·-·-	Drainage
- - -	Potential Haul Road
▤	Waste Pile
□	Claim Boundary

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0 200 400
Feet

TITLE:
Sample Locations Compared
to Mining-Related Features

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

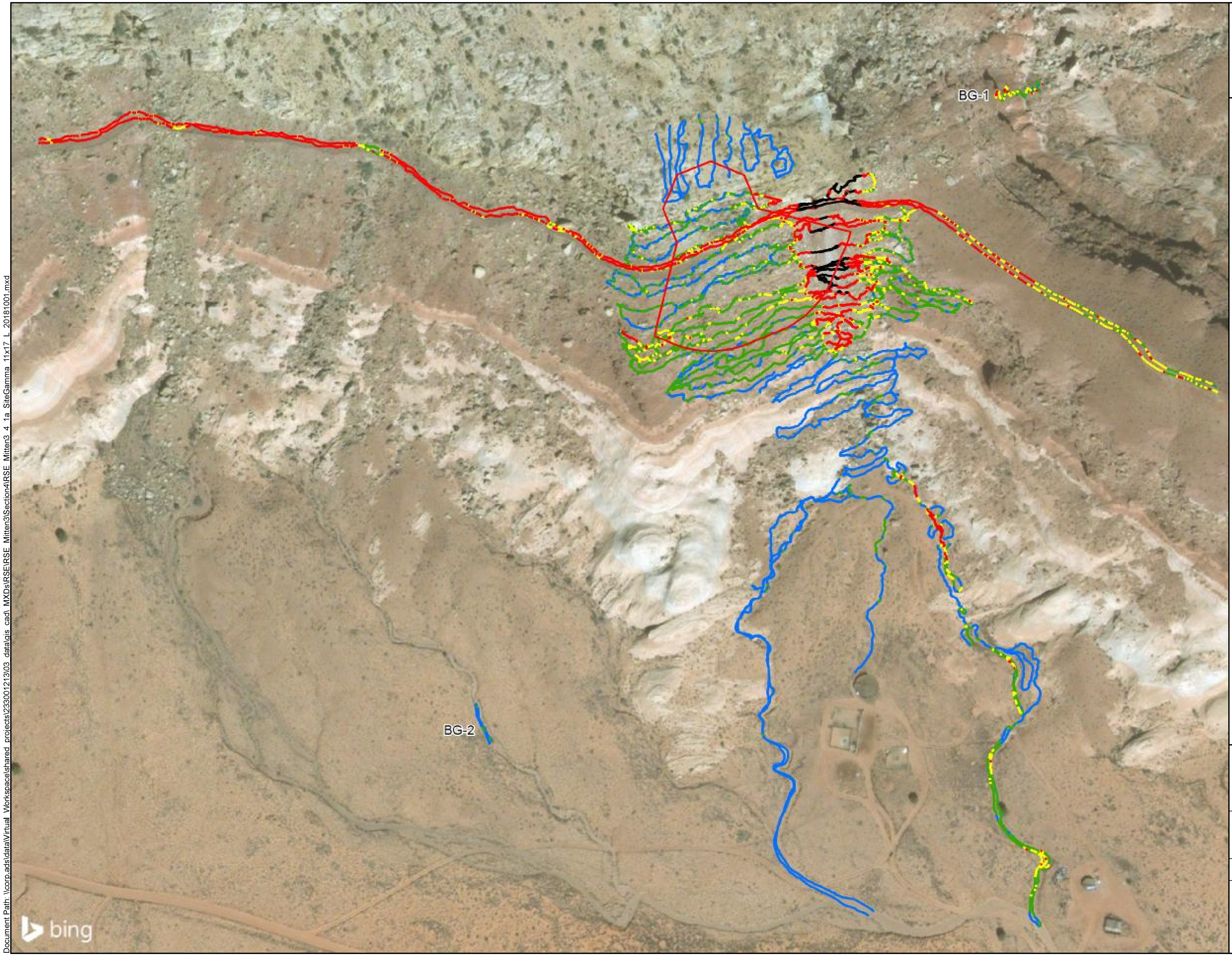
Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 3-6b

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\RSE Mitten3 Soil Sample Locs Site Features 11x17 L 20180927.mxd



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

🟥 Claim Boundary

Gamma Survey

Counts per Minute (CPM)

●	4,266 - 9,172 (Minimum to BG-2 IL)
●	9,173 - 11,220 (>BG-2 IL to CK-BG-2 IL)
●	11,221 - 12,847 (>CK-BG-2 IL to BG-1 IL)
●	12,848 - 25,696 (>BG-1 IL to 2x BG-1 IL)
●	25,697 - 129,220 (>2x BG-1 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 10/2018.

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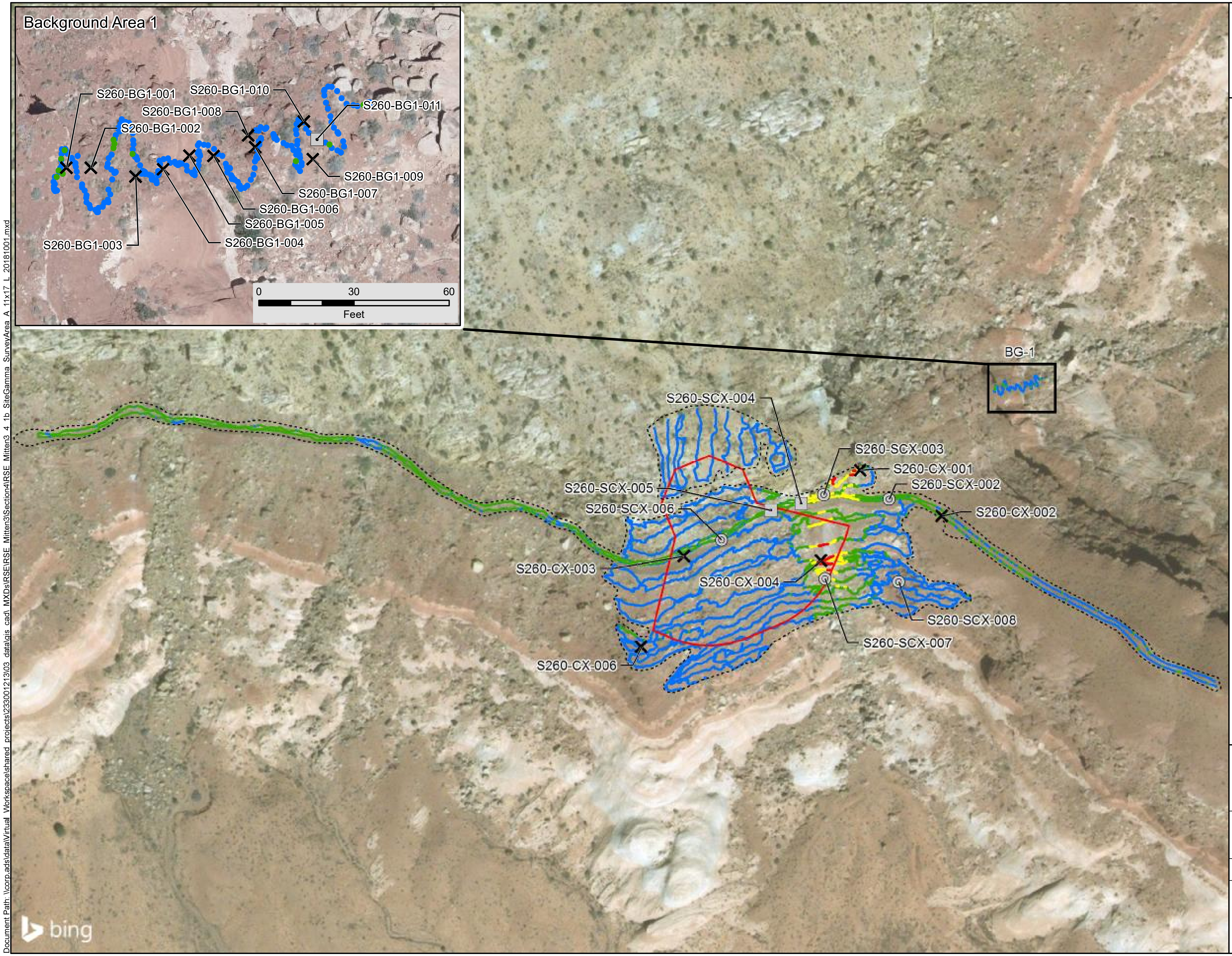
0 200 400
Feet

TITLE:
Gamma Radiation
Survey Results for Site

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/2/2018
DOCUMENT NAME: Removal Site Evaluation Report
Stantec
AUTHOR: EDZ
REVIEWER: CBB
FIGURE: 4-1a

Document Path: \\corp.ads\data\Virtual Workspace\shared projects\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\Section4\RSE Mitten3 4 1a SiteGamma 11x17 L 20181001.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
- ⬚ Survey Area A
- 🟥 Claim Boundary

Gamma Survey

Counts per Minute (CPM)

- ● 4,266 - 12,847 (Minimum to BG-1 IL)
- ● 12,848 - 25,694 (>BG-1 IL to 2x BG-1 IL)
- ● 25,695 - 64,235 (>2x BG-1 IL to 5x BG-1 IL)
- ● 64,236 - 129,220 (>5x BG-1 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 10/2018.

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

N W E S

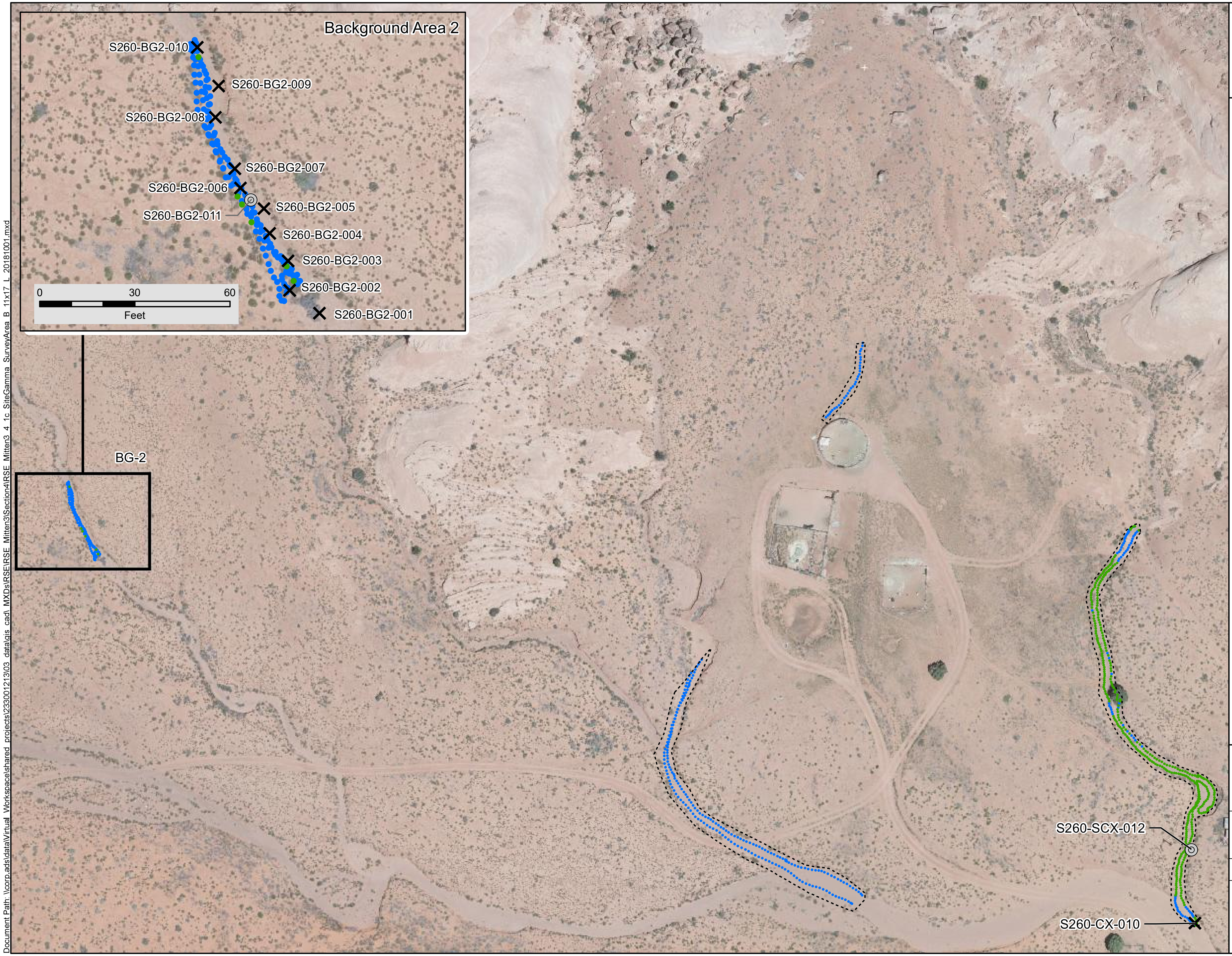
0 200 400
Feet

TITLE:
Gamma Radiation
Survey Results for
Survey Area A

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/2/2018	DOCUMENT NAME: Removal Site Evaluation Report
	AUTHOR: EDZ
	REVIEWER: CBB
	FIGURE: 4-1b

Stantec



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕ Surface Sample Location

◎ Borehole Location - Surface and Subsurface Samples

⬚ Survey Area B

Gamma Survey

Counts per Minute (CPM)

● 5,606 - 9,172 (Minimum to BG-2 IL)

● 9,173 - 13,241 (>BG-2 IL to Maximum)

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

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

N
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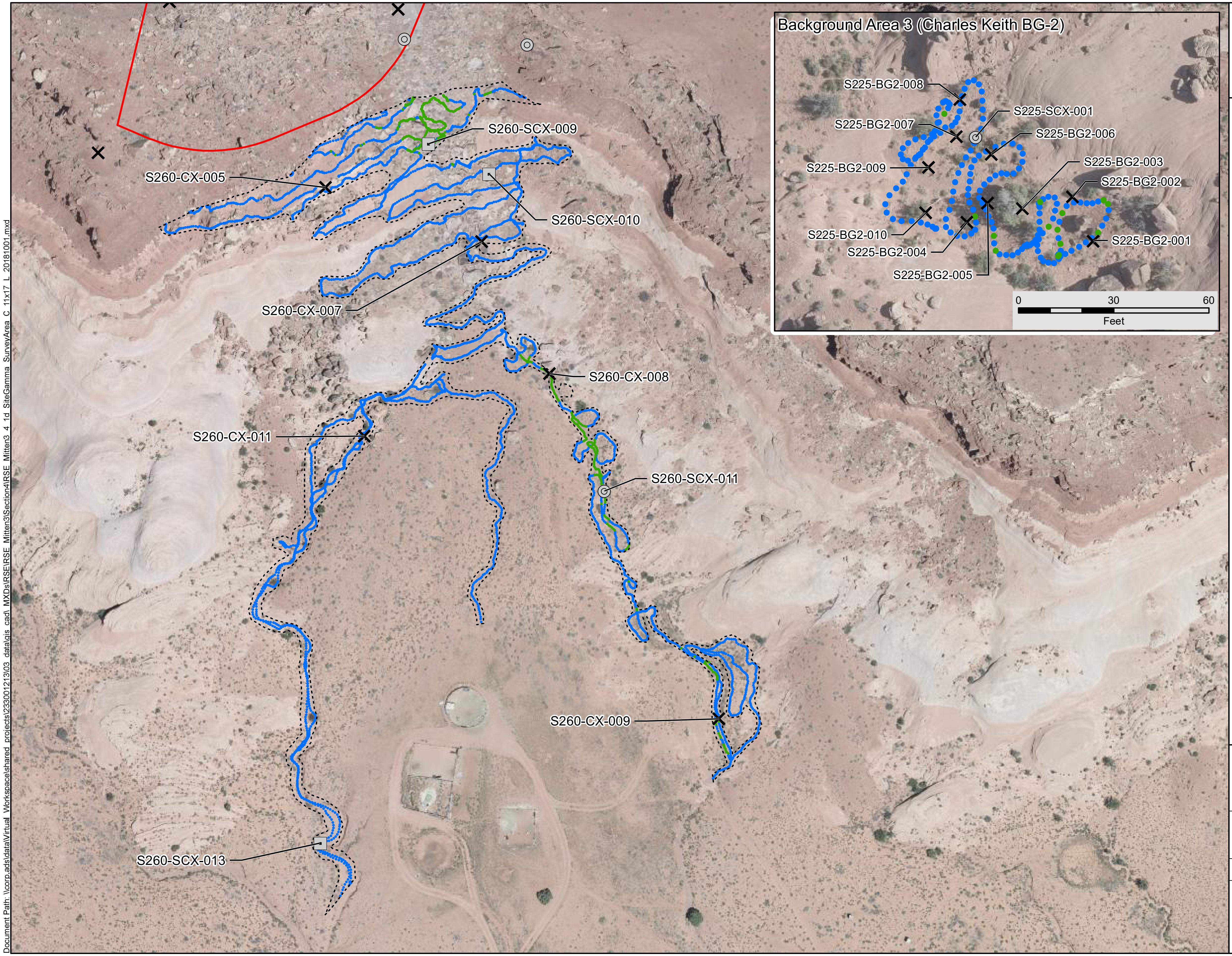
0 100 200
Feet

TITLE:
Gamma Radiation
Survey Results for
Survey Area B

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/2/2018	DOCUMENT NAME: Removal Site Evaluation Report
Stantec	AUTHOR: EDZ / REVIEWER: CBB
	FIGURE: 4-1c

Document Path: \\corp.ads\data\Virtual Workspace\shared projects\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\Section4\RSE Mitten3 4 1c SiteGamma SurveyArea B 11x17 L 20181001.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
- ⬚ Survey Area C
- 🟥 Claim Boundary

Gamma Survey

Counts per Minute (CPM)

- ● 4,973 - 11,220 (Minimum to CK-BG-2 IL)
- ● 11,221 - 20,919 (>CK-BG-2 IL to Maximum)

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

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

N
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0 120 240
Feet

TITLE:
Gamma Radiation
Survey Results for
Survey Area C

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/2/2018

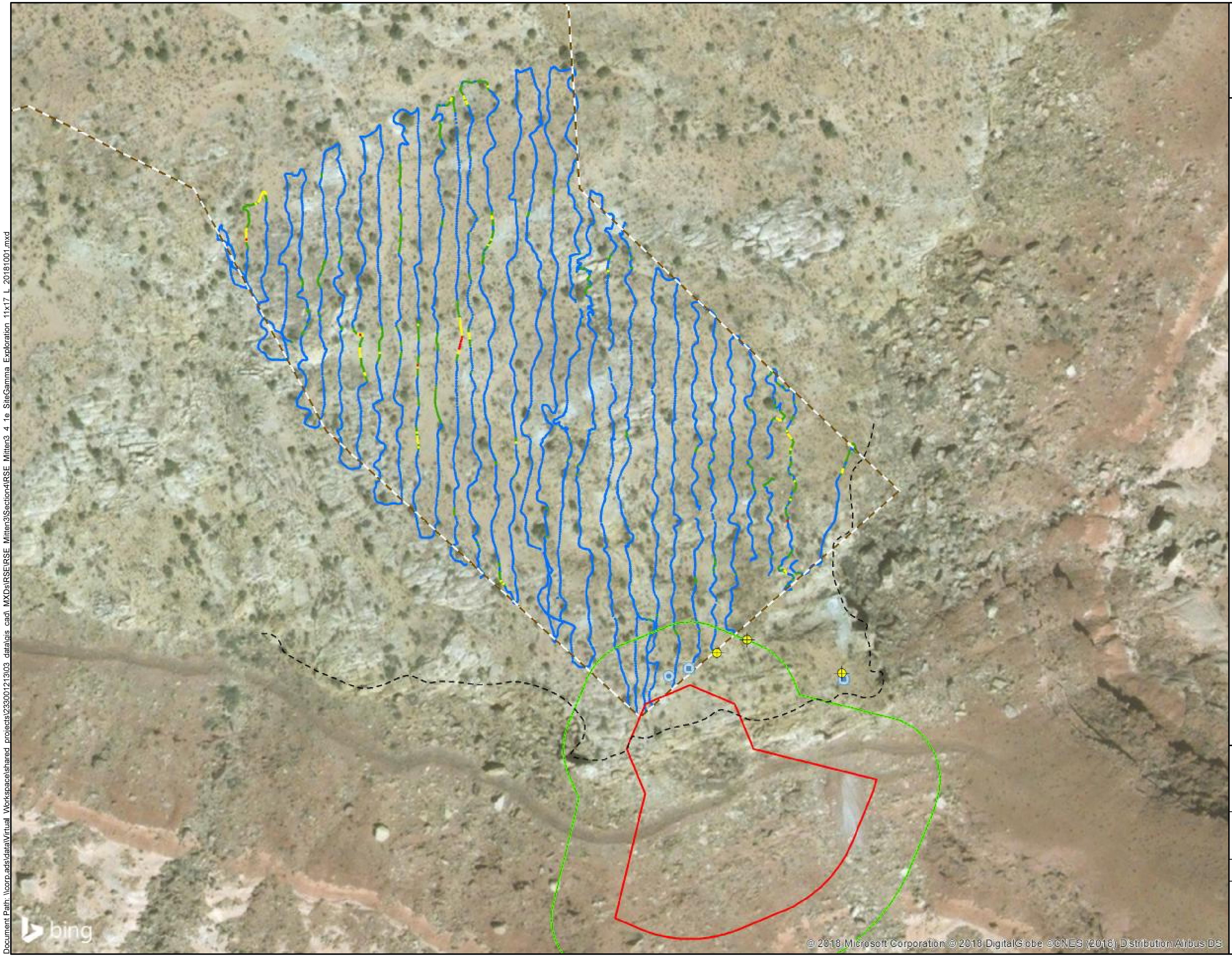
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-1d



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

- ⊕ Historical Borehole
- ◉ Historical Rock Core / Drill Cuttings
- ▣ Historical Metal Rods
- Approximate Edge of Mesa
- Exploration Area
- 🟥 Claim Boundary
- 🟩 100-Foot Claim Buffer

Gamma Survey

Counts per Minute (CPM)

- ● 3,950 - 9,172 (Minimum to BG-2 IL)
- ● 9,173 - 11,220 (>BG-2 IL to CK-BG-2 IL)
- ● 11,221 - 12,847 (>CK-BG-2-IL to BG-1 IL)
- ● 12,848 - 13,806 (>BG-1 IL to Maximum)

NOTE:
A segment of the exploration area on the mesa top was gamma surveyed at the request of the United States Environmental Protection Agency.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 10/2018.

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0 150 300
Feet

TITLE:
Exploration Area - Gamma Radiation Survey Results

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/2/2018

DOCUMENT NAME: Removal Site Evaluation Report

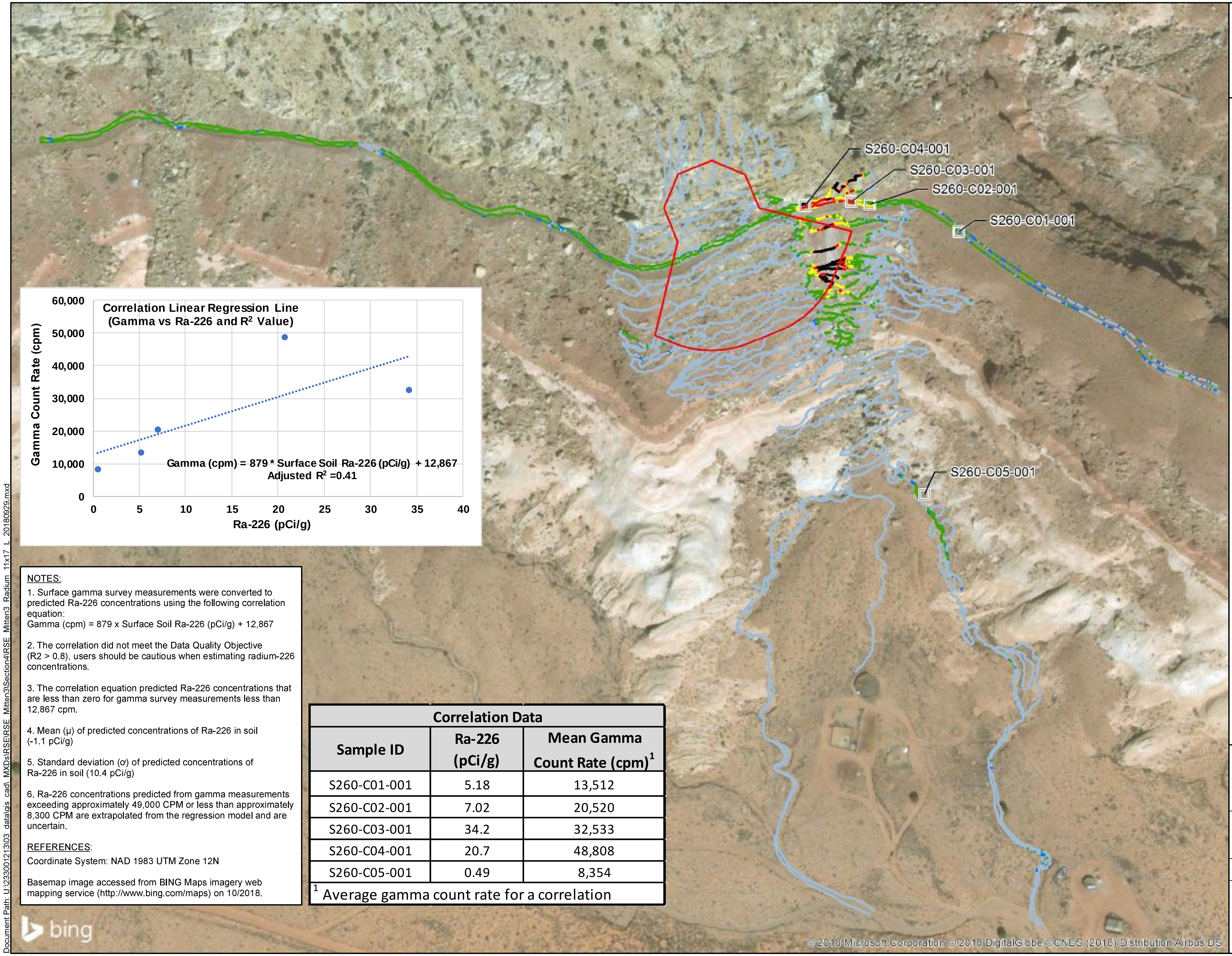
AUTHOR: CBB

REVIEWER: EDZ

Stantec

FIGURE: 4-1e

Document Path: \\corp.ads\data\Virtual_Workspace\shared_projects\233001213\03_data\gis_cad_MXDs\RSE\RSE_Mitten3\Section4\RSE_Mitten3_4_1e_SiteGamma_Exploration_11x17_L_20181001.mxd



NOTES:

1. Surface gamma survey measurements were converted to predicted Ra-226 concentrations using the following correlation equation:
Gamma (cpm) = 879 x Surface Soil Ra-226 (pCi/g) + 12,867

2. The correlation did not meet the Data Quality Objective ($R2 > 0.8$), users should be cautious when estimating radium-226 concentrations.

3. The correlation equation predicted Ra-226 concentrations that are less than zero for gamma survey measurements less than 12,867 cpm.

4. Mean (μ) of predicted concentrations of Ra-226 in soil (-1.1 pCi/g)

5. Standard deviation (σ) of predicted concentrations of Ra-226 in soil (10.4 pCi/g)

6. Ra-226 concentrations predicted from gamma measurements exceeding approximately 49,000 CPM or less than approximately 8,300 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 10/2018.

Correlation Data

Sample ID	Ra-226 (pCi/g)	Mean Gamma Count Rate (cpm)[1]
S260-C01-001	5.18	13,512
S260-C02-001	7.02	20,520
S260-C03-001	34.2	32,533
S260-C04-001	20.7	48,808
S260-C05-001	0.49	8,354

[1] Average gamma count rate for a correlation

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

☐	S260-C01-001 Correlation Location (30' x 30')
▭	Claim Boundary

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

●	-9.8 - -1.1 (μ)[3,4]
●	-1.0 - 0[3]
●	0 - 9.3 (μ + 1σ[5])
●	9.4 - 19.7 (μ + 2σ)
●	19.8- 30.1 (μ + 3σ)
●	30.2 - 132.4

N
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0 200 400
Feet

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

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/3/2018

DOCUMENT NAME: Removal Site Evaluation Report

AUTHOR: EDZ

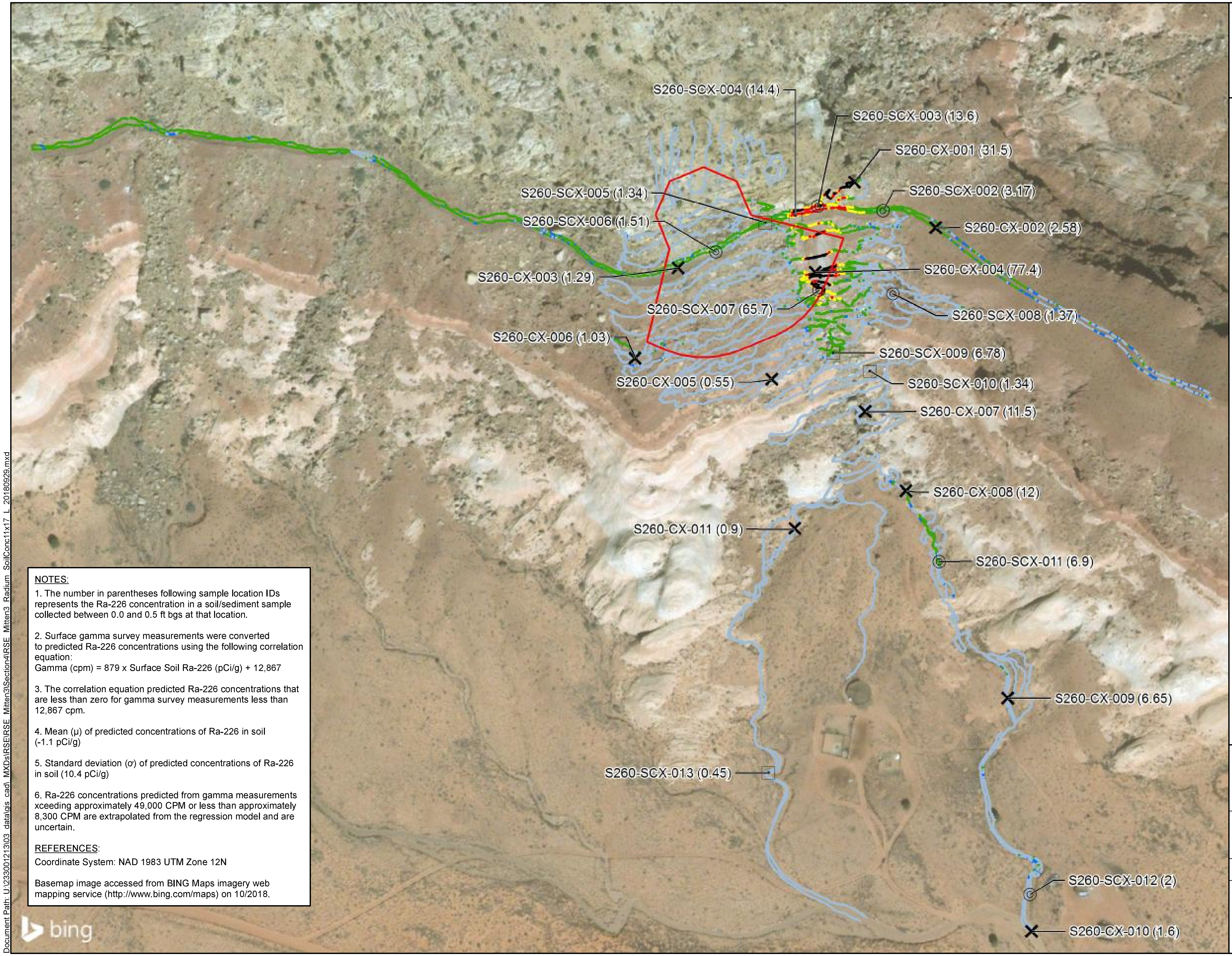
REVIEWER: CBB

Stantec

FIGURE: 4-2a

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE\RSE Mitten3\Section4\RSE Mitten3 Radium 11x17 L 20180929.mxd

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)

- ● -9.8 - -1.1 (μ)^{4,5}
- ● -1.0 - 0^4
- ● 0 - 9.3 (μ + 1σ^6)
- ● 9.4 - 19.7 (μ + 2σ)
- ● 19.8- 30.1 (μ + 3σ)
- ● 30.2 - 132.4

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) = 879 x Surface Soil Ra-226 (pCi/g) + 12,867

3. The correlation equation predicted Ra-226 concentrations that are less than zero for gamma survey measurements less than 12,867 cpm.

4. Mean (μ) of predicted concentrations of Ra-226 in soil (-1.1 pCi/g)

5. Standard deviation (σ) of predicted concentrations of Ra-226 in soil (10.4 pCi/g)

6. Ra-226 concentrations predicted from gamma measurements xceeding approximately 49,000 CPM or less than approximately 8,300 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 10/2018.

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

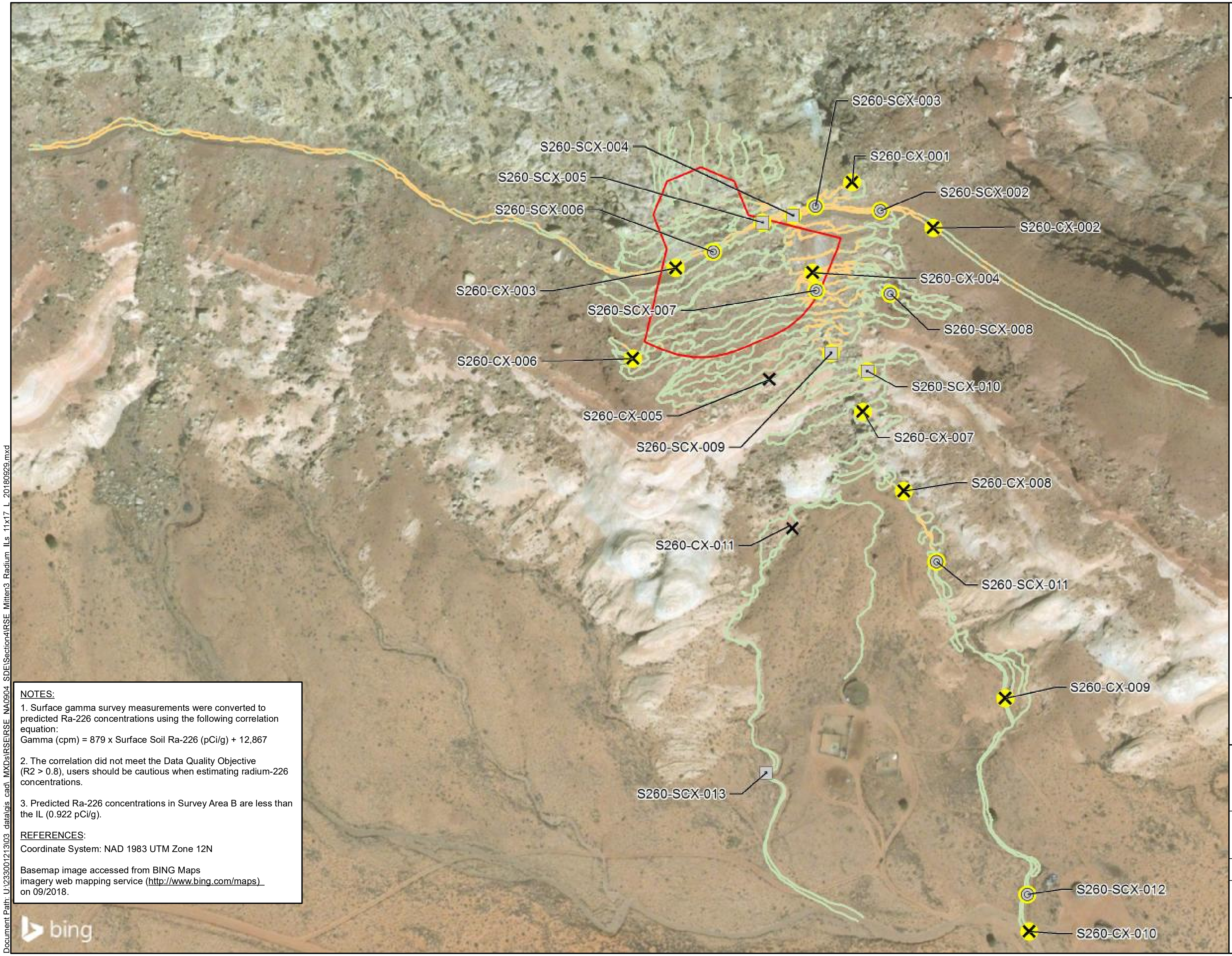
PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/3/2018
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ
REVIEWER: CBB
FIGURE: 4-2b

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\Section4\RSE Mitten3 Radium SoilConc11x17 L 20180929.mxd



NOTES:

1. Surface gamma survey measurements were converted to predicted Ra-226 concentrations using the following correlation equation:
Gamma (cpm) = 879 x Surface Soil Ra-226 (pCi/g) + 12,867

2. The correlation did not meet the Data Quality Objective (R2 > 0.8), users should be cautious when estimating radium-226 concentrations.

3. Predicted Ra-226 concentrations in Survey Area B are less than the IL (0.922 pCi/g).

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
- ● Ra-226 IL Exceedance in Surface Soil
- ☐ Claim Boundary

Predicted Ra-226
Concentrations (pCi/g)

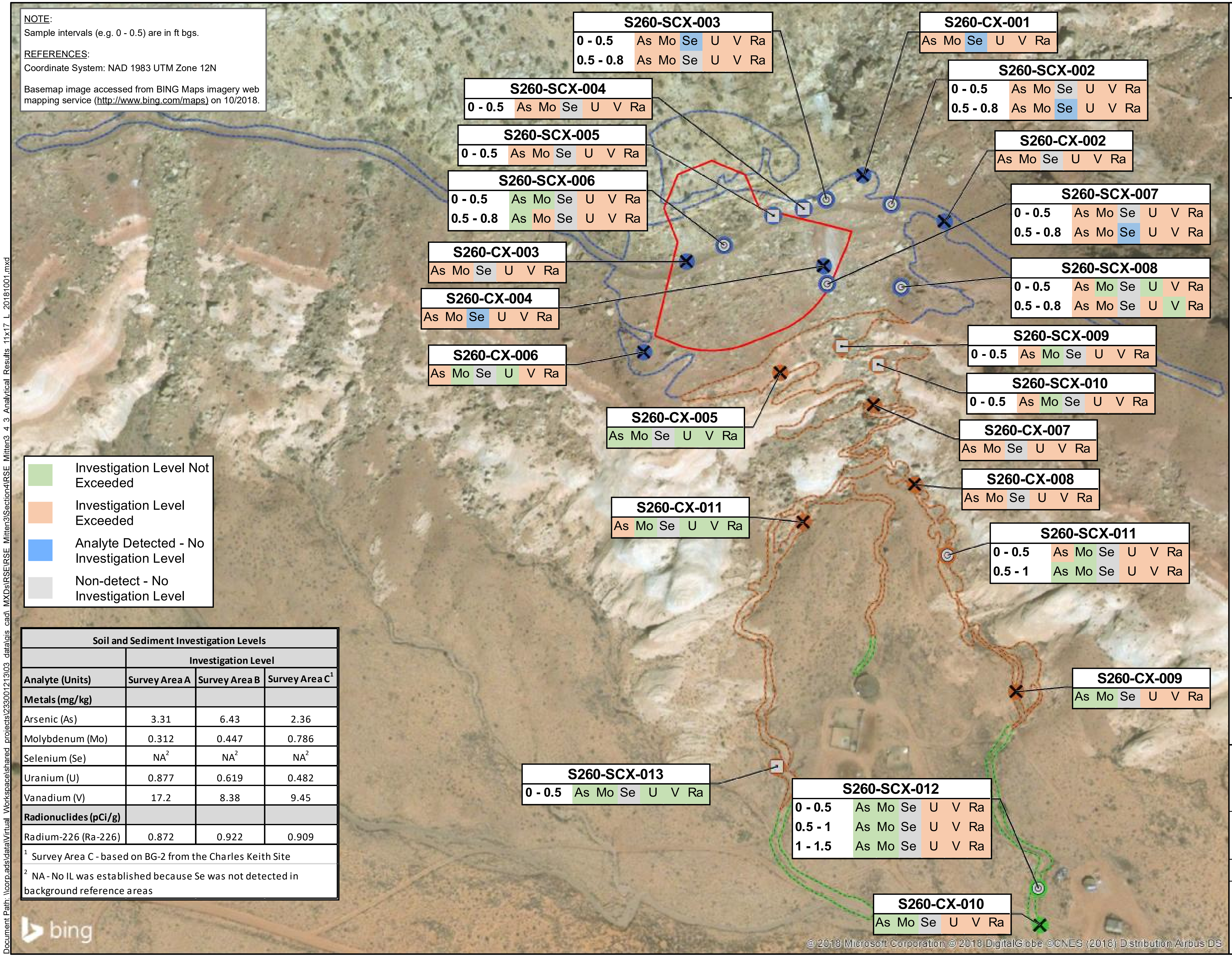
- ● IL Not Exceeded
  - Survey Area A: -9.8 - 0.872
  - Survey Area B: -8.3 - 0.4
  - Survey Area C: -9.0 - 0.909
- ● IL Exceeded
  - Survey Area A: 0.873 - 132.4
  - Survey Area B: N/A
  - Survey Area C: 0.910 - 9.2

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

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 9/29/2018	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 NA0904 SDE\Section4\RSE Mitten3 Radium ILs 11x17 L 20180929.mxd



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 10/2018.

🟩	Investigation Level Not Exceeded
🟧	Investigation Level Exceeded
🟦	Analyte Detected - No Investigation Level
⬜	Non-detect - No Investigation Level

Soil and Sediment Investigation Levels

	Investigation Level		
Analyte (Units)	**Survey Area A**	**Survey Area B**	**Survey Area C[1]**
Metals (mg/kg)			
Arsenic (As)	3.31	6.43	2.36
Molybdenum (Mo)	0.312	0.447	0.786
Selenium (Se)	NA[2]	NA[2]	NA[2]
Uranium (U)	0.877	0.619	0.482
Vanadium (V)	17.2	8.38	9.45
Radionuclides (pCi/g)			
Radium-226 (Ra-226)	0.872	0.922	0.909

[1] Survey Area C - based on BG-2 from the Charles Keith Site

[2] NA - No IL was established because Se was not detected in background reference areas

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

- Survery Area A - Surface Sample Location
- Survery Area A - Borehole Location - Surface and Subsurface Samples
- Survery Area A - Borehole Location - Surface Samples Only
- Survery Area B - Surface Sample Location
- Survery Area B - Borehole Location - Surface and Subsurface Samples
- Survery Area C - Surface Sample Location
- Survery Area C - Borehole Location - Surface and Subsurface Samples
- Survery Area C - Borehole Location - Surface Samples Only
- Claim Boundary
- Survery Area A
- Survery Area B
- Survery Area C

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

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/2/2018

DOCUMENT NAME: Removal Site Evaluation Report

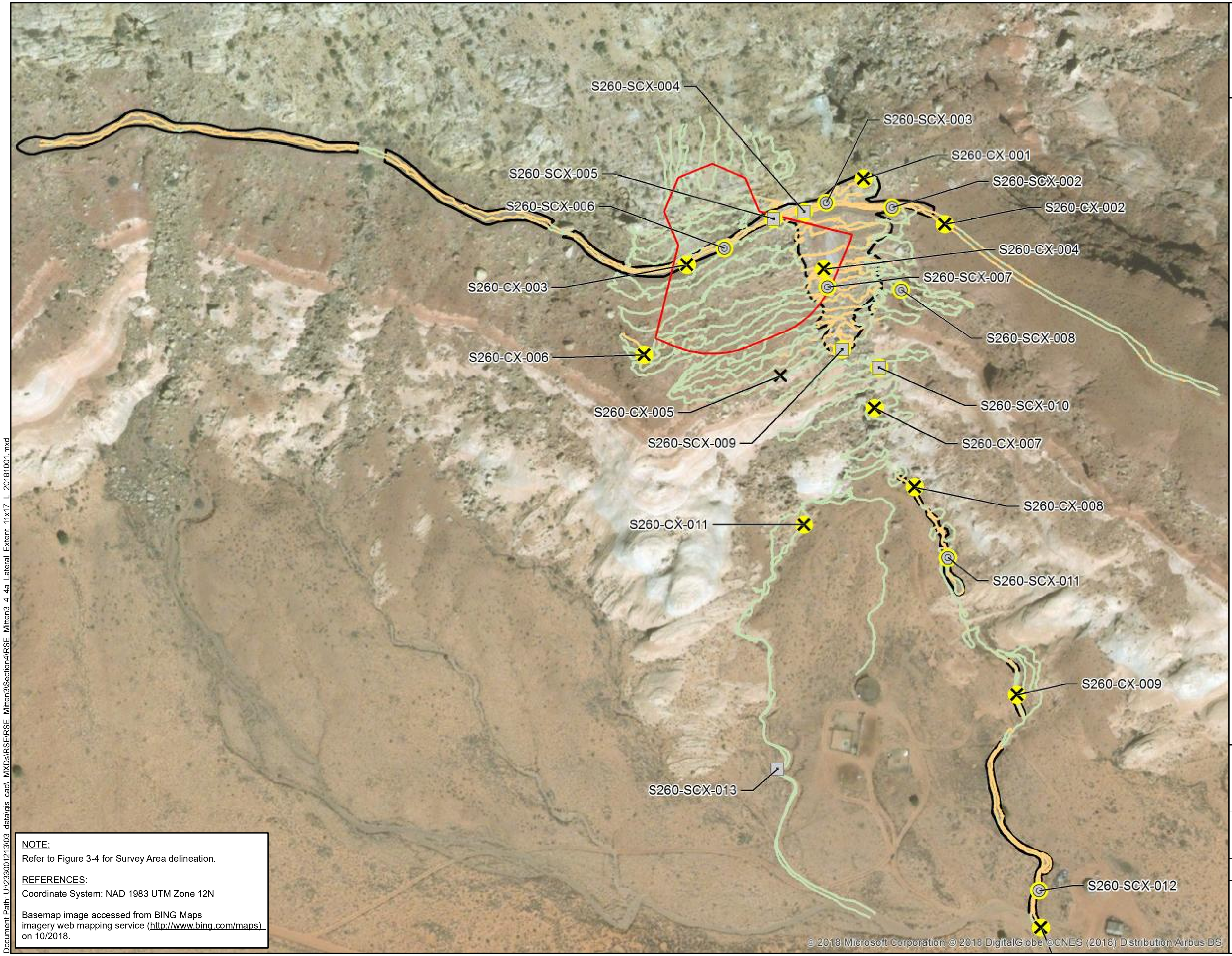
Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-3

Document Path: \\corp.ads\data\Virtual Workspace\shared projects\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\Section4\RSE Mitten3 4 3 Analytical Results 11x17 L 20181001.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 10/2018.

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\Section4\RSE Mitten3 4 4a Lateral Extent 11x17 L 20181001.mxd

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
▣	Borehole Location - Surface Samples Only
●	IL Exceedance in Unconsolidated Material Location
▭	Claim Boundary
▢	Approximate Area where Surface Gamma IL is Exceeded (2.4 acres)

Gamma Survey
Counts per Minute (CPM)

●	IL Not Exceeded Survey Area A: 4,266 - 12,847 Survey Area B: 5,606 - 9,172 Survey Area C: 4,973 - 11,220
●	IL Exceeded Survey Area A: 12,848 - 129,220 Survey Area B: 9,173 - 13,241 Survey Area C: 11,221 - 20,919

N
W E
S

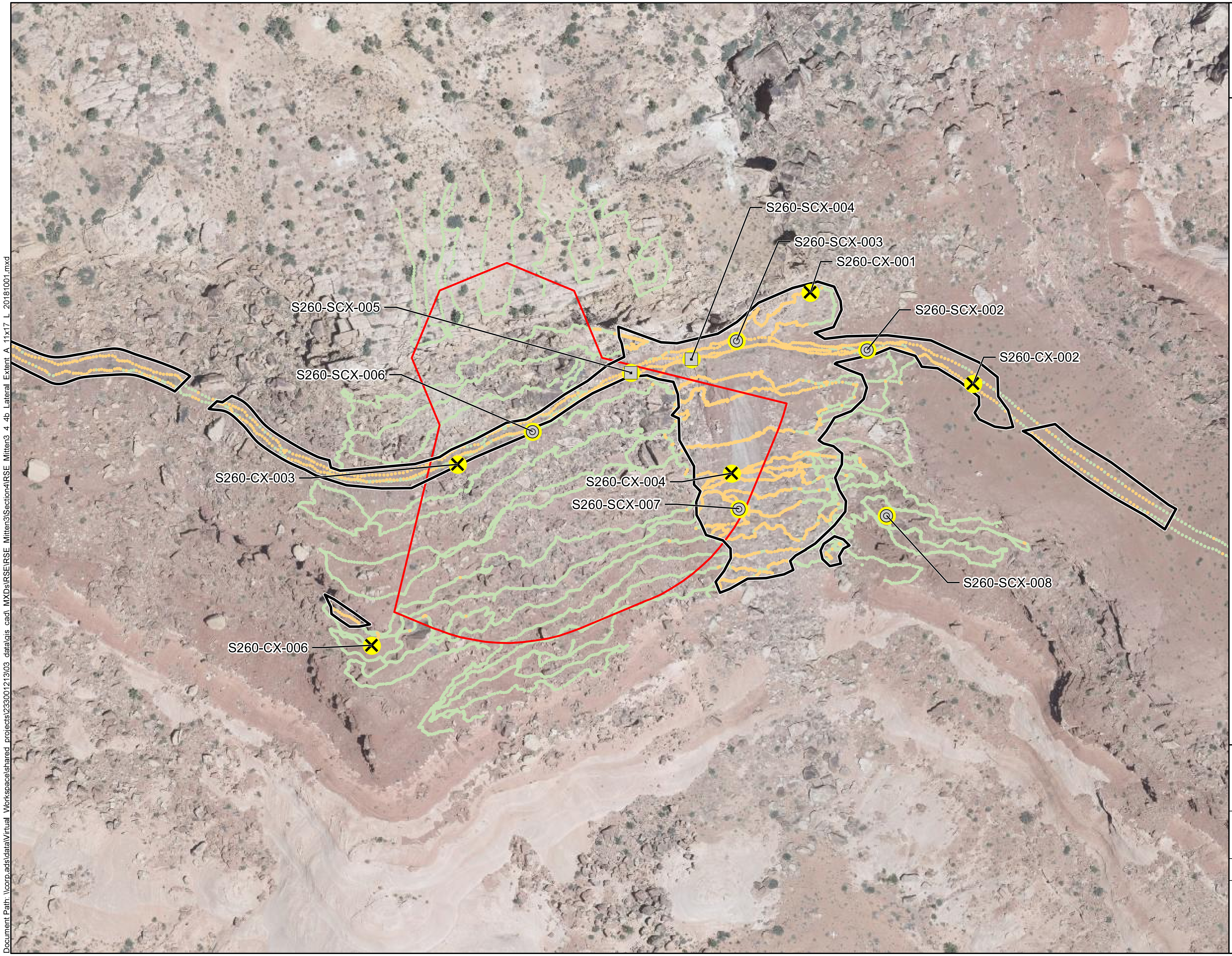
0 200 400
Feet

TITLE:
Lateral Extent of Surface and Subsurface IL Exceedances

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/3/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: EDZ
REVIEWER: CBB
FIGURE: 4-4a

Stantec



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
▣	Borehole Location - Surface Samples Only
●	IL Exceedance in Unconsolidated Material Location
▢	Approximate Area where Surface Gamma IL is Exceeded (2.1 acres)
🟥	Claim Boundary

Gamma Survey

Counts per Minute (CPM)

●	4,266 - 12,847 (IL Not Exceeded)
●	12,848 - 129,220 (IL Exceeded)

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

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

N
W E
S

0 100 200
Feet

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

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/2/2018

DOCUMENT NAME: Removal Site Evaluation Report

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-4b

Stantec

Document Path: \\corp.ads\data\Virtual Workspace\shared projects\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\Section4\RSE Mitten3 4 4b Lateral Extent A 11x17 L 20181001.mxd

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

✕ Surface Sample Location

◎ Borehole Location - Surface and Subsurface Samples

● IL Exceedance in Unconsolidated Material Location

▢ Approximate Area where Surface Gamma IL is Exceeded (0.1 acres)

Gamma Survey

Counts per Minute (CPM)

● 5,606 - 9,172 (IL Not Exceeded)

● 9,173 - 13,241 (IL Exceeded)

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

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

N
W E
S

0 100 200
Feet

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

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/2/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

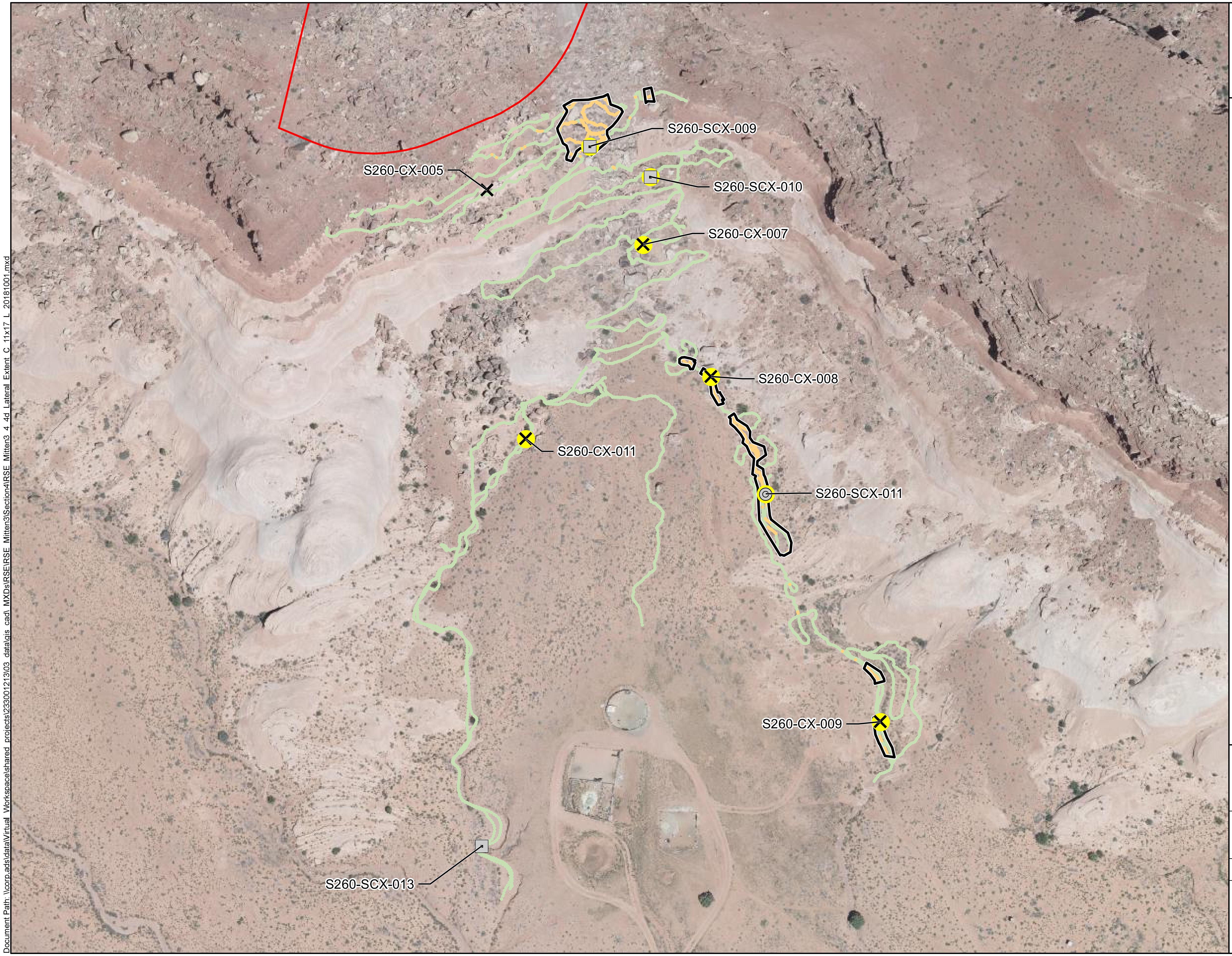
AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-4c

Document Path: \\corp.ads\data\Virtual Workspace\shared projects\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\Section4\RSE Mitten3 4 4c Lateral Extent B 11x17 L 20181001.mxd

Document Path: \\corp.ads\data\Virtual Workspace\shared projects\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\Section4\RSE Mitten3 4 4d Lateral Extent C 11x17 L 20181001.mxd



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
▣	Borehole Location - Surface Samples Only
●	IL Exceedance in Unconsolidated Material Location
▢	Approximate Area where Surface Gamma IL is Exceeded (0.2 acres)
🟥	Claim Boundary

Gamma Survey

Counts per Minute (CPM)

●	4,973 - 11,220 (IL Not Exceeded)
●	11,221 - 20,919 (IL Exceeded)

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

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

N
W E
S

0 120 240
Feet

TITLE:

Survey Area C
Lateral Extent of Surface and Subsurface IL Exceedances

PROJECT:

Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/2/2018

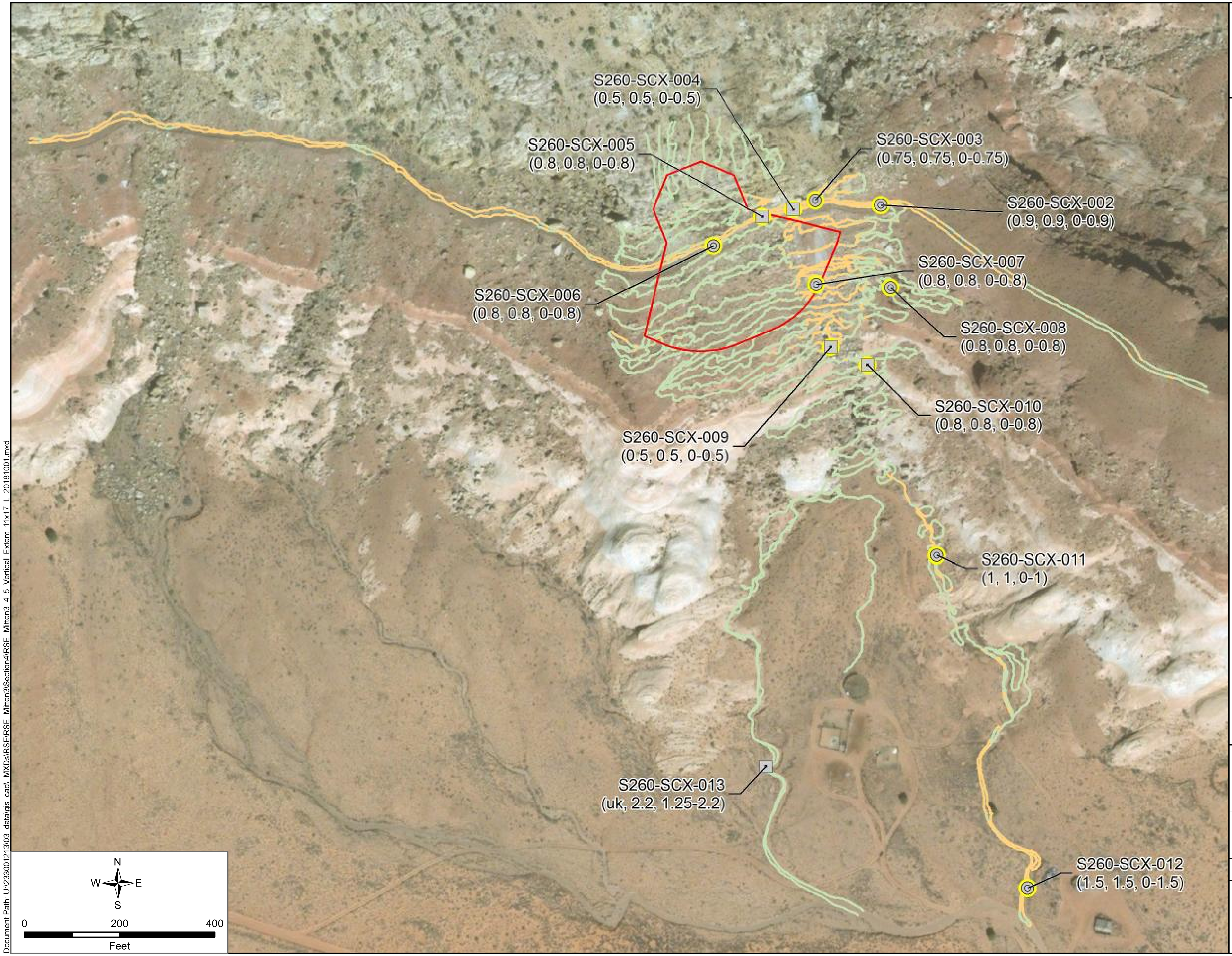
DOCUMENT NAME: Removal Site Evaluation Report

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-4d

Stantec



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

S260-SCX-011 (1, 1, 0-1) Sample ID (Depth of Bedrock, Borehole Depth, Depth Range of IL Exceedance in Unconsolidated Material or Depth of Gamma IL Exceedance in Unconsolidated Material)

◎ Borehole Location - Surface and Subsurface Samples

▣ Borehole Location - Surface Samples Only

● IL Exceedance in Unconsolidated Material Location

▭ Claim Boundary

Gamma Survey

Counts per Minute (CPM)

● IL Not Exceeded
Survey Area A: 4,266 - 12,847
Survey Area B: 5,606 - 9,172
Survey Area C: 4,973 - 11,220

● IL Exceeded
Survey Area A: 12,848 - 129,220
Survey Area B: 9,173 - 13,241
Survey Area C: 11,221 - 20,919

NOTES:

1. Range of Investigation Level (IL) Exceedance in unconsolidated materiall selected based on unconsolidated material analytical results,subsurface gamma measurements, and subsurface observations.

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

3. 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 10/2018.

TITLE:

Vertical Extent of IL Exceedances in Unconsolidated Material

PROJECT:

Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/3/2018

DOCUMENT NAME: Removal Site Evaluation Report

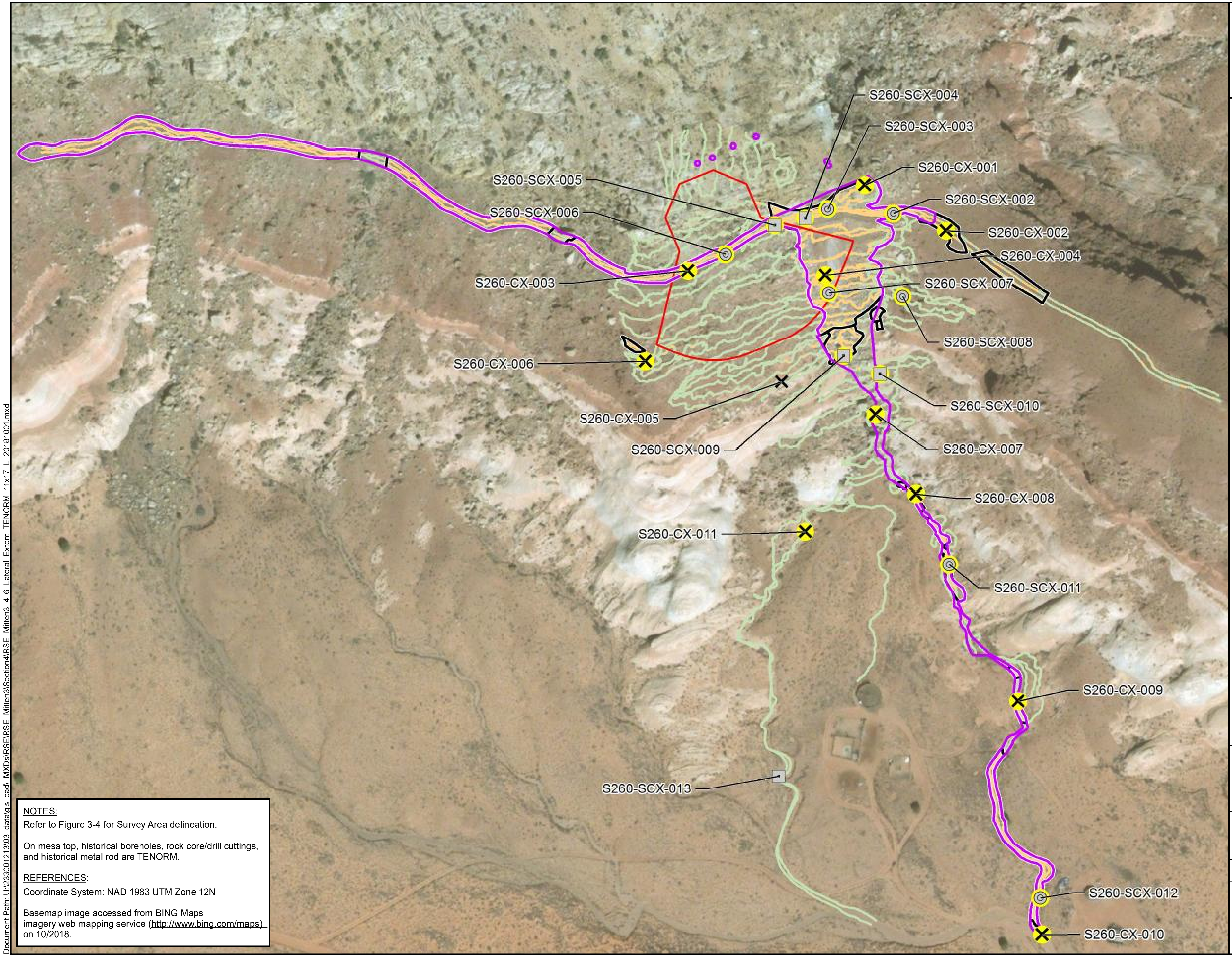
AUTHOR: EDZ

REVIEWER: CBB

Stantec

FIGURE: 4-5

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_Mitten3\Section4\RSE_Mitten3_4_5_Vertical_Extent_11x17_L_20181001.mxd



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

On mesa top, historical boreholes, rock core/drill cuttings, and historical metal rod are TENORM.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap imagery accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 10/2018.

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\Section4\RSE Mitten3 4 6 Lateral Extent TENORM 11x17 L 20181001.mxd

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
▣	Borehole Location - Surface Samples Only
●	IL Exceedance in Unconsolidated Material Location
▢	TENORM (2.7 acres)
▢	Approximate Area where Surface Gamma IL is Exceeded (2.4 acres)
▢	Claim Boundary

Gamma Survey

Counts per Minute (CPM)

●	IL Not Exceeded Survey Area A: 4,266 - 12,847 Survey Area B: 5,606 - 9,172 Survey Area C: 4,973 - 11,220
●	IL Exceeded Survey Area A: 12,848 - 129,220 Survey Area B: 9,173 - 13,241 Survey Area C: 11,221 - 20,919

N
W E
S

0 200 400
Feet

TITLE:
TENORM Compared to
Lateral Extent of IL Exceedances

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/3/2018

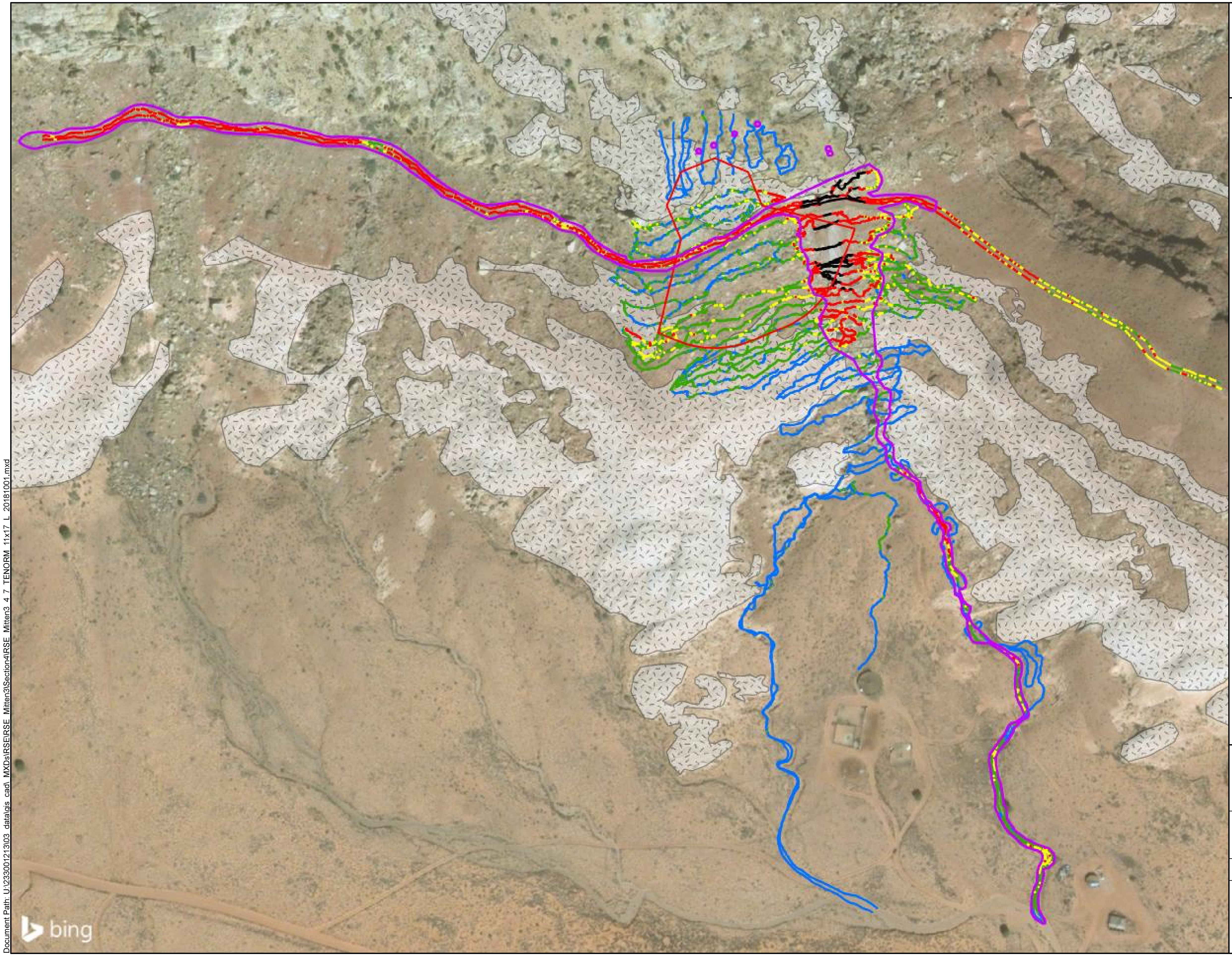
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-6



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

- TENORM (2.7 acres)
- Claim Boundary
- Exposed Bedrock¹

Gamma Survey

Counts per Minute (CPM)

- ● 4,266 - 9,172 (Minimum to BG-2 IL)
- ● 9,173 - 11,220 (>BG-2 IL to CK-BG-2 IL)
- ● 11,221 - 12,847 (>CK-BG-2 IL to BG-1 IL)
- ● 12,848 - 25,696 (>BG-1 IL to 2x BG-1 IL)
- ● 25,697 - 129,220 (>2x BG-1 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 10/2018.

N
W E
S

0 200 400
Feet

TITLE:
TENORM Compared to Gamma Radiation Survey Results

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/3/2018

DOCUMENT NAME: Removal Site Evaluation Report

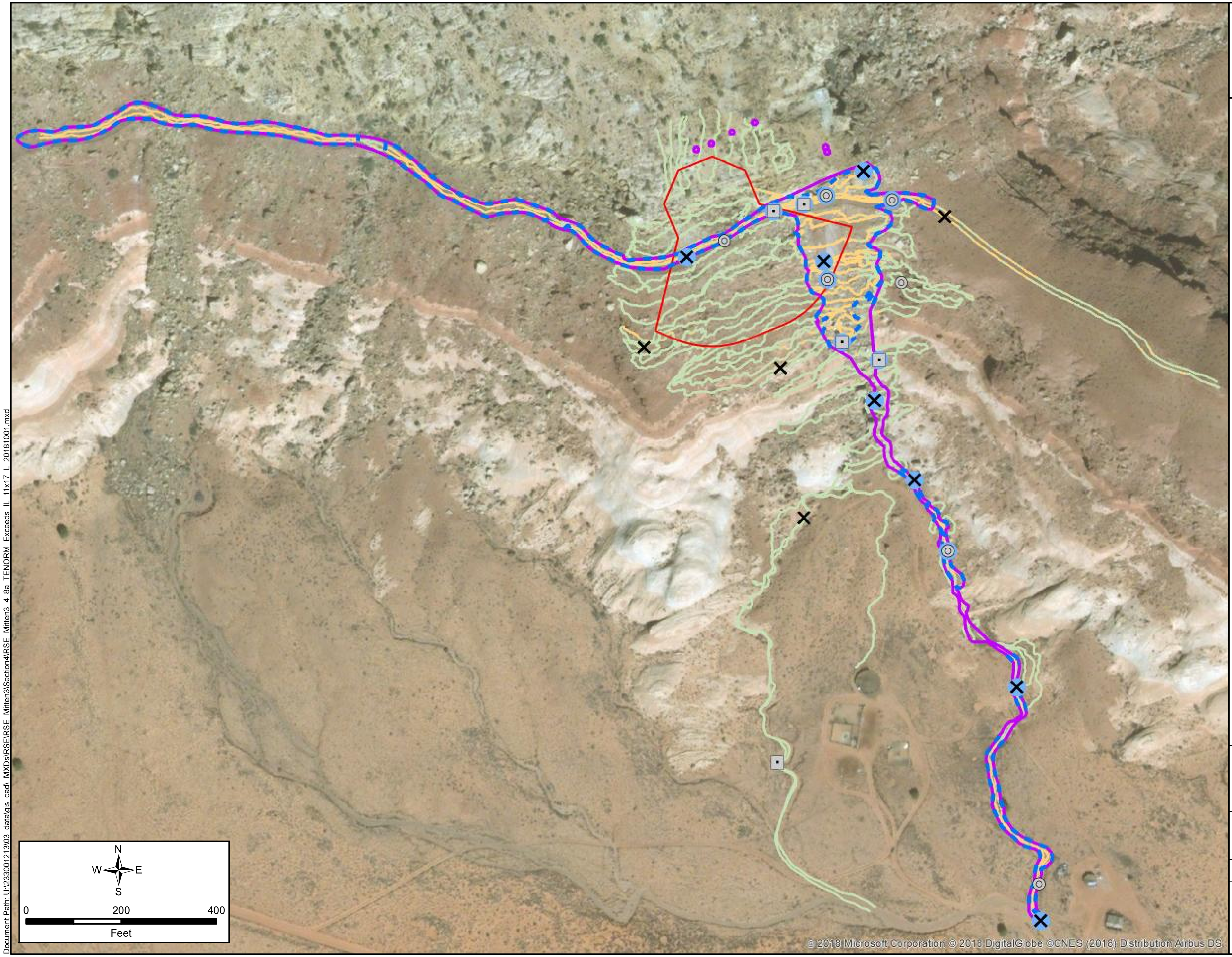
Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-7

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\Section4\RSE Mitten3 4 7 TENORM 11x17 L 20181001.mxd



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

×	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
▣	Borehole Location - Surface Samples Only
●	TENORM Exceeding IL in Unconsolidated Material at Location
⬚	TENORM Area Exceeding Surface Gamma ILs (2.2 acres)
⬚	TENORM (2.7 acres)
⬚	Claim Boundary

Gamma Survey

Counts per Minute (CPM)

●	IL Not Exceeded Survey Area A: 4,266 - 12,847 Survey Area B: 5,606 - 9,172 Survey Area C: 4,973 - 11,220
●	IL Exceeded Survey Area A: 12,848 - 129,220 Survey Area B: 9,173 - 13,241 Survey Area C: 11,221 - 20,919

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 10/2018.

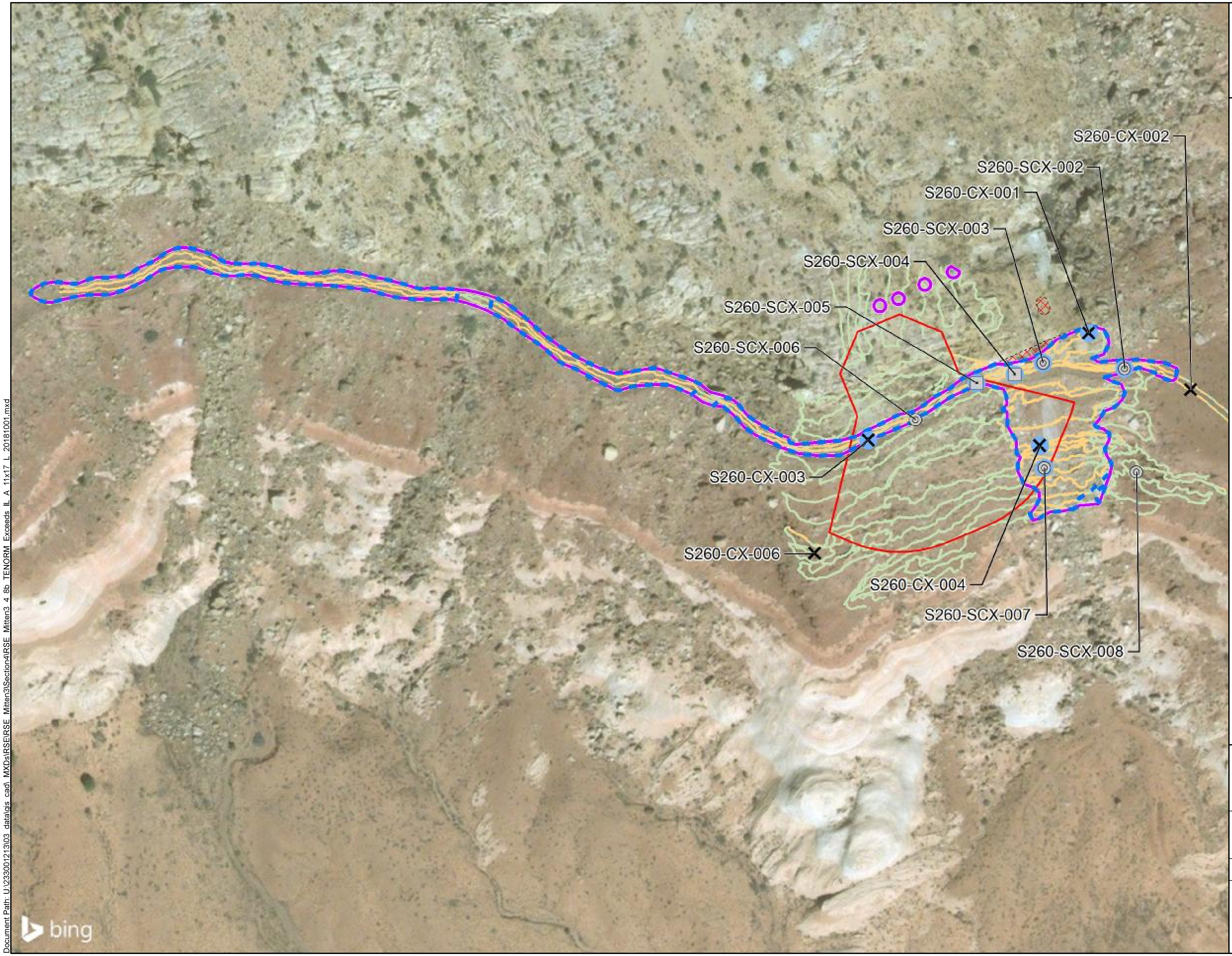
TITLE:
TENORM that Exceeds ILs

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/1/2018
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 Mitten3\Section4\RSE Mitten3 4 8a TENORM Exceeds IL 11x17 L 20181001.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
▣	Borehole Location - Surface Samples Only
●	TENORM Exceeding IL in Unconsolidated Material at Location
⬚	TENORM Area Exceeding Surface Gamma ILs (1.9 acres)
▢	TENORM (2.0 acres)
▨	TENORM Unsurveyed (< 0.1 acres)
▢	Claim Boundary

Gamma Survey [1]

Counts per Minute (CPM)

●	4,266 - 12,847 (IL Not Exceeded)
●	12,848 - 129,220 (IL Exceeded)

NOTE:

1. Gamma Survey Area A is Approximataly 6.7 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 10/2018.

N
W E
S

0 160 320
Feet

TITLE:

TENORM that Exceeds ILs
for Survey Area A

PROJECT:

Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/3/2018

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 Mitten3\Section4\RSE Mitten3 4 8b TENORM Exceeds IL A 11x17 L 20181001.mxd

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕ Surface Sample Location

◎ Borehole Location - Surface and Subsurface Samples

● TENORM Exceeding IL in Unconsolidated Material at Location

▭ TENORM Area Exceeding Surface Gamma ILs (0.1 acres)

▭ TENORM (0.2 acres)

Gamma Survey [1]

Counts per Minute (CPM)

● 5,606 - 9,172 (IL Not Exceeded)

● 9,173 - 13,241 (IL Exceeded)

NOTE:

1. Gamma Survey Area B is Approximataly 0.4 acres

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

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

N
W E
S

0 100 200
Feet

TITLE:

TENORM that Exceeds ILs
for Survey Area B

PROJECT:

Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/3/2018

DOCUMENT NAME: Removal Site Evaluation Report

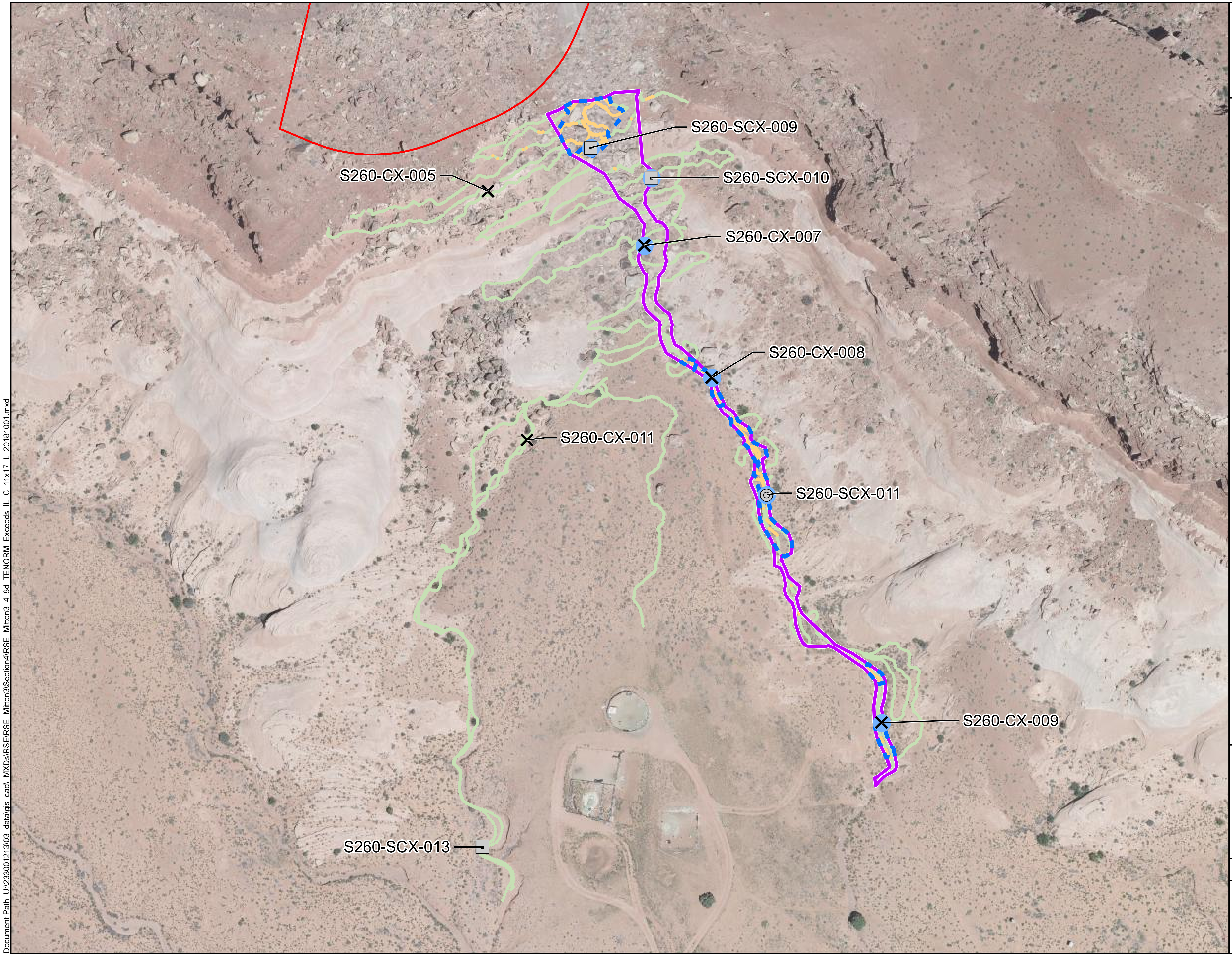
Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-8c

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\Section4\RSE Mitten3 4 8c TENORM Exceeds IL B 11x17 L 20181001.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
- ● TENORM Exceeding IL in Unconsolidated Material at Location
- ⬚ TENORM Area Exceeding Surface Gamma ILs (0.2 acres)
- ⬚ TENORM (0.5 acres)
- ⬚ Claim Boundary

Gamma Survey [1]

Counts per Minute (CPM)

- ● 4,973 - 11,220 (IL Not Exceeded)
- ● 11,221 - 20,919 (IL Exceeded)

NOTE:

1. Gamma Survey Area C is Approximataly 2.1 acres

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

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

N
W E
S

0 120 240
Feet

TITLE:
TENORM that Exceeds ILs
for Survey Area C

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/3/2018

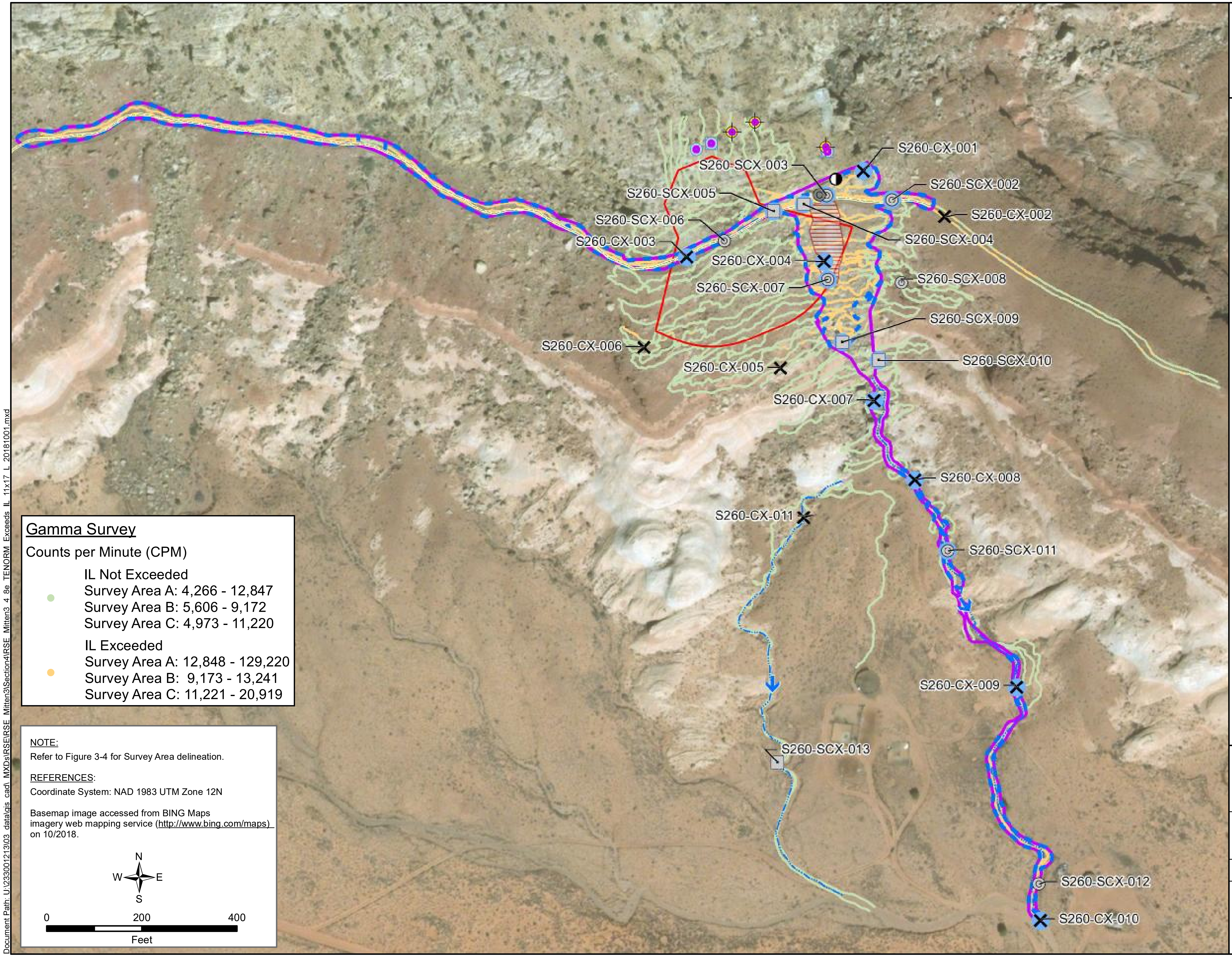
DOCUMENT NAME: Removal Site Evaluation Report

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-8d

Stantec



Gamma Survey

Counts per Minute (CPM)

● IL Not Exceeded
Survey Area A: 4,266 - 12,847
Survey Area B: 5,606 - 9,172
Survey Area C: 4,973 - 11,220

● IL Exceeded
Survey Area A: 12,848 - 129,220
Survey Area B: 9,173 - 13,241
Survey Area C: 11,221 - 20,919

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 10/2018.

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

- ⊕ Historical Borehole
- ◉ Historical Rock Core / Drill Cuttings
- ▣ Historical Metal Rods
- ◉ Approximate Reclaimed Portal Location
- ◑ Prospect Portal
- ✕ Surface Sample Location
- ◎ Borehole Location - Surface and Subsurface Samples
- ▪ Borehole Location - Surface Samples Only
- ● TENORM Exceeding IL in Unconsolidated Material at Location
- ↑ Flow Direction
- Drainage
- Potential Haul Road
- ▤ Waste Pile
- TENORM Area Exceeding Surface Gamma ILs (2.2 acres)
- TENORM (2.7 acres)
- Claim Boundary

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

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/4/2018

DOCUMENT NAME: Removal Site Evaluation Report

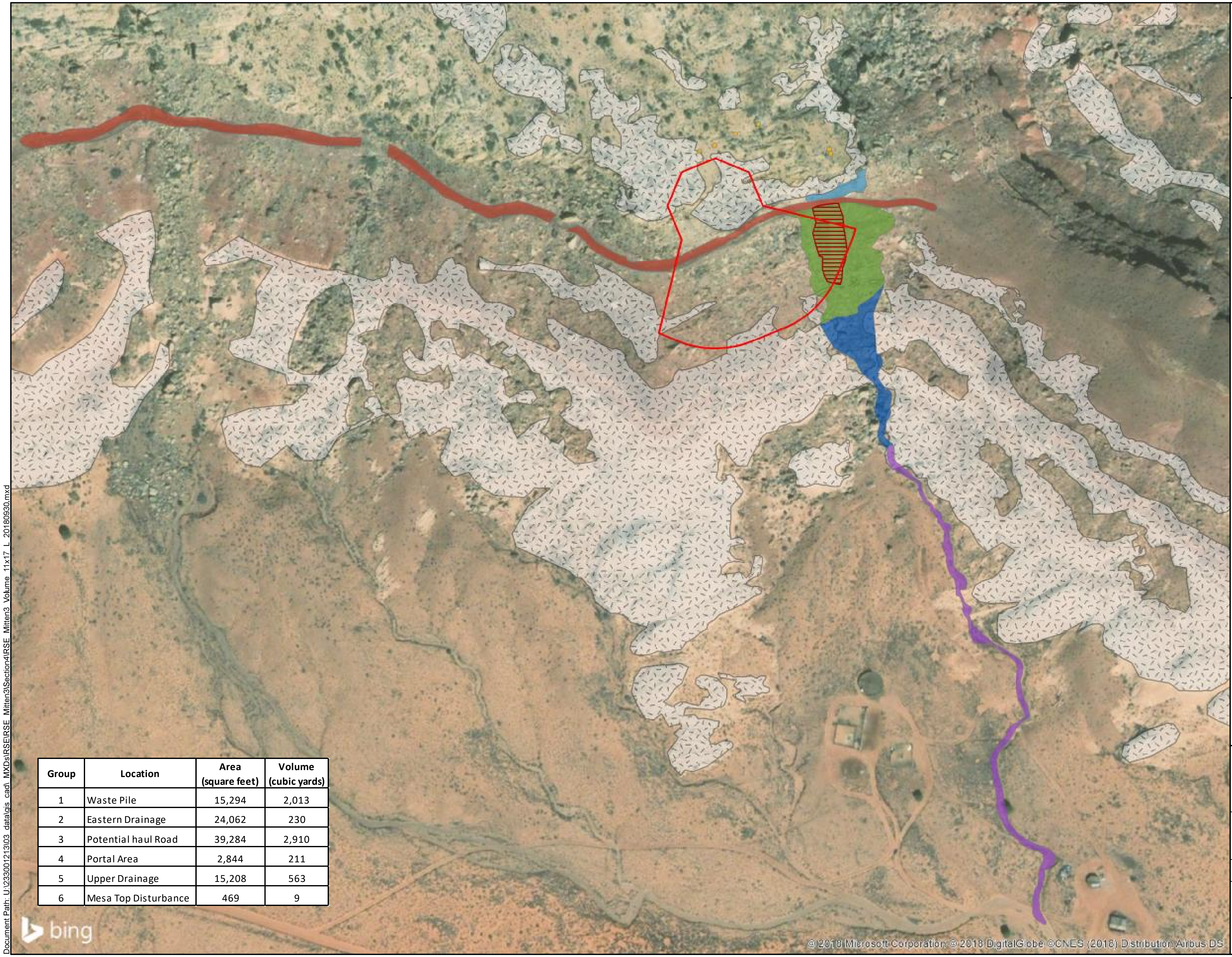
Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-8e

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\Section4\RSE Mitten3 4 8e TENORM Exceeds IL 11x17 L 20181001.mxd



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Group	Location	Area (square feet)	Volume (cubic yards)
1	Waste Pile	15,294	2,013
2	Eastern Drainage	24,062	230
3	Potential haul Road	39,284	2,910
4	Portal Area	2,844	211
5	Upper Drainage	15,208	563
6	Mesa Top Disturbance	469	9

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

- ▤ Waste Pile
- ▨ Exposed Bedrock[1]
- ▭ Claim Boundary

Average Depth by Group (feet below ground surface)

- 🟩 Group 1 - Variable[2]
- 🟪 Group 2 - Variable
- 🟥 Group 3 - 2.0 ft
- 🟦 Group 4 - 2.0 ft
- 🟦 Group 5 - 1.0 ft
- 🟨 Group 6 - 0.5 ft

NOTES:

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

2. A volume estimate was calculated for potential TENORM on the mesa top (Group 6). It is uncertain whether TENORM exceeded ILs on the mesa top because a background reference area was not established for that area.

3. See Figure 4-9b

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from BING Maps imagery web mapping service (http://www.bing.com/maps) on 10/2018.

TITLE:
Volume Estimate of
TENORM that Exceeds ILs

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 10/17/2018
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ
REVIEWER: CBB
FIGURE: 4-9a

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\Section4\RSE Mitten3 Volume 11x17 L 20180930.mxd

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

Approximate Contour (thickness in feet)

🟥 Claim Boundary

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:
Groups 1 and 4
Contours for Volume Estimates

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 9/30/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: 4-9b

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE\RSE Mitten3\Section4\RSE Mitten3 Volume WP Contours 11x17 L 20180930.mxd

APPENDICES

Appendix A Radiological Characterization of the Mitten No.3 Abandoned Uranium Mine

Radiological Characterization of the Mitten No. 3 Abandoned Uranium Mine

September 18, 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

Contents

Tables

Figures

Appendices

Acronyms

AUM	abandoned uranium mine
BG1	Background Reference Area 1
BG2	Background Reference Area 2
CK-BG2	Charles Keith Background Reference Area 2
cpm	counts per minute
DQOs	data quality objectives
EPA	U.S. Environmental Protection Agency
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 Mitten No. 3 abandoned uranium mine (AUM) located in the Oljato Chapter of the Navajo Nation in Monument Valley, Utah. 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) in accordance with the Navajo Nation AUM Environmental Response Trust – First Phase.

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 field activities addressed in this report were conducted on May 4 and October 28, 29, and 31, 2016; and May 23, 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; 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 "Mitten No. 3 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 count rates were observed largely on waste piles extending away from a portal in the mine claim.
- Three 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) = 879 x [radium-226 (pCi/g)] + 12867

- 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 -9.8 to 132.4 pCi/g, with a central tendency (median) of -3.4 pCi/g.

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

- There is no evidence of equilibrium (secular or otherwise) among the uranium decay series radionuclides.

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

  Exposure Rate (microRoentgens per hour [μR/h]) = Gamma Count Rate (cpm) x $5\text{x}10^{-4}$ + 6.1119

- The distribution of exposure rates predicted using this model is rightward tailed. The values in the Survey Area range from 8.3 to 70.7, with a central tendency (median) of 11.0 μR/h.

1.0 Introduction

This report addresses the radiological characterization of the Mitten No. 3 abandoned uranium mine (AUM) located in the Oljato Chapter of the Navajo Nation in Monument Valley, Utah. 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) in accordance with 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 addressed in this report were conducted on May 4 and October 28, 29, and 31, 2016; and May 23, 2017. They included a GPS-based radiological survey of land surfaces over an approximately 9-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; 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 “Mitten No. 3 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 “Mitten No. 3 Removal Site Evaluation Report” (Stantec, 2018).

2.0 GPS-Based Gamma Surveys

This section addresses the GPS-based surveys conducted in three 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 Work Plan.

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	254772
	PR320678	282971
Survey Area	PR154615[a]	138368[a]
	PR303727	254772
	PR295014	196086

Notes:

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

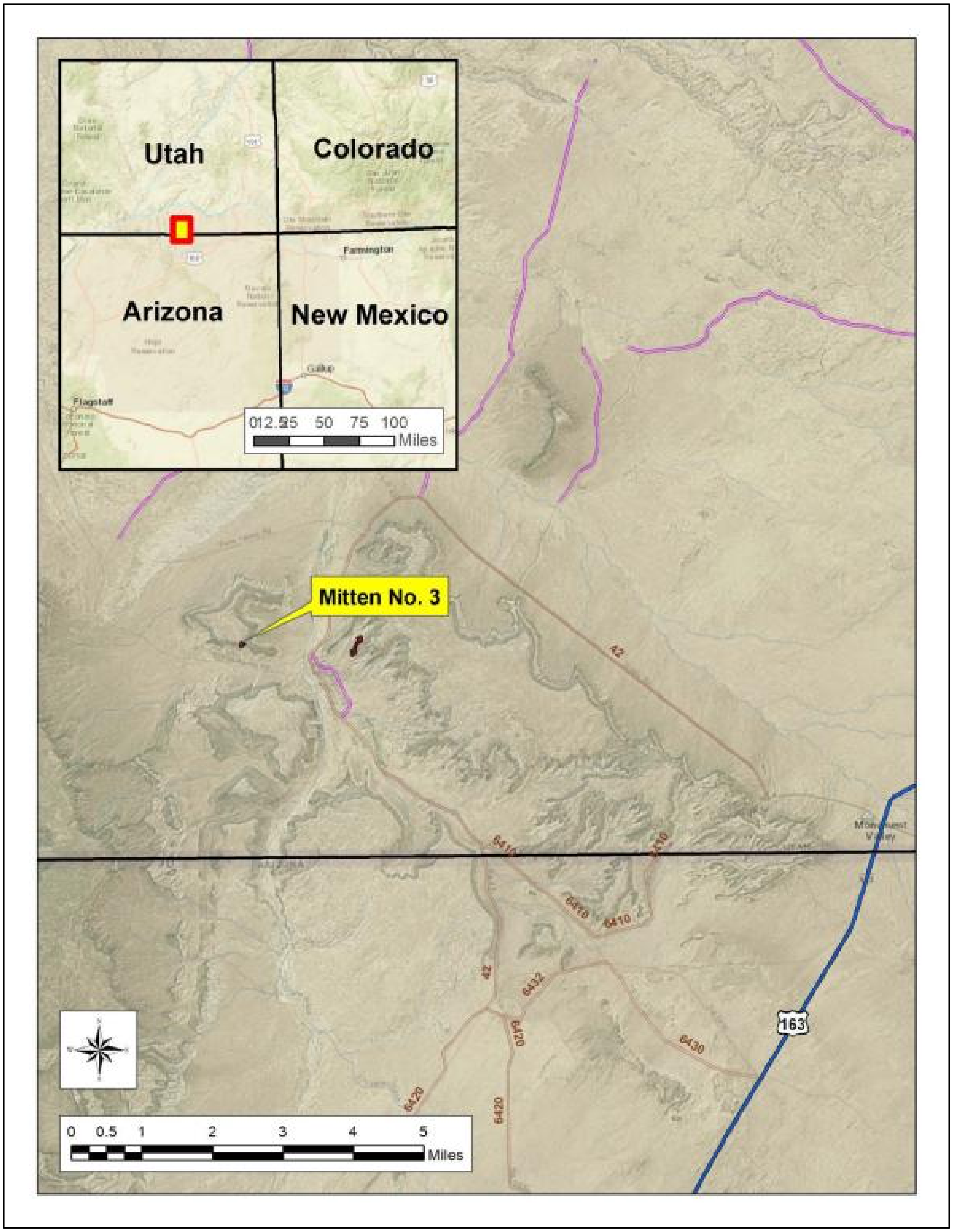


Figure 1. Location of the Mitten No. 3 Abandoned Uranium Mine

2.1 Potential Background Reference Areas

Three potential Background Reference Areas were surveyed, the locations and results of which are depicted on Figure 2. BG1 and BG2 in the figure are Background Reference Areas 1 and 2, respectively. Charles Keith Background Reference Area 2 (CK-BG2) is the third Background Reference Area in the figure. Figure 2 shows the claim area of the Charles Keith AUM site for reference.

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

- BG1 ranged from 6,873 to 15,394 counts per minute (cpm), with a mean and median of 10,304 and 10,326 cpm, respectively.

- BG2 ranged from 7,444 to 9,371 cpm, with a mean and median of 8,374 and 8,317 cpm, respectively.

- CK-BG2 ranged from 6,345 to 12,135 cpm, with a mean and median of 8,898 and 8,726 cpm, respectively.

Figure 3 depicts histograms of the gamma count rates in BG1, BG2, and CK-BG2. 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**
BG1	303	6,873	15,394	10,304	10,326	1,409
BG2	156	7,444	9,371	8,374	8,317	429
CK-BG2	199	6,345	12,135	8,898	8,726	1,265

Notes:
cpm = counts per minute

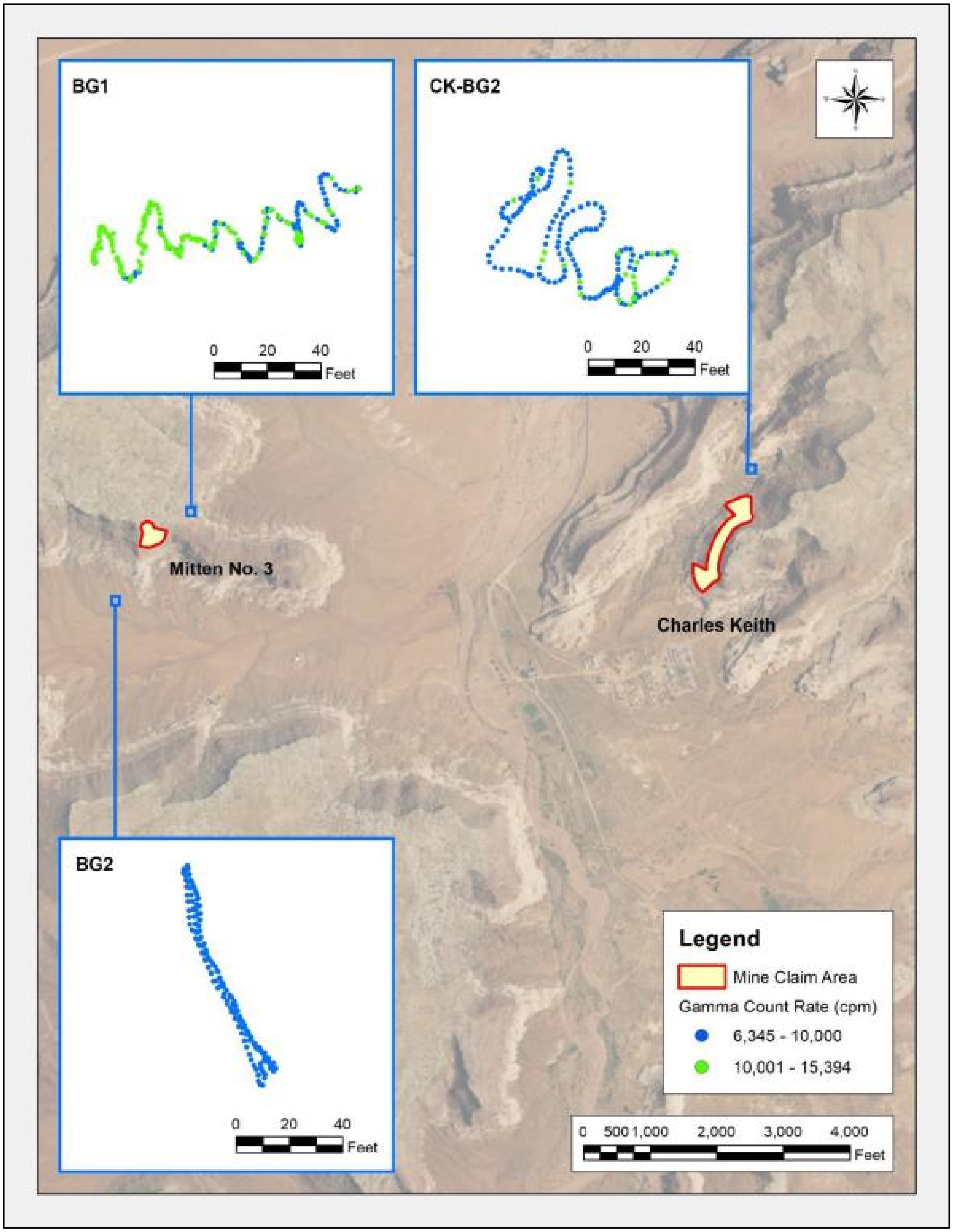
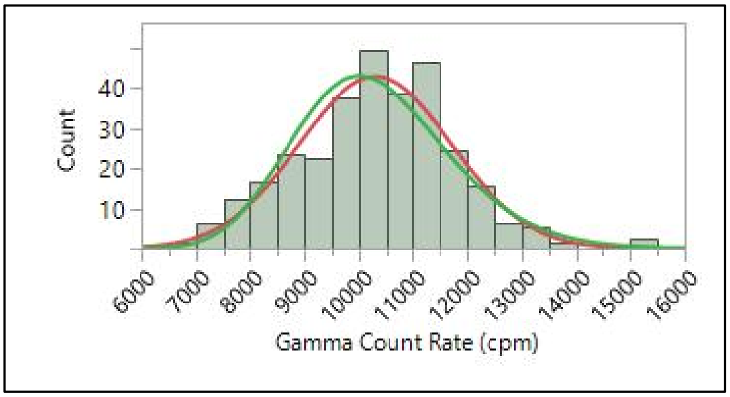
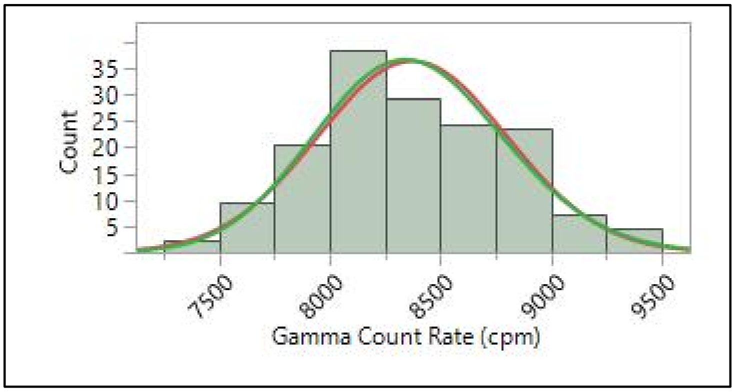


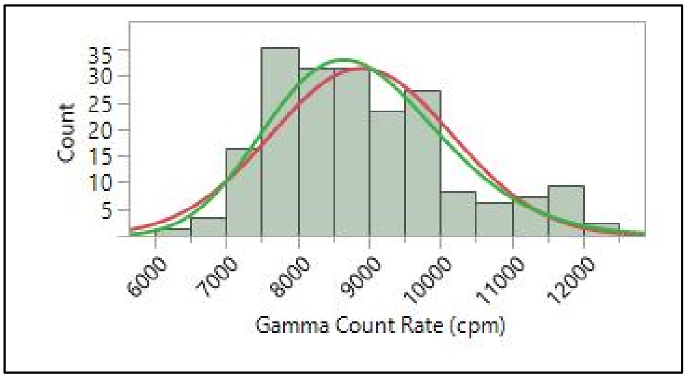
Figure 2. Gamma count rates in the potential Background Reference Areas.



a. Background Reference Area BG1



b. Background Reference Area BG2



c. Background Reference Area CK-BG2

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

2.2 Survey Area

The gamma count rates observed in the Survey Area are depicted in Figure 4. Elevated count rates were observed largely on waste piles extending away from a portal in the mine claim.

Figure 5 is a histogram of the gamma count rate measurements made in the Survey Area, including the area surveyed outside the 100-ft buffer. As stated in Section 2.1, 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 8,327, 9,860, and 12,059 cpm, respectively.

Table 3 is a statistical summary of the measurements, which range from 4,266 to 129,220 cpm and have a central tendency (median) of 9,860 cpm.

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

Parameter	Gamma Count Rate (cpm)
n	20,950
Minimum	4,266
Maximum	129,220
Mean	11,868
Median	9,860
Standard Deviation	9,134

Notes:
cpm = counts per minute

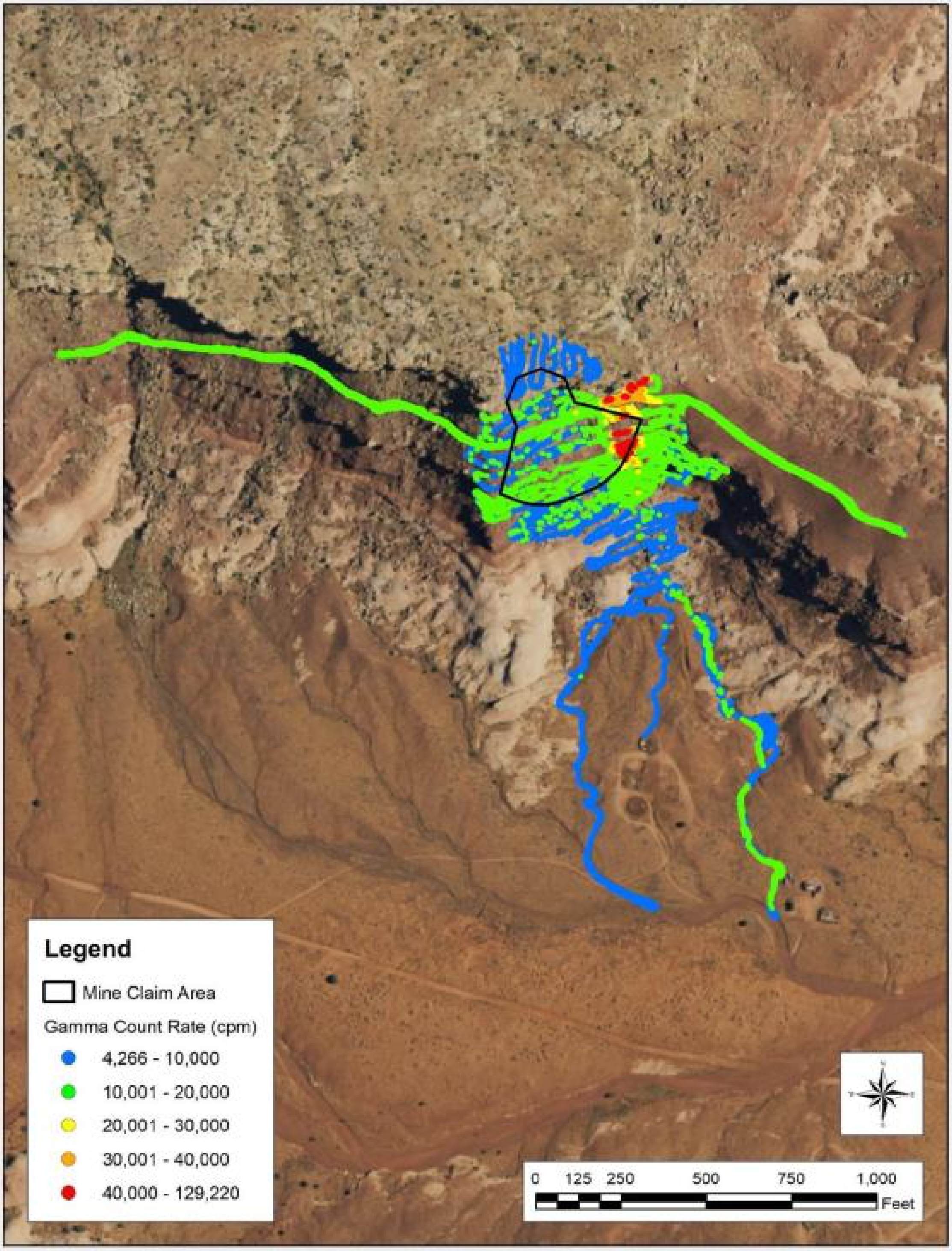


Figure 4. Gamma count rates in the Survey Area.

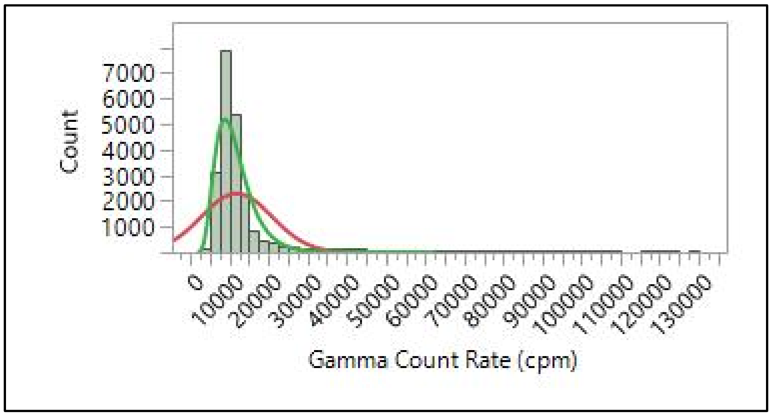


Figure 5. Histogram of gamma count rates in the Survey Area.

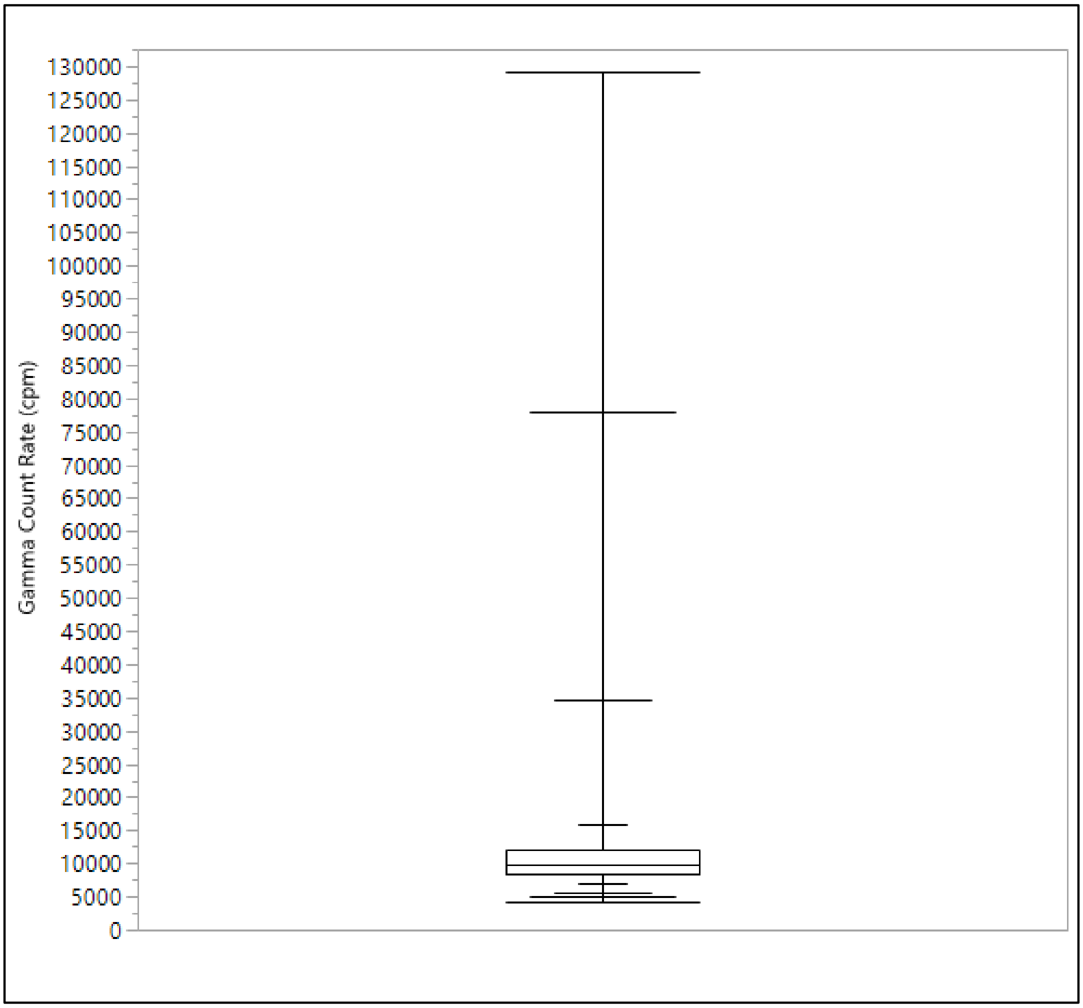


Figure 6. Box plot of gamma count rates in the Survey Area.

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 31, 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 to 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 8,354 to 48,808 cpm. The concentrations of radium-226 range from 0.49 to 34.2 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 Report” in the “Mitten No.3 Removal Site Evaluation Report” (Stantec, 2018).

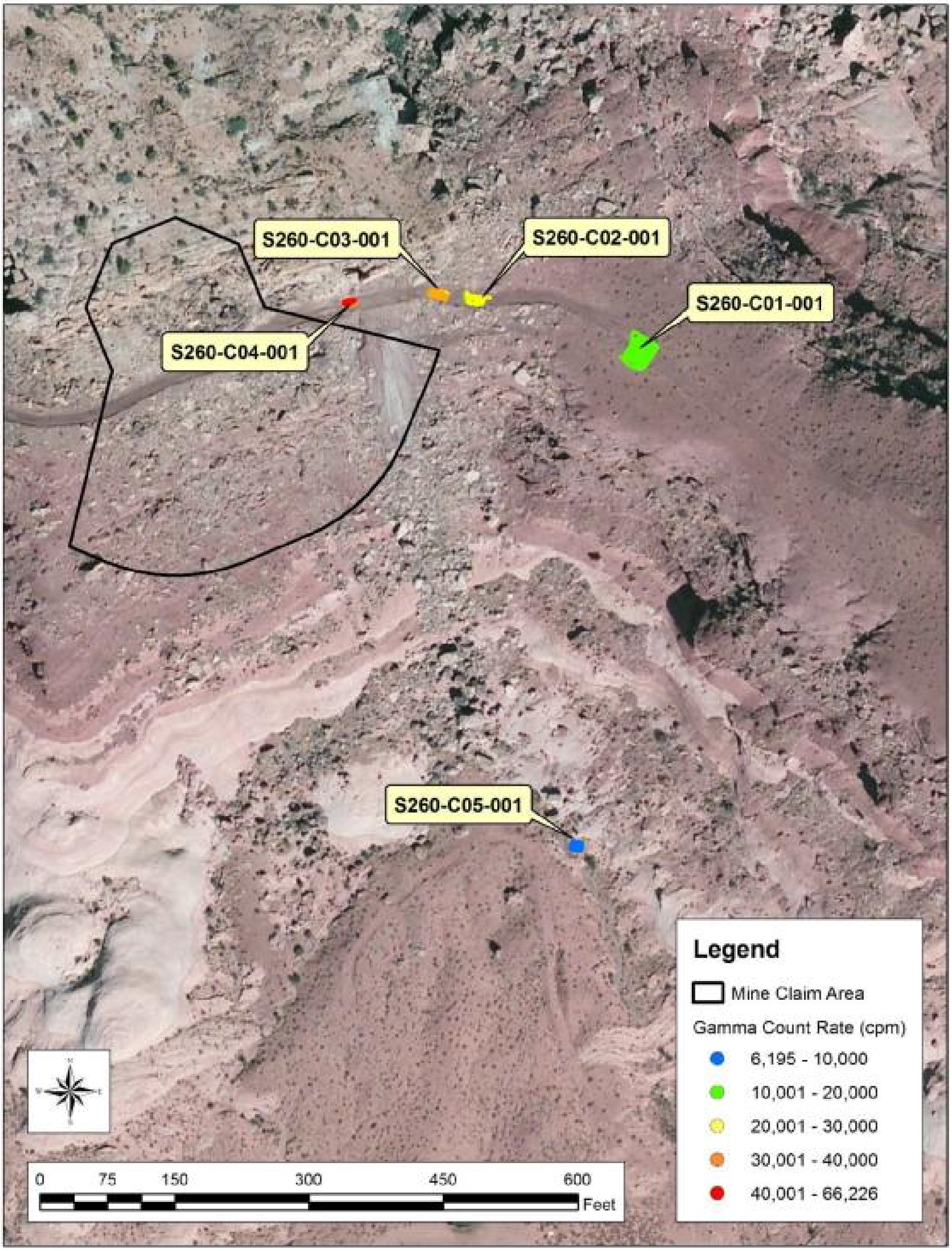


Figure 7. GPS-based gamma count rate measurements made for the correlation study.

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
S260-C01-001	120.0	13,512	11,659	15,742	825	5.18	0.73	0.53
S260-C02-001	31.0	20,520	16,685	24,115	1,297	7.02	0.93	0.51
S260-C03-001	23.0	32,533	27,975	37,060	2,064	34.2	4.2	1
S260-C04-001	14.9	48,808	32,841	66,226	10,167	20.7	2.5	0.6
S260-C05-001	13.5	8,354	6,195	9,984	676	0.49	0.2	0.38

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
S260-C01-001	0.94	0.17	0.05	1.42	0.24	0.07	0.96	0.17	0.03
S260-C02-001	0.93	0.17	0.05	8.8	1.4	0.1	0.99	0.17	0.01
S260-C03-001	0.84	0.16	0.05	17.5	2.7	0.1	0.76	0.14	0.01
S260-C04-001	0.72	0.13	0.05	35.4	5.4	0.1	0.66	0.12	0.01
S260-C05-001	0.443	0.091	0.049	0.405	0.089	0.065	0.468	0.091	0.024

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 0.41, as expressed in the equation:

$$\text{Gamma Count Rate (cpm)} = 879 \times [\text{radium-226 (pCi/g)}] + 12867$$

The root mean square error and p-value for the model are 1.2×10^4 and 0.15, respectively; these parameters are not data quality objectives (DQOs) and are included only as information. The R^2 value for this model does not meet the project DQO of 0.8. The model could be improved with additional correlation data collected in the future.

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 -9.8 to 132.4 pCi/g, with a mean and median of -1.1 and -3.4 pCi/g, respectively. Note that the radium-226 concentrations predicted from gamma count rate measurements exceeding approximately 49,000 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.

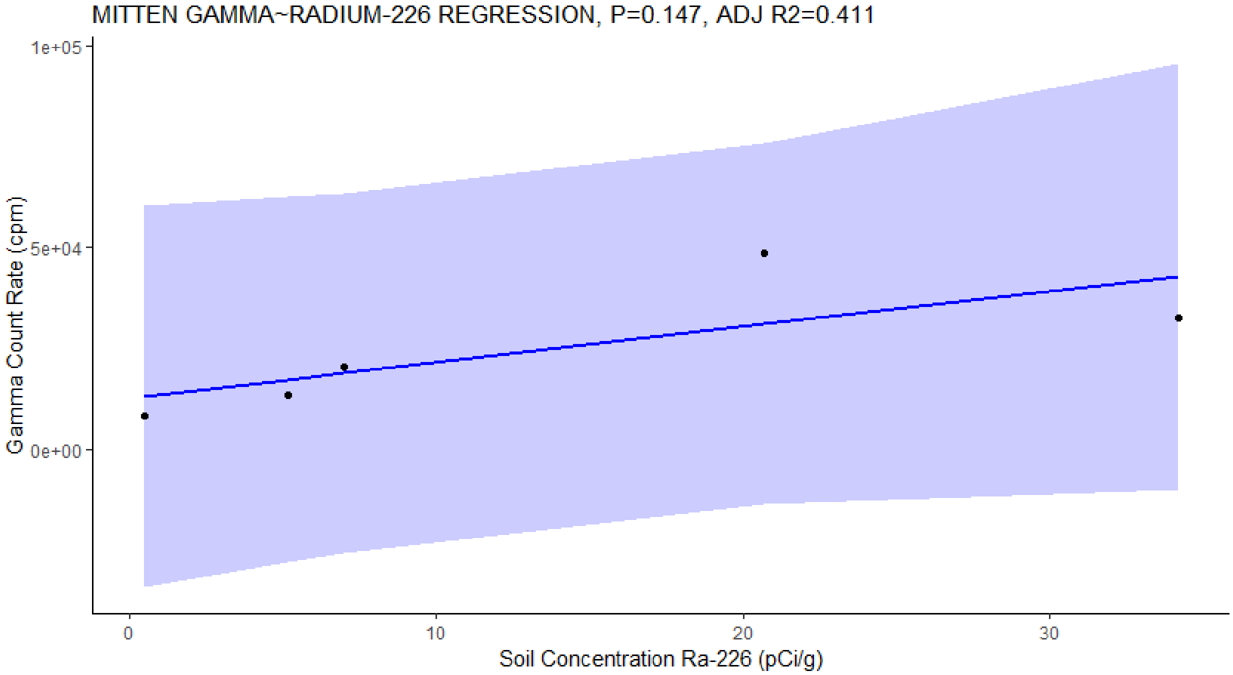


Figure 8. Correlation of gamma count rates and concentrations of radium-226 in surface soils (blue line) and 95% prediction intervals plotted (shaded blue band).

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

Parameter	Radium-226 (pCi/g)
n	20,950
Minimum	-9.8
Maximum	132.4
Mean	-1.1
Median	-3.4
Standard Deviation	10.4

Notes:
pCi/g = picocuries per gram

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 and thorium-232 were both greater than 0.05 (0.25 and 0.92 respectively) and therefore not significant predictors of gamma count rate collectively. 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 0.92 with an adjusted R^2 of -0.33. 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 also not significant ($p = 0.15$), as described above, and the adjusted R^2 value (0.41) did not meet the applicable project DQO ($R^2 > 0.8$).

The depletion of 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 location, 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.

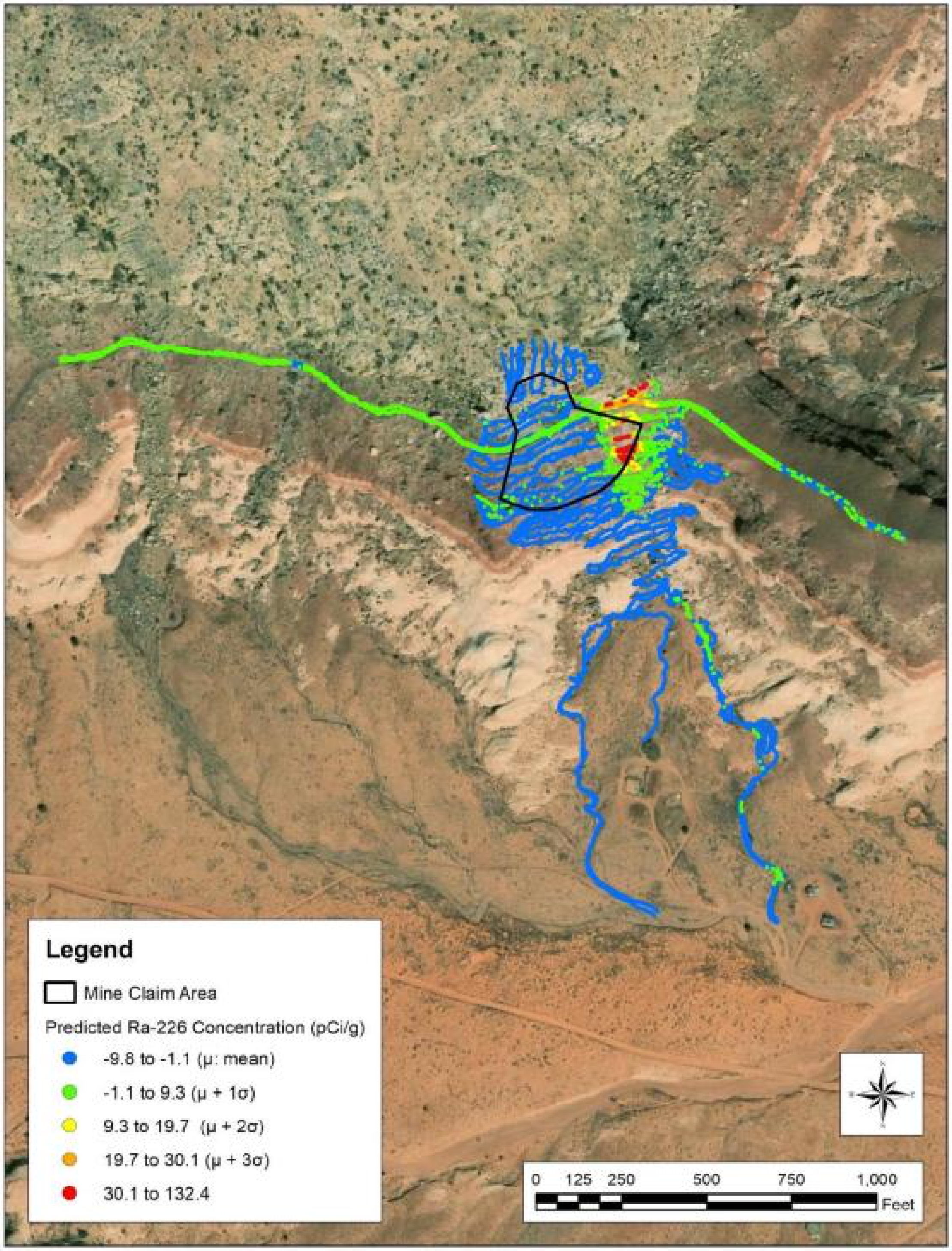


Figure 9. Predicted concentrations of radium-226 in the Survey Area.

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 therefore it wasn't 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 that there is no evidence of equilibrium (secular or otherwise) among the uranium decay series radionuclides (Figure 10).

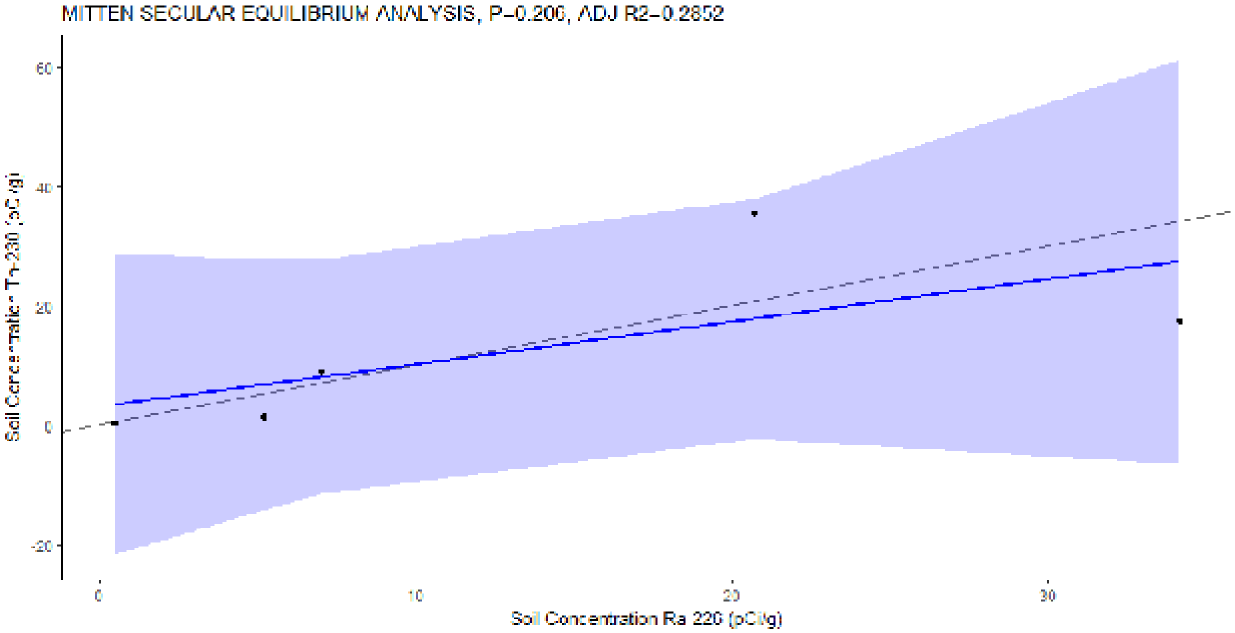


Figure 10. Evaluation of secular equilibrium in the uranium decay series.

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 31, 2016 at 0.5 m and 1 m above the ground surface, respectively. The gamma count rate measurements were made using one of the sodium iodide detection systems used in the GPS-based gamma survey of the AUM (Serial Number PR154615/138368). 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 factor of 1.02 was added to the measured value 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 0.9891. The root mean square error and p-value for the model are 1.069703 and 0.0005, 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:

$$\text{Exposure Rate (microRoentgens per hour [}\mu\text{R/h])} = 5\text{x}10^{-4} \text{ x Gamma Count Rate (cpm)} + 6.1119$$

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.

The range of predicted exposure rates at:

- BG1 is 9.5 to 13.8 µR/h, with a mean and median of 11.3 µR/h
- BG2 is 9.8 to 10.8 µR/h, with a mean and median of 10.3 µR/h
- CK-BG2 is 9.3 to 12.2 µR/h, with a mean and median of 10.6 and 10.5 µR/h, respectively.

The range of predicted exposure rates in the Survey Area is 8.2 to 70.7 µR/h, with a mean and median of 12.0 and 11.0 µR/h, respectively.

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

Location	Gamma Count Rate (cpm)	Exposure Rate (µR/h)
S260-C01-001	13,767	14
S260-C02-001	22,353	17.3
S260-C03-001	35,029	22.7
S260-C04-001	51,099	33.2
S260-C05-001	8,552	10.5

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

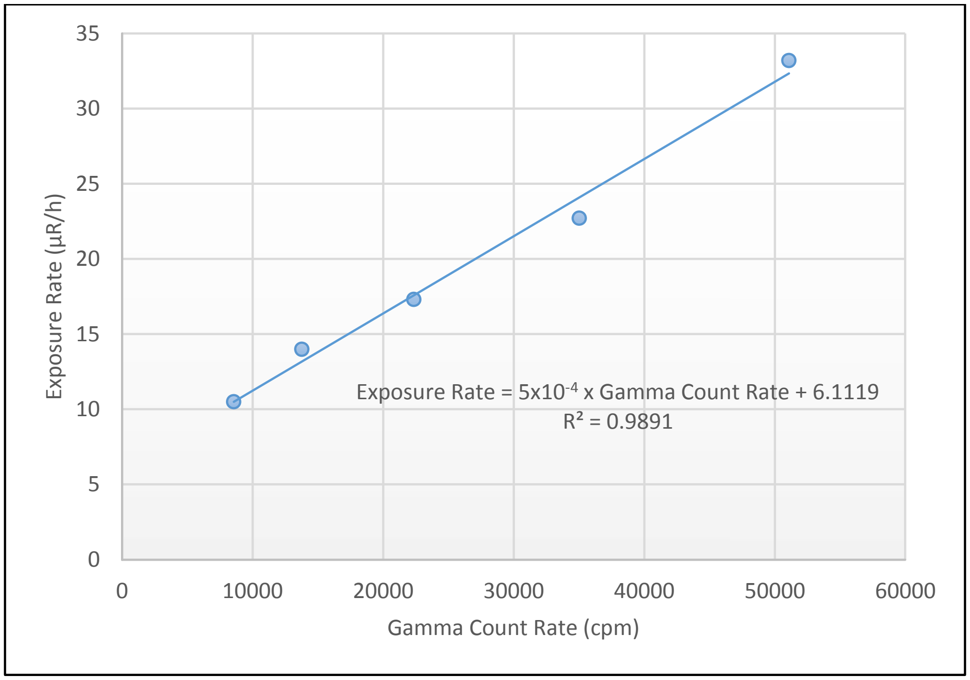


Figure 11. Correlation of gamma count rates and exposure rates.

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

Potential Background Reference Area	BG1	BG2	CK-BG2
Parameter	Exposure Rate (µR/h)		
n	303	156	199
Minimum	9.5	9.8	9.3
Maximum	13.8	10.8	12.2
Mean	11.3	10.3	10.6
Median	11.3	10.3	10.5
Standard Deviation	0.7	0.2	0.6

Notes:
BG1 = Background Reference Area 1
BG2 = Background Reference Area 2
CK-BG2 = Charles Keith Background Reference Area 2
µR/h = microRoentgens per hour

Table 9. Predicted exposure rates in the Survey Area.

Parameter	Exposure Rate (µR/h)
n	20,950
Minimum	8.3
Maximum	70.7
Mean	12.2
Median	11.0
Standard Deviation	4.6

Notes:
µR/h = microRoentgens per hour

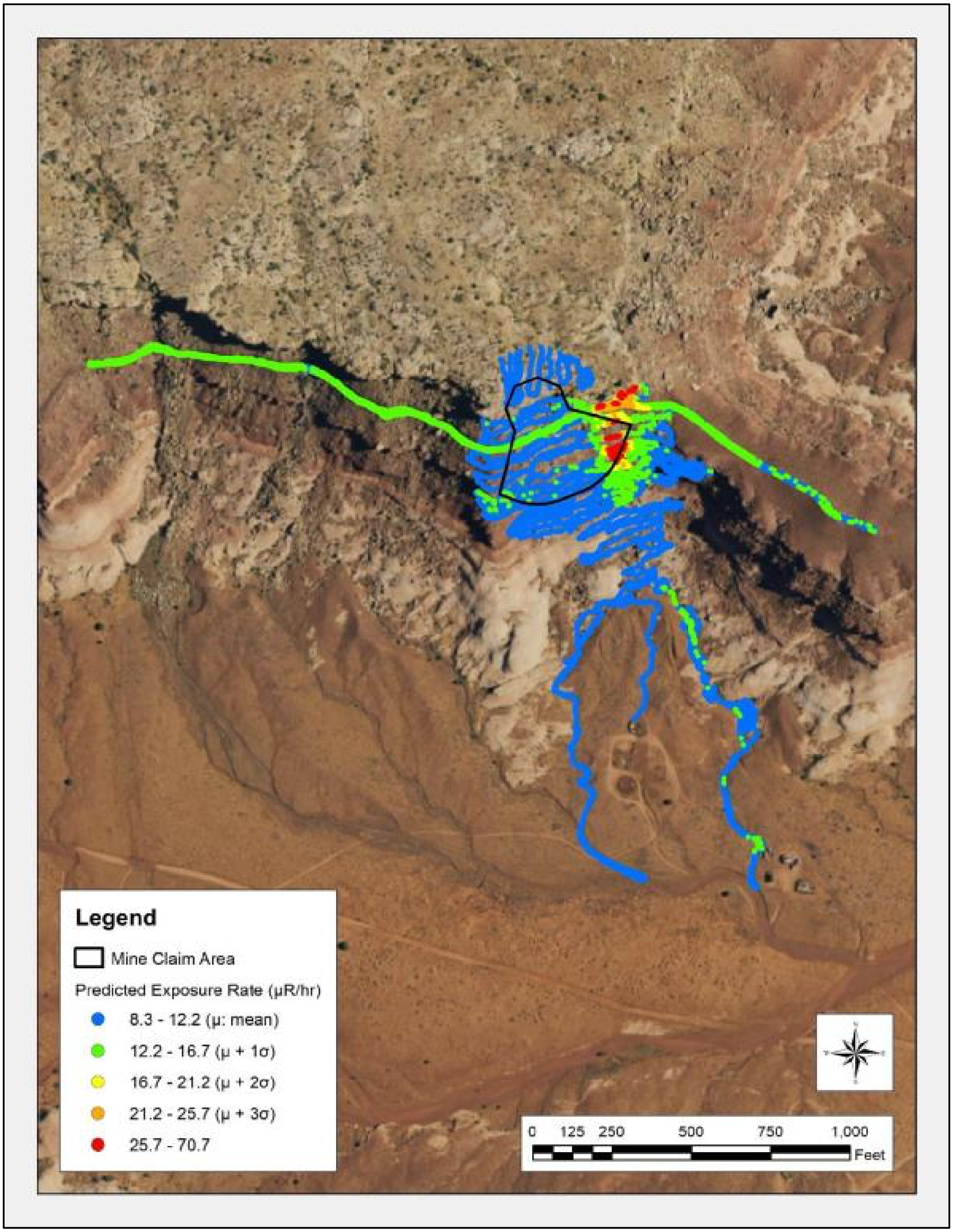


Figure 12. Predicted exposure rates in the Survey Area.

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 count rates were observed largely on waste piles extending away from a portal in the mine claim.
- Three 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:

$$\text{Gamma Count Rate (cpm)} = 879 \times [\text{radium-226 (pCi/g)}] + 12867$$

- 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 -9.8 to 132.4 pCi/g, with a central tendency (median) of -3.4 pCi/g.
- The thorium series radionuclides do not appear to affect the prediction of concentrations of radium-226 from gamma count rates.
- There is no evidence of equilibrium (secular or otherwise) among the uranium decay series radionuclides.
- The relationship between gamma count rates and exposure rates is described by a linear regression model.

$$\text{Exposure Rate (}\mu\text{R/h)} = \text{Gamma Count Rate (cpm)} \times 5\text{x}10^{-4} + 6.1119$$

- The distribution of exposure rates predicted using this model is rightward tailed. The values in the Survey Area range from 8.3 to 70.7, with a central tendency (median) of 11.0 µR/h.
- Further work is recommended to support a robust gamma correlation.

6.0 References

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

Stantec, 2018. Mitten No. 3 Removal Site Evaluation Report, (will be finalized October 2018).

Appendix A Instrument calibration and completed function check forms

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:

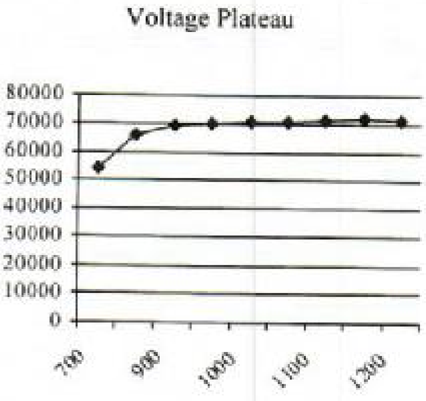
Threshold: 10 mV
Window:

Barometric Pressure: 24.6 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 Coun
x 1000	400	400	400	398773	400
x 1000	100	100	100		100
x 100	400	400	400	39887	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	399	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	53957	
800	65946	
900	69049	
950	69687	
1000	70240	9925
1050	70288	
1100	71224	
1150	71563	
1200	71161	



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

Reference Instruments and/or Sources:

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

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

Calibrated By:
Reviewed By: Ch

Calibration Date: 1-20-16
Calibration Due 1-20-17
Date: 1/20/16

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: 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:

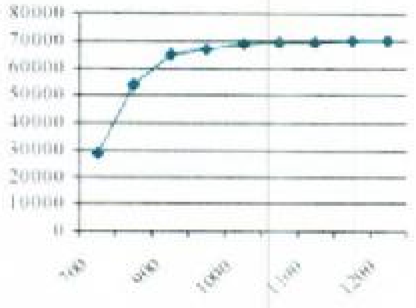
Barometric Pressure: 24.78 inches Hg
Temperature: 74 °F
Relative Humidity: 20 %

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	39980	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

Certificate of Calibration

Calibration and Voltage Plateau

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

Meter:	Manufacturer: Ludlum		Model Number:	2221r	Serial Number:	138368
Detector:	Manufacturer: Ludlum		Model Number:	44-10	Serial Number:	PR154615

☑ Mechanical Check
☑ 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:

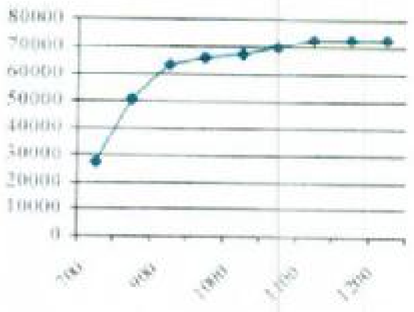
Barometric Pressure: 24.78 inches Hg
Temperature: 74 °F
Relative Humidity: 20 %

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	

Voltage Plateau



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

Reference Instruments and/or Sources:

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

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

Calibrated By:
Calibration Date: 7-6-16
Calibration Due: 7-6-17

Reviewed By:
Date: 7/20/16

ERG Form ITC. 101.A

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

ERG

Certificate of Calibration

Calibration and Voltage Plateau

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

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

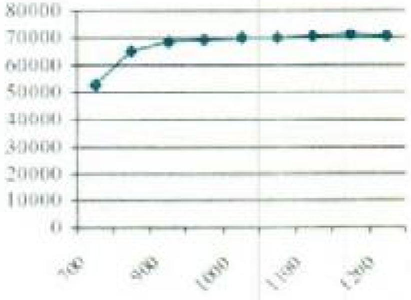
Barometric Pressure: 24.24 inches Hg
Temperature: 78 °F
Relative Humidity: 20 %

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

Date: 3-1-17

ERG Form ITC. 101.A

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

ERG

Certificate of Calibration

Calibration and Voltage Plateau

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

Meter: Manufacturer: Ludlum Model Number: 2221r Serial Number: 228808

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)

Source Distance: ☐ Contact ☑ 6 inches ☐ Other:

Source Geometry ☑ Side ☐ Below ☐ Other:

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

Cable Length: ☐ 39-inch ☐ 72-inch ☑ Other: 60"

Threshold: 10 mV

Window:

Barometric Pressure: 24.66 inches Hg

Temperature: 77 °F

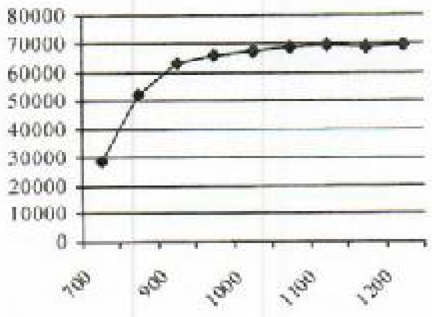
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Coun
x 1000	400	400	400	399291	400
x 1000	100	100	100		100
x 100	400	400	400	39921	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	28606	
800	52277	
900	63294	
950	65720	
1000	66874	
1050	68284	
1100	68903	9557
1150	68635	
1200	69337	

Voltage Plateau



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

Reference Instruments and/or Sources:

Ludlum pulser serial number: ☐ 97743 ☑ 201932

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

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

Fluke multimeter serial number: ☐ 8749012

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

☐ Other Source:

Calibrated By:

Calibration Date: 4-12-16

Calibration Due 4-12-17

Reviewed By:

Date: 4/12/16

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: 218559

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:

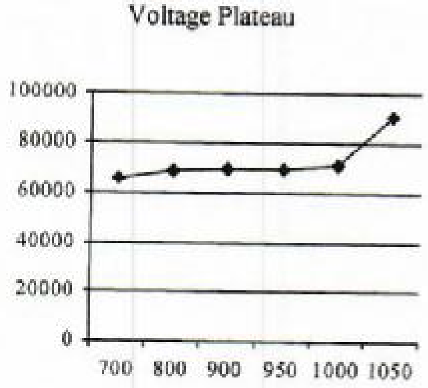
Threshold: 10 mV
Window:

Barometric Pressure: 24.66 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 Cou
x 1000	400	400	400	399164	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	3991	400
x 10	100	100	100		100
x 1	400	400	400	399	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	66548	
800	69805	
900	70095	8964
950	70368	
1000	71748	
1050	90668	



Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV = 900

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: 6-13-16
Calibration Due: 6-13-17

Reviewed By:
Date:

ERG Form ITC. 101.A

This calibration conforms to the requirements and acceptable calibration conditions of

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

ACCREDITED
CALIBRATION CERT #1866.0

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
Title: Calibration Technician

Reviewed By: Angela Roper
Title: Calibration Physicist

Log: M-53 Page: 73

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 **Reviewed By:**
Title: Calibration Technician **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:	7.19.17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR303727
Cal. Due Date:	7.19.17

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
10-26-16	0637	6.1	1008	99	46974	7833	39141	NW	BOYD TISI
10-26-16	1545	6.1	992	98	42850	5959	36891	NW	BOYD TISI
10-27-16	1005	6.0	1004	99	48059	8561	39498	NW	Harvey Blackwater
10-27-16	1555	5.9	999	99	48564	8465	40099	NW	Harvey Blackwater
10-28-16	0808	5.9	1004	99	46814	9142	37672	NW	Harvey Blackwater
10-28-16	1704	5.8	1000	99	43711	5178	38533	NW	Mitten No. 3
10-29-16	0807	5.9	1005	100	43690	5203	38487	NW	Mitten No. 3
10-29-16	1342	5.8	999	99	44561	4801	39760	NW	Mitten No. 3
10-31-16	0840	5.8	1004	99	42426	5084	37342	NW	Mitten No. 3
10-31-16	1507	5.8	999	99	44206	5069	39137	NW	Goulding's back SUV
11-1-16	0748	5.8	1006	100	44441	4842	39599	NW	Charles Keith
11-1-16	1722	5.7	1003	99	44858	5117	39741	NW	Goulding's back of SUV

Reviewed by:

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.:	196096
Cal. Due Date:	7-19-17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR ~~303927~~ 295014 NW
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
10-15-16	0930	5.4	1100	100	45919	7086	38833	NW	Harvey Blackwater
10-15-16	1828	5.3	1094	100	44133	4794	39339	NW	Hat Rock Inn Lot
10-24-16	0807	5.4	1106	100	47875	8702	39173	NW	Boyd Tisi
10-24-16	1211	5.2	1099	100	45787	8272	37515	NW	Boyd Tisi
10-27-16	1000	5.4	1106	100	48630	8414	40216	NW	Harvey Blackwater
10-27-16	1601	5.2	1099	99	48326	8166	40160	NW	Harvey Blackwater
10-28-16	1401	5.3	1101	100	43141	4755	38386	NW	Mitten No. 3
10-28-16	1700	5.2	1101	99	43075	4698	38377	NW	Mitten No. 3
10-29-16	0812	5.3	1105	100	44174	4908	39266	NW	Mitten No. 3
10-29-16	~~08~~ NW 1346	5.2	1098	100	42452	4621	37831	NW	Mitten No. 3
10-31-16	0835	5.3	1105	101	42258	4609	37649	NW	Mitten No. 3
10-31-16	1655	5.3	1100	100	42630	4963	37667	NW	Goulding's back JUV.

Reviewed by: MA

Review Date: 11/29/16

ERG Form ITC.201.A

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.:	138368
Cal. Due Date:	7-19-1~~6~~7 NW

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR154615
Cal. Due Date:	7-19-1~~6~~7 NW

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: 6 in.

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
10-28-16	0813	5.6	1162	144	50583	9051	41532	NW	Harvey Blackwater
10-29-16	0815	5.6	1222	199	44566	5053	39513	NW	Mitten No. 3
10-29-16	1338	5.5	1141	125	44503	4794	39709	NW	Mitten No. 3
10-31-16	0846	5.5	1133	111	44824	4753	40071	NW	Mitten No. 3
10-31-16	1502	5.5	1132	114	44994	4883	40111	NW	Goulding's in SUV
11-1-16	0758	5.5	1133	110	45344	4771	40573	NW	Charles Keith
11-1-16	1712	5.3	1120	100	44220	4928	39292	NW	Goulding's in SUV
11-2-16	0826	5.3	1127	103	44389	5834	38555	NW	Charles Keith
11-2-16	1715	5.3	1125	106	43737	5179	38558	NW	Goulding's in SUV
11-3-16	1055	5.3	1125	105	44443	5368	39075	NW	Charles Keith
11-3-16	1842	5.3	1123	104	47047	7583	39464	NW	Circle Holiday Inn SUV
11-4-16	0900	5.4	1128	104	46230	8402	37828	NW	Occurrence B

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:	2221
Serial No.:	254772
Cal. Due Date:	2-28-18

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PL303727
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:	GE
Model:	RSJ-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: 6-6-94

Distance to Source: Contact-housing

Date	Time	Battery	High Voltage	Threshhold	Source Counts μR/h	BKG Counts μR/h	Net Counts	Initials	Note(s): Project reference points
10-26-16	0525	~6.4	~400	NA	~27.8	~10.5	~17.3	NW	Best Western room- Flagstaff
10-26-16	2010	~6.3	~400	NA	~26	~9.5	~16.5	NW	Gouldings room ~~Best Western room- Flagstaff~~ NW
10-27-16	0720	~6.2	~400	NA	~26.7	~10.0	~16.7	NW	Gouldings room
10-27-16	1710	~6.2	~400	NA	~27.0	~10.8	~16.2	NW	Gouldings room
10-31-16	0609	~6.3	~400	NA	~27.0	~10	~16	NW	Gouldings room
10-31-16	1520	~6.3	~400	NA	~26	~10	~16	NW	Gouldings room
11-3-16	0700	~6.2	~400	NA	~26.5	~10.5	~16	NW	Gouldings room
11-3-16	1924	~6.1	~400	NA	~28.8	~12.5	~16.3	NW	Holiday Inn Chinle-room
11-9-16	0615	~6.3	~400	NA	~30	~12.8	~17.2	NW	Holiday Inn-Chinle room
11-9-16	1430	~6.2	~400	NA	~29.5	~12.5	~17	NW	Holiday Inn Chinle-room
11-11-16	0610	~6.4	~400	NA	~31.5	~13.5	~18	NW	Holiday Inn Chinle-room
11-11-16	1825	~6.2	~400	NA	~28	~11	~17	NW	Holiday Inn Chinle-room

Reviewed by:

Review Date: 11-29-16

NNERT Site Clearance

5-4-16

0645 leave Goulding's for Charles Keith

Function check 2221/44-10

S/N 754772 / PR302727

Detection System 1

BKG = 5770 BAT = 5.1

COUNT = 52003 HV = 1001

TR = 100

walk up to new area on other side of mesa from the waste area/adits

area is a mix of weathered red sandstone / red sandstone / white sandstone

- GPS is not working in the area
- make ten, one-minute integrated count rate measurements across the reference area (provisional)
- JP records the measurements, ca. 12-13k (most are ~13k) in his log book

- go to a second area in the back of the valley, above which sits the mine. JP wants to do an area of colluvium that would be representative of materials under the mine (base of the mesa).

MWH
NNEAT MWH Site Clearance

5-4-16

File: R050409A - colluvial in back of valley w/ C. Keith mine

0930 mob to Mitten #3. provisional BRA is on the mesa (colluvial and bedrock) on the other side of the mine
File: R 05410A

1045 mob to Boyd Tisi: survey three areas (two dune north of the claim. One sandy/gravely area east of the claim
File: R0 504C3A

JP/MW - need to check wind direction @ site, based on the reading of survey.

1500
Function check 2221 / 4410

BAT	5.9
HV	999
TH	100
BKG:	3565
gross:	53238

· offsite ~1527 - Boyd Tisi. Drive to Flagstaff

MWH
NNEAT Site Clearance

5-4-16

1630 MST arrive @ Comfort Inn Flagstaff
. check in and download ssf files and export
- data look ok

- 1900 MST call C. Farr re: loss of connection to satellites. He suggests it is a bluetooth issue w/ the NOMAD. Suggests turning off cell phone.

- 1930 MST have dinner w/ JP

5-4-16

Appendix B Exposure Rate Measurements

Date and Time	Exposure Rate (mR/h)	Location
10/31/2016 10:15	0.0538	Correlation Location 1
10/31/2016 10:15	0.0942	Correlation Location 1
10/31/2016 10:15	0.0827	Correlation Location 1
10/31/2016 10:15	0.0571	Correlation Location 1
10/31/2016 10:15	0.0378	Correlation Location 1
10/31/2016 10:15	0.0264	Correlation Location 1
10/31/2016 10:15	0.0204	Correlation Location 1
10/31/2016 10:15	0.0169	Correlation Location 1
10/31/2016 10:15	0.0154	Correlation Location 1
10/31/2016 10:15	0.0149	Correlation Location 1
10/31/2016 10:16	0.0149	Correlation Location 1
10/31/2016 10:16	0.0148	Correlation Location 1
10/31/2016 10:16	0.0148	Correlation Location 1
10/31/2016 10:16	0.0148	Correlation Location 1
10/31/2016 10:16	0.0145	Correlation Location 1
10/31/2016 10:16	0.014	Correlation Location 1
10/31/2016 10:16	0.0138	Correlation Location 1
10/31/2016 10:16	0.0138	Correlation Location 1
10/31/2016 10:16	0.0136	Correlation Location 1
10/31/2016 10:16	0.0137	Correlation Location 1
10/31/2016 10:17	0.0138	Correlation Location 1
10/31/2016 10:17	0.0138	Correlation Location 1
10/31/2016 10:17	0.0133	Correlation Location 1
10/31/2016 10:17	0.0135	Correlation Location 1
10/31/2016 10:17	0.0138	Correlation Location 1
10/31/2016 10:17	0.0141	Correlation Location 1
10/31/2016 10:17	0.0142	Correlation Location 1
10/31/2016 10:17	0.0141	Correlation Location 1
10/31/2016 10:17	0.0143	Correlation Location 1
10/31/2016 10:17	0.014	Correlation Location 1
10/31/2016 10:18	0.0143	Correlation Location 1
10/31/2016 10:18	0.0145	Correlation Location 1
10/31/2016 10:18	0.0146	Correlation Location 1
10/31/2016 10:18	0.0149	Correlation Location 1
10/31/2016 10:18	0.0149	Correlation Location 1
10/31/2016 10:18	0.0144	Correlation Location 1
10/31/2016 10:18	0.0146	Correlation Location 1
10/31/2016 10:18	0.0144	Correlation Location 1
10/31/2016 10:18	0.0142	Correlation Location 1
10/31/2016 10:18	0.0139	Correlation Location 1
10/31/2016 10:19	0.0137	Correlation Location 1
10/31/2016 10:19	0.0136	Correlation Location 1
10/31/2016 10:19	0.0137	Correlation Location 1
10/31/2016 10:19	0.014	Correlation Location 1
10/31/2016 10:19	0.0141	Correlation Location 1
10/31/2016 10:19	0.0139	Correlation Location 1
10/31/2016 10:19	0.0138	Correlation Location 1
10/31/2016 10:19	0.0137	Correlation Location 1
10/31/2016 10:19	0.0137	Correlation Location 1
10/31/2016 10:19	0.0133	Correlation Location 1
10/31/2016 10:20	0.0133	Correlation Location 1
10/31/2016 10:20	0.0134	Correlation Location 1
10/31/2016 10:20	0.0134	Correlation Location 1
10/31/2016 10:20	0.0138	Correlation Location 1
10/31/2016 10:20	0.0141	Correlation Location 1
10/31/2016 10:20	0.0143	Correlation Location 1
10/31/2016 10:20	0.0144	Correlation Location 1
10/31/2016 10:20	0.0142	Correlation Location 1
10/31/2016 10:20	0.0138	Correlation Location 1
10/31/2016 10:20	0.0137	Correlation Location 1
10/31/2016 10:21	0.0142	Correlation Location 1
10/31/2016 10:21	0.014	Correlation Location 1
10/31/2016 10:21	0.0137	Correlation Location 1
10/31/2016 10:21	0.0137	Correlation Location 1
10/31/2016 10:21	0.0139	Correlation Location 1
10/31/2016 10:21	0.0138	Correlation Location 1
10/31/2016 10:21	0.0138	Correlation Location 1
10/31/2016 10:21	0.0143	Correlation Location 1
10/31/2016 10:21	0.0142	Correlation Location 1
10/31/2016 10:21	0.0144	Correlation Location 1
10/31/2016 10:22	0.0146	Correlation Location 1
10/31/2016 10:22	0.0145	Correlation Location 1
10/31/2016 10:22	0.0146	Correlation Location 1
10/31/2016 10:22	0.0145	Correlation Location 1
10/31/2016 10:22	0.0144	Correlation Location 1
10/31/2016 10:22	0.0141	Correlation Location 1
10/31/2016 10:22	0.0138	Correlation Location 1
10/31/2016 10:22	0.0138	Correlation Location 1
10/31/2016 10:22	0.0137	Correlation Location 1
10/31/2016 10:22	0.0134	Correlation Location 1
10/31/2016 10:23	0.0135	Correlation Location 1
10/31/2016 10:23	0.0135	Correlation Location 1
10/31/2016 10:23	0.0136	Correlation Location 1
10/31/2016 10:23	0.0135	Correlation Location 1
10/31/2016 10:23	0.0134	Correlation Location 1
10/31/2016 10:23	0.0135	Correlation Location 1
10/31/2016 10:23	0.014	Correlation Location 1
10/31/2016 10:23	0.0142	Correlation Location 1
10/31/2016 10:23	0.0141	Correlation Location 1
10/31/2016 10:23	0.0137	Correlation Location 1
10/31/2016 10:24	0.0141	Correlation Location 1
10/31/2016 10:24	0.0142	Correlation Location 1
10/31/2016 10:24	0.014	Correlation Location 1
10/31/2016 10:24	0.0138	Correlation Location 1
10/31/2016 10:24	0.0135	Correlation Location 1
10/31/2016 10:24	0.0136	Correlation Location 1
10/31/2016 10:24	0.0139	Correlation Location 1
10/31/2016 10:24	0.0142	Correlation Location 1
10/31/2016 10:24	0.014	Correlation Location 1
10/31/2016 10:24	0.0136	Correlation Location 1
10/31/2016 10:25	0.0137	Correlation Location 1
10/31/2016 10:25	0.0141	Correlation Location 1
10/31/2016 10:25	0.0143	Correlation Location 1
10/31/2016 10:25	0.0145	Correlation Location 1
10/31/2016 10:25	0.0141	Correlation Location 1
10/31/2016 10:25	0.0135	Correlation Location 1
10/31/2016 10:25	0.0134	Correlation Location 1
10/31/2016 10:25	0.0136	Correlation Location 1
10/31/2016 10:44	0.0545	Correlation Location 2
10/31/2016 10:44	0.096	Correlation Location 2
10/31/2016 10:45	0.0854	Correlation Location 2
10/31/2016 10:45	0.0601	Correlation Location 2

Mitten No. 3 Exposure Rate Measurements for Correlation

Date and Time	Exposure Rate (mR/h)	Location
10/31/2016 10:45	0.0409	Correlation Location 2
10/31/2016 10:45	0.0299	Correlation Location 2
10/31/2016 10:45	0.0241	Correlation Location 2
10/31/2016 10:45	0.021	Correlation Location 2
10/31/2016 10:45	0.019	Correlation Location 2
10/31/2016 10:45	0.0182	Correlation Location 2
10/31/2016 10:45	0.0178	Correlation Location 2
10/31/2016 10:45	0.0173	Correlation Location 2
10/31/2016 10:46	0.0174	Correlation Location 2
10/31/2016 10:46	0.0175	Correlation Location 2
10/31/2016 10:46	0.0176	Correlation Location 2
10/31/2016 10:46	0.017	Correlation Location 2
10/31/2016 10:46	0.0168	Correlation Location 2
10/31/2016 10:46	0.0168	Correlation Location 2
10/31/2016 10:46	0.0168	Correlation Location 2
10/31/2016 10:46	0.0166	Correlation Location 2
10/31/2016 10:46	0.0167	Correlation Location 2
10/31/2016 10:46	0.017	Correlation Location 2
10/31/2016 10:47	0.0172	Correlation Location 2
10/31/2016 10:47	0.0174	Correlation Location 2
10/31/2016 10:47	0.0176	Correlation Location 2
10/31/2016 10:47	0.0178	Correlation Location 2
10/31/2016 10:47	0.0176	Correlation Location 2
10/31/2016 10:47	0.017	Correlation Location 2
10/31/2016 10:47	0.0168	Correlation Location 2
10/31/2016 10:47	0.0165	Correlation Location 2
10/31/2016 10:47	0.0169	Correlation Location 2
10/31/2016 10:47	0.017	Correlation Location 2
10/31/2016 10:48	0.0169	Correlation Location 2
10/31/2016 10:48	0.0168	Correlation Location 2
10/31/2016 10:48	0.017	Correlation Location 2
10/31/2016 10:48	0.0172	Correlation Location 2
10/31/2016 10:48	0.0168	Correlation Location 2
10/31/2016 10:48	0.0167	Correlation Location 2
10/31/2016 10:48	0.0167	Correlation Location 2
10/31/2016 10:48	0.0172	Correlation Location 2
10/31/2016 10:48	0.0175	Correlation Location 2
10/31/2016 10:48	0.0173	Correlation Location 2
10/31/2016 10:49	0.0172	Correlation Location 2
10/31/2016 10:49	0.017	Correlation Location 2
10/31/2016 10:49	0.0172	Correlation Location 2
10/31/2016 10:49	0.0177	Correlation Location 2
10/31/2016 10:49	0.0177	Correlation Location 2
10/31/2016 10:49	0.0175	Correlation Location 2
10/31/2016 10:49	0.0175	Correlation Location 2
10/31/2016 10:49	0.0176	Correlation Location 2
10/31/2016 10:49	0.0175	Correlation Location 2
10/31/2016 10:49	0.0175	Correlation Location 2
10/31/2016 10:50	0.0174	Correlation Location 2
10/31/2016 10:50	0.0175	Correlation Location 2
10/31/2016 10:50	0.0182	Correlation Location 2
10/31/2016 10:50	0.0182	Correlation Location 2
10/31/2016 10:50	0.018	Correlation Location 2
10/31/2016 10:50	0.0178	Correlation Location 2
10/31/2016 10:50	0.0175	Correlation Location 2
10/31/2016 10:50	0.0173	Correlation Location 2
10/31/2016 10:50	0.0169	Correlation Location 2
10/31/2016 10:50	0.0164	Correlation Location 2
10/31/2016 10:51	0.0163	Correlation Location 2
10/31/2016 10:51	0.0168	Correlation Location 2
10/31/2016 10:51	0.0172	Correlation Location 2
10/31/2016 10:51	0.017	Correlation Location 2
10/31/2016 10:51	0.017	Correlation Location 2
10/31/2016 10:51	0.017	Correlation Location 2
10/31/2016 10:51	0.0169	Correlation Location 2
10/31/2016 10:51	0.017	Correlation Location 2
10/31/2016 10:51	0.0175	Correlation Location 2
10/31/2016 10:51	0.018	Correlation Location 2
10/31/2016 10:52	0.018	Correlation Location 2
10/31/2016 10:52	0.0182	Correlation Location 2
10/31/2016 10:52	0.0182	Correlation Location 2
10/31/2016 10:52	0.0177	Correlation Location 2
10/31/2016 10:52	0.0174	Correlation Location 2
10/31/2016 10:52	0.0174	Correlation Location 2
10/31/2016 10:52	0.0172	Correlation Location 2
10/31/2016 10:52	0.017	Correlation Location 2
10/31/2016 10:52	0.0166	Correlation Location 2
10/31/2016 10:52	0.017	Correlation Location 2
10/31/2016 10:53	0.0177	Correlation Location 2
10/31/2016 10:53	0.0173	Correlation Location 2
10/31/2016 10:53	0.0173	Correlation Location 2
10/31/2016 10:53	0.0174	Correlation Location 2
10/31/2016 10:53	0.0173	Correlation Location 2
10/31/2016 10:53	0.017	Correlation Location 2
10/31/2016 10:53	0.0168	Correlation Location 2
10/31/2016 10:53	0.0169	Correlation Location 2
10/31/2016 10:53	0.0169	Correlation Location 2
10/31/2016 10:53	0.017	Correlation Location 2
10/31/2016 10:54	0.0174	Correlation Location 2
10/31/2016 10:54	0.0177	Correlation Location 2
10/31/2016 10:54	0.0175	Correlation Location 2
10/31/2016 10:54	0.0172	Correlation Location 2
10/31/2016 10:54	0.0176	Correlation Location 2
10/31/2016 10:54	0.0177	Correlation Location 2
10/31/2016 10:54	0.0176	Correlation Location 2
10/31/2016 10:54	0.0172	Correlation Location 2
10/31/2016 10:54	0.017	Correlation Location 2
10/31/2016 10:54	0.0172	Correlation Location 2
10/31/2016 10:55	0.0174	Correlation Location 2
10/31/2016 10:55	0.0174	Correlation Location 2
10/31/2016 10:55	0.017	Correlation Location 2
10/31/2016 10:55	0.0173	Correlation Location 2
10/31/2016 10:55	0.0175	Correlation Location 2
10/31/2016 11:18	0.0555	Correlation Location 3
10/31/2016 11:18	0.0989	Correlation Location 3
10/31/2016 11:18	0.0893	Correlation Location 3
10/31/2016 11:18	0.0652	Correlation Location 3
10/31/2016 11:18	0.0467	Correlation Location 3
10/31/2016 11:19	0.0352	Correlation Location 3
10/31/2016 11:19	0.0287	Correlation Location 3
10/31/2016 11:19	0.0256	Correlation Location 3
10/31/2016 11:19	0.0245	Correlation Location 3
10/31/2016 11:19	0.0239	Correlation Location 3
10/31/2016 11:19	0.0237	Correlation Location 3

Date and Time	Exposure Rate (mR/h)	Location
10/31/2016 11:19	0.0232	Correlation Location 3
10/31/2016 11:19	0.023	Correlation Location 3
10/31/2016 11:19	0.023	Correlation Location 3
10/31/2016 11:19	0.0227	Correlation Location 3
10/31/2016 11:20	0.0225	Correlation Location 3
10/31/2016 11:20	0.0225	Correlation Location 3
10/31/2016 11:20	0.0225	Correlation Location 3
10/31/2016 11:20	0.0223	Correlation Location 3
10/31/2016 11:20	0.0225	Correlation Location 3
10/31/2016 11:20	0.0229	Correlation Location 3
10/31/2016 11:20	0.0229	Correlation Location 3
10/31/2016 11:20	0.0228	Correlation Location 3
10/31/2016 11:20	0.0227	Correlation Location 3
10/31/2016 11:20	0.0225	Correlation Location 3
10/31/2016 11:21	0.0225	Correlation Location 3
10/31/2016 11:21	0.0223	Correlation Location 3
10/31/2016 11:21	0.0223	Correlation Location 3
10/31/2016 11:21	0.0227	Correlation Location 3
10/31/2016 11:21	0.0227	Correlation Location 3
10/31/2016 11:21	0.0229	Correlation Location 3
10/31/2016 11:21	0.023	Correlation Location 3
10/31/2016 11:21	0.0231	Correlation Location 3
10/31/2016 11:21	0.0225	Correlation Location 3
10/31/2016 11:21	0.0225	Correlation Location 3
10/31/2016 11:22	0.0225	Correlation Location 3
10/31/2016 11:22	0.0225	Correlation Location 3
10/31/2016 11:22	0.0222	Correlation Location 3
10/31/2016 11:22	0.0223	Correlation Location 3
10/31/2016 11:22	0.0225	Correlation Location 3
10/31/2016 11:22	0.0223	Correlation Location 3
10/31/2016 11:22	0.0223	Correlation Location 3
10/31/2016 11:22	0.0225	Correlation Location 3
10/31/2016 11:22	0.0228	Correlation Location 3
10/31/2016 11:22	0.0229	Correlation Location 3
10/31/2016 11:23	0.0229	Correlation Location 3
10/31/2016 11:23	0.0225	Correlation Location 3
10/31/2016 11:23	0.0221	Correlation Location 3
10/31/2016 11:23	0.022	Correlation Location 3
10/31/2016 11:23	0.0219	Correlation Location 3
10/31/2016 11:23	0.0225	Correlation Location 3
10/31/2016 11:23	0.0231	Correlation Location 3
10/31/2016 11:23	0.023	Correlation Location 3
10/31/2016 11:23	0.0227	Correlation Location 3
10/31/2016 11:23	0.0225	Correlation Location 3
10/31/2016 11:24	0.0233	Correlation Location 3
10/31/2016 11:24	0.0237	Correlation Location 3
10/31/2016 11:24	0.024	Correlation Location 3
10/31/2016 11:24	0.024	Correlation Location 3
10/31/2016 11:24	0.0239	Correlation Location 3
10/31/2016 11:24	0.0237	Correlation Location 3
10/31/2016 11:24	0.0232	Correlation Location 3
10/31/2016 11:24	0.023	Correlation Location 3
10/31/2016 11:24	0.0227	Correlation Location 3
10/31/2016 11:24	0.0223	Correlation Location 3
10/31/2016 11:25	0.0223	Correlation Location 3
10/31/2016 11:25	0.0225	Correlation Location 3
10/31/2016 11:25	0.0232	Correlation Location 3
10/31/2016 11:25	0.0234	Correlation Location 3
10/31/2016 11:25	0.0233	Correlation Location 3
10/31/2016 11:25	0.023	Correlation Location 3
10/31/2016 11:25	0.0227	Correlation Location 3
10/31/2016 11:25	0.0227	Correlation Location 3
10/31/2016 11:25	0.0231	Correlation Location 3
10/31/2016 11:25	0.0229	Correlation Location 3
10/31/2016 11:26	0.0221	Correlation Location 3
10/31/2016 11:26	0.0219	Correlation Location 3
10/31/2016 11:26	0.0222	Correlation Location 3
10/31/2016 11:26	0.022	Correlation Location 3
10/31/2016 11:26	0.0222	Correlation Location 3
10/31/2016 11:26	0.0228	Correlation Location 3
10/31/2016 11:26	0.0227	Correlation Location 3
10/31/2016 11:26	0.0229	Correlation Location 3
10/31/2016 11:26	0.0232	Correlation Location 3
10/31/2016 11:26	0.0235	Correlation Location 3
10/31/2016 11:27	0.0231	Correlation Location 3
10/31/2016 11:27	0.023	Correlation Location 3
10/31/2016 11:27	0.0232	Correlation Location 3
10/31/2016 11:27	0.0232	Correlation Location 3
10/31/2016 11:27	0.0229	Correlation Location 3
10/31/2016 11:27	0.0225	Correlation Location 3
10/31/2016 11:27	0.0225	Correlation Location 3
10/31/2016 11:27	0.0227	Correlation Location 3
10/31/2016 11:27	0.0235	Correlation Location 3
10/31/2016 11:27	0.0235	Correlation Location 3
10/31/2016 11:28	0.0232	Correlation Location 3
10/31/2016 11:28	0.0227	Correlation Location 3
10/31/2016 11:28	0.0223	Correlation Location 3
10/31/2016 11:28	0.0223	Correlation Location 3
10/31/2016 11:28	0.0227	Correlation Location 3
10/31/2016 11:28	0.0231	Correlation Location 3
10/31/2016 11:28	0.0225	Correlation Location 3
10/31/2016 11:28	0.0222	Correlation Location 3
10/31/2016 11:28	0.0219	Correlation Location 3
10/31/2016 11:28	0.0219	Correlation Location 3
10/31/2016 11:29	0.022	Correlation Location 3
10/31/2016 11:29	0.0223	Correlation Location 3
10/31/2016 11:29	0.0223	Correlation Location 3
10/31/2016 11:44	0.0573	Correlation Location 4
10/31/2016 11:45	0.1036	Correlation Location 4
10/31/2016 11:45	0.097	Correlation Location 4
10/31/2016 11:45	0.0744	Correlation Location 4
10/31/2016 11:45	0.0564	Correlation Location 4
10/31/2016 11:45	0.0451	Correlation Location 4
10/31/2016 11:45	0.0389	Correlation Location 4
10/31/2016 11:45	0.0357	Correlation Location 4
10/31/2016 11:45	0.0346	Correlation Location 4
10/31/2016 11:45	0.0341	Correlation Location 4
10/31/2016 11:45	0.0339	Correlation Location 4
10/31/2016 11:46	0.0339	Correlation Location 4
10/31/2016 11:46	0.0341	Correlation Location 4
10/31/2016 11:46	0.0343	Correlation Location 4
10/31/2016 11:46	0.0346	Correlation Location 4
10/31/2016 11:46	0.0346	Correlation Location 4
10/31/2016 11:46	0.0341	Correlation Location 4

Mitten No. 3 Exposure Rate Measurements for Correlation

Date and Time	Exposure Rate (mR/h)	Location
10/31/2016 11:46	0.0341	Correlation Location 4
10/31/2016 11:46	0.0346	Correlation Location 4
10/31/2016 11:46	0.0346	Correlation Location 4
10/31/2016 11:46	0.0345	Correlation Location 4
10/31/2016 11:47	0.0344	Correlation Location 4
10/31/2016 11:47	0.0341	Correlation Location 4
10/31/2016 11:47	0.0339	Correlation Location 4
10/31/2016 11:47	0.0339	Correlation Location 4
10/31/2016 11:47	0.034	Correlation Location 4
10/31/2016 11:47	0.034	Correlation Location 4
10/31/2016 11:47	0.0337	Correlation Location 4
10/31/2016 11:47	0.0328	Correlation Location 4
10/31/2016 11:47	0.0319	Correlation Location 4
10/31/2016 11:47	0.0312	Correlation Location 4
10/31/2016 11:48	0.0309	Correlation Location 4
10/31/2016 11:48	0.0308	Correlation Location 4
10/31/2016 11:48	0.0307	Correlation Location 4
10/31/2016 11:48	0.0308	Correlation Location 4
10/31/2016 11:48	0.0317	Correlation Location 4
10/31/2016 11:48	0.0322	Correlation Location 4
10/31/2016 11:48	0.0322	Correlation Location 4
10/31/2016 11:48	0.0324	Correlation Location 4
10/31/2016 11:48	0.0326	Correlation Location 4
10/31/2016 11:48	0.033	Correlation Location 4
10/31/2016 11:49	0.0332	Correlation Location 4
10/31/2016 11:49	0.0331	Correlation Location 4
10/31/2016 11:49	0.0331	Correlation Location 4
10/31/2016 11:49	0.0332	Correlation Location 4
10/31/2016 11:49	0.033	Correlation Location 4
10/31/2016 11:49	0.033	Correlation Location 4
10/31/2016 11:49	0.0337	Correlation Location 4
10/31/2016 11:49	0.034	Correlation Location 4
10/31/2016 11:49	0.0337	Correlation Location 4
10/31/2016 11:49	0.0335	Correlation Location 4
10/31/2016 11:50	0.0326	Correlation Location 4
10/31/2016 11:50	0.0321	Correlation Location 4
10/31/2016 11:50	0.0324	Correlation Location 4
10/31/2016 11:50	0.033	Correlation Location 4
10/31/2016 11:50	0.0335	Correlation Location 4
10/31/2016 11:50	0.0336	Correlation Location 4
10/31/2016 11:50	0.0336	Correlation Location 4
10/31/2016 11:50	0.0332	Correlation Location 4
10/31/2016 11:50	0.0327	Correlation Location 4
10/31/2016 11:50	0.0328	Correlation Location 4
10/31/2016 11:51	0.0328	Correlation Location 4
10/31/2016 11:51	0.0324	Correlation Location 4
10/31/2016 11:51	0.0327	Correlation Location 4
10/31/2016 11:51	0.033	Correlation Location 4
10/31/2016 11:51	0.0332	Correlation Location 4
10/31/2016 11:51	0.0336	Correlation Location 4
10/31/2016 11:51	0.0337	Correlation Location 4
10/31/2016 11:51	0.034	Correlation Location 4
10/31/2016 11:51	0.0339	Correlation Location 4
10/31/2016 11:51	0.0332	Correlation Location 4
10/31/2016 11:52	0.0332	Correlation Location 4
10/31/2016 11:52	0.0334	Correlation Location 4
10/31/2016 11:52	0.0336	Correlation Location 4
10/31/2016 11:52	0.0336	Correlation Location 4
10/31/2016 11:52	0.0336	Correlation Location 4
10/31/2016 11:52	0.0335	Correlation Location 4
10/31/2016 11:52	0.0335	Correlation Location 4
10/31/2016 11:52	0.0334	Correlation Location 4
10/31/2016 11:52	0.0331	Correlation Location 4
10/31/2016 11:52	0.0327	Correlation Location 4
10/31/2016 11:53	0.0328	Correlation Location 4
10/31/2016 11:53	0.0327	Correlation Location 4
10/31/2016 11:53	0.0321	Correlation Location 4
10/31/2016 11:53	0.0322	Correlation Location 4
10/31/2016 11:53	0.0322	Correlation Location 4
10/31/2016 11:53	0.0322	Correlation Location 4
10/31/2016 11:53	0.0326	Correlation Location 4
10/31/2016 11:53	0.0332	Correlation Location 4
10/31/2016 11:53	0.0334	Correlation Location 4
10/31/2016 11:53	0.0331	Correlation Location 4
10/31/2016 11:54	0.0331	Correlation Location 4
10/31/2016 11:54	0.0328	Correlation Location 4
10/31/2016 11:54	0.0324	Correlation Location 4
10/31/2016 11:54	0.0324	Correlation Location 4
10/31/2016 11:54	0.0328	Correlation Location 4
10/31/2016 11:54	0.0328	Correlation Location 4
10/31/2016 11:54	0.0332	Correlation Location 4
10/31/2016 11:54	0.0339	Correlation Location 4
10/31/2016 11:54	0.034	Correlation Location 4
10/31/2016 11:54	0.034	Correlation Location 4
10/31/2016 11:55	0.034	Correlation Location 4
10/31/2016 11:55	0.0339	Correlation Location 4
10/31/2016 11:55	0.0336	Correlation Location 4
10/31/2016 11:55	0.0334	Correlation Location 4
10/31/2016 11:55	0.0335	Correlation Location 4
10/31/2016 11:55	0.0335	Correlation Location 4
10/31/2016 11:55	0.0331	Correlation Location 4
10/31/2016 11:55	0.0327	Correlation Location 4
10/31/2016 11:55	0.0326	Correlation Location 4
10/31/2016 12:41	0.0531	Correlation Location 5
10/31/2016 12:41	0.0924	Correlation Location 5
10/31/2016 12:41	0.0801	Correlation Location 5
10/31/2016 12:42	0.0544	Correlation Location 5
10/31/2016 12:42	0.0352	Correlation Location 5
10/31/2016 12:42	0.0237	Correlation Location 5
10/31/2016 12:42	0.017	Correlation Location 5
10/31/2016 12:42	0.0136	Correlation Location 5
10/31/2016 12:42	0.0118	Correlation Location 5
10/31/2016 12:42	0.0112	Correlation Location 5
10/31/2016 12:42	0.0108	Correlation Location 5
10/31/2016 12:42	0.0106	Correlation Location 5
10/31/2016 12:42	0.0105	Correlation Location 5
10/31/2016 12:43	0.01	Correlation Location 5
10/31/2016 12:43	0.0099	Correlation Location 5
10/31/2016 12:43	0.0103	Correlation Location 5
10/31/2016 12:43	0.0108	Correlation Location 5
10/31/2016 12:43	0.0105	Correlation Location 5
10/31/2016 12:43	0.0105	Correlation Location 5
10/31/2016 12:43	0.0105	Correlation Location 5
10/31/2016 12:43	0.0104	Correlation Location 5

Date and Time	Exposure Rate (mR/h)	Location
10/31/2016 12:43	0.0102	Correlation Location 5
10/31/2016 12:43	0.0103	Correlation Location 5
10/31/2016 12:44	0.0104	Correlation Location 5
10/31/2016 12:44	0.0105	Correlation Location 5
10/31/2016 12:44	0.0103	Correlation Location 5
10/31/2016 12:44	0.0103	Correlation Location 5
10/31/2016 12:44	0.0102	Correlation Location 5
10/31/2016 12:44	0.0102	Correlation Location 5
10/31/2016 12:44	0.0105	Correlation Location 5
10/31/2016 12:44	0.0103	Correlation Location 5
10/31/2016 12:44	0.0105	Correlation Location 5
10/31/2016 12:44	0.0106	Correlation Location 5
10/31/2016 12:45	0.0108	Correlation Location 5
10/31/2016 12:45	0.0108	Correlation Location 5
10/31/2016 12:45	0.0108	Correlation Location 5
10/31/2016 12:45	0.0106	Correlation Location 5
10/31/2016 12:45	0.0109	Correlation Location 5
10/31/2016 12:45	0.0108	Correlation Location 5
10/31/2016 12:45	0.0108	Correlation Location 5
10/31/2016 12:45	0.0105	Correlation Location 5
10/31/2016 12:45	0.0105	Correlation Location 5
10/31/2016 12:45	0.0109	Correlation Location 5
10/31/2016 12:46	0.0109	Correlation Location 5
10/31/2016 12:46	0.0105	Correlation Location 5
10/31/2016 12:46	0.0104	Correlation Location 5
10/31/2016 12:46	0.0104	Correlation Location 5
10/31/2016 12:46	0.0105	Correlation Location 5
10/31/2016 12:46	0.0105	Correlation Location 5
10/31/2016 12:46	0.0105	Correlation Location 5
10/31/2016 12:46	0.0105	Correlation Location 5
10/31/2016 12:46	0.0105	Correlation Location 5
10/31/2016 12:46	0.0105	Correlation Location 5
10/31/2016 12:47	0.0105	Correlation Location 5
10/31/2016 12:47	0.0105	Correlation Location 5
10/31/2016 12:47	0.0105	Correlation Location 5
10/31/2016 12:47	0.0106	Correlation Location 5
10/31/2016 12:47	0.0104	Correlation Location 5
10/31/2016 12:47	0.0099	Correlation Location 5
10/31/2016 12:47	0.0098	Correlation Location 5
10/31/2016 12:47	0.0098	Correlation Location 5
10/31/2016 12:47	0.0103	Correlation Location 5
10/31/2016 12:47	0.0105	Correlation Location 5
10/31/2016 12:48	0.0108	Correlation Location 5
10/31/2016 12:48	0.0106	Correlation Location 5
10/31/2016 12:48	0.0104	Correlation Location 5
10/31/2016 12:48	0.0102	Correlation Location 5
10/31/2016 12:48	0.01	Correlation Location 5
10/31/2016 12:48	0.0102	Correlation Location 5
10/31/2016 12:48	0.0105	Correlation Location 5
10/31/2016 12:48	0.0105	Correlation Location 5
10/31/2016 12:48	0.0105	Correlation Location 5
10/31/2016 12:48	0.0108	Correlation Location 5
10/31/2016 12:49	0.0108	Correlation Location 5
10/31/2016 12:49	0.0108	Correlation Location 5
10/31/2016 12:49	0.0104	Correlation Location 5
10/31/2016 12:49	0.01	Correlation Location 5
10/31/2016 12:49	0.0103	Correlation Location 5
10/31/2016 12:49	0.0105	Correlation Location 5
10/31/2016 12:49	0.0108	Correlation Location 5
10/31/2016 12:49	0.0108	Correlation Location 5
10/31/2016 12:49	0.0108	Correlation Location 5
10/31/2016 12:49	0.0106	Correlation Location 5
10/31/2016 12:50	0.0103	Correlation Location 5
10/31/2016 12:50	0.0103	Correlation Location 5
10/31/2016 12:50	0.0105	Correlation Location 5
10/31/2016 12:50	0.0105	Correlation Location 5
10/31/2016 12:50	0.0108	Correlation Location 5
10/31/2016 12:50	0.0111	Correlation Location 5
10/31/2016 12:50	0.0109	Correlation Location 5
10/31/2016 12:50	0.0108	Correlation Location 5
10/31/2016 12:50	0.0106	Correlation Location 5
10/31/2016 12:50	0.0105	Correlation Location 5
10/31/2016 12:51	0.0109	Correlation Location 5
10/31/2016 12:51	0.0112	Correlation Location 5
10/31/2016 12:51	0.0114	Correlation Location 5
10/31/2016 12:51	0.0108	Correlation Location 5
10/31/2016 12:51	0.0102	Correlation Location 5
10/31/2016 12:51	0.0099	Correlation Location 5
10/31/2016 12:51	0.0099	Correlation Location 5
10/31/2016 12:51	0.01	Correlation Location 5
10/31/2016 12:51	0.0102	Correlation Location 5
10/31/2016 12:51	0.0103	Correlation Location 5
10/31/2016 12:52	0.0103	Correlation Location 5
10/31/2016 12:52	0.0103	Correlation Location 5
10/31/2016 12:52	0.0102	Correlation Location 5
10/31/2016 12:52	0.01	Correlation Location 5
10/31/2016 12:52	0.0102	Correlation Location 5

Mitten No. 3 Exposure Rate Measurements for Correlation

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.

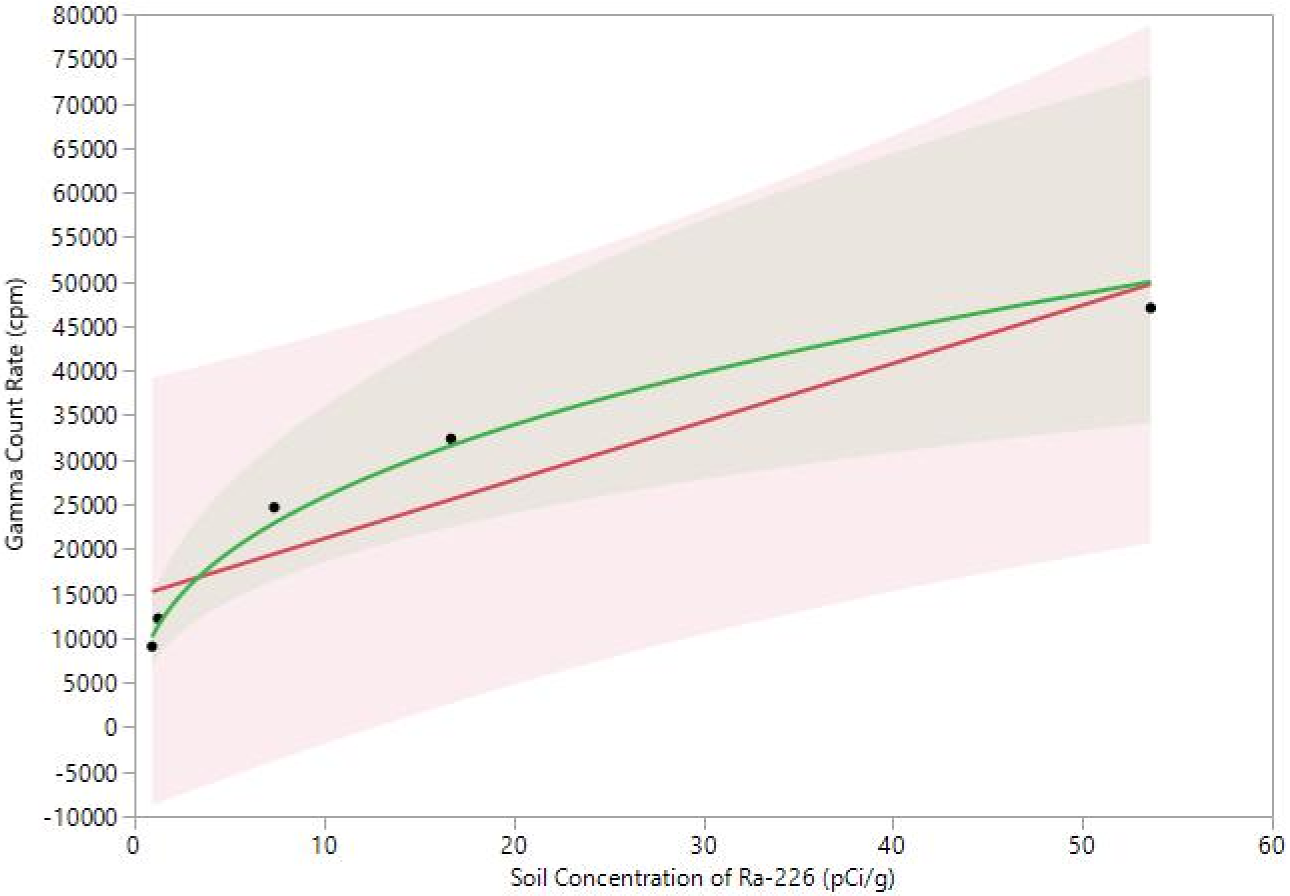

Figure 1. Regression models (linear versus power curve) for gamma count rate regressed on radium-226 showing 95% UPLs (upper prediction limits). Both models meet the study DQO for adjusted R^2 (greater than 0.8). Gamma count rate is not an especially strong predictor of soil concentration of radium-226 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.

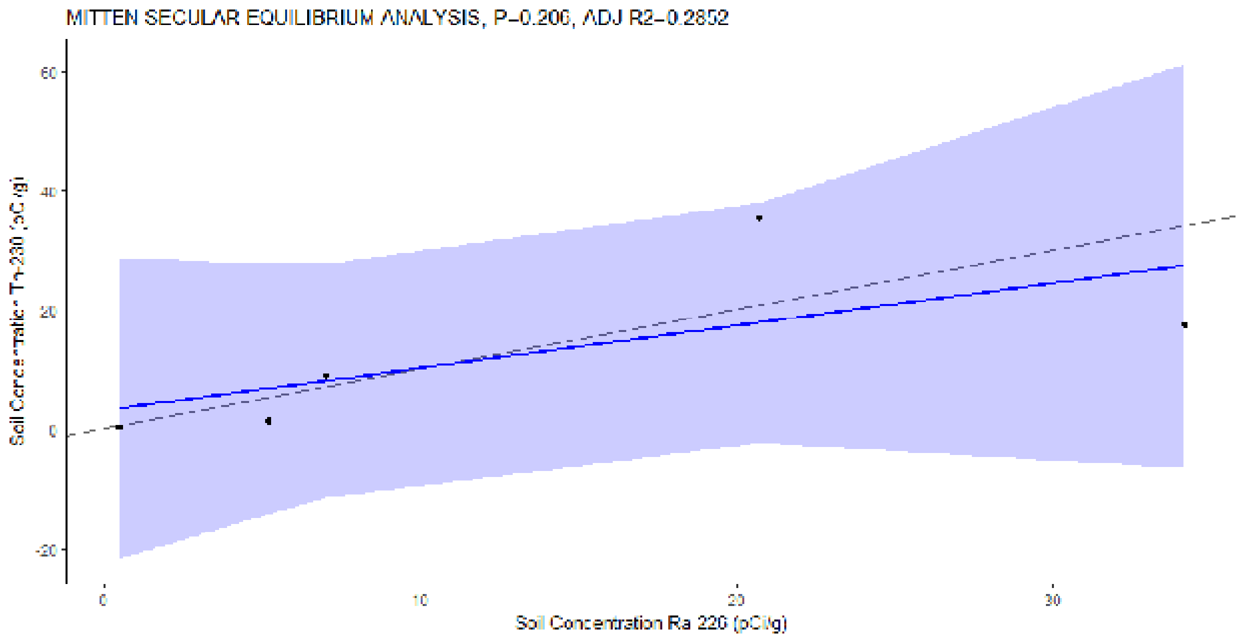

Figure 2. Result for Mitten secular equilibrium analysis, showing failure to meet p-value and adjusted R^2 criteria, i.e., the data are poorly correlated.

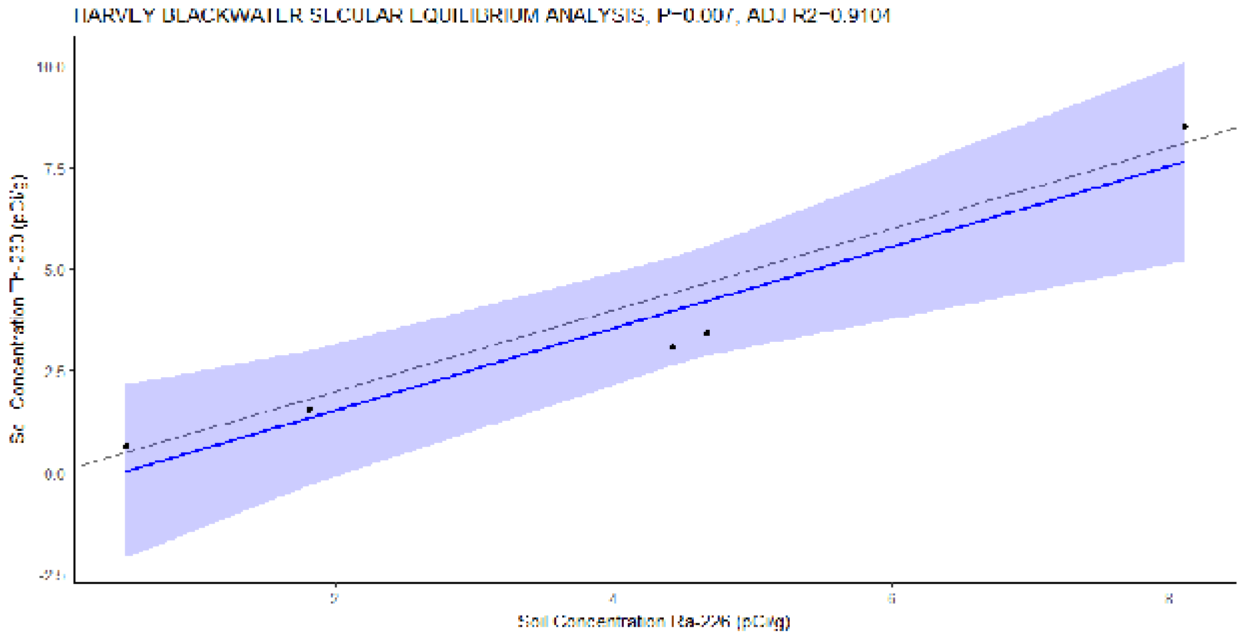

Figure 3. Result for Harvey Blackwater secular equilibrium analysis, showing excellent correlation between the data and the y=x line, i.e., Th-230 and Ra-226 are in secular equilibrium.

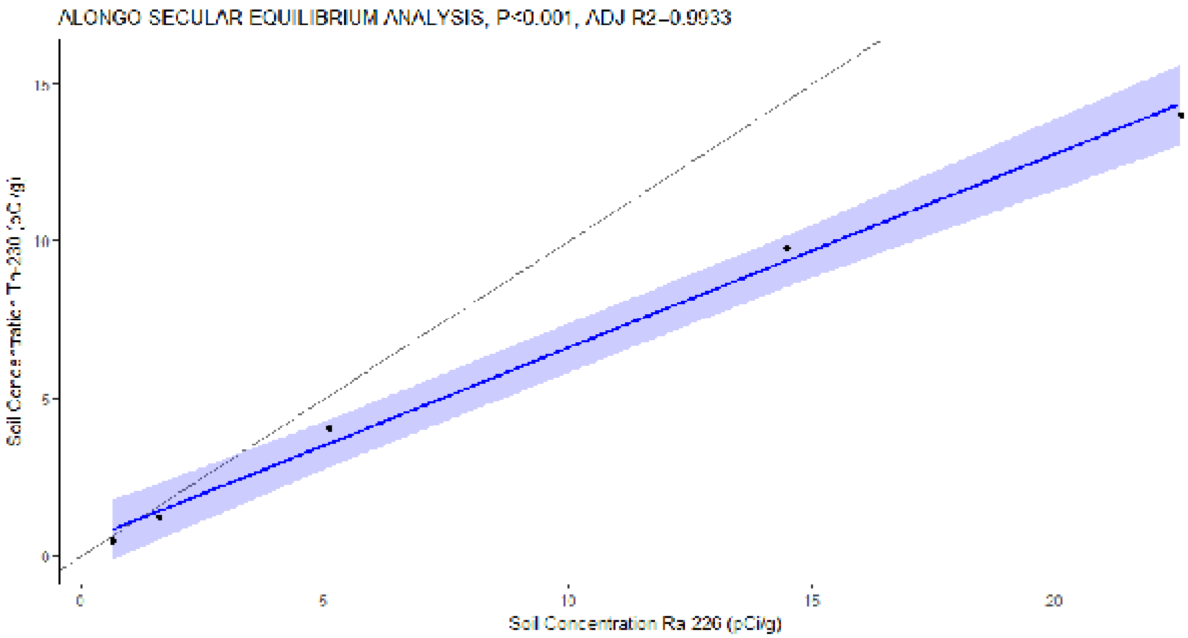

Figure 4. Result for Alongo Mines secular equilibrium analysis, showing excellent correlation between the data, but poor agreement with the y=x line, i.e., Th-230 and Ra-226 are in equilibrium, but not secular equilibrium.

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 "Radiological Characterization of the Mitten No.3 Abandoned Uranium Mine"

Disclaimer: Data and analytical methods used in this Preliminary Report are superseded by the Final Report.

Radiological Characterization of the Mitten No. 3 Abandoned Uranium Mine

Preliminary

February 22, 2018

prepared for:

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Contents

Tables

Figures

Appendices

Acronyms

ANSI	American National Standards Institute
AUM	abandoned uranium mine
BG1	Background Reference Area 1
BG2	Background Reference Area 2
CK-BG2	Charles Keith Background Reference Area 2
cpm	counts per minute
DQOs	data quality objectives
EPA	U.S. Environmental Protection Agency
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 Mitten No. 3 abandoned uranium mine (AUM) located in the Oljato Chapter of the Navajo Nation in Monument Valley, Utah. 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) in accordance with the Navajo Nation AUM Environmental Response Trust – First Phase.

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 field activities addressed in this report were conducted on May 4 and October 28, 29, and 31, 2016; and May 23, 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; 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 “Mitten No. 3 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 count rates were observed largely on waste piles extending away from a portal in the mine claim.
- Three 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:

$$\text{Radium-226 Concentration (picocuries per gram [pCi/g])} = 3\text{x}10^{-9}\text{ x Gamma Count Rate (in counts per minute [cpm])}^{2.1522}$$

- 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 300, with a central tendency (median) of 1.2 pCi/g.

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

- The status of equilibrium in the uranium series radionuclides is inconclusive, based on the results of the correlation samples.

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

  Exposure Rate (microRoentgens per hour [µR/h]) = Gamma Count Rate (cpm) x 5×10^{-4} + 6.1119

- The distribution of exposure rates predicted using this model resembles a lognormal distribution. The values in the Survey Area range from 8.2 to 70.7, with a central tendency (median) of 11.0 µR/h.

1.0 Introduction

This report addresses the radiological characterization of the Mitten No. 3 abandoned uranium mine (AUM) located in the Oljato Chapter of the Navajo Nation in Monument Valley, Utah. 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) in accordance with the Navajo Nation AUM Environmental Response Trust – First Phase.

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 field activities addressed in this report were conducted on May 4 and October 28, 29, and 31, 2016; and May 23, 2017. They included a GPS-based radiological survey of land surfaces over an approximately 9-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; 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 continuing RSE are addressed in “Mitten No. 3 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 “Mitten No. 3 Removal Site Evaluation Report” (Stantec, 2018).

2.0 GPS-Based Gamma Surveys

This section addresses the GPS-based surveys conducted in three 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.

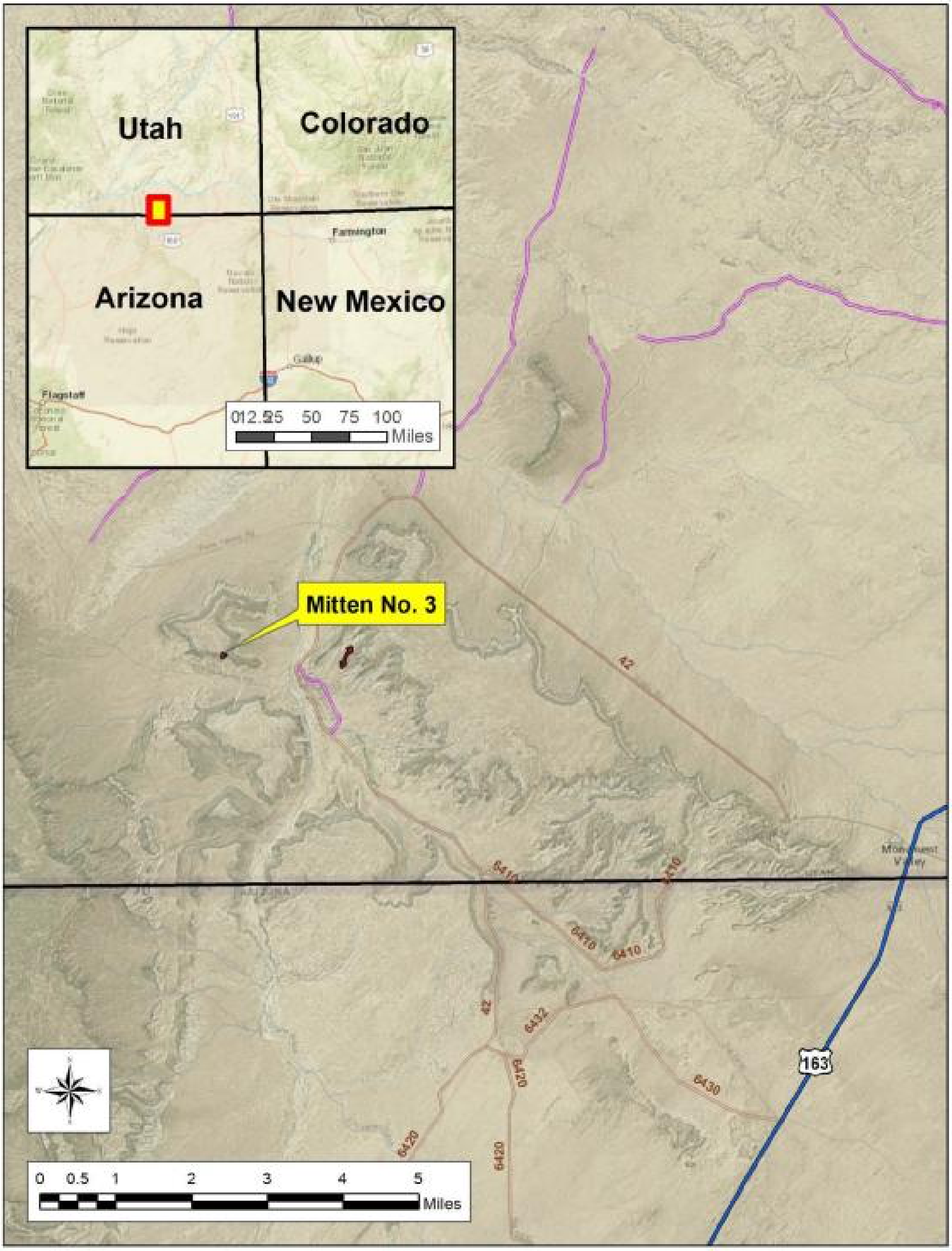


Figure 1. Location of the Mitten No. 3 Abandoned Uranium Mine

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	254772
	PR320678	282971
Survey Area	PR154615[a]	138368[a]
	PR303727	254772
	PR295014	196086

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

2.1 Potential Background Reference Areas

Three potential Background Reference Areas were surveyed, the locations and results of which are depicted on Figure 2. BG1 and BG2 in the figure are Background Reference Areas 1 and 2, respectively. Charles Keith Background Reference Area 2 (CK-BG2) is the third Background Reference Area in the figure. Figure 2 shows the claim area of AUM Charles Keith for reference.

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

- BG1 ranged from 6,873 to 15,394 counts per minute (cpm), with a mean and median of 10,304 and 10,326 cpm, respectively.
- BG2 ranged from 7,444 to 9,371 cpm, with a mean and median of 8,374 and 8,317 cpm, respectively.
- CK-BG2 ranged from 6,349 to 12,135 cpm, with a mean and median of 8,898 and 8,726 cpm, respectively.

Figure 3 depicts histograms of the gamma count rates in BG1, BG2, and BG3. 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
BG1	303	6,873	15,394	10,304	10,326	1,409
BG2	156	7,444	9,371	8,374	8,317	429
CK-BG2	199	6,349	12,135	8,898	8,726	1,265

Notes:
cpm = counts per minute

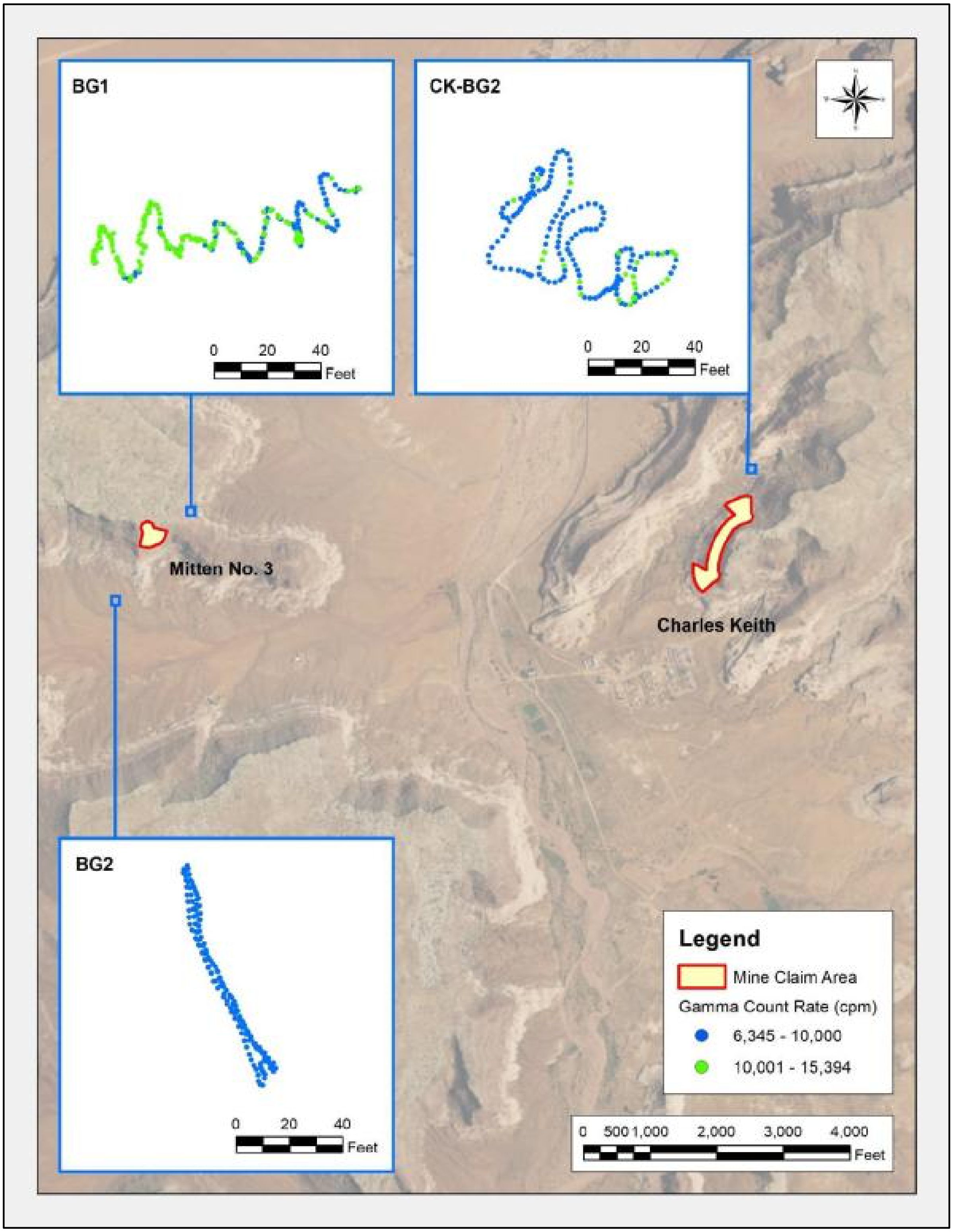
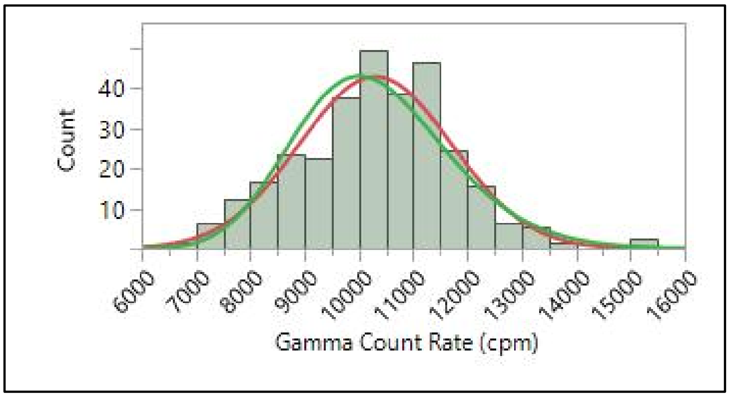
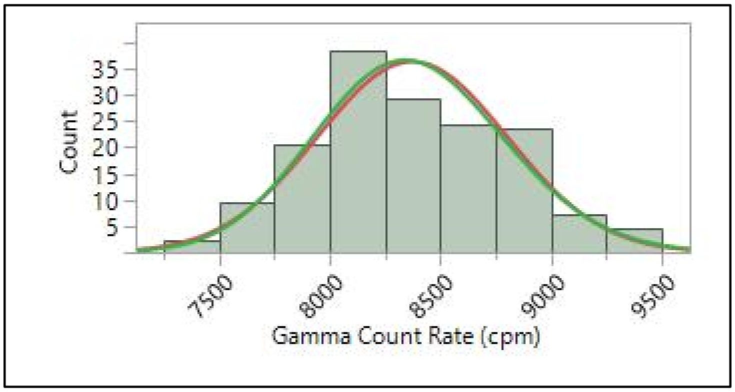


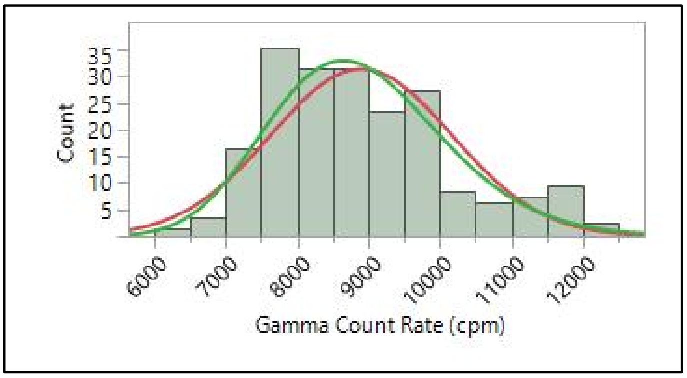
Figure 2. Gamma count rates in the potential Background Reference Areas.



a. **Background Reference Area BG1**



b. **Background Reference Area BG2**



c. **Background Reference Area** CK-BG2

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

2.2 Survey Area

The gamma count rates observed in the Survey Area are depicted in Figure 4. Elevated count rates were observed largely on waste piles extending away from a portal in the mine claim.

Figure 5 is a histogram of the gamma count rate measurements made in the Survey Area, including the area surveyed outside the 100-ft buffer. As stated in Section 2.1, 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 discernible; 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 8,327, 9,860, and 12,059 cpm, respectively.

Table 3 is a statistical summary of the measurements, which range from 4,266 to 129,220 cpm and have a central tendency (median) of 9,860 cpm.

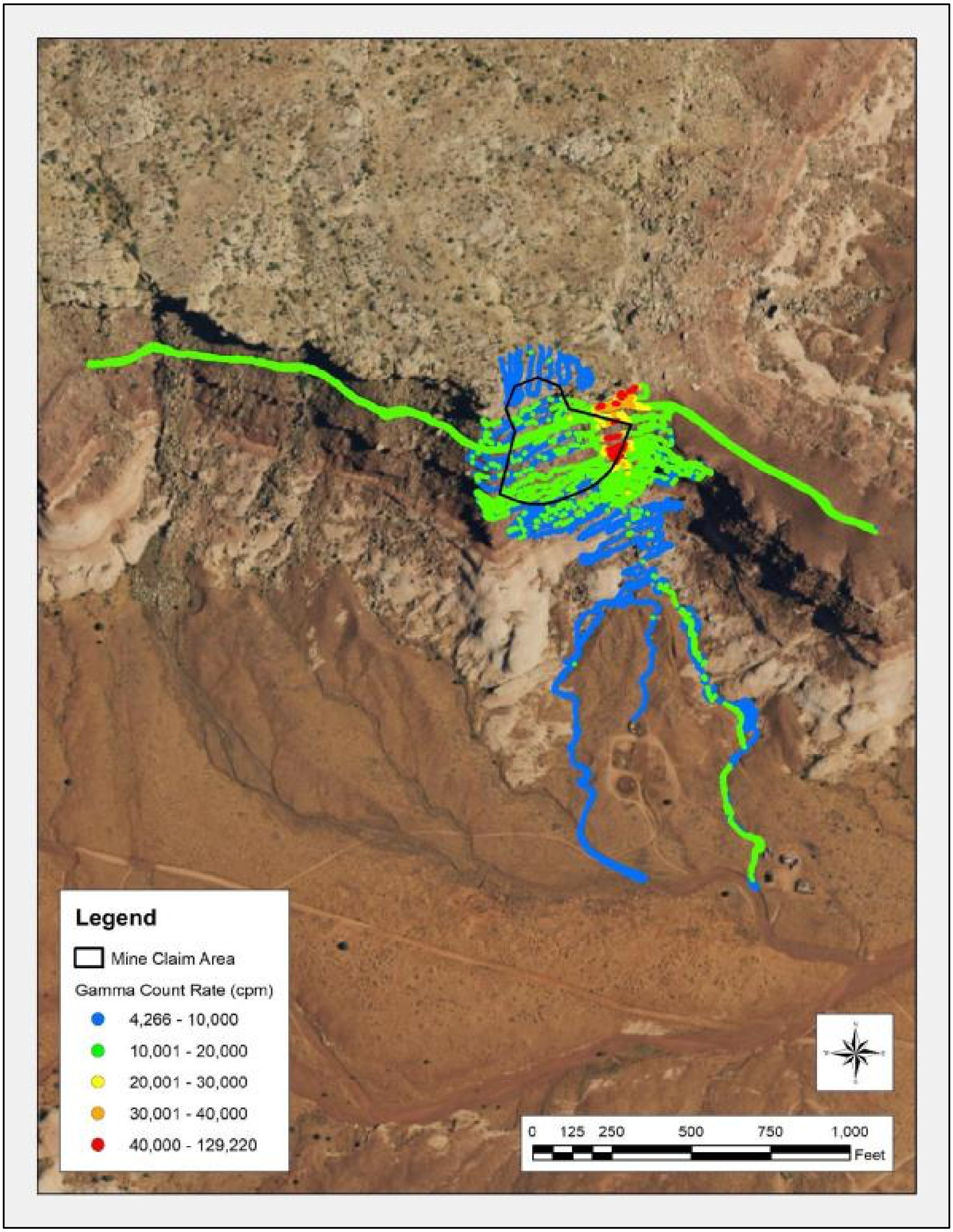


Figure 4. Gamma count rates in the Survey Area.

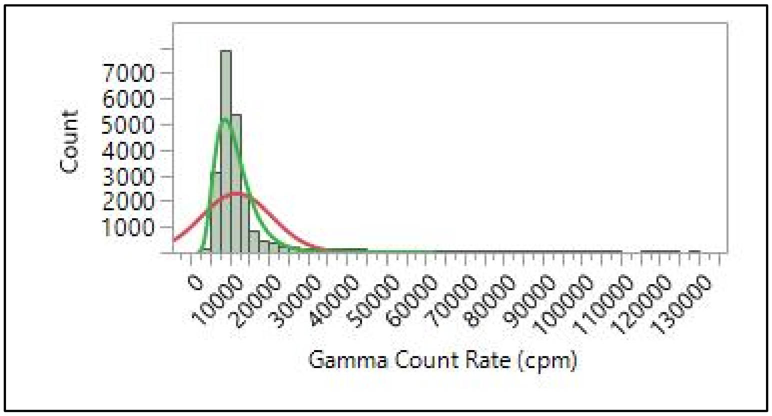


Figure 5. Histogram of gamma count rates in the Survey Area.

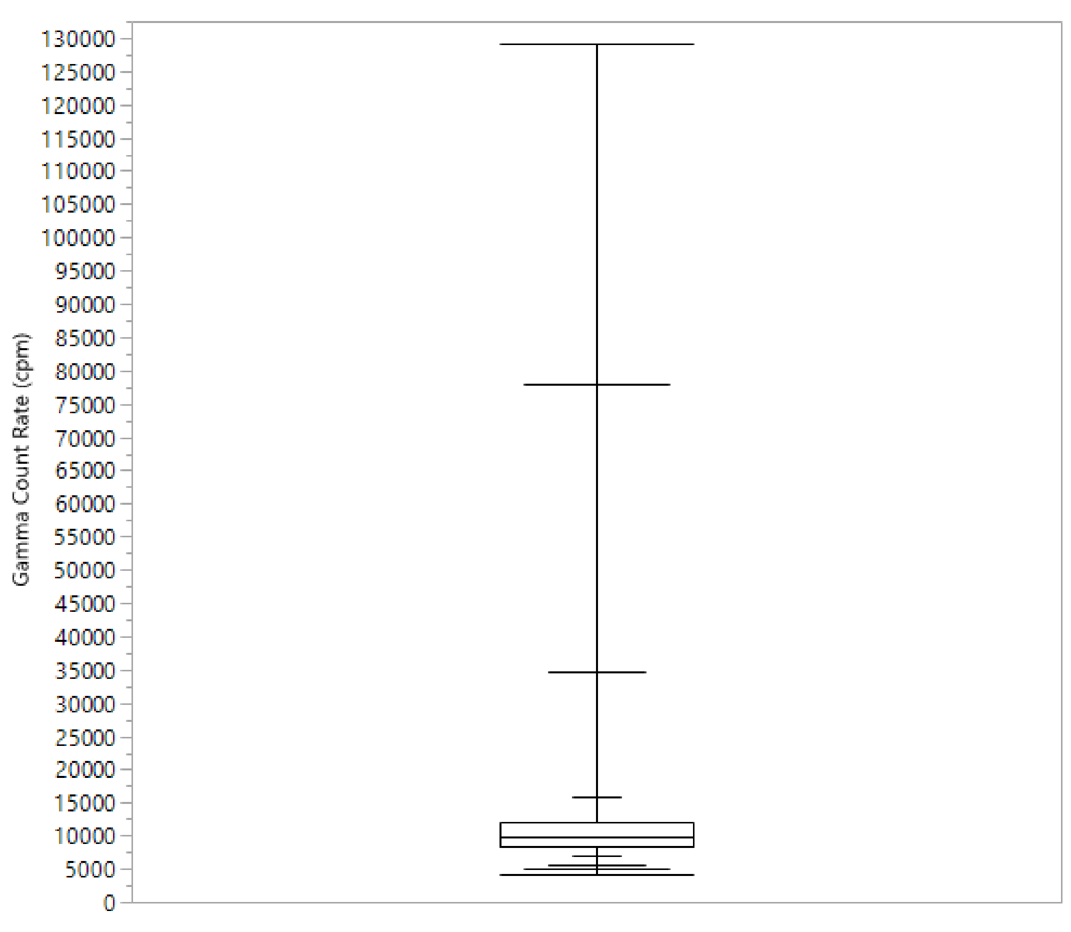


Figure 6. Box plot of gamma count rates in the Survey Area.

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

Parameter	Gamma Count Rate (cpm)
n	20,950
Minimum	4,266
Maximum	129,220
Mean	11,868
Median	9,860
Standard Deviation	9,134

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 31, 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 8,354 to 48,808 cpm. The concentrations of radium-226 range from 0.49 to 34.2 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 "Mitten No. 3 Removal Site Evaluation Report" (Stantec, 2018).

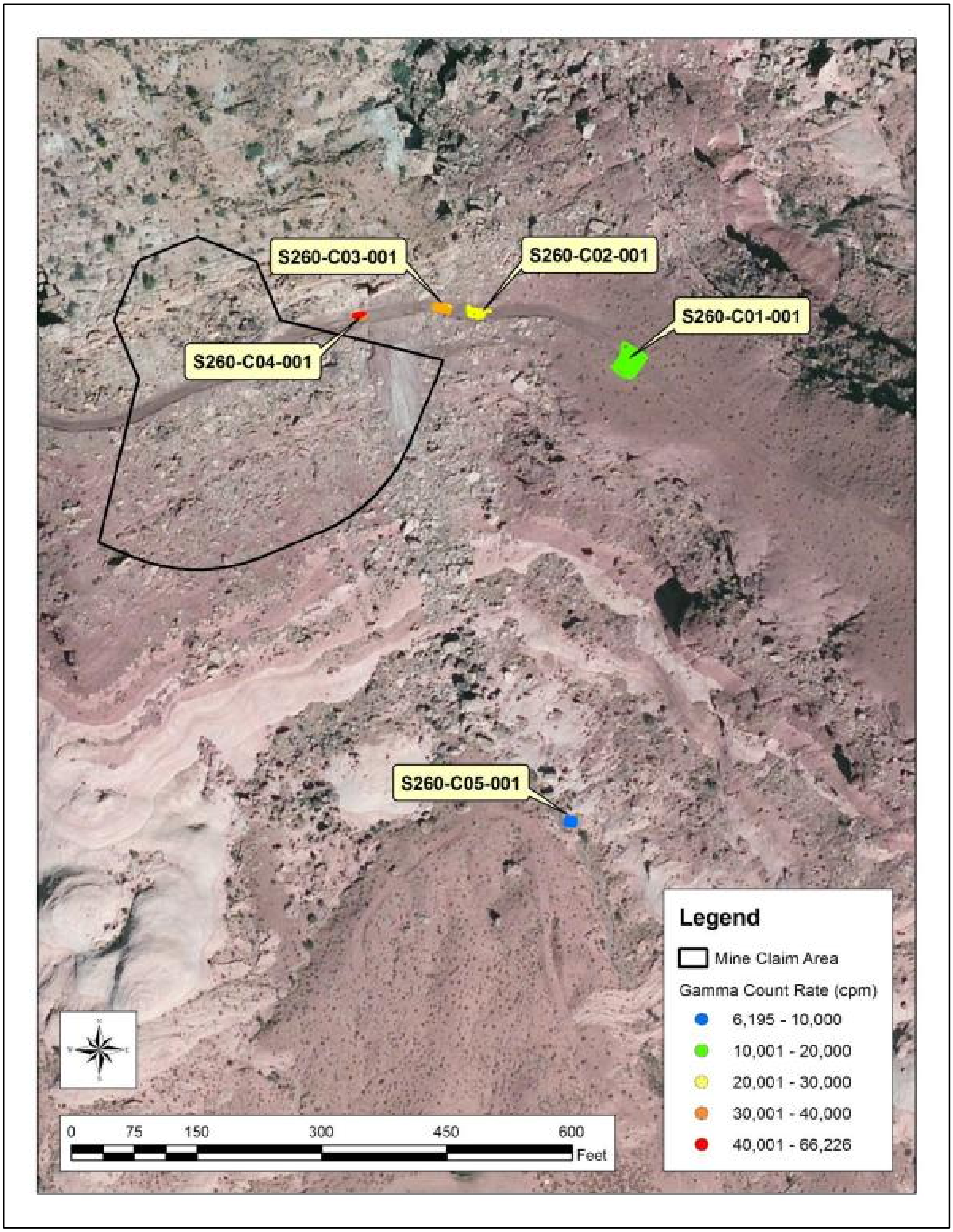


Figure 7. GPS-based gamma count rate measurements made for the correlation study.

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
S260-C01-001	13,512	11,659	15,742	825	5.18	0.73	0.53
S260-C02-001	20,520	16,685	24,115	1,297	7.02	0.93	0.51
S260-C03-001	32,533	27,975	37,060	2,064	34.2	4.2	1
S260-C04-001	48,808	32,841	66,226	10,167	20.7	2.5	0.6
S260-C05-001	8,354	6,195	9,984	676	0.49	0.2	0.38

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
S260-C01-001	0.94	0.17	0.05	1.42	0.24	0.07	0.96	0.17	0.03
S260-C02-001	0.93	0.17	0.05	8.8	1.4	0.1	0.99	0.17	0.01
S260-C03-001	0.84	0.16	0.05	17.5	2.7	0.1	0.76	0.14	0.01
S260-C04-001	0.72	0.13	0.05	35.4	5.4	0.1	0.66	0.12	0.01
S260-C05-001	0.443	0.091	0.049	0.405	0.089	0.065	0.468	0.091	0.024

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 0.8314, as expressed in the equation:

$$\text{Radium-226 concentration (pCi/g)} = 3 \times 10^{-9} \times \text{Gamma Count Rate (cpm)}^{2.1522}$$

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 0.779851 and 0.0309, 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 0.99 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 300 pCi/g, with a mean and median of 3.2 and 1.2 pCi/g, respectively. Note that the radium-226 concentrations predicted from gamma count rate measurements exceeding approximately 49,000 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.

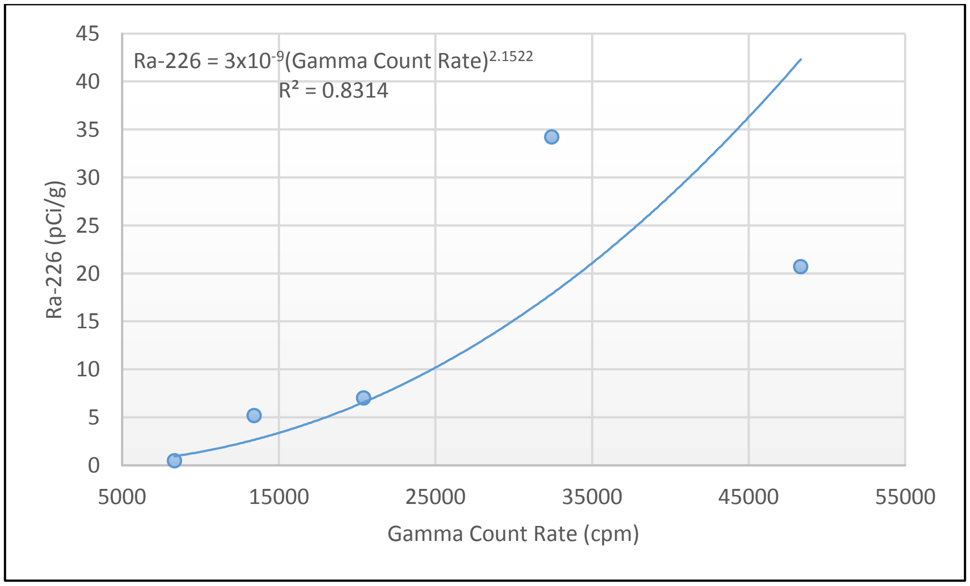


Figure 8. Correlation of gamma count rates and concentrations of radium-226 in surface soils.

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

Parameter	Radium-226 (pCi/g)
n	20,950
Minimum	0.2
Maximum	300
Mean	3.2
Median	1.2
Standard Deviation	13.0

Notes:
pCi/g = picocuries per gram

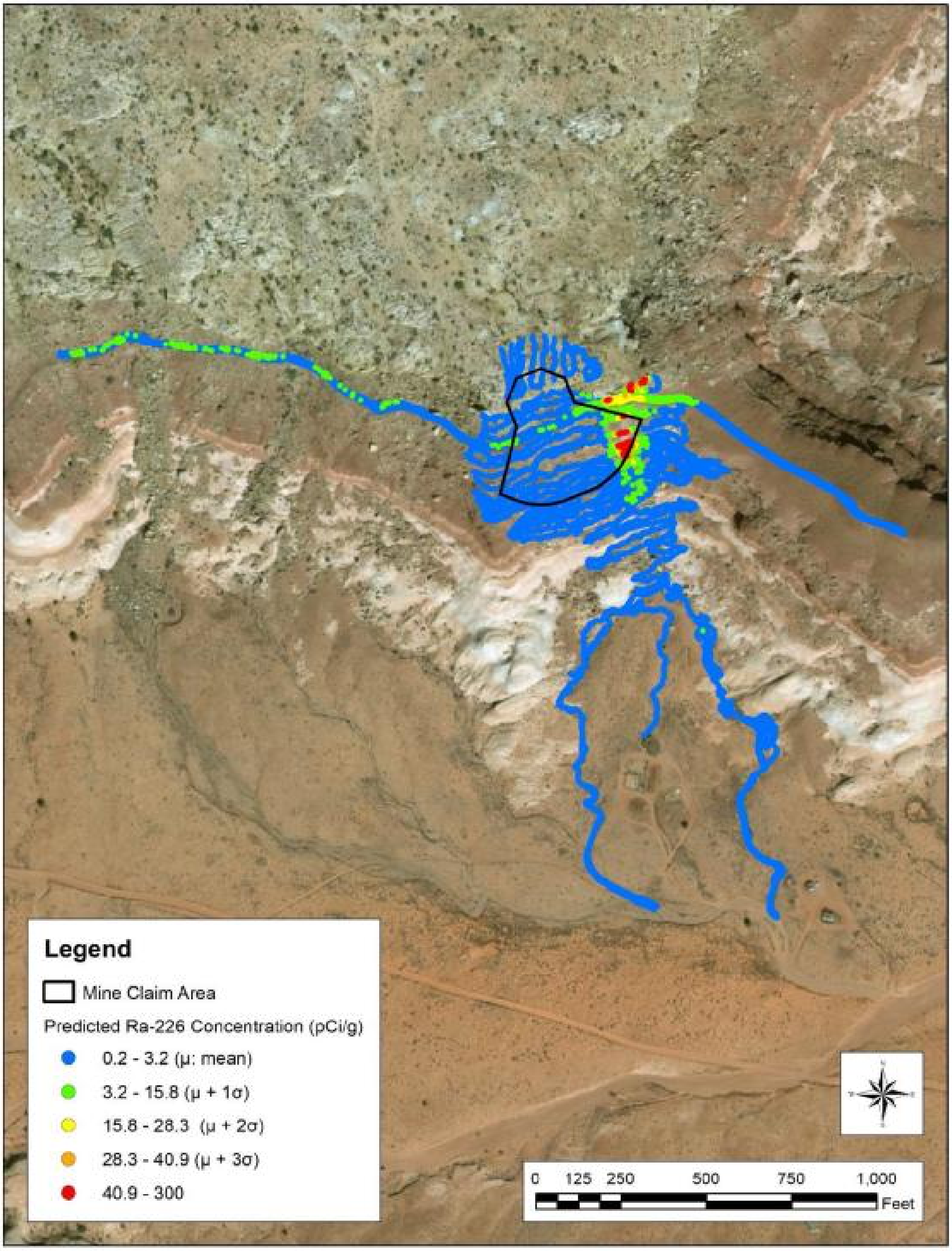


Figure 9. Predicted concentrations of radium-226 in the Survey Area.

3.2 Equilibrium in the uranium series

Secular equilibrium occurs when the activities of a parent radionuclide and its decay product 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 3.6 (Sample S260-C01-001), 0.8 (Sample S260-C02-001), 2.0 (Sample S260-C03-001), 0.6 (Sample S260-C04-001), and 1.2 (Sample S260-C05-001). The results of these samples indicate that the relationship between the two radionuclides and status of equilibrium in the uranium series at this AUM is inconclusive.

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 5 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 31, 2016 at 0.5 m and 1 m above the ground surface, respectively. The gamma count rate measurements were made using one of the sodium iodide detection systems used in the GPS-based gamma survey of the AUM (Serial Number PR154615/138368). 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 B presents the individual (one second) exposure rate measurements.

The best predictive relationship between the measurements is linear with a R^2 of 0.9891, strongly indicating a positive correlation. The root mean square error and p-value for the model are 1.069703 and 0.0005, 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:

$$\text{Exposure Rate (microRoentgens per hour [}\mu\text{R/h]) = } 5\text{x}10^{-4} \text{ x Gamma Count Rate (cpm) + 6.1119}$$

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.

The range of predicted exposure rates at:

- BG1 is 9.5 to 13.8 µR/h, with a mean and median of 11.3 µR/h
- BG2 is 9.8 to 10.8 µR/h, with a mean and median of 10.3 µR/h
- CK-BG2 is 9.3 to 12.2 µR/h, with a mean and median of 10.6 and 10.5 µR/h, respectively.

The range of predicted exposure rates in the Survey Area is 8.2 to 70.7 µR/h, with a mean and median of 12.0 and 11.0 µR/h, respectively.

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

Location	Gamma Count Rate (cpm)	Exposure Rate (µR/h)
S260-C01-001	13,767	14
S260-C02-001	22,353	17.3
S260-C03-001	35,029	22.7
S260-C04-001	51,099	33.2
S260-C05-001	8,552	10.5

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

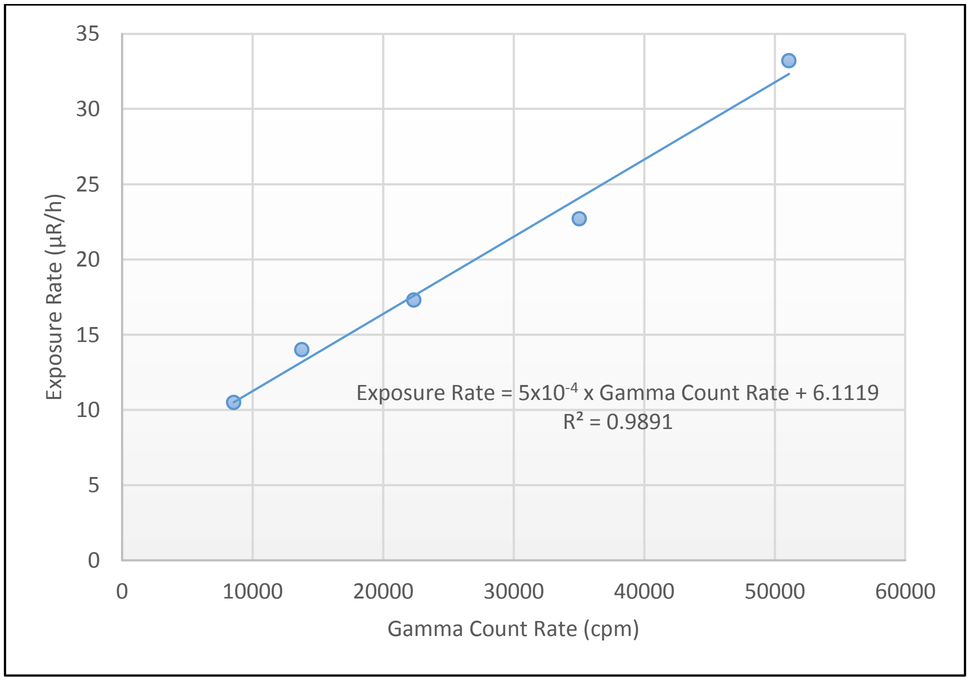


Figure 10. Correlation of gamma count rates and exposure rates.

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

Potential Background Reference Area	BG1	BG2	CK-BG2
Parameter	Exposure Rate (µR/h)		
n	303	156	199
Minimum	9.5	9.8	9.3
Maximum	13.8	10.8	12.2
Mean	11.3	10.3	10.6
Median	11.3	10.3	10.5
Standard Deviation	0.7	0.2	0.6

Notes:
BG1 = Background Reference Area 1
BG2 = Background Reference Area 2
CK-BG2 = Charles Keith Background Reference Area 2
µR/h = microRoentgens per hour

Table 9. Predicted exposure rates in the Survey Area.

Parameter	Exposure Rate (µR/h)
n	20,950
Minimum	8.2
Maximum	70.7
Mean	12.0
Median	11.0
Standard Deviation	4.6

Notes:
µR/h = microRoentgens per hour

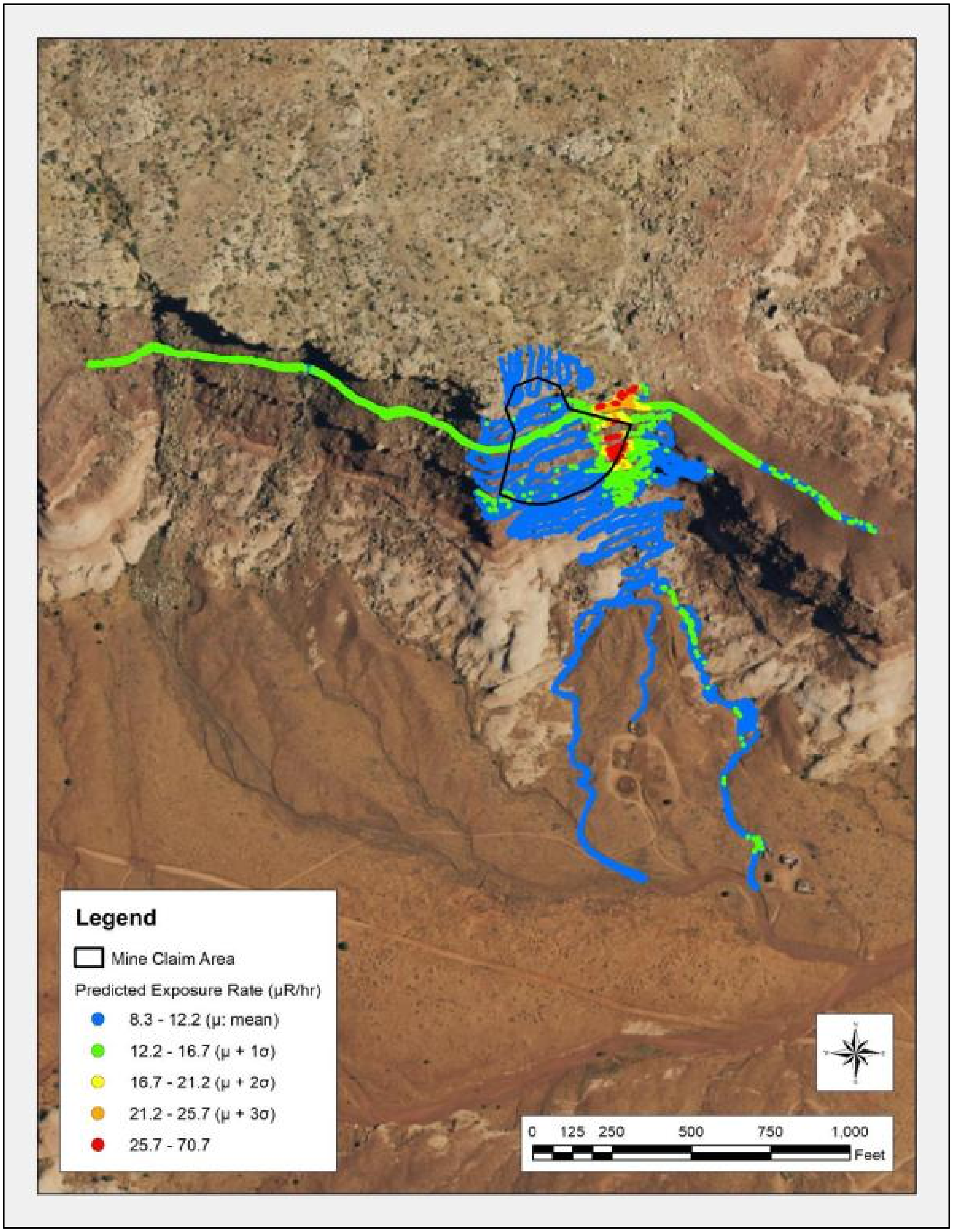


Figure 11. Predicted exposure rates in the Survey Area.

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 count rates were observed largely on waste piles extending away from a portal in the mine claim.

- Three 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) = $3\text{x}10^{-9}$ x Gamma Count Rate $(\text{cpm})^{2.1522}$

- 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 300, with a central tendency (median) of 1.2 pCi/g.

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

- The status of equilibrium in the uranium series radionuclides is inconclusive, based on the results of the correlation samples.

- 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 $5\text{x}10^{-4}$ + 6.1119

- The distribution of exposure rates predicted using this model resembles a lognormal distribution. The values in the Survey Area range from 8.2 to 70.7, with a central tendency (median) of 11.0 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. Mitten No. 3 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:

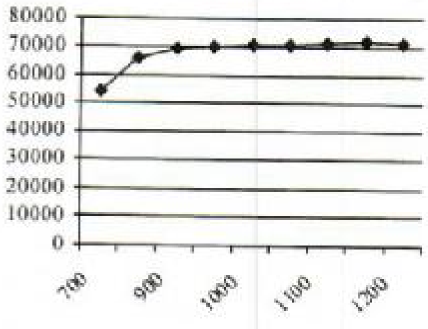
Barometric Pressure: 24.6 inches Hg
Temperature: 73 °F
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Coun
x 1000	400	400	400	398773	400
x 1000	100	100	100		100
x 100	400	400	400	39887	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	399	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	53957	
800	65946	
900	69049	
950	69687	
1000	70240	9925
1050	70288	
1100	71224	
1150	71563	
1200	71161	

Voltage Plateau



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

Reference Instruments and/or Sources:

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

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

Calibrated By: Calibration Date: 1-20-16 Calibration Due 1-20-17

Reviewed By: Date: 1/20/16

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:	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:

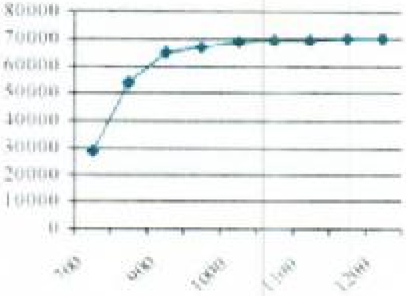
Barometric Pressure: 24.78 inches Hg
Temperature: 74 °F
Relative Humidity: 20 %

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	39980	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

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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: 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:

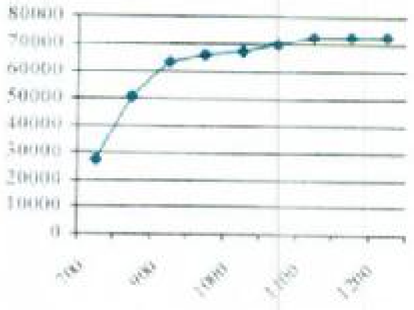
Barometric Pressure: 24.78 inches Hg
Temperature: 74 °F
Relative Humidity: 20 %

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	

Voltage Plateau



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

Reference Instruments and/or Sources:

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

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

Calibrated By: Calibration Date: 7-6-16 Calibration Due: 7-6-17

Reviewed By: Date: 7/20/16

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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:	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:

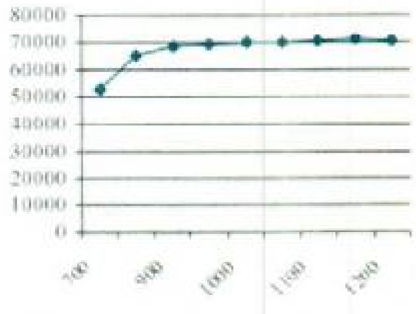
Barometric Pressure: 24.24 inches Hg
Temperature: 78 °F
Relative Humidity: 20 %

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

Date: 3-1-17

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

Certificate of Calibration

Calibration and Voltage Plateau

Meter:	Manufacturer:	Ludlum	Model Number:	2221r	Serial Number:	228808
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: 60"

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

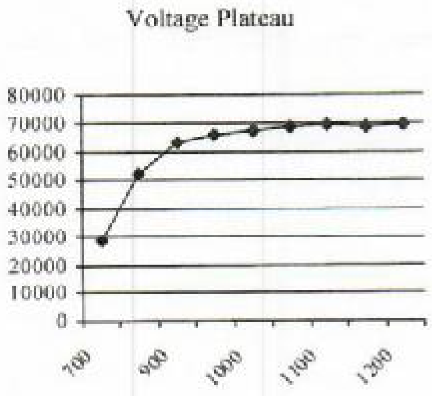
Threshold: 10 mV
Window:

Barometric Pressure: 24.66 inches Hg
Temperature: 77 °F
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Coun
x 1000	400	400	400	399291	400
x 1000	100	100	100		100
x 100	400	400	400	39921	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	28606	
800	52277	
900	63294	
950	65720	
1000	66874	
1050	68284	
1100	68903	9557
1150	68635	
1200	69337	



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

Reference Instruments and/or Sources:

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

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

Calibrated By:
Calibration Date: 4-12-16
Calibration Due 4-12-17

Reviewed By:
Date: 4/12/16

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: 218559

Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR320678

☑ 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: 24.66 inches Hg

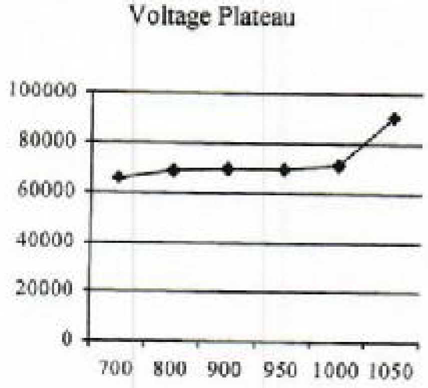
Temperature: 76 °F

Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Cou
x 1000	400	400	400	399164	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	3991	400
x 10	100	100	100		100
x 1	400	400	400	399	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	66548	
800	69805	
900	70095	8964
950	70368	
1000	71748	
1050	90668	



Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV = 900

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

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

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

☐ Other Source:

Calibrated By:

Calibration Date: 6-13-16

Calibration Due: 6 13-17

Reviewed By:

Date:

ERG Form ITC. 101.A

This calibration conforms to the requirements and acceptable calibration conditions of

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

ACCREDITED
CALIBRATION CERT #1866.0

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 Reviewed By: Angela Roper
Title: Calibration Technician Title: Calibration Physicist

Log: M-53 Page: 73

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

ACCREDITED

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 **Reviewed By:**
Richard Hardison
Title: Calibration Technician **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:	7-19-17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR303727
Cal. Due Date:	7-19-17

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 POINT
10-26-16	0637	6.1	1008	99	46974	7833	39141	NW	BOYD TISI
10-26-16	1545	6.1	992	98	42850	5959	36891	NW	BOYD TISI
10-27-16	1005	6.0	1004	99	48059	8561	39498	NW	Harvey Blackwater
10-27-16	1555	5.9	999	99	48564	8465	40099	NW	Harvey Blackwater
10-28-16	0808	5.9	1004	99	46814	9142	37672	NW	Harvey Blackwater
10-28-16	1704	5.8	1000	99	43711	5178	38533	NW	Mitten No. 3
10-29-16	0807	5.9	1005	100	43690	5203	38487	NW	Mitten No. 3
10-29-16	1342	5.8	999	99	44561	4801	39760	NW	Mitten No. 3
10-31-16	0840	5.8	1004	99	42426	5084	37342	NW	Mitten No. 3
10-31-16	1507	5.8	999	99	44206	5069	39137	NW	Goulding's back SUV
11-1-16	0748	5.8	1006	100	44941	4842	39599	NW	Charles Keith
11-1-16	1722	5.7	1003	99	44858	5117	39741	NW	Goulding's back of SUV

Reviewed by:

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.:	196096
Cal. Due Date:	7-19-17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR ~~303927~~ 295014 NW
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
10-15-16	0930	5.4	1100	100	45919	7086	38833	NW	Harvey Blackwater
10-15-16	1829	5.3	1094	100	44133	4794	39339	NW	Hat Rock Inn Lot
10-24-16	0802	5.4	1106	100	47875	8702	39173	NW	Boyd Tisi
10-24-16	1211	5.2	1099	100	45787	8272	37515	NW	Boyd Tisi
10-27-16	1000	5.4	1106	100	48630	8414	40216	NW	Harvey Blackwater
10-27-16	1601	5.2	1099	99	48326	8166	40160	NW	Harvey Blackwater
10-28-16	1401	5.3	1101	100	43141	4755	38386	NW	Mitten No. 3
10-28-16	1700	5.2	1101	99	43075	4698	38377	NW	Mitten No. 3
10-29-16	0812	5.3	1105	100	44174	4908	39266	NW	Mitten No. 3
10-29-16	~~08~~ 1346 NW	5.2	1098	100	42452	4621	37831	NW	Mitten No. 3
10-31-16	0835	5.3	1105	101	42258	4609	37649	NW	Mitten No. 3
10-31-16	1655	5.3	1100	100	42630	4963	37667	NW	Goulding's back lot.

Reviewed by:

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.:	138368
Cal. Due Date:	7-19-17 NW

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR154615
Cal. Due Date:	7-19-17 NW

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: 6 in.

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
10-28-16	0813	5.6	1162	144	50583	9051	41532	NW	Harvey Blackwater
10-29-16	0815	5.6	1222	199	44566	5053	39513	NW	Mitten No. 3
10-29-16	1338	5.5	1141	125	44503	4794	39709	NW	Mitten No. 3
10-31-16	0846	5.5	1133	111	44824	4753	40071	NW	Mitten No. 3
10-31-16	1502	5.5	1132	114	44994	4883	40111	NW	Goulding's in SUV
11-1-16	0758	5.5	1133	110	45344	4771	40573	NW	Charles Keith
11-1-16	1712	5.3	1120	100	44220	4928	39292	NW	Goulding's in SUV
11-2-16	0826	5.3	1127	103	44389	5834	38555	NW	Charles Keith
11-2-16	1715	5.3	1125	106	43737	5179	38558	NW	Goulding's in SUV
11-3-16	1055	5.3	1125	105	44443	5368	39075	NW	Charles Keith
11-3-16	1842	5.3	1123	104	47047	7583	39464	NW	Chinle Holiday Inn SUV
11-4-16	0900	5.4	1128	104	46230	8402	37828	NW	Occurrence B

Reviewed by: MM

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:

[illegible]

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):
5-18-17	1032	5.5	1001	100	38206	6536	31670	NW	Alonzo upper
5-18-17	1202	5.5	1001	100	39193	6515	32678	NW	Alonzo 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	Alonzo 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: Michael

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:	GE
Model:	RSS-131
Serial No.:	07JOUKMI
Cal. Due Date:	6-29-17

DETECTOR	
Manufacturer:	SAME AS METER
Model:	
Serial No.:	
Cal. Due Date:	

Comments:
NNERT

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

Date	Time	Battery	High Voltage	Threshhold	µR/h Source Counts	µR/h BKG Counts	Net Counts	Initials	Note(s): Project reference points
10-26-16	0525	~6.4	~400	NA	~27.8	~10.5	~17.3	NW	Best Western room - Flagstaff
10-26-16	2010	~6.3	~400	NA	~26	~9.5	~16.5	NW	Gouldings room ~~Best Western room - Flagstaff~~ NW
10-27-16	0720	~6.2	~400	NA	~26.7	~10.0	~16.7	NW	Gouldings room
10-27-16	1710	~6.2	~400	NA	~27.0	~10.8	~16.2	NW	Gouldings room
10-31-16	0609	~6.3	~400	NA	~27.0	~10	~16	NW	Gouldings room
10-31-16	1520	~6.3	~400	NA	~26	~10	~16	NW	Gouldings room
11-3-16	0700	~6.2	~400	NA	~26.5	~10.5	~16	NW	Gouldings room
11-3-16	1924	~6.1	~400	NA	~28.8	~12.5	~16.3	NW	Holiday Inn Chinle-room
11-9-16	0615	~6.3	~400	NA	~30	~12.8	~17.2	NW	Holiday Inn-Chinle room
11-9-16	1430	~6.2	~400	NA	~29.5	~12.5	~17	NW	Holiday Inn Chinle - room
11-11-16	0610	~6.4	~400	NA	~31.5	~13.5	~18	NW	Holiday Inn Chinle - room
11-11-16	1825	~6.2	~400	NA	~28	~11	~17	NW	Holiday Inn Chinle - room

Reviewed by: MM

Review Date: 11-29-16

NNERT Site Clearance

5-4-16

0645 leave Goulding's for Charles Keith

Function check 2221/44-10
S/N 754772 / PR302727
Detection System 1
BKG = 5770 BAT = 5.1
COUNT = 52003 HV = 1001
TR = 100

walk up to new area on other side of mesa from the waste area/adits
area is a mix of mottled red sandstone/ red sandstone white sandstone
- GPS is not working in the area
- make ten, one-minute integrated count rate measurements across the reference area (provisional)
- JP records the measurements, ex. 12-13k (most are ~13k) in his log book

- go to a second area in the back of the valley, above which sits the mine. JP wants to do an area of colluvium that would be representative of materials under the mine (base of the mesa).

MWM
NNERT MWM Site Clearance

5-4-16

File: R050409A - colluvial in back of valley
w/ Cibola mine

0930 mob to Mitten #3. provisional BRA is
on the mesa (colluvial and bedrock) on the other side
of the mine
File: R05410A

1045 mob to Boyd Tisi: survey three areas (two
dune north of the claim. One sandy/gravelly area
east of the claim
File: R0504C3A

JP/MW - need to check wind direction @ site, based on
the reading of survey.

1500
Function check 2221 / 4410

BAT	5.9
HV	999
TH	100
Bkg:	3565
gross:	53238

· offsite ~1527 - Boyd Tisi. Drive to Flagstaff

MWM
NNERT Site Clearance

5-4-16

1630 MST arrive @ Comfort Inn Flagstaff
. check in and download ssf files and export
- data look ok

- 1900 MST call C. Farr re: loss of connection
to satellites. He suggest it is a bluetooth issue w/ the
NoMAD. Suggests turning off cell phone.

- 1830 MST have dinner w/ JP

5-4-16

Appendix B Exposure Rate Measurements

Date and Time	Exposure Rate (mR/h)	Location
10/31/2016 10:15	0.0538	Correlation Location 1
10/31/2016 10:15	0.0942	Correlation Location 1
10/31/2016 10:15	0.0827	Correlation Location 1
10/31/2016 10:15	0.0571	Correlation Location 1
10/31/2016 10:15	0.0378	Correlation Location 1
10/31/2016 10:15	0.0264	Correlation Location 1
10/31/2016 10:15	0.0204	Correlation Location 1
10/31/2016 10:15	0.0169	Correlation Location 1
10/31/2016 10:15	0.0154	Correlation Location 1
10/31/2016 10:15	0.0149	Correlation Location 1
10/31/2016 10:16	0.0149	Correlation Location 1
10/31/2016 10:16	0.0148	Correlation Location 1
10/31/2016 10:16	0.0148	Correlation Location 1
10/31/2016 10:16	0.0148	Correlation Location 1
10/31/2016 10:16	0.0145	Correlation Location 1
10/31/2016 10:16	0.014	Correlation Location 1
10/31/2016 10:16	0.0138	Correlation Location 1
10/31/2016 10:16	0.0138	Correlation Location 1
10/31/2016 10:16	0.0136	Correlation Location 1
10/31/2016 10:16	0.0137	Correlation Location 1
10/31/2016 10:17	0.0138	Correlation Location 1
10/31/2016 10:17	0.0138	Correlation Location 1
10/31/2016 10:17	0.0133	Correlation Location 1
10/31/2016 10:17	0.0135	Correlation Location 1
10/31/2016 10:17	0.0138	Correlation Location 1
10/31/2016 10:17	0.0141	Correlation Location 1
10/31/2016 10:17	0.0142	Correlation Location 1
10/31/2016 10:17	0.0141	Correlation Location 1
10/31/2016 10:17	0.0143	Correlation Location 1
10/31/2016 10:17	0.014	Correlation Location 1
10/31/2016 10:18	0.0143	Correlation Location 1
10/31/2016 10:18	0.0145	Correlation Location 1
10/31/2016 10:18	0.0146	Correlation Location 1
10/31/2016 10:18	0.0149	Correlation Location 1
10/31/2016 10:18	0.0149	Correlation Location 1
10/31/2016 10:18	0.0144	Correlation Location 1
10/31/2016 10:18	0.0146	Correlation Location 1
10/31/2016 10:18	0.0144	Correlation Location 1
10/31/2016 10:18	0.0142	Correlation Location 1
10/31/2016 10:18	0.0139	Correlation Location 1
10/31/2016 10:19	0.0137	Correlation Location 1
10/31/2016 10:19	0.0136	Correlation Location 1
10/31/2016 10:19	0.0137	Correlation Location 1
10/31/2016 10:19	0.014	Correlation Location 1
10/31/2016 10:19	0.0141	Correlation Location 1
10/31/2016 10:19	0.0139	Correlation Location 1
10/31/2016 10:19	0.0138	Correlation Location 1
10/31/2016 10:19	0.0137	Correlation Location 1
10/31/2016 10:19	0.0137	Correlation Location 1
10/31/2016 10:19	0.0133	Correlation Location 1
10/31/2016 10:20	0.0133	Correlation Location 1
10/31/2016 10:20	0.0134	Correlation Location 1
10/31/2016 10:20	0.0134	Correlation Location 1
10/31/2016 10:20	0.0138	Correlation Location 1
10/31/2016 10:20	0.0141	Correlation Location 1
10/31/2016 10:20	0.0143	Correlation Location 1
10/31/2016 10:20	0.0144	Correlation Location 1
10/31/2016 10:20	0.0142	Correlation Location 1
10/31/2016 10:20	0.0138	Correlation Location 1
10/31/2016 10:20	0.0137	Correlation Location 1
10/31/2016 10:21	0.0142	Correlation Location 1
10/31/2016 10:21	0.014	Correlation Location 1
10/31/2016 10:21	0.0137	Correlation Location 1
10/31/2016 10:21	0.0137	Correlation Location 1
10/31/2016 10:21	0.0139	Correlation Location 1
10/31/2016 10:21	0.0138	Correlation Location 1
10/31/2016 10:21	0.0138	Correlation Location 1
10/31/2016 10:21	0.0143	Correlation Location 1
10/31/2016 10:21	0.0142	Correlation Location 1
10/31/2016 10:21	0.0144	Correlation Location 1
10/31/2016 10:22	0.0146	Correlation Location 1
10/31/2016 10:22	0.0145	Correlation Location 1
10/31/2016 10:22	0.0146	Correlation Location 1
10/31/2016 10:22	0.0145	Correlation Location 1
10/31/2016 10:22	0.0144	Correlation Location 1
10/31/2016 10:22	0.0141	Correlation Location 1
10/31/2016 10:22	0.0138	Correlation Location 1
10/31/2016 10:22	0.0138	Correlation Location 1
10/31/2016 10:22	0.0137	Correlation Location 1
10/31/2016 10:22	0.0134	Correlation Location 1
10/31/2016 10:23	0.0135	Correlation Location 1
10/31/2016 10:23	0.0135	Correlation Location 1
10/31/2016 10:23	0.0136	Correlation Location 1
10/31/2016 10:23	0.0135	Correlation Location 1
10/31/2016 10:23	0.0134	Correlation Location 1
10/31/2016 10:23	0.0135	Correlation Location 1
10/31/2016 10:23	0.014	Correlation Location 1
10/31/2016 10:23	0.0142	Correlation Location 1
10/31/2016 10:23	0.0141	Correlation Location 1
10/31/2016 10:23	0.0137	Correlation Location 1
10/31/2016 10:24	0.0141	Correlation Location 1
10/31/2016 10:24	0.0142	Correlation Location 1
10/31/2016 10:24	0.014	Correlation Location 1
10/31/2016 10:24	0.0138	Correlation Location 1
10/31/2016 10:24	0.0135	Correlation Location 1
10/31/2016 10:24	0.0136	Correlation Location 1
10/31/2016 10:24	0.0139	Correlation Location 1
10/31/2016 10:24	0.0142	Correlation Location 1
10/31/2016 10:24	0.014	Correlation Location 1
10/31/2016 10:24	0.0136	Correlation Location 1
10/31/2016 10:25	0.0137	Correlation Location 1
10/31/2016 10:25	0.0141	Correlation Location 1
10/31/2016 10:25	0.0143	Correlation Location 1
10/31/2016 10:25	0.0145	Correlation Location 1
10/31/2016 10:25	0.0141	Correlation Location 1
10/31/2016 10:25	0.0135	Correlation Location 1
10/31/2016 10:25	0.0134	Correlation Location 1
10/31/2016 10:25	0.0136	Correlation Location 1
10/31/2016 10:44	0.0545	Correlation Location 2
10/31/2016 10:44	0.096	Correlation Location 2
10/31/2016 10:45	0.0854	Correlation Location 2
10/31/2016 10:45	0.0601	Correlation Location 2

Mitten No. 3 Exposure Rate Measurements for Correlation

Date and Time	Exposure Rate (mR/h)	Location
10/31/2016 10:45	0.0409	Correlation Location 2
10/31/2016 10:45	0.0299	Correlation Location 2
10/31/2016 10:45	0.0241	Correlation Location 2
10/31/2016 10:45	0.021	Correlation Location 2
10/31/2016 10:45	0.019	Correlation Location 2
10/31/2016 10:45	0.0182	Correlation Location 2
10/31/2016 10:45	0.0178	Correlation Location 2
10/31/2016 10:45	0.0173	Correlation Location 2
10/31/2016 10:46	0.0174	Correlation Location 2
10/31/2016 10:46	0.0175	Correlation Location 2
10/31/2016 10:46	0.0176	Correlation Location 2
10/31/2016 10:46	0.017	Correlation Location 2
10/31/2016 10:46	0.0168	Correlation Location 2
10/31/2016 10:46	0.0168	Correlation Location 2
10/31/2016 10:46	0.0168	Correlation Location 2
10/31/2016 10:46	0.0166	Correlation Location 2
10/31/2016 10:46	0.0167	Correlation Location 2
10/31/2016 10:46	0.017	Correlation Location 2
10/31/2016 10:47	0.0172	Correlation Location 2
10/31/2016 10:47	0.0174	Correlation Location 2
10/31/2016 10:47	0.0176	Correlation Location 2
10/31/2016 10:47	0.0178	Correlation Location 2
10/31/2016 10:47	0.0176	Correlation Location 2
10/31/2016 10:47	0.017	Correlation Location 2
10/31/2016 10:47	0.0168	Correlation Location 2
10/31/2016 10:47	0.0165	Correlation Location 2
10/31/2016 10:47	0.0169	Correlation Location 2
10/31/2016 10:47	0.017	Correlation Location 2
10/31/2016 10:48	0.0169	Correlation Location 2
10/31/2016 10:48	0.0168	Correlation Location 2
10/31/2016 10:48	0.017	Correlation Location 2
10/31/2016 10:48	0.0172	Correlation Location 2
10/31/2016 10:48	0.0168	Correlation Location 2
10/31/2016 10:48	0.0167	Correlation Location 2
10/31/2016 10:48	0.0167	Correlation Location 2
10/31/2016 10:48	0.0172	Correlation Location 2
10/31/2016 10:48	0.0175	Correlation Location 2
10/31/2016 10:48	0.0173	Correlation Location 2
10/31/2016 10:49	0.0172	Correlation Location 2
10/31/2016 10:49	0.017	Correlation Location 2
10/31/2016 10:49	0.0172	Correlation Location 2
10/31/2016 10:49	0.0177	Correlation Location 2
10/31/2016 10:49	0.0177	Correlation Location 2
10/31/2016 10:49	0.0175	Correlation Location 2
10/31/2016 10:49	0.0175	Correlation Location 2
10/31/2016 10:49	0.0176	Correlation Location 2
10/31/2016 10:49	0.0175	Correlation Location 2
10/31/2016 10:49	0.0175	Correlation Location 2
10/31/2016 10:50	0.0174	Correlation Location 2
10/31/2016 10:50	0.0175	Correlation Location 2
10/31/2016 10:50	0.0182	Correlation Location 2
10/31/2016 10:50	0.0182	Correlation Location 2
10/31/2016 10:50	0.018	Correlation Location 2
10/31/2016 10:50	0.0178	Correlation Location 2
10/31/2016 10:50	0.0175	Correlation Location 2
10/31/2016 10:50	0.0173	Correlation Location 2
10/31/2016 10:50	0.0169	Correlation Location 2
10/31/2016 10:50	0.0164	Correlation Location 2
10/31/2016 10:51	0.0163	Correlation Location 2
10/31/2016 10:51	0.0168	Correlation Location 2
10/31/2016 10:51	0.0172	Correlation Location 2
10/31/2016 10:51	0.017	Correlation Location 2
10/31/2016 10:51	0.017	Correlation Location 2
10/31/2016 10:51	0.017	Correlation Location 2
10/31/2016 10:51	0.0169	Correlation Location 2
10/31/2016 10:51	0.017	Correlation Location 2
10/31/2016 10:51	0.0175	Correlation Location 2
10/31/2016 10:51	0.018	Correlation Location 2
10/31/2016 10:52	0.018	Correlation Location 2
10/31/2016 10:52	0.0182	Correlation Location 2
10/31/2016 10:52	0.0182	Correlation Location 2
10/31/2016 10:52	0.0177	Correlation Location 2
10/31/2016 10:52	0.0174	Correlation Location 2
10/31/2016 10:52	0.0174	Correlation Location 2
10/31/2016 10:52	0.0172	Correlation Location 2
10/31/2016 10:52	0.017	Correlation Location 2
10/31/2016 10:52	0.0166	Correlation Location 2
10/31/2016 10:52	0.017	Correlation Location 2
10/31/2016 10:53	0.0177	Correlation Location 2
10/31/2016 10:53	0.0173	Correlation Location 2
10/31/2016 10:53	0.0173	Correlation Location 2
10/31/2016 10:53	0.0174	Correlation Location 2
10/31/2016 10:53	0.0173	Correlation Location 2
10/31/2016 10:53	0.017	Correlation Location 2
10/31/2016 10:53	0.0168	Correlation Location 2
10/31/2016 10:53	0.0169	Correlation Location 2
10/31/2016 10:53	0.0169	Correlation Location 2
10/31/2016 10:53	0.017	Correlation Location 2
10/31/2016 10:54	0.0174	Correlation Location 2
10/31/2016 10:54	0.0177	Correlation Location 2
10/31/2016 10:54	0.0175	Correlation Location 2
10/31/2016 10:54	0.0172	Correlation Location 2
10/31/2016 10:54	0.0176	Correlation Location 2
10/31/2016 10:54	0.0177	Correlation Location 2
10/31/2016 10:54	0.0176	Correlation Location 2
10/31/2016 10:54	0.0172	Correlation Location 2
10/31/2016 10:54	0.017	Correlation Location 2
10/31/2016 10:54	0.0172	Correlation Location 2
10/31/2016 10:55	0.0174	Correlation Location 2
10/31/2016 10:55	0.0174	Correlation Location 2
10/31/2016 10:55	0.017	Correlation Location 2
10/31/2016 10:55	0.0173	Correlation Location 2
10/31/2016 10:55	0.0175	Correlation Location 2
10/31/2016 11:18	0.0555	Correlation Location 3
10/31/2016 11:18	0.0989	Correlation Location 3
10/31/2016 11:18	0.0893	Correlation Location 3
10/31/2016 11:18	0.0652	Correlation Location 3
10/31/2016 11:18	0.0467	Correlation Location 3
10/31/2016 11:19	0.0352	Correlation Location 3
10/31/2016 11:19	0.0287	Correlation Location 3
10/31/2016 11:19	0.0256	Correlation Location 3
10/31/2016 11:19	0.0245	Correlation Location 3
10/31/2016 11:19	0.0239	Correlation Location 3
10/31/2016 11:19	0.0237	Correlation Location 3

Mitten No. 3 Exposure Rate Measurements for Correlation

Date and Time	Exposure Rate (mR/h)	Location
10/31/2016 11:19	0.0232	Correlation Location 3
10/31/2016 11:19	0.023	Correlation Location 3
10/31/2016 11:19	0.023	Correlation Location 3
10/31/2016 11:19	0.0227	Correlation Location 3
10/31/2016 11:20	0.0225	Correlation Location 3
10/31/2016 11:20	0.0225	Correlation Location 3
10/31/2016 11:20	0.0225	Correlation Location 3
10/31/2016 11:20	0.0223	Correlation Location 3
10/31/2016 11:20	0.0225	Correlation Location 3
10/31/2016 11:20	0.0229	Correlation Location 3
10/31/2016 11:20	0.0229	Correlation Location 3
10/31/2016 11:20	0.0228	Correlation Location 3
10/31/2016 11:20	0.0227	Correlation Location 3
10/31/2016 11:20	0.0225	Correlation Location 3
10/31/2016 11:21	0.0225	Correlation Location 3
10/31/2016 11:21	0.0223	Correlation Location 3
10/31/2016 11:21	0.0223	Correlation Location 3
10/31/2016 11:21	0.0227	Correlation Location 3
10/31/2016 11:21	0.0227	Correlation Location 3
10/31/2016 11:21	0.0229	Correlation Location 3
10/31/2016 11:21	0.023	Correlation Location 3
10/31/2016 11:21	0.0231	Correlation Location 3
10/31/2016 11:21	0.0225	Correlation Location 3
10/31/2016 11:21	0.0225	Correlation Location 3
10/31/2016 11:22	0.0225	Correlation Location 3
10/31/2016 11:22	0.0225	Correlation Location 3
10/31/2016 11:22	0.0222	Correlation Location 3
10/31/2016 11:22	0.0223	Correlation Location 3
10/31/2016 11:22	0.0225	Correlation Location 3
10/31/2016 11:22	0.0223	Correlation Location 3
10/31/2016 11:22	0.0223	Correlation Location 3
10/31/2016 11:22	0.0225	Correlation Location 3
10/31/2016 11:22	0.0228	Correlation Location 3
10/31/2016 11:22	0.0229	Correlation Location 3
10/31/2016 11:23	0.0229	Correlation Location 3
10/31/2016 11:23	0.0225	Correlation Location 3
10/31/2016 11:23	0.0221	Correlation Location 3
10/31/2016 11:23	0.022	Correlation Location 3
10/31/2016 11:23	0.0219	Correlation Location 3
10/31/2016 11:23	0.0225	Correlation Location 3
10/31/2016 11:23	0.0231	Correlation Location 3
10/31/2016 11:23	0.023	Correlation Location 3
10/31/2016 11:23	0.0227	Correlation Location 3
10/31/2016 11:23	0.0225	Correlation Location 3
10/31/2016 11:24	0.0233	Correlation Location 3
10/31/2016 11:24	0.0237	Correlation Location 3
10/31/2016 11:24	0.024	Correlation Location 3
10/31/2016 11:24	0.024	Correlation Location 3
10/31/2016 11:24	0.0239	Correlation Location 3
10/31/2016 11:24	0.0237	Correlation Location 3
10/31/2016 11:24	0.0232	Correlation Location 3
10/31/2016 11:24	0.023	Correlation Location 3
10/31/2016 11:24	0.0227	Correlation Location 3
10/31/2016 11:24	0.0223	Correlation Location 3
10/31/2016 11:25	0.0223	Correlation Location 3
10/31/2016 11:25	0.0225	Correlation Location 3
10/31/2016 11:25	0.0232	Correlation Location 3
10/31/2016 11:25	0.0234	Correlation Location 3
10/31/2016 11:25	0.0233	Correlation Location 3
10/31/2016 11:25	0.023	Correlation Location 3
10/31/2016 11:25	0.0227	Correlation Location 3
10/31/2016 11:25	0.0227	Correlation Location 3
10/31/2016 11:25	0.0231	Correlation Location 3
10/31/2016 11:25	0.0229	Correlation Location 3
10/31/2016 11:26	0.0221	Correlation Location 3
10/31/2016 11:26	0.0219	Correlation Location 3
10/31/2016 11:26	0.0222	Correlation Location 3
10/31/2016 11:26	0.022	Correlation Location 3
10/31/2016 11:26	0.0222	Correlation Location 3
10/31/2016 11:26	0.0228	Correlation Location 3
10/31/2016 11:26	0.0227	Correlation Location 3
10/31/2016 11:26	0.0229	Correlation Location 3
10/31/2016 11:26	0.0232	Correlation Location 3
10/31/2016 11:26	0.0235	Correlation Location 3
10/31/2016 11:27	0.0231	Correlation Location 3
10/31/2016 11:27	0.023	Correlation Location 3
10/31/2016 11:27	0.0232	Correlation Location 3
10/31/2016 11:27	0.0232	Correlation Location 3
10/31/2016 11:27	0.0229	Correlation Location 3
10/31/2016 11:27	0.0225	Correlation Location 3
10/31/2016 11:27	0.0225	Correlation Location 3
10/31/2016 11:27	0.0227	Correlation Location 3
10/31/2016 11:27	0.0235	Correlation Location 3
10/31/2016 11:27	0.0235	Correlation Location 3
10/31/2016 11:28	0.0232	Correlation Location 3
10/31/2016 11:28	0.0227	Correlation Location 3
10/31/2016 11:28	0.0223	Correlation Location 3
10/31/2016 11:28	0.0223	Correlation Location 3
10/31/2016 11:28	0.0227	Correlation Location 3
10/31/2016 11:28	0.0231	Correlation Location 3
10/31/2016 11:28	0.0225	Correlation Location 3
10/31/2016 11:28	0.0222	Correlation Location 3
10/31/2016 11:28	0.0219	Correlation Location 3
10/31/2016 11:28	0.0219	Correlation Location 3
10/31/2016 11:29	0.022	Correlation Location 3
10/31/2016 11:29	0.0223	Correlation Location 3
10/31/2016 11:29	0.0223	Correlation Location 3
10/31/2016 11:44	0.0573	Correlation Location 4
10/31/2016 11:45	0.1036	Correlation Location 4
10/31/2016 11:45	0.097	Correlation Location 4
10/31/2016 11:45	0.0744	Correlation Location 4
10/31/2016 11:45	0.0564	Correlation Location 4
10/31/2016 11:45	0.0451	Correlation Location 4
10/31/2016 11:45	0.0389	Correlation Location 4
10/31/2016 11:45	0.0357	Correlation Location 4
10/31/2016 11:45	0.0346	Correlation Location 4
10/31/2016 11:45	0.0341	Correlation Location 4
10/31/2016 11:45	0.0339	Correlation Location 4
10/31/2016 11:46	0.0339	Correlation Location 4
10/31/2016 11:46	0.0341	Correlation Location 4
10/31/2016 11:46	0.0343	Correlation Location 4
10/31/2016 11:46	0.0346	Correlation Location 4
10/31/2016 11:46	0.0346	Correlation Location 4
10/31/2016 11:46	0.0341	Correlation Location 4

Date and Time	Exposure Rate (mR/h)	Location
10/31/2016 11:46	0.0341	Correlation Location 4
10/31/2016 11:46	0.0346	Correlation Location 4
10/31/2016 11:46	0.0346	Correlation Location 4
10/31/2016 11:46	0.0345	Correlation Location 4
10/31/2016 11:47	0.0344	Correlation Location 4
10/31/2016 11:47	0.0341	Correlation Location 4
10/31/2016 11:47	0.0339	Correlation Location 4
10/31/2016 11:47	0.0339	Correlation Location 4
10/31/2016 11:47	0.034	Correlation Location 4
10/31/2016 11:47	0.034	Correlation Location 4
10/31/2016 11:47	0.0337	Correlation Location 4
10/31/2016 11:47	0.0328	Correlation Location 4
10/31/2016 11:47	0.0319	Correlation Location 4
10/31/2016 11:47	0.0312	Correlation Location 4
10/31/2016 11:48	0.0309	Correlation Location 4
10/31/2016 11:48	0.0308	Correlation Location 4
10/31/2016 11:48	0.0307	Correlation Location 4
10/31/2016 11:48	0.0308	Correlation Location 4
10/31/2016 11:48	0.0317	Correlation Location 4
10/31/2016 11:48	0.0322	Correlation Location 4
10/31/2016 11:48	0.0322	Correlation Location 4
10/31/2016 11:48	0.0324	Correlation Location 4
10/31/2016 11:48	0.0326	Correlation Location 4
10/31/2016 11:48	0.033	Correlation Location 4
10/31/2016 11:49	0.0332	Correlation Location 4
10/31/2016 11:49	0.0331	Correlation Location 4
10/31/2016 11:49	0.0331	Correlation Location 4
10/31/2016 11:49	0.0332	Correlation Location 4
10/31/2016 11:49	0.033	Correlation Location 4
10/31/2016 11:49	0.033	Correlation Location 4
10/31/2016 11:49	0.0337	Correlation Location 4
10/31/2016 11:49	0.034	Correlation Location 4
10/31/2016 11:49	0.0337	Correlation Location 4
10/31/2016 11:49	0.0335	Correlation Location 4
10/31/2016 11:50	0.0326	Correlation Location 4
10/31/2016 11:50	0.0321	Correlation Location 4
10/31/2016 11:50	0.0324	Correlation Location 4
10/31/2016 11:50	0.033	Correlation Location 4
10/31/2016 11:50	0.0335	Correlation Location 4
10/31/2016 11:50	0.0336	Correlation Location 4
10/31/2016 11:50	0.0336	Correlation Location 4
10/31/2016 11:50	0.0332	Correlation Location 4
10/31/2016 11:50	0.0327	Correlation Location 4
10/31/2016 11:50	0.0328	Correlation Location 4
10/31/2016 11:51	0.0328	Correlation Location 4
10/31/2016 11:51	0.0324	Correlation Location 4
10/31/2016 11:51	0.0327	Correlation Location 4
10/31/2016 11:51	0.033	Correlation Location 4
10/31/2016 11:51	0.0332	Correlation Location 4
10/31/2016 11:51	0.0336	Correlation Location 4
10/31/2016 11:51	0.0337	Correlation Location 4
10/31/2016 11:51	0.034	Correlation Location 4
10/31/2016 11:51	0.0339	Correlation Location 4
10/31/2016 11:51	0.0332	Correlation Location 4
10/31/2016 11:52	0.0332	Correlation Location 4
10/31/2016 11:52	0.0334	Correlation Location 4
10/31/2016 11:52	0.0336	Correlation Location 4
10/31/2016 11:52	0.0336	Correlation Location 4
10/31/2016 11:52	0.0336	Correlation Location 4
10/31/2016 11:52	0.0335	Correlation Location 4
10/31/2016 11:52	0.0335	Correlation Location 4
10/31/2016 11:52	0.0334	Correlation Location 4
10/31/2016 11:52	0.0331	Correlation Location 4
10/31/2016 11:52	0.0327	Correlation Location 4
10/31/2016 11:53	0.0328	Correlation Location 4
10/31/2016 11:53	0.0327	Correlation Location 4
10/31/2016 11:53	0.0321	Correlation Location 4
10/31/2016 11:53	0.0322	Correlation Location 4
10/31/2016 11:53	0.0322	Correlation Location 4
10/31/2016 11:53	0.0322	Correlation Location 4
10/31/2016 11:53	0.0326	Correlation Location 4
10/31/2016 11:53	0.0332	Correlation Location 4
10/31/2016 11:53	0.0334	Correlation Location 4
10/31/2016 11:53	0.0331	Correlation Location 4
10/31/2016 11:54	0.0331	Correlation Location 4
10/31/2016 11:54	0.0328	Correlation Location 4
10/31/2016 11:54	0.0324	Correlation Location 4
10/31/2016 11:54	0.0324	Correlation Location 4
10/31/2016 11:54	0.0328	Correlation Location 4
10/31/2016 11:54	0.0328	Correlation Location 4
10/31/2016 11:54	0.0332	Correlation Location 4
10/31/2016 11:54	0.0339	Correlation Location 4
10/31/2016 11:54	0.034	Correlation Location 4
10/31/2016 11:54	0.034	Correlation Location 4
10/31/2016 11:55	0.034	Correlation Location 4
10/31/2016 11:55	0.0339	Correlation Location 4
10/31/2016 11:55	0.0336	Correlation Location 4
10/31/2016 11:55	0.0334	Correlation Location 4
10/31/2016 11:55	0.0335	Correlation Location 4
10/31/2016 11:55	0.0335	Correlation Location 4
10/31/2016 11:55	0.0331	Correlation Location 4
10/31/2016 11:55	0.0327	Correlation Location 4
10/31/2016 11:55	0.0326	Correlation Location 4
10/31/2016 12:41	0.0531	Correlation Location 5
10/31/2016 12:41	0.0924	Correlation Location 5
10/31/2016 12:41	0.0801	Correlation Location 5
10/31/2016 12:42	0.0544	Correlation Location 5
10/31/2016 12:42	0.0352	Correlation Location 5
10/31/2016 12:42	0.0237	Correlation Location 5
10/31/2016 12:42	0.017	Correlation Location 5
10/31/2016 12:42	0.0136	Correlation Location 5
10/31/2016 12:42	0.0118	Correlation Location 5
10/31/2016 12:42	0.0112	Correlation Location 5
10/31/2016 12:42	0.0108	Correlation Location 5
10/31/2016 12:42	0.0106	Correlation Location 5
10/31/2016 12:42	0.0105	Correlation Location 5
10/31/2016 12:43	0.01	Correlation Location 5
10/31/2016 12:43	0.0099	Correlation Location 5
10/31/2016 12:43	0.0103	Correlation Location 5
10/31/2016 12:43	0.0108	Correlation Location 5
10/31/2016 12:43	0.0105	Correlation Location 5
10/31/2016 12:43	0.0105	Correlation Location 5
10/31/2016 12:43	0.0105	Correlation Location 5
10/31/2016 12:43	0.0104	Correlation Location 5

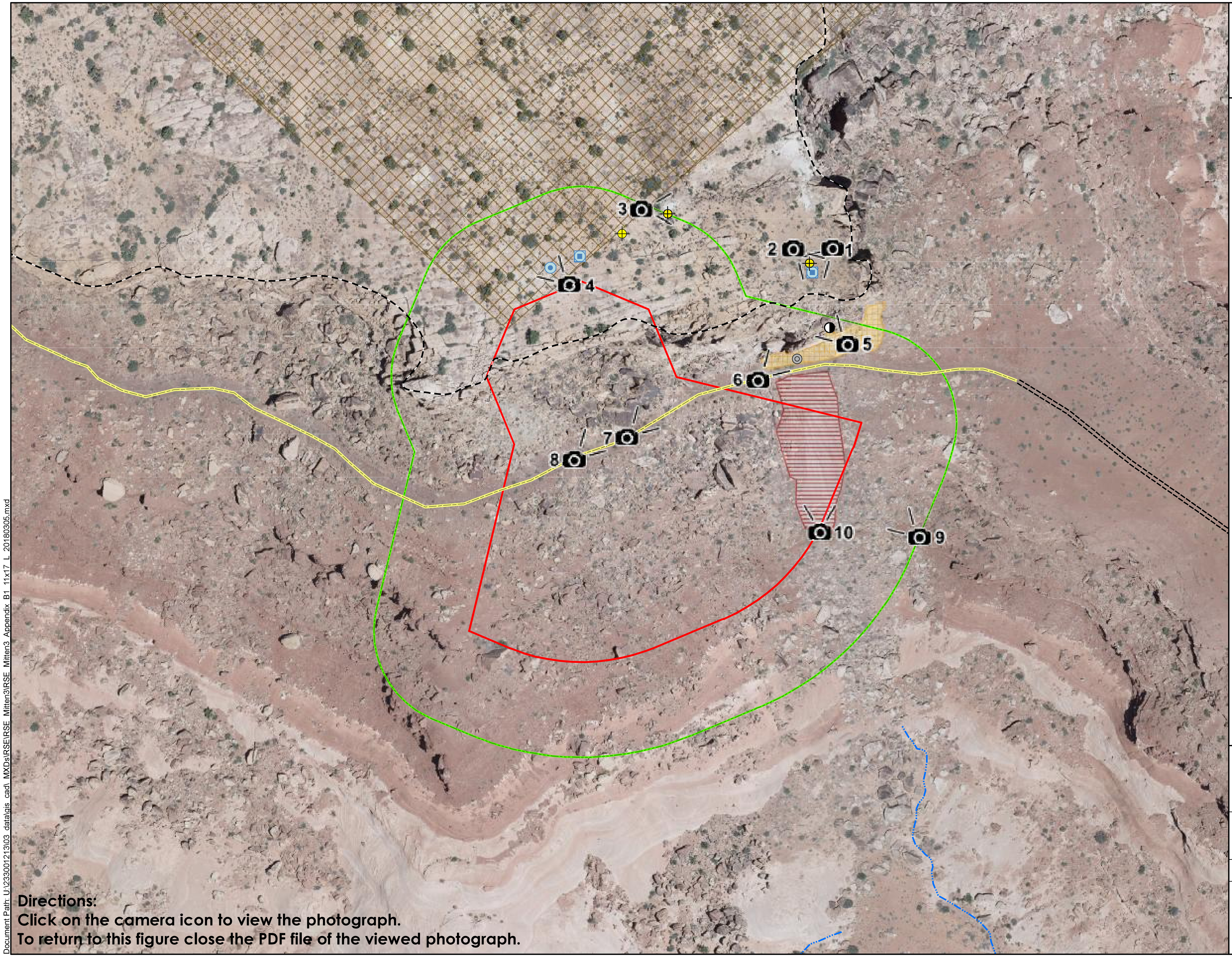
Date and Time	Exposure Rate (mR/h)	Location
10/31/2016 12:43	0.0102	Correlation Location 5
10/31/2016 12:43	0.0103	Correlation Location 5
10/31/2016 12:44	0.0104	Correlation Location 5
10/31/2016 12:44	0.0105	Correlation Location 5
10/31/2016 12:44	0.0103	Correlation Location 5
10/31/2016 12:44	0.0103	Correlation Location 5
10/31/2016 12:44	0.0102	Correlation Location 5
10/31/2016 12:44	0.0102	Correlation Location 5
10/31/2016 12:44	0.0105	Correlation Location 5
10/31/2016 12:44	0.0103	Correlation Location 5
10/31/2016 12:44	0.0105	Correlation Location 5
10/31/2016 12:44	0.0106	Correlation Location 5
10/31/2016 12:45	0.0108	Correlation Location 5
10/31/2016 12:45	0.0108	Correlation Location 5
10/31/2016 12:45	0.0108	Correlation Location 5
10/31/2016 12:45	0.0106	Correlation Location 5
10/31/2016 12:45	0.0109	Correlation Location 5
10/31/2016 12:45	0.0108	Correlation Location 5
10/31/2016 12:45	0.0108	Correlation Location 5
10/31/2016 12:45	0.0105	Correlation Location 5
10/31/2016 12:45	0.0105	Correlation Location 5
10/31/2016 12:45	0.0109	Correlation Location 5
10/31/2016 12:46	0.0109	Correlation Location 5
10/31/2016 12:46	0.0105	Correlation Location 5
10/31/2016 12:46	0.0104	Correlation Location 5
10/31/2016 12:46	0.0104	Correlation Location 5
10/31/2016 12:46	0.0105	Correlation Location 5
10/31/2016 12:46	0.0105	Correlation Location 5
10/31/2016 12:46	0.0105	Correlation Location 5
10/31/2016 12:46	0.0105	Correlation Location 5
10/31/2016 12:46	0.0105	Correlation Location 5
10/31/2016 12:46	0.0105	Correlation Location 5
10/31/2016 12:47	0.0105	Correlation Location 5
10/31/2016 12:47	0.0105	Correlation Location 5
10/31/2016 12:47	0.0105	Correlation Location 5
10/31/2016 12:47	0.0106	Correlation Location 5
10/31/2016 12:47	0.0104	Correlation Location 5
10/31/2016 12:47	0.0099	Correlation Location 5
10/31/2016 12:47	0.0098	Correlation Location 5
10/31/2016 12:47	0.0098	Correlation Location 5
10/31/2016 12:47	0.0103	Correlation Location 5
10/31/2016 12:47	0.0105	Correlation Location 5
10/31/2016 12:48	0.0108	Correlation Location 5
10/31/2016 12:48	0.0106	Correlation Location 5
10/31/2016 12:48	0.0104	Correlation Location 5
10/31/2016 12:48	0.0102	Correlation Location 5
10/31/2016 12:48	0.01	Correlation Location 5
10/31/2016 12:48	0.0102	Correlation Location 5
10/31/2016 12:48	0.0105	Correlation Location 5
10/31/2016 12:48	0.0105	Correlation Location 5
10/31/2016 12:48	0.0105	Correlation Location 5
10/31/2016 12:48	0.0108	Correlation Location 5
10/31/2016 12:49	0.0108	Correlation Location 5
10/31/2016 12:49	0.0108	Correlation Location 5
10/31/2016 12:49	0.0104	Correlation Location 5
10/31/2016 12:49	0.01	Correlation Location 5
10/31/2016 12:49	0.0103	Correlation Location 5
10/31/2016 12:49	0.0105	Correlation Location 5
10/31/2016 12:49	0.0108	Correlation Location 5
10/31/2016 12:49	0.0108	Correlation Location 5
10/31/2016 12:49	0.0108	Correlation Location 5
10/31/2016 12:49	0.0106	Correlation Location 5
10/31/2016 12:50	0.0103	Correlation Location 5
10/31/2016 12:50	0.0103	Correlation Location 5
10/31/2016 12:50	0.0105	Correlation Location 5
10/31/2016 12:50	0.0105	Correlation Location 5
10/31/2016 12:50	0.0108	Correlation Location 5
10/31/2016 12:50	0.0111	Correlation Location 5
10/31/2016 12:50	0.0109	Correlation Location 5
10/31/2016 12:50	0.0108	Correlation Location 5
10/31/2016 12:50	0.0106	Correlation Location 5
10/31/2016 12:50	0.0105	Correlation Location 5
10/31/2016 12:51	0.0109	Correlation Location 5
10/31/2016 12:51	0.0112	Correlation Location 5
10/31/2016 12:51	0.0114	Correlation Location 5
10/31/2016 12:51	0.0108	Correlation Location 5
10/31/2016 12:51	0.0102	Correlation Location 5
10/31/2016 12:51	0.0099	Correlation Location 5
10/31/2016 12:51	0.0099	Correlation Location 5
10/31/2016 12:51	0.01	Correlation Location 5
10/31/2016 12:51	0.0102	Correlation Location 5
10/31/2016 12:51	0.0103	Correlation Location 5
10/31/2016 12:52	0.0103	Correlation Location 5
10/31/2016 12:52	0.0103	Correlation Location 5
10/31/2016 12:52	0.0102	Correlation Location 5
10/31/2016 12:52	0.01	Correlation Location 5
10/31/2016 12:52	0.0102	Correlation Location 5

Mitten No. 3 Exposure Rate Measurements for Correlation

Appendix B Photographs

B.1 Site Photographs

B.2 Regional 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.

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

📷	Photograph Indicating Direction Taken
⌖	Historical Borehole
◉	Historical Rock Core / Drill Cuttings
▣	Historical Metal Rods
◎	Approximate Reclaimed Portal Location
◑	Prospect Portal
-·-·-·	Drainage
------	Potential Haul Road
========	Road
- - - -	Approximate Edge of Mesa
▨	Exploration Area
▦	Mining Disturbed Area
▤	Waste Pile
🟥	Claim Boundary
🟩	100-Foot Claim Buffer

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

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

TITLE:

Site Photographs

PROJECT:

Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 7/5/2018

DOCUMENT NAME: Removal Site Evaluation Report

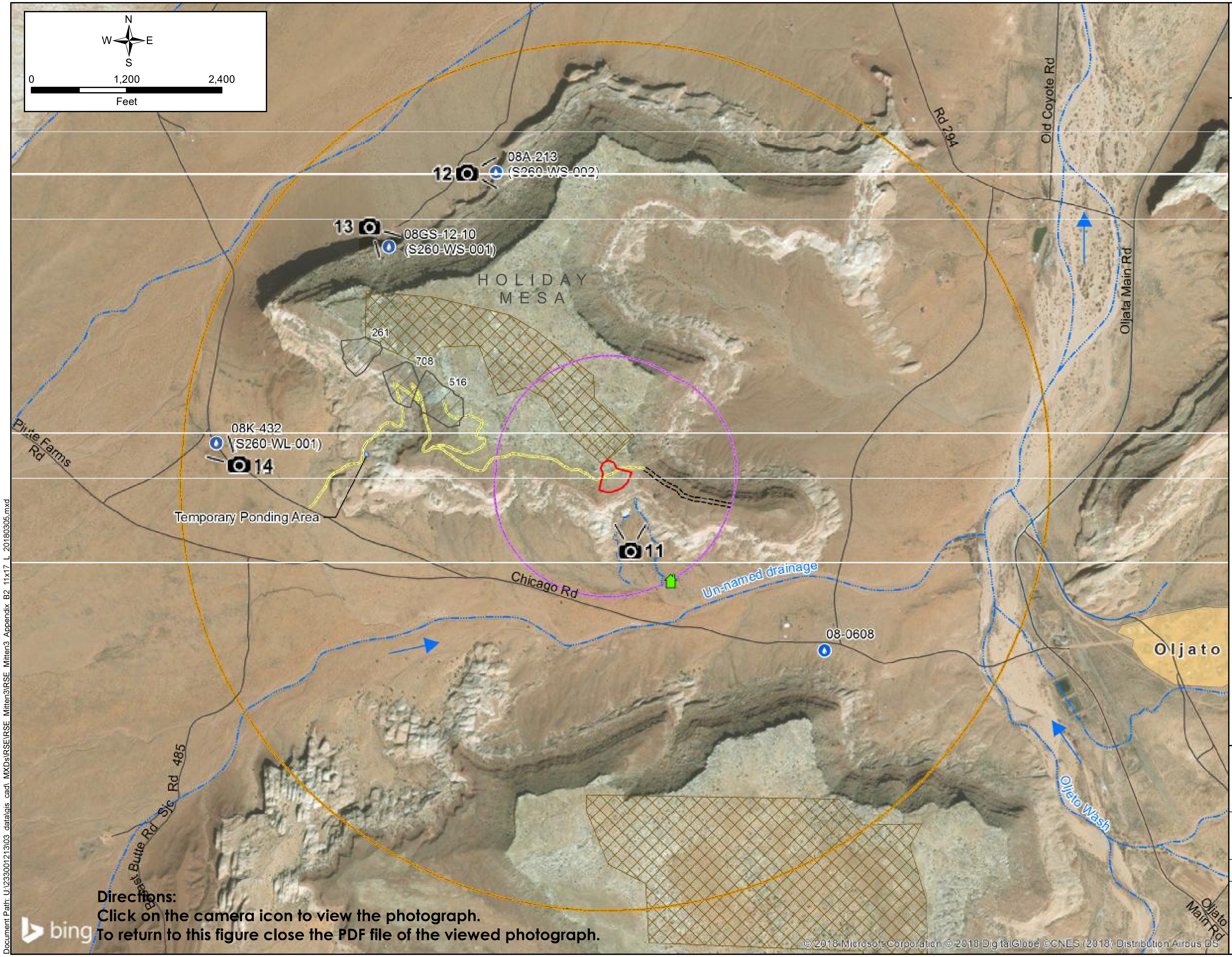
Stantec

AUTHOR: EDZ

REVIEWER: CBB

FIGURE: B-1

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\RSE Mitten3 Appendix B1 11x17 L 20180305.mxd



Directions:
Click on the camera icon to view the photograph.
To return to this figure close the PDF file of the viewed photograph.

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

📷	Photograph Indicating Direction Taken
🟩	Habitable Building
💧	Site Clearance Identified Water Feature[1]
↑	Flow Direction
-·-·-·-	Intermittent Stream/River
- - - -	Potential Haul Road
========	Road
———	Local Road
▨	Exploration Area
🟦	Temporary Ponding Area
🟨	Residential Area
🟥	Claim Boundary
◯	1/4-Mile Claim Boundary Buffer
◯	1-Mile Claim Boundary Buffer
◻	Other Claim Boundary

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

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:
Regional Site Photographs

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 7/5/2018
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ
REVIEWER: CBB
FIGURE: B-2

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE Mitten3\RSE Mitten3 Appendix B2 11x17 L 20180305.mxd

Appendix C Field Activity Forms

C.1 Soil Sample Field Forms

C.2 Hand Auger Borehole Logs

C.3 Water Sample Field Forms

C.1 Soil Sample Field Forms

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S260-BG1-001 (Mitten)

SAMPLE I.D. S260-BG1-001

SAMPLE COLLECTION DATE 10/28/2016

SAMPLE COLLECTION TIME 1500

SAMPLE COLLECTED BY C Lee

WEATHER CONDITIONS 70s, Sunny

FIELD USCS DESCRIPTIONS Fine red sand, w/ trace sand/gravel

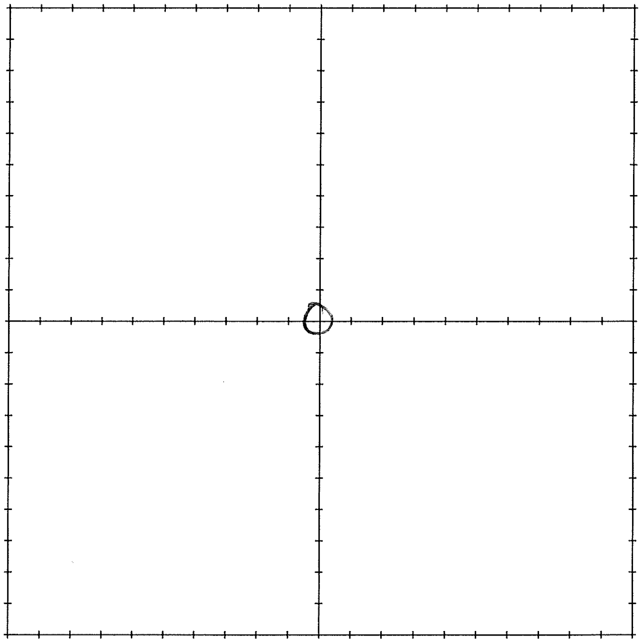
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☒ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Ziplock

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S260-BG1-002 (Mitten)

SAMPLE I.D. S260-BG1-002

SAMPLE COLLECTION DATE 10/28/2016

SAMPLE COLLECTION TIME 1515

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70s, sunny

FIELD USCS DESCRIPTIONS Fine red sand, trace gravel

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC

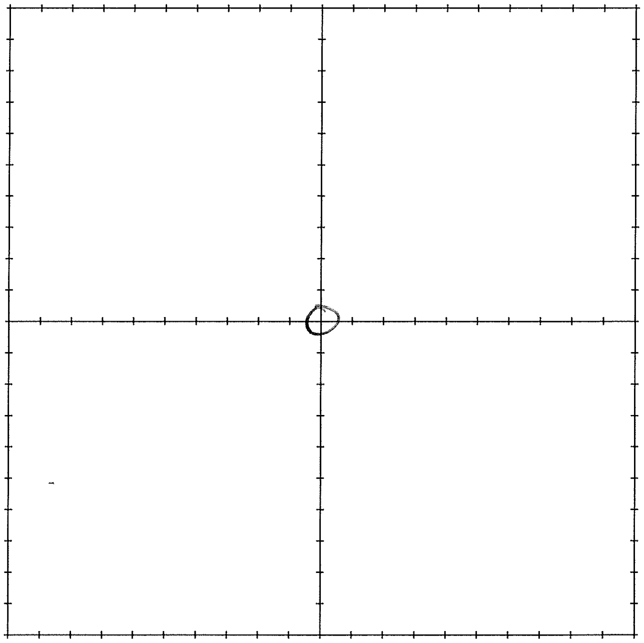
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☒ COARSE

MOISTURE: ☐ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Ziplock

ANALYSES: Ra-226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S260-BG1-003 (Mitten)

SAMPLE I.D. S260-BG1-003

SAMPLE COLLECTION DATE 10/28/2016

SAMPLE COLLECTION TIME 1530

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70s, sunny

FIELD USCS DESCRIPTIONS Fine red sand, trace gravel

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC

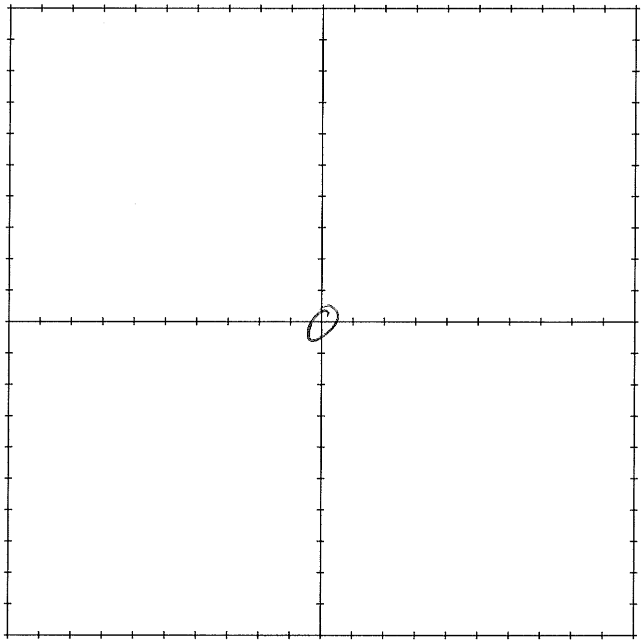
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☒ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Ziplock

ANALYSES: Ra-226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S260-BG1-004 (Milton)

SAMPLE I.D. S260-BG1-004

SAMPLE COLLECTION DATE 10/28/2016

SAMPLE COLLECTION TIME 1545

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70s, Sunny

FIELD USCS DESCRIPTIONS Fine red sand, trace gravel

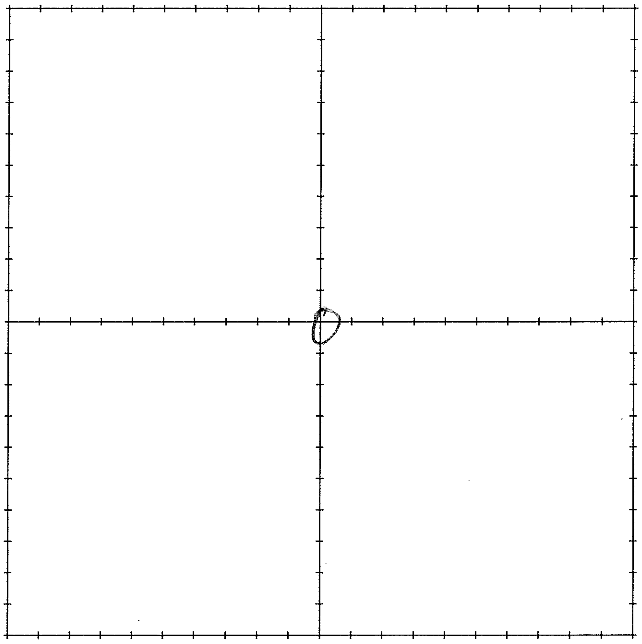
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☒ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Ziplock

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S260-BG1-005 (Mitten)

SAMPLE I.D. S260-BG1-005

SAMPLE COLLECTION DATE 1600

SAMPLE COLLECTION TIME 10/28/2016

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine red sand, trace gravel

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC

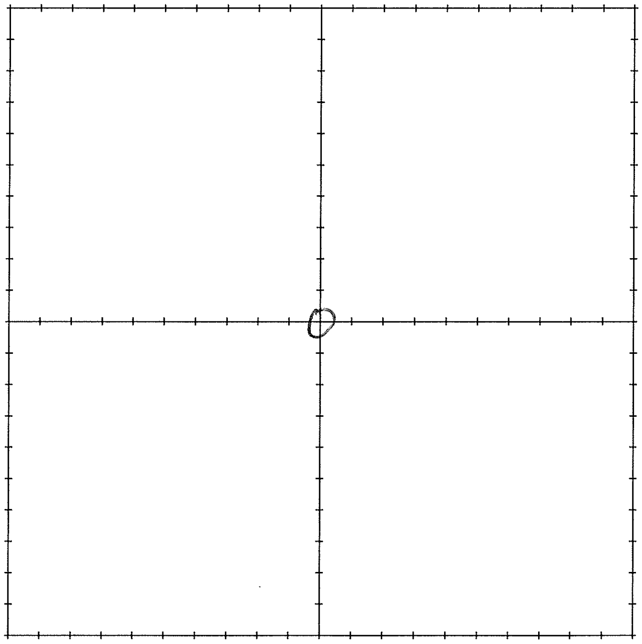
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☒ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Ziplock

ANALYSES: Ra-226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S260-BG1-006 (mitten)

SAMPLE I.D. S260-BG1-006

SAMPLE COLLECTION DATE 10/28/2016

SAMPLE COLLECTION TIME 1615

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine red sand, trace gravel

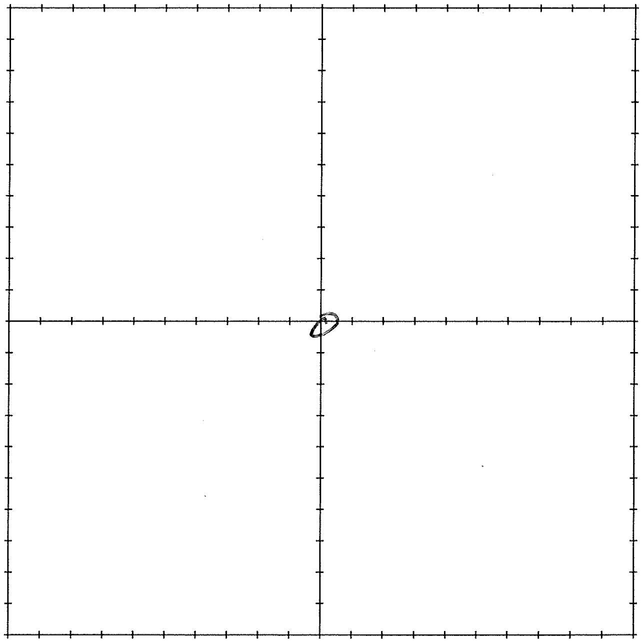
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☒ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Zip lock

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S260-BG1-006 (mitten)

SAMPLE I.D. S260-BG1-206

SAMPLE COLLECTION DATE 10/28/2016

SAMPLE COLLECTION TIME 1615

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine red sand, trace gravel

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC

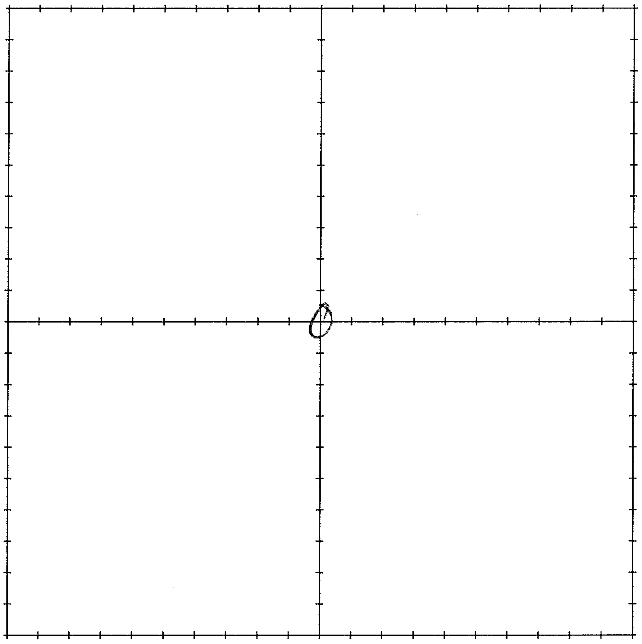
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☑ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☑ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Ziplock

ANALYSES: Ra, 226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S260-BG1-007 (mitten)

SAMPLE I.D. S260-BG1-007

SAMPLE COLLECTION DATE 10/28/2016

SAMPLE COLLECTION TIME 1630

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70s, sunny

FIELD USCS DESCRIPTIONS Red fine sand, trace gravels

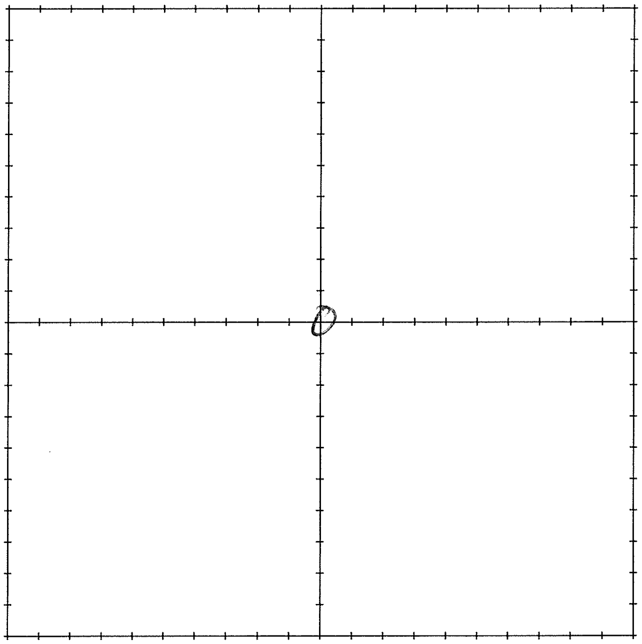
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☒ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☒ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Ziplock

ANALYSES: Ra-226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S260-BG1-008 (Mitten)

SAMPLE I.D. S260-BG1-008

SAMPLE COLLECTION DATE 10/28/2016

SAMPLE COLLECTION TIME 1645

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine red sand, trace gravels

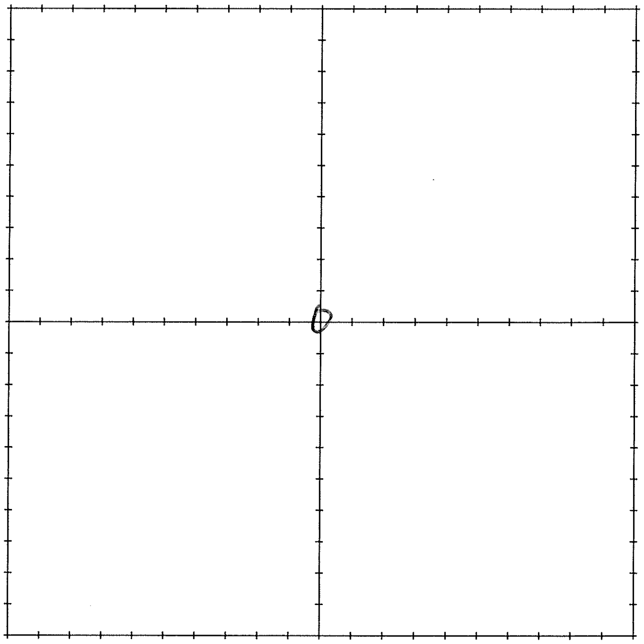
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☑ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Ziplock

ANALYSES: Ra-226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S260-BG1-009 (Mitten)

SAMPLE I.D. S260-BG1-009

SAMPLE COLLECTION DATE 10/28/2016

SAMPLE COLLECTION TIME 1700

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70s, Sunny

FIELD USCS DESCRIPTIONS Fine red sand, trace gravel

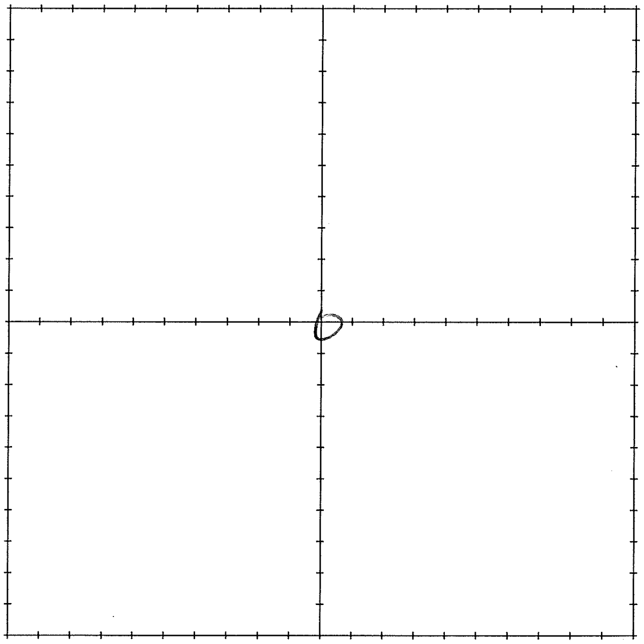
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☐ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Ziplock

ANALYSES: Ra-226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S260-BG1-D10 (mitten)

SAMPLE I.D. S260-BG1-010

SAMPLE COLLECTION DATE 10/28/2016

SAMPLE COLLECTION TIME 1715

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine red sand, trace gravel

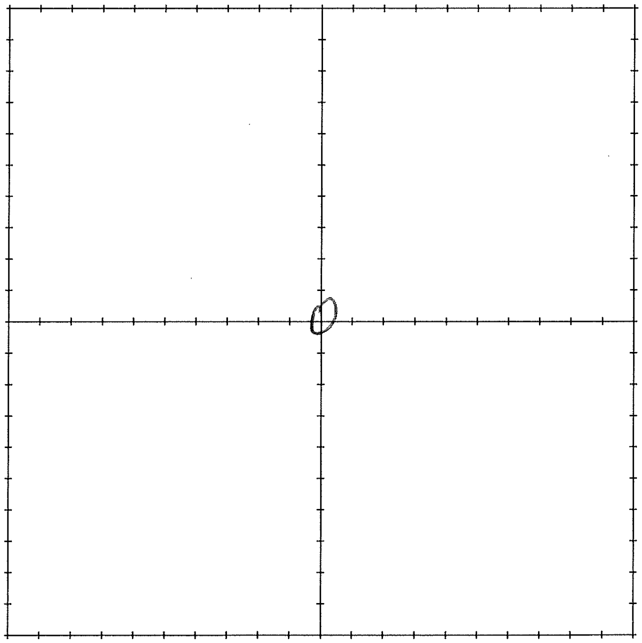
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☑ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Ziplock

ANALYSES: Ra-226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Mitten No. 3

SAMPLE I.D. S260-BG2-001

SAMPLE COLLECTION DATE 8/24/17

SAMPLE COLLECTION TIME 1414

SAMPLE COLLECTED BY TO

WEATHER CONDITIONS Sunny 100' F

FIELD USCS DESCRIPTIONS (SP) poor graded sand Dry, loose, Red

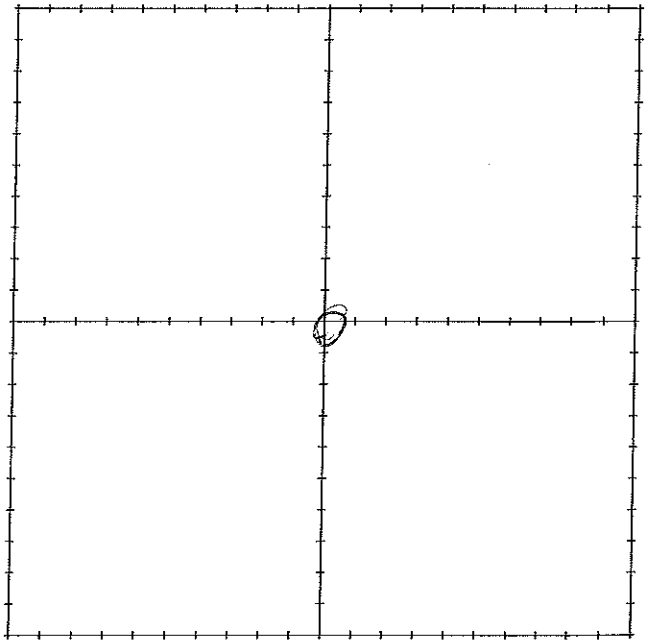
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 Zip locks

ANALYSES: Ra-226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Mitten No. 3

SAMPLE I.D. S260-BG2-002

SAMPLE COLLECTION DATE 8/24/17

SAMPLE COLLECTION TIME 1420

SAMPLE COLLECTED BY TO

WEATHER CONDITIONS Sunny 100°F

FIELD USCS DESCRIPTIONS (SW) Well graded sand grading from fine to coarse grains are rounded red, green, tan (fluvial) 100% sand

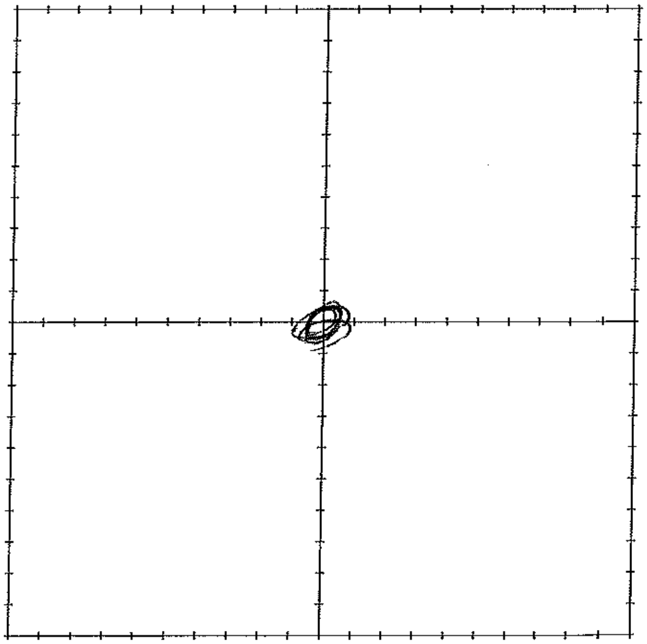
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

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 Mitten No. 3

SAMPLE I.D. S260-BG2-003

SAMPLE COLLECTION DATE 8/24/17

SAMPLE COLLECTION TIME 1425

SAMPLE COLLECTED BY TO

WEATHER CONDITIONS SUNNY 100°F

FIELD USCS DESCRIPTIONS (SW) well graded sand grading from fine to coarse grains are rounded red, green, tan (Fluvial) 100% sand

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC

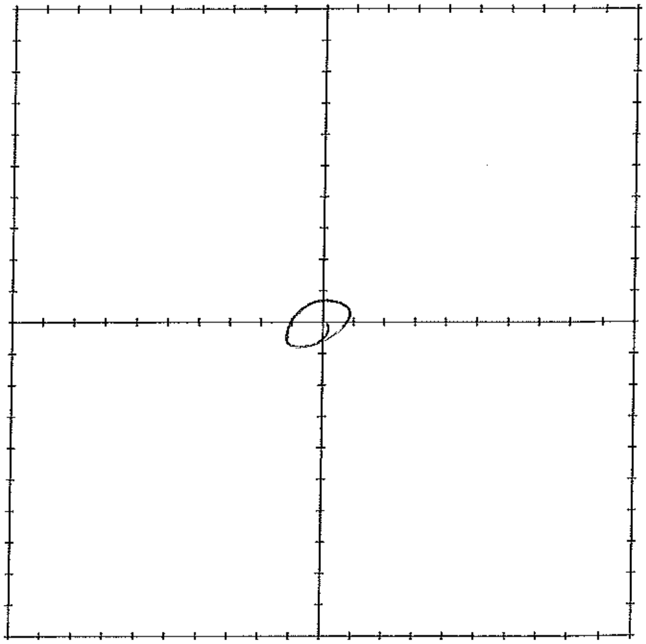
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

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 Mitten No. 3

SAMPLE I.D. S260-BG2-004

SAMPLE COLLECTION DATE 8/24/17

SAMPLE COLLECTION TIME 1930

SAMPLE COLLECTED BY TO

WEATHER CONDITIONS Sunny 100° F

FIELD USCS DESCRIPTIONS (SW) Well ~~[illegible]~~ sand grading from fine to coarse grains are rounded red, green, tan (Fluvial) 100% Sand

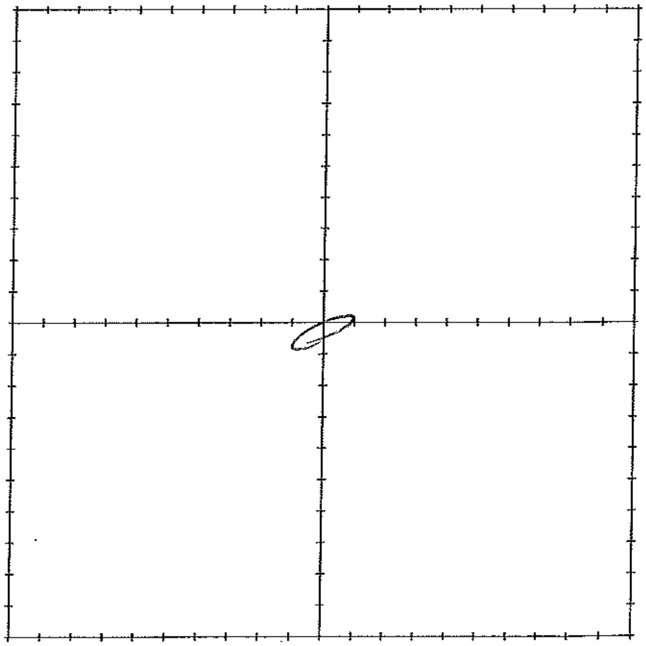
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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 Mitten No. 3

SAMPLE I.D. S260-B62-005 + -205 (Duplicate)

SAMPLE COLLECTION DATE 8/24/17

SAMPLE COLLECTION TIME 1441

SAMPLE COLLECTED BY TO

WEATHER CONDITIONS SUNNY 100° F

FIELD USCS DESCRIPTIONS (SW) well graded sand grading from fine to coarse grains are rounded red, green, tan (fluvial) 100% sand

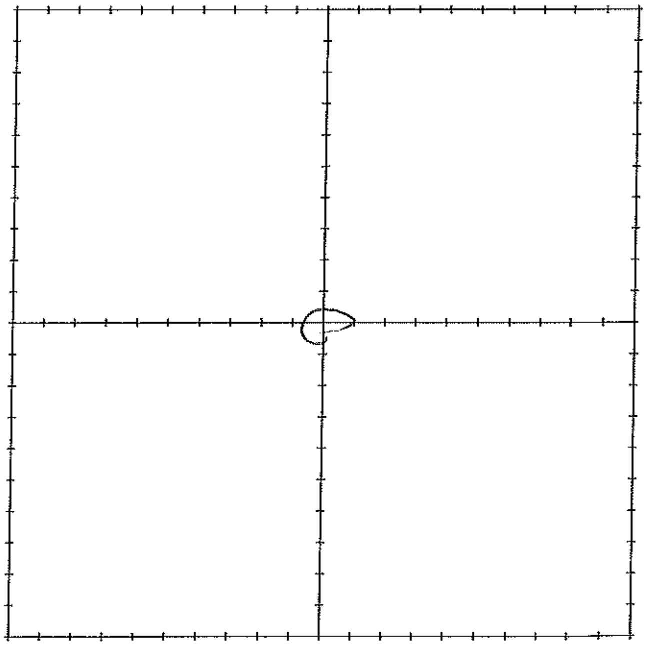
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Mitten No. 3

SAMPLE I.D. S260 - BG2 - 006

SAMPLE COLLECTION DATE 8/24/17

SAMPLE COLLECTION TIME 1450

SAMPLE COLLECTED BY TO

WEATHER CONDITIONS SUNNY 100°F

FIELD USCS DESCRIPTIONS well graded sand grading from fine to coarse (SW) grains are rounded red, green, tan (fluvial) 100% sand

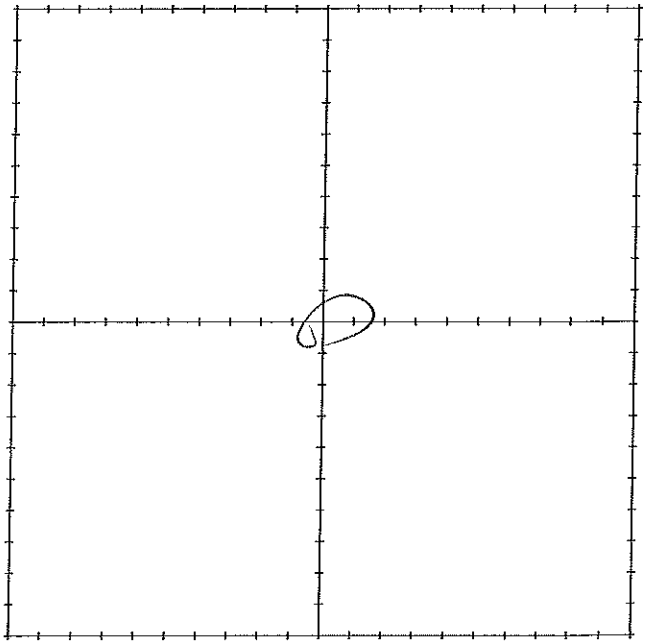
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

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 Milton No. 3

SAMPLE I.D. S260-BG2-007

SAMPLE COLLECTION DATE 8/24/17

SAMPLE COLLECTION TIME 1445

SAMPLE COLLECTED BY TO

WEATHER CONDITIONS SONNY 100° F

FIELD USCS DESCRIPTIONS (SW) Well graded sand grading from fine to coarse grains are rounded red, green, tan, (Fluvial)

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC 100% Sand

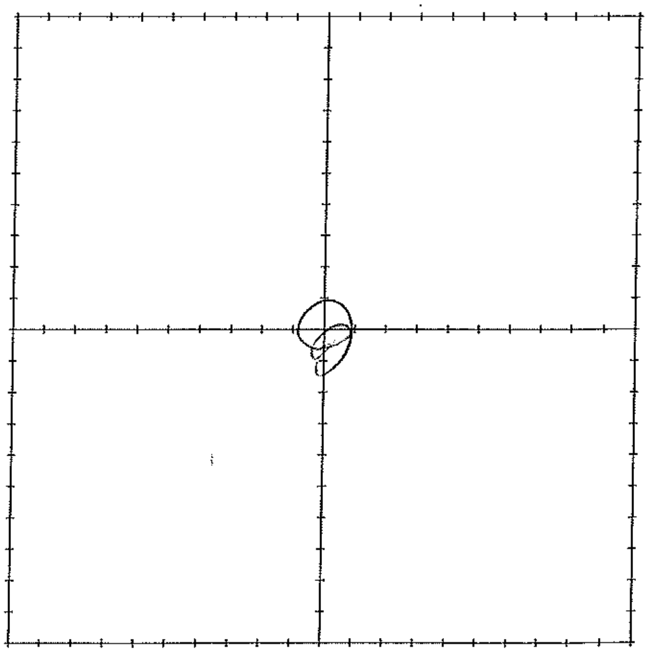
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

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 Mitten No. 3

SAMPLE I.D. S260-B62-008

SAMPLE COLLECTION DATE 8/24/17

SAMPLE COLLECTION TIME 1504

SAMPLE COLLECTED BY TO

WEATHER CONDITIONS Sunny 100°F

FIELD USCS DESCRIPTIONS (SW) well graded sand grading from fine to coarse grains are rounded red, green, tan (Fluvial)

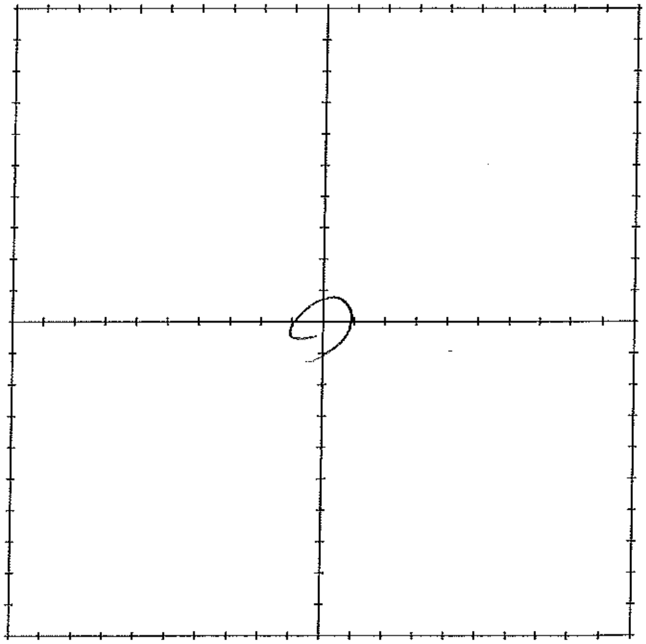
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

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 Milton No. 3

SAMPLE I.D. S260-B62-089

SAMPLE COLLECTION DATE 8/24/17

SAMPLE COLLECTION TIME 1510

SAMPLE COLLECTED BY

WEATHER CONDITIONS Sunny 100 F

FIELD USCS DESCRIPTIONS (SW) well graded sand Fine to medium to coarse grains are rounded red, green, tan (Fluvial)

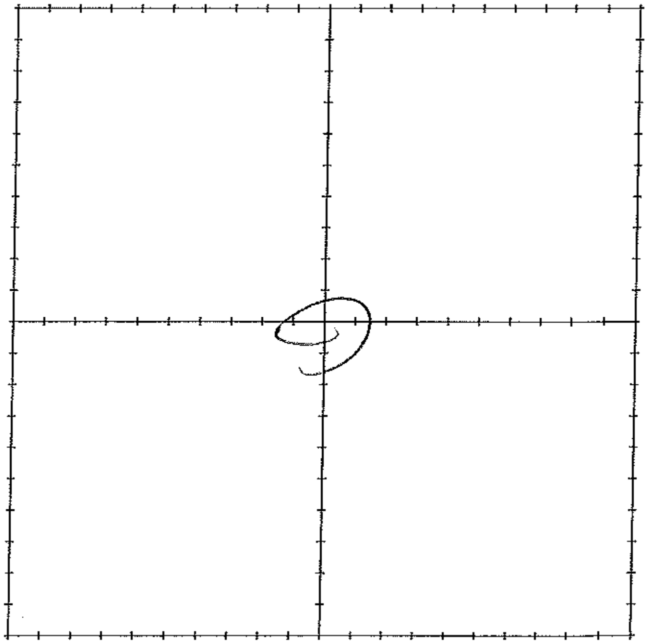
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

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 Mitten No. 3

SAMPLE I.D. S260-BG2-010

SAMPLE COLLECTION DATE 8/24/17

SAMPLE COLLECTION TIME 1520

SAMPLE COLLECTED BY TO

WEATHER CONDITIONS Sonny, 100'F

FIELD USCS DESCRIPTIONS (SW) well graded sand, fine to course grains are rounded, red, green, tan (Fluvial)

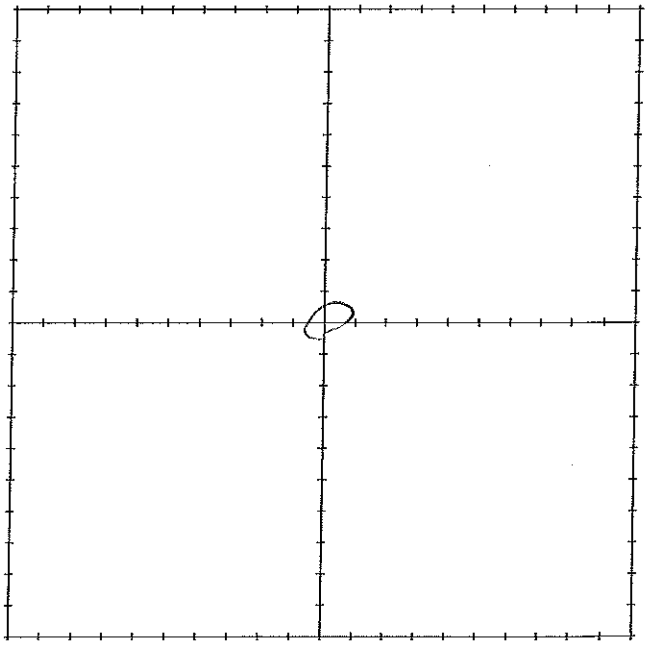
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

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 S260-C01-001 (Mitten)

SAMPLE I.D. S260-C01-001

SAMPLE COLLECTION DATE 10/31/2016

SAMPLE COLLECTION TIME 1010

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine red sand, trace gravel

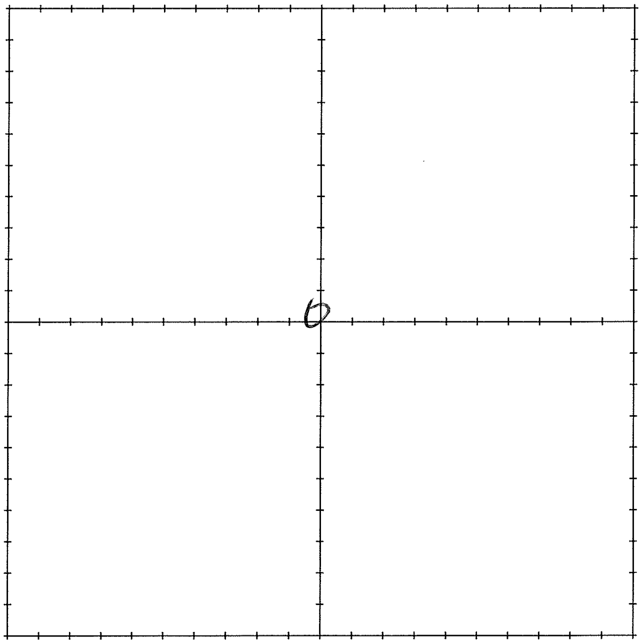
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☒ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Ziplock

ANALYSES: Ra-226, ~~metals~~ thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S260-~~B~~C02-001 (Mitten)

SAMPLE I.D. S260-C02-001

SAMPLE COLLECTION DATE 10/31/2016

SAMPLE COLLECTION TIME 1045

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's Sunny

FIELD USCS DESCRIPTIONS Fine red sand, trace gravels

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC

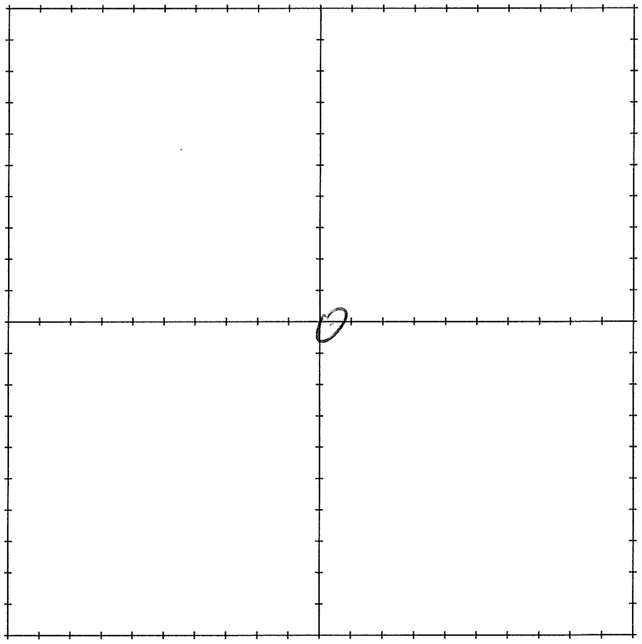
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☑ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Ziplock

ANALYSES: Ra-226, ~~metals~~ thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S260-C03-001 (mitten)

SAMPLE I.D. S260-C03-001

SAMPLE COLLECTION DATE 10/31/2016

SAMPLE COLLECTION TIME 1115

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70s, sunny

FIELD USCS DESCRIPTIONS Fine red sand, trace gravels

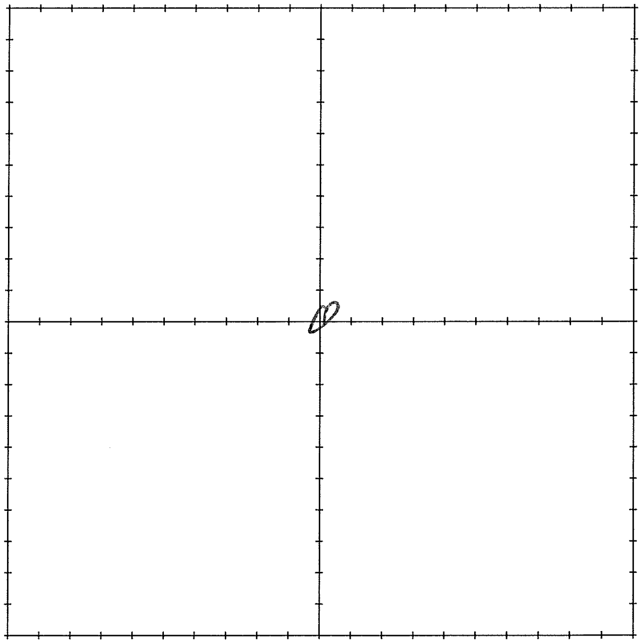
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☑ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☒ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Ziplock

ANALYSES: Ra-226, thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S260-C04-001 (mitten)

SAMPLE I.D. S260-C04-001

SAMPLE COLLECTION DATE 10/31/2016

SAMPLE COLLECTION TIME 1145

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine red sand, trace gravels

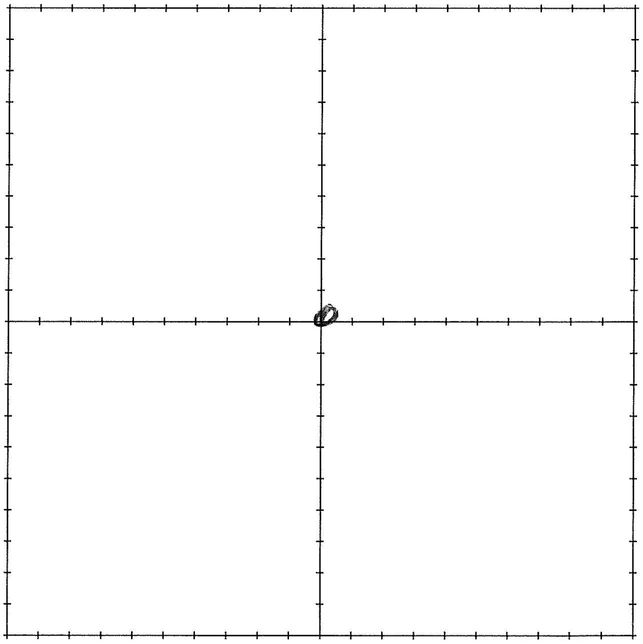
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☒ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Ziplock

ANALYSES: Ra-226, [illegible] thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S260-C05-001 (Mitten)

SAMPLE I.D. S260-C05-001

SAMPLE COLLECTION DATE 10/31/2016

SAMPLE COLLECTION TIME 1245

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70s, sunny

FIELD USCS DESCRIPTIONS Fine red sand

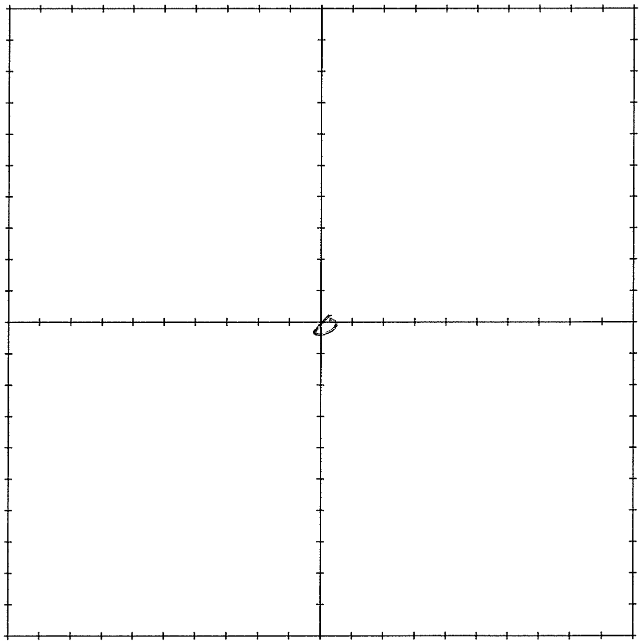
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1 Ziplock

ANALYSES: Ra-226, thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Mitten No3 (S260)

SAMPLE I.D. S260-CX-001

SAMPLE COLLECTION DATE 5/22/17

SAMPLE COLLECTION TIME 815

SAMPLE COLLECTED BY MW/CL

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Tan/light brown sand, coarse

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

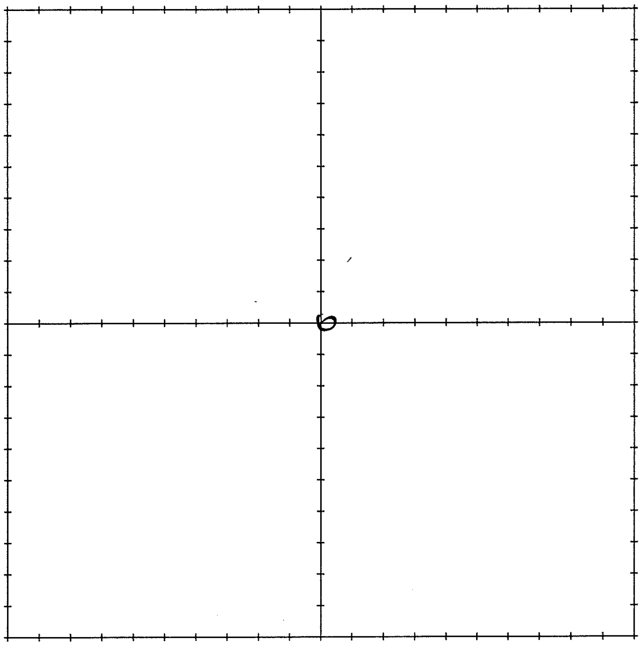
QUALIFIERS: ☐ TRACE ☒ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☒ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

MUNSELL COLOR —

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Mitten No. 3 (8260)

SAMPLE I.D. 8260-CX-002 MS/MSD

SAMPLE COLLECTION DATE 5/22/17

SAMPLE COLLECTION TIME 0832

SAMPLE COLLECTED BY MW/CL

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Red med. to fine sand, platey/shaley gravel

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

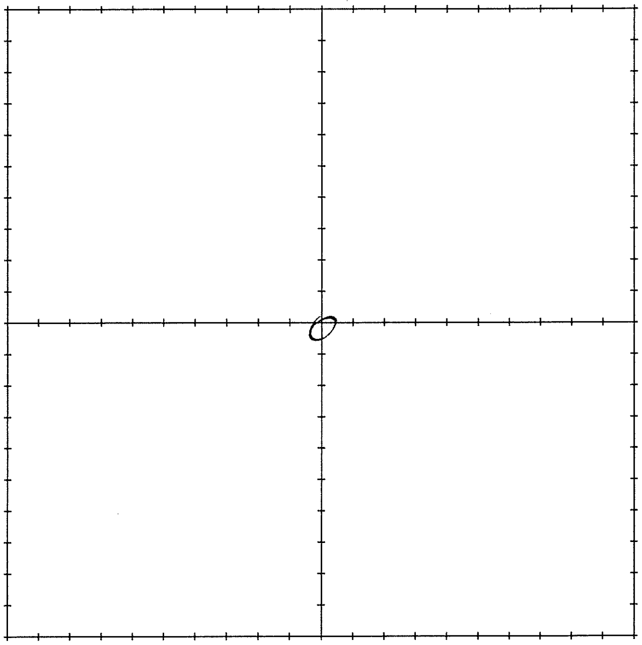
QUALIFIERS: ☒ TRACE ☐ MINOR ☐ SOME: SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

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 Mitten No 3 (S260)

SAMPLE I.D. S260-CX-003

SAMPLE COLLECTION DATE 5/22/17

SAMPLE COLLECTION TIME 1007

SAMPLE COLLECTED BY MW/CL

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine to med sand, red/ brown

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

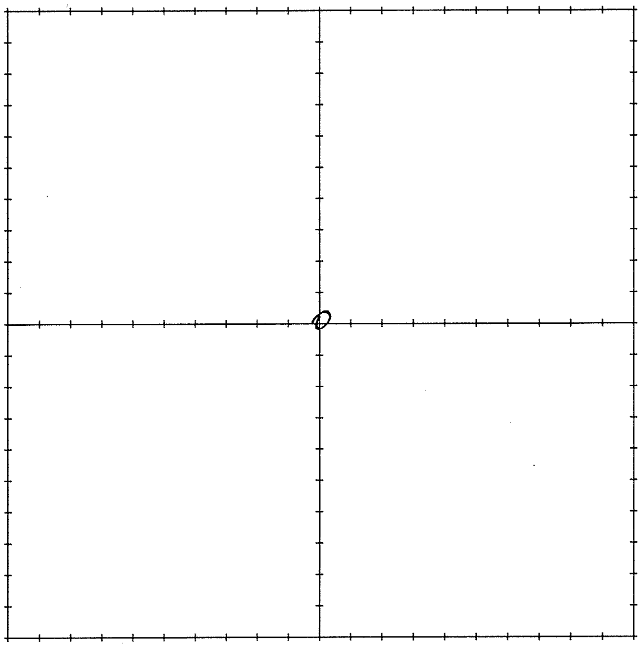
QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

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 Mattox Ho3 (S260)

SAMPLE I.D. S260-CX-004

SAMPLE COLLECTION DATE 5/22/17

SAMPLE COLLECTION TIME 1025

SAMPLE COLLECTED BY MW/CL

WEATHER CONDITIONS 70's sunny

FIELD USCS DESCRIPTIONS Fine red sand, minor gravels (1/8"-1/4")

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

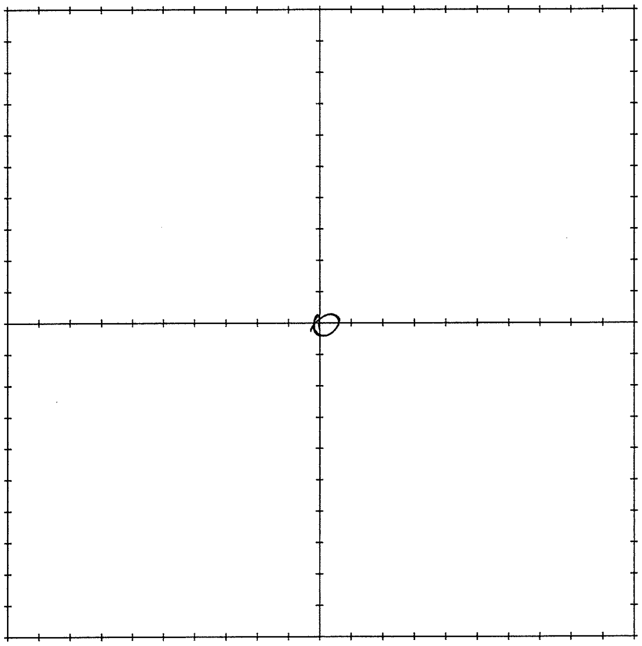
QUALIFIERS: ☐ TRACE ☒ MINOR ☐ SOME; SAND SIZE ☐ FINE ☒ MEDIUM ☐ COARSE

MOISTURE: ☐ DRY ☐ MOIST ☐ WET

MUNSELL COLOR —

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Mitten No. 3 (S260)

SAMPLE I.D. S260-CX-005

SAMPLE COLLECTION DATE 5/22/17

SAMPLE COLLECTION TIME 1130

SAMPLE COLLECTED BY MW/CL

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine brown/red sand, minor med. sands

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

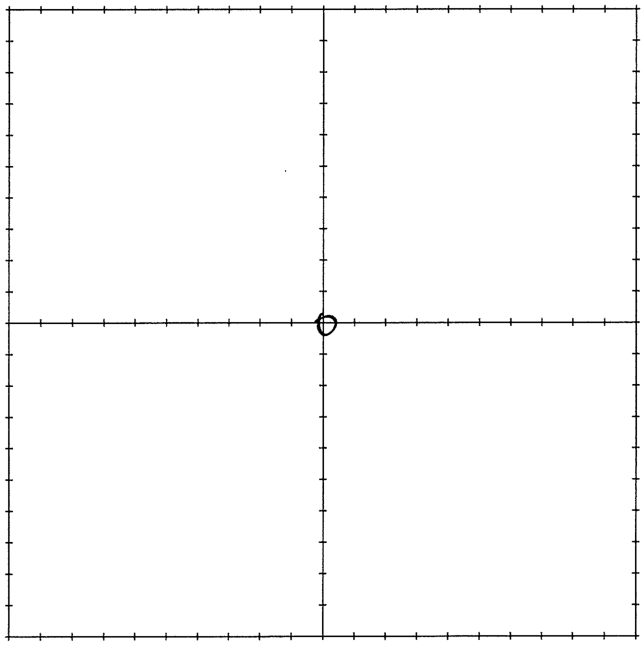
QUALIFIERS: ☐ TRACE ☑ MINOR ☐ SOME; SAND SIZE ☐ FINE ☑ MEDIUM ☐ COARSE

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 Mitter Ho3 (S260)

SAMPLE I.D. S260-LX-006

SAMPLE COLLECTION DATE 5/22/17

SAMPLE COLLECTION TIME 1145

SAMPLE COLLECTED BY MW/CL

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Red-brown sand fine to med., seds not well developed

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

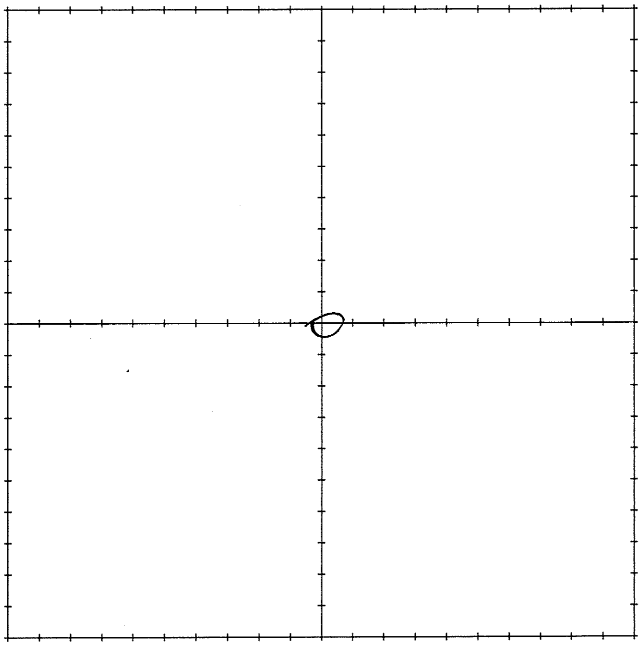
QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

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 Mitter No 3 (S260)

SAMPLE I.D. S260-CX-007

SAMPLE COLLECTION DATE 5/22/17

SAMPLE COLLECTION TIME 1335

SAMPLE COLLECTED BY MW/CL

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine to coarse sand

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

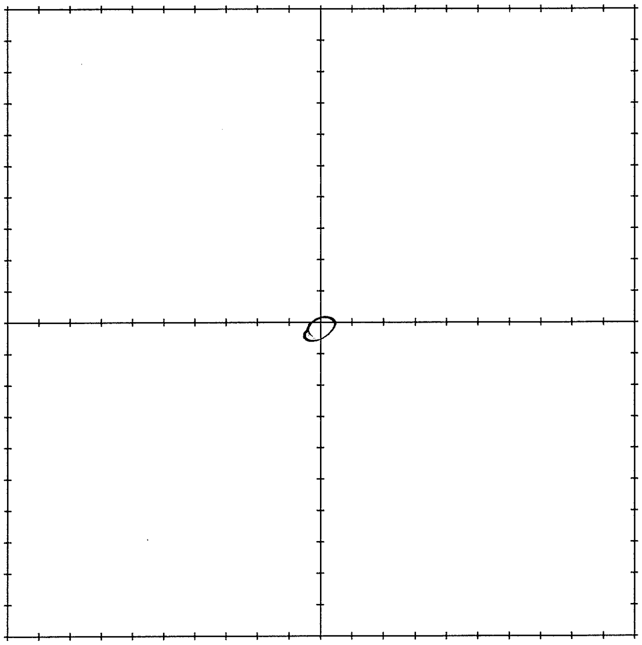
QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

MUNSELL COLOR —

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Mitter No 3 (S260)

SAMPLE I.D. S260 - CX - 008 , 208

SAMPLE COLLECTION DATE 5/22/17

SAMPLE COLLECTION TIME 1345

SAMPLE COLLECTED BY CL/MW

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine - med sand

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

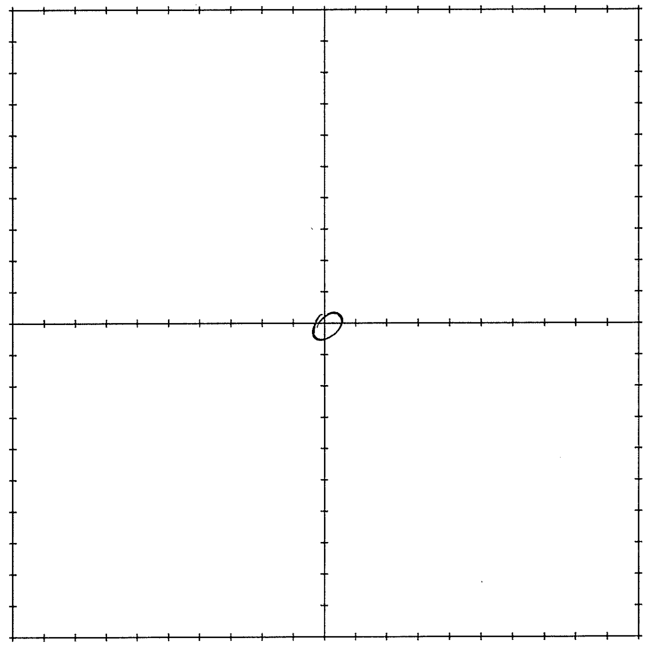
QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

MUNSELL COLOR —

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-Th, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Mitten No 3 (S260)

SAMPLE I.D. S260-CX-009

SAMPLE COLLECTION DATE 5/22/17

SAMPLE COLLECTION TIME 1415

SAMPLE COLLECTED BY MW/CL

WEATHER CONDITIONS 70's Sunny

FIELD USCS DESCRIPTIONS Fine red/tan sand

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

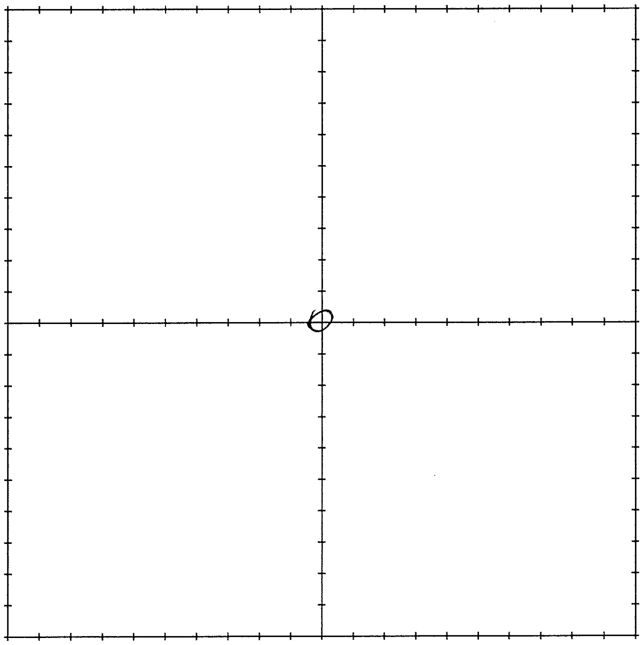
QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

MUNSELL COLOR —

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Mitten No 3 (S260)

SAMPLE I.D. S260-CX-010

SAMPLE COLLECTION DATE 5/22/17

SAMPLE COLLECTION TIME 1451

SAMPLE COLLECTED BY AW/CL

WEATHER CONDITIONS 70s sunny

FIELD USCS DESCRIPTIONS Fine tan/red sand

MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

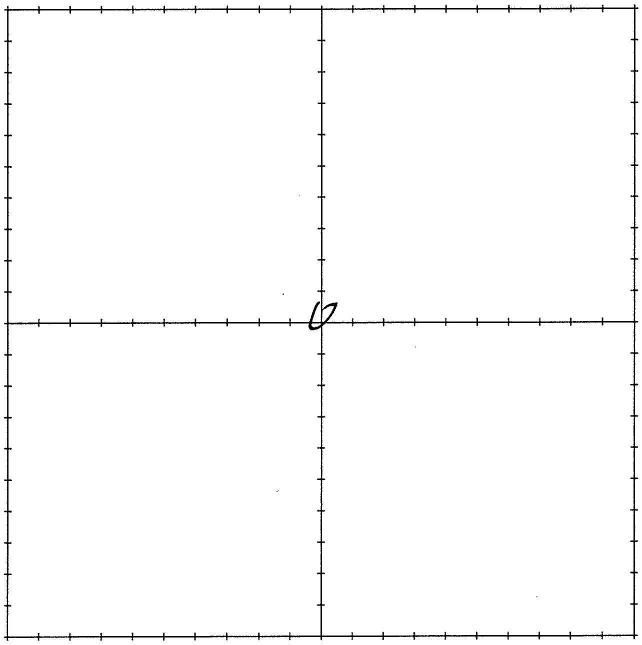
QUALIFIERS: ☐ TRACE ☐ MINOR ☐ SOME; SAND SIZE ☐ FINE ☐ MEDIUM ☐ COARSE

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

MUNSELL COLOR —

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 zips

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME Mitten No3 (S260)

SAMPLE I.D. S260-CX-011

SAMPLE COLLECTION DATE [illegible] 5/22/17

SAMPLE COLLECTION TIME 1517

SAMPLE COLLECTED BY MW/CL

WEATHER CONDITIONS 70's sunny

FIELD USCS DESCRIPTIONS Fine tan/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 zipper

ANALYSES: Ra-226, Metals.

MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

C.2 Hand Auger Borehole Logs

Stantec

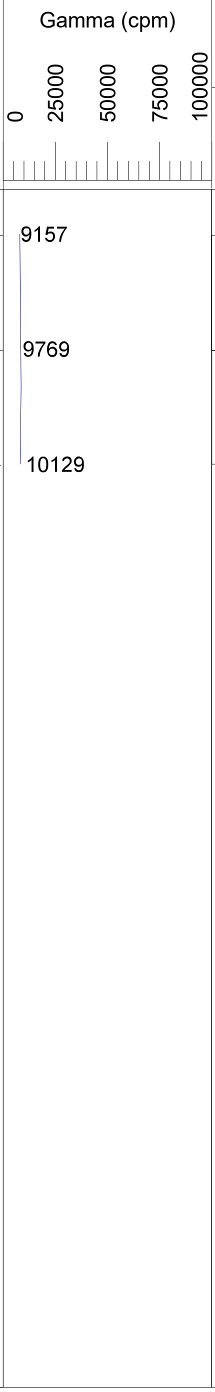
NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S260-SCX-001 (BG-1)**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Mitten No. 3

DRILLING CONTRACTOR: Stantec
DRILLING METHOD: Shovel
DRILLING EQUIPMENT: Shovel
SAMPLING METHOD: Grab

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 559088.74 NORTHING: 4099869.32
DATE STARTED: 10/31/2016 DATE STARTED: 10/31/2016
TOTAL DEPTH (ft.): 1.0 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Luis Rodriguez

				SUBSURFACE SAMPLE INFORMATION			
DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION	Gamma (cpm)	SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	▨	SILTY SAND (SM): red, fine grained sand, minor fine silts, and trace gravels.	9157	S260-SCX-001-1	0-0.5	grab	No Result Samples Lost Prior to Shipment
	▨		9769	S225-SCX-001-2	0.5-1.0	grab	
1		Terminated shovel hole at 1.0 ft. below ground surface. Refusal on sandstone bedrock.	10129				
2							
3							
4							
5							



Notes: cpm = counts per minute grab = grab sample

Stantec

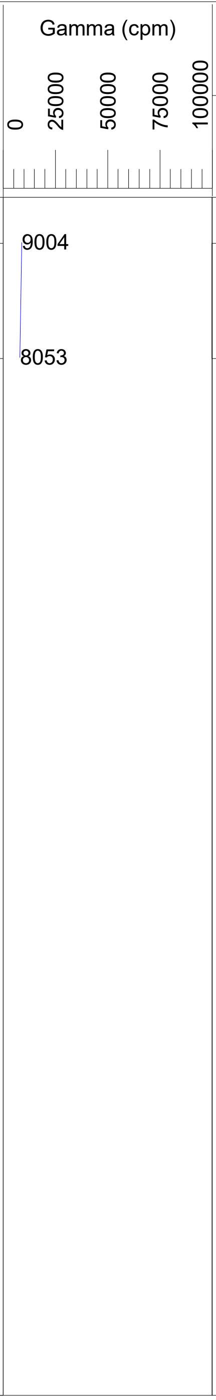
NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S260-BG1-011**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Mitten No. 3

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: 559086.98 NORTHING: 4099871.59
DATE STARTED: 5/23/2017 DATE STARTED: 5/23/2017
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): brown, dark red and trace gray, fine and coarse grained sand, gravels are subrounded to angular, loose, unconsolidated.	9004 8053	S260-BG1-011	0-0.5	grab 🟨	0.45
		Terminated hand auger borehole at 0.5 ft. below ground surface. Refusal on rock.					
1							
2							
3							
4							
5							



Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

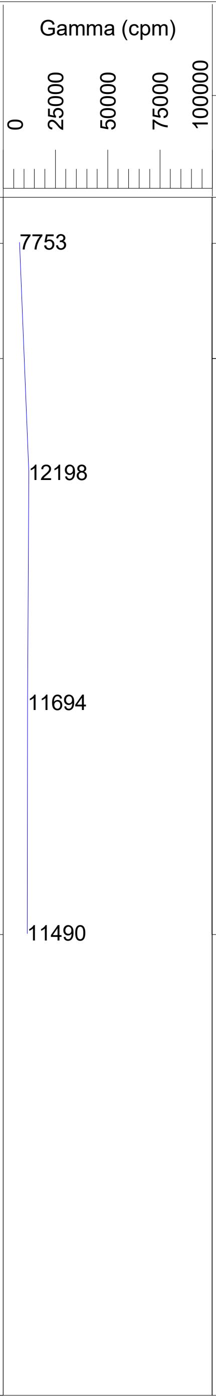
Stantec | NAVAJO NATION AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S260-BG2-011**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Mitten No. 3

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: 558733.09 NORTHING: 4099462.52
DATE STARTED: 8/24/2017 DATE STARTED: 8/24/2017
TOTAL DEPTH (ft.): 3 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0–0.5	WELL GRADED SAND (SW): Red, fine to coarse grained sand. Dry, loose. Grains are rounded.
0.5–3	POORLY GRADED SAND (SP): Red fine grained sand, dry, loose.
3	Terminated hand auger borehole at 3 ft. below ground surface. Refusal on rock.



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S260-BG2-011-01	0-0.5	grab	0.49
S260-BG2-011-02	0.3-3	comp	0.44

Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

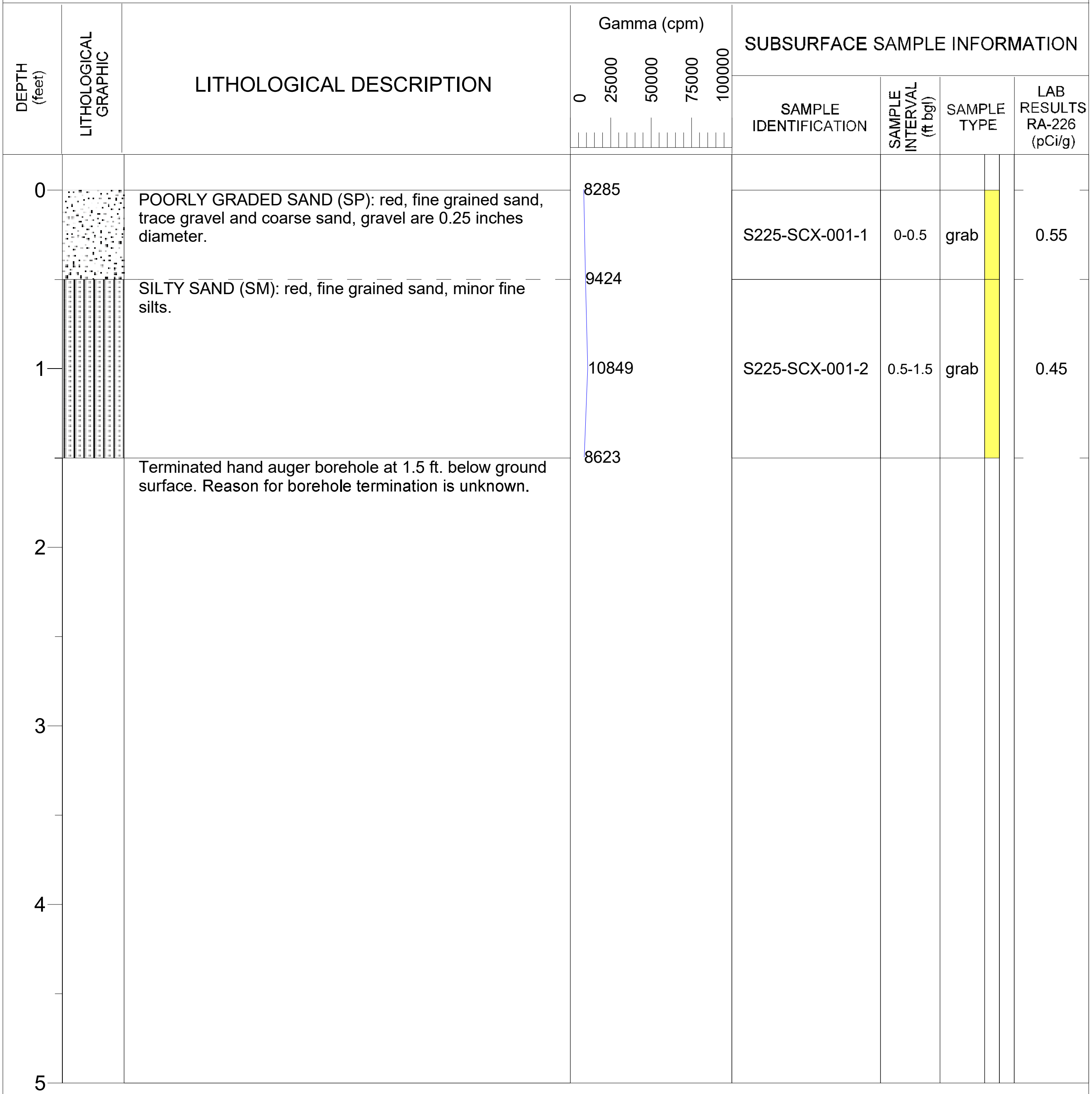
Stantec

NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S225-SCX-001 (CK-BG-2)**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Charles Keith

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: 561637.31
NORTHING: 4100067.76
DATE STARTED: 11/2/2016
DATE STARTED: 11/2/2016
TOTAL DEPTH (ft.): 1.5
BOREHOLE ANGLE: 90 degrees
LOGGED BY: Chris Lee



DEPTH (feet)	LITHOLOGICAL DESCRIPTION	Gamma (cpm)	SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	POORLY GRADED SAND (SP): red, fine grained sand, trace gravel and coarse sand, gravel are 0.25 inches diameter.	8285	S225-SCX-001-1	0-0.5	grab	0.55
0.5	SILTY SAND (SM): red, fine grained sand, minor fine silts.	9424	S225-SCX-001-2	0.5-1.5	grab	0.45
1		10849				
1.5	Terminated hand auger borehole at 1.5 ft. below ground surface. Reason for borehole termination is unknown.	8623				
2						
3						
4						
5						

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

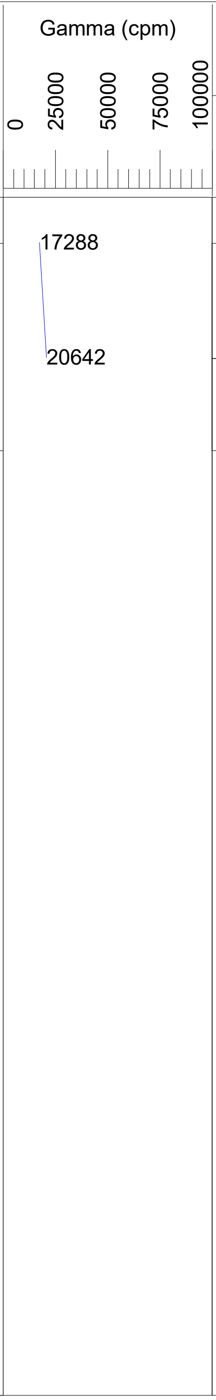
Stantec

NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S260-SCX-002**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Mitten No. 3

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: 558994.45 NORTHING: 4099798.01
DATE STARTED: 5/22/2017 DATE STARTED: 5/22/2017
TOTAL DEPTH (ft.): 0.9 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Michael Ward



DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION	SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	▨	POORLY GRADED SAND WITH GRAVEL (SP): brown, loose, gravels are subrounded to subangular, dry. Road base fill.	S260-SCX-002-1 S260-SCX-202-1	0-0.5	grab	3.17 2.91
			S260-SCX-002-2	0.5-0.9	grab	2.97
1		Terminated hand auger borehole at 0.9 ft. below ground surface. Refusal on rock.				
2						
3						
4						
5						

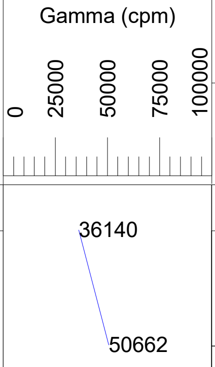
Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

BOREHOLE ID:	**S260-SCX-003**
CLIENT:	NNAUMERT
PROJECT:	Removal Site Evaluation
SITE LOCATION:	Mitten No. 3

DRILLING CONTRACTOR:	Stantec	COORDINATE SYSTEM:		NAD 1983 UTM Zone 12N	
DRILLING METHOD:	Hand auger	EASTING:	558952.61	NORTHING:	4099800.9
DRILLING EQUIPMENT:	Hand auger	DATE STARTED:	5/22/2017	DATE STARTED:	5/22/2017
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	SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0		POORLY GRADED SAND WITH GRAVEL (SP): brown, loose, unconsolidated, dry.	S260-SCX-003-1	0-0.5	grab	13.60
			S260-SCX-003-2	0.5-0.75	grab	10.70
		Terminated hand auger borehole at 0.75 ft. below ground surface. Refusal on rock.				
1						
2						
3						
4						
5						

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

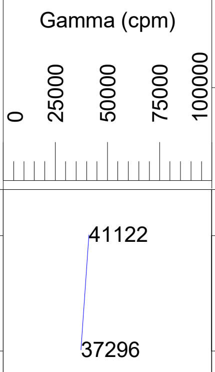
Stantec

NAVAJO NATION
AUM Environmental Response Trust - First Phase

BOREHOLE ID: **S260-SCX-004**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Mitten No. 3

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: 558938.22 NORTHING: 4099795.06
DATE STARTED: 5/22/2017 DATE STARTED: 5/22/2017
TOTAL DEPTH (ft.): 0.5 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Michael Ward



DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION	SUBSURFACE SAMPLE INFORMATION			
			SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	▨	POORLY GRADED SAND WITH GRAVEL AND SILT (SP): brown and gray, loose, unconsolidated, dry. Road base material.	S260-SCX-004-1	0-0.5	grab	14.40
		Terminated hand auger borehole at 0.5 ft. below ground surface. Refusal on 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

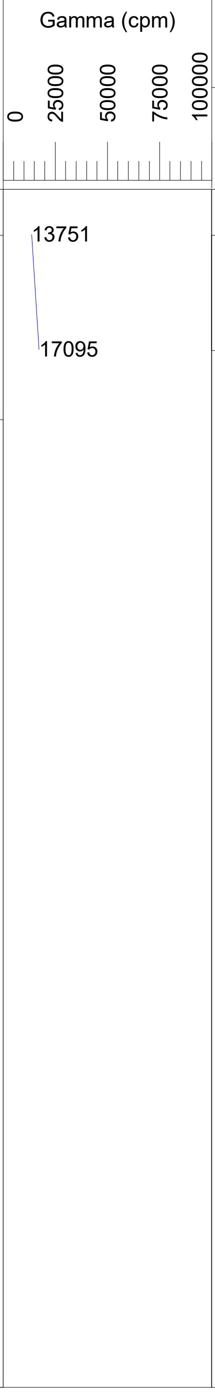
BOREHOLE ID: **S260-SCX-005**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Mitten No. 3

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: 558918.75 NORTHING: 4099790.63
DATE STARTED: 5/22/2017 DATE STARTED: 5/22/2017
TOTAL DEPTH (ft.): 0.8 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Michael Ward

DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION
0	▨	POORLY GRADED SAND WITH GRAVEL (SP): brown and trace white, sands are fine to coarse, gravels are subrounded to angular, loose, dry. Soils are road base material.
0.8		Terminated hand auger borehole at 0.8 ft. below ground surface. Refusal on hard surface or rock.
1		
2		
3		
4		
5		

Gamma (cpm)



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S260-SCX-005-1	0-0.5	grab 🟨	1.34

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

Stantec

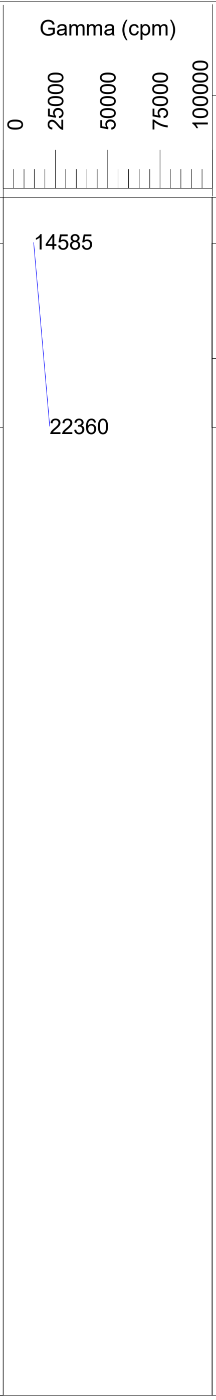
NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S260-SCX-006**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Mitten No. 3

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: 558887.26
NORTHING: 4099771.78
DATE STARTED: 5/22/2017
DATE STARTED: 5/22/2017
TOTAL DEPTH (ft.): 0.8
BOREHOLE ANGLE: 90 degrees
LOGGED BY: Michael Ward

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED SAND WITH GRAVEL (SP): brown, sands are fine to coarse, gravels are subangular to angular, loose, dry.
0.8	Terminated hand auger borehole at 0.8 ft. below ground surface. Refusal on hard surface or rock.
1	
2	
3	
4	
5	



SUBSURFACE SAMPLE INFORMATION

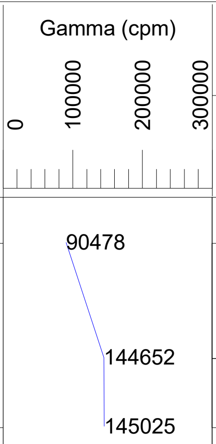
SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S260-SCX-006-1	0-0.5	grab	1.51
S260-SCX-006-2	0.5-0.8	grab	1.45

Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

BOREHOLE ID:	**S260-SCX-007**
CLIENT:	NNAUMERT
PROJECT:	Removal Site Evaluation
SITE LOCATION:	Mitten No. 3

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:	558953.39	NORTHING:	4099747.01
DATE STARTED:	5/22/2017	DATE STARTED:	5/22/2017
TOTAL DEPTH (ft.):	0.8	BOREHOLE ANGLE:	90 degrees
LOGGED BY:	Michael Ward		



DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION	SUBSURFACE SAMPLE INFORMATION			
			SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	▨	POORLY GRADED SAND WITH GRAVEL (SP): assorted color, gray, white, dry, loose.	S260-SCX-007-1	0-0.5	grab	65.70
			S260-SCX-007-2	0.5-0.8	grab	67.10
		Terminated hand auger borehole at 0.8 ft. below ground surface. Refusal on rock.				
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: **S260-SCX-008**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Mitten No. 3

DRILLING CONTRACTOR:	Stantec	COORDINATE SYSTEM:	NAD 1983 UTM Zone 12N
DRILLING METHOD:	Hand auger	EASTING: 559000.64	NORTHING: 4099744.88
DRILLING EQUIPMENT:	Hand auger	DATE STARTED: 5/22/2017	DATE STARTED: 5/22/2017
SAMPLING METHOD:	Regular hand auger, 3 inch diameter	TOTAL DEPTH (ft.): 0.8	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): brown, trace white, loose, unconsolidated, fine and coarse sand, gravels are angular.	14028				
				S260-SCX-008-1	0-0.5	grab	1.37
			18510				
				S260-SCX-008-2	0.5-0.8	grab	1.04
			20803				
		Terminated hand auger borehole at 0.8 ft. below ground surface. Refusal on hard surface or rock.					
1							
2							
3							
4							
5							

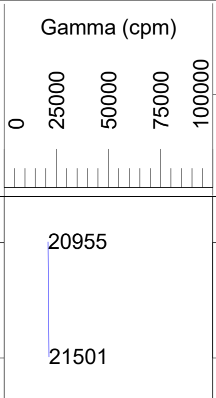
Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

BOREHOLE ID: **S260-SCX-009**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Mitten No. 3

DRILLING CONTRACTOR:	Stantec	COORDINATE SYSTEM:	NAD 1983 UTM Zone 12N
DRILLING METHOD:	Hand auger	EASTING: 558962.74	NORTHING: 4099706.71
DRILLING EQUIPMENT:	Hand auger	DATE STARTED: 5/22/2017	DATE STARTED: 5/22/2017
SAMPLING METHOD:	Regular hand auger, 3 inch diameter	TOTAL DEPTH (ft.): 0.5	BOREHOLE ANGLE: 90 degrees
		LOGGED BY:	Michael Ward



DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION	SUBSURFACE SAMPLE INFORMATION			
			SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	▨	POORLY GRADED SAND WITH GRAVEL (SP): brown, dark red and trace white, loose, unconsolidated, fine and coarse sand, gravels are angular to subrounded.	S260-SCX-009-1	0-0.5	grab 🟨	6.78
		Terminated hand auger borehole at 0.5 ft. below ground surface. Refusal on hard surface or 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

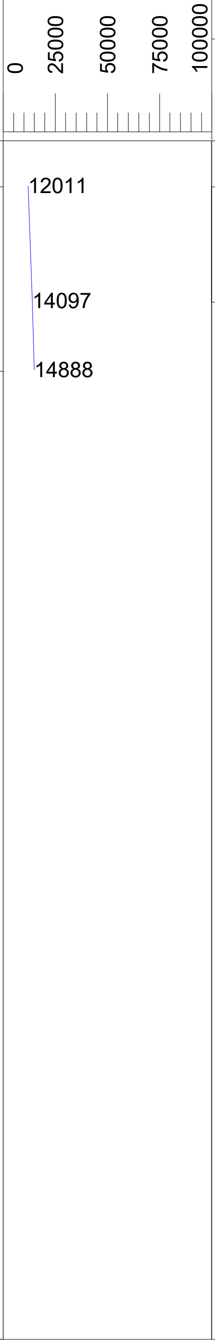
BOREHOLE ID:	**S260-SCX-010**
CLIENT:	NNAUMERT
PROJECT:	Removal Site Evaluation
SITE LOCATION:	Mitten No. 3

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:	558986.02	NORTHING:	4099695.12
DATE STARTED:	5/22/2017	DATE STARTED:	5/22/2017
TOTAL DEPTH (ft.):	0.8	BOREHOLE ANGLE:	90 degrees
LOGGED BY:	Michael Ward		

DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION
0	▒	POORLY GRADED SAND WITH GRAVEL (SP): brown, dark red and trace white, loose, unconsolidated, fine and coarse sand, gravels are angular to subrounded.
0.8		Terminated hand auger borehole at 0.8 ft. below ground surface. Refusal on hard surface or rock.
1		
2		
3		
4		
5		

Gamma (cpm)



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S260-SCX-010-1	0-0.5	grab	1.34

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

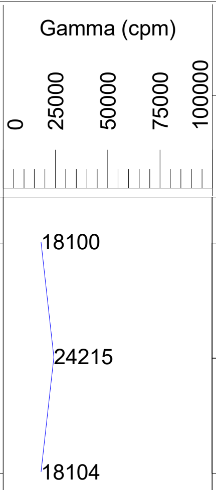
- - - - = approximate contact

BOREHOLE ID: **S260-SCX-011**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: Mitten No. 3

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: 559030.25
NORTHING: 4099573.04
DATE STARTED: 5/22/2017
DATE STARTED: 5/22/2017
TOTAL DEPTH (ft.): 1
BOREHOLE ANGLE: 90 degrees
LOGGED BY: Michael Ward

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED SAND WITH GRAVEL (SP): brown, loose, unconsolidated, fine to medium grained sand, gravels are subangular to subrounded.
1	Terminated hand auger borehole at 1 ft. below ground surface. Refusal on hard surface or rock.
2	
3	
4	
5	



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S260-SCX-011-1	0-0.5	grab	6.90
S260-SCX-011-2	0.5-1	grab	2.37

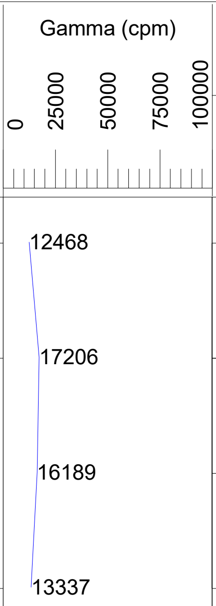
Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

Stantec

NAVAJO NATION
AUM Environmental Response Trust- First Phase

BOREHOLE ID:	**S260-SCX-012**
CLIENT:	NNAUMERT
PROJECT:	Removal Site Evaluation
SITE LOCATION:	Mitten No. 3

DRILLING CONTRACTOR:	Stantec	COORDINATE SYSTEM:		NAD 1983 UTM Zone 12N	
DRILLING METHOD:	Hand auger	EASTING:	559088.46	NORTHING:	4099359.62
DRILLING EQUIPMENT:	Hand auger	DATE STARTED:	5/22/2017	DATE STARTED:	5/22/2017
SAMPLING METHOD:	Regular hand auger, 3 inch diameter	TOTAL DEPTH (ft.):	1.5	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	POORLY GRADED SAND WITH GRAVEL (SP): brown, gray, white, dark red, loose, dry, unconsolidated.	12468	S260-SCX-012-1 S260-SCX-212-1	0-0.5	grab	2.00 2.79
0.5	becoming moist.	17206	S260-SCX-012-2	0.5-1	grab	2.15
1		16189	S260-SCX-012-3	1-1.5	grab	1.40
1.5	Terminated hand auger borehole at 1.5 ft. below ground surface. Refusal on hard surface or rock.	13337				
2						
3						
4						
5						

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

Stantec

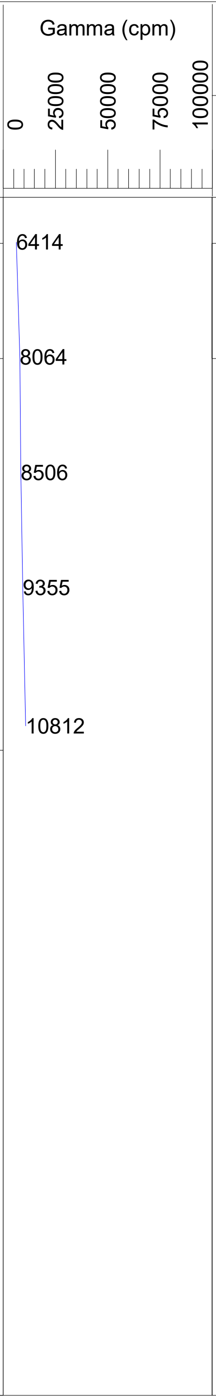
NAVAJO NATION
AUM Environmental Response Trust - First Phase

BOREHOLE ID:	**S260-SCX-013**
CLIENT:	NNAUMERT
PROJECT:	Removal Site Evaluation
SITE LOCATION:	Mitten No. 3

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:	558921.06	NORTHING:	4099437.57
DATE STARTED:	5/22/2017	DATE STARTED:	5/22/2017
TOTAL DEPTH (ft.):	2.2	BOREHOLE ANGLE:	90 degrees
LOGGED BY:	Michael Ward		

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED SAND WITH GRAVEL (SP): light brown, loose, dry, medium to coarse sands, 85% sands, 15% gravels, unconsolidated, subrounded to well rounded gravels.
0.5	becoming moist.
2.2	Terminated hand auger borehole at 2.2 ft. below ground surface. Terminated auger boring due to stable low gamma.



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S260-SCX-013-1	0-0.5	grab	0.45

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

C.3 Water Sample Field Forms

WATER SAMPLE COLLECTION FORM

Project: Removal Site Evaluation Navajo Nation AUM Environmental Response Trust – First Phase

Date 10 / 18 / 16 **Arrival Time** 1218

Field Personnel

J. Kester K. Johnson

SITE DESCRIPTION

Entered 12/20/2016

Surface Water ☒ **Well Water** ☐

Station Name Mitten Seep **Station Number** 08A-213

Site Description Seep with fence around & Trough

original GPS at Cove just North of area.

Water Characteristics (color, odor, appearance): Clear, no odor, Trough with some Algee & Tad poles, insects

SAMPLE COLLECTION

Collection Method: [✓ 1L bottle], Horizontal-bottle, Swing-sampler, Other( ). Up-stream / Across-stream

Sample ID: S260-WS-002 **Sample Time:** 1225

Field Measurements			
Parameter	Sample 1 (normal sample)	Sample 2 (field dup or MS)	Sample 3 (MSD)
Time	1235		
pH	8.19		
FLAG Conductivity (µS/cm)	202.9		10-18-16
Turbidity (NTU)	0.13		
Water Temperature (°C)	17.4		
Salinity ppt	0.10		
Oxidation Reduction Potential (mV)	77.7		

SURFACE WATER FLOW MEASUREMENT FORM

Project: Removal Site Evaluation Navajo Nation AUM Environmental Response Trust – First Phase

Date 10 / 18 / 16 **Time** 1340 **Station Number** Mitten Seep 08A-213

Field Personnel: J. Kester K. Johnson

Flow by Capture Method

Measurement Number	Time (~~sec~~) min	Volume (L)
1	5 min —	~550-600 ml
2	5 min —	~550-600 ml
3	4 min 30 sec	500 ml

Entered 12/20/2016

WATER SAMPLE COLLECTION FORM

Project: Removal Site Evaluation Navajo Nation AUM Environmental Response Trust – First Phase

Date 10 / 18 / 16 **Arrival Time** ~~1045~~ 10-18-16 1114

Field Personnel

J. Kester K. Johnson

Entered 12/20/2016

SITE DESCRIPTION

Surface Water ☐ **Well Water** ☐

Station Name Holiday Mesa Spring (0865-12-10) **Station Number** (0865-12-10) S260-WS-001 SAMPLE

Site Description Spring near Home with Tank - piped to Trough with ~~spik~~ 10-18-16 spigot - Sample from Spigot

Water Characteristics (color, odor, appearance): Clear, no odor

SAMPLE COLLECTION

Collection Method: [✓ 1L bottle], Horizontal-bottle, Swing-sampler, Other( ). Up-stream / Across-stream

Sample ID: S260-WS-001 **Sample Time:** 1120

Field Measurements

Parameter	Sample 1 (normal sample)	Sample 2 (field dup or MS)	Sample 3 (MSD)
Time	1130		
pH	7.91		
FLAG→ Conductivity (µS/cm)	216.7		10-18-16
Turbidity (NTU)	5.12		
Water Temperature (°C)	20.7		
Salinity ppt	0.10		
Oxidation Reduction Potential (mV)	66.5		

SURFACE WATER FLOW MEASUREMENT FORM

Project: Removal Site Evaluation Navajo Nation AUM Environmental Response Trust – First Phase

Date 10 / 18 / 16 **Time** 1114 **Station Number** 0865-12-10

Field Personnel: J. Keoter K. Johnson

Flow by Capture Method

Measurement Number	Time (sec)	Volume (L)
	Not measured	

No flow - AT Spigot & Trough

WATER SAMPLE COLLECTION FORM

Project: Removal Site Evaluation Navajo Nation AUM Environmental Response Trust – First Phase

Date 10/18/16 **Arrival Time** 1405

Field Personnel

J. Koster K. Johnson

Entered 12/20/2016

SITE DESCRIPTION

Surface Water ☐ **Well Water** ☒

Station Name Windmill - Mitten **Station Number** 081L-432

Site Description Spigot at Trough - GPS Taken at Trough

Trough used for farm animals - so.

Water Characteristics (color, odor, appearance): Clear, no odor, some Algae in Trough

SAMPLE COLLECTION

Collection Method: [✓ 1L bottle], Horizontal-bottle, Swing-sampler, Other( ). Up-stream / Across-stream

Sample ID: S260-WL-001 **Sample Time:** 1418

Field Measurements

Parameter	Sample 1 (normal sample)	Sample 2 (field dup or MS)	Sample 3 (MSD)
Time	~~1415~~ 1416		
pH	8.31		
FLAG Conductivity (µS/cm)	1612		
Turbidity (NTU)	2.69		
Water Temperature (°C)	20.9		
Salinity	0.81		
Oxidation Reduction Potential (mV)	89.7		

10-18-16

SURFACE WATER FLOW MEASUREMENT FORM

Project: Removal Site Evaluation Navajo Nation AUM Environmental Response Trust – First Phase

Date 10 / 18 / 16 **Time** 1410 **Station Number** 08IL-432

Mitten Wind Mill

Field Personnel: J. Kester K. Johnson

Flow by Capture Method

Measurement Number	Time (sec)	Volume (L)
	Not Measured	

Well - sampl from Spigot / Trough

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 Mitten No. 3 Site (Site). To select the background reference areas for the Site, personnel considered geology, predominant wind direction, hydrologic influence, similarities of vegetation and ground cover, distance from the Site, 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. In April 2016, one potential background reference area (BG-1) was identified to represent the general conditions of the Site and gamma survey data were collected from BG-1. Soil samples were collected at BG-1 in October 2016.

Following review of data collected at BG-1 and the Site, it was identified that additional potential background reference areas may be required to better characterize the geologic formations present at the Site: the Moenkopi Formation (BG-1 represents this formation); Cutler Formation; and Quaternary deposits in drainages. Three additional potential background reference areas were identified: BG-2 represents the Quaternary deposits in the drainages downgradient from the Site; and BG-3 and BG-4 represent the Cutler Formation. Gamma surveys were conducted at BG-2, BG-3, and BG-4 in May 2017. Soil samples were collected at BG-2 in August 2017. Gamma surveys were completed at the two potential background reference areas representing the Cutler Formation (BG-3 and BG-4), versus evaluating a single area, to screen for heterogeneity within the gamma survey data. Following further review of the Baseline Studies and Site Characterization data from the Site, it was determined that BG-3 and BG-4 would not be used to represent the Cutler formation at the Site, as described in Section 3.0 below.

Data from a potential background reference area in the Cutler Formation at the nearby Charles Keith Site were selected to represent the Cutler Formation at the Mitten No. 3 site. The Charles Keith background reference area is called CK-BG-2 in this RSE Report to avoid confusion. The gamma survey at CK-BG-2 was conducted in May 2016, and sediment samples were collected in October 2016.

The locations of the five potential background reference areas (BG-1, BG-2, BG-3, BG-4, and CK-BG-2) are shown in Figure D.1-1. The four potential background reference areas near the Mitten No. 3 Site along with the Site geology, prominent wind direction, and major mine features are shown in Figure D.1-2. The location of CK-BG-2 at the Charles Keith Site and the site geology for Charles Keith are shown in Figure D.1-3.

A potential background reference area was not selected to represent the mesa top area of the Site, which lies within the Chinle Formation (refer to Figure D.1-2). While there are historical boreholes/cuttings/metal rods present in this area, they are assumed to be associated with the large exploration area on the mesa top that is not directly associated with mining activities at the Site (see RSE Report for information about the exploration area). However, the boreholes/cuttings/metal rods within the exploration area were included in the TENORM estimate at the Site at the Agencies request (NNEPA, 2018). The portal at the Site is located on the contact of the Chinle and Moenkopi Formations, the potential haul road and waste pile are located within the Moenkopi Formation, and there is a near vertical cliff between the portal and the mesa top that is approximately 100 ft tall. Therefore, wind is unlikely to transport waste material to the top of the mesa and water transport from the Moenkopi to the Chinle does not occur.

The potential background reference areas are described below.

- BG-1 encompasses an area of 2,074 ft^2 (approximately 0.05 acres), is located approximately 400 feet northeast of the Site, and is crosswind and hydrologically cross-gradient from the Site. BG-1 is on the opposite side of the mesa from the Site and is sheltered from wind and water transport from the Site. The colluvium-covered slope, and bedrock outcrops at BG-1 represent the upper mesa sidewall at the Site and the Moenkopi Formation. While BG-1 does overlap the Cutler Formation, soil material present in BG-1 consists of colluvium from the Moenkopi Formation because the Cutler Formation is composed of smooth sandstone bedrock that does not generate soil or colluvium in that area. The limited vegetation and ground cover at BG-1 are similar to the Site.

- BG-2 encompasses an area of 785 ft^2 (approximately 0.02 acres), is located approximately 850 feet southwest of the Site, and is crosswind and hydrologically cross-gradient of the Site. Geologically, BG-2 represents the Quaternary deposits (alluvium) found in the drainages downgradient from the Site. The vegetation and ground cover at BG-2 are similar to the drainages downgradient from the Site.

- BG-3 encompasses an area of 1,250 ft^2 (approximately 0.03 acres), is located approximately 880 feet southeast of the Site, and is crosswind and hydrologically cross-gradient of the Site. Geologically, BG-3 represents the Cutler Formation on the mesa sidewall at the Site. BG-3 consists of smooth sandstone bedrock with some overlying poorly formed residual soils that originated from weathering bedrock in the Moenkopi Formation upslope from BG-3. The limited vegetation and ground cover at BG-3 are similar to areas of the Site.

- BG-4 encompasses an area of 1,009 ft^2 (approximately 0.02 acres), is located approximately 275 feet southwest of the Site, and is upwind and hydrologically cross-gradient of the Site. BG-4 is isolated from the Site by a topographic high that would prevent deposition of colluvium from the Site. Geologically, BG-4 represents the Cutler Formation on the mesa sidewall at the Site and consists of smooth sandstone bedrock with some overlying poorly formed residual soils that originated from weathering bedrock in the Moenkopi Formation upslope from BG-4. The limited vegetation and ground cover at BG-4 are similar to areas of the Site.

- CK-BG-2 encompasses an area of 2,615 ft^2 (approximately 0.06 acres), is located 1.6 miles east of the Site and is hydrologically cross-gradient of the Site. CK-BG-2 is downwind from the Site; however, it is sheltered from the Site by a large valley and a mesa. Geologically, CK-BG-2 represents the Cutler Formation areas on the mesa sidewall and pediment and includes limited Quaternary deposits.

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; a borehole could not be advanced beyond 0.5 ft at S260-BG1-011 due to refusal on bedrock, so no subsurface samples were collected at BG-1; surface and subsurface static gamma measurements were collected from borehole location S260-BG1-011

- BG-2: 11 surface sediment grab samples were collected from 11 locations;, one subsurface sediment composite sample and surface and subsurface static gamma measurements were collected from borehole location S260-BG2-011

- CK-BG-2: 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 S225-SCX-001

The sample locations and surface gamma survey data for BG-1 and BG-2 are shown in Figure D.1-4, and sample locations and surface gamma survey data for CK-BG-2 are shown in Figure D.1-5. Samples were categorized as surface soil or sediment samples where sample depths were up to 0.5 ft bgs, as subsurface soil or sediment 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 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 selected to represent the three geologic formations present at or near the Site where mining-related disturbance may have occurred: BG-1 is representative of the Moenkopi Formation, BG-2 represents the Quaternary deposits, and BG-3, BG-4, and CK-BG-2 represent the Cutler Formation. BG-3 and BG-4 were not selected as background reference areas because, while they're located within the Cutler Formation, they consisted of smooth sandstone bedrock with some overlying poorly formed residual soils and colluvium that originated from weathering bedrock in the Moenkopi Formation upslope from BG-3 and BG-4. Additionally, BG-4 is downgradient from the potential haul road and BG-3 is potentially downwind from areas of the drainage that were impacted by TENORM, and so each could have been be mine-impacted. CK-BG-2 was selected to represent the Cutler Formation. CK-BG-2 is located near the Charles Keith Site; however, it is located cross-gradient and cross-wind of mining related disturbances that occurred at the Site as shown on Figure 3-3b in the RSE report. The soils present at CK-BG-2 appear to be more representative of the unconsolidated deposits present on the Cutler Formation in the vicinity of the Site, because they are located on a more gently sloping pediment that is covered with well-developed residual soils or colluvium from weathered bedrock. Gamma survey measurements, soil and sediment sample results, and subsurface static gamma measurements collected from BG-1, BG-2, and CK-BG-2 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.

NNEPA, 2018. Letter and Agency Comments on Draft Mitten No.3 Removal Site Evaluation (RSE) Report. June 4, 2018.

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
Mitten No. 3
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 - Moenkopi Formation						
Total Number of Observations	11	11	11	11	11	11
Percent Non-Detects	--	73%	91%	--	--	9%
Minimum[1]	1.40	--	--	0.210	7.50	--
Minimum Detect[2]	--	0.210	1.20	--	--	0.450
Mean[1]	1.92	--	--	0.436	10.3	--
Mean Detects[2]	--	0.217	1.20	--	--	0.585
Median[1]	1.80	--	--	0.390	9.50	--
Median Detects[2]	--	0.210	--	--	--	0.600
Maximum[1]	2.90	--	--	0.740	15.0	--
Maximum Detect[2]	--	0.230	1.20	--	--	0.710
Distribution	Normal	Normal	Not Calculated	Normal	Normal	Normal
Coefficient of Variation[1]	0.258	--	--	0.359	0.236	--
CV Detects[2]	--	0.053	--	--	--	0.159
UCL Type	95% Student's-t UCL	95% KM (t) UCL	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% KM (t) UCL
UCL Result	2.19	0.140	Not Calculated	0.522	11.7	0.626
UTL Type	UTL Normal	UTL KM Normal	Not Calculated	UTL Normal	UTL Normal	UTL KM Normal
UTL Result	3.31	0.312	Not Calculated	0.877	17.2	0.872
Background Reference Area Study - Background Area 2 - Quaternary Deposits						
Total Number of Observations	11	11	11	11	11	11
Percent Non-Detects	--	45%	100%	--	--	--
Minimum[1]	1.40	--	--	0.220	5.10	0.360
Minimum Detect[2]	--	0.220	--	--	--	--
Mean[1]	2.96	--	--	0.375	6.22	0.585
Mean Detects[2]	--	0.292	--	--	--	--
Median[1]	2.80	--	--	0.350	6.50	0.590
Median Detects[2]	--	0.270	--	--	--	--
Maximum[1]	5.30	--	--	0.540	7.50	0.760
Maximum Detect[2]	--	0.410	--	--	--	--
Distribution	Normal	Normal	Not Calculated	Normal	Normal	Normal
Coefficient of Variation[1]	0.417	--	--	0.232	0.123	0.205
CV Detects[2]	--	0.257	--	--	--	--
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	3.63	0.288	Not Calculated	0.422	6.64	0.650
UTL Type	UTL Normal	UTL KM Normal	Not Calculated	UTL Normal	UTL Normal	UTL Normal
UTL Result	6.43	0.447	Not Calculated	0.619	8.38	0.922

Table D.1-1
Soil and Sediment Sampling Summary
Mitten No. 3
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)
Charles Keith Background Reference Area 2 (CK-BG-2) - Cutler Formation						
Total Number of Observations	11	11	11	11	11	11
Percent Non-Detects	--	18%	100%	--	--	--
Minimum¹	0.640	--	--	0.180	3.40	0.360
Minimum Detect²	--	0.170	--	--	--	--
Mean¹	1.04	--	--	0.265	6.03	0.558
Mean Detects²	--	0.349	--	--	--	--
Median¹	0.980	--	--	0.240	6.40	0.550
Median Detects²	--	0.310	--	--	--	--
Maximum¹	2.10	--	--	0.430	7.20	0.750
Maximum Detect²	--	0.620	--	--	--	--
Distribution	Gamma	Normal	Not Calculated	Normal	Normal	Normal
Coefficient of Variation¹	0.394	--	--	0.290	0.201	0.223
CV Detects²	--	0.431	--	--	--	--
UCL Type	5% Adjusted Gamma UC	95% KM (t) UCL	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL
UCL Result	1.32	0.394	Not Calculated	0.307	6.69	0.626
UTL Type	UTL Gamma WH	UTL KM Normal	Not Calculated	UTL Normal	UTL Normal	UTL Normal
UTL Result	2.36	0.786	Not Calculated	0.482	9.45	0.909

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
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 1

	Background Reference Area 1 (BG-1)	Background Reference Area 2 (BG-2)	Charles Keith Background Reference Area 2 (CK-BG-2)	Background Reference Area 3 (BG-3)	Background Reference Area 4 (BG-4)
Geologic Formation	Moenkopi Formation	Quaternary Deposits	Cutler Formation	Cutler Formation	Cutler Formation
Statistic					
Total Number of Observations	301	156	199	302	219
Minimum	6,873	7,444	6,349	6,942	6,220
Mean	10,314	8,373	8,898	7,969	7,505
Median	10,355	8,317	8,726	7,930	7,451
Maximum	15,394	9,371	12,135	10,190	9,005
Distribution	Normal	Normal	Normal	NORMAL	GAMMA
Coefficient of Variation	0.137	0.051	0.142	0.0574	0.081
UCL Type	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL	95% Approximate Gamma UCL
UCL Result	10,448	8,430	9,046	8013	7,573
UTL Type	UTL Normal	UTL Normal	UTL Normal	UTL Normal	UTL Gamma WH
UTL Result	12,847	9,172	11,220	8,792	8,644

Notes

cpm	Counts per minute
UCL	Upper confidence limit
UTL	Upper tolerance limit
WH	Wilson Hilferty

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

- Flow Direction
- Intermittent Stream/River
- Potential Background Reference Area
- Claim 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 09/2018.

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TITLE:
Potential Background Reference Areas Regional Map

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 9/27/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: EDZ
REVIEWER: CBB
Stantec
FIGURE: D.1-1

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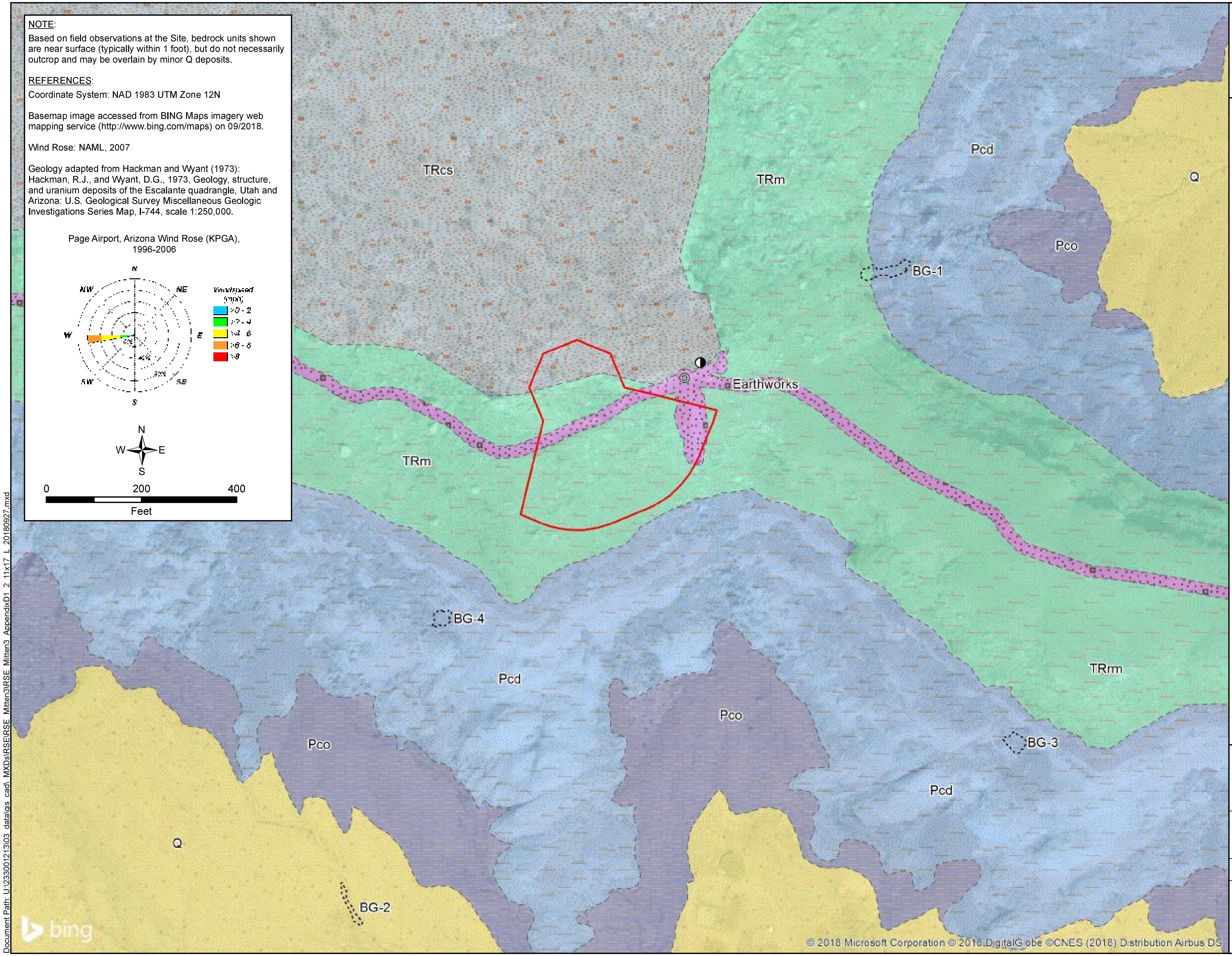

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NOTE:
Based on field observations at the Site, bedrock units shown are near surface (typically within 1 foot), but do not necessarily outcrop and may be overlain by minor Q deposits.

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.

Wind Rose: NAML, 2007

Geology adapted from Hackman and Wyant (1973): Hackman, R.J., and Wyant, D.G., 1973, Geology, structure, and uranium deposits of the Escalante quadrangle, Utah and Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Series Map, I-744, scale 1:250,000.

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

◎ Approximate Reclaimed Portal Location
◑ Prospect Portal
⬚ Potential Background Reference Area
🟥 Claim Boundary
- - Geologic Contact (Inferred)

Site Geology

HOLOCENE

🟪 Earthworks: Human-caused disturbance of the land surface potentially related to mining.

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

TRIASSIC

▨ TRcs: Shinarump member of the Chinle Formation (Upper Triassic) – moderate-orange and yellowish-gray sandstone, siltstone, conglomerate and sandy shale.

🟩 TRm: Moenkopi Formation (Triassic) – reddish-brown, platy to slabby, ripple-marked siltstone, thin marine limestones, and thick beds of brown, fine-grained calcareous sandstone.

PERMIAN

🟦 Pcd: De Chelly Sandstone Member of the Cutler Formation (Permian) – reddish-orange to pale-reddish-brown, fine to medium-grained eolian sandstone; erodes to cliffs and domes.

🟪 Pco: Organ Rock Tongue of the Cutler Formation (Permian) – reddish brown, evenly thin bedded siltstone and fine-grained sandstone.

TITLE: Geologic Map and Potential Background Reference Areas Near Mitten No. 3	
PROJECT: Removal Site Evaluation Mitten No. 3 Mine Site	
DATE: 9/27/2018	DOCUMENT NAME: Removal Site Evaluation Report
Stantec	AUTHOR: EDZ / REVIEWER: CBB
	FIGURE: D.1-2

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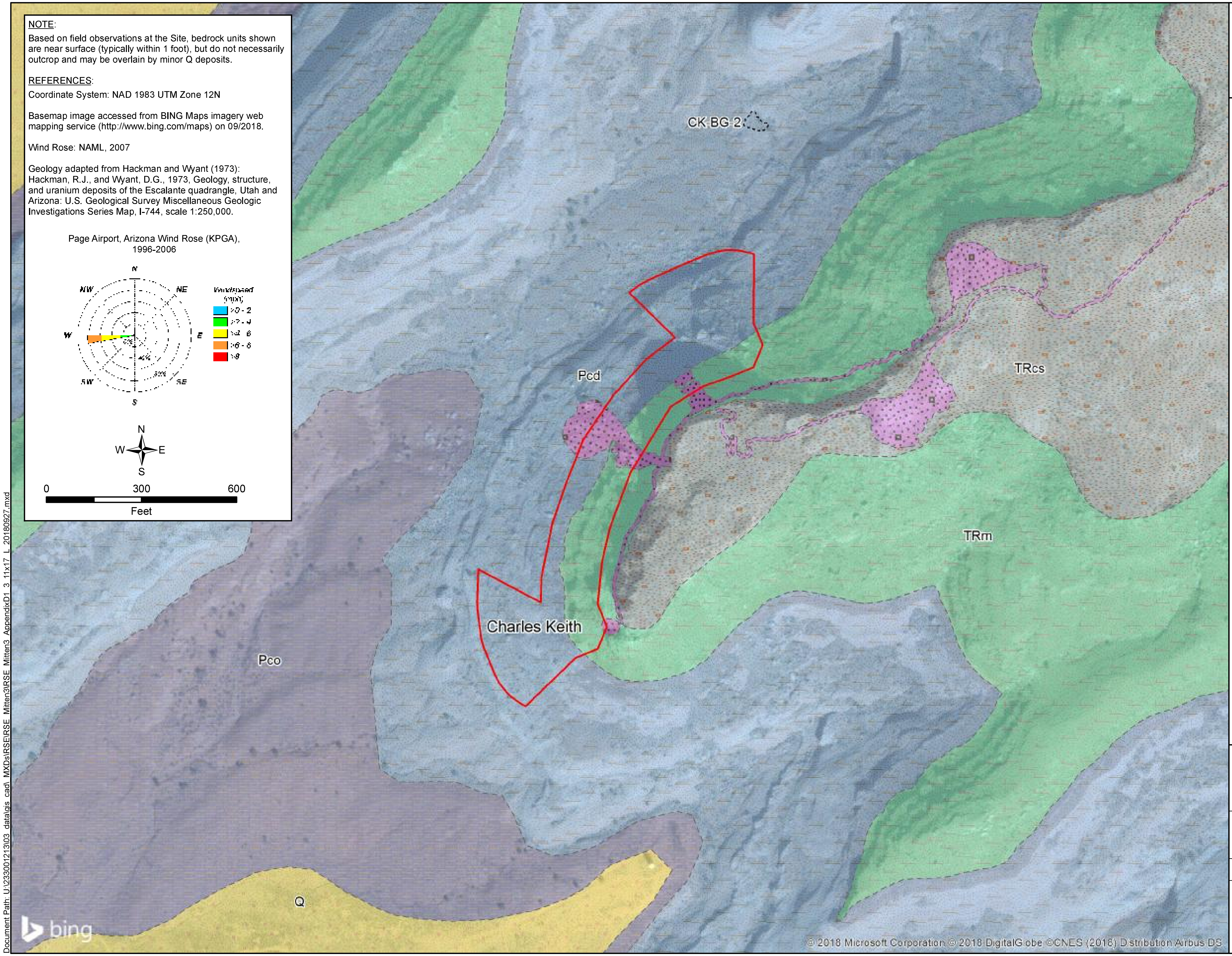

NOTE:
Based on field observations at the Site, bedrock units shown are near surface (typically within 1 foot), but do not necessarily outcrop and may be overlain by minor Q deposits.

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.

Wind Rose: NAML, 2007

Geology adapted from Hackman and Wyant (1973): Hackman, R.J., and Wyant, D.G., 1973, Geology, structure, and uranium deposits of the Escalante quadrangle, Utah and Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Series Map, I-744, scale 1:250,000.

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NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

⬚	Potential Background Reference Area
🟥	Claim Boundary
╌	Geology Contact (Inferred)

Site Geology

HOLOCENE

▨	Earthworks: Human-caused disturbance of the land surface potentially related to mining.
▨	Q: Quaternary Deposits – Undifferentiated (Pleistocene and Holocene) – includes sandy to gravelly colluvial and alluvial deposits, and eolian sand deposits.

TRIASSIC

▨	TRcs: Shinarump member of the Chinle Formation (Upper Triassic) – moderate-orange and yellowish-gray sandstone, siltstone, conglomerate and sandy shale.
▨	TRm: Moenkopi Formation (Triassic) – reddish-brown, platy to slabby, ripple-marked siltstone, thin marine limestones, and thick beds of brown, fine-grained calcareous sandstone.

PERMIAN

▨	Pcd: De Chelly Sandstone Member of the Cutler Formation (Permian) – reddish-orange to pale-reddish-brown, fine to medium-grained eolian sandstone; erodes to cliffs and domes.
▨	Pco: Organ Rock Tongue of the Cutler Formation (Permian) – reddish brown, evenly thin bedded siltstone and fine-grained sandstone.

TITLE:

Geologic Map and Potential Background Reference Area CK-BG-2

PROJECT:

Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 9/27/2018

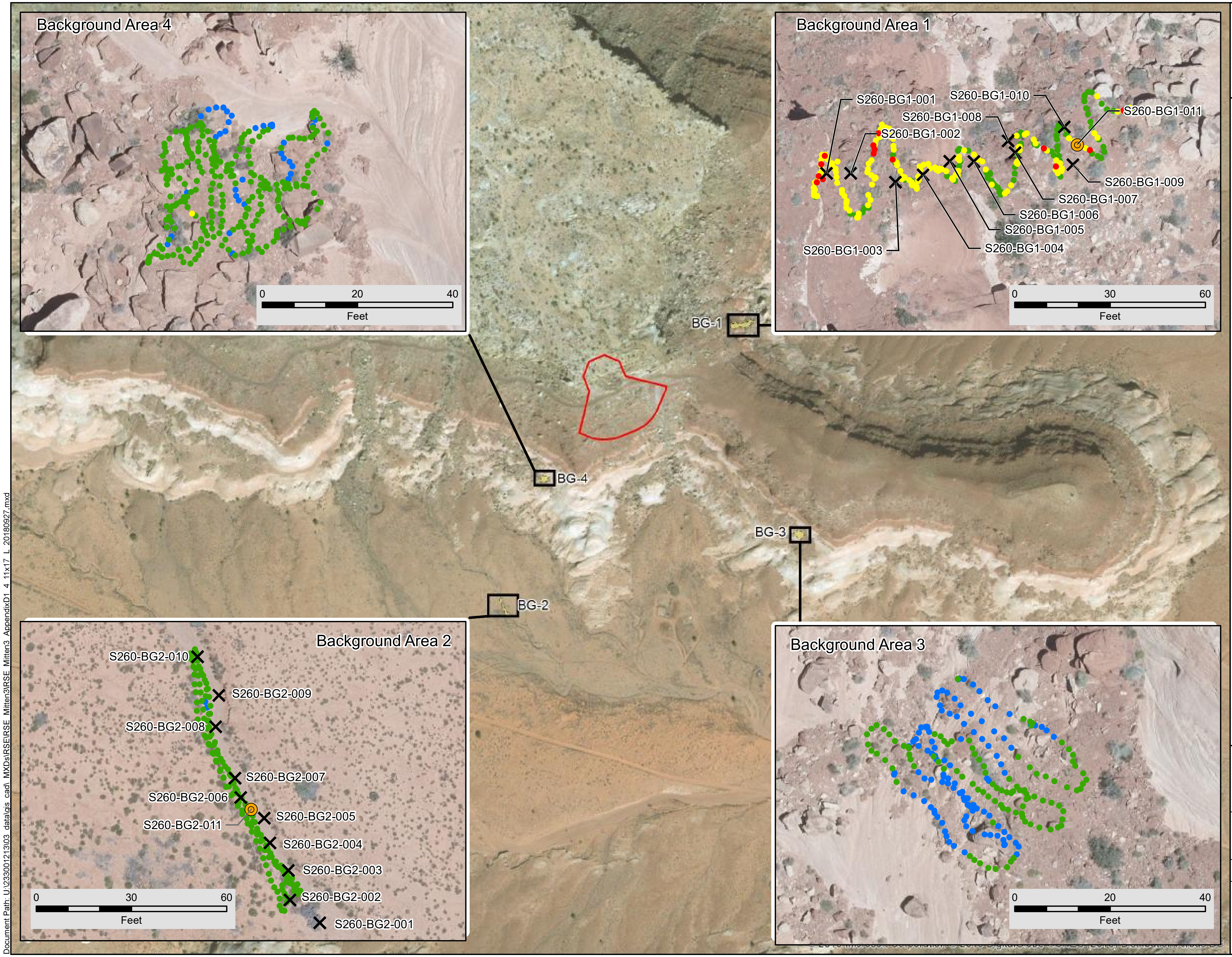
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: D.1-3



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

Counts per Minute (CPM)

- ● 6,220 - 7,500
- ● 7,501 - 10,000
- ● 10,001 - 12,500
- ● 12,501 - 15,394

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.

Background area basemap image inset flown by Cooper Aerial Surveys Co. on June 16, 2017.

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TITLE:
Potential Background Reference Areas
Gamma Radiation Survey Results and
Soil Sample Locations Near Mitten No. 3

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

DATE: 9/27/2018	DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ	REVIEWER: CBB
FIGURE: D.1-4	

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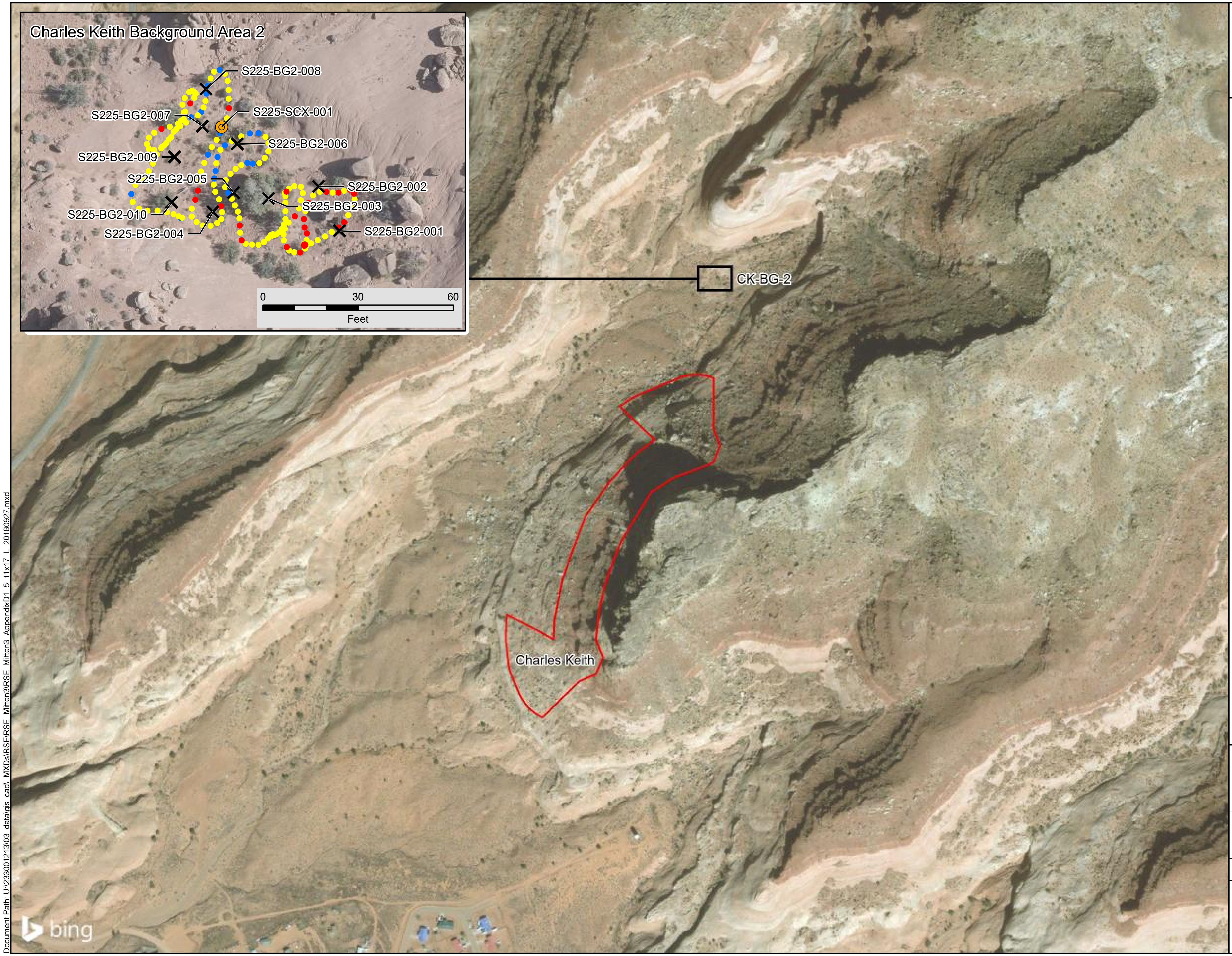

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NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕ Surface Sample Location

◎ Subsurface Borehole Location for Background Reference

▭ Claim Boundary

Gamma Survey

Counts per Minute (CPM)

●	6,349 - 7,500
●	7,501 - 10,000
●	10,001 - 12,135

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.

Background area basemap image inset flown by Cooper Aerial Surveys Co. on June 16, 2017.

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TITLE:
Potential Background Reference Area
Gamma Radiation Survey Results and
Soil Sample Locations at CK-BG-2

PROJECT:
Removal Site Evaluation
Mitten No. 3 Mine Site

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FIGURE: D.1-5

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 Mitten No. 3 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 background references areas and three Survey Areas. These areas are designated Background Reference Area 1 (BG-1), Background Reference Area 2 (BG-2), Charles Keith Background Reference Area 2 (CK-BG-2), Survey Area A, Survey Area B, and Survey Area C. The background reference areas BG-1, BG-2, and CK-BG-2 were selected to represent the region around the Site. Background reference area selection is discussed 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 BG-1 and Survey Area A, BG-2 and Survey Area B, and CK-BG-2 and Survey Area C (box plots, probability plots, hypothesis testing with Wilcoxon Mann-Whitney test). Soil sample and gamma radiation survey results were compared between BG-1 and Survey Area A, BG-2 and Survey Area B, and CK-BG-2 and Survey Area C qualitatively and quantitatively to evaluate similarity or difference in data distributions between the areas, and as a component of evaluating background reference 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 from an analysis solely on a statistical basis. Statistical outlier tests can provide supportive information, but a reasonable scientific rationale needs to be identified for the 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 CK-BG-2 datasets were examined using box plots, probability plots and statistical testing. Descriptive statistics were then calculated with and without the potential outlier values, 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.

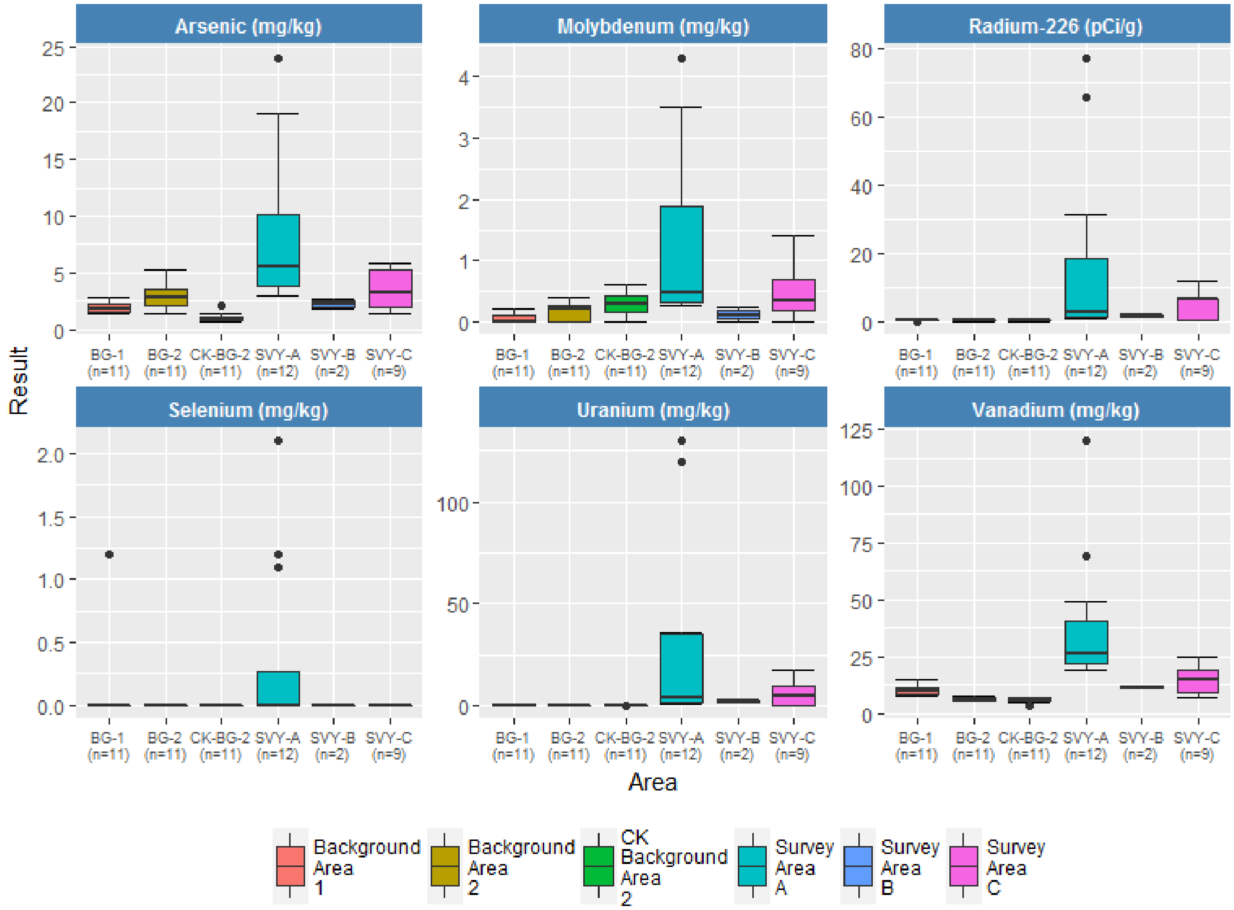
In the Survey Areas at Mitten No. 3, soil samples were collected using a judgmental sampling approach. Specifically, some sample locations were selected to characterize areas of higher gamma radiation and, as a result, potential outlier values are not unexpected in the Survey Area sample statistics. 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 Boxplots

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 Boxplots

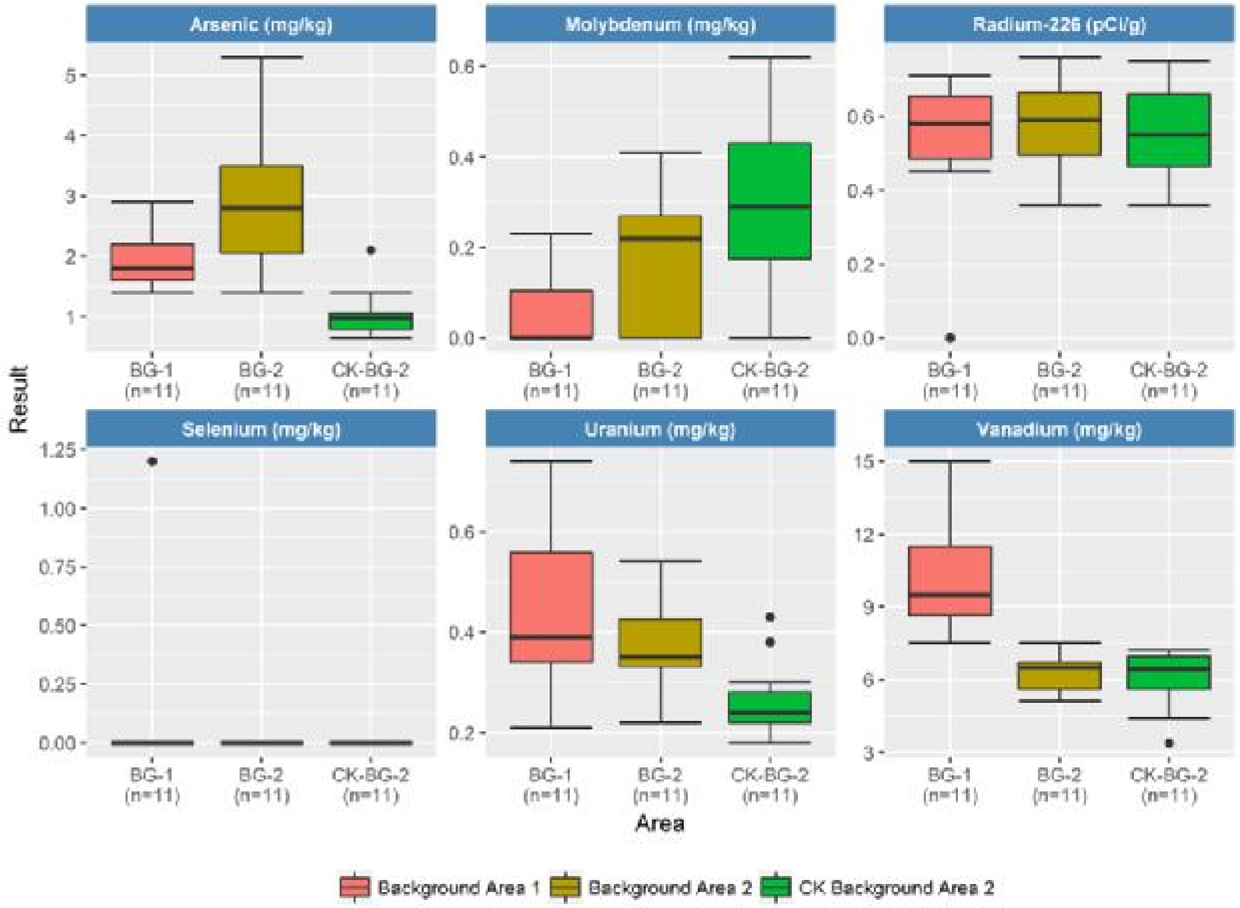
Figure 1A. Survey Areas A, B, and C, and Background Reference Areas 1 (BG-1), 2 (BG-2) and Charles Keith Background Reference Area 2 (CK-BG-2) Soil Sample Box Plots



The soil sample box plots shown on Figure 1A depict differences in the data distributions for analytical constituent concentrations between BG-1, BG-2, CK-BG-2 and Survey Areas A, B, and C. Some high and low potential outlier values are shown for BG-1, CK-BG-2, and Survey Area A.

Potential outlier values are of greatest concern in the BG-1, BG-2, and CK-BG-2 datasets as these data are used to determine the ILs. Background reference area data are presented alone in Figure 1B.

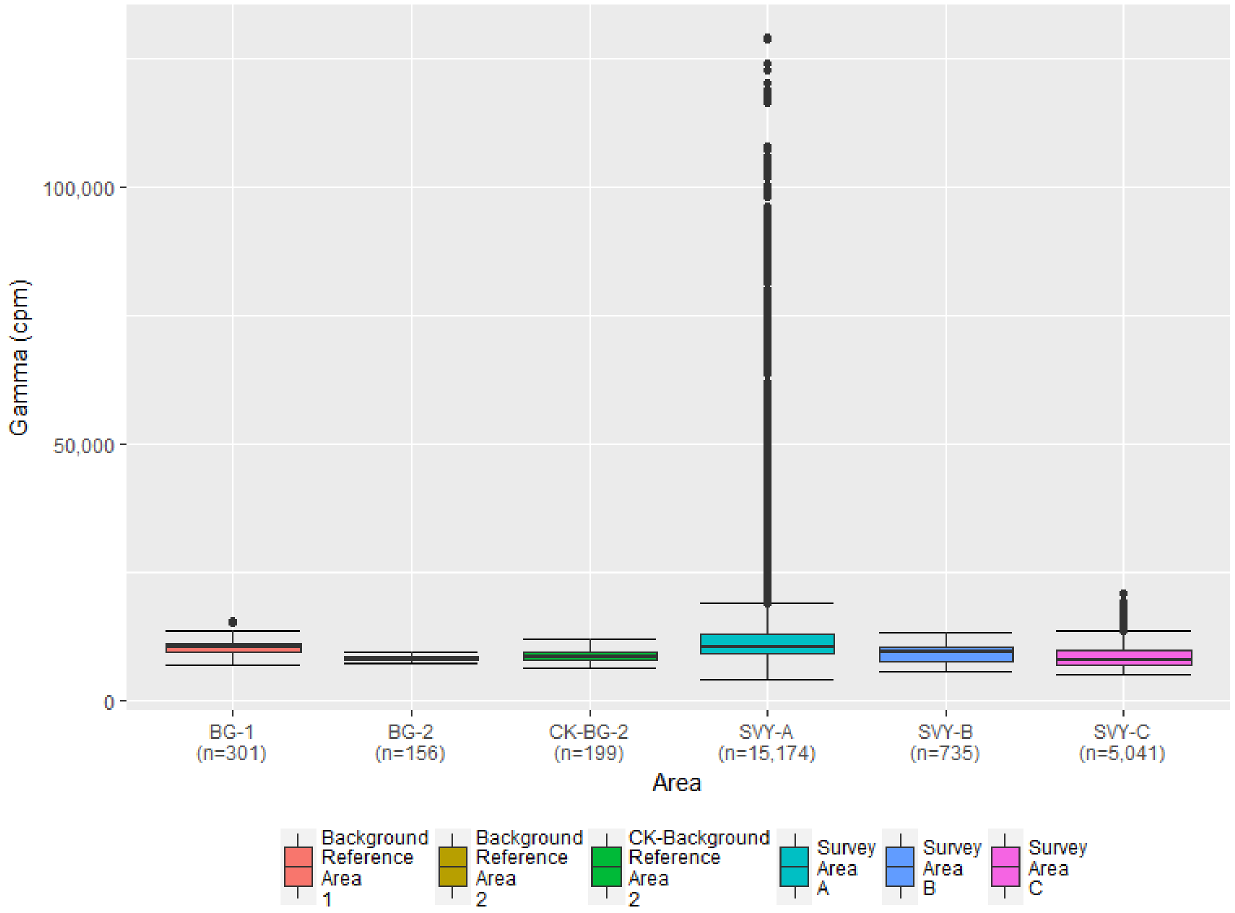
Figure 1B. Background Reference Areas 1 (BG-1), 2 (BG-2) and Charles Keith Background Reference Area 2 (CK-BG-2) Soil Sample Box Plots



One value each for Ra-226 and selenium (Se) are identified as potential outliers (i.e., outside 1.5 times the interquartile range) in the box plots for BG-1. No potential outliers were identified for the BG-2 datasets. One value each for arsenic (As) and vanadium (V), and two values for uranium (U), are identified as potential outliers in the box plots for CK-BG-2. These potential outlier values are further evaluated with the use of probability plots in Section 3.1.2 and statistical testing in Section 3.1.3.

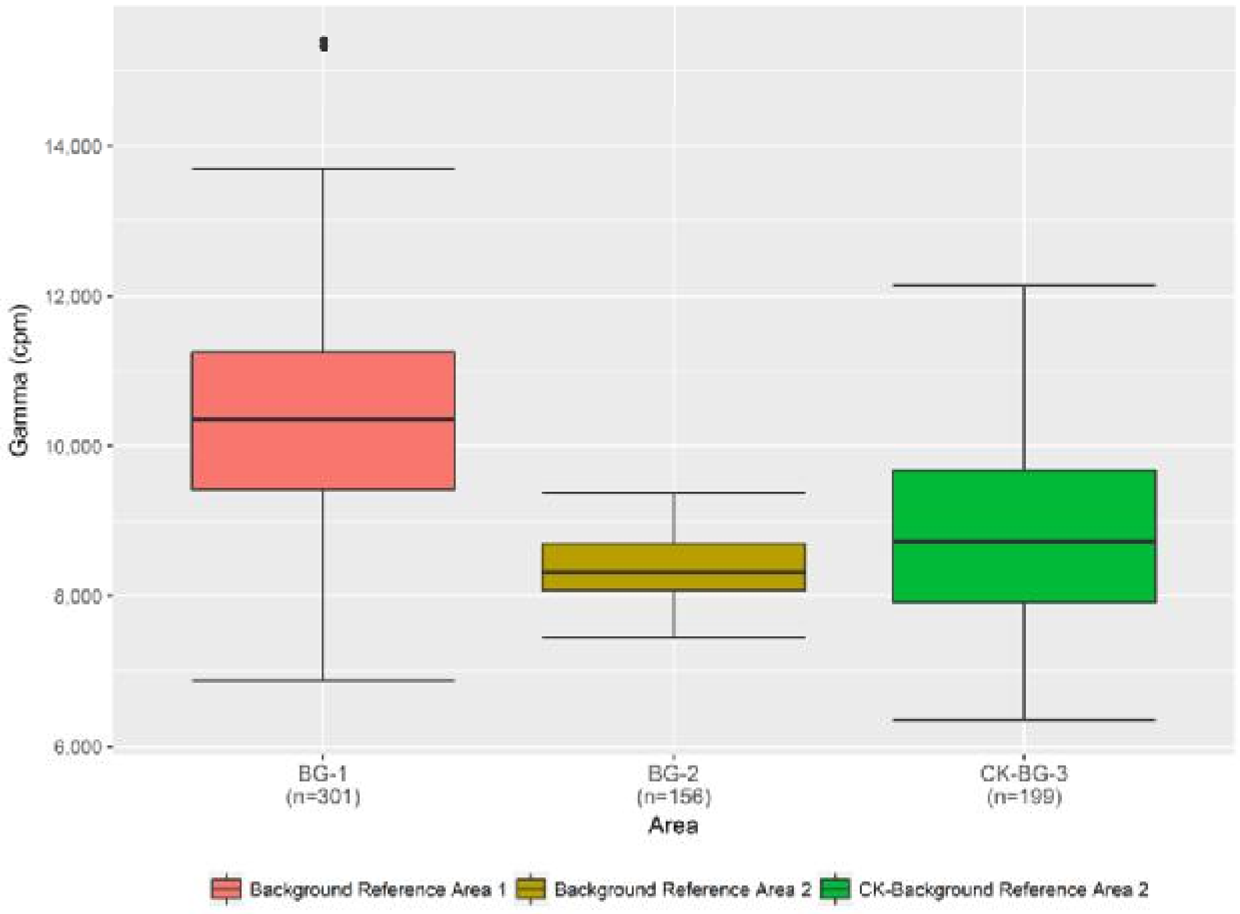
3.1.1.2 Gamma Radiation Results Boxplots

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, CK-BG-2 and Survey Areas A, B and C. The large number of potential outlier values in the Survey Area A and Survey Area C box plots indicate high skewness or possibly non-normally distributed data, instead of potential outlier values. Based on Site geology, the potential gamma radiation outlier values observed for the Survey Area 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 reference area gamma radiation boxplots are shown in Figure 2B.

Figure 2B. Background Reference Area Gamma Radiation Box Plots



There are two potential outlier values shown for gamma data in the BG-1 dataset. These outlier values do not represent skewed data as do the Survey Area results, and the gamma data are shown to be more normally distributed in BG-1 and BG-2 than in CK-BG-2 and the Survey Areas. The potential outlier values shown for BG-1 are most likely representative of natural variation of gamma in this area. These observations are further evaluated with the use of probability plots in Section 3.1.2 and statistical testing in Section 3.1.4.

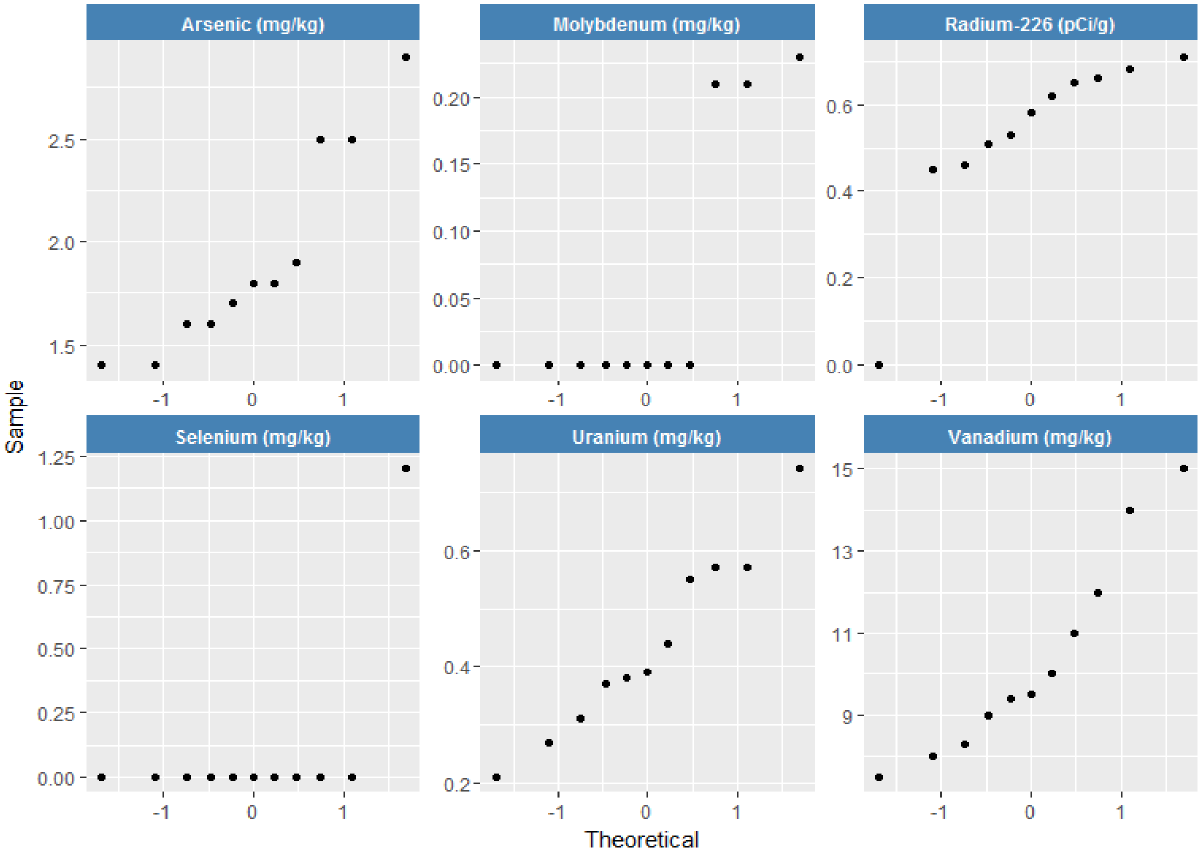
3.1.2 Probability Plots

The normal probability plot is a graphical technique for assessing whether 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

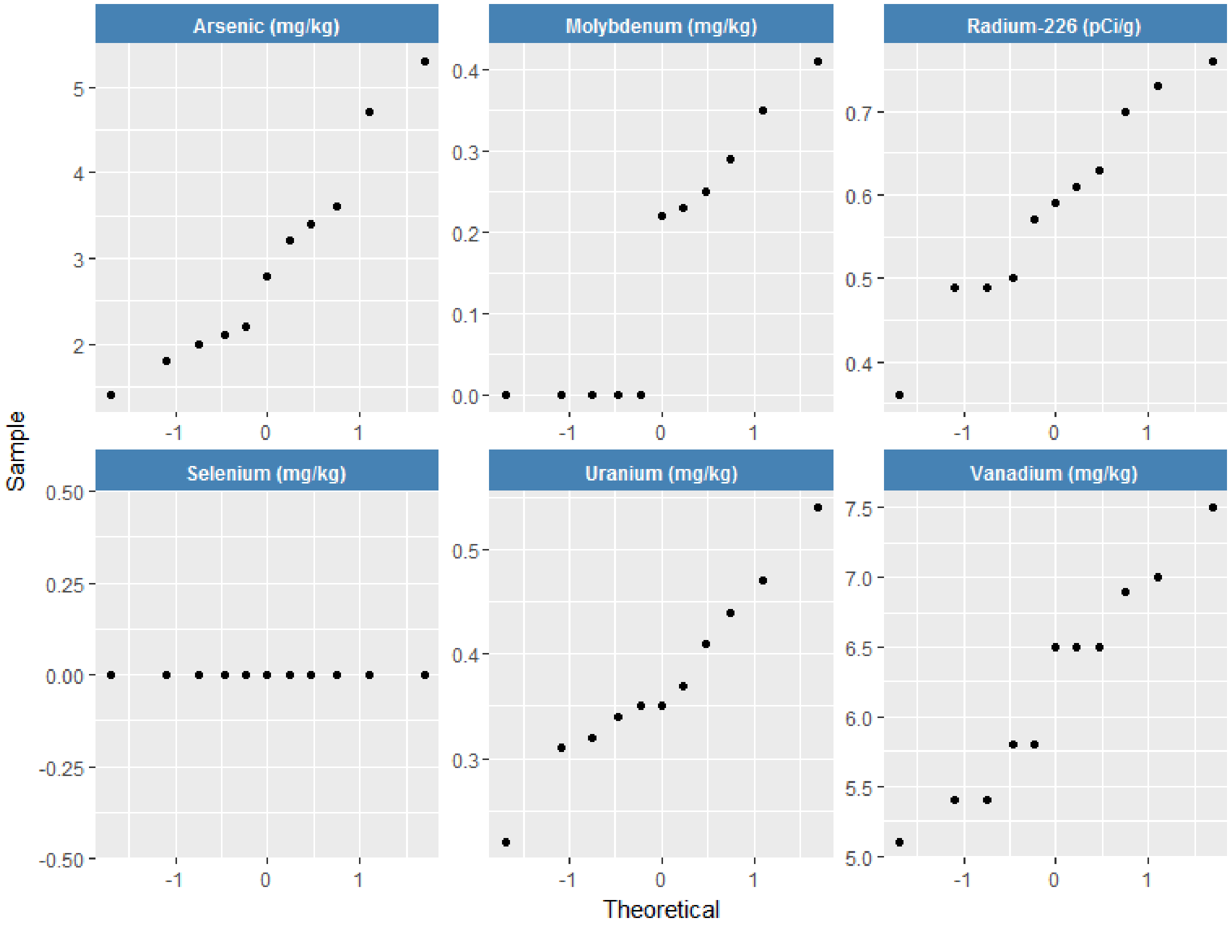
Figures 3 through 5 depict the probability plots for metals and Ra-226 results at BG-1, BG-2, and CK-BG-2.

Figure 3. Background Reference Area 1 (BG-1) Soil Sample Probability Plots



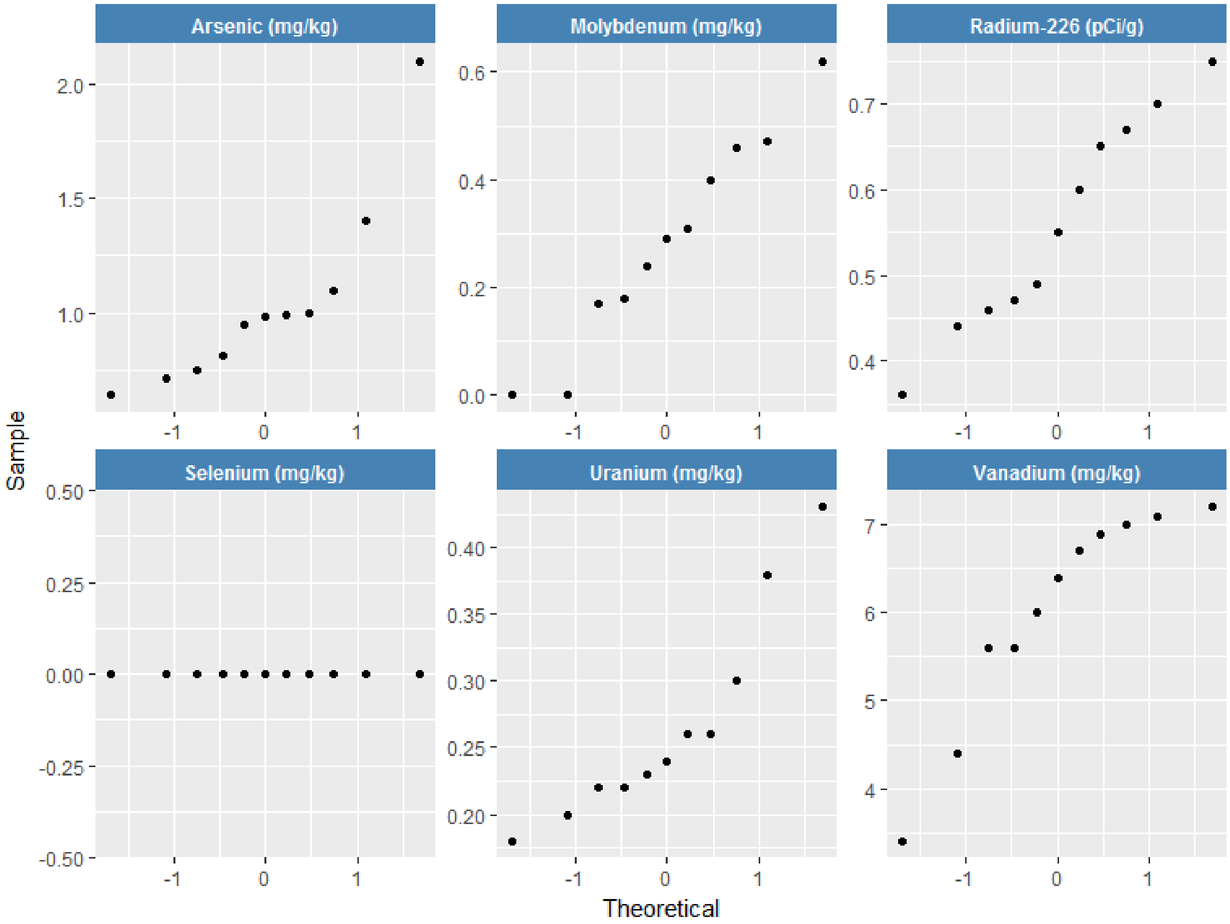
One high value for selenium and one low value for Ra-226 were identified as potential outliers (i.e., outside 1.5 times the interquartile range) in the BG-1 box plots in Figure 1B. When viewed in the probability plots in Figure 3, it is apparent that the high value for selenium is the only detected value in the BG-1 dataset. The single detect in the selenium dataset is anomalous, but as the remaining non-detect values cannot be evaluated statistically it is not considered further as a potential outlier value. The low value for Ra-226 is a non-detect result with a laboratory method detection limit (MDL) of 0.34 pCi/g; however for purposes of plotting the data, the non-detect result was assigned a value of 0.0 pCi/g. The actual non-detect value of 0.34 pCi/g is just below the range of detected values for Ra-226 in BG-1 soil samples. Therefore, the non-detect result is not considered to be a potential outlier.

Figure 4. Background Reference Area 2 (BG-2) Soil Sample Probability Plots



No potential outliers (i.e., values outside 1.5 times the interquartile range) were identified in the BG-2 box plots in Figure 1B. Consistent with Figure 1B, the probability plots in Figure 4 do not appear to show detected values that are substantially higher, lower, or out of line with the rest of their respective datasets, suggesting that they represent natural variability within their datasets rather aberrant measurements. Probability plots in Figure 4 show non-detect values for selenium and molybdenum that do not follow a linear trend. In general, the distributions of detected values for each metal and Ra-226 are nearly linear in Figure 4, indicating normally-distributed data sets.

Figure 5. Charles Keith Background Reference Area 2 (CK-BG-2) Soil Sample Probability Plots

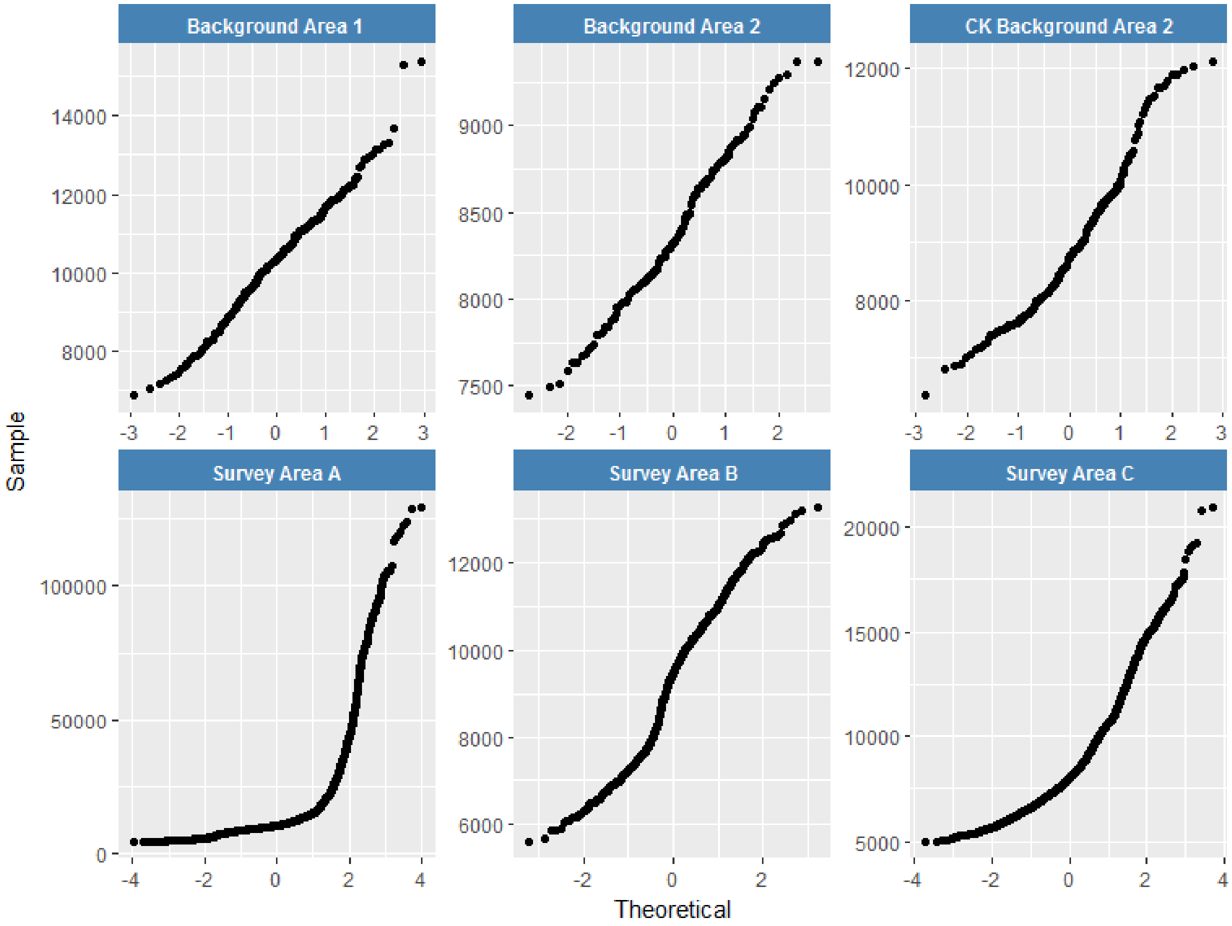


One high value for arsenic, two high values for uranium and one low value for vanadium were identified as potential outlier values (i.e., outside 1.5 times the interquartile range) in the CK-BG-2 box plots in Figure 1B. When viewed in the probability plots in Figure 5, the one arsenic value appears to be substantially higher than the rest of the dataset, while the uranium and vanadium values do not appear to be substantially higher or lower, or otherwise out of line with the rest of their respective datasets, suggesting that they represent natural variability within their datasets rather than aberrant measurements. In addition, the probability plots for all metals except selenium indicate approximately normally-distributed datasets. The probability plot for selenium in Figure 5 shows that all results are non-detect. The four potential outlier values described above are tested further for statistical significance 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 Survey Areas.

Figure 6. Survey Area and Background Reference Area Gamma Probability Plots



The BG-1 and BG-2 gamma probability plots in Figure 6 are approximately linear, indicating normal distributions. The two highest values in BG-1, 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. These values are further evaluated for statistical significance in Section 3.1.4. The two highest values in the BG-2 dataset also appear out of line with the distribution of the rest of the data, however, these two values are not elevated and were not identified as potential outliers.

The gamma probability plots in Figure 6 for Survey Areas A, B and C and CK-BG-2 are non-linear or S-shaped. The Survey Area A and C gamma probability plots 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 plots for the Survey Area A, B and C gamma results confirms that the gamma radiation data are more log-normally distributed than the BG-1, BG-2 and CK-BG-2 gamma results. This suggests that these higher values in Survey Area A and C are not potential outliers, but rather are representative of the spatial variability of gamma radiation in Survey Area A and C.

3.1.3 Potential Soil Sample Data Outliers

Three high results and one low results are identified as potential outlier values in the box plots in Figure 1B and probability plots in Figure 5. These values are:

Charles Keith Background Reference Area 2 (CK-BG-2)

- Arsenic: 2.10 mg/kg
- Uranium: 0.380 mg/kg and 0.430 mg/kg
- Vanadium: 3.40 (low) mg/kg

Dixon's Test (Dixon, 1953) is designed to be used for data sets containing only one or two potential outlier values. Therefore, Dixon's Test was performed to the 95% confidence level on each of the soil sample potential outlier values. The results of Dixon's Test are summarized in Table 1.

Table 1. Summary of Dixon's Test on Maximum Values

Area	Constituent	Location ID	Method	Hypothesis	p_Value	Conclusion
Charles Keith Background Reference Area 2 (CK-BG-2)	As	S225-BG2-001	Dixon test for potential outliers	high value 2.10 is a potential outlier	< 0.05	Hypothesis accepted
	U	S225-BG2-003	Dixon test for potential outliers	high value 0.380 is a potential outlier	> 0.05	Hypothesis rejected
	U	S225-BG2-001	Dixon test for potential outliers	high value 0.430 is a potential outlier	> 0.05	Hypothesis rejected
	V	S225-BG2-008	Dixon test for potential outliers	low value 3.40 is a potential outlier	> 0.05	Hypothesis rejected

As = Arsenic U = Uranium V = Vanadium

The test confirms that one of the four potential outliers tested is statistically significant (p value <0.05). The statistically significant potential outlier value for arsenic at CK-BG-2 was further investigated by reviewing sample forms, field notes and laboratory reports. Field staff and field notes indicate nothing abnormal about the location where the sample was collected, and the laboratory dataset shows no data quality flags were applied to this value that would call its accuracy in to question. Therefore, while this value: 1) is outside the interquartile range of its dataset (Figure 1B), 2) does not conform with its dataset distribution in the probability plot (Figure 5), and 3) is deemed a potential outlier by Dixon's test, it was not removed from the CK-BG-2 dataset because no scientific reason was found to justify removing it. The value is considered representative of the natural variation at BG-CK-2. However, descriptive statistics were calculated with and without this value for comparison (Section 3.3.1).

3.1.4 Potential Gamma Data Outliers

Potential high gamma survey outlier values are observed for the BG-1 gamma dataset shown in the boxplot in Figure 2A and Figure 2B. When viewed in the probability plots in Figure 6, the BG-1 gamma probability plot is linear, indicating normal distribution. The two highest values in BG-1 appear to be higher than, and out of line with the distribution of the rest of the dataset. Because the number of values in the BG-1 gamma dataset is >30, Dixon's Test was not appropriate. 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)	15,394	High	Potential Outlier	Potential Outlier	Potential Outlier
	15,308	High	Potential Outlier	Potential Outlier	Potential Outlier

cpm Counts per minute

One possible reason for the potential outliers in a gamma radiation data set may be the presence of a localized source of radiation. The gamma results were reviewed spatially and BG-1 is thought to representative of Survey Area A, and no scientific reason was found to remove the higher BG-1 values from the evaluation. However, descriptive statistics are calculated with and without these values for comparison in Section 3.3.2.

3.2 COMPARE DATA POPULATIONS

Group comparison analyses provide insight into the relative concentrations of constituents between background reference areas and 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 Figure 1A and Figure 1B suggests that mean metals and Ra-226 values may differ between the background reference areas and the Survey Areas. As shown in Figure 1A and Figure 1B, concentrations of all analytical constituents were significantly elevated at Survey Area A compared with other Survey Areas and the background reference areas. Concentrations at Survey Area C are lower than those at Survey Area A, but generally higher than those at Survey Area B and the background reference areas. Concentrations of analytical constituents appear similar between background reference areas. When interpreting the soil sample boxplots in Figure 1A and Figure 1B, it is important to note that samples at background reference areas were collected randomly, while samples in the Survey Areas were collected judgmentally. Analytical constituent-specific observations from the boxplots in Figure 1A and Figure 1B indicate:

- Arsenic. Arsenic concentrations are significantly elevated at Survey Area A compared with BG-1, slightly elevated at Survey Area C relative to CK-BG-2, and similar between Survey Area B and BG-2. Concentrations at BG-2 are elevated relative to the other background reference areas, and at Survey Area A relative to the other Survey Areas.

- Molybdenum. Molybdenum concentrations are significantly elevated at Survey Area A compared with BG-1, and similar between the other Survey Areas and background reference areas. Concentrations are slightly elevated at CK-BG-2 relative to the other background reference areas, and at Survey Area A relative to the other Survey Areas.

- Ra-226. Ra-226 concentrations are elevated at Survey Area A relative to BG-1, and at Survey Area C relative to CK-BG-2. Ra-226 concentrations are similar between the background reference areas and Survey Area B.

- Selenium. Selenium was detected only once at BG-1 and only three times at Survey Area A; results for selenium at Survey Area A are slightly elevated compared to the single detect at BG-1. No other Survey Areas and background reference areas had detects of selenium.

- Uranium. Uranium concentrations are significantly elevated at Survey Area A compared with BG-1, elevated at Survey Area C relative to CK-BG-2, and slightly elevated at Survey Area B relative to BG-2. Concentrations are similar between the background reference areas, and elevated at Survey Area A relative to the other Survey Areas.

- Vanadium. Vanadium concentrations are significantly elevated at Survey Area A compared with BG-1, elevated at Survey Area C relative to CK-BG-2, and slightly elevated at Survey Area B relative to BG-2. The concentrations are similar between the background reference areas, and elevated at Survey Area A relative to the other Survey Areas.

3.2.1.2 Gamma Radiation Box Plots and Probability Plots

The boxplot comparison in Figure 2A and Figure 2B suggests that interquartile ranges are similar between background reference areas and Survey Areas, with a larger over all range and many potential outlier values at Survey Area A and Survey Area C. Gamma radiation data distributions at BG-1 and BG-2 are approximately normal, while gamma radiation distributions at CK-BG-2 and Survey Areas 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 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 2-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 A	<0.05	Significant Difference
Background Reference Area 1 (BG-1) vs Background Reference Area 1 (BG-1) Potential Outliers Excluded	0.888	No Significant Difference
Background Reference Area 1 (BG-1) Potential Outliers Excluded vs Survey Area A	<0.05	Significant Difference
Background Reference Area 2 (BG-2) vs Survey Area B	<0.05	Significant Difference
Charles Keith Background Reference Area 2 (CK-BG-2) vs Survey Area C	<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) Potential Outliers Excluded vs Background Reference Area 2 (BG-2)	<0.05	Significant Difference
Background Reference Area 1 (BG-1) vs Charles Keith Background Reference Area 2 (CK-BG-2)	<0.05	Significant Difference
Background Reference Area 1 (BG-1) Potential Outliers Excluded vs Charles Keith Background Reference Area 2 (CK-BG-2)	<0.05	Significant Difference
Background Reference Area 2 (BG-2) vs Charles Keith Background Reference Area 2 (CK-BG-2)	<0.05	Significant Difference
Survey Area A vs Survey Area B	<0.05	Significant Difference
Survey Area A vs Survey Area C	<0.05	Significant Difference
Survey Area B vs Survey Area C	<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 A and BG-1 both with and without inclusion of potential outliers in the BG-1 dataset. Mean gamma results are statistically elevated at CK-BG-2 relative to Survey Area C.

- Additionally, gamma results are statistically elevated at Survey Area A relative to Survey Areas B and C, and at Survey Area B relative to Survey Area C. Gamma results at BG-1 are statistically elevated relative to BG-2 and CK-BG-2 (with and without consideration of potential outliers at BG-1), and gamma results at CK-BG-2 are statistically elevated relative to BG-2.

- 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 Survey Areas (see RSE Report Section 3.2.2.2). This latter point does not prohibit 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 outlier values has no statistical effect on data comparison between BG-1 and Survey Area A, BG-2, or CK-BG-2 (i.e., there is a statistically significant difference in gamma results between BG-1 and these other areas with and without outlier values).

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 regard to limits (maximum and minimum), central tendencies (mean and median) as well as data dispersion (coefficient of variance). The ILs for the Site also 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.

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 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

As described in Section 3.2.1.1, arsenic results appear similar between BG-1, CK-BG-2 and Survey Area B. Arsenic results are slightly higher for BG-2 and Survey Area C when compared to BG-1, CK-BG-2 and Survey Area B. Arsenic, molybdenum, selenium, uranium, vanadium and Ra-226 results are elevated at Survey Area A when compared to all other background reference areas and Survey Areas. For molybdenum, uranium and Ra-226, results are similar in BG-1, BG-2, CK-BG-2 and Survey Area B, while results in Survey Area C are slightly higher than these areas. Selenium was only detected in BG-1 and Survey Area A. 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 Areas 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, detected concentrations of arsenic, molybdenum, 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 uranium and Ra-226; elevated concentrations of these constituents in the Survey Areas are likely attributable to residual uranium concentrations and Ra-226 concentrations associated with the mining-related disturbances at the Site.

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	11	11	11	11	11	11
	Percent Non-Detects	--	73%	91%	--	--	9%
	Minimum¹	1.40	--	--	0.210	7.50	--
	Minimum Detect²	--	0.210	1.20	--	--	0.450
	Mean¹	1.92	--	--	0.436	10.3	--
	Mean Detects²	--	0.217	1.20	--	--	0.585
	Median¹	1.80	--	--	0.390	9.50	--
	Median Detects²	--	0.210	--	--	--	0.600
	Maximum¹	2.90	--	--	0.740	15.0	--
	Maximum Detect²	--	0.230	1.20	--	--	0.710
	Distribution	Normal	Normal	Not Calculated	Normal	Normal	Normal
	Coefficient of Variation¹	0.258	--	--	0.359	0.236	--
	CV Detects²	--	0.053	--	--	--	0.159
	UCL Type	95% Student's-t UCL	95% KM (t) UCL	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% KM (t) UCL
	UCL Result	2.19	0.140	Not Calculated	0.522	11.7	0.626
	UTL Type	UTL Normal	UTL KM Normal	Not Calculated	UTL Normal	UTL Normal	UTL KM Normal
	UTL Result	3.31	0.312	Not Calculated	0.877	17.2	0.872
Background Reference Area 2 (BG-2) All Data	Total Number of Observations	11	11	11	11	11	11
	Percent Non-Detects	--	45%	100%	--	--	--
	Minimum¹	1.40	--	--	0.220	5.10	0.360
	Minimum Detect²	--	0.220	--	--	--	--
	Mean¹	2.96	--	--	0.375	6.22	0.585
	Mean Detects²	--	0.292	--	--	--	--
	Median¹	2.80	--	--	0.350	6.50	0.590
	Median Detects²	--	0.270	--	--	--	--
	Maximum¹	5.30	--	--	0.540	7.50	0.760
	Maximum Detect²	--	0.410	--	--	--	--
	Distribution	Normal	Normal	Not Calculated	Normal	Normal	Normal
	Coefficient of Variation¹	0.417	--	--	0.232	0.123	0.205
	CV Detects²	--	0.257	--	--	--	--
	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	3.63	0.288	Not Calculated	0.422	6.64	0.650
	UTL Type	UTL Normal	UTL KM Normal	Not Calculated	UTL Normal	UTL Normal	UTL Normal
	UTL Result	6.43	0.447	Not Calculated	0.619	8.38	0.922
Charles Keith Background Area 2 (CK-BG-2) All Data	Total Number of Observations	11	11	11	11	11	11
	Percent Non-Detects	--	18%	100%	--	--	--
	Minimum¹	0.640	--	--	0.180	3.40	0.360
	Minimum Detect²	--	0.170	--	--	--	--
	Mean¹	1.04	--	--	0.265	6.03	0.558
	Mean Detects²	--	0.349	--	--	--	--
	Median¹	0.980	--	--	0.240	6.40	0.550
	Median Detects²	--	0.310	--	--	--	--
	Maximum¹	2.10	--	--	0.430	7.20	0.750
	Maximum Detect²	--	0.620	--	--	--	--
	Distribution	Gamma	Normal	Not Calculated	Normal	Normal	Normal
	Coefficient of Variation¹	0.394	--	--	0.290	0.201	0.223
	CV Detects²	--	0.431	--	--	--	--
	UCL Type	95% Adjusted Gamma UCL	95% KM (t) UCL	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL
	UCL Result	1.32	0.394	Not Calculated	0.307	6.69	0.626
	UTL Type	UTL Gamma WH	UTL KM Normal	Not Calculated	UTL Normal	UTL Normal	UTL Normal
	UTL Result	2.36	0.786	Not Calculated	0.482	9.45	0.909

Area	Statistic	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Uranium (mg/kg)	Vanadium (mg/kg)	Radium-226 (pCi/g)
CK Background Area 2 (CK-BG-2) Excluding Potential Outliers [3]	Total Number of Observations	10	--	--	--	--	--
	Minimum[1]	0.640	--	--	--	--	--
	Mean[1]	0.933	--	--	--	--	--
	Median[1]	0.965	--	--	--	--	--
	Maximum[1]	1.40	--	--	--	--	--
	Distribution	Normal	--	--	--	--	--
	Coefficient of Variation[1]	0.237	--	--	--	--	--
	UCL Type	95% Student's-t UCL	--	--	--	--	--
	UCL Result	1.06	--	--	--	--	--
	UTL Type	UTL Normal	--	--	--	--	--
	UTL Result	1.58	--	--	--	--	--
Survey Area A	Total Number of Observations	12	12	12	12	12	12
	Percent Non-Detects	--	--	75%	--	--	--
	Minimum[1]	3.00	0.260	--	0.770	19.0	1.03
	Minimum Detect[2]	--	--	1.10	--	--	--
	Mean[1]	8.77	1.33	--	30.4	39.4	17.9
	Mean Detects[2]	--	--	1.47	--	--	--
	Median[1]	5.60	0.485	--	4.40	26.0	2.88
	Median Detects[2]	--	--	1.20	--	--	--
	Maximum[1]	24.0	4.30	--	130	120	77.4
	Maximum Detect[2]	--	--	2.10	--	--	--
	Distribution	Gamma	Unknown	Normal	Gamma	Unknown	Unknown
	Coefficient of Variation[1]	0.797	1.09	--	1.52	0.741	1.49
	CV Detects[2]	--	--	0.376	--	--	--
	UCL Type	95% Adjusted Gamma UCL	95% Chebyshev (Mean, Sd) UCL	95% KM (t) UCL	95% Adjusted Gamma UCL	95% Chebyshev (Mean, Sd) UCL	99% Chebyshev (Mean, Sd) UCL
	UCL Result	14.1	3.15	1.28	91.8	76.2	94.7
	UTL Type	UTL Gamma WH	UTL Non-Parametric	UTL KM Normal	UTL Gamma WH	UTL Non-Parametric	UTL Non-Parametric
	UTL Result	35.4	4.30	1.95	275	120	77.4
Survey Area B	Total Number of Observations	2	2	2	2	2	2
	Percent Non-Detects	--	50%	100%	--	--	--
	Minimum[1]	1.80	--	--	1.60	11.0	1.60
	Minimum Detect[2]	--	0.240	--	--	--	--
	Mean[1]	2.25	--	--	2.20	11.5	1.80
	Mean Detects[2]	--	0.240	--	--	--	--
	Median[1]	2.25	--	--	2.20	11.5	1.80
	Maximum[1]	2.70	--	--	2.80	12.0	2.00
	Maximum Detect[2]	--	0.240	--	--	--	--
	Distribution	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
	Coefficient of Variation[1]	0.283	--	--	0.386	0.062	0.157
	UCL Type	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
	UCL Result	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
	UTL Type	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
	UTL Result	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated

Area	Statistic	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Uranium (mg/kg)	Vanadium (mg/kg)	Radium-226 (pCi/g)
Survey Area C	Total Number of Observations	9	9	9	9	9	9
	Percent Non-Detects	--	22%	100%	--	--	--
	Minimum[1]	1.40	--	--	0.300	6.70	0.450
	Minimum Detect[2]	--	0.200	--	--	--	--
	Mean[1]	3.48	--	--	6.60	14.6	5.21
	Mean Detects[2]	--	0.637	--	--	--	--
	Median[1]	3.20	--	--	5.00	15.0	6.65
	Median Detects[2]	--	0.590	--	--	--	--
	Maximum[1]	5.80	--	--	18.0	25.0	12.0
	Maximum Detect[2]	--	1.40	--	--	--	--
	Distribution	Normal	Normal	Not Calculated	Normal	Normal	Normal
	Coefficient of Variation[1]	0.498	--	--	1.04	0.435	0.892
	CV Detects[2]	--	0.680	--	--	--	--
	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	4.55	0.806	Not Calculated	10.9	18.6	8.09
	UTL Type	UTL Normal	UTL KM Normal	Not Calculated	UTL Normal	UTL Normal	UTL Normal
	UTL Result	8.73	1.75	Not Calculated	27.4	33.9	19.3

[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 statistical outliers were identified, calculated with the outliers removed.

CV	Coefficient of variation
KM	Kaplan 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

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	301
	Minimum	6,873
	Mean	10,314
	Median	10,355
	Maximum	15,394
	Distribution	Normal
	Coefficient of Variation	0.137
	UCL Type	95% Student's-t UCL
	UCL Result	10,448
	UTL Type	UTL Normal
	UTL Result	12,847
Background Reference Area 1 (BG-1) Excluding Potential Outliers	Total Number of Observations	299
	Minimum	6,873
	Mean	10,281
	Median	10,326
	Maximum	13,698
	Distribution	Normal
	Coefficient of Variation	0.131
	UCL Type	95% Student's-t UCL
	UCL Result	10,410
	UTL Type	UTL Normal
	UTL Result	12,711
Background Reference Area 2 (BG-2) All Data	Total Number of Observations	156
	Minimum	7,444
	Mean	8,373
	Median	8,317
	Maximum	9,371
	Distribution	Normal
	Coefficient of Variation	0.051
	UCL Type	95% Student's-t UCL
	UCL Result	8,430
	UTL Type	UTL Normal
	UTL Result	9,172
Charles Keith Background Area 2 (CK-BG-2) All Data	Total Number of Observations	199
	Minimum	6,349
	Mean	8,898
	Median	8,726
	Maximum	12,135
	Distribution	Normal
	Coefficient of Variation	0.142
	UCL Type	95% Student's-t UCL
	UCL Result	9,046
	UTL Type	UTL Normal
	UTL Result	11,220

Area	Statistic	Gamma (cpm)
Survey Area A	Total Number of Observations	20,215
	Minimum	4,266
	Mean	11,964
	Median	9,875
	Maximum	129,220
	Distribution	Normal
	Coefficient of Variation	0.776
	UCL Type	95% Student's-t UCL
	UCL Result	12,071
	UTL Type	UTL Normal
	UTL Result	27,392
Survey Area B	Total Number of Observations	735
	Minimum	5,606
	Mean	9,233
	Median	9,482
	Maximum	13,241
	Distribution	Normal
	Coefficient of Variation	0.188
	UCL Type	95% Student's-t UCL
	UCL Result	9,339
	UTL Type	UTL Normal
	UTL Result	12,262
Survey Area C	Total Number of Observations	5,041
	Minimum	4,973
	Mean	8,585
	Median	7,987
	Maximum	20,919
	Distribution	Normal
	Coefficient of Variation	0.263
	UCL Type	95% Student's-t UCL
	UCL Result	8,637
	UTL Type	UTL Normal
	UTL Result	12,373

As noted for metals and Ra-226 in Section 3.3.1, gamma results measured within Survey Areas A and C 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 gamma results at the background reference areas. Elevated gamma results in portions of the Survey Areas are likely attributable to 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, B and C are based on Background Reference Areas BG-1, BG-2, and CK-BG-2, respectively.

4.1 SURVEY AREA A INVESTIGATION LEVELS

- Arsenic (mg/kg): 3.31
- Molybdenum (mg/kg): 0.312
- Selenium (mg/kg): None (One detection is not sufficient to calculate an IL)
- Uranium (mg/kg): 0.877
- Vanadium (mg/kg): 17.2
- Ra-226 (pCi/g): 0.872
- Gamma radiation measurements (cpm): 12,847

4.2 SURVEY AREA B INVESTIGATION LEVELS

- Arsenic (mg/kg): 6.43
- Molybdenum (mg/kg): 0.447
- Selenium (mg/kg): None (All results non-detect)
- Uranium (mg/kg): 0.619
- Vanadium (mg/kg): 8.38
- Ra-226 (pCi/g): 0.922
- Gamma radiation measurements (cpm): 9,172

4.3 SURVEY AREA C INVESTIGATION LEVELS

- Arsenic (mg/kg): 2.36
- Molybdenum (mg/kg): 0.786
- Selenium (mg/kg): None (All results non-detect)
- Uranium (mg/kg): 0.482
- Vanadium (mg/kg): 9.45
- Ra-226 (pCi/g): 0.909
- Gamma radiation measurements (cpm): 11,220

5.0 REFERENCES

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Appendix E Cultural and Biological Resource Clearance Documents

BIOLOGICAL EVALUATION

For the Proposed:

Mitten No. 3
Abandon Uranium Mine Project

Sponsored by:

MWH Global / Stantec

Prepared by:

Adkins Consulting, Inc.
180 East 12th Street, Unit 5
Durango, Colorado 81301

Revised August 2016
June 2016

TABLE OF CONTENTS

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 Mitten No. 3 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

Mitten No. 3 is located in San Juan County, Utah, approximately 10 miles northwest of Monument Valley, Utah at an elevation of approximately 5,300 feet. Global Positioning System coordinates are 37° 2' 32” N by 110° 20' 15” W NAD 83. The site is located on Navajo Tribal Trust Lands within the Bureau of Indian Affairs (BIA) Tuba City Agency. The legal description of the project surface location is as follows: Section 14, Township 43 South, Range 14 East, Salt Lake Principal Meridian. Project area maps are provided in Appendix A.

2.2. Estimated Disturbance

MWH proposes a phased approach to scientific investigations at the Mitten No. 3 AUM. The study area encompasses the claim boundary and a 100-foot perimeter buffer zone for a total of approximately 6.2 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 Mitten No. 3 includes the mine boundary with a 100-foot buffer zone surrounding the perimeter of the boundary. 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 Southeastern Utah located within the USEPA designated Colorado Plateau Level III Ecoregion. The Colorado Plateau ecoregion is located Utah and Colorado with extensions in New Mexico and Arizona. It has an area of 32,387 square miles. The Colorado Plateau is an uplifted, eroded, and deeply dissected tableland. Its benches, mesas, buttes, salt valleys, cliffs, and canyons are formed in and underlain by thick layers of sedimentary rock. The ecoregion has a broad latitudinal range, from the Uinta Basin in the north to the arid canyon lands along the border of Arizona and New Mexico.

Mitten No. 3 is situated on a southeast facing cliff on the southern end of Holiday Mesa. Terrain is steep with crumbling sandstone ledges. An eroded sandstone mesa arm extends southeast from the PPA.

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. The Mitten No. 3 site is predominantly rocky with very little vegetation.

Fauna

Wildlife or evidence of wildlife observed within the PPA included common raven (*Corvus corax*) and cottontail rabbit (*Sylvilagus* sp.). No signs of consistent raptor use such as whitewash or nests were observed. No prairie dog (*Cynomys* sp.) burrows were recorded within the PPA or immediate vicinity. 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.

Run-off from precipitation in the project area generally drains south into an unnamed tributary to Oljeto Wash. Oljeto Wash drains north for 20 miles and joins the San Juan River approximately 10 miles east of Lake Powell. There are no wetlands, seeps, springs, or riparian areas within the proposed 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 20 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.

Redente will conduct surveys for plant species of concern in July 2016 as this is the appropriate season based on accepted protocol. Results from the July survey will be presented in a subsequent document and attached to this report as Appendix C.

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 (06E23000-2016-SLI-0210) on April 8, 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 March 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 with a slight breeze. All plant and wildlife species observed in the action area were recorded, and digital photos were taken (Appendix B).

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 plant and animal 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 Species List for the Mitten No. 3 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 suitable habitat for species to occur.
Mexican spotted owl (*Strix occidentalis lucida*)	Threatened with Designated Critical Habitat	Year-round range.[1]	Mixed conifer forests. Typically where unlogged, uneven-aged, closed-canopy forests occur in steep canyons.[1]	No potential. Action area does not provide suitable habitat for species to occur.
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 suitable habitat for species to occur.

Table 1: USFWS Species List for the Mitten No. 3 Project

Species	Status	Occurrence Within Region	Habitat	Potential to Occur within Action Area
California condor *(Gymnogyps californianus)*	Experimental Population, NonEssential	In northern Arizona, condors are located primarily near the Vermilion cliffs, Grand Canyon and Coconnino County.[3]	Large areas of remote country for foraging, roosting, and nesting. Roost on large trees or snags, or on isolated rocky outcrops and cliffs. Nests are located in shallow caves and rock crevices on cliffs where there is minimal disturbance. Foraging habitat includes open grasslands and oak savanna foothills that support populations of large mammals such as deer and cattle.[1]	No potential. Action area does not provide suitable habitat for species to occur. Lack of prey base a limiting factor.
Gunnison sage-grouse *(Centrocercus minimus)*	Threatened	Utah population is near Monticello[1]	Sagebrush with a diversity of grasses and forbs and healthy wetland and riparian ecosystems. Requires sagebrush for cover and fall and winter food.	No potential. Action area does not provide suitable 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.
Greenback Cutthroat trout *(Oncorhynchus clarki stomias)*	Threatened	San Juan County Utah[1]	Cold water streams and cold water lakes with adequate stream spawning habitat present during spring. Generally require clear, cold, well-oxygenated water.[1]	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.

Table 1: USFWS Species List for the Mitten No. 3 Project

Species	Status	Occurrence Within Region	Habitat	Potential to Occur within Action Area
Razorback sucker *(Xyrauchen texanus)*	Endangered	Known to occur in San Juan River.[2]	Slow areas, backwaters, and eddies of medium to large rivers and their impoundments. Often associated with sand, mud, and rock substrate in areas with sparse aquatic vegetation, where temperatures are moderate to warm.[2]	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.
PLANTS				
Navajo sedge *(Carex specuicola)*	Threatened	From the Navajo Creek drainage in Coconino Co, east to the Tsegi Canyon Watershed in Navajo Co, south to the Rock Point/Mexican Water & Canyon de Chelly National Monument, Apache Co, AZ area. Also known from Chinle Creek, San Juan Co, UT.[3]	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 the Redente site 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 nine (9) ESA-listed species that have the potential to occur in the project area based on the USFWS IPaC Official Species List. All of the species in Table 1 have been eliminated from further discussion in this report. 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 NFWD found in Appendix D, the Golden eagle (*Aquila chrysaetos*) is known to occur within three miles of the project site. Biologists evaluated the potential for species of concern listed in the table below to occur within 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	Springs, slow streams, marshes, bogs, ponds, canals, flood plains, reservoirs, and lakes; usually permanent water with rooted aquatic vegetation. 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.
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 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]	No potential. Action area does not provide suitable habitat for species to occur.
Golden eagle (*Aquila chrysaetos*)	NESL G3	In the west, mostly open habitats in mountainous, canyon terrain. Nests primarily on cliffs.[1,3]	Action area provides suitable 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	Action area provides potential foraging habitat for species to occur. Sandstone

Species	Status	Habitat Associations	Potential to Occur in Project or Action Area
		plant associations. [3]	cliffs within and surrounding the site provide potential nesting habitat.
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.

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 seven (7) NESL and Navajo Species of Concern that have the potential to occur in the project area based on 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*), American peregrine falcon (*Falco peregrinus*), and Parish's alkali grass (*Puccinellia parishii*). None of these species were observed during surveys of the proposed project area or immediate surroundings. Critical habitats of these species do not exist within or adjacent to the proposed project area. 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.[1,3]	Action area provides suitable 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. Sandstone cliffs within and surrounding the site provide potential nesting habitat.

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.

4.4. 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 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 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.	No suitable habitat present within the action area for species to occur.
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.
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.	No suitable habitat 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 central & western portions of NM; most common in southwest NM.	No suitable habitat 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.

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 encompasses the claim boundary and a 100-foot perimeter buffer zone for a total of approximately 6.2 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.

5.1.1. Golden eagle

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. Ferruginous hawk

Habitat potential was assessed for the ferruginous hawk within the action area. ACI biologists determined the sandstone cliffs within and surrounding the site to be potential nesting habitat for this species and closely examined the cliff faces for any signs of use. Observations following Navajo Natural Heritage Program (NNHP) protocol were conducted during April 2016. ACI biologists did not see any sign of use by this species including old or inactive nests.

<u>Phase I:</u>
Noise and surface disturbance will be low and short term during pedestrian survey activity. Adult raptors would not be directly impacted by Phase I because of their mobility and ability to avoid areas of human activity. The area is not currently occupied as a nest territory; Phase I activities that may occur within the breeding season are unlikely to discourage adults from selecting the area as a new nest territory. Direct and indirect effects from Phase I are expected to be short term and negligible.

<u>Phase II:</u>
During Phase II, noise may be moderate for a short duration, and surface disturbance will be light to moderate within a minimal footprint at the study area. No permanent structures will be left on site. Adult raptors would not be directly harmed by Phase II activities because of their mobility and ability to avoid areas of human activity. The area is not currently occupied as a nest territory; Phase II activities that may occur within the breeding season may discourage adults from selecting the area as a new nest territory. Nest initiation or new nesting activity within the PPA is not expected to be directly impacted if activities occur outside of the raptor breeding season for the region for ferruginous hawk, 1 March to 1 May for nests with no eggs and until mid to late July for productive nests (Navajo Nation Division of Natural Resources, Department of Fish and Wildlife 2008b).

5.1.3. Migratory Birds

The PPA encompasses approximately 6.2 acres of potential migratory bird habitat in the form of mostly sandstone cliffs. No trees would be removed as a result of the proposed project.

Phase I:
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 negligible.

Phase II:
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

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. 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 and the availability of adjacent similar habitats.

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 short term activity within approximately 6.2 acres of potential migratory bird habitat in the form of mostly sandstone cliffs. 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 is anticipated to be minor and short term due to the limited degree of vegetation and soil disruption and the abundance of adjacent habitat for these species.

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. No impacts to wetlands are anticipated. 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.

Navajo Endangered Species List (NESL) and Species of Concern

Two (2) NESL and Navajo species of concern have potential to occur within the PPA based on habitat suitability or actual record of observation. Based on site surveys, ACI determined the PPA contains potential foraging habitat for golden eagle and potential nesting habitat for 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 two (2) NESL and Navajo species of concern.

7. RECOMMENDATIONS FOR AVOIDANCE

ACI recommends that the proponent implement standard Best Management Practices (BMPs) designed to protect sensitive wildlife species during project activity 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.

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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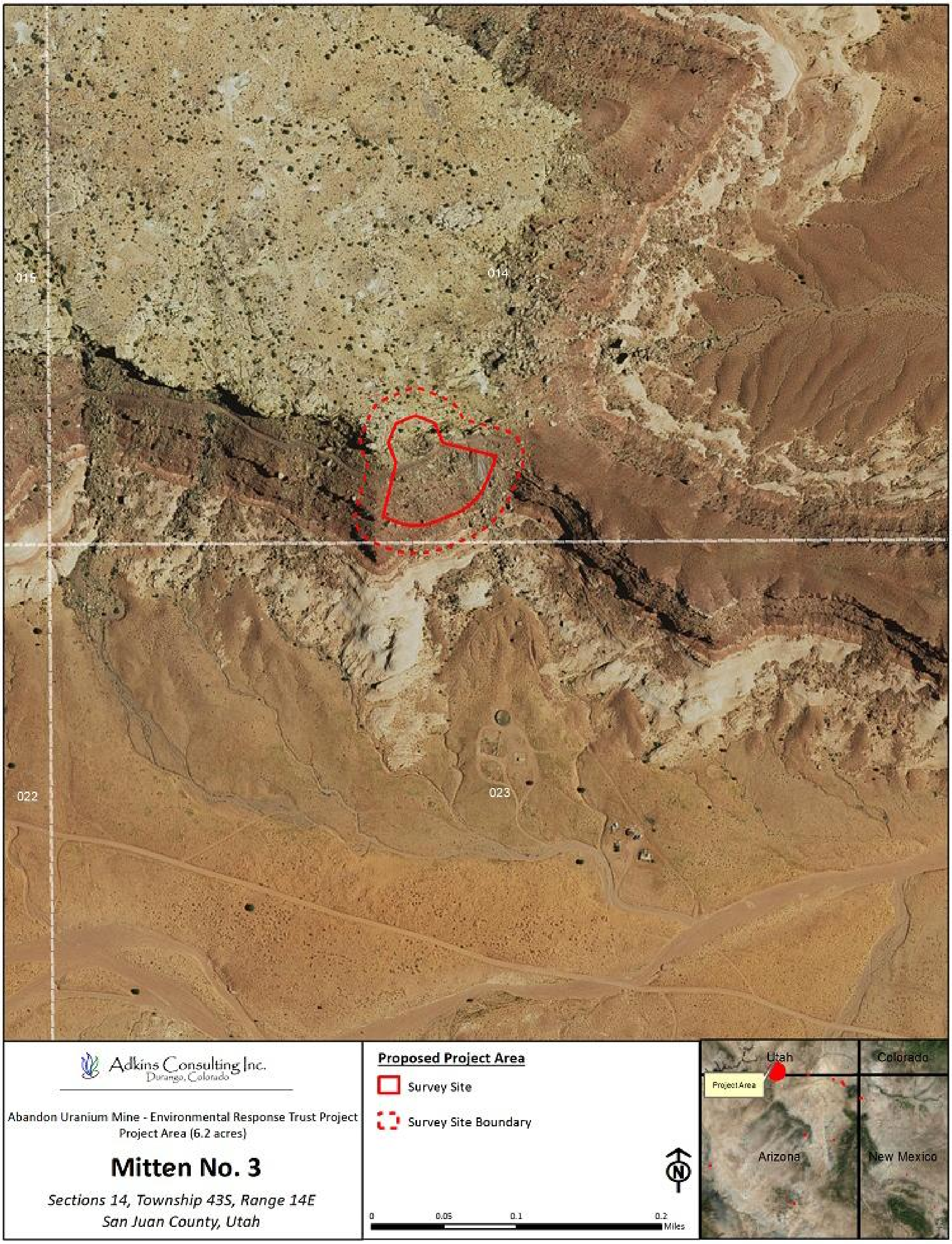
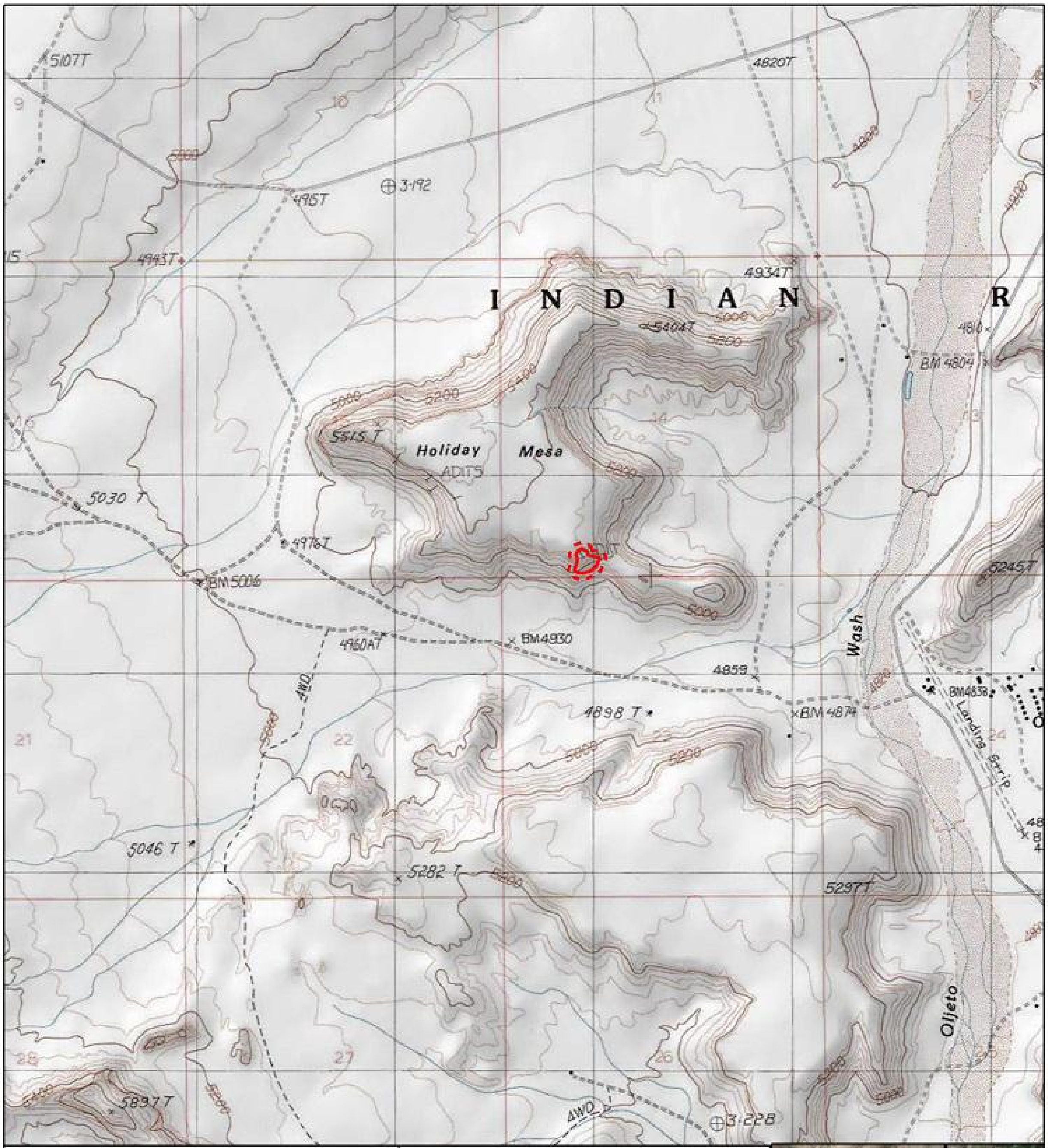
APPENDIX A. MAPS





Adkins Consulting Inc.
Durango, Colorado

Abandon Uranium Mine - Environmental Response Trust Project
Project Area (6.2 acres)

Mitten No. 3

Sections 14, Township 43S, Range 14E
San Juan County, Utah

Proposed Project Area

🟥 Survey Site

▭ Survey Site Boundary

N

0 0.25 0.5 1 Miles

APPENDIX B. PHOTOGRAPHS

View from the south looking north at the PPA

View from south looking north at PPA

APPENDIX C. REDENTE PLANT SURVEY REPORT

Navajo Nation AUM Environmental Response Trust

Plant Survey Report for Species of Concern
At Mitten No. 3 Project Site
San Juan County, Utah
August 2016

Prepared by:
Redente Ecological Consultants
1322 Alene Circle
Fort Collins, CO 80525

TABLE OF CONTENTS

INTRODUCTION

Purpose of Report

A biological survey was conducted at the Mitten No. 3 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

Mitten No. 3 is located in San Juan County Utah, just to the north and east of Oljato, Utah at an elevation of approximately 1,585 m (5,200 ft). Global Positioning System coordinates are 37° 02' 32" N by 110° 20' 17" W (North American Datum of 1983). The site is located on Tribal Trust Land (TTL).

Environmental Setting

Climate

The climate of the Mitten No. 3 site is classified as arid, with an average annual precipitation of 182 mm (7.2 in) with the greatest precipitation months occurring between July and October (USDA 1980). Average annual temperature is 13.9° C (57° F).

Soils

The U.S. Department of Agriculture (USDA) Soil Survey for the Navajo Indian Reservation—San Juan County, Utah was published in 1980 in cooperation with the Bureau of Indian Affairs. The survey includes the area where Mitten No. 3 is located. The Mota-Moenkopie-Rock Outcrop is the primary soil mapping unit on the Mitten No. 3 site. The soil is classified as Moenkopie and is formed in residuum from sandstone and shale. The soil is well drained and the rock outcrop consists of exposed interbedded sandstone and shale bedrock.

Plant Community Type

The vegetation on the Mitten No. 3 site is part of the Colorado Plateau Shrub-Grassland type (USDA 1980). The most common species on the site include blue grama (*Bouteloua gracilis*), Indian ricegrass (*Achnatherum hymenoides*), alkali sacaton (*Sporobolus airoides*), broom snakeweed (*Gutierrizia sarathrae*), shadscale saltbush (Atriplex confertifolia), fourwing saltbush (*Atriplex canescens*), and Mormon tea (*Ephedra viridis*).

Land Use

The land type on the Mitten No. 3 site is rangeland and the principal land use is wildlife habitat.

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 and the USFWS listed Navajo sedge (*Carex specuicola*) as the one endangered plant species of concern that may occur in the project 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 summer (July) of 2016 during the appropriate season to observe the phenological characteristics of the special status plant species that were necessary for identification.

The botanical survey team was assisted during the survey by GIS trained staff from MWH with training specifically in the use of 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 "transect" lines through each area and looked for suitable habitat for *Carex specuicola*, specifically seeps and hanging gardens. 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

One plant species of concern, *Carex specuicola*, was identified as potentially occurring within the proximity of the project area. *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.

The survey at Mitten No. 3 on July 22, 2016 did not identify *Carex specuicola* on the Mitten No. 3 site. This species occurs in seeps, alcoves or hanging gardens and this habitat was not found on the site.

Photo #1—Overview of general landscape and plant community at Mitten No. 3.

Photo #2—Overview of general landscape and plant community at Mitten No. 3.

REFERENCES

ANPS. 2000. Arizona Rare Plant Field Guide. U.S. Government Printing Office. Washington, D.C.

Navajo Nation Department of Fish and Wildlife (NNDFW), 2008. Biological Resource Land Use Clearance Policies and Procedures, RCS-44-08. September 10.

Navajo Natural Heritage Program (NNHP), 2008. *Species Accounts*, Navajo Nation Endangered Species List, version 3.08.

USDA. 1980. Soil Survey of Navajo Indian Reservation San Juan County, Utah. USDA and USDI-Bureau of Indian Affairs. Washington, D.C.

USFWS. 1996. Guidelines for Conducting and Reporting Botanical Inventories for Federally Listed, Proposed, and Candidate Plants. Sacramento Fish and Wildlife Office, Sacramento, California.

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

NNHP
Navajo Natural Heritage Program

PO Box 1480
Window Rock, AZ
86515

P 928.871.6472
F 928.871.7603

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
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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.

3665 John F Kennedy Pkwy TEL 970 377 9410
Bldg 1, Suite 206 FAX 970 377 9406
Ft. Collins, CO 80525 www.mwhglobal.com

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&SRPM
	T.	43	N.,	R.	19	E-	Sec.	UP;	Mexican Hat	Quadrangle,	Apache	County	AZ	G&SRPM
	T.	41&40	N.,	R.	27. 28& 23	E-	Sec.	UP;	Toh Atin Mesa West	Quadrangle,	Apache	County	AZ	G&SRPM
	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:

<u>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:</u>

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.**

<u>Site NM-I-24-88:</u>

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.

<u>TCPs.</u>

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 11/27/16 Navajo Region Approval ☑ Yes ☐ No SEP 28 2016
BIA – Navajo Regional Office Date
Acting

NNDFW Review No. 15mwh101-m3

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.: Mitten No. 3 - 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 ft. in width would be necessary to move equipment to the site. Disturbance would be light to moderate. No permanent structures would be left onsite. The proposed project area (mine boundary and buffer) would be approximately 6.2 acres.

LOCATION: 37°02'32"N 110°20'15"W, Oljato Chapter, San Juan County, Utah

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-Mitten No. 3 Abandoned Uranium Mine Project/AUG 2016/Lori Gregory, Plant Survey Report for Species of Concern At Mitten No. 3 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.

POTENTIAL IMPACTS

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) ☐Disapproval (with memo) ☐Categorical Exclusion (with request letter) ☐None (with memo)	Gloria M. Tom, Director, Navajo Nation Department of Fish and Wildlife	11/16/16

*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 Mitten No. 3 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 17, 2016 and August 24, 2017 and were analyzed by ALS Environmental of Ft. Collins, Colorado, for all methods except mercury in water. ACZ Laboratories, Inc. of Steamboat Springs, Colorado, analyzed water samples for mercury. 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
- Radium-226 in water by USEPA Method 903.1
- Radium-228 in water by USEPA Method 904
- Gross alpha/beta in water by USEPA Method 900
- Total and dissolved metals in water by USEPA 200.8
- Total dissolved solids in water by USEPA 160.1
- Alkalinity in water by USEPA 310.1
- Chloride and sulfate in water by USEPA 300.0
- Total and dissolved mercury in water by USEPA Method 1631

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 and water data, plus ten percent of the non-radiological data (Level IV only)

- All non-radiological soil and water 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 metals. Table F.1-1 lists the analytes where an MS and/or MSD percent recovery was outside the acceptance criteria. Sample results were qualified with a "J-" flag to indicate the results were estimated and potentially biased low. All MS/MSD RPDs were within acceptance criteria.

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. Sample results qualified due to laboratory duplicate RPDs outside of the acceptance criteria are listed on Table F.1-1. The sample results were qualified with a "J" flag if not otherwise qualified to indicate an estimated result.

Serial Dilution Evaluation. All serial dilution percent differences were within acceptance criteria.

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 four metals and two radium-226. 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 and one sample for the analysis of gross alpha. 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 45 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-" or "UJ" 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 qualified.

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
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 5

Field Sample Identification	Sample Date	Analysis Code	Analyte	Sample Result	Units	QC Type	QC Result	QC Limit	Added Flag	Comment
S260-BG1-001	10/28/16	E901.1	Radium-226	0.65	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG1-002	10/28/16	E901.1	Radium-226	0.71	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG1-003	10/28/16	E901.1	Radium-226	0.51	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG1-004	10/28/16	E901.1	Radium-226	0.66	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG1-005	10/28/16	E901.1	Radium-226	0.46	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG1-006	10/28/16	E901.1	Radium-226	0.62	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG1-206	10/28/16	E901.1	Radium-226	0.57	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG1-007	10/28/16	E901.1	Radium-226	0.53	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG1-008	10/28/16	E901.1	Radium-226	0.58	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG1-009	10/28/16	E901.1	Radium-226	0.34 U	pCi/g	Result Verification		±15%	UJ	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG1-010	10/28/16	E901.1	Radium-226	0.68	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.

Notes

mg/kg milligrams per kilogram	MS matrix spike
pCi/g picocuries per gram	MSD matrix spike duplicate
LCS laboratory control sample	RPD relative percent difference
LR laboratory replicate (duplicate)	

Table F.1-1
Summary of Qualified Data
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase

Field Sample Identification	Sample Date	Analysis Code	Analyte	Sample Result	Units	QC Type	QC Result	QC Limit	Added Flag	Comment
S260-C02-001	10/31/16	E901.1	Radium-226	7.02	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-C03-001	10/31/16	E901.1	Radium-226	34.2	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-C04-001	10/31/16	E901.1	Radium-226	20.7	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-CX-002	5/22/17	SW6020	Uranium	3.7	mg/kg	MS MSD LR	-1% 29% 40%	75% - 125% 75% - 125% 20%	J-	Result is estimated, potentially biased low. MS and MSD recoveries below acceptance criteria. LR RPD outside
S260-CX-002	5/22/17	SW6020	Vanadium	35	mg/kg	MS MSD LR	29% 25% 30%	75% - 125% 75% - 125% 20%	J-	Result is estimated, potentially biased low. MS and MSD recoveries below acceptance criteria. LR RPD outside
S260-CX-011	5/22/17	E901.1	Radium-226	0.7	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-CX-211	5/22/17	E901.1	Radium-226	0.7	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-CX-003	5/22/17	E901.1	Radium-226	1.29	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-CX-007	5/22/17	E901.1	Radium-226	11.5	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-CX-208	5/22/17	E901.1	Radium-226	8.2	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.

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

Table F.1-1
Summary of Qualified Data
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 3 of 5

Field Sample Identification	Sample Date	Analysis Code	Analyte	Sample Result	Units	QC Type	QC Result	QC Limit	Added Flag	Comment
S260-SCX-002-1	5/22/17	E901.1	Radium-226	3.17	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-SCX-009-1	5/22/17	E901.1	Radium-226	6.78	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-SCX-010-1	5/22/17	E901.1	Radium-226	1.34	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-SCX-202-1	5/22/17	E901.1	Radium-226	2.91	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-SCX-002-2	5/22/17	E901.1	Radium-226	2.97	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-SCX-003-1	5/22/17	E901.1	Radium-226	13.6	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-SCX-003-2	5/22/17	E901.1	Radium-226	10.7	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-SCX-004-1	5/22/17	E901.1	Radium-226	14.4	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-SCX-005-1	5/22/17	E901.1	Radium-226	1.34	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-SCX-006-1	5/22/17	E901.1	Radium-226	1.51	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-SCX-006-2	5/22/17	E901.1	Radium-226	1.45	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.

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

Table F.1-1
Summary of Qualified Data
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase

Field Sample Identification	Sample Date	Analysis Code	Analyte	Sample Result	Units	QC Type	QC Result	QC Limit	Added Flag	Comment
S260-SCX-011-1	5/22/17	SW6020	Arsenic	3.2	mg/kg	LR	67%	20%	J	Result is estimated, bias unknown. LR RPD outside acceptance criteria.
S260-SCX-011-1	5/22/17	SW6020	Uranium	7.8	mg/kg	LR	45%	20%	J	Result is estimated, bias unknown. LR RPD outside acceptance criteria.
S260-SCX-012-1	5/22/17	E901.1	Radium-226	2	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-SCX-212-1	5/22/17	E901.1	Radium-226	2.79	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-SCX-012-2	5/22/17	E901.1	Radium-226	2.15	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-SCX-012-3	5/22/17	E901.1	Radium-226	1.4	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-SCX-013-1	5/22/17	E901.1	Radium-226	0.45	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG1-011	5/22/17	E901.1	Radium-226	0.45	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG2-008	8/24/17	SW6020	Arsenic	3.2	mg/kg	LR	29%	20%	J	Result is estimated, bias unknown. LR RPD outside acceptance criteria.
S260-BG2-008	8/24/17	SW6020	Uranium	0.37	mg/kg	LR	26%	20%	J	Result is estimated, bias unknown. LR RPD outside acceptance criteria.
S260-BG2-007	8/24/17	E901.1	Radium-226	0.49	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG2-008	8/24/17	E901.1	Radium-226	0.63	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG2-010	8/24/17	E901.1	Radium-226	0.73	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.

Notes

mg/kg milligrams per kilogram	MS matrix spike
pCi/g picocuries per gram	MSD matrix spike duplicate
LCS laboratory control sample	RPD relative percent difference
LR laboratory replicate (duplicate)	

Table F.1-1
Summary of Qualified Data
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase

Field Sample Identification	Sample Date	Analysis Code	Analyte	Sample Result	Units	QC Type	QC Result	QC Limit	Added Flag	Comment
S260-BG2-011-01	8/24/17	E901.1	Radium-226	0.49	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG2-002	8/24/17	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.
S260-BG2-003	8/24/17	E901.1	Radium-226	0.5	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG2-004	8/24/17	E901.1	Radium-226	0.7	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S260-BG2-006	8/24/17	E901.1	Radium-226	0.57	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S225-BG2-008	10/17/16	E901.1	Radium-226	0.47	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.

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

Table F.1-2
Results that did not Meet the Relative Percent Difference Guidance
Mitten No. 3
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 1

Primary Sample / Duplicate Indentification	Sample Date	Parameter	Primary Result	Duplicate Result	Units	RPD (%)
S260-BG1-006/S260-BG1-206	10/28/2016	Uranium	0.74	0.35	mg/kg	72
S260-CX-008/S260-CX-208	5/22/2017	Molybdenum	1.4	0.77	mg/kg	58
S260-CX-008/S260-CX-208	5/22/2017	Uranium	16	11	mg/kg	37
S260-CX-008/S260-CX-208	5/22/2017	Radium-226	12	8.2	pCi/g	38
S260-CX-011/S260-CX-211	5/22/2017	Uranium	0.43	0.61	mg/kg	35
S260-SCX-012-1/S260-SCX-212-1	5/22/2017	Radium-226	2	2.79	pCi/g	33

Notes
mg/kg milligrams per kilogram
pCi/g picocuries per gram
RPD relative percent difference