NA-0928 (#63)

Removal Site Evaluation Report

Final | October 2, 2018

Stantec

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

NA-0928 (#63) Removal Site Evaluation Report - Final

October 2, 2018

Prepared for:

Navajo Nation AUM Environmental Response Trust
– First Phase

Prepared by:

Stantec Consulting Services Inc.

Title and Approval Sheet

Title: **NA-0928 Removal Site Evaluation Report - Final**

Approvals

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

10/15/18

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Revision Log

Revision No.	Date	Description
0	May 14, 2018	Submission of Draft RSE report to Agencies for review
1	October 2, 2018	Submission of Final RSE report to Agencies

Sign-off Sheet

This document entitled *NA-0928 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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- 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 and Malan, 1973 – The Uranium Deposits of Northeastern Arizona
    - Chenoweth, 1984 – Historical Review of Uranium-Vanadium Production in the Eastern Carrizo Mountains, San Juan County, New Mexico, and Apache County, Arizona
    - Chenoweth, 1985 – Historical Review Uranium-Vanadium Production in the Northern and Western Carrizo Mountains, Apache County, Arizona
    - Hendricks, 2001 – An Aerial Radiological Survey of Abandoned Uranium Mines in the Navajo Nation
    - NAML, 2000 – The Navajo Nation, Navajo Abandoned Mine Lands Reclamation Program Tse Tah 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, 2010 - NA-0928 AUM Site Navajo Abandoned Uranium Mine Site Screen Report

Executive Summary

Introduction

The NA-0928 site (the Site) is located within the Navajo Nation, Shiprock Bureau of Indian Affairs (BIA) Agency, Sweetwater Chapter in northeastern Arizona, near the border of Arizona and 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 September 2017 at the Site. The primary objectives of the RSEs are to provide data required to evaluate relevant site conditions and to support future removal action evaluations at the Sites. It is not intended to establish cleanup levels or determine cleanup options or potential remedies. The purpose of the RSE data (e.g., the review of relevant information and the collection of data related to historical mining activities) is to determine the volume of technologically enhanced naturally occurring radioactive material (TENORM) at the Site in excess of Investigation Levels (ILs) as a result of historical mining activities. ILs are based on the background gamma measurements (in counts per minute [cpm]), and Radium-226 (Ra-226) and metals concentrations, determined through statistical analyses, that are used to evaluate potential mining-related impacts.

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

Site History and Physical Characteristics

The Site is located within the Colorado Plateau physiographic province, which is an area of approximately 240,000 square miles in the Four Corners region of Utah, Colorado, Arizona, and New Mexico. The Site is located in-between Toh Atin Mesa and the Carrizo Mountain mining region. Bedrock on the Site consists of the Jurassic Morrison Formation. The Morrison Formation produced approximately 4.7 million pounds of uranium from areas of Arizona and New Mexico. The Site is also located within the San Juan River watershed, an area of approximately 24,600 square miles spanning Utah, Colorado, New Mexico, and Arizona. Topographically the Site is located along a mesa and the elevation on-site is approximately 5,700 ft above mean sea level. On-site overland surface water flow, when present is controlled by a decrease in elevation from the mesa top to the surrounding plains.

Site-specific historical mining information is minimal and the only such information discovered was reported in the *2007 AUM Atlas* (USEPA, 2007a). The *2007 AUM Atlas* reported the Site was reclaimed. Ore production information pertaining to the Site was not identified. However, an important consideration is that even though ore production information pertaining to the Site was not identified, the *2007 AUM Atlas* reported that sometimes production from multiple mines was reported as a single combined value for one of the mines. In these cases, the mines were included on a single lease, and the ore production reported was inclusive of all of the mines on that single lease (USEPA, 2007a). It is unknown if the Site was part of a multi-mine lease but, it is possible that ore could have been mined from the Site, and combined with reports from other mine ore productions, for a combined reported production value.

In 2000, Navajo Abandoned Mine Lands Reclamation Program (NAML) issued an invitation for bids for the reclamation of 15 AUMs, referred to as the Tse Tah 3 NAML Reclamation Project (NAML, 2000). The Site was one of the 15 AUMs included in the bid document. Closeout reports for the Tse Tah 3 NAML Reclamation Project could not be located. However, in 2007 the EPA listed the Site as reclaimed (USEPA, 2007a). In 2010, Weston Solutions (Weston) performed 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

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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"

conducted two sequential tasks to complete the RSE: Baseline Studies activities and Site Characterization Activities and Assessment. Details of the Site Clearance activities, Baseline Studies activities, and Site Characterization and Assessment activities are as follows:

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

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

- **Site Characterization Activities and Assessment** included surface and subsurface soil and sediment sampling, 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 well water analyses were used to evaluate mining impacts to well water.

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. An IL for selenium was not identified because selenium sample results were non-detect in the background areas. However, because selenium was detected in soil/sediment samples from the Survey Area (i.e., the full areal extent of the Site surface gamma survey), it is also confirmed as a COPC for the Site. Based on the data analyses performed for this report along with the multiple lines of evidence, approximately 4.3 acres, out of the 36.8 acres of the Survey Area (i.e., the full areal extent of the Site surface gamma survey), were estimated to contain TENORM. Of the 4.3 acres that contain TENORM, 2.3 acres contain TENORM exceeding the surface gamma ILs. The volume of TENORM in excess of ILs was estimated to be 7,301 yd^3 (5,582 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 radium-226 concentrations. Additional correlation studies may be needed to identify the relationship between gamma and Ra-226.

Water sampling results. Water samples were collected from one water well. Analytical results indicated the well water sample had total and dissolved arsenic concentrations which exceeded the arsenic IL. All other metals and radionuclides were below their respective ILs. Results of general chemistry parameters indicated that total dissolved solids (TDS) was also above its respective IL. All other general chemistry parameter results were below their respective ILs. Based on these results, arsenic and TDS are confirmed COPCs for the water well. Because arsenic and TDS exceeded their respective ILs for the well water sample, additional characterization may be considered at the water well 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
e.g.	exempli gratia
etc.	et cetera
bcy	bank cubic yard
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
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
R2	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
VCA	Vanadium Corporation of America
Weston	Weston Solutions

Glossary

Alluvium – material deposited by flowing water.

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

Bank cubic yard – 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.

Class A material - mine waste piles, overburden, subsoil, topsoil or other suitable backfill material with Radium-226 (Ra-226) concentration equal to or less than the average Ra-226 concentration of the background area in the immediate vicinity of the project as computed from ground-contact radiological measurements. The material must be free from solid waste, hazardous waste, toxic waste, oil/grease, trash, vegetation, combustible materials and materials that retard vegetative growth (NAML, 2000).

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.

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.

Scarified – to break up, loosen, or roughen the surface of something (such as a field or road).

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 September 2017 at the NA-0928 site (the Site) located in northeastern Arizona, near the border of Arizona and 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 #63 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 7.7 acres (335, 412 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 locations and surface extents 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)(2010) 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 and drilling borehole locations), and subsurface sampling and laboratory analyses. Hand auger and drilling borehole locations are referred to hereafter as boreholes.
- Characterization of well water – 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 *NA-0928 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 *NA-0928 Site Baseline Studies Field Report* (Stantec, 2017) and summarized in Section 3.3 of this report. Details regarding the Site Characterization Activities and Assessment are provided in Section 3.3 of this report. Findings are presented in Section 4.0 of this report.

1.3 REPORT ORGANIZATION

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

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

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

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

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

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

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

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

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

Tables Included at the end of this RSE report.

Figures Included at the end of this RSE report.

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

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

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

2.0 SITE HISTORY AND PHYSICAL CHARACTERISTICS

2.1 SITE HISTORY AND LAND USE

2.1.1 Mining Practices and Background

The Site is located on the Navajo Nation near the border of Arizona and Utah and approximately 5.5 miles southeast of Red Mesa, Arizona, as shown in Figure 1-1 inset. Site-specific historical mining information is minimal and the only such information discovered was reported in the *2007 AUM Atlas*. The *2007 AUM Atlas* reported the Site was reclaimed. Ore production information pertaining to the Site was not identified. However, an important consideration is that even though ore production information pertaining to the Site was not identified, the *2007 AUM Atlas* reported that sometimes production from multiple mines was reported as a single combined value for one of the mines. In these cases, the mines were included on a single lease, and the ore production reported was inclusive of all of the mines on that single lease (USEPA, 2007a). It is unknown if the Site was part of a multi-mine lease but, it is possible that ore could have been mined from the Site, and combined with reports from other mine ore productions, for a combined reported production value[4].

The only other historical information found was for other AUMs located within the same mining region as the Site, in-between Toh Atin Mesa and the Carrizo Mountain mining region. Therefore, information regarding historical mining practices and background for the Site are presented on a regional level (i.e., the Toh Atin Mesa, within the Carrizo Mountain mining region). A summary of historical mining on the Carrizo Mountain region is presented below.

During the 1920s and 1930s, mining on the Navajo Nation primarily focused on vanadium mining. In November 1920, the first recorded shipment of uranium and vanadium ore was shipped from the Carrizo Mountain mining region (Chenoweth, 1984 and Chenoweth, 1985). Between 1942 and 1944, Vanadium Corporation of America (VCA) operated numerous vanadium mines in the Carrizo Mountain mining region. By 1945, mines in the Carrizo Mountain region became inactive due to the decreased market for vanadium.

After 1947, prospecting and mining for uranium increased in the Carrizo Mountains region. In light of new regulations, exploration drilling by both the US Atomic Energy Commission (USAEC) and uranium mining companies increased in 1953 and additional ore bodies were discovered. To fill the USAEC’s need for uranium, VCA reopened its inactive vanadium mines in the Carrizo Mountain region and began mining them for uranium. During the mid-1950s, there were more mining operations in the northern and western Carrizo Mountains than at any other time, resulting in large mines, as well as numerous small mining operations throughout the Carrizo Mountain mining region. The final ore shipment from the Carrizo Mountain mining region was

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[4] USEPA (2007a) noted that occasionally the ore mined from multiples sites within one lease were reported collectively. Thus it is possible, but less likely, that ore was mined from NA-0928 but reported for a different mine.

sent June 1968 (Chenoweth, 1984 and Chenoweth, 1985). Chenoweth and Malan (1973) reported that the total ore production from the northwestern Carrizo Mountain mining region was 27.4 tons (approximately 54,800 pounds) of ore containing 0.21 percent U_3O_8 (uranium oxide) and 1.54 percent V_2O_5 (vanadium oxide). The northwestern Carrizo Mountain mining region was inclusive of 36 properties located on the Toh Atin Mesa. The Site was not included in the report prepared by Chenoweth and Malan; however, four other historical AUMs surrounding the Site were included in the report: Plot 1, Plot 2, McKenzie 3, and Silentman 1 (refer to Figure 2-1) (Chenoweth and Malan, 1973).

2.1.2 Ownership and Surrounding Land Use

The Site is located within the Navajo Nation, Shiprock Bureau of Indian Affairs (BIA) Agency in Section 35 of Township 41 North, Range 28 East, Gila and Salt River Principal Meridian. Land ownership where the Site is located falls under Navajo Trust lands. The Site is located within the Sweetwater Chapter of the Navajo Nation, as shown in Figure 1-1, and is in Grazing Unit 9, as designated by the Navajo Nation Division of Natural Resources (NNDNR, 2006). The Site is currently uninhabited, but two home-sites are located north-northeast of and within 0.25 miles of the Site, as shown in Figure 2-1. One home-site is also located just outside of the 0.25 mile claim boundary buffer, as shown in Figure 2-1.

2.1.3 Site Access

In 2015, the Navajo Nation Department of Justice (NNDOJ) provided the Trustee with legal access to all Navajo Trust lands to implement work in accordance with the *Trust Agreement*. The Trustee also obtained individual written access agreements from residents living at or near the Site, or with an interest in lands at or near the Site, such as home-site leases and grazing rights, as applicable. In addition, the Trustee consulted with the Sweetwater 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 Tsetah Wash 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 Tsetah Wash area covered approximately 16.8 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 5 µR/hr to 7 µR/hr and excess bismuth (i.e., bismuth activity greater than approximately 3.5 µR/hr) present in approximately 0.003 square miles (2.1 acres) of the area (*2007 AUM Atlas*). The aerial radiological survey results for the Tsetah Wash area indicated a gross exposure rate range of 3.54 µR/hr to 38.62 µR/hr and excess bismuth (i.e., bismuth activity greater than approximately 3.5 µR/hr) present in approximately 0.11 square miles of the 16.8 square miles of the Tsetah Wash flight area (Hendricks, 2001).

2.1.4.2 2000 Tse Tah 3 Reclamation Project Invitation for Reclamation Bids

In 2000, NAML issued an invitation for bids for the reclamation of 15 AUMs, referred to as the Tse Tah 3 NAML Reclamation Project (NAML, 2000). The bid document stated that the Site had four waste areas containing 400 bank cubic yard (bcy) of waste material (inclusive of nine waste piles) and six rim strips. The bid document included a historical drawing of the Site (refer to map #17 in the bid document) that showed the locations of the waste areas, waste piles (WP1 through WP9), rim strips, and bury/borrow area 1 (to be used during reclamation as a staging/borrow/burial area). For comparison, the historical NAML drawing was overlain on the current 2017 image (Cooper Aerial Surveys Company [Cooper], 2017) of the Site in Figure 2-2. The historical drawing location in relation to the current image of the Site was approximate because the historical image could not be georeferenced. In addition, the black-dashed border labeled “Boundary Area 5.71 acres” on the historical drawing was a border for the reclamation work area and was not meant to represent the claim boundary, thus this border and the claim boundary are not meant to line up. Survey markers left by NAML are shown in Appendix B photograph numbers 4 and 5. The bid document listed the following reclamation activities for the Site:

- Upgrade the access road to the areas of the Site that are going to be reclaimed
- Excavate and stockpile 600 bcy of Class A material at bury/borrow area 1 (65 ft long by 50 ft wide by 5 ft deep). In the bid document Class A material was defined as: mine waste piles, overburden, subsoil, topsoil or other suitable backfill material with Ra-226 concentration equal to or less than the average Ra-226 concentration of the background area in the immediate vicinity of the project as computed from ground-contact radiological measurements. The material must be free from solid waste, hazardous waste, toxic waste, oil/grease, trash, vegetation, combustible materials and materials that retard vegetative growth.
- Excavate and haul 100 bcy of material from waste areas 1, 2, and 4 and bury the material at bury/borrow area 1.
- Excavate 300 bcy of material from waste area 3 and backfill rimstrip 6 with the material. Regrade the surface of the backfill areas to match the natural terrain.
- Haul 100 bcy of Class A material to cover rim strips 2, 3, and 4. Contour the backfill with the natural terrain and ensure positive drainage and rough grading.

- Haul 200 bcy of Class A material to cover rim strips 1, 5, and 6. Contour the backfill with the natural terrain and ensure positive drainage and rough grading.
- Complete covering of bury/borrow area 1 with the remaining 300 bcy of Class A material. Ensure positive drainage and rough grading.
- Excavate 60 bcy of rocky material from near rimstrip 6 and construct a 60-foot diversion berm near rimstrip 6. The berm should have a 3 ft top width by 3 ft high by 2h:1v (horizontal to vertical) side slopes.
- Scarify the access roads and all areas disturbed by equipment and vehicle travel.

Closeout reports for the Tse Tah 3 NAML Reclamation Project could not be located. However, the *2007 AUM Atlas* reported the Site was reclaimed by NAML.

2.1.4.3 2010 Site Screening

In 2010, Weston performed site screening on behalf of the USEPA (Weston, 2010). The screening included: (1) recording site observations (i.e., number of homes, water sources, and sensitive environments[5] around the Site); (2) recording the type, number, and reclamation status of mine features; and (3) performing a surface gamma survey. Weston reported one home-site was within 0.25 miles of the Site, no water features within a one-mile radius of the Site, and no sensitive environments were identified. Weston also reported the Site was reclaimed and identified a possible waste pile on the east side of the Site that measured 50 ft by 30 ft by 1.5 ft. Based on Weston’s performance of a surface gamma survey, Weston determined that the highest gamma measurements were greater than 36 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 2-3 presents a current regional aerial photograph (NAIP, 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

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[5] 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”

east, the drier shrub-lands and woodlands to the north, and the lower, hotter, less-vegetated areas to the west and south.

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

The Site is located in the central portion of the Colorado Plateau. Figure 2-4 presents the regional US Geological Survey (USGS) topographic map of a portion of the Colorado Plateau in the vicinity of the Site. Figure 2-5 presents the Site topography (Cooper; refer to Section 3.2.2.1) within a portion of the Colorado Plateau. The Site is located along a mesa and the elevation on-site is approximately 5,700 ft above mean sea level (amsl) (refer to Figure 2-5).

2.2.2 Geologic Conditions

2.2.2.1 Regional Geology

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

Bedrock on-site consists of the Jurassic Summerville Formation and the Jurassic Salt Wash Member of the Morrison Formation. Regionally, the Summerville Formation is of marginal marine and tidal origin composed of reddish-brown, thinly bedded sandstone with interbedded gypsiferous siltstone, sandy siltstone, or mudstone and is known for its thin beds of rippled sandstones and mud cracks (University of Utah, 2018). Regionally, the Morrison Formation is composed of various rocks of lacustrine and fluvial continental origin, including mudstone, sandstone, limestone, and siltstone (USGS, 1967). Figure 2-6 depicts a regional geology map showing the Site in relation to the regional extent of the Morrison Formation. The sandstone strata of the Morrison Formation contains the majority of uranium ore reserves in the US. Deposition of the Morrison Formation may have coincided with uplift of the western basin-and-range region and the beginning of the Nevadan orogeny. The Morrison Formation covers an area of approximately 600,000 square miles (USGS, 1967) and is centered in Wyoming and Colorado, with outcrops in Canada, Montana, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Utah, Idaho, New Mexico, and Arizona (Turner and Peterson, 2004). Approximately 4.7 million pounds of uranium was mined from the Morrison Formation within areas of Arizona and New Mexico (USEPA, 2007a).

2.2.2.2 Site Geology

Bedrock outcrops on or adjacent to the Site consist of the Jurassic Salt Wash Member of the Morrison Formation and the Jurassic Summerville Formation, as shown in Figure 2-7a. The Salt Wash Member of the Morrison Formation consists of white and moderate-orange, very fine- to medium- grained sandstone and grayish-red shale. The Summerville Formation consists of reddish-brown to light-orange very fine- to fine-grained flat bedded silty sandstone and thin-bedded silty sandstone, claystone, and siltstone. The transition between the Summerville Formation and the Quaternary deposits on-site is not a defined boundary and the Summerville Formation (and also in places the Morrison Formation) is often overlain by the Quaternary deposits. Shallow or outcropping mineralized bedrock on Site is shown in Figure 2-7b.

Unconsolidated deposits on-site are alluvium, colluvium, and eolian deposits consisting of variable amounts of silt, sand, and gravel. During the Site Characterization field activities, boreholes were advanced through the unconsolidated deposits using a hand auger or Geoprobe™ 8140LC rotary sonic drilling rig until termination within native material or termination due to refusal at hard surface/bedrock (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 11.0 ft below ground surface (bgs).

According to the US Department of Agriculture (USDA) Soil Survey for Apache County, Arizona, soils on-site that have not been disturbed, are classified as Shinume soil consisting of eolian soil derived from sandstone (USDA, 2011).

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 028468, Teec Nos Pos, Arizona (Western Regional Climate Center, 2017) located approximately 12 miles northeast of the Site, ranges between 41.5 degrees Fahrenheit (°F) in January to 93.1°F in July. Daily temperature extremes reach as high as 105°F in summer and as low as 18°F in winter. Teec Nos Pos receives an average annual precipitation of 8.1 inches, with August being the wettest month, averaging 1.16 inches, and June being the driest month, averaging 0.26 inches.

Potential evaporation in the area is greater than the area's average annual precipitation. The potential evaporation noted at the Many Farms School, Arizona weather station, located approximately 41 miles southwest of the Site, averages 91 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 Cortez, Colorado airport, located approximately 50 miles to the northeast of the Site, had the most complete record of wind conditions. A wind rose for the Cortez airport is presented on Figure 1-1. The wind rose was produced using data contained in the *2007 AUM Atlas* for the years 1996 to 2006. Predominant winds were from the east-northeast (refer to the wind rose on Figure 1-1). However, Stantec field personnel (field personnel) generally observed wind from the west when in the area of the Site.

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 overland surface water flow, when present, is controlled by a decrease in elevation from the mesa top to the surrounding plains (refer to Figures 2-5, 2-8a, and 2-8b). Numerous parallel patterned ephemeral drainages are present on-site that drain to the northwest or northeast. The drainages that drain northwest terminate in the surrounding plains and the drainages that drain northeast join an un-named drainage, as shown in Figure 2-1.

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 of 2016, biological surveys were conducted as part of Site Clearance activities. In April 2016, Adkins conducted a wildlife survey and in May 2016, Redente Ecological Consultants (Redente), under contract to Stantec, conducted a 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 primarily sparsely vegetated grassland with sporadic shrubs (refer to Appendix E). During the surveys, Stantec and/or its subcontractors observed on-site wildlife including wild/feral horses, common raven, cottontail rabbit, coyote, mule deer, turkey vulture, and prairie falcon (refer to Appendix E).

2.2.6 Cultural Resources

In April 2016, as part of Site Clearance activities, Dinétahdóó Cultural Resource Management (Dinétahdóó), under contract to Stantec, conducted a cultural resource survey, as well as ethnographic and historical data reviews, and interviewed a local resident living near the Site (Dinétahdóó, 2016). The local resident stated that their family had lived in the general area between NA-0928 and NA-0904 and had herded sheep and goats in the area. The resident did not provide any information pertaining to historical mining at the Site.

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

2.2.7 Observations of Potential Mining and Reclamation

During RSE activities, field personnel observed the following features indicative of potential mining or reclamation activities at the Site: potential haul roads, debris, mining/reclaimed disturbed areas, and the approximate location of a buried rim strip. Details regarding these observations are presented in Section 3.2.2.1.

On April 13 and 14, 2017, a representative from NAML met on-site with field personnel to verify what reclamation activities had occurred and in which locations. NAML verified the following (refer to Figure 2-2):

- The general location of the bury/borrow area 1 and that the area was covered with Class A material. The surface expression of this area was difficult to discern from native surroundings.
- 100 bcy of material from waste areas 1, 2, and 4 were excavated, hauled, and buried at the bury/borrow area 1.
- The material from WP1 and WP6 was used to backfill rimstrip 6 and then rimstrip 6 was covered with Class A material from the bury/borrow area 1.
- Rim strips 1 through 6 and WP2 were covered with Class A material that consisted of red fine-grained sand. The cover material had eroded away in some areas.
- The access roads and all areas disturbed during reclamation by equipment and vehicle travel were scarified.

These observations and NAML confirmations 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 September 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[6] 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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[6] (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 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 1949, 1976, 1997, and 2005 for comparison against a current 2017 image (Cooper, 2017). The selected historical photographs are shown in Figure 3-1a. Figures 3-1b and 3-1c compare the aerial photographs from 1949 and 1976 to the current 2017 image. The potential haul road that runs from the northeast corner of the claim boundary is present in the current 2017 and 1976 images but is not present in the 1949 image.

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

- Four potential 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. These findings contradict Weston (2010) reporting that no water features were within four miles of the Site.

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

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

3.2.2 Field Investigations

3.2.2.1 Site Mapping

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

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

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

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

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

- Topographic features

- Potential background reference areas

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

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

- Claim boundaries – 100-ft buffers of the claim boundaries, as shown in Figure 2-8a, were marked in the field with stakes and/or flagging and mapped with a global positioning system (GPS).
- Drainages – Numerous parallel patterned ephemeral drainages were mapped, as shown in Figure 2-8a. The drainages drained to the northwest or northeast. The drainages that drained northwest terminated in the surrounding plains and the drainages that drained northeast join an un-named drainage, as shown in Figure 2-1. One of the on-site drainages is shown in Appendix B photograph number 2.
- Topographic features – The mapped area can be divided into two primary topographic areas: a mesa and the surrounding plains, as shown in Figure 2-5. Site topography is shown in Appendix B photograph numbers 7, 8, and 9.
- Potential haul roads – Potential haul roads were mapped, as shown in Figure 2-8a and Appendix B photograph number 3. The potential haul roads ran along the mesa top and branched at the northeast corner of the claim boundary.
- Rim strips – The approximate location of six buried rim strips (Rim Strip 1 through Rim Strip 6) were mapped, as shown in Figures 2-8a and 2-8b. The actual rim strips were not visible to field personnel because they had been covered during reclamation. The location of the rim strips in relation to the historical mine drawing overlay are shown in Figure 2-2 (refer to Section 2.1.4). Of note, three rim strip locations were provided in the *2007 AUM Atlas*, but their locations did not match up with where the rim strips are shown on the historical mine drawing overlay used in Figure 2-2. The rim strips are also shown as part of the earthworks in Figures 2-7a and 2-7b.
- Mining/reclaimed disturbed areas – Nine mining/reclaimed disturbed areas (RA1 through RA8 and Potential Bury/Borrow Area #1) were mapped, as shown in Figures 2-8a and 2-8b. These areas were coincident with the four historical waste areas and the historical bury/borrow area 1, as shown in Figure 2-2 and discussed in Section 2.1.4. The mining/reclaimed disturbed areas are also shown as part of the earthworks in Figures 2-7a and 2-7b. RA2 is shown in Appendix B photograph number 11, RA5 is shown in photograph number 10, RA7 is shown in photograph number 6, and the Potential Bury/Borrow Area #1 is shown in photograph number 12.
- Debris – One debris pile was mapped, as shown in Figure 2-8a. The debris pile contained scrap metal, mattress bedsprings, and other metal debris, as shown in Appendix B photograph number 1.
- Structures – The Site is currently uninhabited, but two home-sites were located north-northeast of and within 0.25 mile of the Site and one home-site was located just outside of the 0.25 mile claim boundary buffer, as shown in Figure 2-1. These observations contradict

Weston (2010) reporting that only one home-site was within 0.25 mile of the Site. Field personnel observed horses, sheep, and goats in corrals located near the home-sites.

- Water features – Field personnel assessed the four potential 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. In addition, during site mapping activities field personnel identified an oil well feature, as described in Table 3-1a.
- Ground cover – Ground cover and vegetation observed on-site are discussed in Sections 2.2.2.2 and 2.2.5, respectively.

During site mapping, field personnel did not observe the possible waste pile reported by Weston (2010).

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 Sweetwater 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 six potential background reference areas (BG-1 through BG-6) for the Site, as shown in Figure 3-2, and described in Appendix D.1. BG-2, BG-3, and BG-4 were selected as suitable background reference areas for the Site for the following reasons:

- BG-2 encompassed an area of 1,499 ft^2 (approximately 0.03 acres), was located 3,410 ft west of the claim boundary, and was cross-wind and hydrologically cross-gradient from the Site, and across a drainage divide. The thin soils, colluvium-covered slopes, and bedrock outcrops represented the portions of the Survey Area that were within the Morrison Formation. The vegetation and ground cover at BG-2 were similar to the mesa portions of the Site and mesa sidewall portions of the site.
- BG-3 encompassed an area of 2,411 ft^2 (approximately 0.06 acres), was located 670 ft west of the claim boundary, and was cross-wind and hydrologically cross-gradient from the Site, and across a valley. The thicker soils deposits, colluvium-covered slopes, and bedrock outcrops represented the portions of the Survey Area that were within the Summerville Formation and the Quaternary deposits. The vegetation and ground cover at BG-3 were similar to the area where the mesa transitions into the plains portions of the Site.
- BG-4 encompassed an area of 463 ft^2 (approximately 0.01 acres), was located 520 ft west of the claim boundary, and was cross-wind and hydrologically cross-gradient from the Site, and across a drainage divide. The sediments represented the portions of the Survey Area that consisted of Quaternary deposits, including alluvium, in the drainages. The vegetation and ground cover at BG-4 were similar to the drainages that drain the Site to the north.

BG-1, BG-5, and BG-6 were not selected as background reference areas for the Site for the reasons described in Appendix D.1

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

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

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

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

3.2.2.3 Biological Surveys

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

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

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

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

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

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

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

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

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

Vegetation Survey - In May 2016, Redente performed a spring vegetation survey 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[7]. A copy of this letter is included in Appendix E. A summer 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 summer survey.

The NNDFW listed two T&E plant species that may occur on-site; Parish's alkali grass (G4) and Zuni fleabane (G2). The USFWS did not list any T&E plant species that may occur on-site. Parish's alkali grass is a native annual grass that grows in a series of widely discontinuous populations ranging from southern California to eastern Arizona and western New Mexico in alkaline seeps, springs and seasonally wet areas and washes at elevations from 5,000 ft to 7,200 ft amsl. Zuni Fleabane is a native perennial forb that is found growing in fine textured clay hillsides primarily in

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[7] 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).

pinyon juniper type and at elevations from 2,135 ft to 2,530 ft amsl. Its distribution is in Apache County in Arizona.

Before beginning the Site vegetation surveys, Redente reviewed the ecologic and taxonomic information for the T&E species to understand ecological characteristics of the species, habitat requirements, and key taxonomic indicators for proper identification (Arizona Native Plant Society, 2000). Redente also reviewed currently accepted resource agency protocols and guidelines for conducting and reporting botanical inventories for special status plant species (USFWS, 1996). An experienced Redente botanist with local flora knowledge conducted the rare plant survey. The botanist walked transect lines on the Site with emphasis on areas with suitable habitat for the T&E species, specifically alkali seeps and fine-textured clay hillsides.

The Redente botanist did not identify either of the two T&E species at the Site, based on observations he made during the on-site survey. The botanist concluded he did not identify any of the T&E species at the Site because the Site was not a likely habitat for the T&E species. The Site is primarily sparsely vegetated grassland with sporadic shrubs.

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

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

The wildlife evaluation was performed for species listed as NNESL, Federally Endangered, Federally Threatened, or Federal Candidate, and species protected under the Migratory Bird Treaty Act (MBTA) that have the potential to occur on-site. Prior to the start of the wildlife survey, Adkins submitted data requests to USFWS and NNDFW for animal species listed under the ESA. The NNESL species were further classified as G2, G3, or G4. The USFWS included seven ESA-species with the potential to occur in the area of the Site; two birds (Mexican spotted owl and western yellow-billed cuckoo), two fish (roundtail chub and Zuni bluehead sucker), two mammals (black-footed ferret and gray wolf), and one reptile (northern Mexican gartersnake). The NNDFW included: six birds (mountain plover [G4], golden eagle [G3], ferruginous hawk [G3], southwestern willow flycatcher [G2], American peregrine falcon [G4], and western burrowing owl [G4]), one fish (Colorado pikeminnow [G2]), 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 remained as species of concern warranting further analysis during the Site survey: golden eagle and ferruginous hawk.

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"[8] 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 has 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.

3.2.2.4 Cultural Resource Survey

In April 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[9]).

The survey included the areas within the claim boundary and the 100-ft claim boundary buffer, as shown in Figure 2-8a. Dinétahdóó did not survey areas on steep terrain due to safety concerns. The survey identified one archaeological site and three isolated occurrences. For confidentiality reasons, details regarding the archaeological site and isolated occurrences are not provided herein. NNHPD can be contacted for additional information. NNHPD contact information is located on the *Cultural Resource Compliance Form* included in Appendix E.

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

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

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 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 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.

3.3.1 Baseline Studies Activities

3.3.1.1 Background Reference Area Study

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

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

Background Reference Area Study in accordance with the *RSE Work Plan,* Sections 4.2, 4.4, and 4.5.

The surface gamma surveys at BG-2 and BG-3 were completed in May 2016 and soil samples were collected in October 2016 (refer to Appendix D.1). Upon review of the surface gamma survey data and soil samples locations, it was determined that the surface gamma survey did not align spatially with the areal extent of the soil sample locations in BG-2. Supplemental gamma surveys for BG-2 were conducted in April 2017. Following review of data collected at the Site, it was determined that an additional potential background reference area may be required to characterize sediments in the drainage downgradient from the Site. BG-4 was identified and gamma surveys and sediment sampling were conducted in September 2017.

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

The same equipment used for the surface gamma surveys was also used to collect static one-minute gamma measurements at the ground surface and down-hole (subsurface) at borehole locations S059-SCX-001 (BG-2), S059-SCX-003 (BG-3), and S059-BG4-011 (BG-4). Refer to Appendix C.2 for borehole logs. Static gamma measurements were categorized as surface measurements where they were collected at ground surface (0.0 ft) and as subsurface measurements where depths were below ground surface due to the influence of downhole geometric effects on subsurface static gamma measurements (refer to Section 4.1). Gamma measurements were collected according to the methods described in the *RSE Work Plan,* Section 4.2 and Appendix E.

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

- BG-2 – In October 2016, 10 surface soil grab samples were collected from 10 locations and one subsurface soil grab sample was collected from borehole S059-SCX-001
- BG-3 – In October 2016, 11 surface soil grab samples were collected from 11 locations and one subsurface soil grab sample was collected from borehole S059-SCX-003
- BG-4 – In September 2017, 11 surface sediment grab samples were collected from 11 locations and one subsurface sediment grab sample was collected from borehole S059-BG4-011

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 0.7 acres of the mesa were not surveyed because field personnel were unable to safely access these areas, as shown in Figure 3-4. This is identified as a data gap in Section 4.9. In addition, for the section of the potential haul road that runs along the north/northeast portion of the Site (refer to Figure 2-8a), only the shoulders were surveyed. The centerline was not surveyed due to a miscommunication with the field personnel. This is identified as 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 well water samples were also collected and used to evaluate mining-related impacts (refer to Section 3.3.2).

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

The full areal extent of the surface gamma survey is referred to as the Survey Area, as shown in Figure 3-4. The Survey Area was 36.8 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 Salt Wash Member of the Morrison Formation (based on BG-2), Survey Area B is within the Summerville Formation (based on BG-3), and Survey Area C is within the Quaternary deposits (based on BG-4). In addition, potential background reference area BG-1 is included in the RSE report for discussion purposes (refer to Section 4.2) because BG-1 provides a valuable comparison to BG-2 regarding the variation in gamma measurements that may occur in background areas and the heterogeneity present within the Morrison Formation. BG-1 is also applicable to some areas of the portion of the mesa that trends northwest-southeast; however, mining-related disturbances were not observed in those areas.

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. Appendix A does not include the raw exposure rate data for the Site because the raw data were inadvertently deleted by field personnel following calculation of the mean exposure rates for the Site. This is a potential data gap. However, the missing raw field data does not impact the scope of the work because the inadvertent deletion occurred after the mean values for the raw exposure rate measurements were calculated and recorded. Therefore, the missing raw exposure rate data are a minor data gap and a repeat collection is not required.

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 and larger at one of the Gamma Correlation Study locations, to minimize the variability of gamma measurements observed. The area used for the Gamma Correlation Study is shown in Figure 3-5, where the box shown at the five study locations represents a 900 ft^2 area in comparison to the actual area covered for the study, as shown by the extent of the gamma measurements within each area.

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

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

3.3.1.4 Secular Equilibrium

The Gamma Correlation Study soil 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 April and June 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. Thirty-four surface soil/sediment grab samples were collected from 34 locations in the Survey Area (19 from Survey Area A, two from Survey Area B, and 13 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). Composite samples were collected to provide a screening level assessment across an interval (e.g., soil collected from mining/reclaimed disturbed areas). The usefulness of a composite sample may be limited when the sample is collected over an interval with varying soil or rock types or is excessively long (e.g., greater than 5 ft), which tends to dilute the constituent concentrations or sample heterogeneity. 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.

Subsurface samples were collected by advancing subsurface boreholes to a desired sample depth using either a 3-inch diameter hand auger or a Geoprobe™ 8140LC rotary sonic drilling rig (refer to Appendix C.2). Field personnel advanced the hand auger boreholes to the desired sample depth manually, and the sonic drilling rig advanced the boreholes to the desired sample depth. The sonic drilling rig was equipped with a 4-inch diameter sonic core barrel that used cutting rotation and vibration to advance the boreholes. The sonic drilling method is ideal for use in rocky soils to obtain continuous samples in materials that are difficult to sample using other drilling methods (ASTM, 2016) and it recovers a continuous and relatively undisturbed core sample for review and analysis that are representative of the lithological column at that borehole location (refer to Appendix C.2).

Twenty-three boreholes were advanced in the Survey Area (13 in Survey Area A, one in Survey Area B, and nine in Survey Area C). The boreholes were advanced through the unconsolidated deposits until: (1) refusal at hard surface/bedrock; or (2) subsurface static gamma measurements were below initial background levels. Borehole depths ranged from 0.5 to 15.0 ft bgs, and the depth of unconsolidated deposits to bedrock in boreholes ranged from 0.5 to 11.0 ft bgs. The boreholes were advanced through variable amounts of silt, sand, and gravel, claystone, sandstone, weathered sandstone, and shale (refer to Appendix C.2 for borehole information).

In April and June 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. Fourth-eight subsurface samples (44 soil/sediment and four bedrock) were collected from 20 borehole locations in the Survey Area (multiple subsurface samples were collected from multiple boreholes). Nineteen subsurface samples were collected from Survey Area A, one from Survey Area B, and 28 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 Water Sampling

Four potential water features were identified during the Site Clearance desktop study and one water feature was identified during site mapping, as shown in Figure 2-1 and Table 3-1a. Three of the four features were not sampled because two of the features were related to oil and gas wells, *outside the scope of the RSE Work Plan*, and the remaining one feature was not observed by field personnel during site mapping. One water feature was sampled as described below.

On September 29, 2016, a well water sample (S059-WL-001) was collected from a water well identified in the NNDWR database and the *2007 AUM Atlas* as 09T-546/RV990317TNW002 (09T-546). Water well 09T-546 was completed in February 1960 to a total depth of 874 ft bgs (refer to Table 3-1b for additional well build specifications). The well was a windmill well located 0.25 miles northeast of the Site and the well water sample was collected from the valve at the trough associated with the water well. Prior to shipment of the collected water sample, field personnel discovered that the bottle containing the mercury sample was broken. Therefore, on May 24, 2017 field personnel returned to water well 09T-546 and collected a water well sample for mercury analysis and general water quality field parameters.

The water sample collected for dissolved metals analyses was 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, conductivity, turbidity, temperature, salinity and oxidation reduction potential). Salinity was not collected as part of the May 24, 2017 specified field measurements because the water quality meter field personnel were using could not measure salinity. This was identified as a data gap in Section 4.9. Table 3-4 provides a summary of the water analyses. Per the *RSE Work Plan*, if well water sample analyte concentrations are above the established ILs then those sample areas would be considered for additional characterization in the future. 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 (do not exist for this Site)
    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:

    - **<u>Precision</u>** 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 reported.

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

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

- **Completeness** All media and QC sample results were valid and collected as scheduled (i.e., as planned in the *RSE Work Plan*); therefore, completeness for these is 100 percent.
- **Comparability** Standard methods of sample collection and standard units of measure were used during this project. The analyses performed by the laboratory were in accordance with current USEPA methodology and the QAPP.

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

4.0 FINDINGS AND DISCUSSION

4.1 BACKGROUND REFERENCE AREA STUDY RESULTS AND CALCULATION OF INVESTIGATION LEVELS

The results of the background reference area surface gamma survey are shown in Figure 4-1a with sample locations in the background reference areas shown for BG-2, BG-3, and BG-4. The surface gamma surveys in BG-2, BG-3, and BG-4 did not cover the areal extent of the soil/sediment sample locations with the background reference areas. However, the gamma survey measurements in BG-2, BG-3, and BG-4 were within approximately 3 ft of the soil/sediment sample locations that were not within the areal extent of the surface gamma survey area. Analytical results of the samples collected from BG-2, BG-3, and BG-4 are summarized in Table 4-1. The gamma measurements and surface soil sample analytical results collected from BG-2, BG-3, and BG-4 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; as requested by the Agencies, this is identified 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 Salt Wash Member of the Morrison Formation; refer to Figure 2-7a) were established using statistical analysis of background data collected from BG-2 (refer to Figures 3-2 and 3-3) and are as follows:

- Arsenic – 4.38 milligrams per kilogram (mg/kg)
- Molybdenum – an IL for molybdenum was not identified because sample results in BG-2 were all non-detect
- Selenium – an IL for selenium was not identified because sample results in BG-2 were all non-detect
- Uranium – 3.28 mg/kg
- Vanadium – 18.7 mg/kg
- Ra-226 – 3.34 pCi/g
- Surface gamma measurements – 11,068 cpm

The ILs for Survey Area B (i.e., the Summerville Formation; refer to Figure 2-7a) were established using statistical analysis of background data collected from BG-3 (refer to Figures 3-2 and 3-3) and are as follows:

- Arsenic – 2.25 mg/kg
- Molybdenum – an IL for molybdenum was not identified because all but one sample result in BG-3 were non-detect
- Selenium – an IL for selenium was not identified because selenium sample results in BG-3 were all non-detect
- Uranium – 0.836 mg/kg
- Vanadium – 18.0 mg/kg
- Ra-226 – 1.06 pCi/g
- Surface gamma measurements – 10,447 cpm

The ILs for Survey Area C (i.e., the Quaternary deposits; refer to Figure 2-7a) were established using statistical analysis of background data collected from BG-4 (refer to Figures 3-2 and 3-3) and are as follows:

- Arsenic – 2.88 mg/kg
- Molybdenum – 0.334 mg/kg
- Selenium – an IL for selenium was not identified because selenium sample results in BG-4 were all non-detect
- Uranium – 0.948 mg/kg
- Vanadium – 8.65 mg/kg
- Ra-226 – 0.895 pCi/g
- Surface gamma measurements – 9,911 cpm

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 background reference areas. These measurements were used to establish subsurface static gamma screening levels for Survey Areas A, B, and C. Where possible, the selected subsurface static gamma screening level measurement met the following criteria: (1) it was the lowest value measured at or below 1 ft bgs and (2) it was not directly measured on bedrock. These subsurface static gamma screening levels provide a comparison and assessment tool for Survey Areas A, 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. Background subsurface static gamma measurements are summarized in Table 4-2 and in Appendix C.2, and are described below:

- BG-2 – One subsurface static gamma measurement (13,249 cpm) was collected at a down-hole depth of 0.5 ft bgs from BG-2 borehole S059-SCX-001; therefore, 13,249 cpm was considered the subsurface static gamma IL for Survey Area A. This borehole was terminated at 0.6 ft bgs due to refusal on bedrock.

- BG-3 – Two subsurface static gamma measurements (11,880 and 13,159 cpm) were collected from borehole S059-SCX-003 at down-hole depths of 0.5 and 1.1 ft bgs, respectively. The reason the borehole was terminated was not provided on the field form. The lowest measurement collected at a depth of one or more ft bgs was 13,159 cpm, and because refusal was not confirmed to be on bedrock, it was selected as the Survey Area B subsurface static gamma IL.

- BG-4 – Three subsurface static gamma measurements (9,348, 10,141 and 11,166 cpm) were collected from BG-4 borehole S059-BG4-011at down-hole depths of 0.5, 1.0, and 1.5 ft bgs, respectively. The lowest measurement collected at a depth of 1.0 ft bgs or below was 10,141 cpm. Because this measurement was not on bedrock, 10,141 cpm was selected as the Survey Area C subsurface static gamma IL.

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 4-1b 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 BG-2 and BG-4 ILs, and the maximum site gamma measurement. The maximum survey measurement was 104,004 cpm, which was greater than nine times the maximum IL (i.e. BG-2 IL of 11,068 cpm), and occurred within Survey Area A, between the potential haul road and the approximate northwest edge of the mesa (refer to Figure 2-8a and Figure 4-1c). Surface gamma measurements were generally highest near the edge of the mesa, potential haul roads, mining/reclaimed disturbed areas, rim strip locations, and ephemeral drainages. A description and photographs of these areas are provided in Section 3.2.2.1 and Appendix B photograph numbers 2, 6, 9, 10, 11, 12, and 13.

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

- Survey Area A (refer to Figures 3-4 and 4-1c) – Surface gamma IL exceedances (greater than 11,068 cpm) occurred primarily in areas associated with, or downgradient of, mining-related disturbances, including the potential haul roads, mining/reclaimed disturbed areas, and rim strip locations. Surface gamma IL exceedances also occurred near the edge of the mesa, and in and adjacent to ephemeral drainages. The maximum measurement of 104,004 cpm was greater than nine times the IL.

- Survey Area B (refer to Figures 3-4 and 4-1d) – Surface gamma IL exceedances (greater than 10,447 cpm) were sporadic and minimal, and the maximum measurement of 13,662 cpm was less than two times the IL.

- Survey Area C (refer to Figures 3-4 and 4-1e) – Surface gamma IL exceedances (greater than 9,911 cpm) occurred primarily in the following areas: (1) within and near RA1, RA6, RA7, and RA8; (2) in an area of exposed bedrock and sediments downgradient from the bedrock within the ephemeral drainage east of the Site; and (3) in the northern area of the plains within Survey Area C that is bound to the west by a drainage and to the east and north by a dirt road. The maximum measurement of 97,546 cpm was greater than nine times the IL and occurred in an area of exposed bedrock in the ephemeral drainage east of the Site (refer to Appendix B photograph 13).

Figure 4-1c also compares Survey Area A to the surface gamma IL calculated for BG-1 (19,403 cpm; refer to Appendix D.1 and Table D.1-4). The higher IL calculated in BG-1 is an indication of the natural heterogeneity that is present in the Morrison Formation. Consideration of this alternate screening level provides a valuable assessment tool for the Site. Figure 4-1c shows that the majority of the measurements along the northwest-southeast trending portion of the mesa top are greater than the BG-2 IL, but less than the BG-1 IL (green bin range).

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

1. The gamma survey was not conducted in 0.7 acres of overly steep areas due to safety concerns (refer to Figure 3-4).

2. The gamma survey was not extended laterally in the portions of the ephemeral drainage, located in Survey Area C, where gamma measurements were greater than the IL due to a miscommunication with the field personnel. This is considered a minor data gap because: (1) the surface gamma survey measurements were less than the IL for approximately 450 ft of the drainage between the Site and the elevated measurements; and (2) the elevated gamma measurements were associated with exposed bedrock and downgradient sediments that originated from the exposed bedrock within the drainage. Therefore, the exceedances appear to be associated with naturally occurring materials.

3. The gamma survey did not include the drainages northwest of the claim boundary because based on professional judgement, that area contained only NORM. This is considered a minor data gap because the mining and reclamation did not take place in that area and the drainages did not drain portions of the Site where mining-related disturbance was present.

4. For the section of the potential haul road that runs along the north/northeast portion of the Site (refer to Figure 2-8a), only the shoulders were surveyed. The centerline was not surveyed due to a miscommunication with the field personnel.

5. The gamma survey was not extended into the northern portion of Survey Area C, north of the dirt road until gamma measurements reached background levels. This area was not surveyed, based on professional judgement that this area contained only NORM, for the following reasons:

    a. The IL exceedances on the mesa along the northwest to southeast trending portion of the mesa edge contained undisturbed NORM (refer to Section 4.6) and overland surface water flow from this area drains to the northeast.

    b. The runoff from the NORM can potentially transport NORM material to the areas north and northeast of the Site (i.e., the northern portion of Survey Area C).

    c. Bedrock was also present in the roadway. Elevated gamma measurements may be associated with the presence of the bedrock.

4.2.1.2 Subsurface Gamma Survey

Surface and subsurface static gamma measurements were collected at all 23 borehole locations, with the exception that surface static gamma measurements were not collected at S063-SCX-001. Surface and subsurface static gamma measurement locations are shown in Figures 3-6a and 3-6b. Measurements and corresponding measurement depths are provided in

Table 4-2 and are shown on the borehole logs in Appendix C.2. Subsurface static gamma measurements from the boreholes are presented below by Survey Area:

- Survey Area A (refer to Figures 3-6a and 3-6b) – Thirteen boreholes were completed in Survey Area A with refusal on rock, or bedrock encountered, between 0.5 and 3 ft bgs. The subsurface static gamma IL (13,249 cpm) was exceeded in soil/sediment in 10 of the 13 boreholes in Survey Area A and the three boreholes where the IL was not exceeded S063-SCX-003, -SCX-005 and -SCX-021. Seven boreholes in Survey Area A were terminated in bedrock; one of which was S063-SCX-021 where the IL was not exceeded. The highest subsurface static measurement in unconsolidated material (284,866 cpm) was greater than 21 times the IL and was measured in borehole S063-SCX-011 located within RA6, at a depth of 1.0 ft bgs. The highest measurement in bedrock (815,064 cpm) was also measured in borehole S063-SCX-011 at a depth of 3.5 ft bgs. Subsurface static gamma measurements greater than 10 times the IL were detected in unconsolidated material within six boreholes (S063-SCX-002, -SCX-004, -SCX-010, -SCX-011, -SCX-012, and –SCX-019). With the exception of S063-SCX-002, these borehole locations were within or adjacent to RA3, RA4, or RA6. Borehole S063-SCX-002 was located in the northwestern portion of the claim, west of the potential haul road. Excluding surface static gamma measurements (refer to Section 4.1), subsurface static gamma measurements in unconsolidated material increased with depth in two boreholes (S063-SCX-004, and –SCX-018). These borehole locations were within or downgradient from RA4. Subsurface static gamma measurements in unconsolidated material generally decreased with depth in four boreholes (S063-SCX-002, -SCX-003, -SCX-010, and -SCX-020). Boreholes S063-SCX-002 and -SCX-003 were located along the eastern edge of the mesa, adjacent to the potential haul road, and boreholes S063-SCX-010 and SCX-020 were within RA6 and RA3, respectively. Subsurface static gamma measurements fluctuated with depth in borehole S063-SCX-012, which was also located in RA6. When comparing the static gamma measurements collected at the surface to the first measurement collected down-hole, static gamma measurements increased with depth in all 13 Survey Area A boreholes.

- Survey Area B (refer to Figures 3-6a and 3-6b) – One borehole was completed in Survey Area B (S063-SCX-001) to a depth of 2.5 ft bgs. This borehole was terminated in unconsolidated material without refusal. Subsurface static gamma measurements exceeded the IL (13,159 cpm) in three out of four subsurface measurements; however, the maximum measurement (13,973 cpm) was only slightly above the IL. The Survey Area B borehole was located within a drainage in the eastern plains. The subsurface static gamma measurements increased with depth.

- Survey Area C (refer to Figures 3-6a and 3-6b) – Nine boreholes were completed in Survey Area C with all nine boreholes terminated at bedrock. Bedrock was encountered between 0.5 and 11 ft bgs. The subsurface static gamma IL (10,141 cpm) was exceeded in unconsolidated material in seven of the nine boreholes in Survey Area C. The two boreholes where measurements in soil/sediment did not exceed the IL were located within RA7 (S063-SCX-008, and –SCX-009). The highest subsurface static gamma measurement from unconsolidated material (98,460 cpm) was more than nine times the IL and was measured in a borehole located within the Potential Bury/Borrow Pit #1 (S063-SCX-017; 5.0 ft bgs). The highest measurement in bedrock (30,700 cpm) was measured in sandstone from a borehole that was also located in the Potential Bury/Borrow Pit #1 (S063-SCX-013; 11.5 ft bgs). Only two additional boreholes had subsurface static gamma measurements greater than three times the IL (S063-SCX-015, and –SCX-023). These boreholes were also located within the Potential Bury/Borrow Area #1. Excluding surface static gamma measurements (refer to Section 4.1), subsurface static gamma measurements increased with depth in two boreholes (S063-SCX-013 and -SCX-023). These borehole locations were within the Potential Bury/Borrow Area #1. Subsurface static gamma measurements decreased with depth in S063-SCX-008, this borehole was located within RA7. Subsurface static gamma measurements in unconsolidated material were variable in five borehole locations (S063-SCX-014, -SCX-015, -SCX-016, -SCX-017 and -SCX-024). These borehole locations were either within the Potential Bury/Borrow Area #1, RA7, or downgradient from RA6.When comparing the static gamma measurements collected at the surface to the first measurement collected down-hole, static gamma measurements increased with depth in all nine boreholes in Survey Area C (potentially due, in part, to 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.

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 0.64 which is not within the acceptance DQO 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 correlation model may have been influenced by the limited number of correlation sample locations. Users of the regression equation should be aware of the limitations of the dataset and be cautious when estimating Ra-226 concentrations. The regression equation to convert gamma measurements in cpm to predicted surface soil Ra-226 concentrations in pCi/g for the Site is:

$$\text{Gamma (cpm)} = 1{,}080 \times \text{Surface Soil Ra-226 (pCi/g)} + 14{,}119$$

The predicted Ra-226 concentrations in soil, as calculated from the gamma measurements using the developed regression equation, are shown in Figure 4-2a. Ra-226 concentrations predicted using gamma measurements lower than the minimum (10,068 cpm) and greater than the maximum (73,334 cpm) mean gamma measurements from the Gamma Correlation Study are extrapolated from the regression model and are therefore uncertain. Using the regression equation, the predicted Ra-226 concentration associated with the minimum mean gamma measurement is -3.8 pCi/g and the concentration associated with the maximum mean gamma measurement is 66.8 pCi/g. Therefore, predicted Ra-226 concentrations less than -3.8 pCi/g and greater than 66.8 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 regression equation predicted Ra-226 concentrations that were less than zero for gamma survey measurements below 14,119 cpm. The predicted concentrations are shown in Figure 4-2a and the values less than zero are located across most of the Site. The elevated predicted Ra-226 concentrations shown in Figure 4-2a occur in the same areas where the elevated surface gamma measurements occur (refer to Section 4.2.1). This is because the predicted Ra-226 concentrations are based on a correlation with the gamma measurements. Predicted Ra-226 concentrations in the Survey Area range from -8.8 to 83.2 pCi/g, with a mean of -5.3 pCi/g, and a standard deviation, of 3.3 pCi/g. Bin ranges in Figure 4-2a are based on these mean and standard deviation values.

The regression equation 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, to further evaluate the accuracy of the regression equation for the Site, as shown in Figure 4-2b. The correlation results were also compared to investigation levels, as shown in Figure 4-2c. Per the Agencies, these comparisons can be used for site characterization and are one of many analyses that can be used to interpret the data (NNEPA, 2018).

When comparing the predicted Ra-226 concentrations to the Ra-226 laboratory concentrations, soil/sediment sample locations are generally not co-located with specific gamma measurement locations (refer to Figure 4-2b). Therefore, the measured Ra-226 laboratory concentrations can only be qualitatively compared to the nearby predicted Ra-226 concentrations. The measured Ra-226 laboratory concentrations were within the applicable predicted Ra-226 bin ranges for seven out of 34 surface sample locations. In 25 of the sample locations where the predicted Ra-226 concentration and the Ra-226 laboratory concentration measured in the soil/sediment sample did not agree, the predicted concentration was lower than the reported laboratory concentration measured in the soil/sediment sample. The remaining two sample locations had higher predicted Ra-226 concentrations than the Ra-226 laboratory measurements. Of these 27 sample locations, one location (S069-SCX-022) had notably higher predicted Ra-226 concentration than the laboratory sample concentration and four had notably lower predicted Ra-226 concentrations than their respective laboratory Ra-226 concentrations. Three sample locations were located within mining disturbed areas: S063-CX-005 within RA-7, -SCX-020 in RA-3, and -SCX-022 in RA-1; and two locations were not in mining-disturbed areas (S063-CX-001 and -SCX-024). The differences observed between the predicted and actual Ra-226 values are likely a function of the regression equation not meeting the DQO, and natural heterogeneity in Ra-226 concentrations and gamma radiation measurements. Natural heterogeneity affects the correlation based on the five Gamma Correlation Study areas, and the predicted values, based on the subsequent gamma measurements.

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 for less than

10 percent of the Site. A majority of the soil/sediment sample locations where the Ra-226 laboratory concentration exceeded the Ra-226 IL were within/adjacent to an area where the predicted Ra-226 concentrations 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 significant (i.e., $p < 0.05$) and the adjusted R^2 meets the study DQO (adjusted $R^2 > 0.8$), indicating that Ra-226 and Th-230 exist in equilibrium. Additionally, when compared to a y=x line (this line represents a perfect 1:1 ratio between Th-230 and Ra-226, indicating secular equilibrium), the y=x line falls within outside of the 95% UCL bands of the Th-230/Ra-226 regression, indicating Ra-226 and Th-230 are in secular equilibrium at the Site (refer to figures in Appendix A). This may be a consideration in the future if a human health and/or ecological risk assessment is performed.

4.3 SOIL METALS AND RADIUM-226 ANALYTICAL RESULTS

A total of 34 surface soil/sediment grab samples (29 soil and five sediment) from 34 locations and 48 subsurface samples (43 soil, one sediment, and four bedrock) from 20 borehole locations were collected in Survey Areas A, B, and C (refer to Table 3-2). Seventeen of the subsurface samples were composite samples and 31 were grab samples. The metals and Ra-226 analytical results for each Survey Area are compared to their respective ILs and presented in Tables 4-4a, 4-4b, and 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 did not exceed their respective ILs in 24 (four in Survey Area A, two in Survey Area B, and 18 in Survey Area C) out of the 78 total (surface and subsurface) soil/sediment samples collected. The maximum concentration for Ra-226 was from surface sample S063-SCX-002, located on the mesa in Survey Area A. The maximum concentrations for arsenic, selenium, and molybdenum were from a subsurface bedrock sample collected from borehole S063-SCX-011, located in Survey Area A. The maximum concentrations for arsenic and molybdenum in an unconsolidated (non-bedrock) sample, and uranium and vanadium in any sample were from a subsurface sample collected from borehole S063-SCX-012, located in Survey Area A. Both S063-SCX-011 and S063-SCX-012 were located within RA6. The maximum concentration for selenium in an unconsolidated sample was collected from surface sample location S063-CX-003, located in Survey Area C within the Potential Bury/Borrow Area #1. Surface and subsurface soil/sediment IL exceedances for each analyte, with respect to each of the three survey areas, are described below. Presented sample counts include normal samples and do not include duplicate samples:

- Ra-226
  - Survey Area A – The Ra-226 IL (3.34 pCi/g) was exceeded in ten out 19 surface soil/ sediment samples and 14 out of 17 subsurface soil/sediment samples from ten boreholes. Ra-226 concentrations ranged from 0.54 to 175 pCi/g and the maximum detection was from surface sediment sample S063-SCX-002, located near a potential haul road on the mesa. The maximum detection was greater than 52 times the IL.
  - Survey Area B – The Ra-226 IL (1.06 pCi/g) was not exceeded in any of the two surface samples or the one subsurface soil/ sediment sample. Ra-226 concentrations ranged from 0.46 to 0.72 pCi/g and the maximum detection was from surface sediment sample collected from borehole S063-SCX-001, located within a drainage in the eastern plains.
  - Survey Area C – The Ra-226 IL (0.895 pCi/g) was exceeded in five out of 13 surface soil samples and eight out of 26 subsurface soil/bedrock samples from eight boreholes. Ra-226 concentrations ranged from 0 to 27.4 pCi/g. The maximum detection was from a subsurface soil sample collected from 4 to 6 ft bgs at borehole S063-SCX-017, located within the Potential Bury/Borrow Area #1. The maximum detection was greater than 30 times the IL.
- Uranium
  - Survey Area A – The uranium IL (3.28 mg/kg) was exceeded in 11 out of 19 surface soil/sediment samples and 14 out of 17 subsurface soil/sediment samples from ten boreholes. Uranium concentrations ranged from 0.53 to 410 mg/kg and the maximum detection was from a subsurface soil sample collected from 2 to 3 ft bgs at borehole S063-SCX-012, located within RA6. The maximum detection was 125 times the IL.
  - Survey Area B – The uranium IL (0.836 mg/kg) was not exceeded in any of the two surface or one soil/sediment subsurface samples. Uranium concentrations ranged from 0.25 to 0.45 mg/kg and the maximum detection was from a subsurface sediment sample collected from 2 to 2.5 ft bgs at borehole S063-SCX-001, located within a drainage in the eastern plains.
  - Survey Area C – The uranium IL (0.948 mg/kg) was exceeded in five out of 13 surface soil samples and seven out of 28 subsurface soil/bedrock samples from eight boreholes. Uranium concentrations ranged from 0.39 to 18 mg/kg and the maximum detection was from a subsurface soil sample collected from 4 to 6 ft bgs at borehole S063-SCX-017, located within the Potential Bury/Borrow Area #1. The maximum detection was greater than 18 times the IL.

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 samples collected in Survey Area B. In Survey Area A, 23 samples were greater than the regional range and were primarily associated with samples collected adjacent to or within RA3 and RA6. In Survey Area C two samples were greater than the regional range and were associated with samples collected within the Potential Bury/Borrow Area #1.

- Arsenic
    - Survey Area A – The arsenic IL (4.38 mg/kg) was exceeded in five out of 19 surface soil/sediment samples and 9 out of 19 subsurface soil/sediment samples from ten boreholes. Arsenic concentrations ranged from 0.51 to 43 mg/kg in soil/sediment samples. The maximum concentration (43 mg/kg) in an unconsolidated sample was from a subsurface soil sample collected at 2 to 3 ft bgs from borehole S063-SCX-012. The maximum detection in Survey Area A (130 mg/kg) was from a subsurface bedrock sample collected at 3 to 4 ft bgs from borehole S063-SCX-011. Both S063-SCX-011 and S063-SCX-012 were located within RA6. The maximum detection in an unconsolidated sample was greater than 9 times the IL.
    - Survey Area B – The arsenic IL (2.25 mg/kg) was exceeded in one of the two surface soil/ sediment samples and was not exceeded in the one subsurface sample. Arsenic concentrations ranged from 0.91 to 2.6 mg/kg and the maximum detection was from a surface soil sample collected from S063-CX-008, located within a drainage in the eastern plains. The maximum detection was less than two times the IL.
    - Survey Area C – The arsenic IL (2.88 mg/kg) was exceeded in one out of 13 surface soil/bedrock samples and one out of two subsurface bedrock samples. The arsenic IL was not exceeded in any subsurface soil/sediment samples. Arsenic concentrations ranged from 0.52 to 7.8 mg/kg. The maximum detection was from a surface soil sample collected at borehole S063-SCX-009, located within RA7. The maximum detection was less than three times the IL.

As a broader point of reference, a regional study of the Western US documented arsenic concentrations in soil that ranged from less than 0.10 to 97 mg/kg, with a mean value of 5.5 mg/kg (USGS, 1984). Arsenic concentrations were within the typical range of regional values in samples collected in Survey Areas B and C. In Survey Area A one sample was greater than the regional range (130 mg/kg) and was collected from bedrock within RA6.

- Molybdenum – ILs for molybdenum were not identified for Survey Areas A and B because molybdenum sample results in BG-2 were all non-detect. All but one sample result in BG-3 were non-detect.
    - Survey Area A – Molybdenum was detected in seven out of 19 surface soil/sediment samples and 13 out of 19 subsurface soil/sediment samples from ten boreholes. Molybdenum concentrations ranged from non-detect to 9.5 mg/kg in unconsolidated material. The maximum concentration (9.5 mg/kg) in an unconsolidated sample was from a subsurface soil sample collected at 2 to 3 ft bgs from borehole S063-SCX-012. The

maximum detection in Survey Area A (88 mg/kg) was from a subsurface bedrock sample collected at 1.5 to 2 ft bgs from borehole S063-SCX-011. Both S063-SCX-011 and S063-SCX-012 were located within RA6.

- Survey Area B – Molybdenum results were below the laboratory reporting limit for all surface and subsurface soil/sediment samples collected in Survey Area B.
- Survey Area C – The molybdenum IL (0.334 mg/kg) for Survey Area C was exceeded in one out of 13 surface soil/bedrock samples and four out of 26 subsurface soil samples from eight boreholes. Molybdenum concentrations ranged from non-detect to 1.2 mg/kg and the maximum detection was from a subsurface soil sample collected at 7.5 to 8 ft bgs from borehole S063-SCX-017, located within the Potential Bury/Borrow Area #1. The maximum detection was less than four times the IL.

As a broader point of reference, a regional study of the Western US documented molybdenum concentrations in soil that ranged from less than 3 to 7 mg/kg, with a mean value of 0.85 mg/kg (USGS, 1984). Molybdenum concentrations were within the typical range of regional values in samples collected in Survey Areas B and C. In Survey Area A, two samples (one bedrock and one soil) were greater than the regional range and both were collected within RA6.

- Selenium – ILs for selenium were not identified because selenium sample results in BG-2, BG-3, and BG-4 were all non-detect.
    - Survey Area A – Selenium was detected in three out of 19 surface soil/sediment samples and four out of 17 subsurface soil/sediment samples from ten boreholes. Selenium concentrations in unconsolidated material ranged from non-detect to 3 mg/kg. The maximum concentration (3 mg/kg) in an unconsolidated sample was from a surface soil sample collected from borehole S063-SCX-004. The maximum detection in Survey Area A (6.3 mg/kg) was from a subsurface bedrock sample collected at 3 to 4 ft bgs from borehole S063-SCX-011. S063-SCX-004 was located within RA4 and S063-SCX-011 was located within RA6.
    - Survey Area B – Selenium results were below the laboratory reporting limit for all surface and subsurface soil/sediment samples collected in Survey Area B.
    - Survey Area C – Selenium was detected in one out of 13 surface soil/bedrock samples and no subsurface soil or bedrock samples. Selenium concentrations ranged from non-detect to 3.1 mg/kg and the only detection was from a surface soil sample collected at S063-CX-003, located within the Potential Bury/Borrow Area #1.

As a broader point of reference, a regional study of the Western US documented selenium concentrations in soil that typically ranged from less than 0.10 to 4.3 mg/kg, with a mean value of 0.23 mg/kg (USGS, 1984). Selenium concentrations were within the typical range of regional values in samples collected in Survey Areas B and C. In Survey Area A one sample, that was bedrock, was greater than the regional range, and was collected within RA6.

- Vanadium
    - Survey Area A – The vanadium IL (18.7 mg/kg) was exceeded in 14 out of 19 surface soil/sediment samples and all subsurface soil/sediment samples from 10 boreholes. Vanadium concentrations ranged from 9.4 to 1400 mg/kg. The maximum detection was from a subsurface soil sample collected at 2 to 3 ft bgs from borehole S063-SCX-012, located within RA6. The maximum detection was greater than 74 times the IL.
    - Survey Area B – The vanadium IL (18 mg/kg) was not exceeded in any of the two surface or one subsurface soil/ sediment samples. Vanadium concentrations ranged from 6.4 to 9.9 mg/kg. The maximum detection was from a subsurface sediment sample collected from 2 to 2.5 ft bgs at borehole S063-SCX-001, located within a drainage in the eastern plains.
    - Survey Area C – The vanadium IL (8.65 mg/kg) was exceeded in eight out of 13 surface soil/bedrock samples and 11 out of 28 subsurface soil samples from eight boreholes. Vanadium concentrations ranged from 3.6 to 150 mg/kg. The maximum detections (150 mg/kg) were from a surface soil sample collected at S063-SCX-009, located within RA7 and a subsurface soil sample collected at S063-SCX-017, located in the Potential Bury/Borrow Area #1. The maximum detections were greater than 17 times the IL.

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 values in samples collected in Survey Areas B and C. In Survey Area A, eight samples were greater than the regional range and were primarily associated with samples collected adjacent to or within RA3 and RA6.

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 as COPCs for the Site. In addition, selenium was also confirmed as a COPC because it was detected in soil samples from Survey Areas A and C, even though it was non-detect in all background reference area samples.

4.5 AREAS THAT EXCEED THE INVESTIGATION LEVELS

The approximate lateral extent of surface gamma IL exceedances in soil/sediment is 6.7 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.

Thirteen sample locations had Ra-226 and/or metal ILs exceedances but were not included in the 6.7 acres because the surface gamma IL was not exceeded at these locations. The areas of nine of the sample locations that were outside of the 6.7 acres, where the surface gamma exceeded the ILs, were included in the TENORM volume estimate (refer to Sections 4.6 and 4.7). They were included in the TENORM volume estimate because Ra-226 and/or metals concentrations exceeded the ILs and the samples were located in mining/reclamation disturbed locations (S063-CX-003, -CX-011, -SCX-013, -SCX-014, -SCX-015, -SCX-016, -SCX-017, -SCX-020, and -SCX-023). The remaining four sample locations with IL exceedances were located in areas that were not disturbed by mining, as follows:

- Surface soil sample S063-CX-008 was located in the plains area and had an arsenic detection that was less than two times the IL
- S063-SCX-001 was located in the plains area and had static gamma measurements that were less than two times the IL
- S063-SCX-003 and –SCX-005 had vanadium detections that exceeded the IL, but the boreholes were located downgradient from mineralized bedrock along the western mesa edge

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 shows the surface gamma IL exceedances for reference.

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

The lateral extent of the IL exceedances (for surface gamma data) shown in Figure 4-4a were compared to the predicted Ra-226 concentrations that exceeded ILs in Figure 4-2c. Predicted Ra-226 concentrations exceeded the Ra-226 IL in a smaller area of the Site (primarily within Survey Area A) than the surface gamma IL exceedances. When compared to surface gamma IL exceedances, a much smaller area of predicted Ra-226 concentrations along the northwest-southeast trending ridge exceed the Ra-226 and a smaller area of predicted Ra-226 concentrations in the area northeast of the claim boundary exceeded the Ra-226 IL. The inconsistency between the predicted Ra-226 exceedances and the surface gamma exceedances within Survey Area A 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, 4.3 acres, out of the 36.8 acres of the Survey Area, were estimated to contain TENORM at the Site. This estimate is inclusive of the following areas: mining/reclaimed disturbed areas RA1 through RA8; rim strips; the Potential Bury/Borrow Area #1; ephemeral drainages; and potential haul roads. 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
  - Indicating that NAML issued an invitation for bids to provide costs for reclamation activities for the Site. The bid document reported the Site had four waste areas containing 400 bcy of waste material (inclusive of nine waste piles) and six rim strips.
  - Indicating that the following reclamation activities were proposed for the Site:
    - Excavate and haul 100 bcy of material from Waste Areas 1, 2, and 4 and bury the material at the Potential Bury/Borrow Area #1
    - Excavate 300 bcy of material from Waste Area 3, backfill Rim Strip 6 with the material, and regrade the surface of the backfill areas to match the natural terrain
    - Haul 100 bcy of Class A material to cover Rim Strips 2, 3, and 4, contour the backfill with the natural terrain and ensure positive drainage and rough grading
    - Haul 200 bcy of Class A material to cover Rim Strips 1, 5, and 6, contour the backfill with the natural terrain and ensure positive drainage and rough grading
    - Complete covering of the Potential Bury/Borrow Area #1 with the remaining 300 bcy of Class A material, while ensuring positive drainage and rough grading
    - Excavate 60 bcy of rocky material from near Rim Strip 6 and construct a 60-foot diversion berm
    - Scarify the access roads and all areas disturbed by equipment and vehicle travel
- Geology/geomorphology
  - Bedrock at the Site consisted of two geologic formations: the Jurassic Salt Wash Member of the Morrison Formation and the Jurassic Summerville Formation. The Morrison Formation is known to have natural enrichments of uranium. In addition, portions of the Site consisted of shallow or outcropping bedrock. Therefore, the geology and

geomorphology of the Site was conducive to the presence of NORM at or below the ground surface.

  - Numerous parallel patterned ephemeral drainages are present on-site that drain to the northwest or northeast. The drainages that drain northwest terminate in the surrounding plains and the drainages that drain northeast join an un-named drainage. The drainages could transport NORM/TENORM to the northwest or northeast.

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

  - The approximate locations of six buried rim strips (Rim Strip 1 through Rim Strip 6) were observed and discussed on-site with NAML personnel. Of note, three rim strip locations were provided in the *2007 AUM Atlas* (USEPA, 2007a), but their locations did not match up with where the rim strips were shown on the historical mine drawing overlay used in Figure 2-2. During the on-site visit, NAML personnel stated that rim stripping at the Site was limited to the area north and northeast of the claim boundary and rim stripping did not occur within the claim boundary.

  - Nine mining/reclaimed disturbed areas (RA1 through RA8 and the Potential Bury/Borrow Area #1) were observed that are coincident with historical mining/reclamation areas and the historical Potential Bury/Borrow Area #1.

  - Potential haul roads were observed that ran along the mesa top and branched at the northeast corner of the claim boundary.

- Site Characterization

  - Surface gamma IL exceedances in Survey Area A occurred primarily in areas associated with, or downgradient of, mining-related disturbances, including the potential haul roads, mining/reclaimed/disturbed areas, and rim strip locations. Surface gamma IL exceedances also occurred near the edge of the mesa and adjacent to ephemeral drainages. In general, the greatest exceedances of Ra-226 and metals ILs were from samples collected from an area of the mesa top near the potential haul road (S063-SCX-002) and within or adjacent to RA3 and RA6.

  - Surface gamma IL exceedances in Survey Area B were sporadic and minimal, and the maximum measurement of 13,662 cpm was less than two times the IL. The arsenic concentration for S063-CX-008 was less than two-times the IL and it was the only metals/Ra-226 concentration to exceed an IL in Survey Area B.

  - Surface gamma IL exceedances in Survey Area C occurred primarily in areas associated with RA7 and in bedrock and downgradient sediments within the ephemeral drainage that drains northeast, and the northern portion of the plains in Survey Area C. The maximum measurement of 97,546 cpm was greater than nine times the IL and occurred in an area of exposed bedrock and downgradient sediments located in the ephemeral drainage. In general, the greatest exceedances of Ra-226 and metals ILs were from samples collected from RA7 and a location within the Potential Bury/Borrow Area #1.

- Ra-226/metals IL exceedances and subsurface static gamma measurements in two boreholes (S063-SCX-015 and -SCX-017) suggest buried mine waste was present from approximately 3.0 to 8.0 ft bgs in a portion of the Potential Bury/Borrow Area #1. Subsurface static gamma measurements in the boreholes began increasing at approximately 3.0 ft bgs with the highest measurements at 6.0 and 5.0 ft bgs in the S063-SCX-015 and –SCX-017 boreholes, respectively. Subsurface static gamma measurements were decreasing until approximately 8.0 ft bgs. The subsurface lithology in S063-SCX-015 was variable from 5.0 to 8.0 ft bgs, including subangular gravels, boulders, and sands that may have been representative of buried waste rock material.

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

- Subsurface samples were not collected in the areas of RA-2, RA-5, and RA-8, this is identified as a data gap in Section 4.9. Additionally, subsurface samples were not collected from the potential haul roads and additional characterization may be warranted during future studies.

- No potential mine waste was observed at the ground surface at the Site. However, potential mine waste materials were observed in the subsurface in one borehole at the Site located within RA-4 (S063-SCX-019), which contained silty and clayey sand that was light gray in color. Borehole S063-SCX-004, also located in RA-4, did not contain obvious waste material but did contain clayey sand that was tan and green in color and may be mine waste material. Additionally, Ra-226/metals IL exceedances and subsurface static gamma measurements in two boreholes (S063-SCX-015 and -SCX-017) suggest buried mine waste was present from approximately 3.0 to 8.0 ft bgs in a portion of the Potential Bury/Borrow Area #1.

- It is important to consider that except for one location, 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. Borehole S063-SCX-023 is the one exception; Ra-226 and metals concentrations did not exceed the IL. However, subsurface static gamma measurements were increasing with depth in that borehole and the nearby S063-SCX-013 borehole. Those two boreholes were within the Potential Bury/Borrow Area #1 and were also adjacent to boreholes that contained potential mine waste (refer to bullet above), so TENORM was assumed to extend to 11.0 ft bgs in that area.

The area of the Site considered to contain TENORM (i.e., multiple lines of evidence indicated the presence of mining-related impacts) was 4.3 acres, as shown on Figure 4-8a. Portions of the TENORM exceeded one or more IL, where approximately 2.3 acres contained TENORM that exceeded the surface gamma IL and the majority of the sample locations where TENORM exceeds the ILs. TENORM exceeding the ILs was observed at nine sample locations 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 7,301 yd^3, as shown in Figure 4-9. The volumes and areas 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 mining documentation. Field observations included observations of disturbance, changes in vegetation, estimating/projecting the slope of underlying bedrock, and estimating the shape and topography of waste material and/or soil deposits.

TENORM exceeding the ILs at the Site was split into groups based on the depth or type of material to aid in analysis and describing the basis of the volumes. The locations, volume, and areas of these groups are shown in Figure 4-9. The assumptions 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 one ft bgs), the additional volume was assumed to be accounted for by the TENORM depth estimates.
- With the exceptions of two boreholes in Potential Bury/Borrow Area #1 (refer to Group 6 below), 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 static gamma IL was used as one line of evidence as described in Section 4.1.

Group Assumptions

- Group 1 (578 yd^3) – Group 1 consists of the Potential Haul Roads. The volume of TENORM exceeding ILs was assumed to extend to 1.0 ft bgs based on field observations of the disturbance in the area between RAs 1, 2, 3, 5, and 6. In general, the potential haul roads follow existing topography (i.e., fill material was not used to complete portions of the potential haul roads). The potential haul roads consist of a mixture of bedrock and soils on the mesa, and generally consist of soils on the plains. The 1.0 ft estimate is based on the general composition of the potential haul roads on the plains.

Groups 2 through 5 estimate TENORM exceeding ILs for RA1, RA6, RA7, and RA3 and RA4, respectively. Estimate assumptions were supported by field mapping, gamma survey results, reclamation documentation, and the results of surface and subsurface soil sampling. The volumes, number of boreholes, and assumed depths are as follows:

- Group 2 (232 yd^3) – Group two consists of RA1. One borehole (S063-SCX-022) was advanced within RA1 and IL exceedances extended to the bedrock contact at 1.5 ft bgs. The estimated volume of TENORM exceeding ILs was calculated by assuming the maximum depth (1.5 ft) over the RA1 polygon.

- Group 3 (302 yd^3) – Group three consists of RA6. Three boreholes (S063-SCX-010, -SCX-011, and -SCX-012) were advanced within RA6 and IL exceedances in unconsolidated material extended up to 3.0 ft bgs. The estimated volume of TENORM exceeding ILs was calculated by assuming the maximum depth (3.0 ft) over the RA6 polygon.

- Group 4 (711 yd^3) – Group 4 consists of RA7. Two boreholes (S063-SCX-008 and -SCX-009) were advanced within RA7 and IL exceedances in unconsolidated material extended up to 3.0 ft bgs. The estimated volume of TENORM exceeding ILs was calculated by assuming the maximum depth (3.0 ft) over the RA7 polygon.

- Group 5 (417 yd^3) – Group 5 consists of RA3 and RA4. One borehole (S063-SCX-020) was advanced within RA3 and IL exceedances within unconsolidated material extended to 2 ft bgs. IL exceedances in two boreholes in RA-4 (S063-SCX-004 and –SCX-019) extended to 1.5 ft bgs. A polygon was fit around RA3 and RA4 mining/reclaimed disturbed areas, TENORM within the polygon was assumed to extend to 2.0 ft bgs.

- Group 6 (2,517 yd^3) – Group 6 includes the Potential Bury/Borrow Pit #1 and areas surrounding it. Six boreholes were advanced in/near the Potential Bury/Borrow Area #1 and the vertical extent of IL exceedances within unconsolidated material ranged between 9.5 and 11.0 ft bgs. The estimated volume of TENORM exceeding ILs was calculated by assuming the maximum depth (11.0 ft) over the entire area of the Group 6 polygon. It is important to consider that this volume estimate may be high because subsurface data indicated that the interval of waste rock burial was likely between 3.0 to 8.0 ft bgs. This is because static gamma measurements and characterization sample results in boreholes S063-SCX-015 and -SCX-017 were most elevated between approximately 3.0 and 8.0 ft bgs, suggesting that this is the likely interval where buried mine waste may be present in the Potential Bury/Borrow Area #1. Static gamma measurements were relatively stable down-hole in boreholes S063-SCX-014 and -SCX-016 with one Ra-226 IL exceedance of 8.8 pCi/g (the IL was 8.6 pCi/g) in the surface sample collected at S063-SCX-014. Metals and Ra-226 exceedances in borehole S063-SCX-013 occurred from the ground surface to 3.0 ft bgs; however, static gamma measurements in that borehole and in borehole S063-SCX-023 increased with depth. Because the static gamma measurements increased with depth in S063-SCX-013 and -SCX-023, TENORM in Group 6 is estimated to extend to 11.0 ft bgs. Refer to discussion below comparing this volume estimate to historical reclamation data relevant to the Potential Bury/Borrow Area #1.

- Group 7 (135 yd^3) – Group 7 consists of the drainage channels. One borehole (S063-SCX-006) was advanced in one of the drainages. IL exceedances in unconsolidated material extended to 0.5 ft bgs. The estimated volume of TENORM exceeding ILs was calculated by assuming 0.5 ft of unconsolidated material over the combined areas of all Group 7 polygons.

- Group 8 (2,409 yd^3) – TENORM in the general area surrounding the potential haul roads, mining/reclaimed disturbed areas, and drainage was estimated to extend to 1.0 ft bgs as a general estimate for the area. Due to the close proximity of the mining/reclaimed disturbed areas and potential haul roads, it was assumed these areas were potentially impacted due to mining activities and were therefore included as TENORM.

Historical reclamation planning documents stated that approximately 600 yd^3 of borrow material was to be excavated from bury/borrow area 1 and then 100 yd^3 of mine waste material from Waste Areas 1, 2, and 4 (refer to Figure 2-2) was to be buried in the bury/borrow area 1, followed by the placement of cover material (NAML, 2000). A representative from NAML met with field personnel in April 2017 and confirmed that material was buried in Potential Bury/Borrow Area #1. Based on RSE activities, approximately 2,513 yd^3 of TENORM (including cover material) was estimated to be present in Potential Bury/Borrow Area #1. The calculated volume is more than four-times the volume that NAML proposed to remove and replace in the area. The potential cause of the discrepancy is that the volume estimate is overly conservative and buried mining-impacted material may not extend to 11.0 ft bgs (estimated based on increasing static gamma measurements in two boreholes as described in the Group 6 bullet above). When the volume estimate is calculated with the assumption that buried mining-impacted material extends to 8.0 ft bgs (based on observations of potential mine waste in two boreholes) the calculated volume for Group 6 is 1,831 yd^3, which is three-times the planned NAML borrow volume. However, it is important to consider that the reclamation documents were planning documents and a final volume from reclamation activities was not provided.

4.8 WATER ANALYTICAL RESULTS

The well water samples collected as part of the Site Characterization activities were analyzed for the constituents listed in Section 3.3.2. Water well 09T-546 (sample S059-WL-001) located approximately 0.25 miles northeast of the Site, was sampled in September 2016 and an additional sample was collected in May 2017 and analyzed for mercury only (refer to Section 3.3.2.3). The location of this water feature is shown in Figure 2-1.

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 the well water sample (S059-WL-001) had total and dissolved arsenic concentrations of 15 micrograms per liter (µg/L), which exceeded the arsenic IL (10 µg/L). All other metals and radionuclides were below their respective ILs. Results of general chemistry parameters indicated that TDS was also above its respective IL. All other general chemistry parameter results were below their respective ILs. Based on these results arsenic and TDS are confirmed COPCs for water well 09T-546. Because arsenic and TDS exceeded their respective ILs for the well water sample, additional characterization may be considered at water well 09T-546 in the future. 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

Eight 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. Appendix A does not include the raw exposure rate data for correlation of gamma measurements to exposure rates. The raw exposure rate data were inadvertently deleted following calculation of the mean exposure rates. However, the missing raw field data does not impact the scope of the work because the inadvertent deletion occurred after the mean values for the raw exposure rate measurements were calculated and recorded. Therefore, the missing raw exposure rate data are a minor data gap and a repeat collection is not required.

2. The gamma survey was not conducted in 0.7 acres of overly steep areas due to safety concerns (refer to Figure 3-4).

3. The gamma survey was not extended laterally in the portions of the northeastern ephemeral drainage, located in Survey Area C, where gamma measurements were greater than the IL due to a miscommunication with the field personnel.

4. The gamma survey did not include the drainages northwest of the claim boundary because, based on professional judgement, that area was not downgradient from mining-related impacts at the Site.

5. For the section of the potential haul road that runs along the north/northeast portion of the Site (refer to Figure 2-8a), only the shoulders were surveyed. The centerline was not surveyed due to a miscommunication with the field personnel.

6. The gamma survey was not extended into the northern portion of Survey Area C, north of the dirt road, until gamma measurements reached background levels. This area was not surveyed based on the professional judgement in the field that this area contained only NORM.

7. Salinity was not collected as part of the May 24, 2017 specified field measurements because the water quality meter field personnel were using could not measure salinity.

8. Subsurface samples were not collected in RA-2. RA-5, and RA-8 because field samples were collected judgmentally in areas of interest. The Agencies requested the lack of subsurface samples be identified as a data gap (NNEPA, 2018).

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. Subsurface samples were not collected in the potential haul roads and additional characterization may be warranted during future studies.

3. 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.

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 September 2017. The Site is known as the NA-0928 site and is also identified by the USEPA as AUM identification #63 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. A well water sample was 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.

Site-specific historical mining information is minimal and the only such information discovered was reported in the *2007 AUM Atlas*. The *2007 AUM Atlas* reported the Site was reclaimed. Ore production information pertaining to the Site was not identified. However, an important consideration is that even though ore production information pertaining to the Site was not identified, the *2007 AUM Atlas* reported that sometimes production from multiple mines was reported as a single combined value for one of the mines. In these cases, the mines were included on a single lease, and the ore production reported was inclusive of all of the mines on that single lease (USEPA, 2007a). It is unknown if the Site was part of a multi-mine lease but, it is possible that ore could have been mined from the Site, and combined with reports from other mine ore productions, for a combined reported production value.

Six potential background reference areas were considered. Three background reference areas (BG-2, BG-3, and BG-4) were selected to develop surface gamma, subsurface gamma, Ra-226, and metals ILs for the three Survey Areas (Survey Area A, Survey Area B, and Survey Area C) at the Site.

Arsenic, uranium, vanadium, and Ra-226 concentrations and gamma radiation measurements exceeded their respective ILs and were confirmed as COPCs for the Site. A molybdenum IL was not established for Survey Areas A and B but was detected in samples from Survey Area A. A molybdenum IL was established for Survey Area C and sample concentrations exceeded the IL. Molybdenum was confirmed as a COPC for the Site. Selenium ILs were not established for the Site. Selenium was detected in samples from Survey Areas A and C. Selenium was confirmed as a COPC for the Site.

Surface gamma measurements and Ra-226 and metals concentrations were generally highest in areas that were identified as mining/reclaimed disturbed areas, rim strips, Potential Bury/Borrow Area #1, and potential haul roads. The greatest surface gamma survey readings were located near S063-SCX-002 and within/adjacent to mining/reclaimed disturbed areas RAs 1 and 6.

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

Based on the data analysis performed for this RSE report along with the multiple lines of evidence, approximately 4.3 acres out of the 36.8 acres of the Survey Area were estimated to contain TENORM. This estimate is inclusive of eight areas: potential haul roads; mining/reclaimed disturbed areas RAs 1 through 8; areas around the mining/reclaimed disturbed areas; Potential Bury/Borrow Area #1; and ephemeral drainages. The areas outside of the TENORM boundary show no signs of disturbance related to mining and, therefore, are considered NORM (i.e., naturally occurring). Of the 4.3 acres that contain TENORM, 2.3 acres contain TENORM exceeding the surface gamma ILs and TENORM that exceeded the ILs at a majority of the soil/sediment sample locations. The volume of TENORM exceeding ILs is estimated to be 7,301 yd^3 (5,582 cubic meters). It should be noted that the COPC measurements and concentrations in the area that contains TENORM that exceeds ILs are generally higher than the COPC measurements and concentrations in NORM located outside the TENORM boundary.

An analytical well water sample and field parameter measurements were collected as part of the Site Characterization activities. Analytical results indicated the well water sample (S059-WL-001) had total and dissolved arsenic concentrations of 15 µg/L, which exceeded the arsenic IL (10 µg/L). All other metals and radionuclides were below their respective ILs. Results of general chemistry parameters indicated that TDS was also above its respective IL. All other general chemistry parameter results were below their respective ILs. Based on these results arsenic and TDS are confirmed COPCs for water well 09T-546. Because arsenic and TDS exceeded their respective ILs for the well water sample, additional characterization may be considered at water well 09T-546 in the future.

Eight 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 NA-0928 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 NA-0928 RSE were $465,480. Stantec's costs associated with interim actions (sign installation) were $4,000. In addition, Administrative costs provided by the Trust were estimated currently at $191,500[10,11]. Administrative costs will change due to continued community outreach and close out activities.

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

[11] Administrative costs were averaged across all Sites.

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TABLES

Table 3-1a
Identified Potential Water Features
NA-0928
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Identified Water Feature	Source of Identified Water Feature	Water Feature Identification	Field Sample Identification	Field Personnel Observations
No Feature	2007 AUM Atlas[1], NNDWR	09T-563	NA	No surface water or water well observed at this location.
Windmill Well	2007 AUM Atlas[1], NNDWR	09T-546 /RV990317TNW002	S059-WL-001	Windmill well, water tank, and water trough were observed at this location. This water feature was also located within a one-mile radius of AUM site NA-0904, and was sampled as part of the RSE activities for NA-004. Water sample ID S059-WL-001 was collected from the valve at the trough on September 29, 2016. Due to a broken mercury sample bottle from the September 29, 2016 sampling event, a second visit was made on May 24, 2017 to collect a water well sample for mercury analysis and field parameters.
Oil Well or Equipment	Stantec	S059-Gas Well-3	NA	No surface water or windmill well observed at this location during RSE activities. Equipment for oil well observed in area of this location.
Oil Well or Equipment	2007 AUM Atlas[1], NNDWR	NAVAJO 138#3	NA	No surface water or windmill well observed at this location during RSE activities. Equipment for oil well observed in area of this location.
Oil Well or Equipment	2007 AUM Atlas[1], NNDWR	TEX PACF 1	NA	No surface water or windmill well observed at this location during RSE activities. Equipment for oil well observed in area of this location.

Notes
NA - Water feature not sampled
AUM - abandoned uranium mine
ID - identification
NNDWR - Navajo Nation Department of Water Resources
RSE - Removal Site Evaluation
[1] USEPA, 2007a

Table 3-1b
Water Well Specifications for 09T-546
NA-0928
Removal Site Evaluation Report - Final
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Description	Water Well Information
Tribal Well Number	09T-546
Easting[1]	651977
Northing[1]	4085357
Operator	Tribe Operations and Maintenance
Well Completed Date	2/26/1960
Elevation (ft amsl)	5,860
Well Depth (ft bgs)	874
Well Type	Water Well
Well Status	Active
Well Use	Livestock
Well Borehole Diameter (inches)	8.0
Well Casing Diameter (inches)	4.0
Top of Well Casing (ft ags)	0
Bottom of Well Casing (ft bgs)	unknown
Well Build Material	unknown
Top of Well Screen Perforation (ft bgs)	unknown
Bottom of Well Screen Perforation (ft bgs)	unknown

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
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									Sample Types		
Sample Location	Sample Depth (ft bgs)	Sample Media	Sample Category	Sample Collection Method	Survey Area	Sample Date	Easting [1]	Northing [1]	Metals, Total	Ra-226	Thorium
Background Reference Area Study - Background Area 2*											
S059-BG2-001	0 - 0.5	soil	SF	grab	NA	10/5/2016	650513.41	4084635.51	N;FD	N;FD	--
S059-BG2-002	0 - 0.5	soil	SF	grab	NA	10/5/2016	650510.96	4084633.92	N	N	--
S059-BG2-003	0 - 0.5	soil	SF	grab	NA	10/5/2016	650511.44	4084631.57	N	N	--
S059-BG2-004	0 - 0.5	soil	SF	grab	NA	10/5/2016	650513.19	4084630.23	N	N	--
S059-BG2-005	0 - 0.5	soil	SF	grab	NA	10/5/2016	650516.29	4084634.25	N	N	--
S059-BG2-006	0 - 0.5	soil	SF	grab	NA	10/5/2016	650515.81	4084631.17	N	N	--
S059-BG2-007	0 - 0.5	soil	SF	grab	NA	10/5/2016	650518.59	4084629.54	N	N	--
S059-BG2-008	0 - 0.5	soil	SF	grab	NA	10/5/2016	650518.56	4084626.43	N	N	--
S059-BG2-009	0 - 0.5	soil	SF	grab	NA	10/5/2016	650513.06	4084625.85	N	N	--
S059-BG2-010	0 - 0.5	soil	SF	grab	NA	10/5/2016	650516.93	4084624.85	N;FD	N;FD	--
S059-SCX-001	0 - 0.6	soil	SF	grab	NA	10/11/2016	650513.05	4084630.51	N	N	--
Background Reference Area Study - Background Area 3*											
S059-BG3-001	0 - 0.5	soil	SF	grab	NA	10/6/2016	651139.20	4085183.03	N	N	--
S059-BG3-002	0 - 0.5	soil	SF	grab	NA	10/6/2016	651142.96	4085181.59	N	N	--
S059-BG3-003	0 - 0.5	soil	SF	grab	NA	10/6/2016	651145.92	4085184.25	N	N	--
S059-BG3-004	0 - 0.5	soil	SF	grab	NA	10/6/2016	651143.92	4085177.81	N;MS;MSD	N	--
S059-BG3-005	0 - 0.5	soil	SF	grab	NA	10/6/2016	651146.45	4085176.00	N	N	--
S059-BG3-006	0 - 0.5	soil	SF	grab	NA	10/6/2016	651149.62	4085178.17	N	N	--
S059-BG3-007	0 - 0.5	soil	SF	grab	NA	10/6/2016	651146.08	4085172.25	N	N	--
S059-BG3-008	0 - 0.5	soil	SF	grab	NA	10/6/2016	651149.88	4085170.76	N	N	--
S059-BG3-009	0 - 0.5	soil	SF	grab	NA	10/6/2016	651150.91	4085167.27	N	N	--
S059-BG3-010	0 - 0.5	soil	SF	grab	NA	10/6/2016	651153.79	4085166.11	N;FD	N;FD	--
S059-SCX-003	0 - 0.5	soil	SF	grab	NA	10/11/2016	651152.99	4085166.31	N	N	--
S059-SCX-003	0.5 - 1.2	soil	SB	grab	NA	10/11/2016	651152.99	4085166.31	N	N	--
Background Reference Area Study - Background Area 4*											
S059-BG4-001	0 - 0.5	sediment	SF	grab	NA	9/14/2017	651140.63	4085261.30	N	N	--
S059-BG4-002	0 - 0.5	sediment	SF	grab	NA	9/14/2017	651141.30	4085262.68	N;FD	N;FD	--
S059-BG4-003	0 - 0.5	sediment	SF	grab	NA	9/14/2017	651141.30	4085265.84	N	N	--
S059-BG4-004	0 - 0.5	sediment	SF	grab	NA	9/14/2017	651141.36	4085268.74	N;FD	N;FD	--
S059-BG4-005	0 - 0.5	sediment	SF	grab	NA	9/14/2017	651143.27	4085270.56	N	N	--
S059-BG4-006	0 - 0.5	sediment	SF	grab	NA	9/14/2017	651143.44	4085271.66	N;FD	N;FD	--
S059-BG4-007	0 - 0.5	sediment	SF	grab	NA	9/14/2017	651145.58	4085272.25	N	N	--
S059-BG4-008	0 - 0.5	sediment	SF	grab	NA	9/14/2017	651146.59	4085274.17	N;FD	N;FD	--
S059-BG4-009	0 - 0.5	sediment	SF	grab	NA	9/14/2017	651149.95	4085276.61	N	N	--
S059-BG4-010	0 - 0.5	sediment	SF	grab	NA	9/14/2017	651151.11	4085277.83	N	N	--
S059-BG4-011	0 - 0.5	sediment	SF	grab	NA	9/14/2017	651151.68	4085277.53	N	N	--
S059-BG4-011	0.5 - 1.5	sediment	SB	grab	NA	9/14/2017	651151.68	4085277.53	N	N	--
Correlation											
S063-C01-001	0 - 0.5	soil	SF	5-point composite	NA	10/12/2016	650830.21	4086229.38	--	N	N
S063-C02-001	0 - 0.5	soil	SF	5-point composite	NA	10/12/2016	650699.89	4086195.86	--	N	N
S063-C03-001	0 - 0.5	soil	SF	5-point composite	NA	10/12/2016	650726.93	4086182.41	--	N	N
S063-C04-001	0 - 0.5	soil	SF	5-point composite	NA	10/12/2016	650752.30	4086197.20	--	N	N
S063-C05-001	0 - 0.5	soil	SF	5-point composite	NA	10/12/2016	650643.54	4086103.15	--	N	N

Notes

*	Background Reference Areas from NA-0904 were used for NA-0928
--	Not Sampled
N	Normal
FD	Field Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
Ra-226	Radium 226
NA	Not Applicable
SB	Subsurface Sample
SF	Surface Sample
ft bgs	feet below ground surface

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

Table 3-2
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									Sample Types		
Sample Location	Sample Depth (ft bgs)	Sample Media	Sample Category	Sample Collection Method	Survey Area	Sample Date	Easting ¹	Northing ¹	Metals, Total	Ra-226	Thorium
Characterization											
S063-CX-001	0 - 0.5	soil	SF	grab	A	4/15/2017	650549.25	4086410.83	N	N	--
S063-CX-002	0 - 0.5	sediment	SF	grab	A	4/15/2017	650606.41	4086458.46	N	N	--
S063-CX-003	0 - 0.5	soil	SF	grab	C	4/15/2017	650749.28	4086294.55	N;FD	N;FD	--
S063-CX-004	0 - 0.5	sediment	SF	grab	A	4/15/2017	650825.04	4086282.83	N	N	--
S063-CX-005	0 - 0.5	soil	SF	grab	C	4/15/2017	650829.17	4086234.74	N	N	--
S063-CX-006	0 - 0.5	soil	SF	grab	A	4/15/2017	650601.04	4086040.77	N	N	--
S063-CX-007	0 - 0.5	soil	SF	grab	C	4/15/2017	650734.18	4086163.04	N	N	--
S063-CX-008	0 - 0.5	soil	SF	grab	B	4/15/2017	650697.28	4086073.52	N	N	--
S063-CX-009	0 - 0.5	soil	SF	grab	C	4/15/2017	650753.74	4086111.67	N	N	--
S063-CX-010	0 - 0.5	soil	SF	grab	A	4/15/2017	650680.36	4086157.23	N;MS;MSD	N	--
S063-CX-011	0 - 0.5	soil	SF	grab	A	4/15/2017	650676.13	4086179.91	N	N	--
S063-SCX-001	0 - 0.5	sediment	SF	grab	B	4/15/2017	650737.84	4086081.66	N;FD	N;FD	--
S063-SCX-001	2 - 2.5	sediment	SB	grab	B	4/15/2017	650737.84	4086081.66	N	N	--
S063-SCX-002	0 - 0.5	soil	SF	grab	A	4/15/2017	650641.64	4086133.16	N	N	--
S063-SCX-002	0.5 - 1.0	soil	SB	grab	A	4/15/2017	650641.64	4086133.16	N	N	--
S063-SCX-003	0 - 0.5	soil	SF	grab	A	4/15/2017	650564.56	4086031.84	N	N	--
S063-SCX-003	0.5 - 1.0	soil	SB	grab	A	4/15/2017	650564.56	4086031.84	N	N	--
S063-SCX-004	0 - 0.5	soil	SF	grab	A	4/17/2017	650684.17	4086256.45	N	N	--
S063-SCX-004	0.5 - 1.0	soil	SB	grab	A	4/17/2017	650684.17	4086256.45	N	N	--
S063-SCX-004	1.0 - 1.5	soil	SB	grab	A	4/17/2017	650684.17	4086256.45	N	N	--
S063-SCX-005	0 - 0.5	sediment	SF	grab	A	4/17/2017	650611.76	4086312.10	N	N	--
S063-SCX-006	0 - 0.5	sediment	SF	grab	A	4/17/2017	650666.54	4086402.30	N	N	--
S063-SCX-008	0 - 0.5	soil	SF	grab	C	6/3/2017	650817.12	4086218.26	N	N	--
S063-SCX-008	0.5 - 1.5	soil	SB	grab	C	6/3/2017	650817.12	4086218.26	N	N	--
S063-SCX-008	1.5 - 2.0	soil	SB	grab	C	6/3/2017	650817.12	4086218.26	N	N	--
S063-SCX-008	2.0 - 2.5	soil	SB	grab	C	6/3/2017	650817.12	4086218.26	N	N	--
S063-SCX-008	2.5 - 3.0	soil	SB	grab	C	6/3/2017	650817.12	4086218.26	N	N	--
S063-SCX-009	0 - 0.5	soil	SF	grab	C	6/3/2017	650830.45	4086232.98	N	N	--
S063-SCX-009	0.5 - 1.0	bedrock	SB	grab	C	6/3/2017	650830.45	4086232.98	N	N	--
S063-SCX-010	0 - 0.5	soil	SF	grab	A	6/3/2017	650752.45	4086196.87	N	N	--
S063-SCX-010	0.5 - 1.5	soil	SB	grab	A	6/3/2017	650752.45	4086196.87	N	N	--
S063-SCX-010	1.5 - 2.5	soil	SB	grab	A	6/3/2017	650752.45	4086196.87	N	N	--
S063-SCX-010	2.5 - 3.0	soil	SB	grab	A	6/3/2017	650752.45	4086196.87	N	N	--
S063-SCX-011	0 - 0.5	soil	SF	grab	A	6/3/2017	650760.12	4086198.66	N	N	--
S063-SCX-011	0.5 - 1.0	soil	SB	grab	A	6/3/2017	650760.12	4086198.66	N	N	--
S063-SCX-011	1.0 - 1.5	soil	SB	grab	A	6/3/2017	650760.12	4086198.66	N;FD	N;FD	--
S063-SCX-011	1.5 - 2.0	bedrock	SB	grab	A	6/3/2017	650760.12	4086198.66	N	N	--
S063-SCX-011	3.0 - 4.0	bedrock	SB	grab	A	6/3/2017	650760.12	4086198.66	N;MS;MSD	N	--
S063-SCX-012	0 - 0.5	soil	SF	grab	A	6/4/2017	650762.23	4086201.54	N	N	--
S063-SCX-012	0.5 - 1.0	soil	SB	grab	A	6/4/2017	650762.23	4086201.54	N	N	--
S063-SCX-012	1.0 - 2.0	soil	SB	grab	A	6/4/2017	650762.23	4086201.54	N	N	--
S063-SCX-012	2.0 - 3.0	soil	SB	grab	A	6/4/2017	650762.23	4086201.54	N;FD	N;FD	--
S063-SCX-013	0 - 0.5	soil	SF	grab	C	6/4/2017	650746.29	4086274.54	N	N	--
S063-SCX-013	0.5 - 3.0	soil	SB	composite	C	6/4/2017	650746.29	4086274.54	N	N	--
S063-SCX-013	3.0 - 5.0	soil	SB	composite	C	6/4/2017	650746.29	4086274.54	N	N	--
S063-SCX-013	5.0 - 7.0	soil	SB	composite	C	6/4/2017	650746.29	4086274.54	N	N	--
S063-SCX-013	7.0 - 7.5	soil	SB	grab	C	6/4/2017	650746.29	4086274.54	N	N	--
S063-SCX-013	7.5 - 10.5	soil	SB	composite	C	6/4/2017	650746.29	4086274.54	N	N	--
S063-SCX-014	0 - 0.5	soil	SF	grab	C	6/4/2017	650753.26	4086281.77	N;FD	N;FD	--
S063-SCX-014	0.5 - 10.0	soil	SB	composite	C	6/4/2017	650753.26	4086281.77	N	N	--

Notes

*	Background Reference Areas from NA-0904 were used for NA-0928
--	Not Sampled
N	Normal
FD	Field Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
Ra-226	Radium 226
NA	Not Applicable
SB	Subsurface Sample
SF	Surface Sample
ft bgs	feet below ground surface
¹ Coordinate System:	NAD 1983 UTM Zone 12N

Table 3-2
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Sample Location	Sample Depth (ft bgs)	Sample Media	Sample Category	Sample Collection Method	Survey Area	Sample Date	Easting ¹	Northing ¹	Sample Types		
									Metals, Total	Ra-226	Thorium
Characterization continued											
S063-SCX-015	0 - 0.5	soil	SF	grab	C	6/4/2017	650744.85	4086283.20	N	N	--
S063-SCX-015	0.5 - 5.0	soil	SB	composite	C	6/4/2017	650744.85	4086283.20	N	N	--
S063-SCX-015	5.5 - 6.75	soil	SB	composite	C	6/4/2017	650744.85	4086283.20	N	N	--
S063-SCX-015	6.75 - 7.25	soil	SB	grab	C	6/4/2017	650744.85	4086283.20	N	N	--
S063-SCX-015	7.25 - 7.5	soil	SB	grab	C	6/4/2017	650744.85	4086283.20	N	N	--
S063-SCX-015	7.5 - 10.0	soil	SB	composite	C	6/4/2017	650744.85	4086283.20	N;MS;MSD	N	--
S063-SCX-015	10.0 - 10.5	soil	SB	grab	C	6/4/2017	650744.85	4086283.20	N	N	--
S063-SCX-016	0 - 0.5	soil	SF	grab	C	6/4/2017	650743.58	4086291.40	N	N	--
S063-SCX-016	0.5 - 10.0	soil	SB	composite	C	6/4/2017	650743.58	4086291.40	N;FD	N;FD	--
S063-SCX-016	10.0 - 11.0	soil	SB	grab	C	6/4/2017	650743.58	4086291.40	N	N	--
S063-SCX-017	0 - 0.5	soil	SF	grab	C	6/4/2017	650739.47	4086280.93	N	N	--
S063-SCX-017	0.5 - 4.0	soil	SB	composite	C	6/4/2017	650739.47	4086280.93	N	N	--
S063-SCX-017	4.0 - 6.0	soil	SB	composite	C	6/4/2017	650739.47	4086280.93	N	N	--
S063-SCX-017	6.0 - 7.5	soil	SB	composite	C	6/4/2017	650739.47	4086280.93	N	N	--
S063-SCX-017	7.5 - 8.0	soil	SB	grab	C	6/4/2017	650739.47	4086280.93	N	N	--
S063-SCX-017	8.0 - 9.5	soil	SB	composite	C	6/4/2017	650739.47	4086280.93	N;FD	N;FD	--
S063-SCX-018	0 - 0.5	soil	SF	grab	A	6/4/2017	650706.93	4086275.26	N	N	--
S063-SCX-018	0.5 - 2.0	soil	SB	composite	A	6/4/2017	650706.93	4086275.26	N	N	--
S063-SCX-018	2.0 - 2.5	soil	SB	grab	A	6/4/2017	650706.93	4086275.26	N	N	--
S063-SCX-019	0 - 0.5	soil	SF	grab	A	6/5/2017	650685.38	4086256.31	N	N	--
S063-SCX-019	0.5 - 1.5	soil	SB	grab	A	6/5/2017	650685.38	4086256.31	N	N	--
S063-SCX-020	0 - 0.5	soil	SF	grab	A	6/5/2017	650672.63	4086244.10	N	N	--
S063-SCX-020	0.5 - 2.0	soil	SB	composite	A	6/5/2017	650672.63	4086244.10	N	N	--
S063-SCX-021	0 - 0.5	soil	SF	grab	A	6/5/2017	650674.72	4086185.78	N	N	--
S063-SCX-022	0 - 0.5	soil	SF	grab	A	6/5/2017	650728.38	4086179.27	N;FD	N;FD	--
S063-SCX-022	0.5 - 1.5	soil	SB	grab	A	6/5/2017	650728.38	4086179.27	N;MS;MSD	N	--
S063-SCX-023	0 - 0.5	soil	SF	grab	C	6/5/2017	650738.09	4086271.31	N	N	--
S063-SCX-023	0.5 - 9.5	soil	SB	composite	C	6/5/2017	650738.09	4086271.31	N	N	--
S063-SCX-023	9.5 - 10.0	bedrock	SB	grab	C	6/5/2017	650738.09	4086271.31	N	N	--
S063-SCX-024	0 - 0.5	soil	SF	grab	C	6/5/2017	650779.60	4086192.41	N	N	--
S063-SCX-024	0.5 - 3.5	soil	SB	composite	C	6/5/2017	650779.60	4086192.41	N	N	--
S063-SCX-024	3.5 - 4.0	soil	SB	grab	C	6/5/2017	650779.60	4086192.41	N	N	--

Notes

*	Background Reference Areas from NA-0904 were used for NA-0928
--	Not Sampled
N	Normal
FD	Field Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
Ra-226	Radium 226
NA	Not Applicable
SB	Subsurface Sample
SF	Surface Sample
ft bgs	feet below ground surface
¹ Coordinate System:	NAD 1983 UTM Zone 12N

Table 3-3
Mine Feature Samples and Area
NA-0928
Removal Site Evaluation Report - Final
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Mine Feature	Surface Samples	Subsurface Samples	Area (sq. ft)	Volume of TENORM exceeding ILs (yd^3)
Potential Bury/Borrow Area #1	7	20	6,179	2,517
Mining/Reclaimed Disturbed Area 1	1	1	3,139	232
Mining/Reclaimed Disturbed Area 2	1	0	922	--
Mining/Reclaimed Disturbed Area 3	1	1	4,757	352
Mining/Reclaimed Disturbed Area 4	2	3	338	25
Mining/Reclaimed Disturbed Area 5	0	0	1,048	--
Mining/Reclaimed Disturbed Area 6	3	10	2,720	302
Mining/Reclaimed Disturbed Area 7	3	5	6,391	711
Mining/Reclaimed Disturbed Area 8	0	0	327	12
Debris	0	0	3,852	0
Potential Haul Roads	1	0	*	578
Drainages	5	1	**	135

Notes

sq.ft - square feet

yd^3 - cubic yards

ILs - investigation levels

TENORM - technologically enhanced naturally occurring radioactive material

-- Feature is not included in area of TENORM exceeding ILs

* Area not determined because the width of the potential haul roads vary throughout the Site

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

Table 3-4
Water Sampling Summary
NA-0928
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase

Field Sample Identification	Water Feature Identification	Sample Date	Easting ¹	Northing ¹	Sample Types Ra-226	Ra-228	Gross Alpha	Metals, Dissolved	Metals, Total	TDS	Anions	Cations
Well Water[2]												
S059-WL-001	09T-546 /RV990317TNW002	9/29/2016	651904.10	4085529.22	N	N	N	N	N;MS;MSD	N	N;MS;MSD	N
S059-WL-001	09T-546 /RV990317TNW002	5/24/2017	651904.10	4085529.22	--	--	--	N	N;MS;MSD	--	--	--

Notes

--	Not Sampled
N	Normal
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] Metals total 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
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Location Identification*	S059-BG2-001	S059-BG2-001 Dup	S059-BG2-002	S059-BG2-003	S059-BG2-004	S059-BG2-005	S059-BG2-006	S059-BG2-007	S059-BG2-008	S059-BG2-009	S059-BG2-010
Date Collected	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016
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	1.4	1.2	2	1.5	1.4	1.7	4.2	1.7	2.1	2.1	1.6
Molybdenum	<0.18	<0.19	<0.21	<0.2	<0.2	<0.19	<0.18	<0.2	<0.18	<0.18	<0.18
Selenium	<0.92	<0.93	<1	<0.98	<0.99	<0.95	<0.92	<1	<0.9	<0.9	<0.92
Uranium	2.3	2.3	1.2	1.6	1.2	2	2.4	1.8	1.3	1.2	2.5
Vanadium	6.8	6.6	15	7.9	8.2	13	14	9.3	9.1	12	10
Radionuclides (pCi/g)											
Radium-226	1.58 ± 0.31	1.27 ± 0.28	1.79 ± 0.33	1.23 ± 0.27	1.18 ± 0.27	1.98 ± 0.33	2.94 ± 0.49	1.26 ± 0.28	0.92 ± 0.23	1.57 ± 0.31	2.04 ± 0.37

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
<	Result not detected above associated laboratory reporting limit
*	Background Reference Areas from NA-0904 were used for NA-0928
J-	Data are estimated and are potentially biased low due to associated quality control data
J+	Data are estimated and are potentially biased high due to associated quality control data

Table 4-1
Background Reference Area Soil and Sediment Sample Analytical Results
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Location Identification*	S059-BG2-010 Dup	S059-SCX-001	S059-BG3-001	S059-BG3-002	S059-BG3-003	S059-BG3-004	S059-BG3-005	S059-BG3-006	S059-BG3-007	S059-BG3-008	S059-BG3-009	S059-BG3-010
Date Collected	10/5/2016	10/11/2016	10/6/2016	10/6/2016	10/6/2016	10/6/2016	10/6/2016	10/6/2016	10/6/2016	10/6/2016	10/6/2016	10/6/2016
Depth (feet)	0 - 0.5	0 - 0.6	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	1.5	2.2	1.4	1.3	1.5	1.3 J+	1.4	1.4	1.4	1.5	1.7	2
Molybdenum	<0.2	<0.19	<0.17	<0.18	0.24	<0.18	<0.19	<0.2	<0.2	<0.19	<0.18	<0.19
Selenium	<0.99	<0.96	<0.85	<0.89	<0.95	<0.88	<0.95	<0.98	<1	<0.94	<0.91	<0.95
Uranium	2.6	1.5	0.4	0.45	0.59	0.6 J+	0.61	0.51	0.78	0.56	0.58	0.56
Vanadium	10	12	6.3	6.9	7.3	7.8 J+	8.2	9.5	9.3	11	17	12
Radionuclides (pCi/g)												
Radium-226	1.62 ± 0.3	1.26 ± 0.29	0.5 ± 0.23	0.43 ± 0.19	0.84 ± 0.23	0.86 ± 0.24	0.68 ± 0.2	0.49 ± 0.2	0.58 ± 0.21	0.61 ± 0.27	0.44 ± 0.17	0.79 ± 0.24 J-

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
<	Result not detected above associated laboratory reporting limit
*	Background Reference Areas from NA-0904 were used for NA-0928
J-	Data are estimated and are potentially biased low due to associated quality control data
J+	Data are estimated and are potentially biased high due to associated quality control data

Table 4-1
Background Reference Area Soil and Sediment Sample Analytical Results
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Location Identification*	S059-BG3-010 Dup	S059-SCX-003	S059-SCX-003	S059-BG4-001	S059-BG4-002	S059-BG4-002 Dup	S059-BG4-003	S059-BG4-004	S059-BG4-004 Dup	S059-BG4-005	S059-BG4-006
Date Collected	10/6/2016	10/11/2016	10/11/2016	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017
Depth (feet)	0 - 0.5	0 - 0.5	0.5 - 1.2	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	2	1.9	1.5	1.5	5.1	2.2	2.4	2	1.6	1.8
Molybdenum	<0.19	<0.2	<0.21	0.27	<0.2	<0.19	0.28	<0.19	<0.2	<0.2	<0.2
Selenium	<0.93	<0.98	<1	<0.98	<1	<0.97	<1	<0.95	<1	<0.99	<0.99
Uranium	0.56	0.55	0.48	0.69	0.67	1	0.66	0.85	0.72	0.69	0.71
Vanadium	12	9.4	7.8	5.9	6.5	7.8	6.6	8.2	7.4	6.9	6
Radionuclides (pCi/g)											
Radium-226	0.61 ± 0.2 J-	0.62 ± 0.19	0.6 ± 0.2	0.81 ± 0.22	0.61 ± 0.17 J-	0.52 ± 0.18 J-	0.56 ± 0.17	0.75 ± 0.19	0.8 ± 0.21	0.67 ± 0.19 J-	0.7 ± 0.19

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
<	Result not detected above associated laboratory reporting limit
*	Background Reference Areas from NA-0904 were used for NA-0928
J-	Data are estimated and are potentially biased low due to associated quality control data
J+	Data are estimated and are potentially biased high due to associated quality control data

Table 4-1
Background Reference Area Soil and Sediment Sample Analytical Results
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Location Identification*	S059-BG4-006 Dup	S059-BG4-007	S059-BG4-008	S059-BG4-008 Dup	S059-BG4-009	S059-BG4-010	S059-BG4-011	S059-BG4-011
Date Collected	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017
Depth (feet)	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0.5 - 1.5
Analyte (Units)								
Metals[1] (mg/kg)								
Arsenic	3.9	1.5	1.8	1.8	2.5	1.5	1.7	1.8
Molybdenum	0.61	<0.2	<0.19	0.21	0.3	<0.19	<0.2	<0.21
Selenium	<1	<1	<0.96	<0.95	<0.99	<0.96	<0.99	<1.1
Uranium	0.77	0.59	0.7	0.71	0.87	0.66	0.76	0.76
Vanadium	6.9	5.9	6	6.2	7	7.2	7	6.8
Radionuclides (pCi/g)								
Radium-226	0.76 ± 0.22	0.77 ± 0.21	0.67 ± 0.24	0.91 ± 0.21	0.62 ± 0.17 J-	0.7 ± 0.2	0.71 ± 0.2 J-	0.7 ± 0.22

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
<	Result not detected above associated laboratory reporting limit
*	Background Reference Areas from NA-0904 were used for NA-0928
J-	Data are estimated and are potentially biased low due to associated quality control data
J+	Data are estimated and are potentially biased high due to associated quality control data

Table 4-2
Static Gamma Measurement Summary
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Sample Location	Survey Area	Subsurface Static Gamma Investigation Level (cpm)	Sample Depth (ft bgs)	Media	Static Gamma Measurement (cpm)
S059-SCX-001	Background Area 2	*	0.0	soil	8,379
S059-SCX-001	Background Area 2	*	0.5	soil	13,249
S059-SCX-003	Background Area 3	*	0.5	soil	11,880
S059-SCX-003	Background Area 3	*	1.1	soil	13,159**
S059-BG4-011	Background Area 4	*	0.0	sediment	8,051
S059-BG4-011	Background Area 4	*	0.5	sediment	9,348
S059-BG4-011	Background Area 4	*	1.0	sediment	10,141
S059-BG4-011	Background Area 4	*	1.5	sediment	11,166**
S063-SCX-002	A	--	0.0	soil	194,868
S063-SCX-002	A	13,249	0.5	soil	267,359
S063-SCX-002	A	13,249	1.0	soil	189,897**
S063-SCX-003	A	--	0.0	soil	8,031
S063-SCX-003	A	13,249	0.5	soil	10,930
S063-SCX-003	A	13,249	1.0	soil	10,515**
S063-SCX-004	A	--	0.0	soil	53,916
S063-SCX-004	A	13,249	0.5	soil	147,356
S063-SCX-004	A	13,249	1.0	soil	165,960
S063-SCX-004	A	13,249	1.5	soil	189,122**
S063-SCX-005	A	--	0.0	sediment	7,685
S063-SCX-005	A	13,249	0.5	sediment	8,725**
S063-SCX-006	A	--	0.0	sediment	12,066
S063-SCX-006	A	13,249	0.5	sediment	22,620**
S063-SCX-010	A	--	0.0	soil	73,324
S063-SCX-010	A	13,249	1.0	soil	167,864
S063-SCX-010	A	13,249	2.0	soil	117,042
S063-SCX-010	A	13,249	3.0	soil/bedrock	117,348
S063-SCX-010	A	13,249	4.0	bedrock	112,966
S063-SCX-011	A	--	0.0	soil	59,284
S063-SCX-011	A	13,249	1.0	soil	284,866
S063-SCX-011	A	13,249	2.0	bedrock	211,208
S063-SCX-011	A	13,249	3.0	bedrock	490,870
S063-SCX-011	A	13,249	3.5	bedrock	815,064
S063-SCX-012	A	--	0.0	soil	16,266
S063-SCX-012	A	13,249	1.0	soil	142,312
S063-SCX-012	A	13,249	2.0	soil	181,426
S063-SCX-012	A	13,249	3.0	soil	47,320**

Notes

Bold	Bolded result indicates measurement exceeds subsurface gamma investigation level
*	The subsurface gamma investigation levels are derived from the NA-0904 background area □
**	Measurement collected at interface of unconsolidated material and refusal material (e.g., bedrock)
--	The subsurface gamma investigation level does not apply to surface static gamma measurements
IL	Investigation Level
RSE	Removal Site Investigation
cpm	counts per minute
ft bgs	feet below ground surface

Table 4-2
Static Gamma Measurement Summary
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Sample Location	Survey Area	Subsurface Static Gamma Investigation Level (cpm)	Sample Depth (ft bgs)	Media	Static Gamma Measurement (cpm)
S063-SCX-018	A	--	0.0	soil	9,598
S063-SCX-018	A	13,249	1.0	soil	16,428
S063-SCX-018	A	13,249	2.0	soil	21,738
S063-SCX-018	A	13,249	3.0	bedrock	29,740
S063-SCX-018	A	13,249	4.0	bedrock	37,834
S063-SCX-018	A	13,249	5.0	bedrock	46,698
S063-SCX-018	A	13,249	6.0	bedrock	49,172
S063-SCX-018	A	13,249	7.0	bedrock	51,862
S063-SCX-019	A	--	0.0	soil	86,070
S063-SCX-019	A	13,249	1.0	soil	172,696
S063-SCX-019	A	13,249	2.0	bedrock	118,348
S063-SCX-019	A	13,249	3.0	bedrock	77,600
S063-SCX-020	A	--	0.0	soil	19,948
S063-SCX-020	A	13,249	1.0	soil	39,002
S063-SCX-020	A	13,249	2.0	soil/bedrock	32,390
S063-SCX-020	A	13,249	3.0	bedrock	33,726
S063-SCX-021	A	--	0.0	soil	6,886
S063-SCX-021	A	13,249	1.0	soil/bedrock	9,246
S063-SCX-021	A	13,249	1.5	bedrock	9,326
S063-SCX-022	A	--	0.0	soil	15,540
S063-SCX-022	A	13,249	1.0	soil	51,790
S063-SCX-022	A	13,249	2.0	bedrock	41,598
S063-SCX-022	A	13,249	3.0	bedrock	38,428
S063-SCX-001	B	13,159	0.5	sediment	10,957
S063-SCX-001	B	13,159	1.0	sediment	12,330
S063-SCX-001	B	13,159	1.5	sediment	13,638
S063-SCX-001	B	13,159	2.0	sediment	13,708
S063-SCX-001	B	13,159	2.5	sediment	13,973
S063-SCX-008	C	--	0.0	soil	6,882
S063-SCX-008	C	10,141	1.0	soil	9,610
S063-SCX-008	C	10,141	2.0	soil	9,466
S063-SCX-008	C	10,141	3.0	soil/bedrock	7,524
S063-SCX-008	C	10,141	4.0	bedrock	6,376
S063-SCX-008	C	10,141	5.0	bedrock	6,440
S063-SCX-009	C	--	0.0	soil	12,096
S063-SCX-009	C	10,141	1.0	bedrock	13,972
S063-SCX-009	C	10,141	2.0	bedrock	17,796
S063-SCX-009	C	10,141	3.0	bedrock	14,046

Notes

Bold	Bolded result indicates measurement exceeds subsurface gamma investigation level
*	The subsurface gamma investigation levels are derived from the NA-0904 background area
**	Measurement collected at interface of unconsolidated material and refusal material (e.g., bedrock)
--	The subsurface gamma investigation level does not apply to surface static gamma measurements
IL	Investigation Level
RSE	Removal Site Investigation
cpm	counts per minute
ft bgs	feet below ground surface

Table 4-2
Static Gamma Measurement Summary
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Sample Location	Survey Area	Subsurface Static Gamma Investigation Level (cpm)	Sample Depth (ft bgs)	Media	Static Gamma Measurement (cpm)
S063-SCX-013	C	--	0.0	soil	6,968
S063-SCX-013	C	10,141	0.5	soil	9,496
S063-SCX-013	C	10,141	1.5	soil	9,792
S063-SCX-013	C	10,141	2.5	soil	10,622
S063-SCX-013	C	10,141	3.5	soil	12,928
S063-SCX-013	C	10,141	4.5	soil	14,368
S063-SCX-013	C	10,141	5.5	soil	14,704
S063-SCX-013	C	10,141	6.5	soil	15,270
S063-SCX-013	C	10,141	7.5	soil	17,406
S063-SCX-013	C	10,141	8.5	soil	19,322
S063-SCX-013	C	10,141	9.5	soil	21,810
S063-SCX-013	C	10,141	10.5	soil/bedrock	25,486
S063-SCX-013	C	10,141	11.5	bedrock	30,700
S063-SCX-014	C	--	0.0	soil	7,730
S063-SCX-014	C	10,141	1.0	soil	10,342
S063-SCX-014	C	10,141	2.0	soil	11,152
S063-SCX-014	C	10,141	3.0	soil	11,536
S063-SCX-014	C	10,141	4.0	soil	12,618
S063-SCX-014	C	10,141	5.0	soil	13,056
S063-SCX-014	C	10,141	6.0	soil	12,664
S063-SCX-014	C	10,141	7.0	soil	11,402
S063-SCX-014	C	10,141	8.0	soil	11,152
S063-SCX-014	C	10,141	9.0	soil	12,284
S063-SCX-014	C	10,141	10.0	soil/bedrock	14,200
S063-SCX-014	C	10,141	11.0	bedrock	16,358
S063-SCX-014	C	10,141	12.0	bedrock	24,228
S063-SCX-014	C	10,141	13.0	bedrock	28,136
S063-SCX-015	C	--	0.0	soil	7,184
S063-SCX-015	C	10,141	1.0	soil	11,134
S063-SCX-015	C	10,141	2.0	soil	12,802
S063-SCX-015	C	10,141	3.0	soil	15,126
S063-SCX-015	C	10,141	4.0	soil	21,934
S063-SCX-015	C	10,141	5.0	boulder	36,946
S063-SCX-015	C	10,141	6.0	soil	42,374
S063-SCX-015	C	10,141	7.0	soil	21,204
S063-SCX-015	C	10,141	8.0	soil	16,236
S063-SCX-015	C	10,141	9.0	soil	14,892
S063-SCX-015	C	10,141	10.0	soil	17,882
S063-SCX-015	C	10,141	10.5	soil	18,740**

Notes

Bold	Bolded result indicates measurement exceeds subsurface gamma investigation level
*	The subsurface gamma investigation levels are derived from the NA-0904 background area
**	Measurement collected at interface of unconsolidated material and refusal material (e.g., bedrock)
--	The subsurface gamma investigation level does not apply to surface static gamma measurements
IL	Investigation Level
RSE	Removal Site Investigation
cpm	counts per minute
ft bgs	feet below ground surface

Table 4-2
Static Gamma Measurement Summary
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Sample Location	Survey Area	Subsurface Static Gamma Investigation Level (cpm)	Sample Depth (ft bgs)	Media	Static Gamma Measurement (cpm)
S063-SCX-016	C	--	0.0	soil	6,138
S063-SCX-016	C	10,141	1.0	soil	9,898
S063-SCX-016	C	10,141	2.0	soil	10,792
S063-SCX-016	C	10,141	3.0	soil	12,066
S063-SCX-016	C	10,141	4.0	soil	18,598
S063-SCX-016	C	10,141	5.0	soil	15,210
S063-SCX-016	C	10,141	6.0	soil	13,942
S063-SCX-016	C	10,141	7.0	soil	15,075
S063-SCX-016	C	10,141	8.0	soil	13,434
S063-SCX-016	C	10,141	9.0	soil	12,526
S063-SCX-016	C	10,141	10.0	soil	12,388
S063-SCX-016	C	10,141	11.0	soil/bedrock	15,230
S063-SCX-016	C	10,141	11.5	bedrock	19,984
S063-SCX-017	C	--	0.0	soil	7,146
S063-SCX-017	C	10,141	1.0	soil	12,318
S063-SCX-017	C	10,141	2.0	soil	15,562
S063-SCX-017	C	10,141	3.0	soil	23,250
S063-SCX-017	C	10,141	4.0	soil	74,740
S063-SCX-017	C	10,141	5.0	soil	98,460
S063-SCX-017	C	10,141	6.0	soil	32,334
S063-SCX-017	C	10,141	7.0	soil	18,328
S063-SCX-017	C	10,141	8.0	soil	17,020
S063-SCX-017	C	10,141	9.0	soil	18,076
S063-SCX-017	C	10,141	10.0	bedrock	20,524
S063-SCX-017	C	10,141	11.0	bedrock	20,722
S063-SCX-023	C	--	0.0	soil	7,456
S063-SCX-023	C	10,141	1.0	soil	13,090
S063-SCX-023	C	10,141	2.0	soil	17,206
S063-SCX-023	C	10,141	3.0	soil	21,322
S063-SCX-023	C	10,141	4.0	soil	25,174
S063-SCX-023	C	10,141	5.0	soil	29,752
S063-SCX-023	C	10,141	6.0	soil	38,060
S063-SCX-023	C	10,141	7.0	soil	46,496
S063-SCX-023	C	10,141	8.0	boulder	58,572
S063-SCX-023	C	10,141	9.0	soil	75,476
S063-SCX-023	C	10,141	9.5	soil	77,650**
S063-SCX-024	C	--	0.0	soil	10,858
S063-SCX-024	C	10,141	1.0	soil	14,268
S063-SCX-024	C	10,141	2.0	soil	10,792
S063-SCX-024	C	10,141	3.0	soil	11,458
S063-SCX-024	C	10,141	4.0	soil/bedrock	11,368
S063-SCX-024	C	10,141	5.0	bedrock	8,240
S063-SCX-024	C	10,141	5.5	bedrock	8,076

Notes

Bold	Bolded result indicates measurement exceeds subsurface gamma investigation level
*	The subsurface gamma investigation levels are derived from the NA-0904 background area
**	Measurement collected at interface of unconsolidated material and refusal material (e.g., bedrock)
--	The subsurface gamma investigation level does not apply to surface static gamma measurements
IL	Investigation Level
RSE	Removal Site Investigation
cpm	counts per minute
ft bgs	feet below ground surface

Table 4-3
Gamma Correlation Study Soil Sample Analytical Results
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Location Identification	S063-C01-001	S063-C02-001	S063-C03-001	S063-C04-001	S063-C05-001
Date Collected	10/12/2016	10/12/2016	10/12/2016	10/12/2016	10/12/2016
Depth (feet)	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Analyte (Units)					
Radionuclides (pCi/g)					
Radium-226	6.25 ± 0.82	1.73 ± 0.35	34 ± 4.1	49.1 ± 5.9	4.3 ± 0.62
Thorium-228	0.453 ± 0.096	0.242 ± 0.063	0.288 ± 0.069	0.454 ± 0.094	0.364 ± 0.082
Thorium-230	4.51 ± 0.72	1.5 ± 0.25	23.4 ± 3.6	44.9 ± 6.9	2.97 ± 0.48
Thorium-232	0.497 ± 0.099	0.284 ± 0.063	0.342 ± 0.072	0.54 ± 0.1	0.328 ± 0.07

Notes

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

Table 4-4a
Site Characterization Soil and Sediment Sample Analytical Results for Survey Area A
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Location Identification		S063-CX-001	S063-CX-002	S063-CX-004	S063-CX-006	S063-CX-010	S063-CX-011	S063-SCX-002	S063-SCX-002	S063-SCX-003	S063-SCX-003	S063-SCX-004	S063-SCX-004
Date Collected		4/15/2017	4/15/2017	4/15/2017	4/15/2017	4/15/2017	4/15/2017	4/15/2017	4/15/2017	4/15/2017	4/15/2017	4/17/2017	4/17/2017
Depth (feet)		0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0.5 - 1.0	0 - 0.5	0.5 - 1.0	0 - 0.5	0.5 - 1.0
Sample Category		surface	surface	surface	surface	surface	surface	surface	subsurface	surface	subsurface	surface	subsurface
Sample Collection Method		grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab
Media		soil	sediment	sediment	soil	soil	soil	soil	soil	soil	soil	soil	soil
Analyte (Units)													
Metals[1] (mg/kg)	Investigation Level												
Arsenic	4.38	1.7	1.5	1.9	2.9	1.1	0.51	37	20	2.7	3.9	28	19
Molybdenum	NA	<0.2	<0.2	<0.19	<0.2	<0.2	<0.19	2.4	0.78	<0.22	<0.23	2	1.1
Selenium	NA	<1	<1	<0.97	<1	<0.99	<0.95	1.4	<1.1	<1.1	<1.2	3	2
Uranium	3.28	5.3	2.1	8.7	4	0.98	1.2	47	22	1.6	2.8	31	26
Vanadium	18.7	16	15	170	91	18 J+	20	480	250	85	100	110	140
Radionuclides (pCi/g)													
Radium-226	3.34	4.54 ± 0.68	1.66 ± 0.31	8.6 ± 1.1	3.88 ± 0.58	0.84 ± 0.21	0.54 ± 0.18	175 ± 21	71.2 ± 8.4	1.78 ± 0.38 J+	1.97 ± 0.38 J+	52.5 ± 6.3 J+	41.5 ± 5 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 and molybdenum sample results in BG-2 were all non-detect
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-diluted value
<	Result not detected above associated laboratory reporting limit
D	Sample dilution required for analysis; reported values reflect the dilution
J+	Data are estimated and are potentially biased high due to associated quality control data

Table 4-4a
Site Characterization Soil and Sediment Sample Analytical Results for Survey Area A
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Location Identification		S063-SCX-004	S063-SCX-005	S063-SCX-006	S063-SCX-010	S063-SCX-010	S063-SCX-010	S063-SCX-010	S063-SCX-011	S063-SCX-011	S063-SCX-011	S063-SCX-011
Date Collected		4/17/2017	4/17/2017	4/17/2017	6/3/2017	6/3/2017	6/3/2017	6/3/2017	6/3/2017	6/3/2017	6/3/2017	6/3/2017
Depth (feet)		1.0 - 1.5	0 - 0.5	0 - 0.5	0 - 0.5	0.5 - 1.5	1.5 - 2.5	2.5 - 3.0	0 - 0.5	0.5 - 1.0	1.0 - 1.5	1.5 - 2.0
Sample Category		subsurface	surface	surface	surface	subsurface	subsurface	subsurface	surface	subsurface	subsurface	subsurface
Sample Collection Method		grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab
Media		soil	sediment	sediment	soil	soil	soil	soil	soil	soil	soil	bedrock
Analyte (Units)												
Metals[1] (mg/kg)	Investigation Level											
Arsenic	4.38	15	2.2	4.3	14	5.8	3.7	7	5.5	4.7	6.7	10
Molybdenum	NA	0.39	0.42	<0.2	1.3	0.51	0.23	0.43	1.8	1.5	2.6	3.9
Selenium	NA	1.6	<1	<1	<0.99	<1	<1	<1	<1	<0.94	<1	<1
Uranium	3.28	26	1.8	3.7	130 D	250 D	89	180 D	98 D	89	210 D	310 D
Vanadium	18.7	510	20	24	520	470	350	990	390	380	770	1100 D
Radionuclides (pCi/g)												
Radium-226	3.34	105 ± 12 J+	1.87 ± 0.37	4.12 ± 0.6	93 ± 11	106 ± 12	49.8 ± 5.9	94 ± 11	51.4 ± 6.1	53.9 ± 6.4	97 ± 11	137 ± 16

Notes

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

Table 4-4a
Site Characterization Soil and Sediment Sample Analytical Results for Survey Area A
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	Location Identification	S063-SCX-011	S063-SCX-012	S063-SCX-012	S063-SCX-012	S063-SCX-012	S063-SCX-018	S063-SCX-018	S063-SCX-018	S063-SCX-019
	Date Collected	6/3/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/5/2017
	Depth (feet)	3.0 - 4.0	0 - 0.5	0.5 - 1.0	1.0 - 2.0	2.0 - 3.0	0 - 0.5	0.5 - 2.0	2.0 - 2.5	0 - 0.5
	Sample Category	subsurface	surface	subsurface	subsurface	subsurface	surface	subsurface	subsurface	surface
	Sample Collection Method	grab	grab	grab	grab	grab	grab	grab	grab	grab
	Media	bedrock	soil	soil	soil	soil	soil	soil	soil	soil
Analyte (Units)										
Metals^1 (mg/kg)	Investigation Level									
Arsenic	4.38	130	3.2	2.3	4.1	43	1.3	1.8	2.1	15
Molybdenum	NA	88	0.72	0.46	2.5	9.5	<0.2	<0.2	0.2	0.32
Selenium	NA	6.3	<1	<0.96	<1	2.2	<1	<1	<0.99	1.4
Uranium	3.28	67	36	20	36	410 D	0.98	1.9	1.8	30
Vanadium	18.7	540	160	110	330	1400 D	22	22	82	660
Radionuclides (pCi/g)										
Radium-226	3.34	70 ± 8.3	11.4 ± 1.4	10.7 ± 1.4	22.7 ± 2.8	163 ± 19	1.92 ± 0.36	2.03 ± 0.34	1.39 ± 0.31	116 ± 14

Notes

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

Table 4-4a
Site Characterization Soil and Sediment Sample Analytical Results for Survey Area A
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Location Identification		S063-SCX-019	S063-SCX-020	S063-SCX-020	S063-SCX-021	S063-SCX-022	S063-SCX-022 Dup	S063-SCX-022
Date Collected		6/5/2017	6/5/2017	6/5/2017	6/5/2017	6/5/2017	6/5/2017	6/5/2017
Depth (feet)		0.5 - 1.5	0 - 0.5	0.5 - 2.0	0 - 0.5	0 - 0.5	0 - 0.5	0.5 - 1.5
Sample Category		subsurface	surface	subsurface	surface	surface	surface	subsurface
Sample Collection Method		grab	grab	grab	grab	grab	grab	grab
Media		soil	soil	soil	soil	soil	soil	soil
Analyte (Units)								
Metals[1] (mg/kg)	Investigation Level							
Arsenic	4.38	22	1.6	1.8	0.93	1	1.1	1.9
Molybdenum	NA	1.9	<0.2	<0.21	<0.2	<0.2	<0.2	<0.2
Selenium	NA	1.5	<1	<1.1	<1	<1	<1	<1
Uranium	3.28	38	20	7.8	0.53	0.92	1.5	14
Vanadium	18.7	330	50	49	9.4	12	11	280
Radionuclides (pCi/g)								
Radium-226	3.34	50.6 ± 6 J+	10.4 ± 1.3	7.17 ± 0.94	0.92 ± 0.25	1.03 ± 0.26	1.24 ± 0.25	16.6 ± 2.1

Notes

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

Table 4-4b
Site Characterization Soil and Sediment Sample Analytical Results for Survey Area B
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Location Identification		S063-CX-008	S063-SCX-001	S063-SCX-001	S063-SCX-001 Dup
Date Collected		4/15/2017	4/15/2017	4/15/2017	4/15/2017
Depth (feet)		0 - 0.5	0 - 0.5	2 - 2.5	0 - 0.5
Sample Category		surface	surface	subsurface	surface
Sample Collection Method		grab	grab	grab	grab
Media		soil	sediment	sediment	sediment
Analyte (Units)					
Metals[1] (mg/kg)	Investigation Level				
Arsenic	2.25	2.6	0.91	1.2	0.99
Molybdenum	NA	<0.19	<0.19	<0.2	<0.19
Selenium	NA	<0.94	<0.97	<1	<0.95
Uranium	0.836	0.25	0.43	0.45	0.37
Vanadium	18	6.4	8.5	9.9	7
Radionuclides (pCi/g)					
Radium-226	1.06	0.46 ± 0.17	0.72 ± 0.2 J-	0.47 ± 0.19 J-	0.91 ± 0.27 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 in BG-3 molybdenum sample results were all non-detect and selenium had only one detection
[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 4-4c
Site Characterization Soil Sample Analytical Results for Survey Area C
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Location Identification		S063-CX-003 Dup	S063-CX-003	S063-CX-005	S063-CX-007	S063-CX-009	S063-SCX-008	S063-SCX-008	S063-SCX-008	S063-SCX-008	S063-SCX-008	S063-SCX-009	S063-SCX-009	S063-SCX-013
Date Collected		4/15/2017	4/15/2017	4/15/2017	4/15/2017	4/15/2017	6/3/2017	6/3/2017	6/3/2017	6/3/2017	6/3/2017	6/3/2017	6/3/2017	6/4/2017
Depth (feet)		0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0.5 - 1.5	1.5 - 2.0	2.0 - 2.5	2.5 - 3.0	0 - 0.5	0.5 - 1.0	0 - 0.5
Sample Category		surface	surface	surface	surface	surface	surface	subsurface	subsurface	subsurface	subsurface	surface	subsurface	surface
Sample Collection Method		grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab
Media		soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	bedrock	soil
Analyte (Units)														
Metals[1] (mg/kg)	Investigation Level													
Arsenic	2.88	1.1	1.3	2.4	0.91	0.81	0.66	0.83	0.92	0.91	0.75	7.8	4.9	1
Molybdenum	0.334	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.19	<0.2	<0.2	<0.21	0.2	<0.2	<0.21
Selenium	NA	<1	3.1	<0.99	<0.99	<1	<0.99	<0.95	<1	<0.99	<1	<1	<1	<1
Uranium	0.948	0.44	0.44	6.2	2.6	0.69	0.43	0.48	0.54	0.55	0.89	6.7	2.3	2.5
Vanadium	8.65	9.1	9.1	52	23	7.1	8.1	8.1	8.6	11	11	150	140	15
Radionuclides (pCi/g)														
Radium-226	0.895	0.54 ± 0.19	0.64 ± 0.19	13.8 ± 1.7	2.44 ± 0.42	0.57 ± 0.23	0.49 ± 0.18	0.71 ± 0.2	0.62 ± 0.22	0.96 ± 0.25	0.85 ± 0.22	4.36 ± 0.62	1.85 ± 0.33	1.16 ± 0.26

Notes

Bold	Bolded result indicates positively identified compound
Shaded	Shaded result indicates result greater than or equal to the investigation level
Shaded	Shaded result indicates analyte detected, where that analyte does not have an investigation level
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
NA	An investigation level is not identified because selenium sample results in BG-4 were all non-detect
[1]	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-diluted value
<	Result not detected above associated laboratory reporting limit
D	Sample dilution required for analysis; reported values reflect the dilution
J	Data are estimated due to associated quality control data
J-	Data are estimated and are potentially biased low due to associated quality control data

Table 4-4c
Site Characterization Soil Sample Analytical Results for Survey Area C
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Location Identification		S063-SCX-013	S063-SCX-013	S063-SCX-013	S063-SCX-013	S063-SCX-013	S063-SCX-014	S063-SCX-014	S063-SCX-014 Dup	S063-SCX-015	S063-SCX-015	S063-SCX-015	S063-SCX-015	S063-SCX-015
Date Collected		6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017
Depth (feet)		0.5 - 3.0	3.0 - 5.0	5.0 - 7.0	7.0 - 7.5	7.5 - 10.5	0 - 0.5	0.5 - 10.0	0 - 0.5	0 - 0.5	0.5 - 5.0	10.0 - 10.5	5.5 - 6.75	6.75 - 7.25
Sample Category		subsurface	subsurface	subsurface	subsurface	subsurface	surface	subsurface	surface	surface	subsurface	subsurface	subsurface	subsurface
Sample Collection Method		composite	composite	composite	grab	composite	grab	composite	grab	grab	composite	grab	grab	grab
Media		soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil
Analyte (Units)														
Metals[1] (mg/kg)	Investigation Level													
Arsenic	2.88	0.88	1.2	0.53	0.77	0.77	0.96	0.92	0.99	0.86	0.98	0.87	1.4	1.5
Molybdenum	0.334	<0.2	<0.2	<0.2	1.1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.27	<0.2	0.24
Selenium	NA	<1	<0.99	<1	<0.98	<1	<0.98	<1	<1	<1	<1	<1	<1	<1
Uranium	0.948	1.7	0.72	0.68	0.71	0.69	0.55	0.52	0.54	0.45	0.67	1.2	12	0.78
Vanadium	8.65	12	7.9	4.2	6.5	6.2	8.8	6.9	9.1	8	8	12	120	9.5
Radionuclides (pCi/g)														
Radium-226	0.895	0.84 ± 0.25	0.81 ± 0.23	0.51 ± 0.2	0.5 ± 0.18	0.84 ± 0.21	0.72 ± 0.24	0.78 ± 0.21	0.87 ± 0.25	0.72 ± 0.24	0.73 ± 0.2	2.18 ± 0.35	9.5 ± 1.2	0.78 ± 0.24

Notes

Bold	Bolded result indicates positively identified compound
Shaded	Shaded result indicates result greater than or equal to the investigation level
Shaded	Shaded result indicates analyte detected, where that analyte does not have an investigation level
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
NA	An investigation level is not identified because selenium sample results in BG-4 were all non-detect
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-diluted value
<	Result not detected above associated laboratory reporting limit
D	Sample dilution required for analysis; reported values reflect the dilution
J	Data are estimated due to associated quality control data
J-	Data are estimated and are potentially biased low due to associated quality control data

Table 4-4c
Site Characterization Soil Sample Analytical Results for Survey Area C
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Location Identification		S063-SCX-015	S063-SCX-015	S063-SCX-016	S063-SCX-016	S063-SCX-016	S063-SCX-016 Dup	S063-SCX-017	S063-SCX-017	S063-SCX-017	S063-SCX-017	S063-SCX-017	S063-SCX-017
Date Collected		6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017	6/4/2017
Depth (feet)		7.25 - 7.5	7.5 - 10.0	0 - 0.5	0.5 - 10.0	10.0 - 11.0	0.5 - 10.0	0 - 0.5	0.5 - 4.0	4.0 - 6.0	6.0 - 7.5	7.5 - 8.0	8.0 - 9.5
Sample Category		subsurface	subsurface	surface	subsurface	subsurface	subsurface	surface	subsurface	subsurface	subsurface	subsurface	subsurface
Sample Collection Method		grab	grab	grab	composite	grab	grab	grab	composite	composite	composite	grab	composite
Media		soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil	soil
Analyte (Units)													
Metals[1] (mg/kg)	Investigation Level												
Arsenic	2.88	1.4	0.52	0.77	0.74	0.68	0.85	1	0.96	1.6	0.64	0.66	0.65
Molybdenum	0.334	0.4	<0.19	<0.21	<0.2	0.41	<0.2	<0.2	<0.2	<0.2	<0.2	1.2	<0.2
Selenium	NA	<0.99	<0.97	<1	<1	<1	<1	<1	<0.99	<0.99	<1	<1	<1
Uranium	0.948	1.2	0.39	0.51	0.46	0.58	0.51	0.48	0.57	18	0.49	0.89	0.56
Vanadium	8.65	27	3.6	7.1	5.7	3.6	6.1	8.7	8.3	150	4.6	11	5.1
Radionuclides (pCi/g)													
Radium-226	0.895	0.92 ± 0.21 J-	0.43 ± 0.21	0 ± 0.23	0.52 ± 0.19	0.38 ± 0.15	0.51 ± 0.17	0.64 ± 0.2	0.57 ± 0.2	27.4 ± 3.3	0.55 ± 0.21	1.02 ± 0.25	0.67 ± 0.19

Notes

Bold	Bolded result indicates positively identified compound
Shaded	Shaded result indicates result greater than or equal to the investigation level
Shaded	Shaded result indicates analyte detected, where that analyte does not have an investigation level
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
NA	An investigation level is not identified because selenium sample results in BG-4 were all non-detect
[1]	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-diluted value
<	Result not detected above associated laboratory reporting limit
D	Sample dilution required for analysis; reported values reflect the dilution
J	Data are estimated due to associated quality control data
J-	Data are estimated and are potentially biased low due to associated quality control data

Table 4-4c
Site Characterization Soil Sample Analytical Results for Survey Area C
NA-0928
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 4 of 4

	Location Identification	S063-SCX-017 Dup	S063-SCX-023	S063-SCX-023	S063-SCX-023	S063-SCX-024	S063-SCX-024	S063-SCX-024
	Date Collected	6/4/2017	6/5/2017	6/5/2017	6/5/2017	6/5/2017	6/5/2017	6/5/2017
	Depth (feet)	8.0 - 9.5	0 - 0.5	0.5 - 9.5	9.5 - 10.0	0 - 0.5	0.5 - 3.5	3.5 - 4.0
	Sample Category	subsurface	surface	subsurface	subsurface	surface	subsurface	subsurface
	Sample Collection Method	composite	grab	composite	grab	grab	composite	grab
	Media	soil	soil	soil	bedrock	soil	soil	soil
Analyte (Units)								
Metals[1] (mg/kg)	Investigation Level							
Arsenic	2.88	0.72	0.93	0.73	0.67	1.5	1	0.92
Molybdenum	0.334	<0.2	<0.2	<0.2	<0.2	0.43	0.27	<0.2
Selenium	NA	<0.99	<1	<1	<0.99	<1	<0.97	<0.98
Uranium	0.948	0.74	0.5	0.57	0.5 J	7.3	3.7	2.1
Vanadium	8.65	7.1	8.4	5.2	4.7 J	36	25	15
Radionuclides (pCi/g)								
Radium-226	0.895	0.57 ± 0.19	0.4 ± 0.16	0.57 ± 0.2	0.61 ± 0.18	4.03 ± 0.59	1.35 ± 0.3	1.61 ± 0.29

Notes

Bold	Bolded result indicates positively identified compound
Shaded	Shaded result indicates result greater than or equal to the investigation level
Shaded	Shaded result indicates analyte detected, where that analyte does not have an investigation level
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
NA	An investigation level is not identified because selenium sample results in BG-4 were all non-detect
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-diluted value
<	Result not detected above associated laboratory reporting limit
D	Sample dilution required for analysis; reported values reflect the dilution
J	Data are estimated due to associated quality control data
J-	Data are estimated and are potentially biased low due to associated quality control data

Table 4-5
Summary of Investigation Level Exceedances in Soil at Borehole Locations
NA-0928
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 1

Sample Location	Survey Area	Investigation Level Exceedances
S063-SCX-001	B	Static Gamma
S063-SCX-002[1,2]	A	As, Mo, Se, U, V, Ra-226, Static Gamma
S063-SCX-003	A	V, Static Gamma
S063-SCX-004[1,2]	A	As, Mo, Se, U, V, Ra-226, Static Gamma
S063-SCX-005[2]	A	Mo, V, Static Gamma
S063-SCX-006	A	U, V, Ra-226, Static Gamma
S063-SCX-008	C	V, Ra-226, Static Gamma
S063-SCX-009	C	As, U, V, Ra-226, Static Gamma
S063-SCX-010[2]	A	As, Mo, U, V, Ra-226, Static Gamma
S063-SCX-011[2]	A	As, Mo, U, V, Ra-226, Static Gamma
S063-SCX-012[1,2]	A	As, Mo, Se, U, V, Ra-226, Static Gamma
S063-SCX-013	C	Mo, U, V, Ra-226, Static Gamma
S063-SCX-014	C	V, Static Gamma
S063-SCX-015	C	Mo, U, V, Ra-226, Static Gamma
S063-SCX-016	C	Mo, Static Gamma
S063-SCX-017	C	Mo, U, V, Ra-226, Static Gamma
S063-SCX-018[2]	A	V, Static Gamma
S063-SCX-019[1,2]	A	As, Mo, Se, U, V, Ra-226, Static Gamma
S063-SCX-020	A	U, V, Ra-226, Static Gamma
S063-SCX-022	A	U, V, Ra-226, Static Gamma
S063-SCX-023	C	Static Gamma
S063-SCX-024	C	Mo, U, V, Ra-226, Static Gamma

Notes

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

[2] Detections of Mo included for reference, no IL was established for Mo for Survey Area A and Survey Area B

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

Table 4-6a
Water Sampling Investigation Level Derivation
NA-0928
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase

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
NA-0928
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 1

	Water Feature Identification	09T-546 /RV990317TNW002	09T-546 /RV990317TNW003	09T-546 /RV990317TNW004	09T-546 /RV990317TNW005
	Field Sample Identification	S059-WL-001	S059-WL-001	S059-WL-001	S059-WL-001
	Date Collected	9/29/2016	9/29/2016	5/24/2017	5/24/2017
	Matrix	Water Well	Water Well	Water Well	Water Well
	Preparation	Dissolved	Total	Dissolved	Total
Analyte (Units)					
Radionuclides (pCi/L)	Investigation Level				
Ra-226	5 [1]	NS	0 ± 0.074	NS	NS
Ra-228	5 [1]	NS	0 ± 0.33	NS	NS
Gross Alpha	--	NS	13.4 ± 2.7	NS	NS
Adjusted Gross Alpha [2]	15	NS	8.1	NS	NS
Gross Beta	--	NS	0 ± 1.4	NS	NS
Mercury (ng/L)					
Mercury	2000	NS	NS	0.6	1.6
Metals [3] (µg/L)					
Antimony	5.6	<0.3	<0.3	NS	NS
Arsenic	10	15	15	NS	NS
Barium	2000	7.9	8.2	NS	NS
Beryllium	4	<0.5	<0.5	NS	NS
Cadmium	5	<0.3	0.34	NS	NS
Chromium, Total	100	<10	<10	NS	NS
Cobalt	--	<1	<1	NS	NS
Copper	1300	11	22	NS	NS
Lead	15	0.63	1.6	NS	NS
Molybdenum	--	4.5	4.5	NS	NS
Nickel	610	<5	<5	NS	NS
Selenium	50	<1	<1	NS	NS
Silver	35	<0.1	<0.1	NS	NS
Thallium	2	<0.2	<0.2	NS	NS
Uranium	30	7.3	7.9	NS	NS
Vanadium	--	13	14	NS	NS
Zinc	2100	520	960	NS	NS
General Chemistry Parameters (mg/L)					
TDS	500	--	620	NS	NS
Carbonate	--	--	20	NS	NS
Bicarbonate	--	--	240	NS	NS
Chloride	250	--	11	NS	NS
Sulfate	250	--	40	NS	NS
Calcium	--	1400	1700	NS	NS
Sodium	--	140000	150000	NS	NS
Field Parameters					
Oxidation Reduction Potential(millivolts)	--	NS	105.9	NS	138.6
pH(pH units)	--	NS	8.79	NS	8.99
Salinity(PPTV)	--	NS	0.3	NS	--
Specific Conductivity(µS/cm)	--	NS	1215	NS	589
Temperature(°C)	--	NS	18.2	NS	17.2
Turbidity(NTU)	--	NS	13.3	NS	3.16

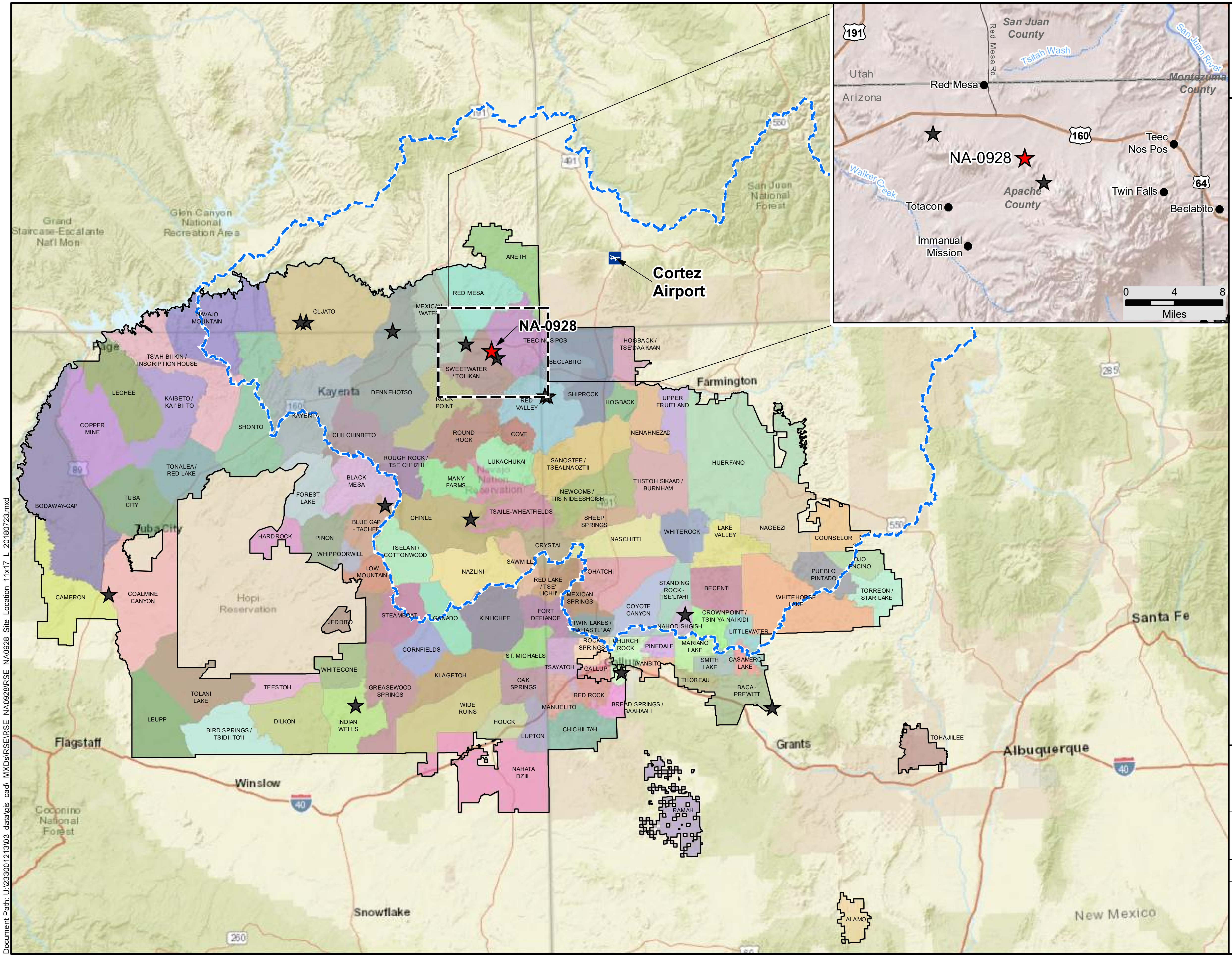
Notes

Bold	Bolded result indicates positively identified compound
Shaded	Shaded result indicates result or reporting limit greater than or equal to the investigation level
°C	Degrees Celsius
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
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
NA	not applicable
NAD	North American Datum
NAVD88	North American Vertical Datum of 1988
pCi/g	picocuries per gram
Ra	radium-226
Ra-226	radium-226
Se	selenium
TENORM	Technologically Enhanced Naturally Occurring Radioactive Materials
uk	unknown
U	uranium
UTL	upper tolerance limit
UTM	Universal Transverse Mercator
V	vanadium



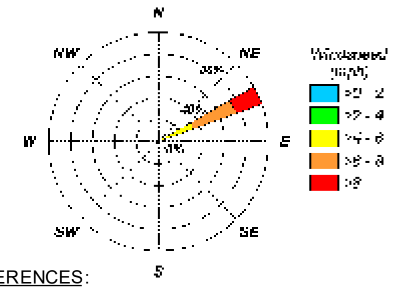
NAVAJO NATION

AUM Environmental Response Trust-First Phase

LEGEND

★	NA-0928 Mine Site
★	Priority Abandoned Uranium Mine (AUM) Site
●	Populated Place
	US Highway
	State Highway
	Major Road
	Stream
	Intermittent Stream
	San Juan Watershed
	Navajo Nation Boundary
	Navajo Nation Chapter

Cortez Airport, Colorado Wind Rose (KCEZ), 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

N
W E
S

0 25 50
Miles

TITLE:

Site Location

PROJECT:

Removal Site Evaluation
NA-0928 Mine Site

DATE: 7/24/2018

DOCUMENT NAME: Removal Site Evaluation Report

AUTHOR: CBB

REVIEWER: EDZ

Stantec

FIGURE: 1-1

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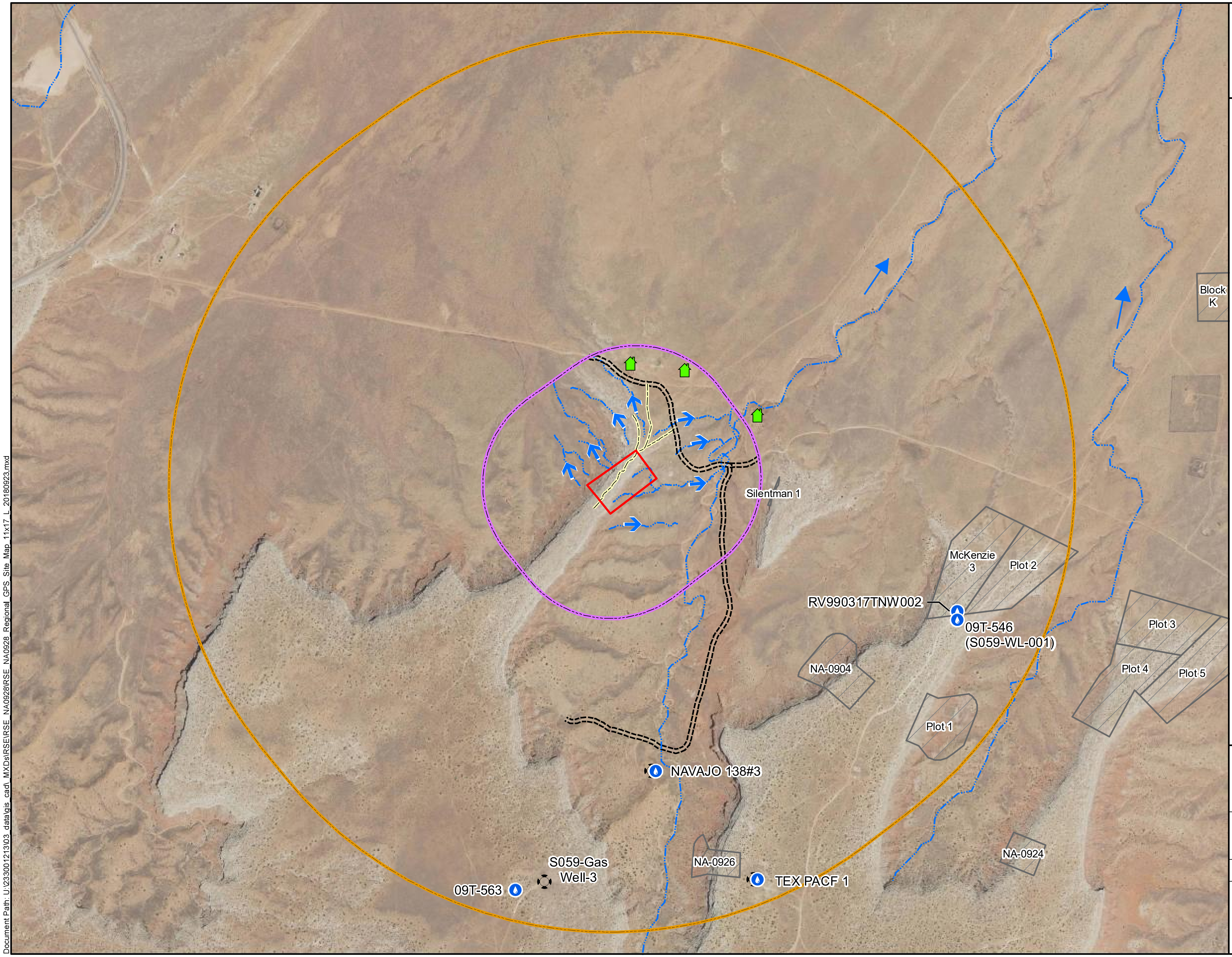

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

- 💧 Site Clearance Identified Potential Water Feature[1]
- ⊗ Oil / Gas Well[2]
- 🟩 Habitable Building
- ↑ Flow Direction
- Intermittent Stream/River
- Potential Haul Road
- Road
- 🟥 Claim Boundary
- 1/4-Mile Claim Boundary Buffer
- 1-Mile Claim Boundary Buffer
- Other Claim Boundary

NOTES:

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

2. S059-Gas Well-3 identified during site mapping.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agriculture Imagery Program (NAIP) web mapping service (https://gis.apfo.usda.gov/arcgis/services/) on 9/23/2018

N W E S

0 1,200 2,400
Feet

TITLE:

Site Features

PROJECT:

Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/23/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 2-1

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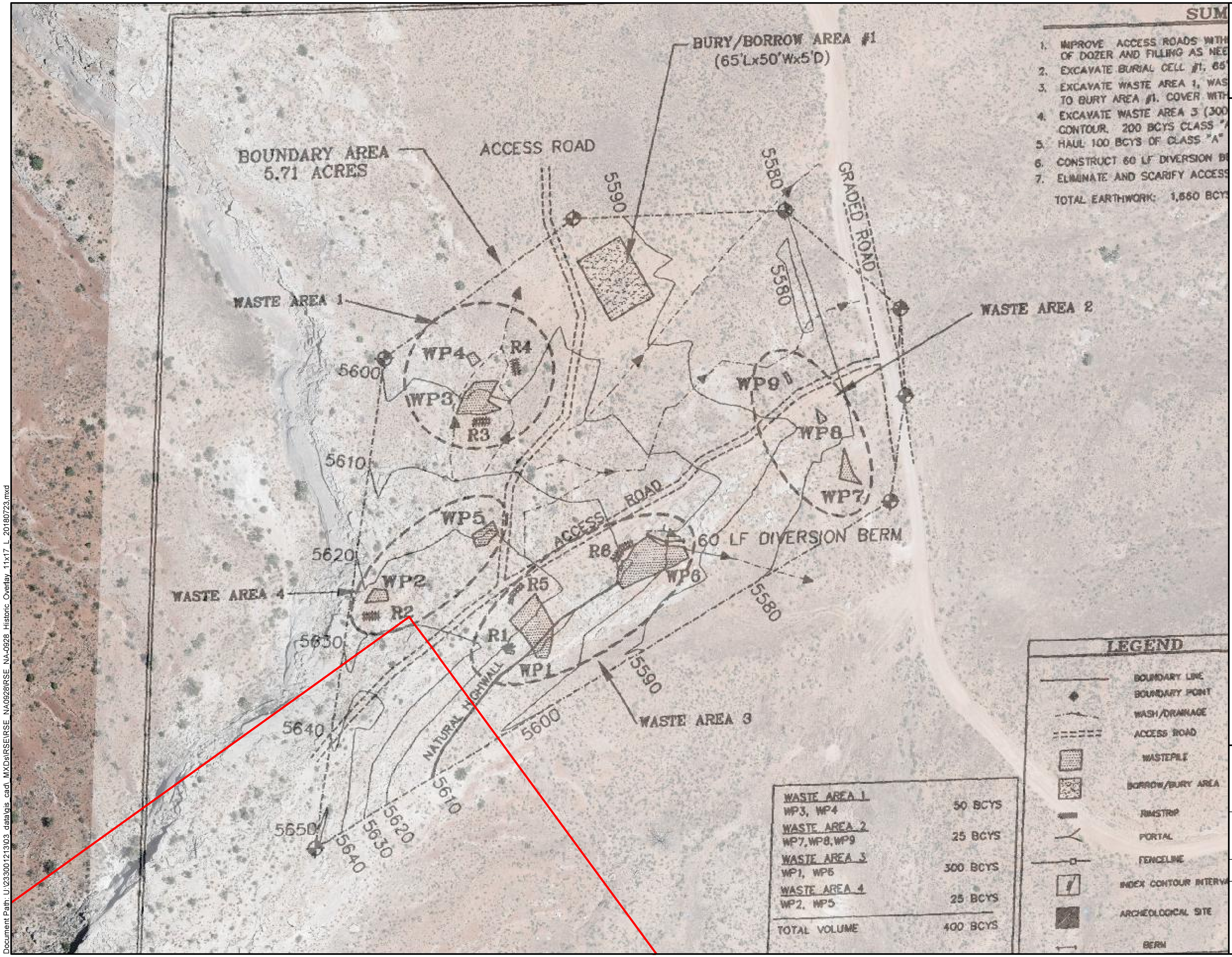

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

🟥 Claim Boundary

NOTES:
Historical site drawing scale and orientation is approximate due to lack of tie points needed for georeferencing.

WP = Waste Pile

R1 = Rim Strip 1

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Historical Site Drawing:
Navajo Abandoned Mine Land Reclamation Program (NAML), 2000. Technical Specifications, Tsetah Reclamation Project, Tsetah, Arizona.

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

N
W E
S

0 100 200
Feet

TITLE:
Historical Mine Drawing Overlay

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 7/23/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 2-2

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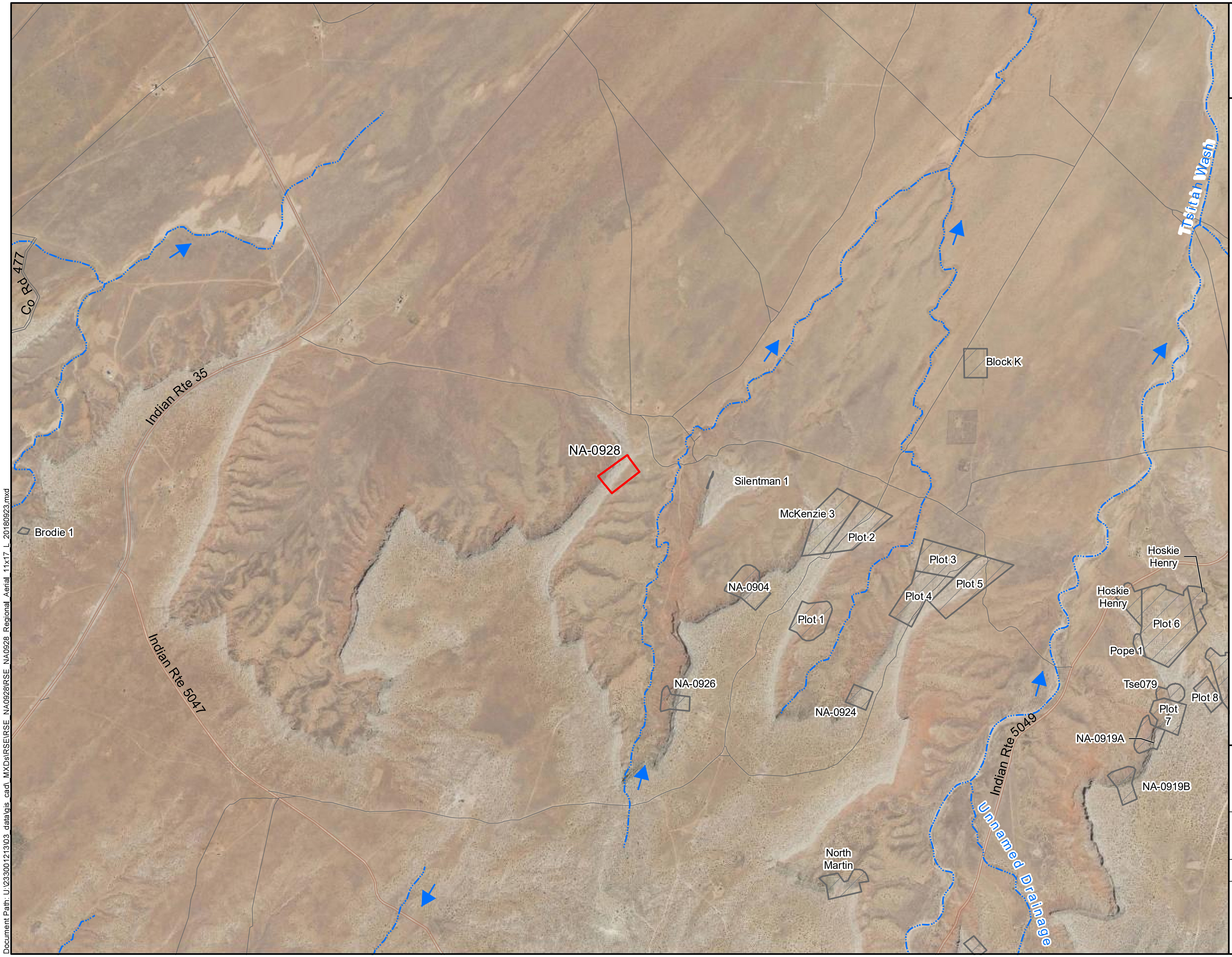

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NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

↑	Flow Direction
-··-··-	Intermittent Stream/River
═	Tribal Road
═	County Road
—	Local Road
🟥	Claim Boundary
▨	Other Claim Boundary

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agriculture Imagery Program (NAIP) web mapping service (https://gis.apfo.usda.gov/arcgis/services/) on 9/23/2018

N
W E
S

0 2,000 4,000
Feet

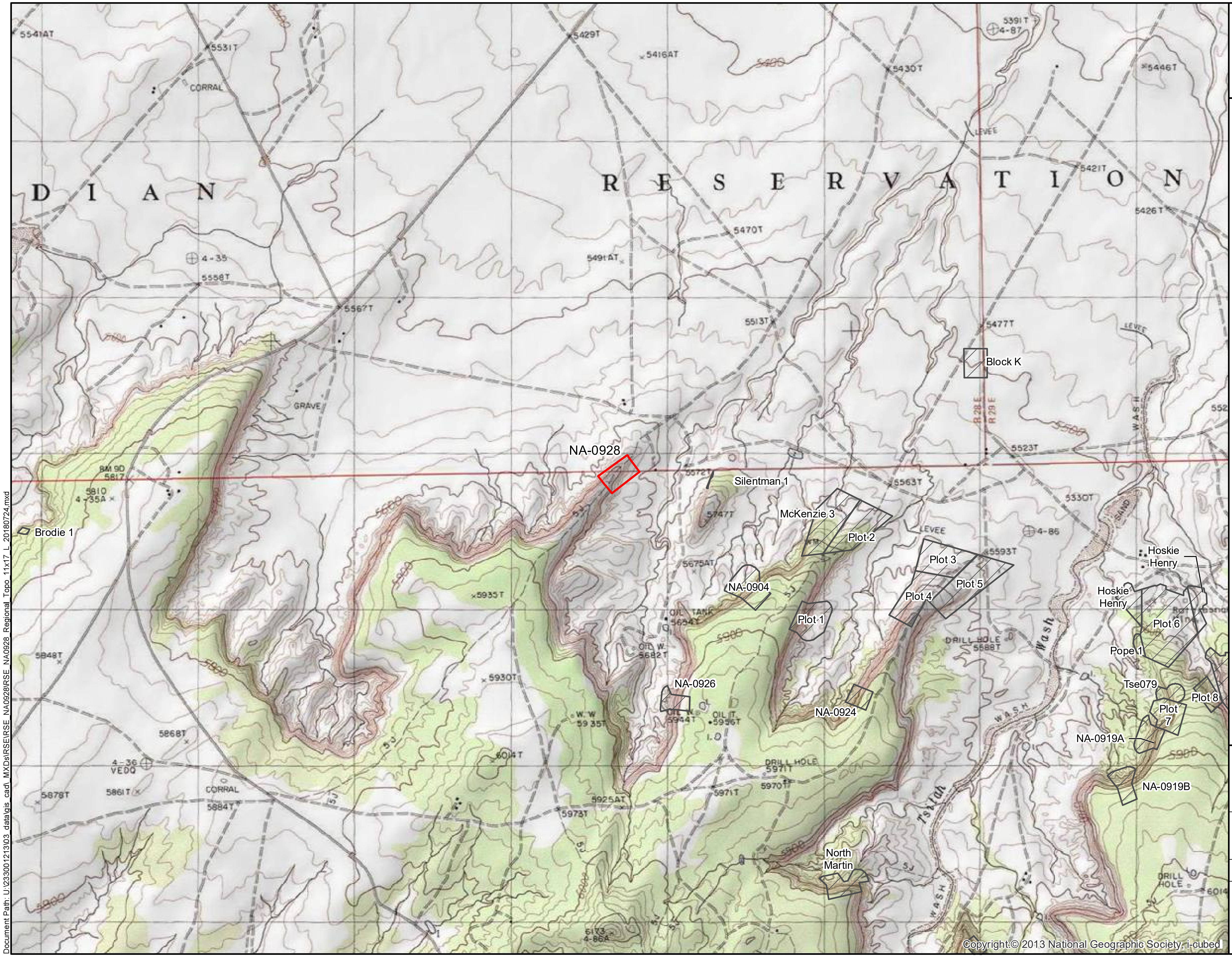
TITLE:
Regional Aerial Photograph

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/23/2018
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB
REVIEWER: EDZ
FIGURE: 2-3



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

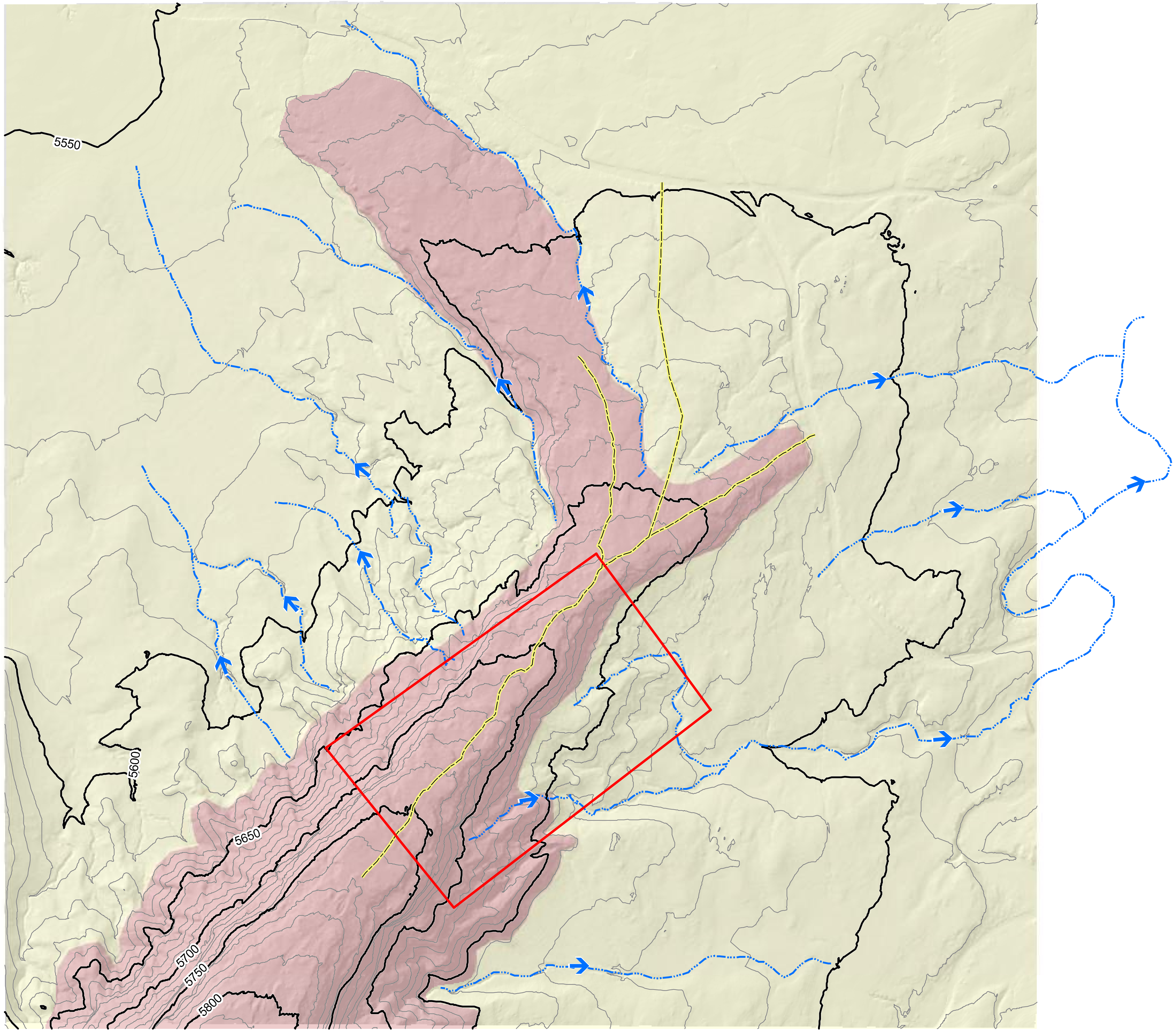
TITLE:
Regional Topographic Map

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 7/24/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: CBB
REVIEWER: EDZ
FIGURE: 2-4

Stantec

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_NA0928\RSE_NA0928_Regional_Topo_11x17_L_20180724.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

↑	Flow Direction
-·-·-	Drainage
- - -	Potential Haul Road
∼	Index Contour (50 ft Interval)
∼	Intermediate Contour (10 ft Interval)
□	Claim Boundary

Geomorphology Features

🟥	Mesa
🟨	Plains

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

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

0 250 500
Feet

TITLE:
Site Topography

PROJECT:
Removal Site Evaluation
NA0928 Mine Site

DATE: 7/24/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: EDZ

REVIEWER: CBB

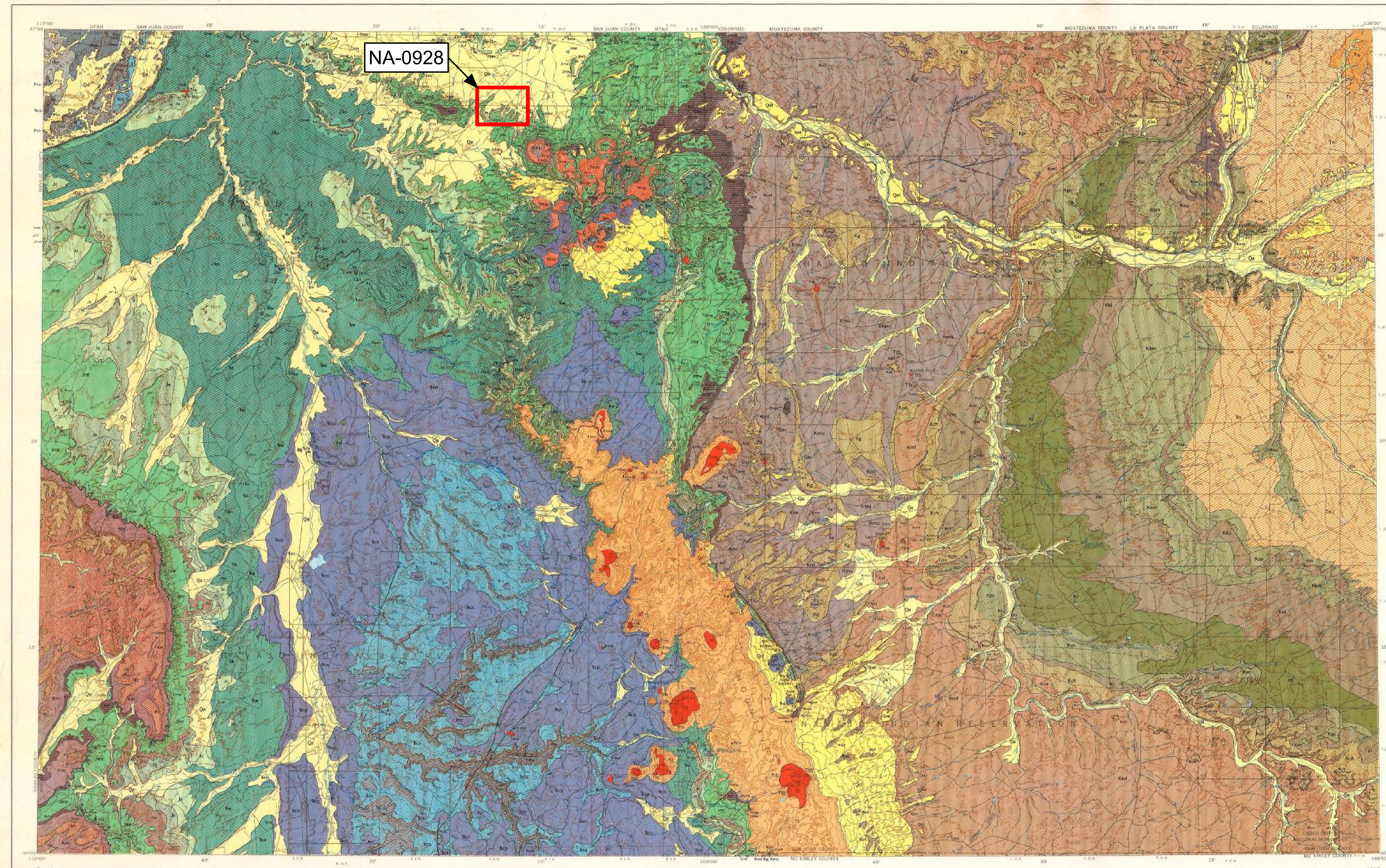
FIGURE: 2-5

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE\RSE NA0928\RSE NA0928 Site Topo 11x17 L 20180724.mxd

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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

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



Base from Army Map Service Shiprock sheet, 1954

SCALE 1:250 000

CONTOUR INTERVAL 200 FEET
DATUM IS MEAN SEA LEVEL

Geology compiled in 1958

EXPLANATION

QUATERNARY

Recent

Qa Alluvium
Unconsolidated surficial deposits of valley fill, mainly stream-deposited silt, sand, and gravel, but includes some wind-blown sand and silt, colluvial material, and locally, low-level terrace gravels. In the Monument Valley area also includes unconsolidated gravel in a matrix of fine- to medium-grained sand

Qel Landslide debris
Unconsolidated surficial masses of broken rock mostly along the east side of the Chuska Mountains where composed predominantly of Chuska sandstone; one large landslide in the Mesa Verde area is composed mainly of Cliff House sandstone

Qat Terrace gravel
Surficial veneer of unconsolidated gravel and sand on stream-cut terrace surfaces along and near the San Juan River

Qap Pediment gravel
Surficial veneer of unconsolidated gravel and boulder debris on pediment surfaces around the Carrizo Mountains, near Mexican Water, east of the Chuska Mountains, and around Barker Dome

TERTIARY

Pliocene

Tt Trachybasalt[1]
Intrusive and extrusive basaltic rock composed of diopside, biotite-phlogopite, sanidine, and accessory minerals; locally, some glass

Tsb Serpentine-bearing[1] breccia
Includes large and small fragments of sedimentary and crystalline rocks with variable amounts of comminuted serpentine and accessory diopside, mica, and garnets of unknown origin

Tmi Minette[1]
Intrusive basaltic rock composed of diopside, biotite-phlogopite, and sanidine and accessory minerals

Tmq Monchiquite[1]
Intrusive basaltic rock composed of augite, analcite, and accessory minerals

Ttb Tuff-breccia[1]
Trachybasalt tuff and tuff-breccia, breccia, and subordinate trachybasalt agglomerate. Locally includes small dikes and irregular bodies of minette and sparse to abundant large blocks and small fragments of sedimentary rocks

Pliocene(?)

Tc Chuska sandstone
Light-brown, yellowish-gray to white crossbedded sandstone and little interbedded reddish-brown siltstone and shale

Eocene

Tsj San José formation of Simpson (1948)
Buff, massive sandstone and conglomeratic sandstone and interbedded gray and red shale

Paleocene

Tbr Brecciated rocks
Brecciated sandstone cemented by veinlets of quartz; earlier fractured diorite porphyry containing sparse pyrite and rare chalcopyrite

Tn Nacimiento formation
Gray and brown shale and tan medium-grained and conglomeratic sandstone

TKdp Diorite porphyry
Diorite porphyry in sills, laccoliths, and dikes of the Carrizo Mountains; composed of abundant phenocrysts of plagioclase (andesine), hornblende, and locally, quartz in a groundmass of feldspar and quartz; contains abundant hornblendic inclusions. Also includes some dacite intrusives composed of phenocrysts of andesine, quartz, and hornblende in an aphanitic groundmass of quartz, feldspar, and glass

CRETACEOUS

Upper Cretaceous

Kos Ojo Alamo sandstone
Tan fine- to coarse-grained and conglomeratic sandstone

Ka Animas formation
Purple and greenish shale, moderate-yellow and light-gray sandstone and conglomerate. Along the La Plata River only the lower part of the Animas formation is present

Kku / Kkm / Kkl Kirtland shale
Kku, *upper shale member, greenish-gray.*
Kkm, *Farmington sandstone member, tan, fine- to medium-grained*
Kkl, *lower shale member, greenish-gray*

× **Kf** Fruitland formation*
Gray, brown, and black shale, yellowish-brown and tan crossbedded sandstone, and coal

Kkf Kirtland shale and Fruitland formation*
Greenish-gray shale and siltstone, light-gray sandstone, and carbonaceous shale. This unit only occurs in the Chuska Mountains area south of Toadlena

Kpc Pictured Cliffs sandstone*
Tan crossbedded medium- to massive-bedded fine- to medium-grained sandstone. In a small area approximately eight miles east of Newcomb where the Lewis shale is absent, the Pictured Cliffs sandstone cannot be separated from the underlying Cliff House sandstone and is mapped with the Cliff House sandstone

Kl Lewis shale*
Light to dark-gray shale, concretionary beds of limestone, and, especially in the upper and lower transitional zone, thin platy beds of sandstone

Mesaverde group

Kch Cliff House sandstone*
Tan and gray crossbedded fine- to medium-grained sandstone with varying amounts of interbedded gray shale. Locally Cliff House sandstone includes tongues of the Menefee formation

Kmf Menefee formation*
Alternating beds of tan and brown sandstone, gray and brown claystone and shale; coal; and scattered layers of ironstone and limestone concretions

Kpl / Kph Point Lookout sandstone*
Tan and brown sandstone with lesser amounts of gray shale. In the Toadlena-Crystal area the Hosta tongue, Kph, is separated from the main body of the Point Lookout by the Satan tongue of the Mancos shale

Ky Yale Point sandstone
Yellowish-gray, coarse- to medium-grained crossbedded sandstone

Kcc Crevasse Canyon formation*
Alternating beds of tan irregularly bedded and lenticular sandstone, drab shale, claystone, and coal; consists of three members, the Gibson coal, Dalton sandstone and Dilco coal member equivalent. As mapped in one small area 4 miles southeast of Crystal it consists of Gibson coal member and Dalton sandstone member and includes the Mulatto tongue of the Mancos shale. The Dilco coal member equivalent of the Crevasse Canyon formation and stray sandstone of Sears, Hunt, and Hendricks (1941) are mapped with the Gallup sandstone

Kw Wepo formation
Interbedded light-gray and olive-drab shaly siltstone, yellowish-gray sandstone, and coal

× **Kt** Toreva formation
Light-brown and yellowish-gray fine- to coarse-grained sandstone and lesser amounts of gray siltstone and carbonaceous shale

Kg / Kcs Gallup sandstone and Dilco coal member equivalent and stray sandstone of Sears, Hunt, and Hendricks (1941)*
Tan, brown, and pinkish-gray, thin- to massive-bedded, very fine- to very coarse-grained sandstone, with lesser amounts of brown carbonaceous shale, gray shale, and some thin coal seams. South of the San Juan River the Gallup sandstone and Dilco equivalent grade into Mancos shale. Between this pinchout and the San Juan River only the stray sandstone, Kcs, is shown. North of the San Juan River the stray sandstone is mapped with the Mancos shale

Lower and Upper Cretaceous

Kmu / Kms / Kmm / Kml / Km Mancos shale*
Predominantly light- to dark-gray marine shale with subordinate tan fine-grained sandstone and siltstone and bedded or concretionary limestone. North of the San Juan River includes the stray sandstone of Sears, Hunt, and Hendricks (1941). South of the San Juan River the Mancos shale, Km, is divided by the Gallup sandstone into upper, Kmu, and lower, Kml, parts. South of Toadlena the upper part of the Mancos intertongues with other units of the Mesaverde to form the Satan tongue, Kms, and the Mulatto tongue, Kmm. In a small area 4 miles southeast of Crystal the Mulatto tongue is mapped with the Crevasse Canyon formation. On Black Mesa the Mancos shale, Km, is not divided.

Kmd Mancos shale and Dakota sandstone, undifferentiated
On Black Mesa and at Black Rock Point in the Carrizo Mountains the Dakota sandstone is mapped locally with the Mancos shale

Kd Dakota sandstone
Tan, brown, and gray sandstone, conglomeratic sandstone, brownish-gray shale, and lenses of coal

UNCONFORMITY

JURASSIC

Middle and Upper Jurassic

× **Jmb / Jmw / Jmr / Jms / Jmu / Jml / Jm** Morrison formation
Jmb, *Brushy Basin member, green, purple, and gray shale and siltstone; gray and tan sandstone and conglomeratic sandstone may locally include the Burro Canyon formation. The Brushy Basin member may be present at Yale Point but not elsewhere on Black Mesa.*
Jmw, *Westwater Canyon member, yellowish-gray sandstone with conglomeratic lenses, and greenish-gray sandy shale.*
Jmr, *Recapture member, white and brown fine- to medium-grained sandstone, siltstone, and dark reddish-brown shale.*
Jms, *Salt Wash member, white and moderate-orange, very fine- to medium-grained sandstone, and grayish-red shale.*
In some areas the members of the Morrison formation are not shown separately, Jm; in other areas it is divided into upper, Jmu, and lower, Jml, parts. Locally in the Carrizo Mountains and along the east side of the Chuska Mountains south of the limit of deposition of the Salt Wash member, the Brushy Basin, Westwater Canyon, and Recapture members are mapped together, Jmbwr

Jcs Cow Springs sandstone
Greenish-gray to light yellowish-gray, fine- to medium-grained crossbedded sandstone, which tongues and grades into members of the Morrison formation and grades into the Summerville formation of the San Rafael group

San Rafael group

Js Summerville formation
Moderate reddish-brown fine- to medium-grained sandstone and argillaceous siltstone. In the Carrizo Mountains area the Bluff sandstone, a medium-grained and friable, very pale orange to pale reddish-brown, crossbedded sandstone, is mapped with the Summerville formation. In the Yale Point-Red Point area a tongue of the Cow Springs sandstone is mapped with the Summerville. Southeast of Lohali Point the Summerville formation grades laterally into the Cow Springs sandstone

Jse Summerville and Entrada formations undifferentiated

Jte Todilto and Entrada formations undifferentiated
In the Horse Mesa-Beautiful Mountain area and in the southeastern part of Bitlabito dome

× **Jt** Todilto limestone
Gray thin-bedded limestone and reddish-brown sandy shale and siltstone

Je Entrada sandstone
Reddish-brown fine-grained sandstone and siltstone

Jste Summerville, Todilto, and Entrada formations undifferentiated

Jsec Summerville, Entrada, and Carmel formations undifferentiated

Jc Carmel formation
Dark grayish-red claystone, siltstone, and interbedded reddish-orange sandstone

Upper Triassic(?)

Glen Canyon group

Jn Navajo sandstone
Light-brown and pale-orange, fine- to medium-grained crossbedded sandstone

Jk Kayenta formation
Lenticular pale-red to reddish-brown sandstone, siltstone, grit, conglomerate, and minor limestone

JTrnk Navajo sandstone and Kayenta formation
Navajo and Kayenta are too thin to be mapped separately

TRIASSIC

Upper Triassic

Trw Wingate sandstone
South of Laguna Creek includes the upper, Lukachukai member, pale reddish-brown, fine- to medium-grained crossbedded sandstone, and a lower, Rock Point member, pale reddish-brown silty sandstone and siltstone. North of Laguna Creek the Lukachukai member constitutes the entire Wingate sandstone and the Rock Point member is classified as the Church Rock member of the Chinle formation

× **Trco / Trcp / Trcr / Trcs / Trcu / Trc** Chinle formation
In most of the map area the Chinle is divided into:
Trco, *Owl Rock member, interbedded limestone and reddish-brown siltstone.*
Trcp, *Petrified Forest member, blue to white bentonitic claystone and minor amounts of siltstone and sandstone.*
Trcr, *the red member, dark reddish-brown bentonitic siltstone, sandstone, and lime-pellet conglomerate.*
Trcs, *Shinarump member, moderate-orange and yellowish-gray sandstone, siltstone, conglomerate, and sandy shale.*
In the Monument Valley area the Chinle formation is divided into an upper unit, Trcu, which consists in descending order of the Church Rock member, Owl Rock member, Petrified Forest member and Monitor Butte member; and the Shinarump member, Trcs, at the base.
Trc, *members of the Chinle formation not shown separately in the southeastern part of the Carrizo Mountains area and along the east side of the Chuska Mountains*

UNCONFORMITY

TRIASSIC(?)

Lower(?) Triassic, and Lower and Middle(?) Triassic

Trm Moenkopi formation
Upper part, chocolate- to reddish-brown, even-bedded ripple-marked shaly siltstone, overlying the Hoskininni member, reddish-brown, even-bedded siltstone and some interbedded sandstone; the Moenkopi pinches out eastward approximately under Chinle Wash. In Monument Valley the Moenkopi formation is mapped locally with the underlying De Chelly sandstone member of the Cutler formation, Pcd

PERMIAN

Pcd / Pco / Pcc / Pch Cutler formation
In Monument Valley the Cutler is divided into:
Pcd, *De Chelly sandstone member, buff massive crossbedded sandstone.*
Pco, *Organ Rock tongue, reddish-brown even-bedded siltstone locally interbedded with lenses of red to gray sandstone.*
Pcc, *Cedar Mesa sandstone member, orange-brown crossbedded sandstone with thin lenticular interbeds of light-gray limy siltstone.*
Pch, *Halgaito tongue, reddish-brown shaly siltstone and silty sandstone with thin lenticular beds of light-gray limestone*

Pcd / Pcl Cutler formation
In the Carrizo Mountains area:
Pcd, *De Chelly sandstone member, reddish- to grayish-orange and crossbedded.*
Pcl, *lower member, conglomeratic red arkosic sandstone and red, green, and gray claystone*

Pdc De Chelly sandstone
Reddish-orange and pale-orange crossbedded sandstone; in De Chelly upwarp

PENNSYLVANIAN AND PERMIAN

PPs Supai formation
Reddish-brown and reddish-orange fine-grained sandstone and siltstone with some thin lenses of limestone

Contact
Dashed where approximately located

Fault, showing downthrown side
Dashed where approximately located

Jte Jt Je

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

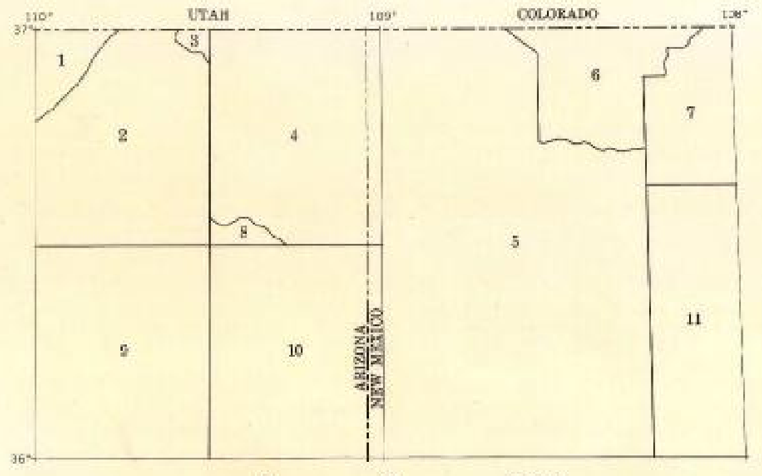
×
Uranium-bearing formation or member

*See schematic diagram

[1]

REFERENCES CITED IN EXPLANATION

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

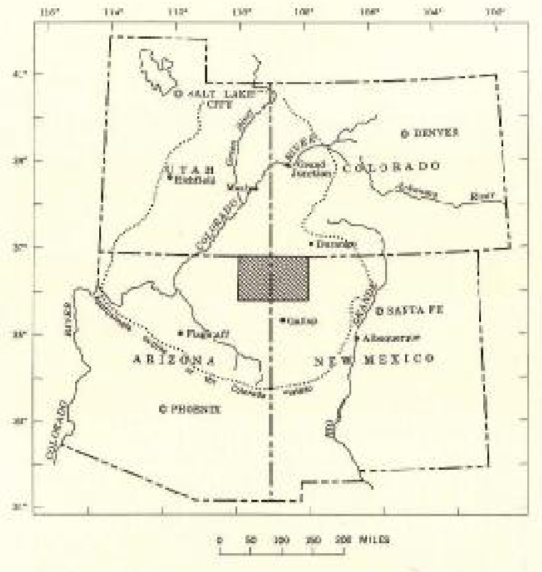


INDEX MAP SHOWING SOURCES OF GEOLOGIC DATA

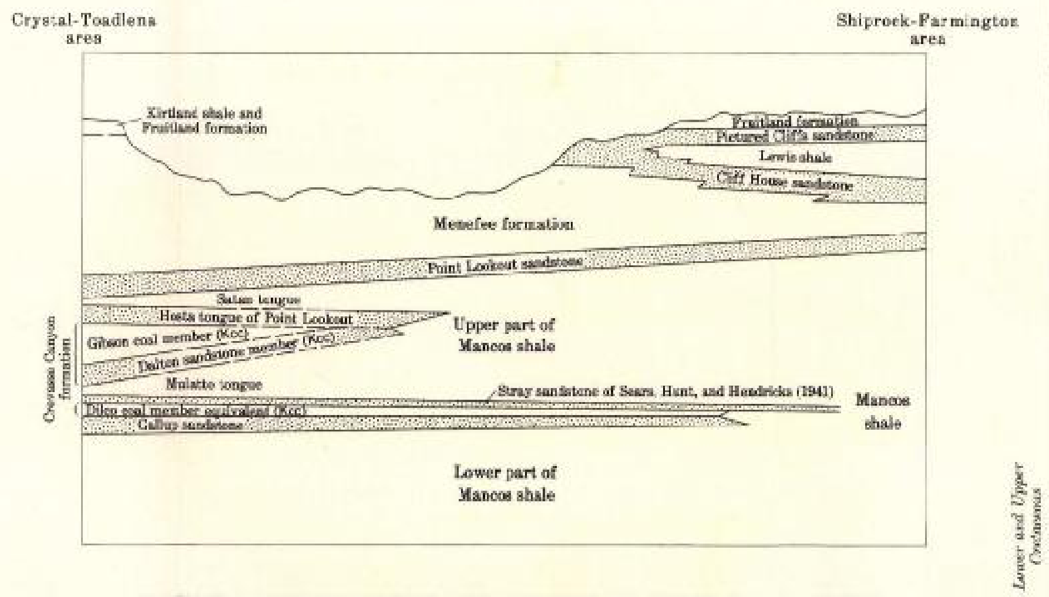
GEOLOGIC SOURCES

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

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



INDEX MAP SHOWING AREA OF SHIPROCK QUADRANGLE



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

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

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

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

NAVAJO NATION
AUM Environmental Response Trust-First Phase

TITLE:
Regional Geology

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 7/23/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: CBB
REVIEWER: EDZ
FIGURE: 2-6

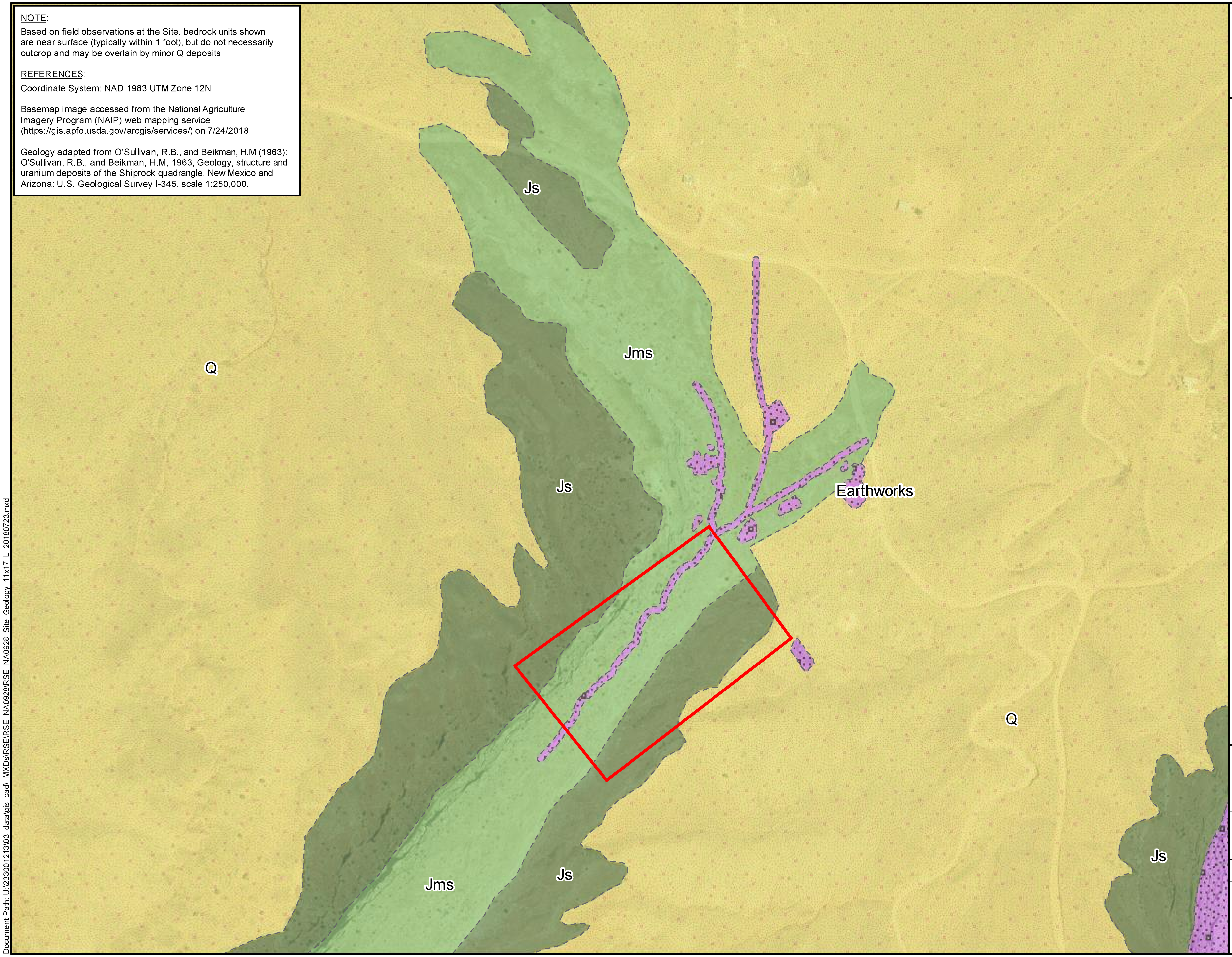
Stantec

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

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agriculture Imagery Program (NAIP) web mapping service (https://gis.apfo.usda.gov/arcgis/services/) on 7/24/2018

Geology adapted from O'Sullivan, R.B., and Beikman, H.M (1963): O'Sullivan, R.B., and Beikman, H.M, 1963, Geology, structure and uranium deposits of the Shiprock quadrangle, New Mexico and Arizona: U.S. Geological Survey I-345, scale 1:250,000.



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

🟥 Claim Boundary

- - - Geologic Contact (Inferred)

Site Geology

HOLOCENE

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

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

JURASSIC

🟩 Jms: Salt Wash Member of the Morrison Formation (Upper Jurassic) – white and moderate-orange, very fine- to medium-grained sandstone, and grayish-red shale.

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

N
W E
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0 300 600
Feet

TITLE:
Site Geology

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 7/24/2018
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB
REVIEWER: EDZ
FIGURE: 2-7a

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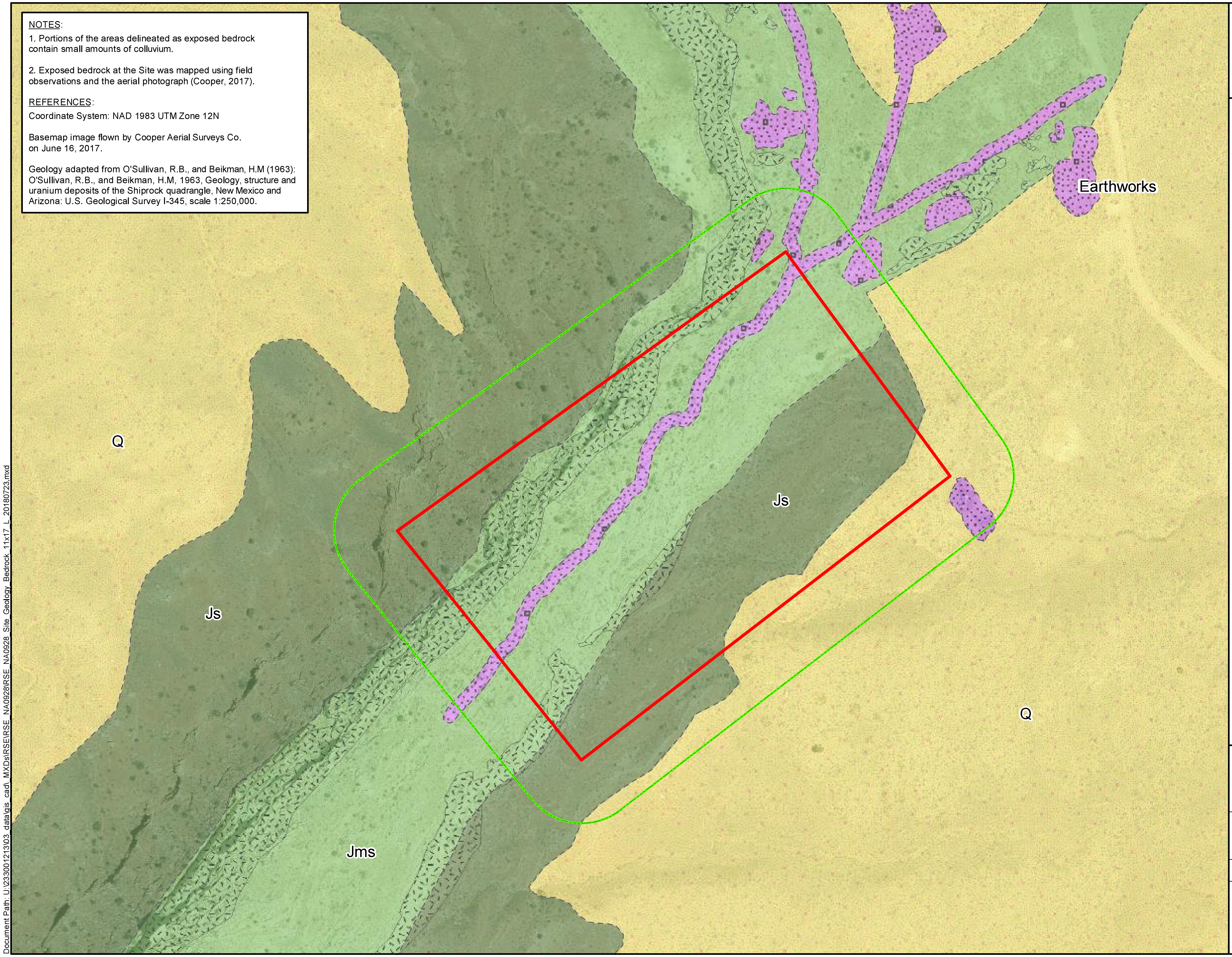


NOTES:

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

Geology adapted from O'Sullivan, R.B., and Beikman, H.M (1963): O'Sullivan, R.B., and Beikman, H.M, 1963, Geology, structure and uranium deposits of the Shiprock quadrangle, New Mexico and Arizona: U.S. Geological Survey I-345, 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 or reclamation.

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

JURASSIC

🟩 Jms: Salt Wash Member of the Morrison Formation (Upper Jurassic) – white and moderate-orange, very fine- to medium-grained sandstone, and grayish-red shale.

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

N
W E
S

0 150 300
Feet

TITLE:

Site Exposed Bedrock

PROJECT:

Removal Site Evaluation
NA-0928 Mine Site

DATE: 7/24/2018

DOCUMENT NAME: Removal Site Evaluation Report

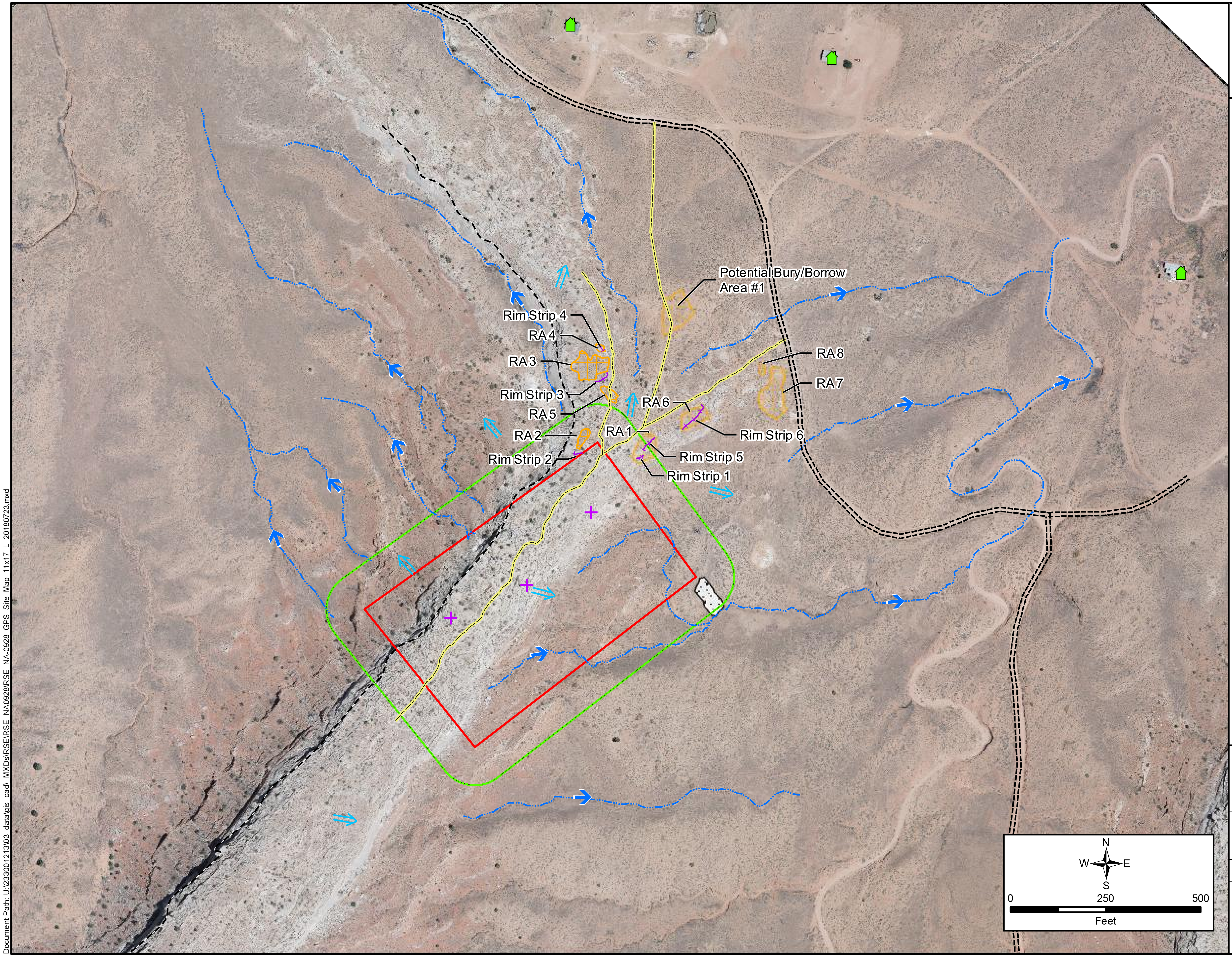
AUTHOR: CBB

REVIEWER: EDZ

Stantec

FIGURE: 2-7b

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_NA0928\RSE_NA0928_Site_Geology_Bedrock_11x17_L_20180723.mxd



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

⌂	Habitable Building
↑	Flow Direction
⇑	Approximate Overland Water Flow Direction
+	Rim Strip Location per 2007 AUM Atlas[1]
+++++	Rim Strip (Buried - Location Approximate)
- - - -	Approximate Edge of Mesa
-·-·-	Drainage
- - - -	Potential Haul Road
=======	Road
▨	Debris
▦	Mining / Reclaimed Disturbed Area
□	Claim Boundary
□	100-Foot Claim Buffer

NOTES:

1. Rim strips as shown in the 2007 AUM Atlas were not observed during field mapping (USEPA, 2007a).

2. Reclamation areas (RA) are numbered consistent with NAML records. Waste piles have been reclaimed / covered, although erosion of cover material has occurred in some locations.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

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

TITLE:

Site Map

PROJECT:

Removal Site Evaluation
NA-0928 Mine Site

DATE: 7/24/2018	DOCUMENT NAME: Removal Site Evaluation Report
Stantec	AUTHOR: CBB REVIEWER: EDZ
	FIGURE: 2-8a

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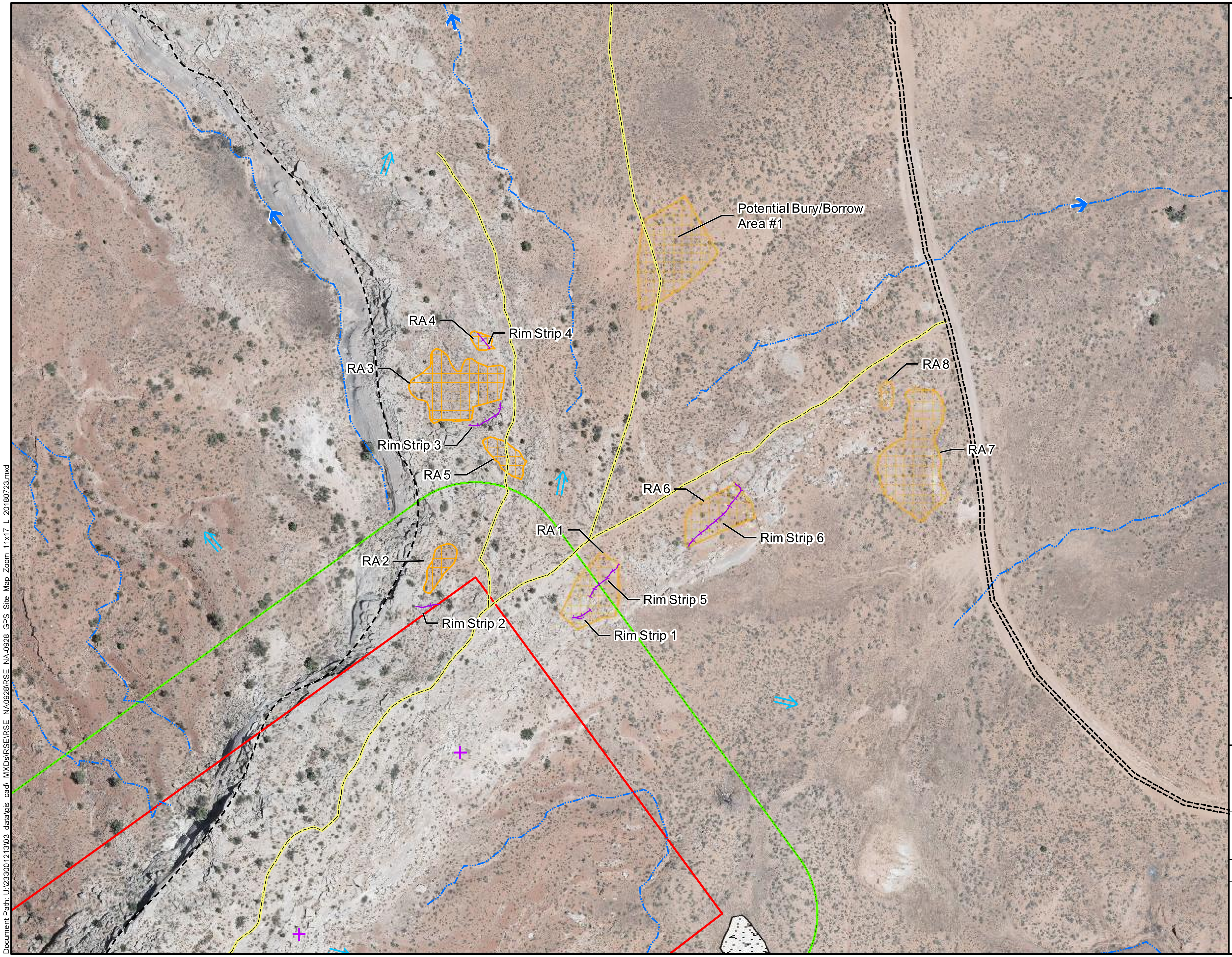


NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

↑	Flow Direction
⇑	Approximate Overland Water Flow Direction
+	Rim Strip Location per 2007 AUM Atlas¹
+++++	Rim Strip (Buried - Location Approximate)
- - - -	Approximate Edge of Mesa
-··-··-	Drainage
-----	Potential Haul Road
========	Road
▨	Debris
▦	Mining / Reclaimed Disturbed Area
🟥	Claim Boundary
🟩	100-Foot Claim Buffer

NOTES:

1. Rim strips as shown in the 2007 AUM Atlas were not observed during field mapping (USEPA, 2007a).

2. Reclamation areas (RA) are numbered consistent with NAML records. Waste piles have been reclaimed / covered, although erosion of cover material has occurred in some locations.

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:
Mine Claim Area
Site Map

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 7/24/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

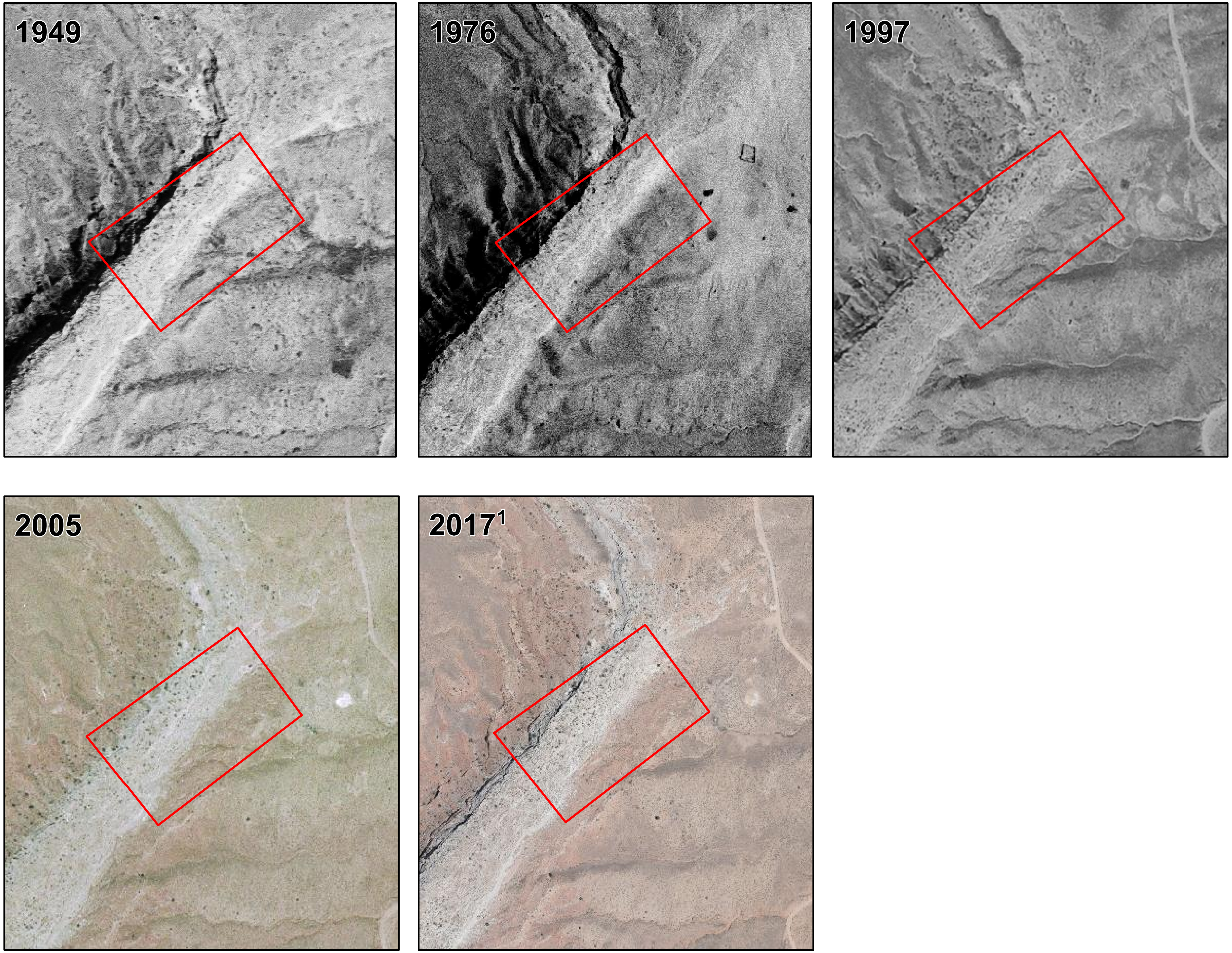
AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 2-8b

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\RSE NA-0928 GPS Site Map Zoom 11x17 L 20180723.mxd

NAVAJO NATION
AUM Environmental Response Trust-First Phase



LEGEND

▭ NA-0928 Claim Boundary

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

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

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

N
W E
S

0 400 800
Feet

TITLE:
Historical Aerial
Photograph Comparison

PROJECT:
Removal Site Evaluation
NA0928 Mine Site

DATE: 7/24/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: WDC

REVIEWER: CBB

FIGURE: 3-1a

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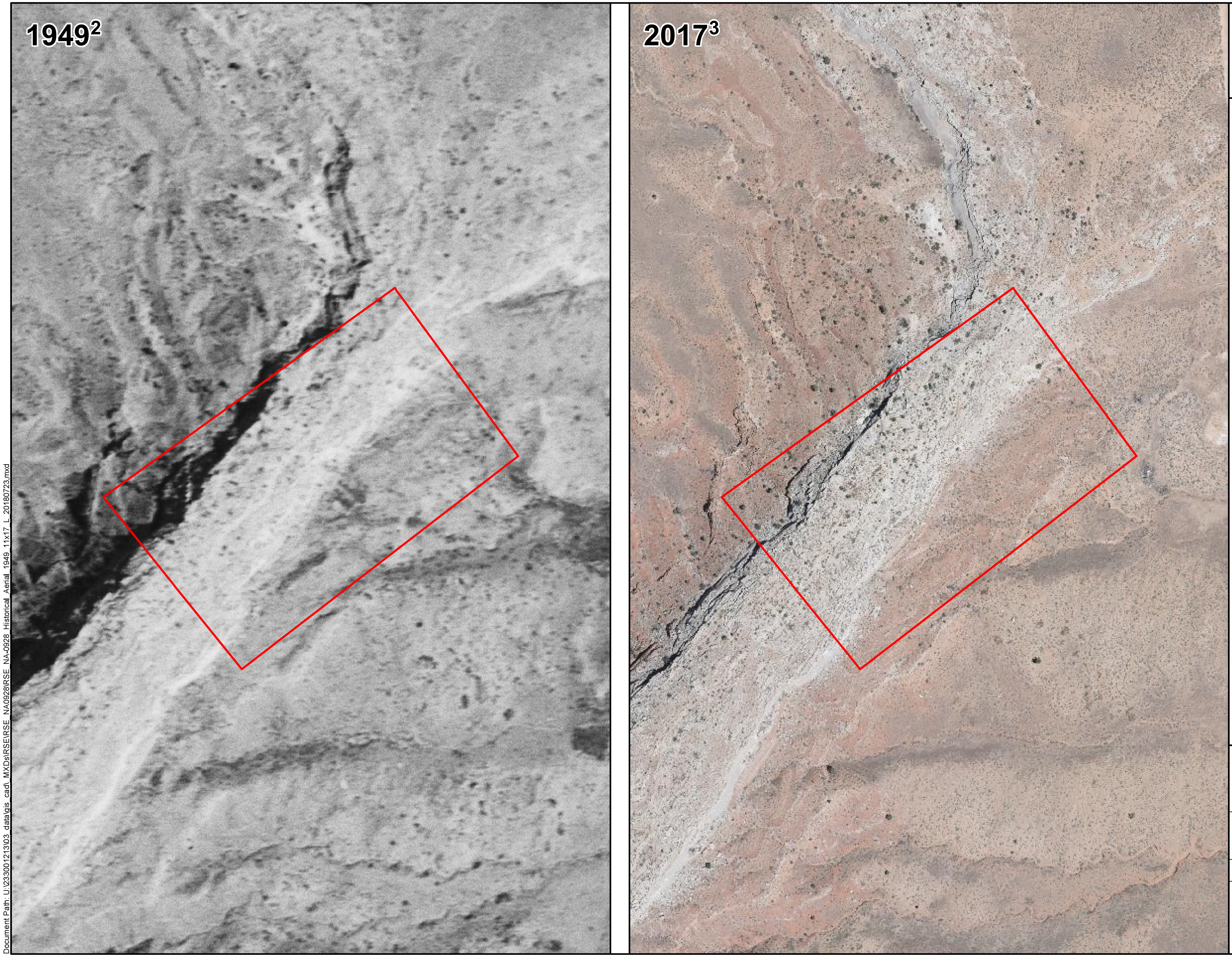


NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

🟥 Claim Boundary

REFERENCES:

1. Coordinate System: NAD 1983 UTM Zone 12N

2. 1949 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

0 200 400
Feet

TITLE:
1949 Historical Aerial Photograph Comparison

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 7/23/2018

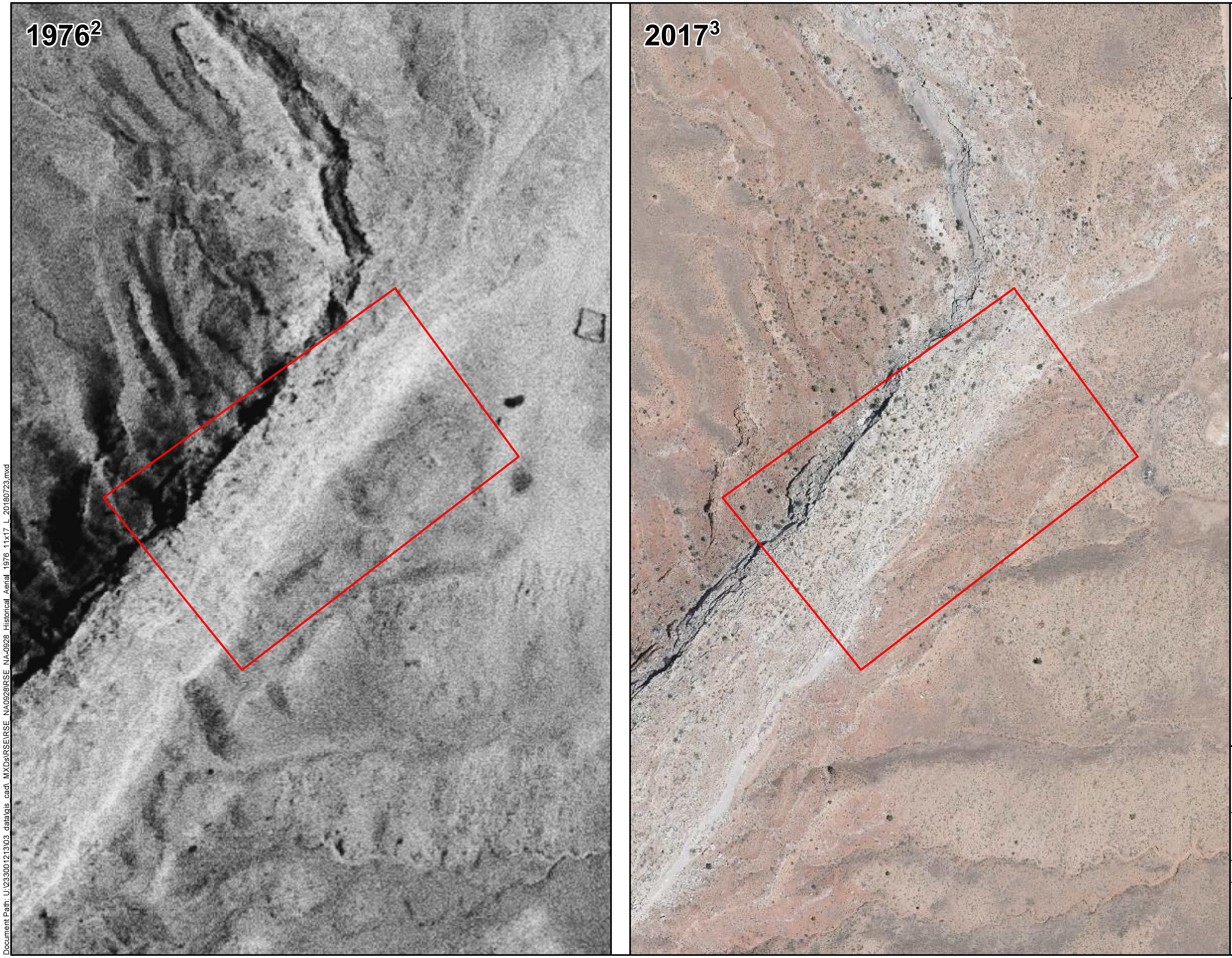
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 3-1b



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

□ Claim Boundary

REFERENCES:

1. Coordinate System: NAD 1983 UTM Zone 12N

2. 1976 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

0 200 400
Feet

TITLE:

1976 Historical Aerial
Photograph Comparison

PROJECT:

Removal Site Evaluation
NA-0928 Mine Site

DATE: 7/23/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 3-1c

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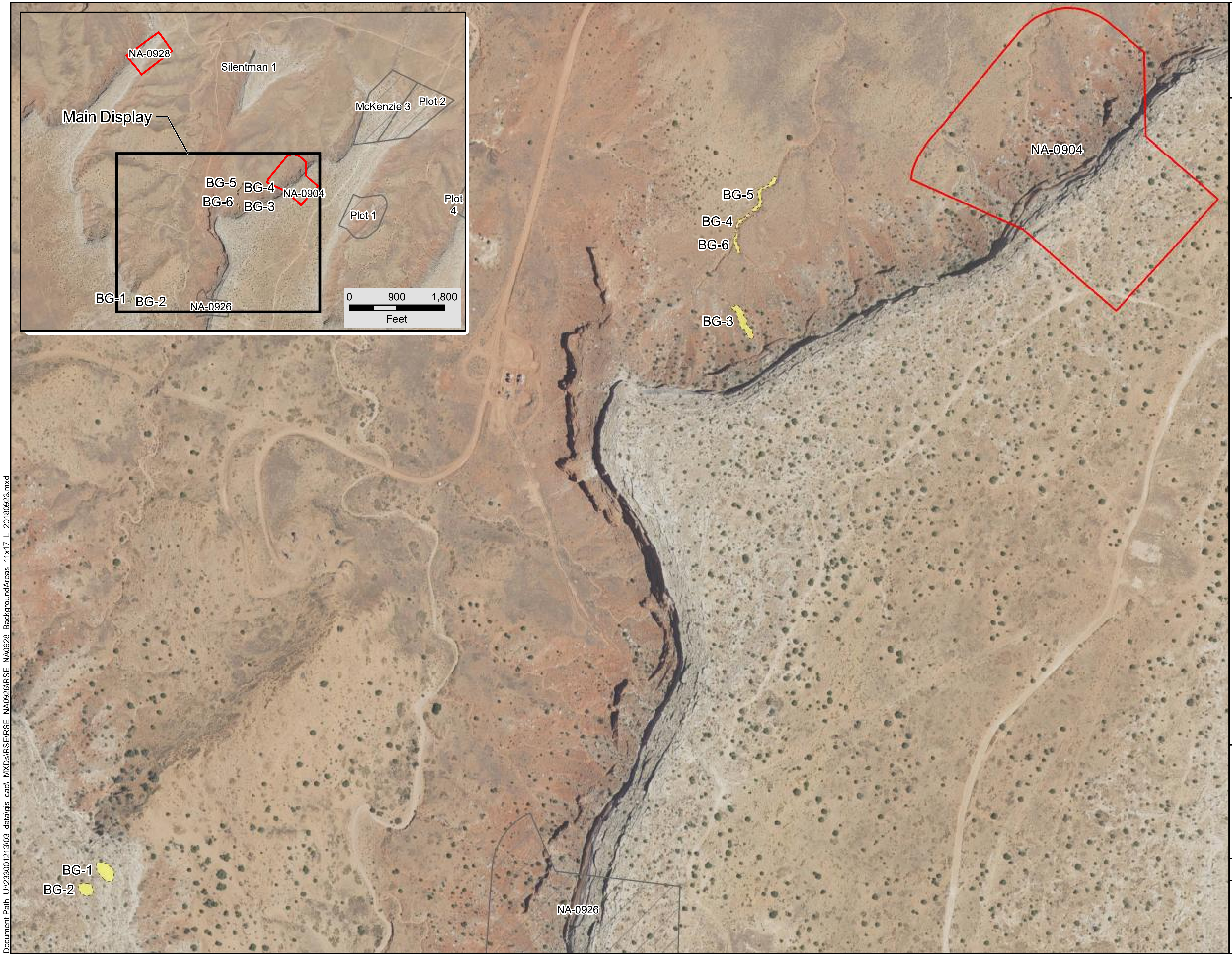


NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

🟨 Potential Background Reference Area

🟥 Claim Boundary

⬜ Other Claim Boundary

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agriculture Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 09/2018.

N
W E
S

0 300 600
Feet

TITLE:
Potential Background
Reference Areas

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/23/2018

DOCUMENT NAME: Removal Site Evaluation Report

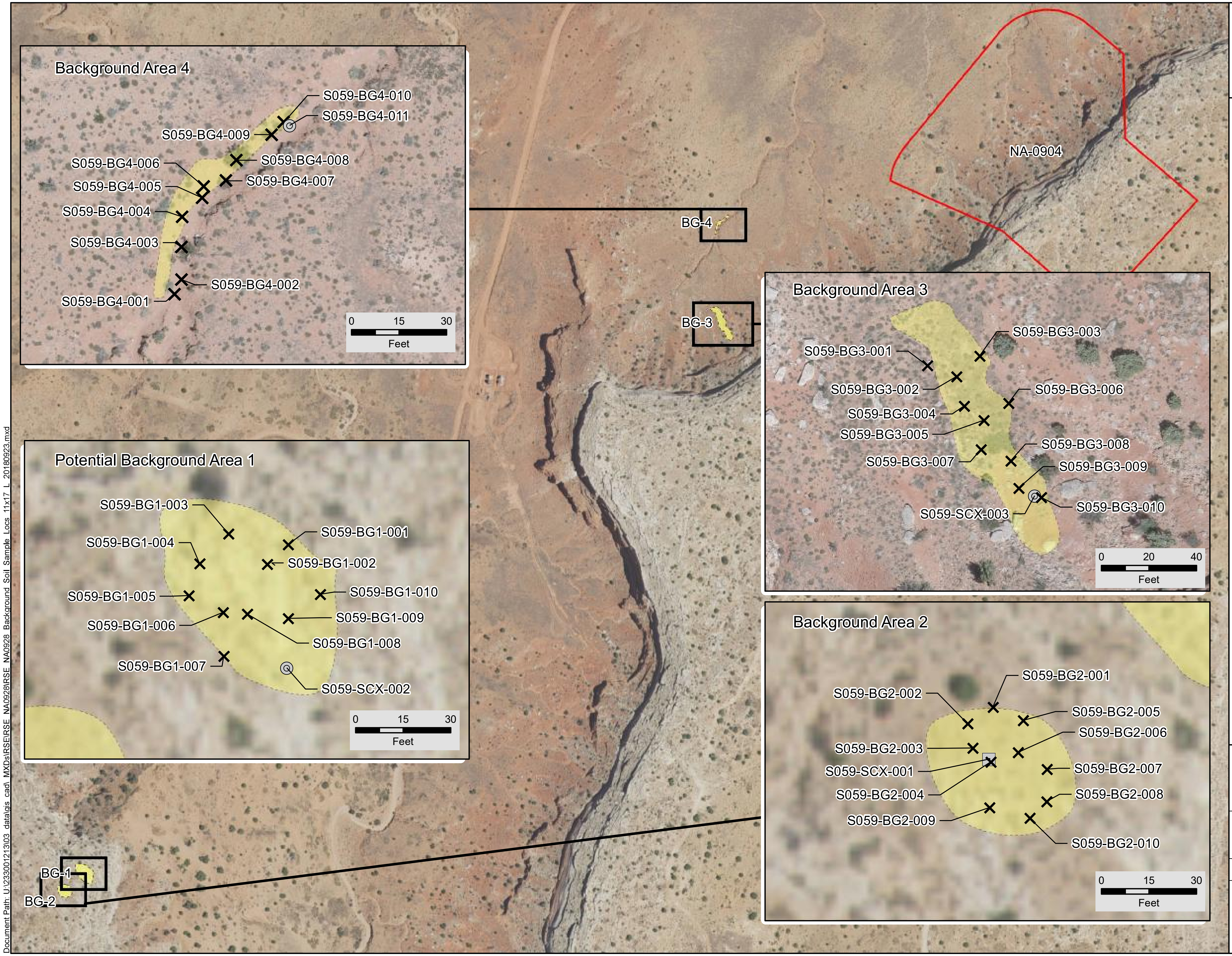
AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 3-2

Stantec

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_NA0928\RSE_NA0928_BackgroundAreas_11x17_L_20180923.mxd



Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_NA0928\RSE_NA0928_Background_Soil_Sample_Locs_11x17_L_20180923.mxd

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

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

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Main display and Background Areas 1 and 2 basemap image insets accessed from the National Agriculture Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 09/2018.

Background Areas 3 and 4 basemap image insets flown by Cooper Aerial Surveys Co. on June 16, 2017.

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TITLE:
Background Reference Areas -
Sample Locations

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

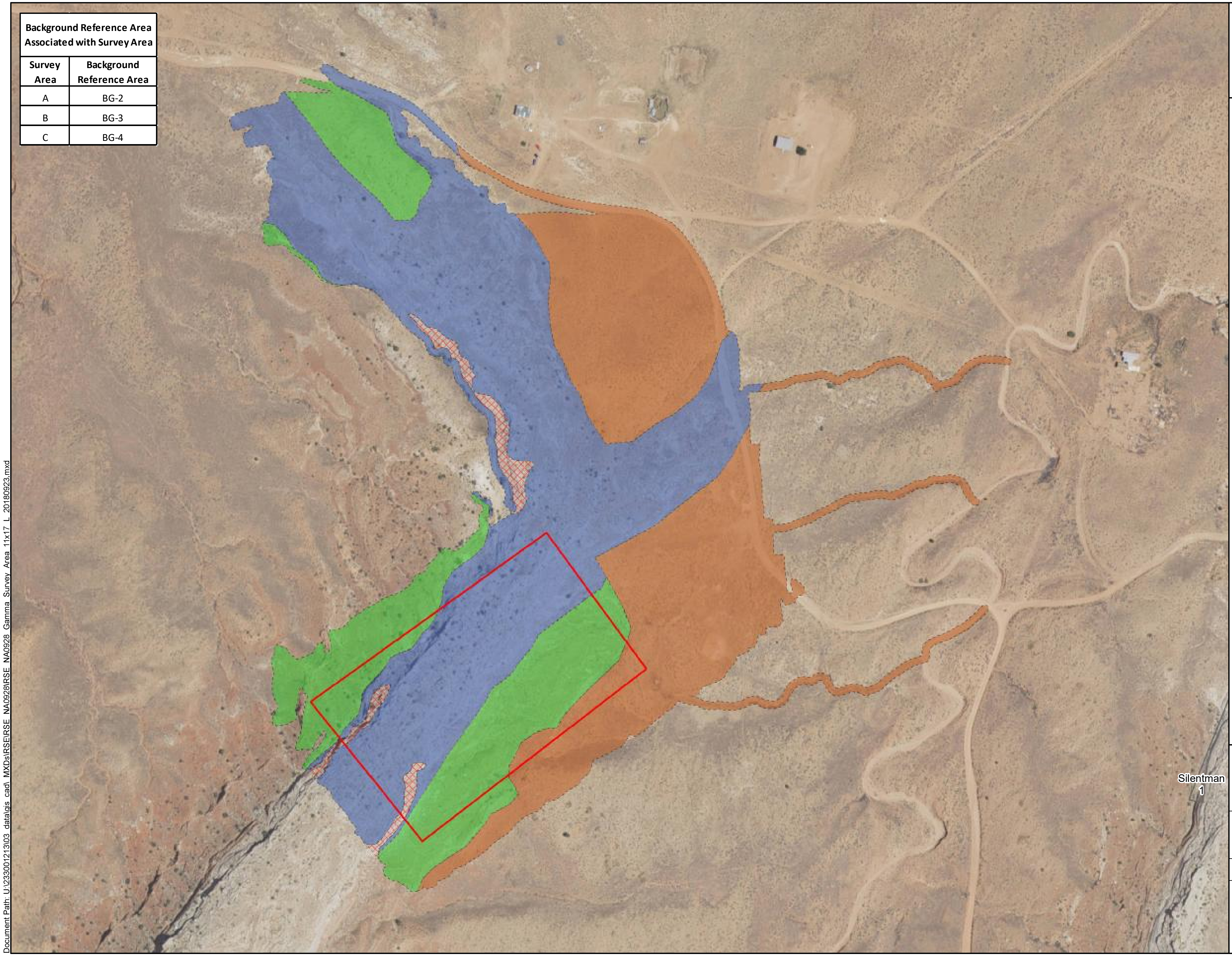
AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 3-3

NAVAJO NATION
AUM Environmental Response Trust-First Phase

Background Reference Area Associated with Survey Area	
Survey Area	Background Reference Area
A	BG-2
B	BG-3
C	BG-4



LEGEND

- 🟦 Survey Area A
- 🟩 Survey Area B
- 🟧 Survey Area C
- ▨ Unsurveyed Area[1]
- 🟥 Claim Boundary
- ☐ Other Claim Boundary

NOTE:

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

2. Gamma survey area is approximately 36.8 acres.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agriculture Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 09/2018.

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TITLE:

Gamma Radiation Survey Areas

PROJECT:

Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/23/2018

DOCUMENT NAME: Removal Site Evaluation Report

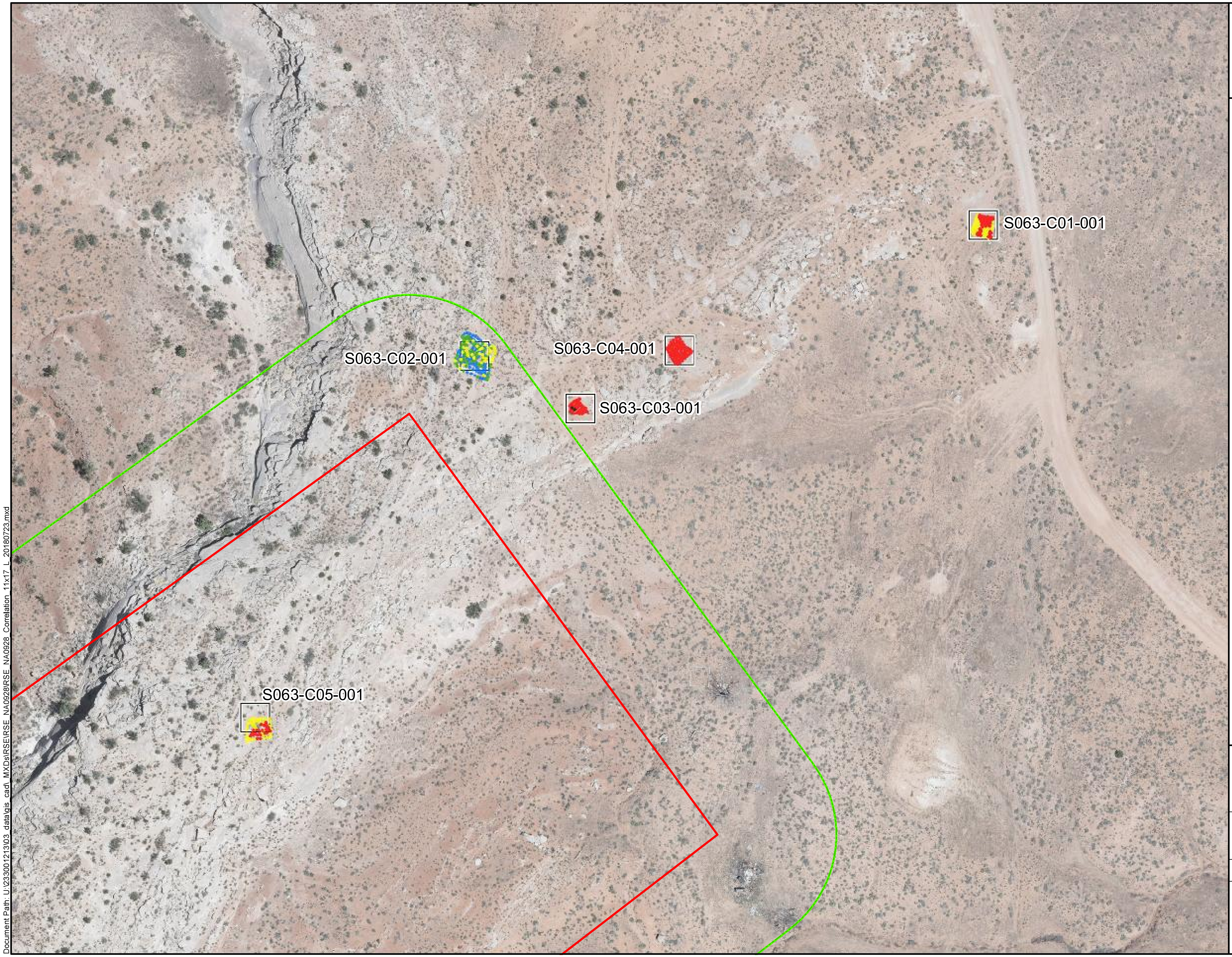
AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 3-4

Stantec

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\RSE NA0928 Gamma Survey Area 11x17 L 20180923.mxd



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

☐	S063-C01-001 Correlation Location (30' x 30')
🟥	Claim Boundary
🟩	100-Foot Claim Buffer

Gamma Survey
Counts per Minute (CPM)

●	7,250 - 9,911 (Minimum to BG-4 UTL)
●	9,912 - 11,068 (>BG-4 UTL to BG-2 UTL)
●	11,069 - 19,822 (>BG-2 UTL to 2x BG-4 UTL)
●	19,823 - 110,680 (>2x BG-4 UTL to 10x BG-2 UTL)
●	110,681 - 113,678 (>10x BG-2 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 by Cooper Aerial Surveys Co. on June 16, 2017.

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0 80 160
Feet

TITLE:
Gamma Correlation
Study Locations

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 7/24/2018

DOCUMENT NAME: Removal Site Evaluation Report

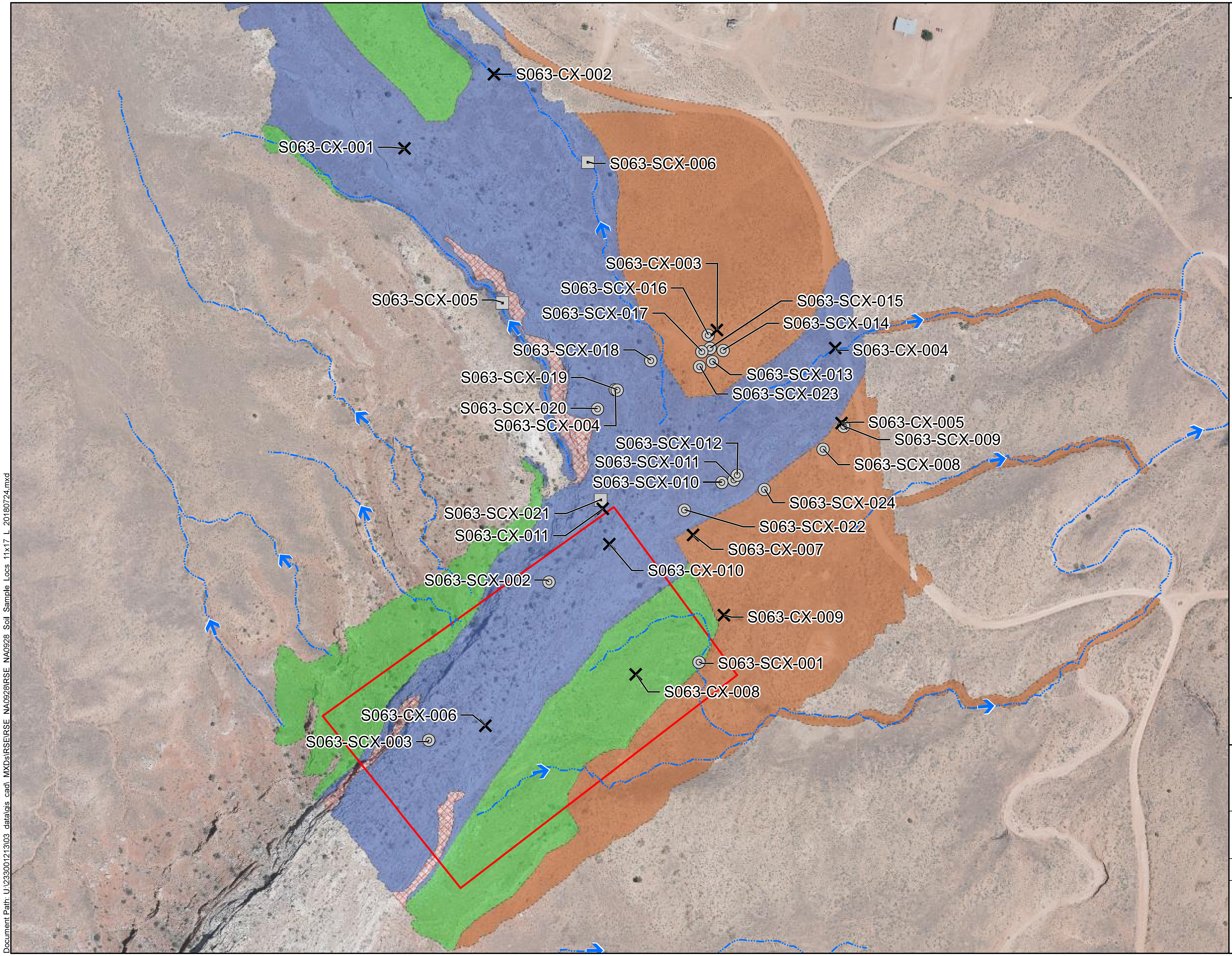
Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 3-5

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\RSE NA0928 Correlation 11x17 L 20180723.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

- ✕ Surface Sample Location
- ◎ Borehole Location - Surface and Subsurface Samples
- ▣ Borehole Location - Surface Samples Only
- ↑ Flow Direction
- ⋯ Drainage
- 🟦 Survey Area A
- 🟩 Survey Area B
- 🟧 Survey Area C
- ▨ Unsurveyed Area
- 🟥 Claim Boundary

NOTES:

Surface and subsurface static gamma measurements were collected at all borehole locations with one exception; only subsurface static gamma measurements were collected at S063-SCX-001.

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

Subsurface soil samples range from 0.5 - 11.0 ft bgs

Static gamma measurements range from 0.0 - 13.0 ft bgs

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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0 200 400
Feet

TITLE:

Site Characterization Surface and Subsurface Sample Locations

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/11/2018

DOCUMENT NAME: Removal Site Evaluation Report

AUTHOR: EDZ

REVIEWER: EY

Stantec

FIGURE: 3-6a

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_NA0928\RSE_NA0928_Soil_Sample_Locs_11x17_L_20180724.mxd

NOTES:

1. Rim strips as shown in the 2007 AUM Atlas were not observed during field mapping (USEPA, 2007a).

2. Surface and subsurface static gamma measurements were collected at all borehole locations with one exception; only subsurface static gamma measurements were collected at S063-SCX-001.

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

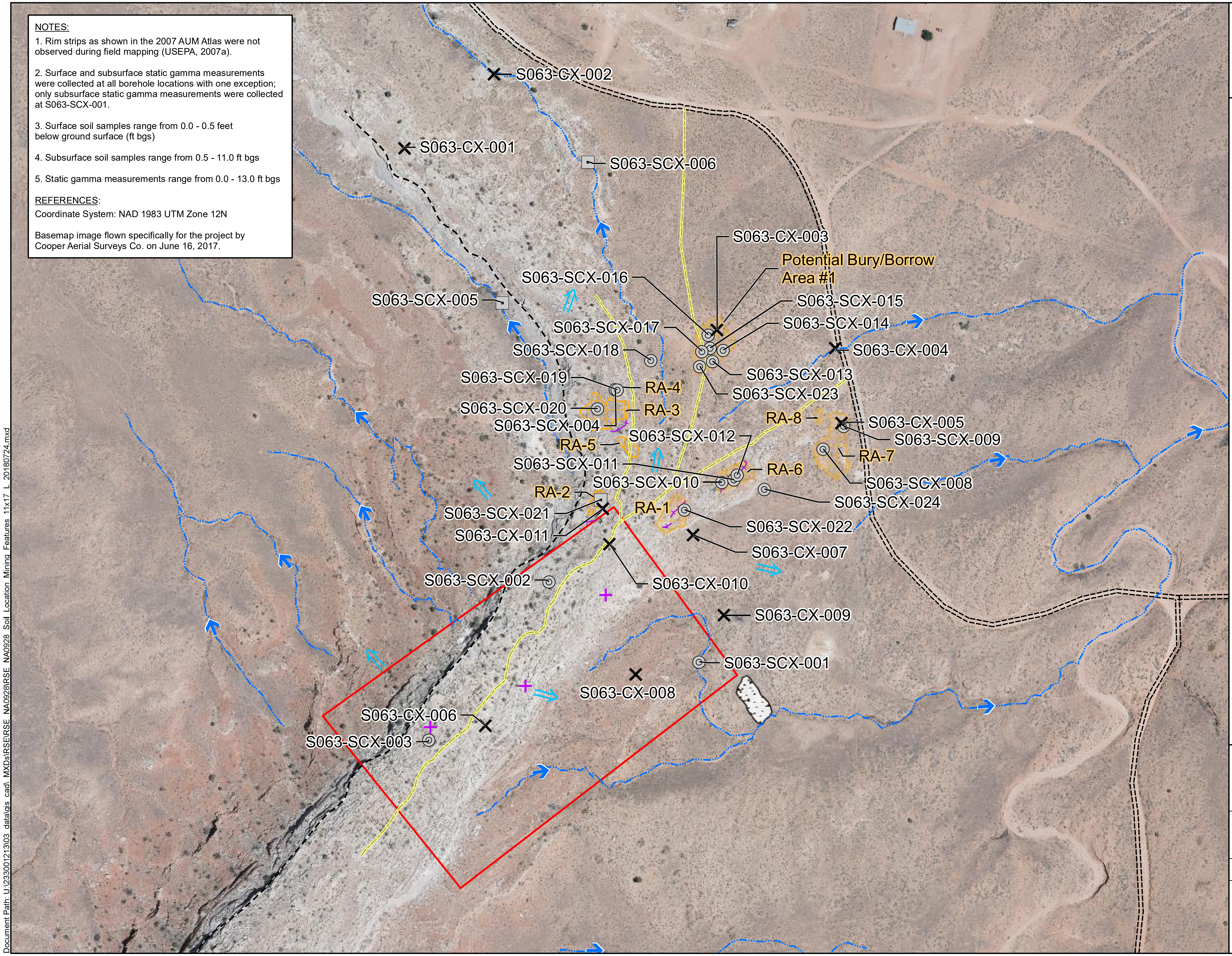
4. Subsurface soil samples range from 0.5 - 11.0 ft bgs

5. Static gamma measurements range from 0.0 - 13.0 ft bgs

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

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



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
▣	Borehole Location - Surface Samples Only
↑	Flow Direction
⇑	Approximate Overland Water Flow Direction
-.-.-	Drainage
+	Rim Strip Location per 2007 AUM Atlas¹
+-+-+	Rim Strip (Buried - Location Approximate)
- - - -	Approximate Edge of Mesa
------	Potential Haul Road
========	Road
▨	Debris
▦	Mining / Reclaimed Disturbed Area
□	Claim Boundary

N W E S

0 200 400
Feet

TITLE:
Sample Locations Compared to Mining-Related Features

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/24/2018

DOCUMENT NAME: Removal Site Evaluation Report

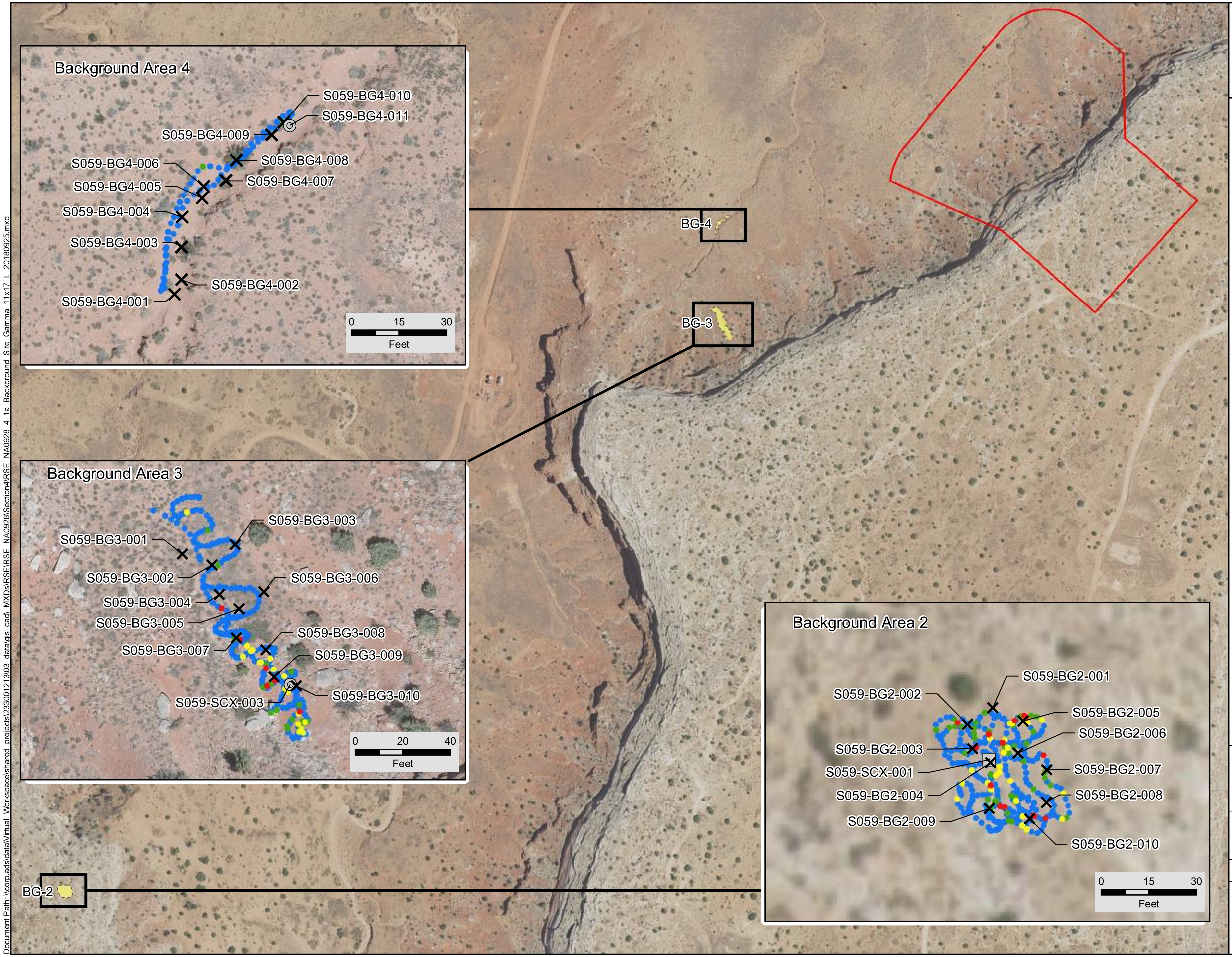
AUTHOR: AJS

REVIEWER: CBB

Stantec

FIGURE: 3-6b

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\RSE NA0928 Soil Location Mining Features 11x17 L 20180724.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

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

Gamma Survey

Counts per Minute (CPM)

- ● 5,599 - 9,911 (Minimum to BG-4 IL)
- ● 9,912 - 10,447 (>BG-4 IL to BG-3 IL)
- ● 10,448 - 11,068 (>BG-3 IL to BG-2 IL)
- ● 11,069 - 13,471 (>BG-2 IL to Maximum)

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Main display and Background Area 2 basemap image inset accessed from the National Agriculture Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 09/2018.

Background Areas 3 and 4 basemap image insets flown by Cooper Aerial Surveys Co. on June 16, 2017.

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Feet

TITLE:
Background Reference Areas
Gamma Radiation Survey Results

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

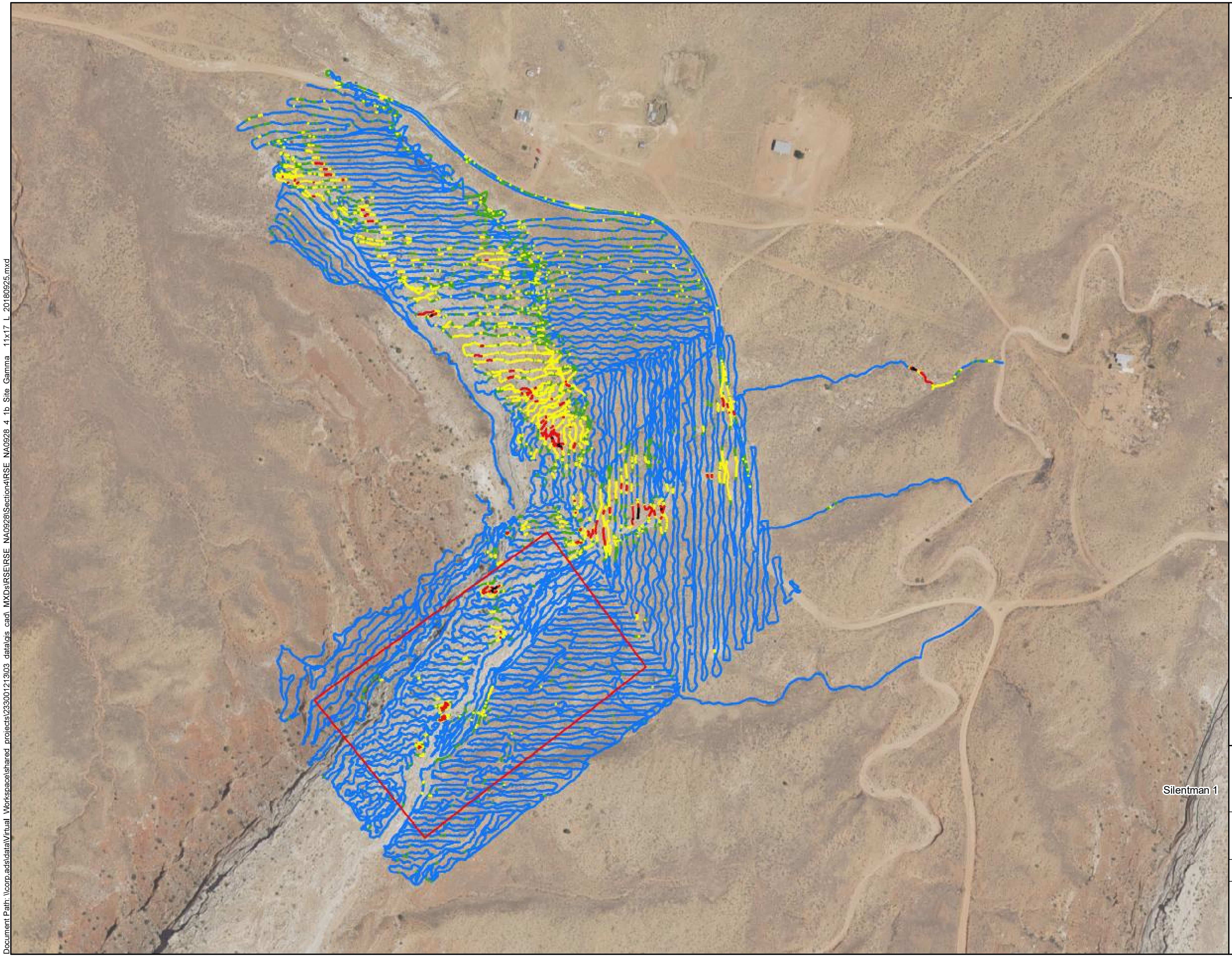
Stantec

AUTHOR: JSB

REVIEWER: CBB

FIGURE: 4-1a

Document Path: \\corp.ads\data\Virtual Workspace\shared projects\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\Section4\RSE NA0928 4 1a Background Site Gamma 11x17 L 20180925.mxd



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

🟥 Claim Boundary

☐ Other Claim Boundary

Gamma Survey

Counts per Minute (CPM)

- ● 4,640 - 9,911 (Minimum to BG-4 IL)
- ● 9,912 - 11,068 (>BG-4 IL to BG-2 IL)
- ● 11,069 - 19,822 (>BG-2 IL to 2x BG-4 IL)
- ● 19,823 - 55,340 (>2x BG-4 IL to 5x BG-2 IL)
- ● 55,341 - 104,004 (>5x BG-2 IL to Maximum)

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

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agricultural Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 09/2018.

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0 250 500
Feet

TITLE:
Gamma Radiation Survey
Results for Site

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

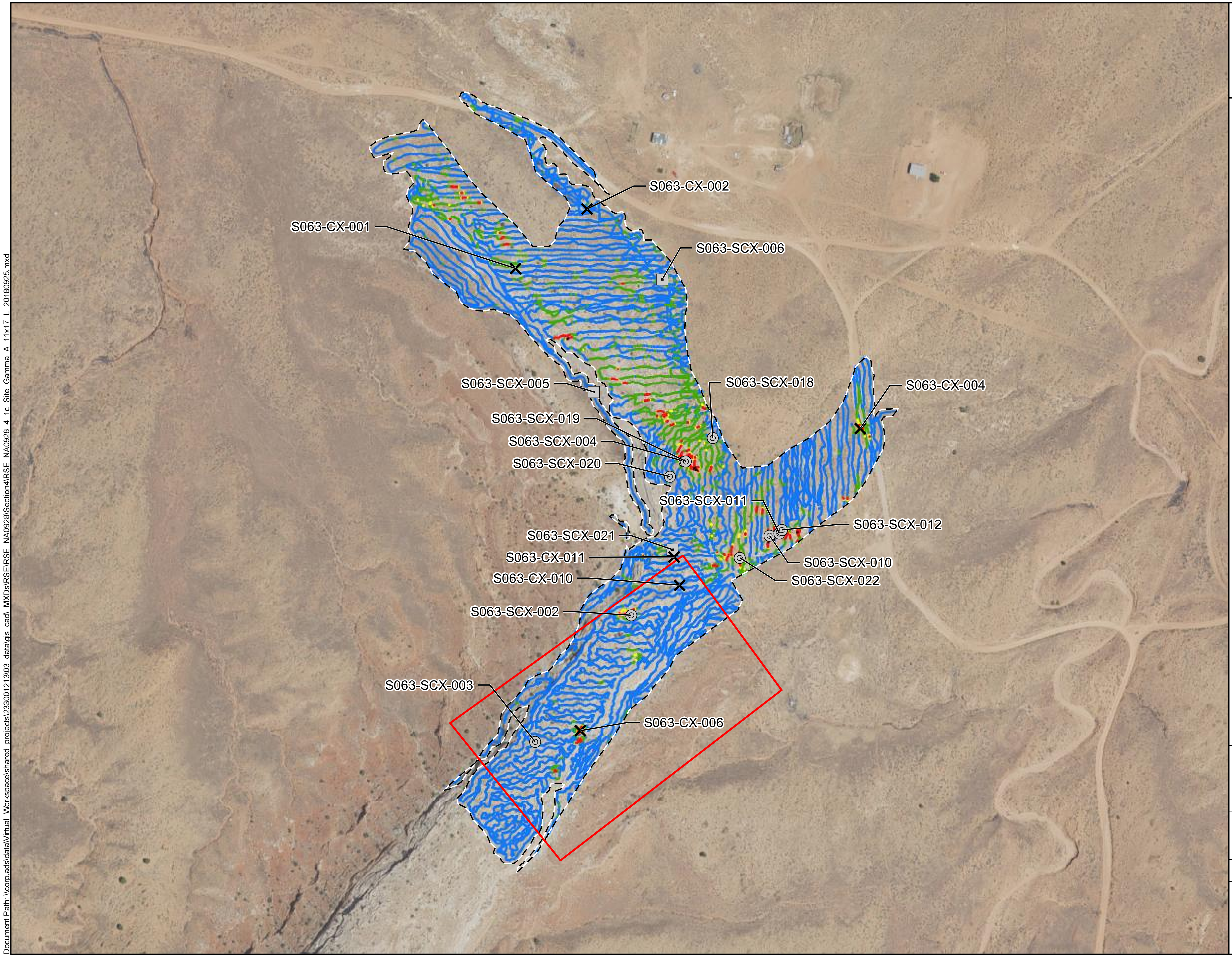
Stantec

AUTHOR: TMW

REVIEWER: CBB

FIGURE: 4-1b

Document Path: \\corp.ads\data\Virtual Workspace\shared projects\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\Section4\RSE NA0928 4 1b Site Gamma 11x17 L 20180925.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)

● 4,640 - 11,068 (Minimum to BG-2 IL)

● 11,069 - 19,403 (>BG-2 IL to BG-1 IL)

● 19,404 - 22,136 (>BG-1 IL to 2x BG-2 IL)

● 22,137 - 55,340 (>2x BG-2 IL to 5x BG-2 IL)

● 55,341 - 104,004 (>5x BG-2 IL to Maximum)

NOTE:
BG-1 UTL incorporated for comparison purposes.

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agricultural Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 09/2018.

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0 250 500
Feet

TITLE:
Gamma Radiation Survey Results
for Survey Area A

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

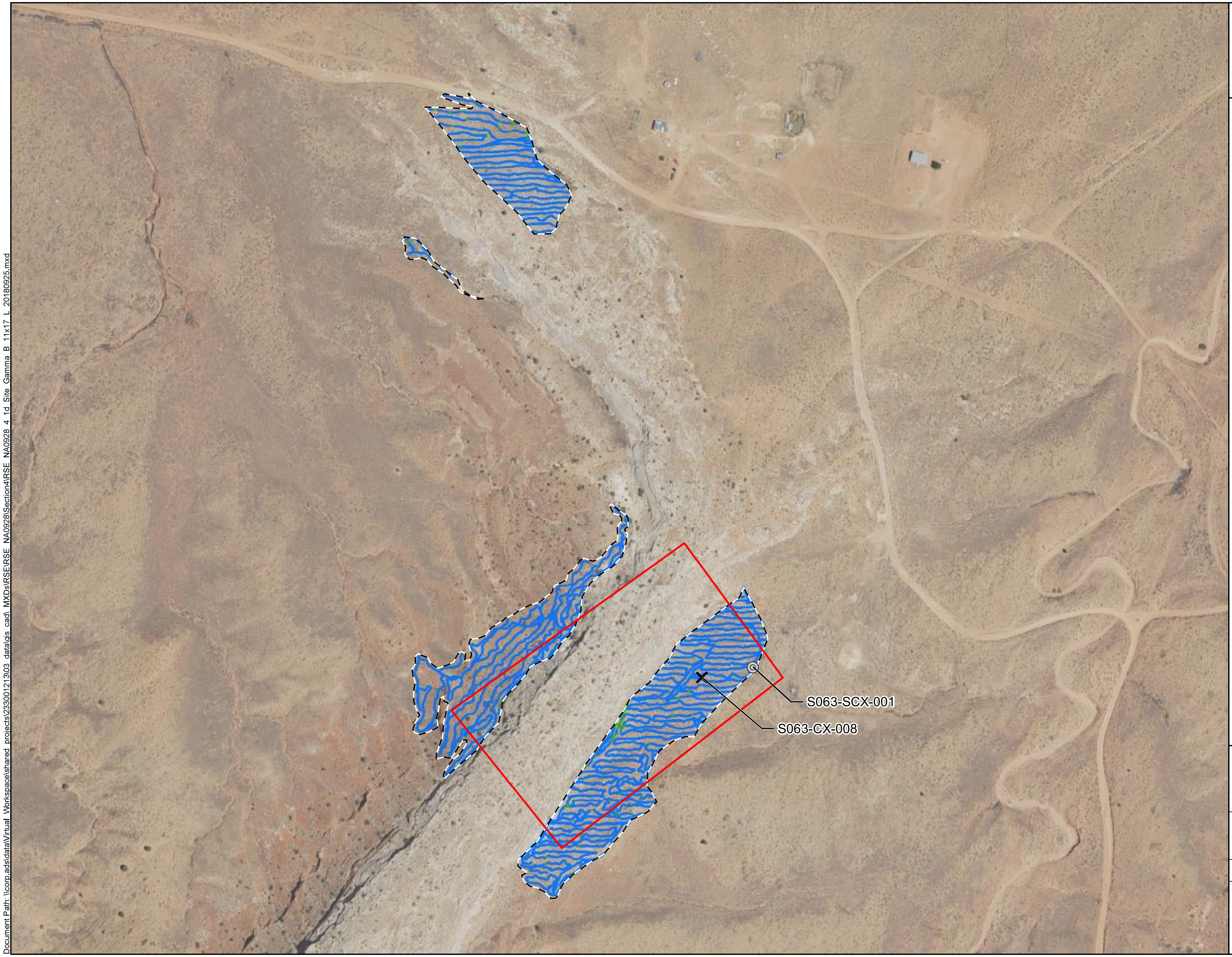
Stantec

AUTHOR: TMW

REVIEWER: CBB

FIGURE: 4-1c

Document Path: \\corp.ads\data\Virtual Workspace\shared projects\233001213\03 data\gis cad\ MXDs\RSE\RSE\RSE NA0928\Section4\RSE NA0928 4 1d Site Gamma B 11x17 L 20180925.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

- ✕ Surface Sample Location
- ◎ Borehole Location - Surface and Subsurface Samples
- ⬚ Survey Area B
- 🟥 Claim Boundary

Gamma Survey

Counts per Minute (CPM)

- ● 4,847 - 10,447 (Minimum to BG-3 IL)
- ● 10,448 - 13,662 (>BG-3 IL to Maximum)

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agricultural Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 09/2018.

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Feet

TITLE:

Gamma Radiation Survey Results for Survey Area B

PROJECT:

Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/27/2018

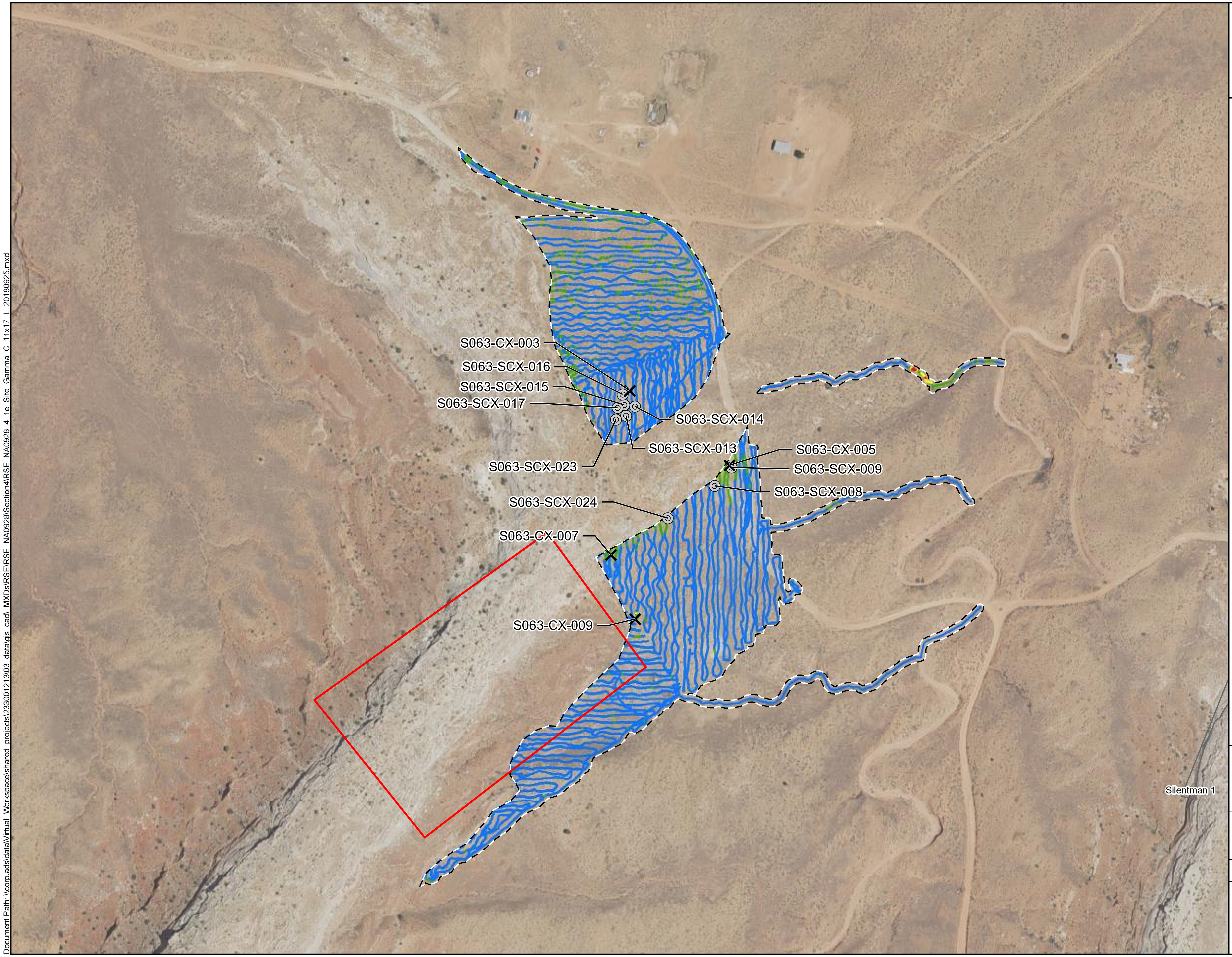
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: TMW

REVIEWER: CBB

FIGURE: 4-1d



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
⬚	Survey Area C
🟥	Claim Boundary
▨	Other Claim Boundary

Gamma Survey

Counts per Minute (CPM)

●	4,871 - 9,911 (Minimum to BG-4 IL)
●	9,912 - 19,822 (>BG-4 IL to 2x BG-4 IL)
●	19,823 - 49,555 (>2x BG-4 IL to 5x BG-4 IL)
●	49,556 - 97,546 (>5x BG-4 IL to Max)

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agricultural Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 09/2018.

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0 250 500
Feet

TITLE:
Gamma Radiation Survey Results
for Survey Area C

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

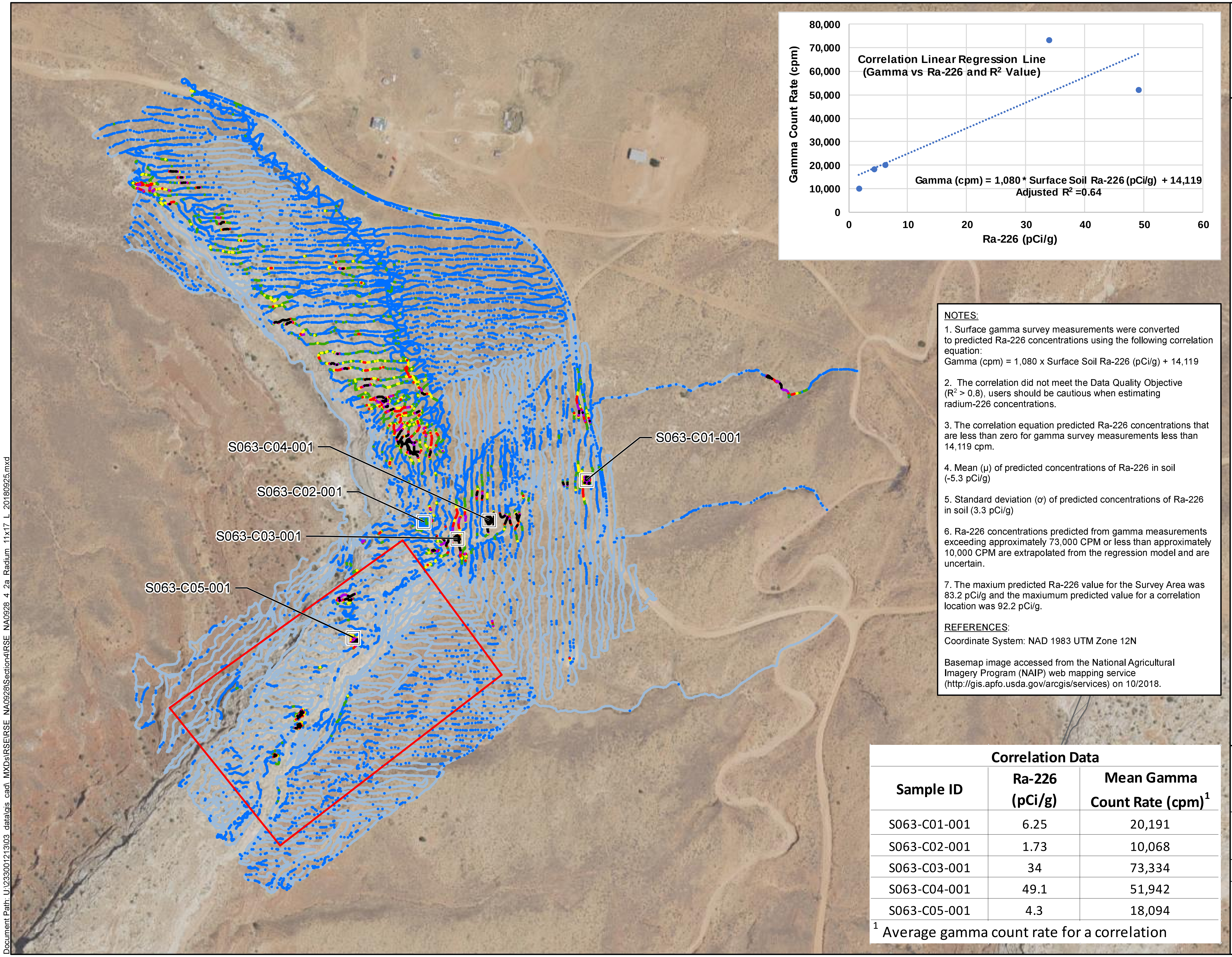
Stantec

AUTHOR: TMW

REVIEWER: CBB

FIGURE: 4-1e

Document Path: \\corp.ads\data\Virtual Workspace\shared projects\2330012103\03 data\gis cad\ MXDs\RSE\RSE\RSE NA0928\Section4\RSE NA0928 4 1e Site Gamma C 11x17 L 20180925.mxd



NOTES:

1. Surface gamma survey measurements were converted to predicted Ra-226 concentrations using the following correlation equation:
Gamma (cpm) = 1,080 x Surface Soil Ra-226 (pCi/g) + 14,119

2. The correlation did not meet the Data Quality Objective ($R^2 > 0.8$), 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 14,119 cpm.

4. Mean (μ) of predicted concentrations of Ra-226 in soil (-5.3 pCi/g)

5. Standard deviation (σ) of predicted concentrations of Ra-226 in soil (3.3 pCi/g)

6. Ra-226 concentrations predicted from gamma measurements exceeding approximately 73,000 CPM or less than approximately 10,000 CPM are extrapolated from the regression model and are uncertain.

7. The maxium predicted Ra-226 value for the Survey Area was 83.2 pCi/g and the maxiumum predicted value for a correlation location was 92.2 pCi/g.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agricultural Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 10/2018.

Correlation Data

Sample ID	Ra-226 (pCi/g)	Mean Gamma Count Rate (cpm)[1]
S063-C01-001	6.25	20,191
S063-C02-001	1.73	10,068
S063-C03-001	34	73,334
S063-C04-001	49.1	51,942
S063-C05-001	4.3	18,094

[1] Average gamma count rate for a correlation

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

☐ S063-C01-001 Correlation Location (30' x 30')

▭ Claim Boundary

▭ Other Claim Boundary

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

- ● -8.8 - -5.3 (μ)[2,3,4]
- ● -5.2 - -1.9 (μ + 1σ[5])
- ● -1.8 - 0[2]
- ● 0.1 - 1.4 (μ + 2σ)
- ● 1.5- 4.7 (μ + 3σ)
- ● 4.8 - 8.0 (μ + 4σ)
- ● 8.1 - 92.2[7]

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Feet

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

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 10/19/2018

DOCUMENT NAME: Removal Site Evaluation Report

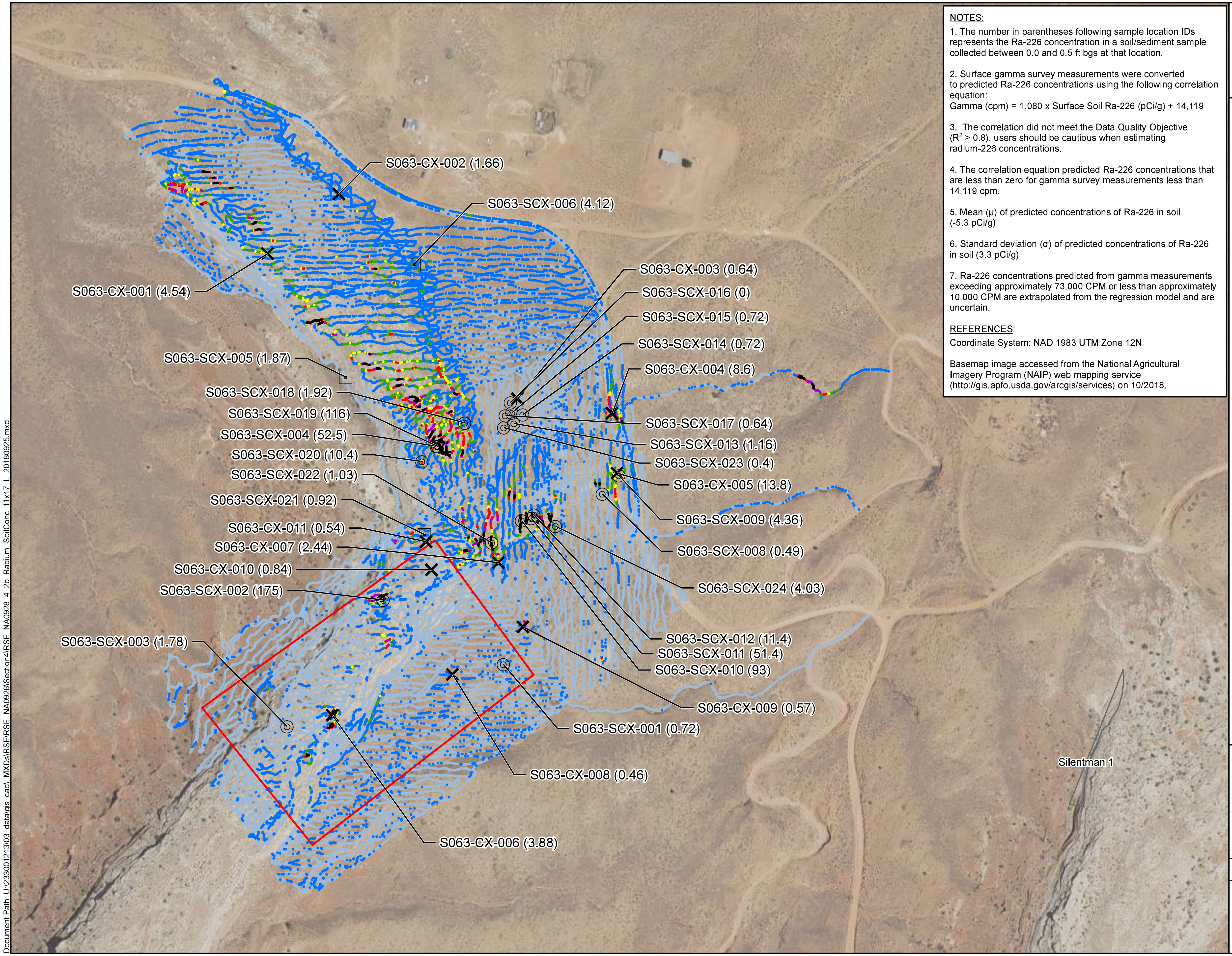
Stantec

AUTHOR: TMW

REVIEWER: CBB

FIGURE: 4-2a

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\Section4\RSE NA0928 4 2a Radium 11x17 L 20180925.mxd



NOTES:

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

2. Surface gamma survey measurements were converted to predicted Ra-226 concentrations using the following correlation equation:
Gamma (cpm) = 1,080 x Surface Soil Ra-226 (pCi/g) + 14,119

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

4. The correlation equation predicted Ra-226 concentrations that are less than zero for gamma survey measurements less than 14,119 cpm.

5. Mean (μ) of predicted concentrations of Ra-226 in soil (-5.3 pCi/g)

6. Standard deviation (σ) of predicted concentrations of Ra-226 in soil (3.3 pCi/g)

7. Ra-226 concentrations predicted from gamma measurements exceeding approximately 73,000 CPM or less than approximately 10,000 CPM are extrapolated from the regression model and are uncertain.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agricultural Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 10/2018.

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

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

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

●	-8.8 - -5.3 (μ)^{3,4,5}
●	-5.2 - -1.9 (μ + 1σ^6)
●	-1.8 - 0^3
●	0.1 - 1.4 (μ + 2σ)
●	1.5- 4.7 (μ + 3σ)
●	4.8 - 8.0 (μ + 4σ)
●	8.1 - 83.2

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0 250 500
Feet

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

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 10/2/2018

DOCUMENT NAME: Removal Site Evaluation Report

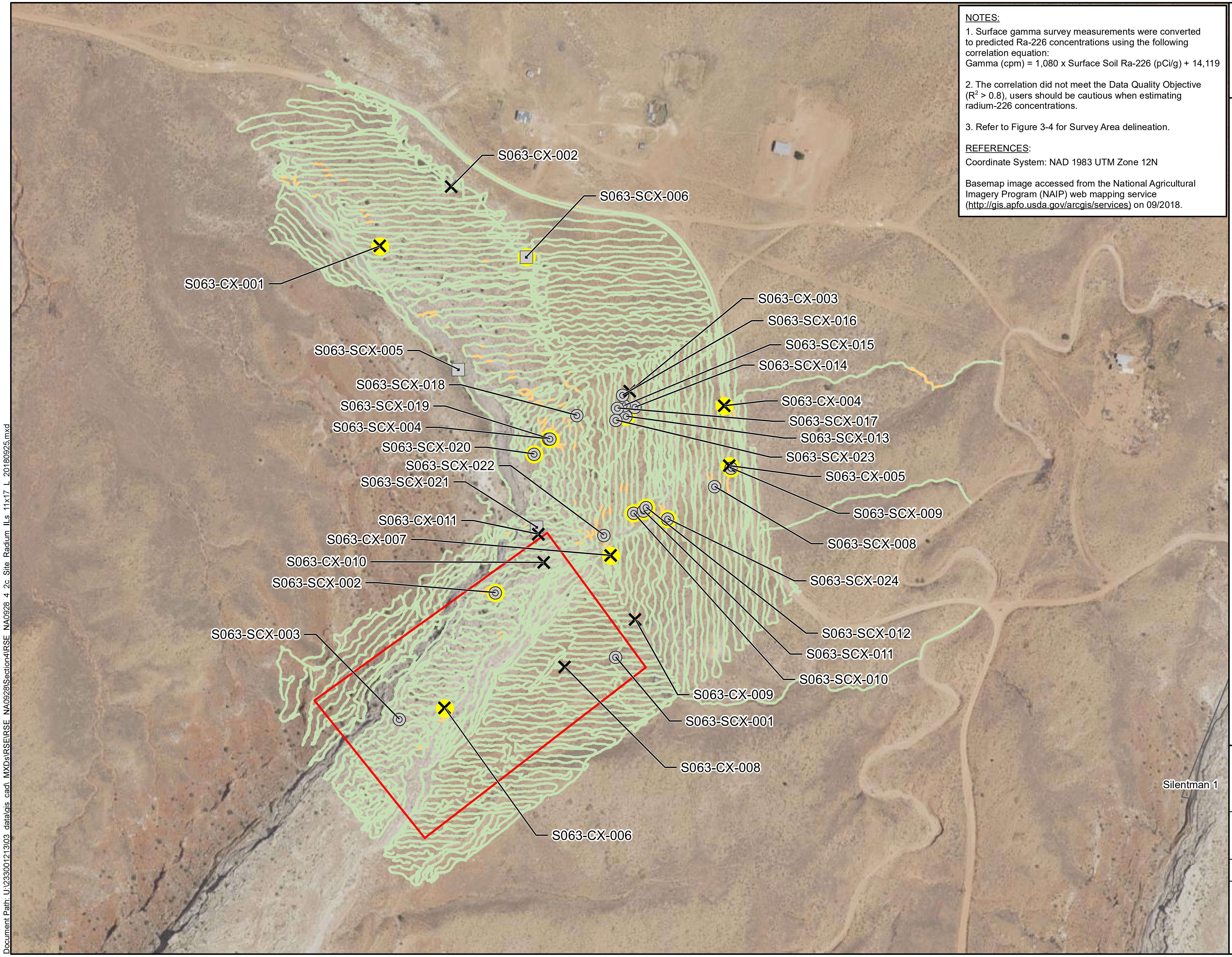
AUTHOR: TMW

REVIEWER: CBB

Stantec

FIGURE: 4-2b

Document Path: U:\233001213\03_data\gis_cad_MXDs\RSE\RSE_NA0928\Section4\RSE_NA0928_4_2b_Radium_SoilConc_11x17_L_20180925.mxd



NOTES:

1. Surface gamma survey measurements were converted to predicted Ra-226 concentrations using the following correlation equation:
Gamma (cpm) = 1,080 x Surface Soil Ra-226 (pCi/g) + 14,119

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

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

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agricultural Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) 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
- ▱ Other Claim Boundary
- 🟥 Claim Boundary

Predicted Ra-226 Concentrations (pCi/g)

● IL Not Exceeded
Survey Area A: -8.8 - 3.34
Survey Area B: -8.6 - 0.4
Survey Area C: -8.6 - 0.895

● IL Exceeded
Survey Area A: 3.35 - 83.2
Survey Area B: N/A
Survey Area C: 0.896 - 77.2

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0 250 500
Feet

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

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/29/2018

DOCUMENT NAME: Removal Site Evaluation Report

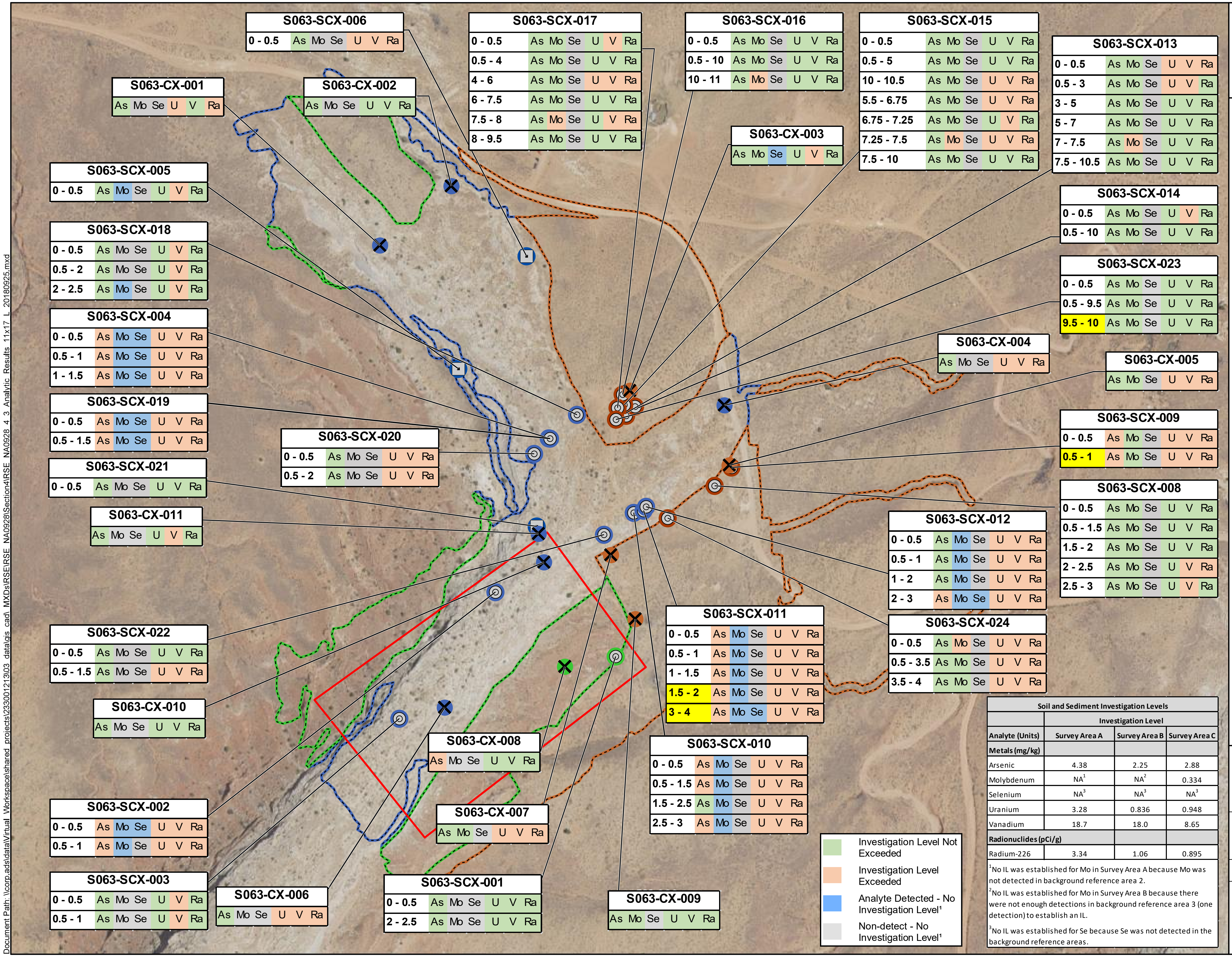
AUTHOR: TMW

REVIEWER: CBB

Stantec

FIGURE: 4-2c

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\Section4\RSE NA0928 4 2c Site Radium ILs 11x17 L 20180925.mxd



🟩 Investigation Level Not Exceeded

🟧 Investigation Level Exceeded

🟦 Analyte Detected - No Investigation Level[1]

⬜ Non-detect - No Investigation Level[1]

Soil and Sediment Investigation Levels			
	Investigation Level		
Analyte (Units)	Survey Area A	Survey Area B	Survey Area C
Metals (mg/kg)			
Arsenic	4.38	2.25	2.88
Molybdenum	NA[1]	NA[2]	0.334
Selenium	NA[3]	NA[3]	NA[3]
Uranium	3.28	0.836	0.948
Vanadium	18.7	18.0	8.65
Radionuclides (pCi/g)			
Radium-226	3.34	1.06	0.895

[1] No IL was established for Mo in Survey Area A because Mo was not detected in background reference area 2.

[2] No IL was established for Mo in Survey Area B because there were not enough detections in background reference area 3 (one detection) to establish an IL.

[3] No IL was established for Se because Se was not detected in the background reference areas.

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

⊗	Survey Area A - Surface Sample Location
◎	Survey Area A - Borehole Surface and/or Subsurface Sample Location
⊡	Borehole Location - Surface Samples Only
⊗	Survey Area B - Surface Sample Location
◎	Survey Area B - Borehole Surface and/or Subsurface Sample Location
⊗	Survey Area C - Surface Sample Location
◎	Survey Area B - Borehole Surface and/or Subsurface Sample Location
▭	Claim Boundary
▭	Survey Area A
▭	Survey Area B
▭	Survey Area C

NOTES:

1. No Investigation Level - Selenium and molybdenum were not detected in corresponding background reference area.

2. Samples intervals (e.g. 0 - 0.5) are in ft bgs.

3. Highlighted sample intervals are partially or completely within bedrock.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agricultural Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 09/2018.

N
W E
S
0 250 500
Feet

TITLE:

Surface and Subsurface Metals and Ra-226 Analytical Results

PROJECT:

Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

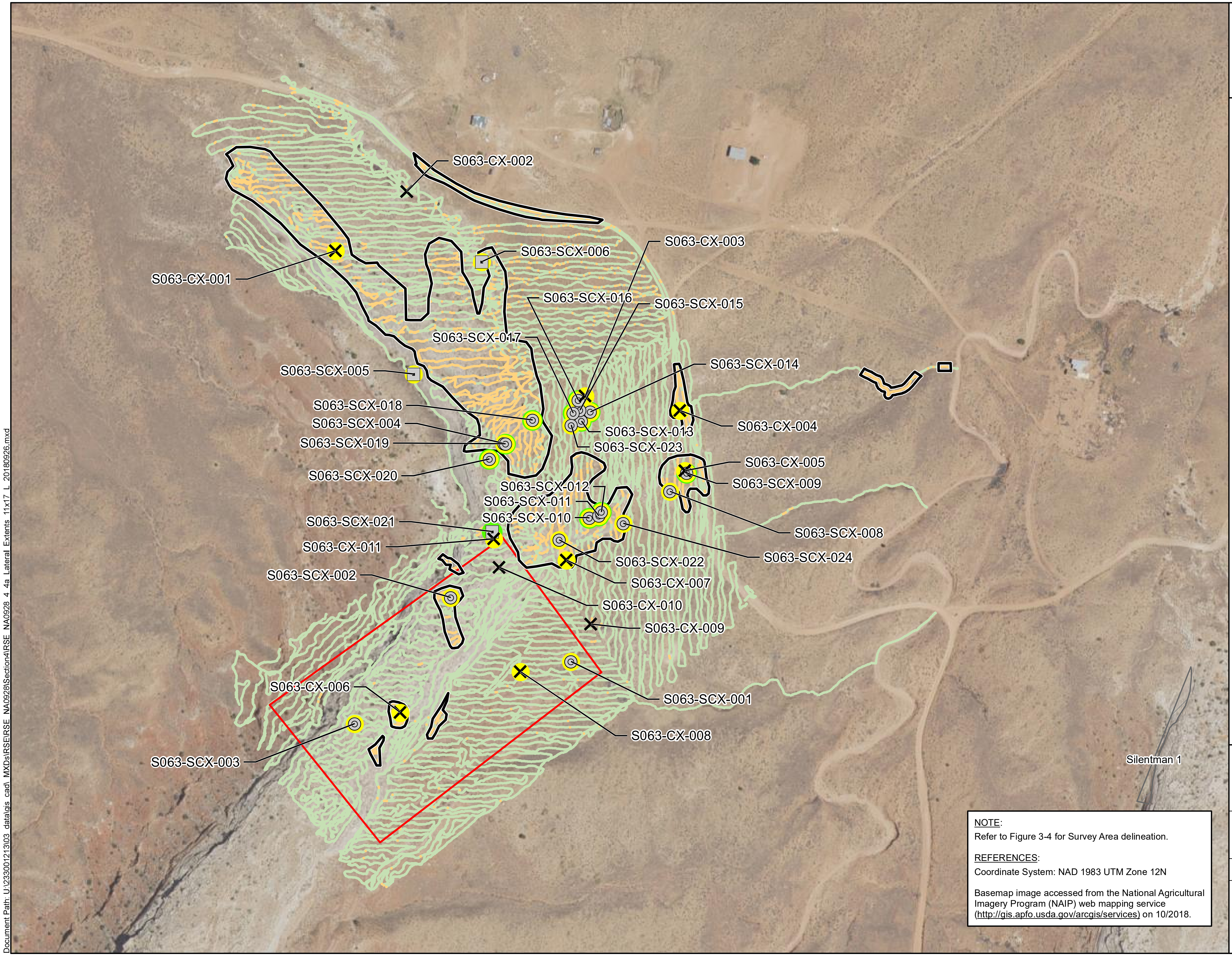
Stantec

AUTHOR: TMW

REVIEWER: CBB

FIGURE: 4-3

Document Path: \\corp.ads\data\Virtual Workspace\shared projects\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\Section4\RSE NA0928 4 3 Analytic Results 11x17 L 20180925.mxd



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

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agricultural Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 10/2018.

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 at Location
- ● IL Exceedance in Bedrock in Borehole
- ▭ Approximate Area where Surface Gamma ILs are Exceeded (6.7 acres)
- ▭ Claim Boundary
- ▭ Other Claim Boundary

Gamma Survey

Counts per Minute (CPM)

● IL Not Exceeded
Survey Area A: 4,640 - 11,068
Survey Area B: 4,847 - 10,447
Survey Area C: 4,871 - 9,911

● IL Exceeded
Survey Area A: 11,069 - 104,004
Survey Area B: 10,448 - 13,662
Survey Area C: 9,912 - 97,546

N
W E
S

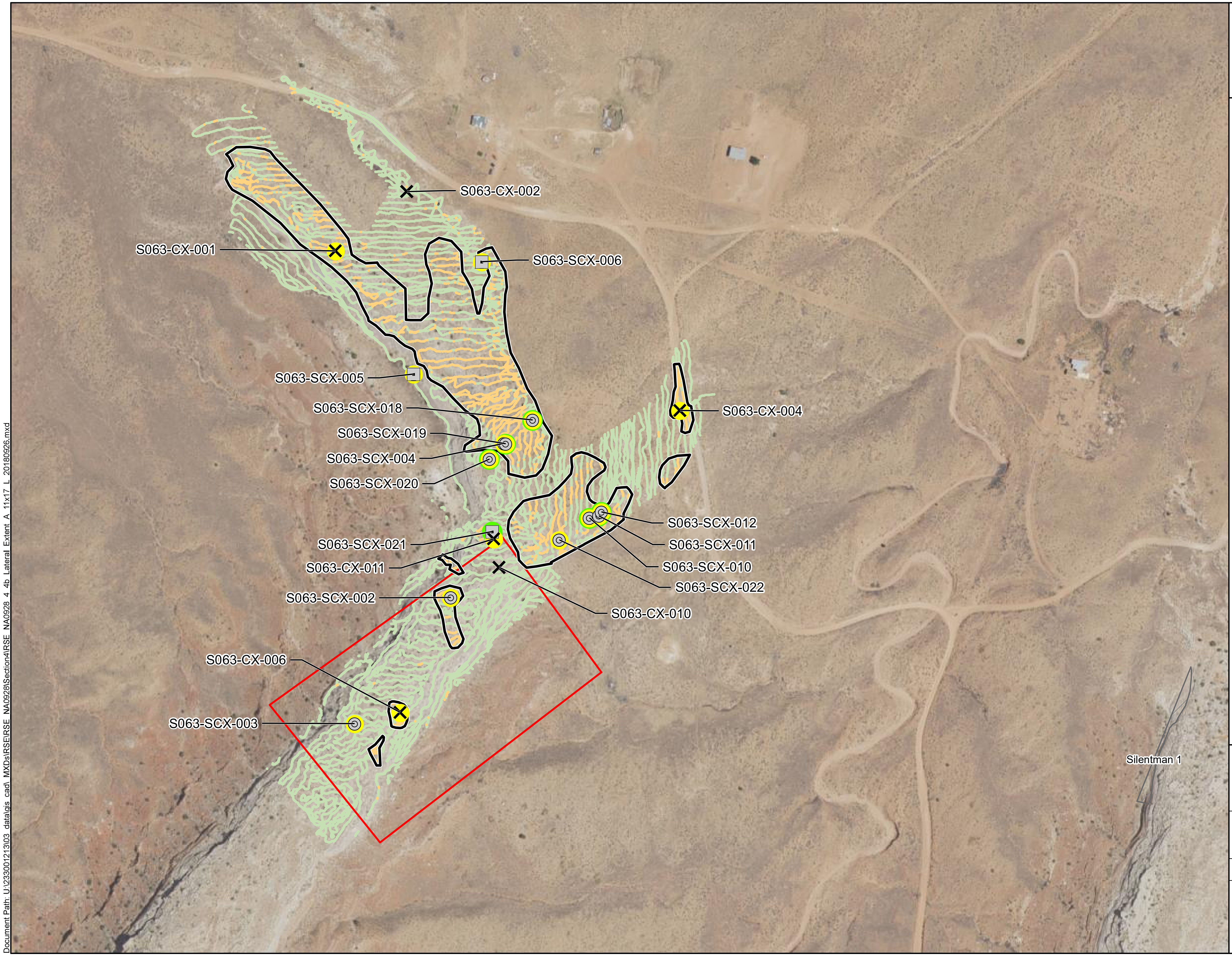
0 250 500
Feet

Lateral Extent of Surface and Subsurface IL Exceedances

Removal Site Evaluation
NA-0928 Mine Site

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

Document Path: U:\2330012130\03 data\gis cad\ MXDs\RSE\RSE NA0928\Section4\RSE NA0928 4 4a Lateral Extents 11x17 L 20180926.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

- ✕ Surface Sample Location
- ▣ Borehole Location - Surface Samples Only
- ◎ Borehole Location - Surface and Subsurface Samples
- 🟡 IL Exceedance in Unconsolidated Material at Location
- 🟢 IL Exceedance in Bedrock in Borehole
- ▭ Approximate Area where Surface Gamma IL is Exceeded (5.8 acres)
- 🟥 Claim Boundary
- ▱ Other Claim Boundary

Gamma Survey

Counts per Minute (CPM)

- ● 4,640 - 11,068 (IL Not Exceeded)
- ● 11,069 - 104,004 (IL Exceeded)

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agricultural Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 10/2018.

N
W E
S

0 250 500
Feet

Survey Area A
Lateral Extent of Surface and Subsurface IL Exceedances

Removal Site Evaluation
NA-0928 Mine Site

10/2/2018

DOCUMENT NAME: Removal Site Evaluation Report

AUTHOR: TMW
REVIEWER: CBB

Stantec

FIGURE: 4-4b

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\Section4\RSE NA0928 4 4b Lateral Extent A 11x17 L 20180926.mxd

NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

- ✕ Surface Sample Location
- ◎ Borehole Location - Surface and Subsurface Samples
- ● IL Exceedance in Unconsolidated Material at Location
- ▭ Approximate Area where Surface Gamma IL is Exceeded (0.1 acres)
- 🟥 Claim Boundary
- ▨ Other Claim Boundary

Gamma Survey

Counts per Minute (CPM)

- ● 4,847 - 10,447 (IL Not Exceeded)
- ● 10,448 - 13,662 (IL Exceeded)

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agricultural Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 10/2018.

N
W E
S

0 250 500
Feet

Survey Area B
Lateral Extent of Surface and Subsurface IL Exceedances

Removal Site Evaluation
NA-0928 Mine Site

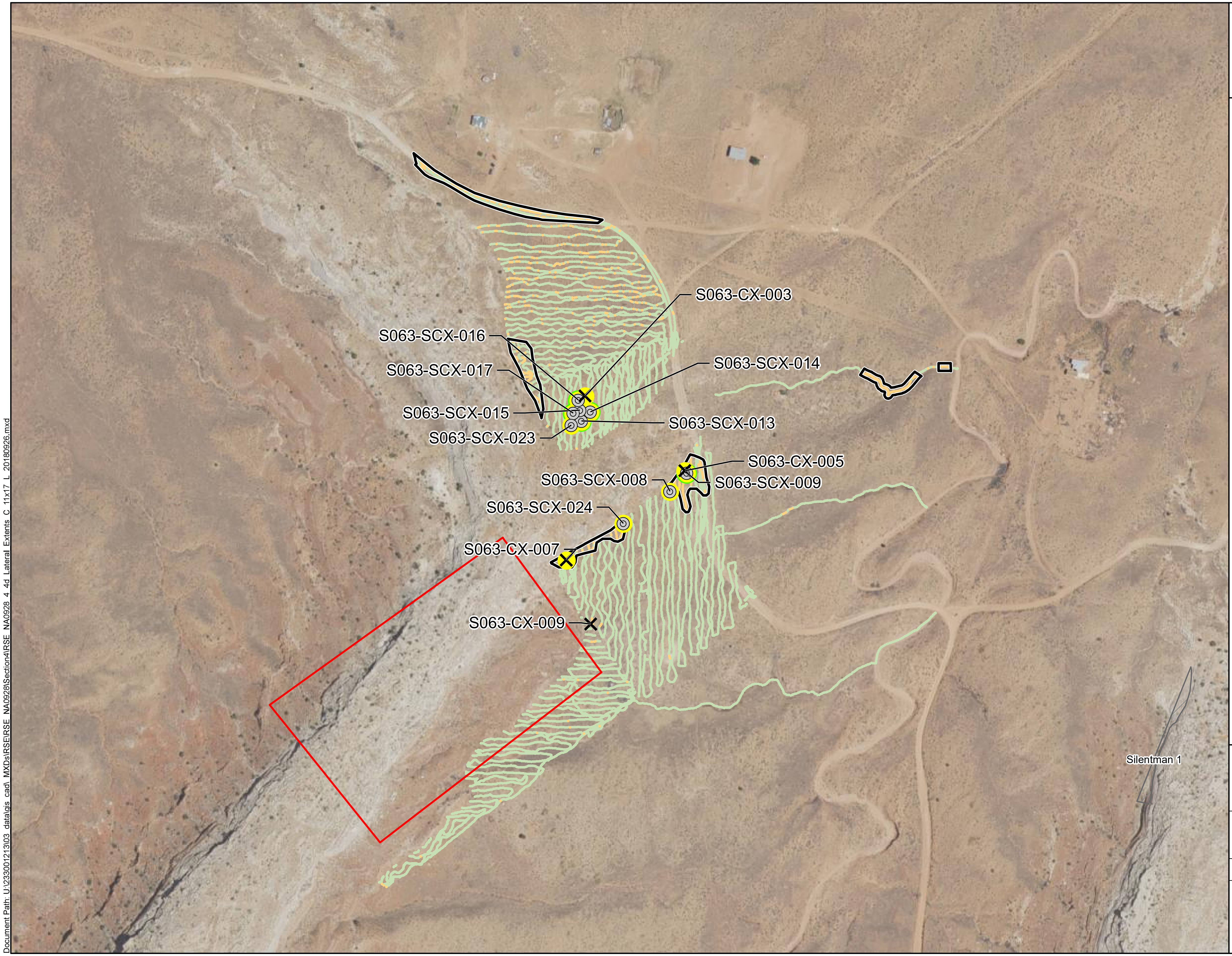
10/2/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: TMW
REVIEWER: CBB
FIGURE: 4-4c

Document Path: U:\203300121\03_data\gis_cad_MXDs\RSE\RSE_NA0928\Section4\RSE_NA0928_4_4c_Lateral_Extents_B_11x17_L_20180926.mxd



NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

- × Surface Sample Location
- ◎ Borehole Location - Surface and Subsurface Samples
- ● IL Exceedance in Unconsolidated Material at Location
- ● IL Exceedance in Bedrock in Borehole
- ▭ Approximate Area where Surface Gamma IL is Exceeded (0.8 acres)
- 🟥 Claim Boundary
- ▨ Other Claim Boundary

Gamma Survey

Counts per Minute (CPM)

- ● 4,871 - 9,911 (IL Not Exceeded)
- ● 9,912 - 97,546 (IL Exceeded)

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agricultural Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 10/2018.

N
W E
S

0 250 500
Feet

Sruvey Area C
Lateral Extent of Surface and Subsurface IL Exceedances

Removal Site Evaluation
NA-0928 Mine Site

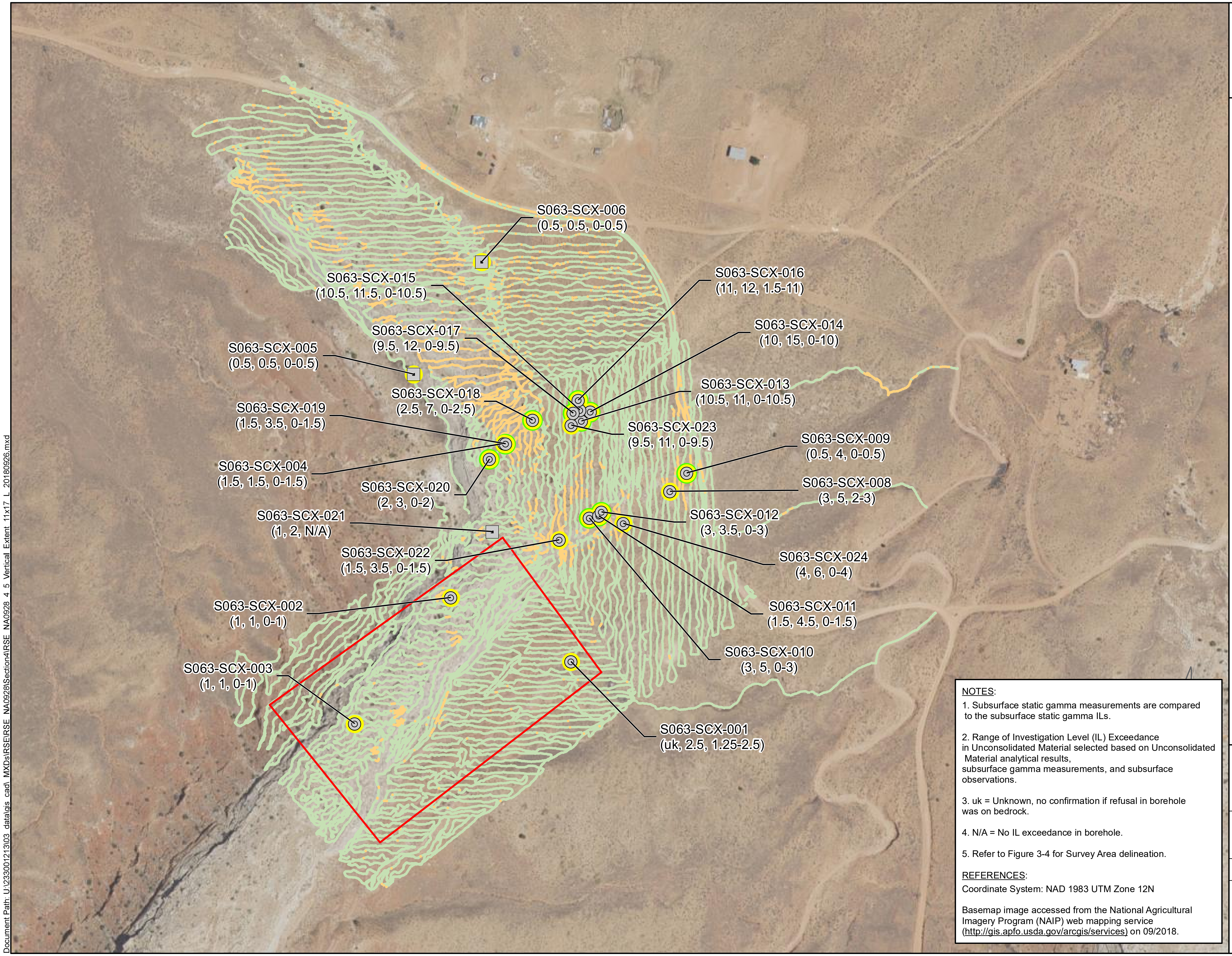
10/2/2018

DOCUMENT NAME:
Removal Site Evaluation Report

Stantec

AUTHOR: TMW
REVIEWER: CBB
FIGURE: 4-4d

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\Section4\RSE NA0928 4 4d Lateral Extents C 11x17 L 20180926.mxd



NOTES:

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

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

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

4. N/A = No IL exceedance in borehole.

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

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agricultural Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 09/2018.

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

S063-SCX-006 (0.5, 0.5, 0-0.5)	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 at Location
🟢	IL Exceedance in Bedrock in Borehole
🟥	Claim Boundary
▨	Other Claim Boundary

Gamma Survey

Counts per Minute (CPM)

●	IL Not Exceeded Survey Area A: 4,640 - 11,068 Survey Area B: 4,847 - 10,447 Survey Area C: 4,871 - 9,911
●	IL Exceeded Survey Area A: 11,069 - 104,004 Survey Area B: 10,448 - 13,662 Survey Area C: 9,912 - 97,546

N
W E
S

0 250 500
Feet

TITLE:
Vertical Extent of IL Exceedances in Unconsolidated Material

PROJECT:
Removal Site Evaluation
NA0928 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

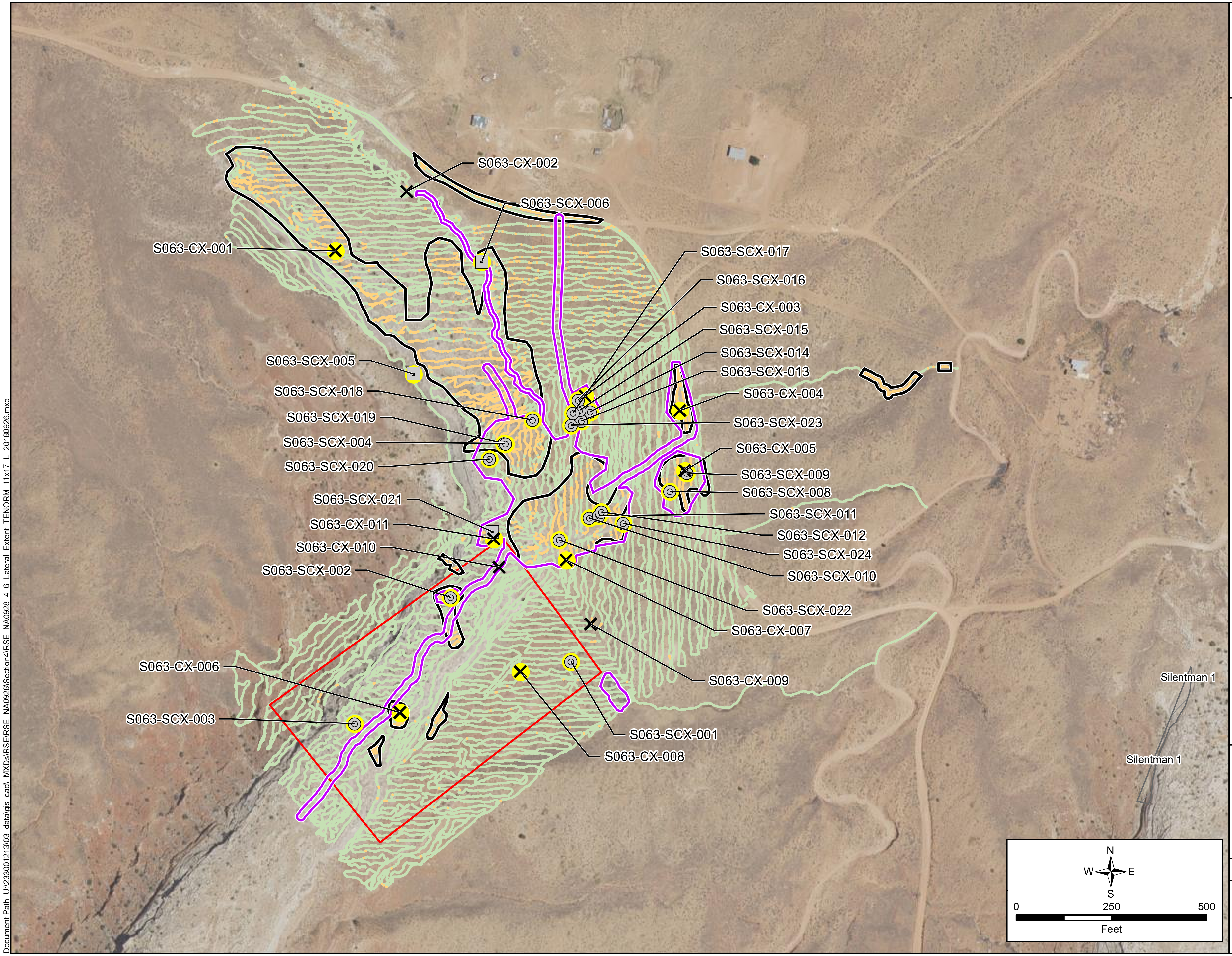
Stantec

AUTHOR: TMW

REVIEWER: CBB

FIGURE: 4-5

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\Section4\RSE NA0928 4 5 Vertical Extent 11x17 L 20180926.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
●	IL Exceedance in Unconsolidated Material at Location
▭	TENORM (4.3 acres)
▭	Approximate Area where Surface Gamma ILs are Exceeded (6.7 acres)
🟥	Claim Boundary
▨	Other Claim Boundary

Gamma Survey
Counts per Minute (CPM)

●	IL Not Exceeded Survey Area A: 4,640- 11,068 Survey Area B: 4,847 - 10,447 Survey Area C: 4,871 - 9,911
●	IL Exceeded Survey Area A: 11,069 - 104,004 Survey Area B: 10,448 - 13,662 Survey Area C: 9.912 - 97,546

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

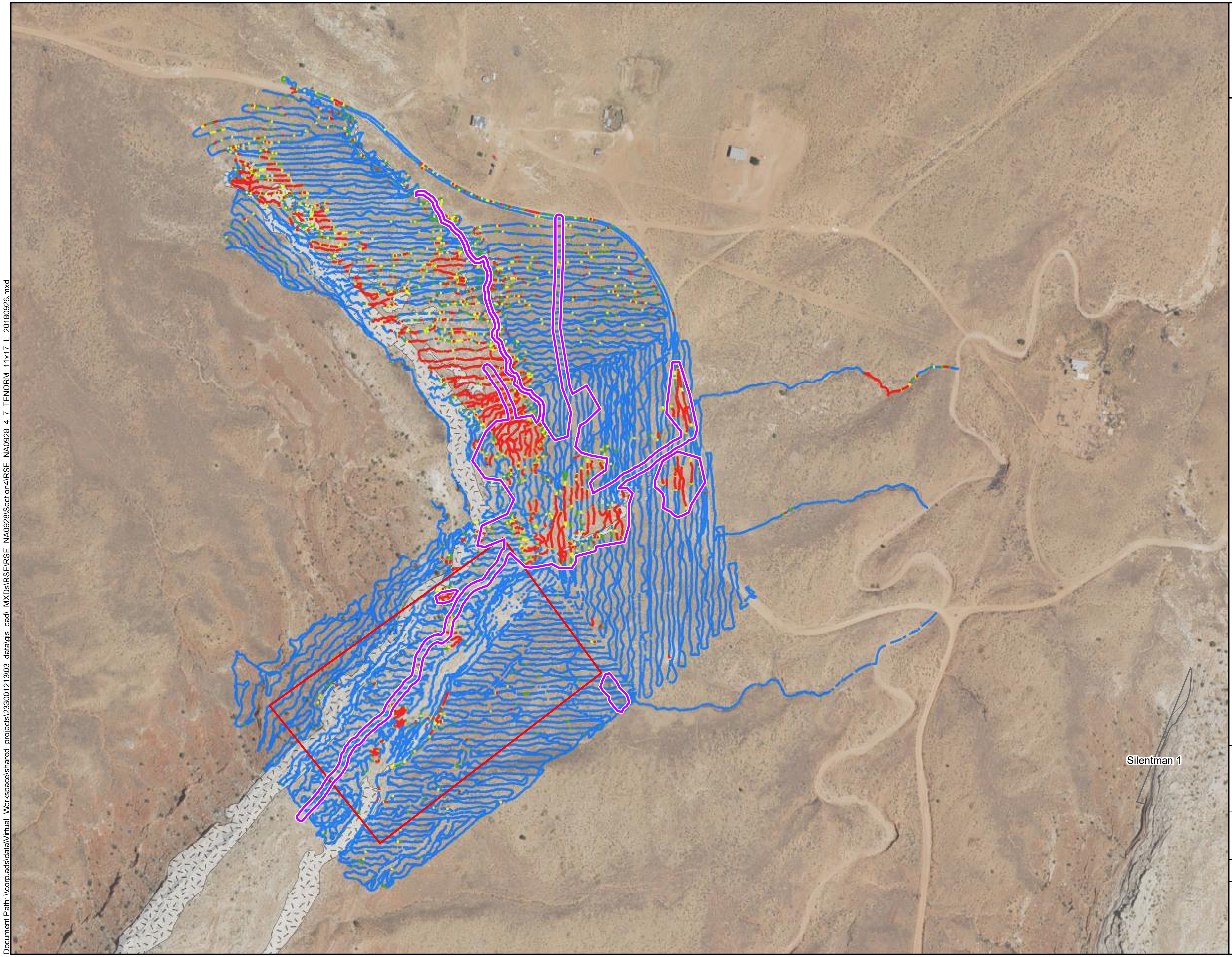
REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agricultural Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 10/2018.

TITLE:
TENORM Compared to Lateral Extent of IL Exceedances

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 10/2/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: CBB
REVIEWER: CBB
Stantec
FIGURE: 4-6



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

- TENORM (4.3 acres)
- Exposed Bedrock[1]
- Claim Boundary
- Other Claim Boundary

Gamma Survey

Counts per Minute (CPM)

●	4,640 - 9,911 (Minimum to BG-4 IL)
●	9,912 - 10,447 (>BG-4 IL to BG-3 IL)
●	10,448 - 11,068 (>BG-3 IL to BG-2 IL)
●	11,069 - 104,004 (>BG-2 IL to Maximum)

NOTES:

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

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

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agricultural Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 09/2018.

N
W E
S

0 250 500
Feet

TITLE:
TENORM Compared to Gamma Radiation Survey Results

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

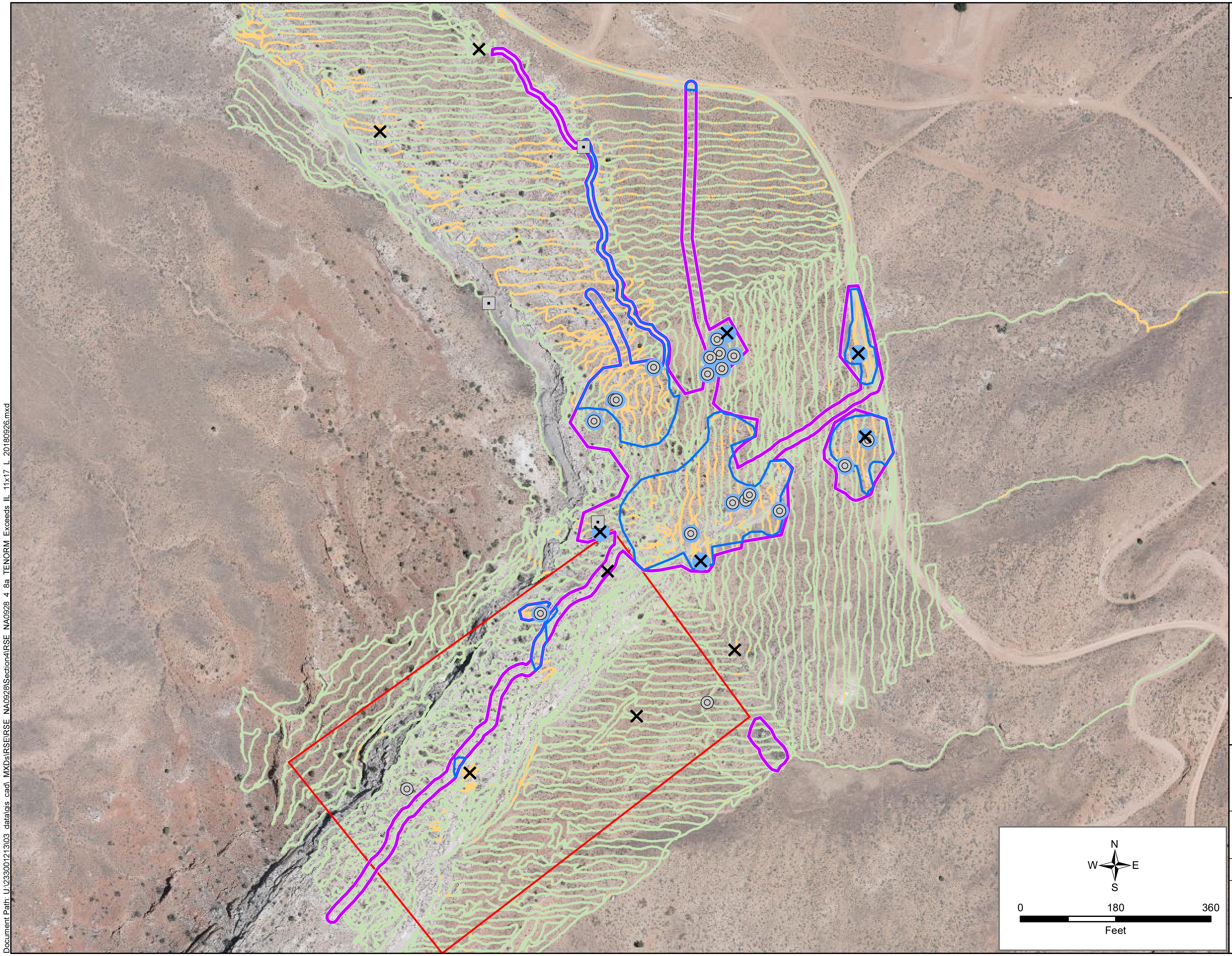
Stantec

AUTHOR: TMW

REVIEWER: CBB

FIGURE: 4-7

Document Path: \\corp.ads\data\Virtual Workspace\shared projects\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\Section4\RSE NA0928 4 7 TENORM 11x17 L 20180926.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 (2.3 acres)

▭ TENORM (4.3 acres)

▭ Claim Boundary

Gamma Survey

Counts per Minute (CPM)

● IL Not Exceeded
Survey Area A: 4,640- 11,068
Survey Area B: 4,847 - 10,447
Survey Area C: 4,871 - 9,911

● IL Exceeded
Survey Area A: 11,069 - 104,004
Survey Area B: 10,448 - 13,662
Survey Area C: 9.912 - 97,546

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

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

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

TITLE:

TENORM that Exceeds ILs

PROJECT:

Removal Site Evaluation
NA-0928 Mine Site

DATE: 10/2/2018

DOCUMENT NAME: Removal Site Evaluation Report

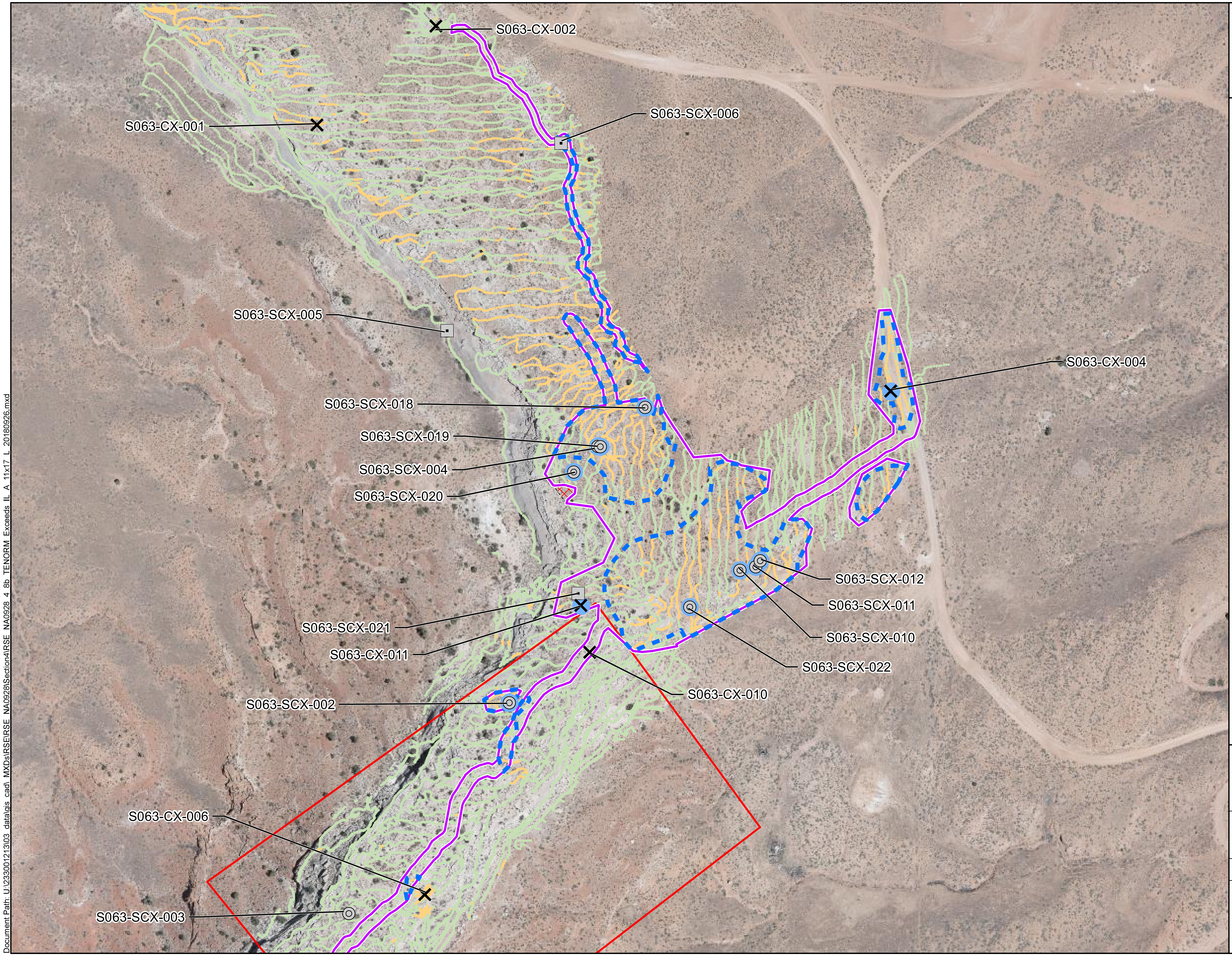
Stantec

AUTHOR: AJS

REVIEWER: CBB

FIGURE: 4-8a

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\Section4\RSE NA0928 4 8a TENORM Exceeds IL 11x17 L 20180926.mxd



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

✕	Surface Sample Location
⊡	Borehole Location - Surface Samples Only
◎	Borehole Location - Surface and Subsurface Samples
●	TENORM Exceeding IL in Unconsolidated Material at Location
⬚	TENORM Area Exceeding Surface Gamma ILs (2.0 acres)
⬚	TENORM (3.4 acres)
▨	TENORM Unsurveyed (0.01 acres)
☐	Claim Boundary

Gamma Survey[1]
Counts per Minute (CPM)

●	IL Not Exceeded Survey Area A: 4,640 - 11,068
●	IL Exceeded Survey Area A: 11,069 - 104,004

NOTE:
1. Gamma Survey Area A is approximately 16.8 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

0 150 300
Feet

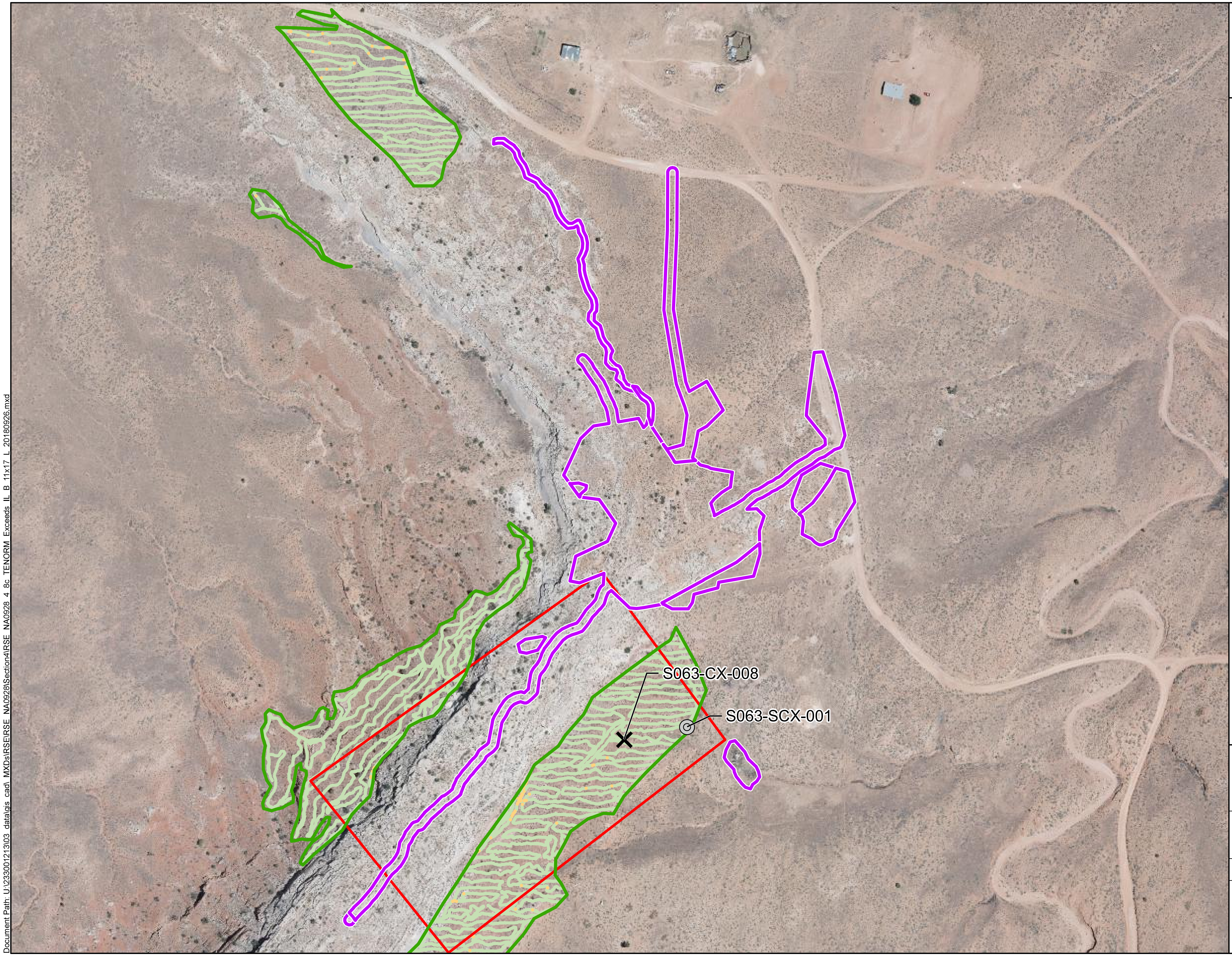
TITLE:
Survey Area A
TENORM that Exceeds ILs

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 10/2/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: AJS
REVIEWER: CBB
FIGURE: 4-8b

Stantec

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\Section4\RSE NA0928 4 8b TENORM Exceeds IL A 11x17 L 20180926.mxd



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NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Borehole Location - Surface and Subsurface Samples
🟦	TENORM Area Exceeding ILs (0.0 acres)
🟪	TENORM (0.0 acres)
🟩	Survey Area B
🟥	Claim Boundary

Gamma Survey[1]
Counts per Minute (CPM)

●	IL Not Exceeded Survey Area B: 4,847 - 10,447
●	IL Exceeded Survey Area B: 10,448 - 13,662

NOTE:

1. Gamma Survey Area B is approximately 7.2 acres

2. TENORM is not present in Survey Area B.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

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

N
W E
S

0 200 400
Feet

TITLE:

Survey Area B
TENORM that Exceeds ILs

PROJECT:

Removal Site Evaluation
NA-0928 Mine Site

DATE: 10/2/2018

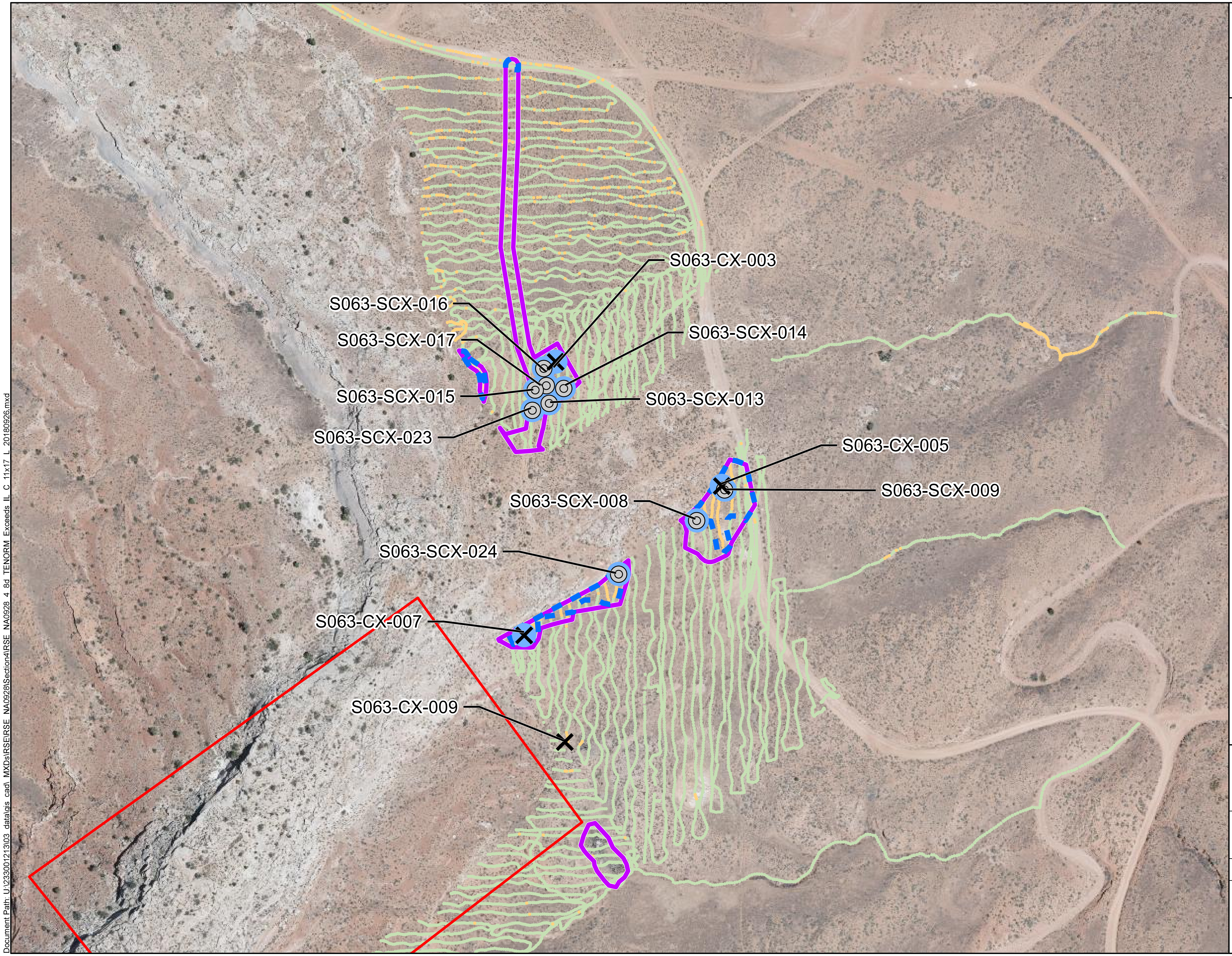
DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB

REVIEWER: CBB

FIGURE: 4-8c



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 (0.3 acres)
⬚	TENORM (0.9 acres)
☐	Claim Boundary

Gamma Survey[1]
Counts per Minute (CPM)

●	IL Not Exceeded Survey Area C: 4,871 - 9,911
●	IL Exceeded Survey Area C: 9,912 - 97,546

NOTE:
Gamma Survey Area C is approximately 13.0 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

0 150 300
Feet

TITLE:
Survey Area C
TENORM that Exceeds ILs

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 10/2/2018

DOCUMENT NAME: Removal Site Evaluation Report

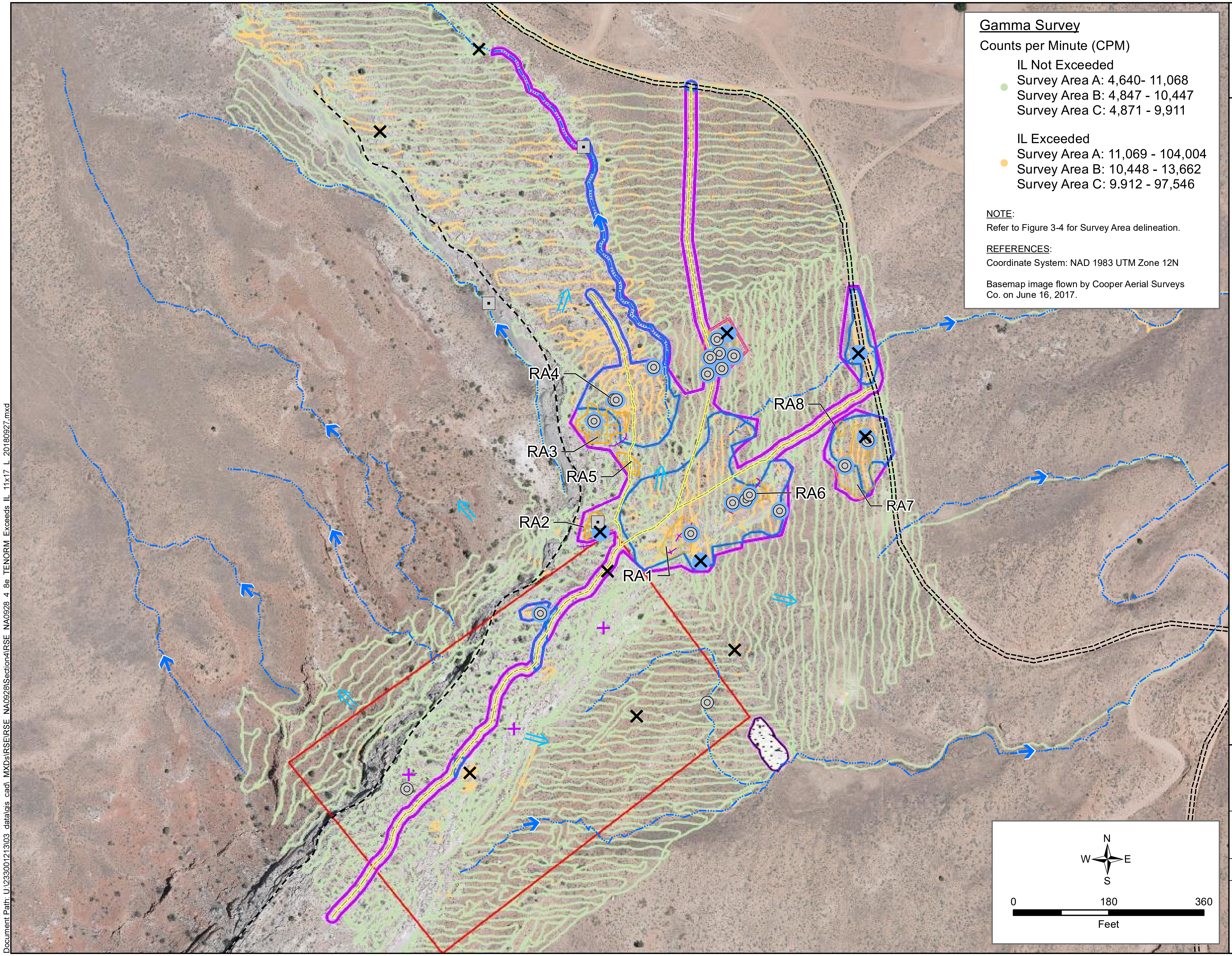
AUTHOR: AJS

REVIEWER: CBB

Stantec

FIGURE: 4-8d

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE\RSE NA0928\Section4\RSE NA0928 4 8d TENORM Exceeds IL C 11x17 L 20180926.mxd



Gamma Survey

Counts per Minute (CPM)

● IL Not Exceeded
Survey Area A: 4,640- 11,068
Survey Area B: 4,847 - 10,447
Survey Area C: 4,871 - 9,911

● IL Exceeded
Survey Area A: 11,069 - 104,004
Survey Area B: 10,448 - 13,662
Survey Area C: 9.912 - 97,546

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

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

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

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

- ✕ Surface Sample Location
- ◎ Borehole Location - Surface and Subsurface Samples
- ⊡ Borehole Location - Surface Samples Only
- ● TENORM Exceeding IL in Unconsolidated Material at Location
- + Rim Strip Location per 2007 AUM Atlas¹
- ↑ Flow Direction
- ⇧ Approximate Overland Water Flow Direction
- -··- Drainage
- -+- Rim Strip (Buried - Location Approximate)
- - - - Approximate Edge of Mesa
- --- Potential Haul Road
- ==== Road
- ▨ Debris
- ▦ Mining / Reclaimed Disturbed Area
- ▢ TENORM Area Exceeding Surface Gamma ILs (2.3 acres)
- ▢ TENORM (4.3 acres)
- ▢ Claim Boundary

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

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 10/2/2018

DOCUMENT NAME: Removal Site Evaluation Report

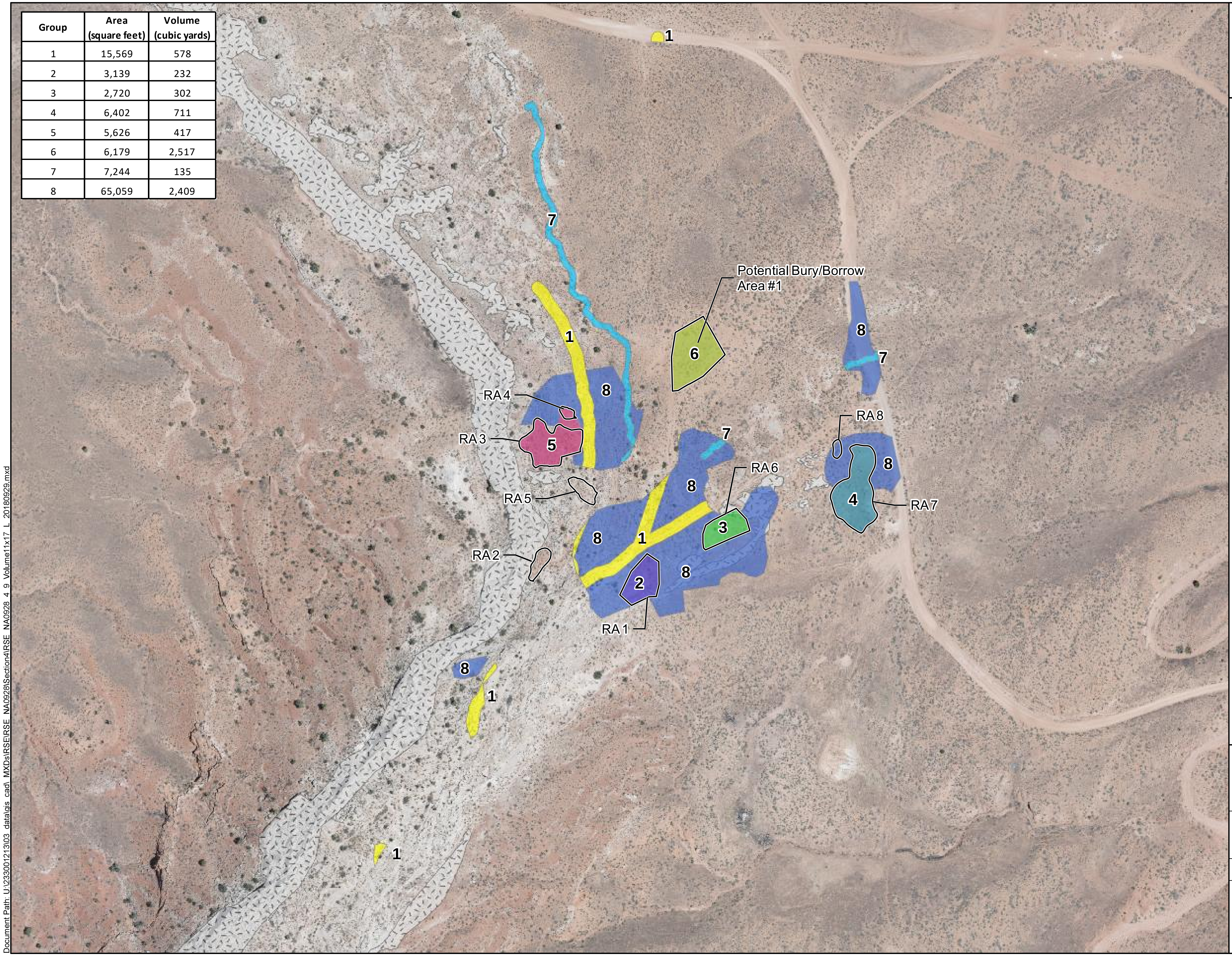
AUTHOR: AJS

REVIEWER: CBB

Stantec

FIGURE: 4-8e

Group	Area (square feet)	Volume (cubic yards)
1	15,569	578
2	3,139	232
3	2,720	302
4	6,402	711
5	5,626	417
6	6,179	2,517
7	7,244	135
8	65,059	2,409



NAVAJO NATION
AUM Environmental Response Trust-First Phase

LEGEND

▢	Mining / Reclaimed Disturbed Area
▨	Exposed Bedrock¹

Average Depth by Group (feet below ground surface)

🟨	Group 1 - 1.0 ft
🟪	Group 2 - 2.0 ft
🟩	Group 3 - 3.0 ft
🟦	Group 4 - 3.0 ft
🟥	Group 5 - 2.0 ft
🟩	Group 6 - 11.0 ft
🟦	Group 7 - 0.5 ft
🟦	Group 8 - 1.0 ft

NOTES:

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

2. Reclamation areas (RA) are numbered consistent with NAML records. Waste piles have been reclaimed / covered, although erosion of cover material has occurred in some locations.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

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

N
W E
S

0 150 300
Feet

TITLE:

Volume Estimate of TENORM that Exceeds IL

PROJECT:

Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/29/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: 4-9

Document Path: U:\23300121303 data\gis cad\ MXDs\RSE\RSE NA0928\Section4\RSE NA0928 4 9 Volume11x17 L 20180929.mxd

APPENDICES

Appendix A Radiological Characterization of the NA-0928 Abandoned Uranium Mine

Radiological Characterization of the NA-0928 Abandoned Uranium Mine

September 18, 2018

prepared for:

Stantec Consulting Services Inc.

2130 Resort Drive, Suite 350
Steamboat Springs, CO 80487

prepared by:

ERG

Environmental Restoration Group, Inc.

8809 Washington St. NE
Suite 150
Albuquerque, NM 87113

Contents

Tables

Figures

Appendices

Acronyms

ANSI	American National Standards Institute
AUM	abandoned uranium mine
BG2	Background Reference Area 2
BG3	Background Reference Area 3
BG4	Background Reference Area 4
cpm	counts per minute
DQOs	data quality objectives
ERG	Environmental Restoration Group, Inc.
ft	foot
GPS	global positioning system
MDC	minimum detectable concentration
µR/h	microRoentgens per hour
pCi/g	picocuries per gram
R^2	Pearson's Correlation Coefficient
RSE	removal site evaluation
σ	standard deviation
Stantec	Stantec Consulting Services Inc.

Executive Summary

This report addresses the radiological characterization of the NA-0928 abandoned uranium mine (AUM) located in the Sweetwater Chapter of the Navajo Nation near Red Mesa, Arizona. 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 Stantec Consulting Services Inc. (Stantec) on behalf of 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 3, September 29 and 30, and October 4 and 12, 2016; and March 23, April 11 and 14, and September 12 and 14, 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 “NA-0928 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 in several small areas in the mine claim and on waste rock immediately east of the mine claim. In addition, elevated count rates were associated with naturally occurring materials extending northwest away from the northeast corner of 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:

$$\text{Gamma Count Rate (cpm)} = 1080 \text{ x } [\text{radium-226 (pCi/g)}] + 14119$$

- 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 -8.8 to 83.2 pCi/g, with a central tendency (median) of -5.9 pCi/g.

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

- There is evidence that thorium-230 and radium-226 are in secular equilibrium.

- 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 $4\text{x}10^{-4}$ + 7.895

- The distribution of exposure rates predicted using this model is rightward tailed. The values in the Survey Area range from 9.7 to 50, with a central tendency (median) of 11.0 µR/h.

1.0 Introduction

This report addresses the radiological characterization of the NA-0928 abandoned uranium mine (AUM) located in the Sweetwater Chapter of the Navajo Nation near Red Mesa, Arizona. 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 Stantec Consulting Services Inc. (Stantec) on behalf of 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 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 3, September 29 and 30, and October 4 and 12, 2016; and March 23, April 11 and 14, and September 12 and 14, 2017. They included a GPS-based radiological survey of land surfaces over an approximately 37-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 "NA-0928 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 "NA-0928 Removal Site Evaluation Report" (Stantec, 2018).

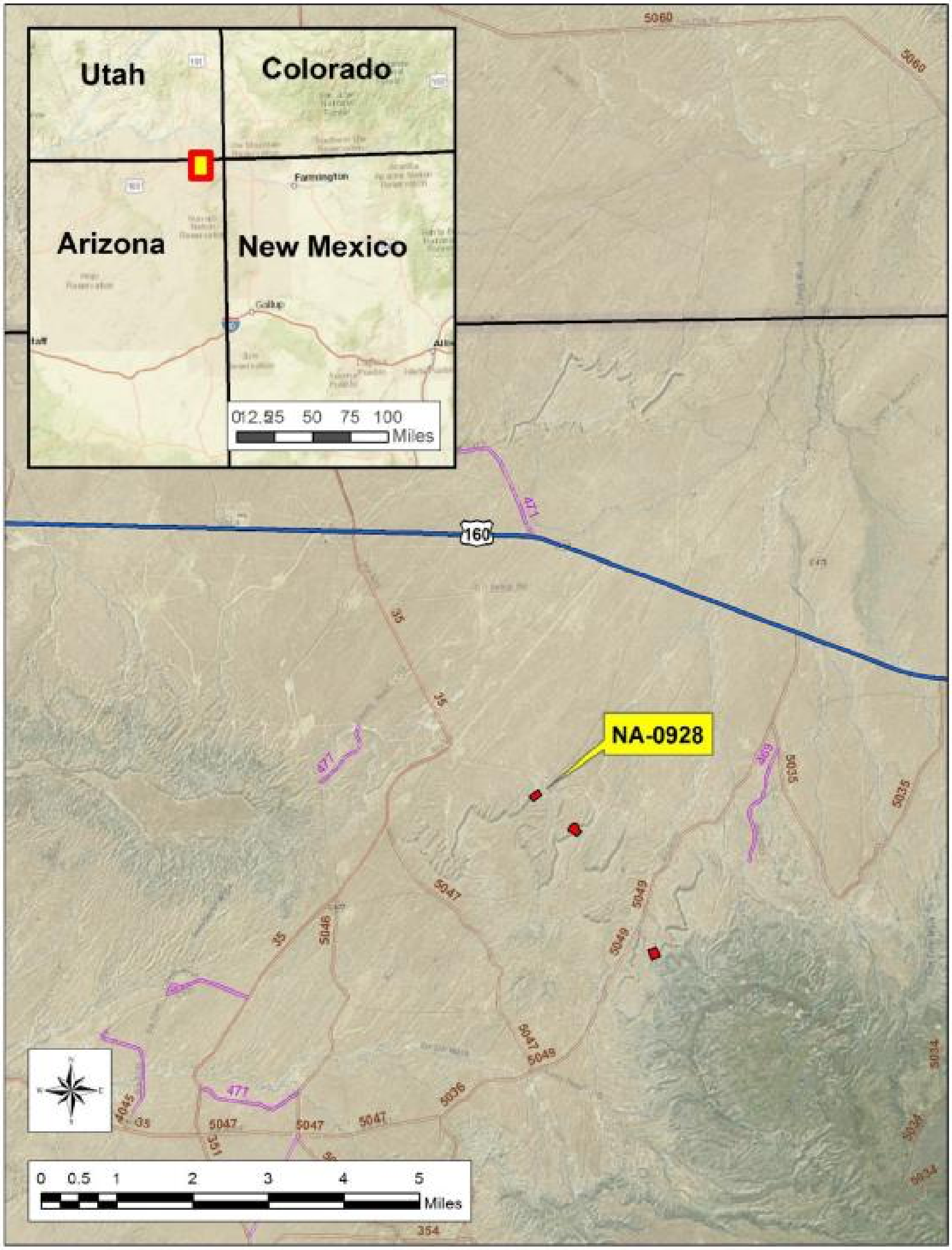


Figure 1. Location of the NA-0928 Abandoned Uranium Mine

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 workplan.

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

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

Survey Area	Ludlum Model 44-10	Ludlum Model 2221 Ratemeter/Scaler
Potential Background Reference Areas	PR303727[a]	254772[a]
	PR355763	138368
Survey Area	PR295014	196086
	PR295017	271435
	PR303727[a]	254772[a]
	PR320678	282971
	PR355763	138368

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

2.1 Potential Background Reference Areas

Three potential Background Reference Areas were surveyed, the locations and results of which are depicted on Figure 2. BG2, BG3, and BG4 in the figure are Background Reference Areas 2, 3, and 4, respectively. These potential Background Reference Areas are the same as those used for AUM NA-0904, which is shown in the figure for its proximity to NA-0928. Table 2 lists a summary of the gamma count rates, which in:

- BG2 ranged from 7,118 to 13,741 counts per minute (cpm), with a mean and median of 9,369 and 9,310 cpm, respectively.

- BG3 ranged from 5,599 to 12,226 cpm, with a mean and median of 8,668 and 8,490 cpm, respectively.

- BG4 ranged from 7,158 to 10,204 cpm, with a mean and median of 8,463 and 8,430 cpm, respectively.

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

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

	Gamma Count Rate (cpm)					
Potential Background Reference Area	**n**	**Minimum**	**Maximum**	**Mean**	**Median**	**Standard Deviation**
2	328	7,118	13,741	9,369	9,310	948
3	378	5,599	12,226	8,668	8,490	999
4	70	7,158	10,204	8,463	8,430	729

Notes:
cpm = counts per minute

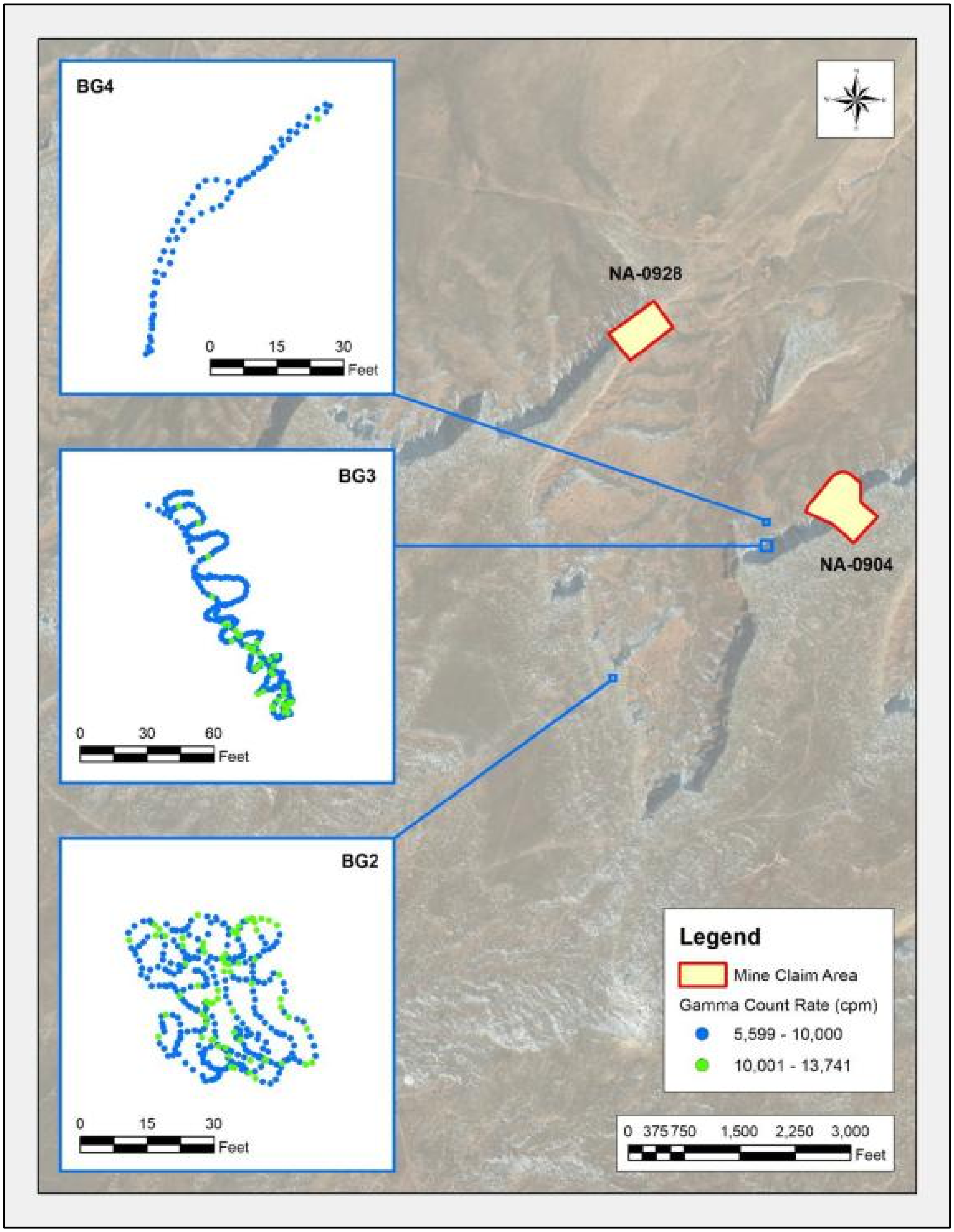
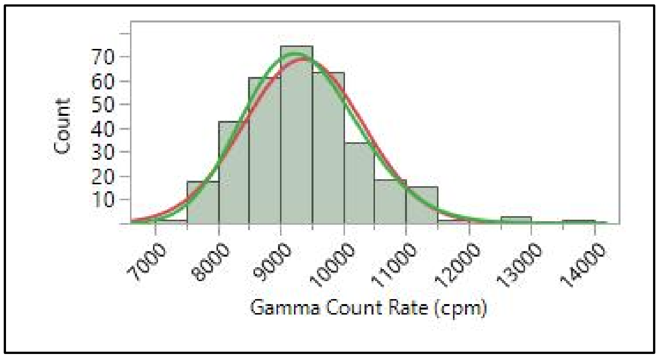
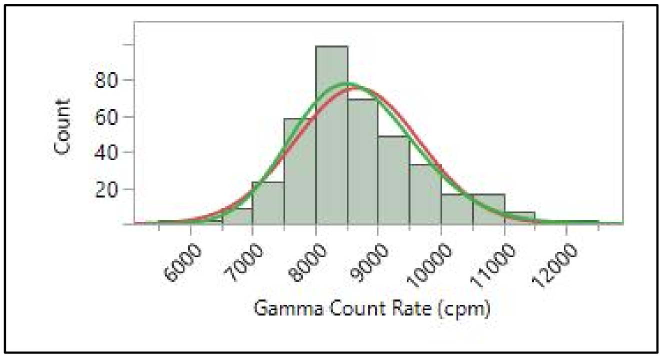


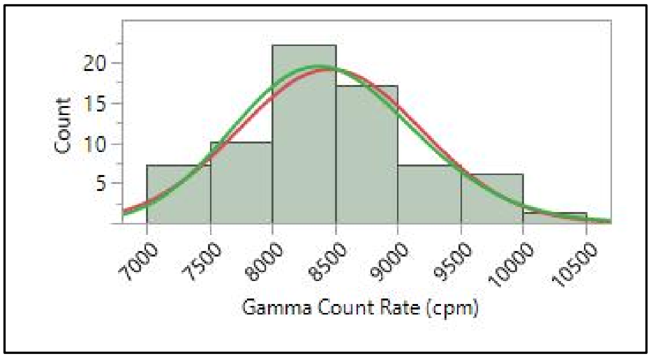
Figure 2. Gamma count rates in the potential Background Reference Areas.



a. Background Reference Area 2



b. Background Reference Area 3



c. Background Reference Area 4

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

2.2 Survey Area

The gamma count rates observed in the Survey Area are depicted in Figure 4. Elevated count rates were observed in several small areas in the mine claim and on waste rock immediately east of the mine claim. In addition, elevated count rates were associated with naturally occurring materials extending northwest away from the northeast corner of 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 (version 5.1.002), 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 7,003, 7,758, and 8,865 cpm, respectively.

Table 3 is a statistical summary of the measurements, which range from 4,640 to 104,004 cpm and have a central tendency (median) of 7,758 cpm.

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

Parameter	Gamma Count Rate (cpm)
n	52,265
Minimum	4,640
Maximum	104,004
Mean	8,448
Median	7,758
Standard Deviation	3,572

Notes:
cpm = counts per minute

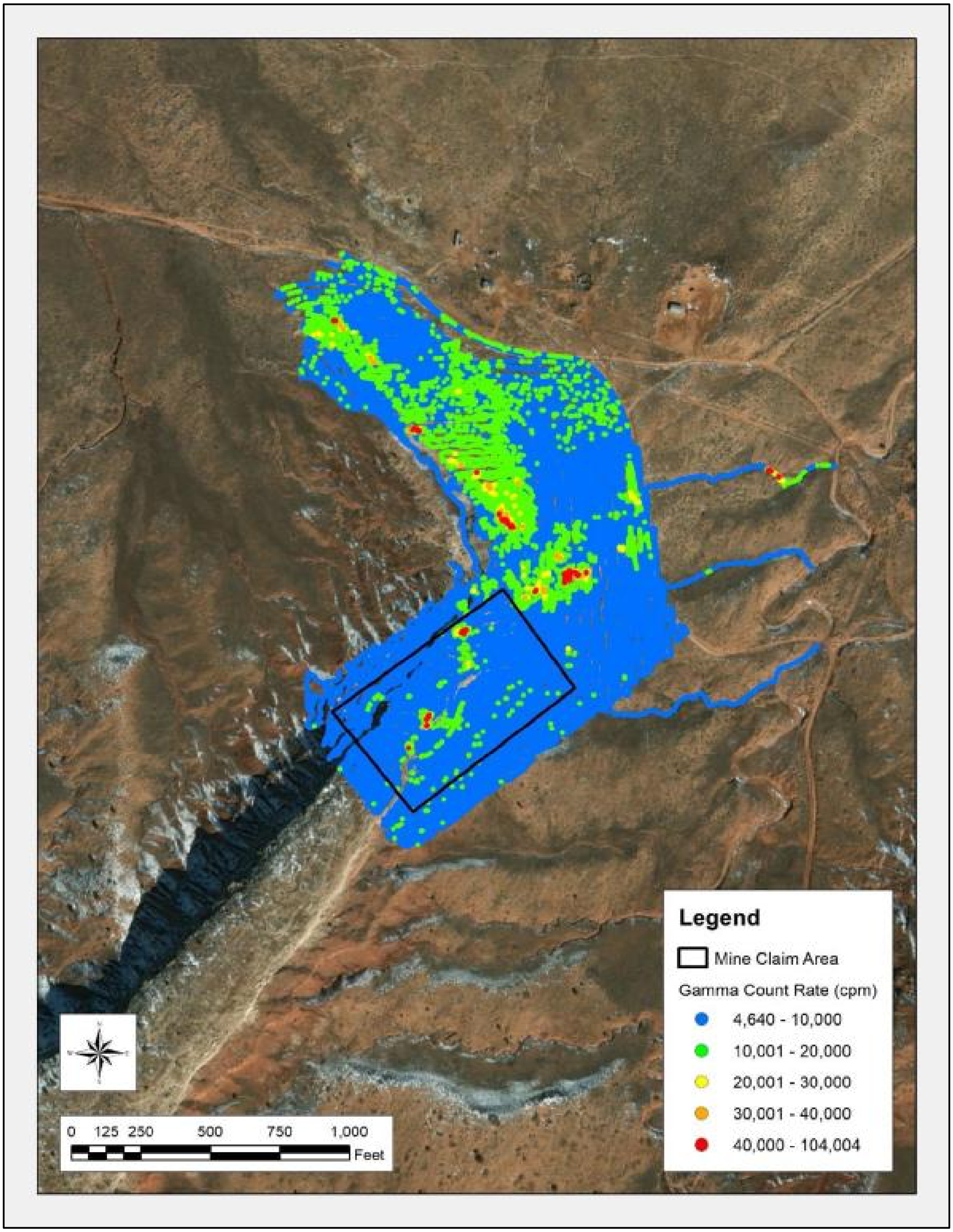


Figure 4. Gamma count rates in the Survey Area.

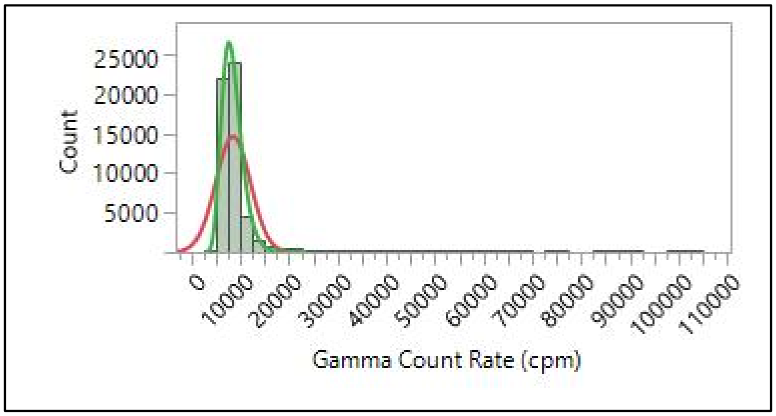


Figure 5. Histogram of gamma count rates in the Survey Area.

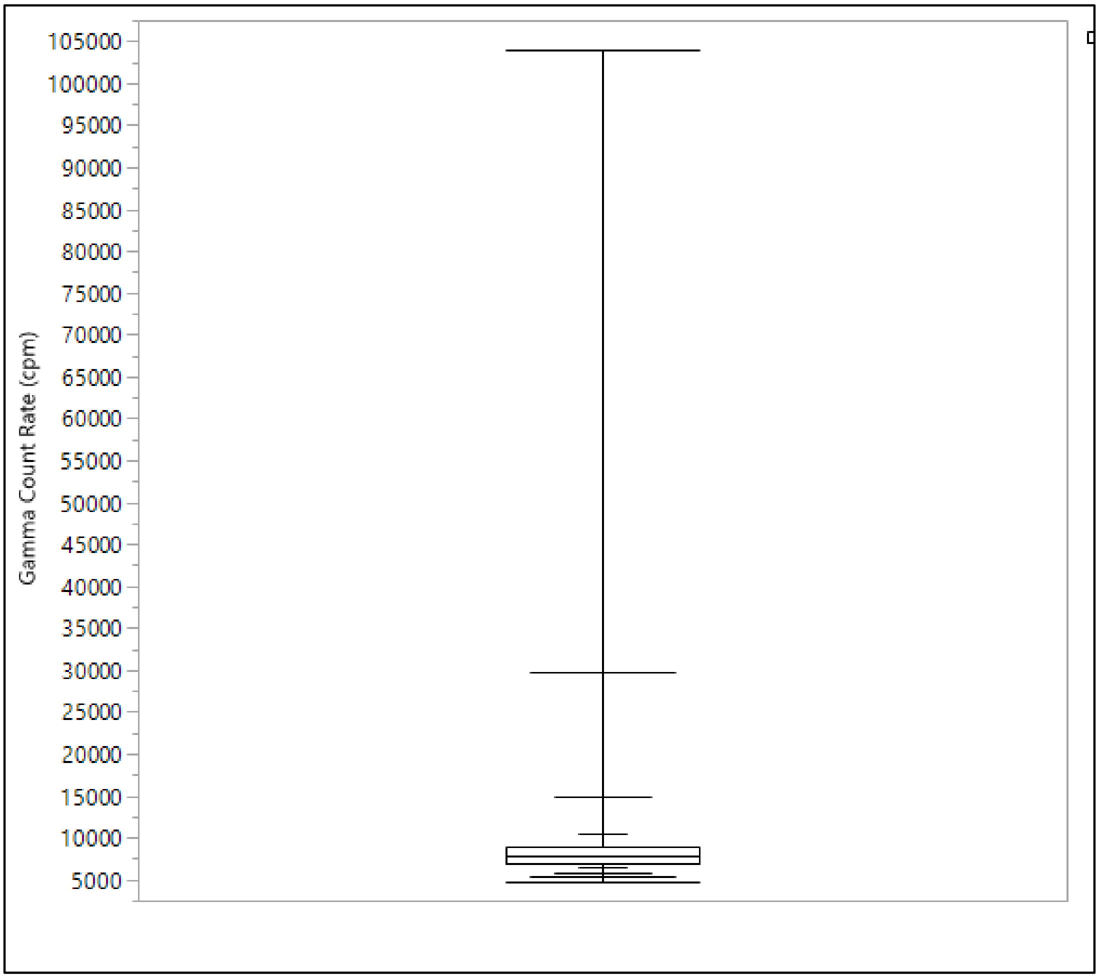


Figure 6. Box plot of gamma count rates in the Survey Area.

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 12, 2016 field personnel made GPS-based gamma count rates measurements and collected five-point composite samples of surface soils in each of five areas at the AUM. These areas were selected using criteria established in the RSE Work Plan. No DQO was established for homogeneity of the correlation plots and as described in Section 4.3 and Appendix E of the RSE Work Plan, homogeneity of the correlation plots was evaluated qualitatively. Sub-samples were collected from the correlation plot centroid and at each corner of the plot. The activities were performed contemporaneously, by area and all on the same day, such that variations in the gamma count rate measurements could be limited largely to those posed by the soils and rocks at the locations. Figure 7 shows the GPS-based gamma count rate measurements in the five areas (labeled with location identifiers).

The soil samples were analyzed by ALS Laboratories in Ft Collins, CO for radium-226 and isotopic thorium. The latter analysis was included to assess the potential effects of thorium series isotopes on the correlation and evaluate thorium-230 and radium-226 activities to indicate the status of equilibrium in the uranium decay series. Table 4 lists the results of the gamma count rate measurements and radium-226 concentrations in the soil samples. The means of the gamma count rate measurements range from 10,068 to 73,334 cpm. The concentrations of radium-226 in the soil samples range from 1.73 to 49.1 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 “NA-0928 Removal Site Evaluation Report” (Stantec, 2018).

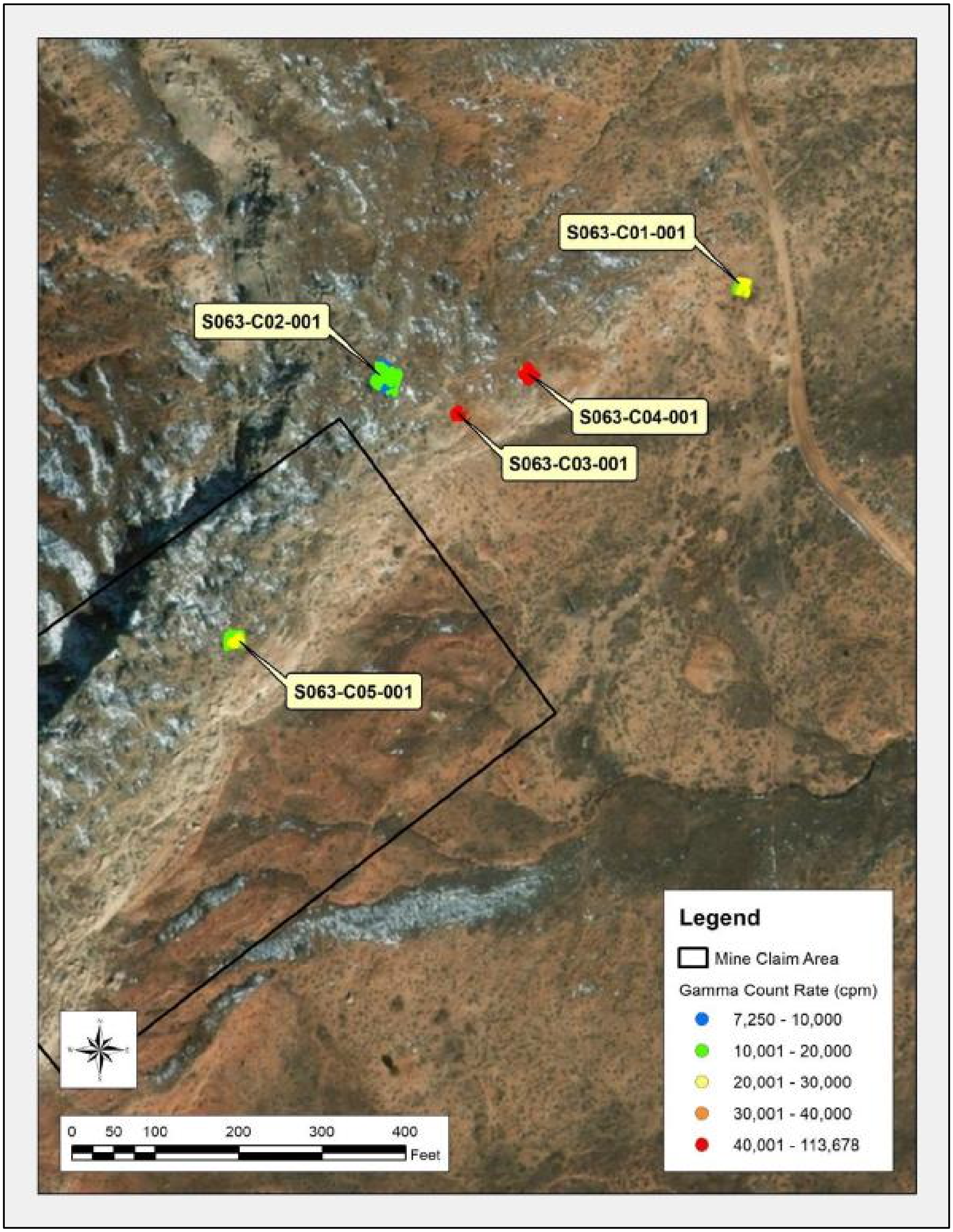


Figure 7. GPS-based gamma count rate measurements made for the correlation study.

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**
S063-C01-001	33.0	20,191	12,689	29,666	3,617	6.25	0.82	0.43
S063-C02-001	96.3	10,068	7,250	18,570	1,389	1.73	0.35	0.49
S063-C03-001	14.5	73,334	38,231	113,678	21,319	34	4.1	0.7
S063-C04-001	32.5	51,942	36,915	64,425	6,867	49.1	5.9	0.9
S063-C05-001	39.2	18,094	10,407	27,553	3,549	4.3	0.62	0.44

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**
S063-C01-001	0.453	0.096	0.046	4.51	0.72	0.07	0.497	0.099	0.014
S063-C02-001	0.242	0.063	0.053	1.5	0.25	0.07	0.284	0.063	0.016
S063-C03-001	0.288	0.069	0.048	23.4	3.6	0.1	0.342	0.072	0.019
S063-C04-001	0.454	0.094	0.051	44.9	6.9	0.1	0.54	0.1	0.01
S063-C05-001	0.364	0.082	0.056	2.97	0.48	0.07	0.328	0.07	0.013

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 0.64, as expressed in the equation:

$$\text{Gamma Count Rate (cpm)} = 1080 \times [\text{radium-226 (pCi/g)}] + 14119$$

The root mean square error and p-value for the model are 1.6×10^4 and 0.065, 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 -8.8 to 83.2 pCi/g, with a mean and median of -5.3 and -5.9 pCi/g, respectively. Note that the radium-226 concentrations predicted from gamma count rate measurements exceeding approximately 75,000 cpm are extrapolated from the regression model and are outside of the correlation dataset and therefore inherently uncertain. While the gamma correlation equation can be used to convert gamma count rates to concentrations of Ra-226 in soil, the resulting radium concentrations are highly uncertain estimates, as the wide prediction interval bands illustrated in Figure 8 demonstrate. Users of the regression equation should be aware of the limitations of the dataset and be cautious when estimating radium-226 concentrations.

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

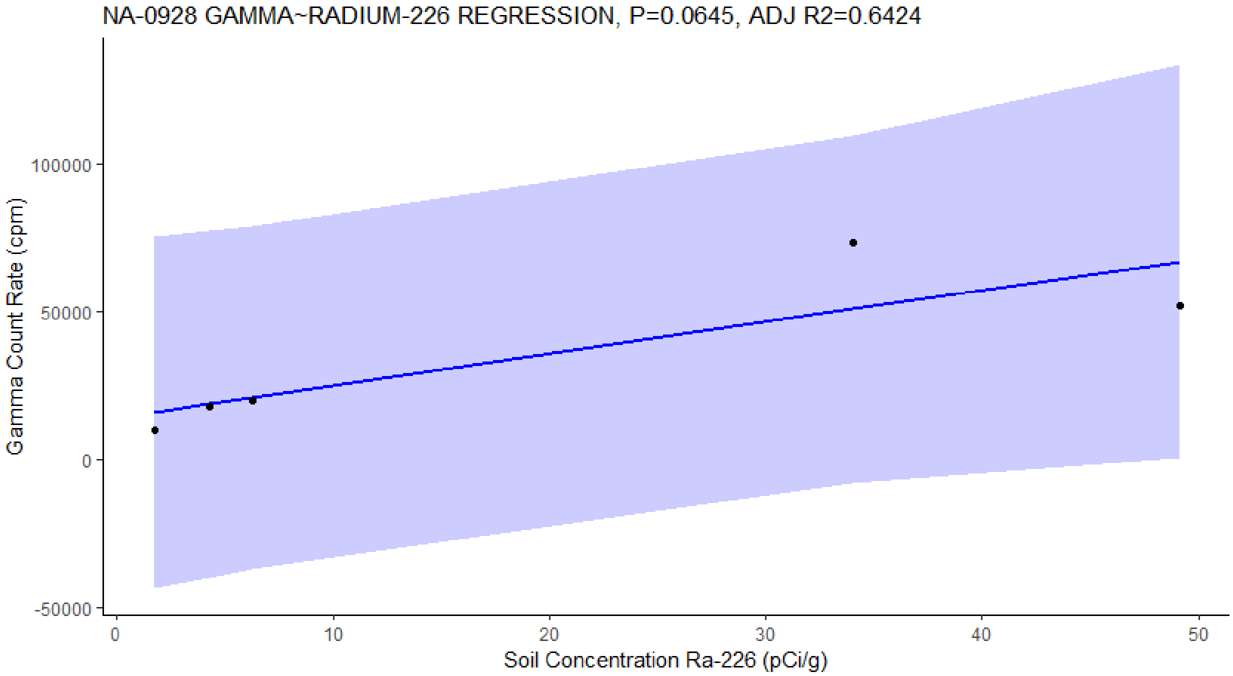


Figure 8. Correlation of gamma count rates and concentrations of radium-226 in surface soils (blue line) with 95% upper prediction level bands plotted (shaded area).

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

Parameter	Radium-226 (pCi/g)
n	52,265
Minimum	-8.8
Maximum	83.2
Mean	-5.3
Median	-5.9
Standard Deviation	3.3

Notes:
pCi/g = picocuries per gram

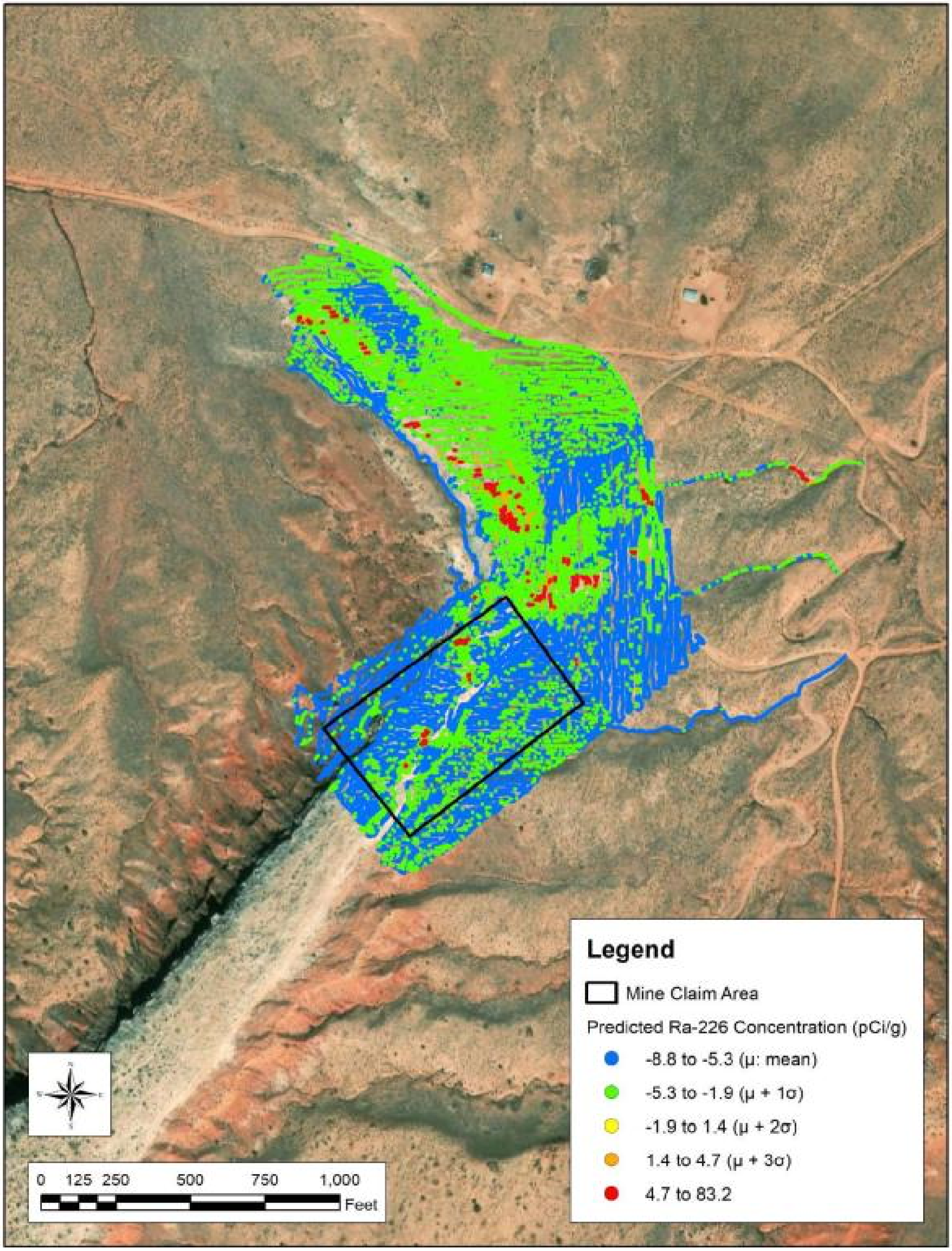


Figure 9. Predicted concentrations of radium-226 in the Survey Area.

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

A multivariate linear regression (MLR) was used to evaluate the influence of thorium-232 and thorium-228, isotopes in the thorium series, on the average gamma count rate in the correlation locations. The MLR model was first run using radium-226, thorium-232, and thorium-228 as predictors of gamma count rate. The model failed to produce results because thorium-232 and thorium-228 are colinear. The MLR model was subsequently run without thorium-228. For the second model, the p-values for radium-226 and thorium-232 were both greater than 0.05 (0.11 and 0.48 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 0.71 with an adjusted R^2 of -0.26. 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 ($p = 0.065$), as described above, and the adjusted R^2 value (0.64) 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.

3.2 Equilibrium in the uranium series

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

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

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

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

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

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

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

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

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

Based on this method, ERG concludes there is evidence that thorium-230 and radium-226 are in secular equilibrium (Figure 10).

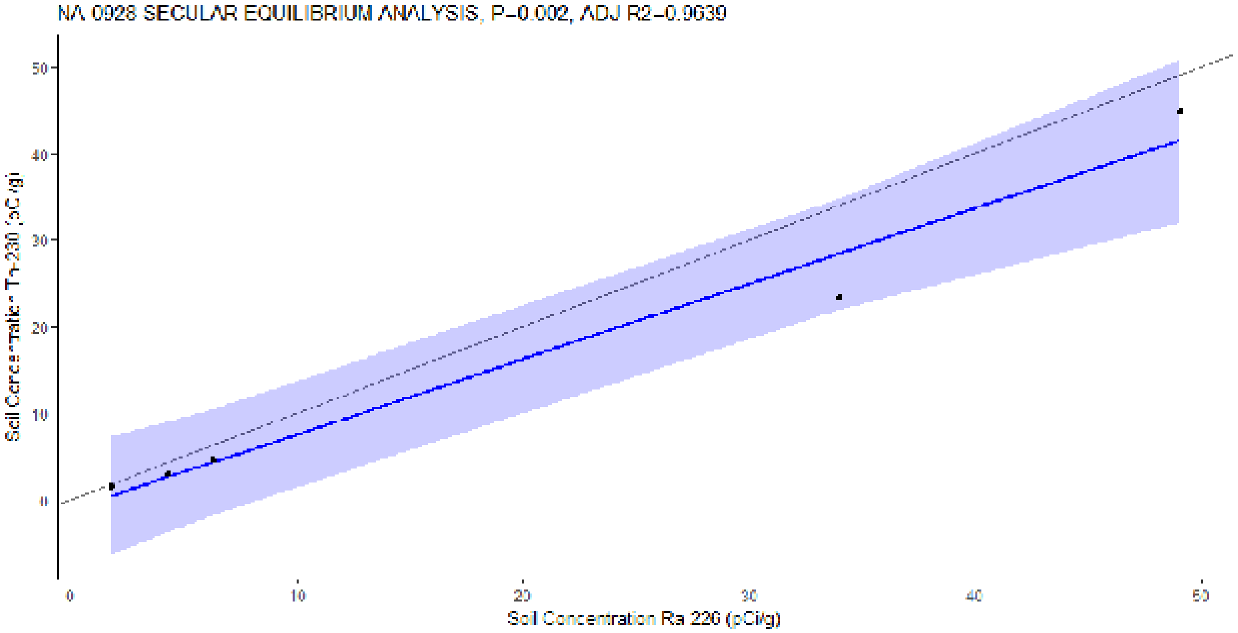


Figure 10. Evaluation of secular equilibrium in the uranium decay series.

3.3 Exposure rates and gamma count rates

On October 12, 2016 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 at 0.5 m and 1 m above the ground surface, respectively. The gamma count rate measurements were made with one of the sodium iodide detection systems used in the GPS-based gamma survey of the AUM (Serial Number PR303727/254772).

The exposure rate measurements were made using a Reuter Stokes Model RSS-131 (Serial Number 07J00KM1) high pressure ionization chamber (HPIC) at six-second intervals for about 10 minutes. The exposure rates used in the comparison was the mean of these measurements, less those occurring in initial instrument spikes. The HPIC was in current calibration and function checked before and after use. A correction factor of 1.02 was applied to the measured value per the manufacturer's recommendation by the software of the unit. Calibration forms for the HPIC are provided in Appendix A. Table 7 presents the results for the two types of measurements made at each of the five locations. The individual (one second) exposure rate measurements are not presented in this report, given that the data were lost.

The best predictive relationship between the measurements is linear with a R^2 of 0.9901. The root mean square error and p-value for the model are 1.64873 and less than 0.0004, respectively; these parameters are not DQOs and are included only as information.

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

$$\text{Exposure Rate (microRoentgens per hour [µR/h])} = 4\text{x}10^{-4} \text{ x Gamma Count Rate (cpm)} + 7.895$$

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

Tables 8 and 9 present summary statistics for the predicted exposure rates in the three Background Reference Areas and AUM, respectively.

The range of predicted exposure rates at:

- BG2 is 10.7 to 13.4 µR/h, with a mean and median of 11.6 µR/h
- BG3 is 10.1 to 12.8 µR/h, with a mean and median of 11.4 and 11.3 µR/h, respectively
- BG4 is 10.8 to 12.0 µR/h, with a mean and median of 11.3

The range of predicted exposure rates in the Survey Area is 9.7 to 50 µR/h, with a mean and median of 11.3 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)
S063-C01-001	26066	18
S063-C02-001	9998	11.7
S063-C03-001	94160	45.8
S063-C04-001	54791	33.1
S063-C05-001	17769	15

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

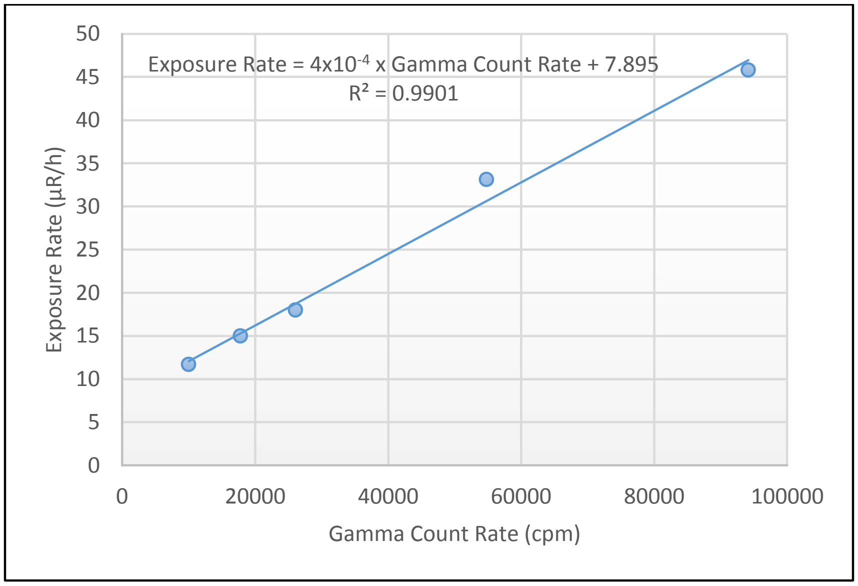


Figure 11. Correlation of gamma count rates and exposure rates.

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

Potential Background Reference Area	BG2	BG3	BG4
Parameter	Exposure Rate (µR/h)		
N	328	378	70
Minimum	10.7	10.1	10.8
Maximum	13.4	12.8	12.0
Mean	11.6	11.4	11.3
Median	11.6	11.3	11.3
Standard Deviation	0.4	0.4	0.3

Notes:
BG2 = Background Reference Area 2
BG3 = Background Reference Area 3
BG4 = Background Reference Area 4
µR/h = microRoentgens per hour

Table 9. Predicted exposure rates in the Survey Area.

Parameter	Exposure Rate (µR/h)
n	52,265
Minimum	9.7
Maximum	50
Mean	11.3
Median	11.0
Standard Deviation	1.4

Notes:
µR/h = microRoentgens per hour

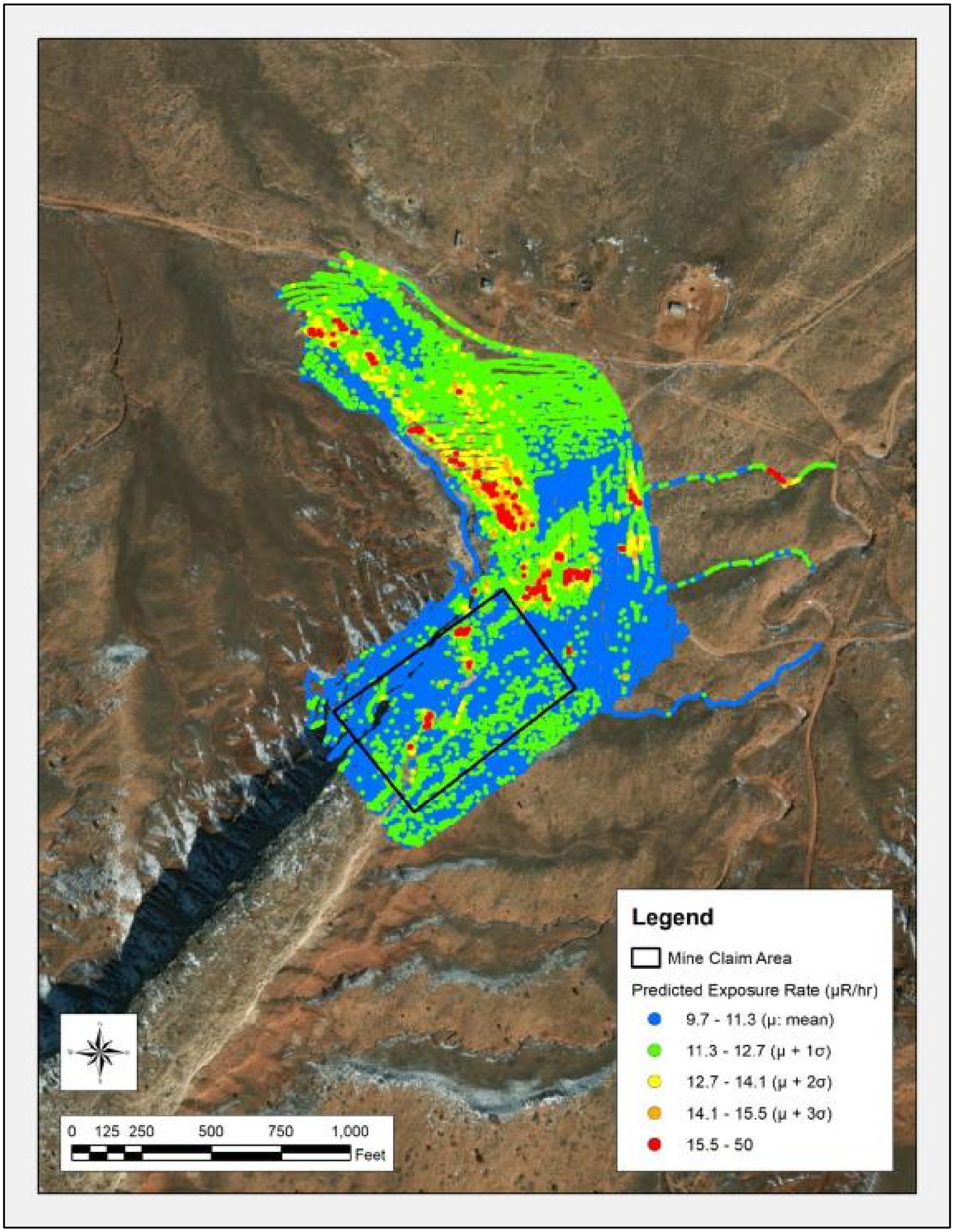


Figure 12. Predicted exposure rates in the Survey Area.

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 in several small areas in the mine claim and on waste rock immediately east of the mine claim. In addition, elevated count rates were associated with naturally occurring materials extending northwest away from the northeast corner of 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:

$$\text{Gamma Count Rate (cpm)} = 1080 \times [\text{radium-226 (pCi/g)}] + 14119$$

- 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 -8.8 to 83.2 pCi/g, with a central tendency (median) of -5.9 pCi/g.
- The thorium series radionuclides do not appear to affect the prediction of concentrations of radium-226 from gamma count rates.
- There is evidence that thorium-230 and radium-226 are in secular equilibrium.
- The relationship between gamma count rates and exposure rates is described by a linear regression model:

$$\text{Exposure Rate } (\mu\text{R/h}) = \text{Gamma Count Rate (cpm)} \times 4\text{x}10^{-4} + 7.895$$

- The distribution of exposure rates predicted using this model is rightward tailed. The values in the Survey Area range from 9.7 to 50, 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. NA-0928 Removal Site Evaluation Report, (to be finalized in October 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

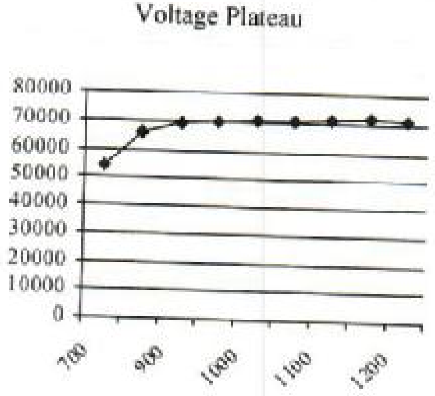
Temperature: 73 °F

Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Cour
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:

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 [illegible]

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

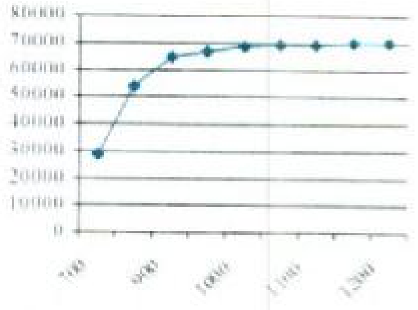
Relative Humidity: 20 %

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	39989	400
x 100	100	100	100		100
x 10	400	400	400	3999	400
x 10	100	100	100		100
x 1	400	400	400	400	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	28456	
800	53330	
900	64430	
950	66209	
1000	68333	
1050	69077	
1100	69121	8924
1150	69973	
1200	70155	

Voltage Plateau



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

Reference Instruments and/or Sources:

Ludlum pulser serial number: 97743 ✓ 201932

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

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

Fluke multimeter serial number: 87490128

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

Other Source:

Calibrated By:

Calibration Date: 7/[illegible]/16

Calibration Due: 7/[illegible]/17

Reviewed By:

Date: 7/20/16

ERG Form ITC. 101.A

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323 - 1997

ERG

Certificate of Calibration

Calibration and Voltage Plateau

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

Meter:	Manufacturer:	Ludlum	Model Number:	2221r	Serial Number:	254772
Detector:	Manufacturer:	Ludlum	Model Number:	44-10	Serial Number:	PR303727

☑ Mechanical Check
☑ F/S Response Check
☑ Geotropism
☑ Meter Zeroed

☑ THR/WIN Operation
☑ Reset Check
☑ Audio Check
☑ Battery Check (Min 4.4 VDC)

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

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

Threshold: 10 mV
Window:

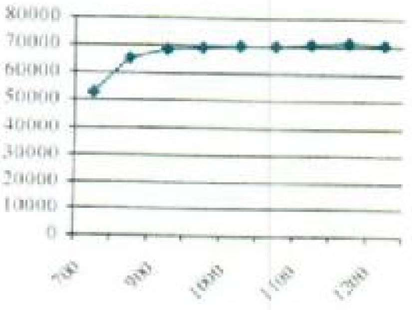
Barometric Pressure: 24.24 inches Hg
Temperature: 78 °F
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400	400	400	399859	400
x 1000	100	100	100		100
x 100	400	400	400	39991	400
x 100	100	100	100		100
x 10	400	400	400	4001	400
x 10	100	100	100		100
x 1	400	400	400	400	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	52821	
800	65213	
900	68644	
950	69245	
1000	69492	9111
1050	69792	
1100	70472	
1150	71183	
1200	70571	

Voltage Plateau



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

Reference Instruments and/or Sources:

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

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

Calibrated By:
Reviewed By:

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

Date: 3-1-17

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:

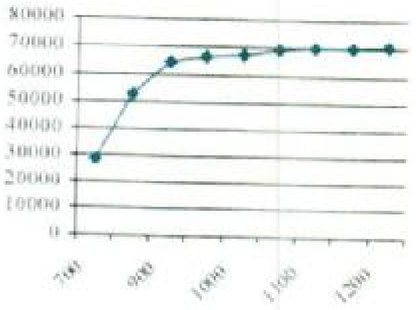
Barometric Pressure: 24.27 inches Hg
Temperature: 78 °F
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400	400	400	399386	400
x 1000	100	100	100		100
x 100	400	400	400	39949	400
x 100	100	100	100		100
x 10	400	400	400	3995	400
x 10	100	100	100		100
x 1	400	400	400	399	400
x 1	100	100	100		100

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

Voltage Plateau



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

Reference Instruments and/or Sources:

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

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

Calibrated By:
Reviewed By:

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

Date: 3/1-17

ERG Form ITC. 101.A

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

ERG

Certificate of Calibration

Calibration and Voltage Plateau

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

Meter:	Manufacturer:	Ludlum	Model Number:	2221r	Serial Number:	271435
Detector:	Manufacturer:	Ludlum	Model Number:	44-10	Serial Number:	PR295017

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

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

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

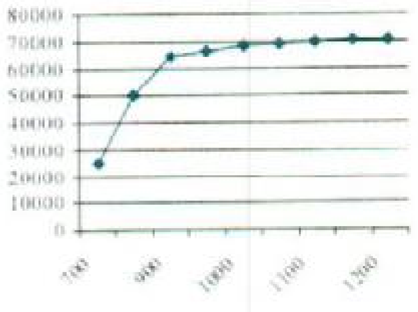
Source Distance: ☐ Contact ☑ 6 inches ☐ Other:
Source Geometry: ☑ Side ☐ Below ☐ Other:
Threshold: 10 mV
Window:

Instrument found within tolerance: ☑ Yes ☐ No

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

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

Voltage Plateau



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

Reference Instruments and/or Sources:

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

Calibrated By:
Calibration Date: 3 13-17
Calibration Due: 3-13-18

Reviewed By:
Date: 14 March 2017

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

ERG

Certificate of Calibration

Calibration and Voltage Plateau

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

Meter: Manufacturer: Ludlum Model Number: 2221r Serial Number: 138368
Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR355763

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

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

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

Threshold: 10 mV
Window:

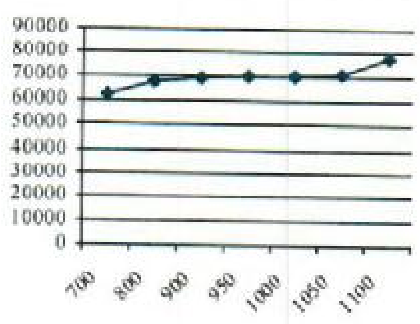
Barometric Pressure: 24.75 inches Hg
Temperature: 76 °F
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400	400	400	398875	400
x 1000	100	100	100		100
x 100	400	400	400	39883	400
x 100	100	100	100		100
x 10	400	400	400	3988	400
x 10	100	100	100		100
x 1	400	400	400	398	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	62275	
800	68049	
900	69726	
950	70112	9509
1000	70068	
1050	71042	
1100	77619	

Voltage Plateau



Comments: Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV = 950

Reference Instruments and/or Sources:

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

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

Reviewed By:
Date: 09/08/17

ERG Form ITC. 101.A

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

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

ACCREDITED
CALIBRATION CERT #1866.01

CALIBRATION REPORT

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

INSTRUMENT: Reuter Stokes RSS-131, #07J00KM1

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

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

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

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

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

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

ACCREDITED

CALIBRATION CERTIFICATE

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

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

Sensor Type: 100 mR/h

Serial Number: 07J00KM1

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

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

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

Found RAC: 2.169e-8

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

Calibrated By: Richard Hardison Reviewed By: Angela Roye
Richard Hardison [illegible]
Title: Calibration Technician Title: Calibration Physicist

Log: M-53 Page: 73

Revision 12/12/2011

AS FOUND DATA
Reuter-Stokes Chamber Calibration

June 27, 2016 *Test Number M161588*

CHAMBER:

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

SUBMITTED BY:

ERG

Albuquerque, NM

ORIENTATION/CONDITIONS:

Serial number away from source

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

ATMOSPHERIC COMMUNICATION: SEALED

POLARIZING POTENTIAL 401V

LEAKAGE: negligible

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

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

Calibrated By Richard Hardison
Title: Richard Hardison
Calibration Technician

Reviewed By:
Title: Calibration Physicist

Checked By:
Prepared By: REH

Form RSS

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	254772
Cal. Due Date:	7-19-17

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

Comments:
NNERT

Source: Cs-137

Serial No.: 333-94

Activity: 5.12 uCi

Emission Rate: NA cpm/emissions

Source Date: 6-6-94

Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
9-27-16	1126	6.1	1002	99	45988	6844	39144	NW	Project Reference Point, NA-0904
9-27-16	1619	5.9	997	99	44136	6788	37348	NW	NA-0904
9-28-16	1023	5.9	1001	99	44612	6242	38370	NW	Comfort Suites Parking lot
9-28-16	1754	5.9	1000	99	43583	6742	36841	NW	NA-0928
9-29-16	0936	5.9	1001	100	44695	5574	39121	NW	Comfort Suites Parking Lot
9-29-16	1600	5.8	1002	99	46024	6760	39264	NW	NA-0928
9-30-16	0920	5.8	1002	99	44958	5748	39210	NW	NA-0904
9-30-16	1436	5.7	998	99	44138	6240	37898	NW	NA-0504
10-1-16	0915	5.7	1002	100	43656	5047	38609	NW	Oak 124/125
10-1-16	1605	5.6	995	99	43105	6275	36830	NW	Alonzo
10-3-16	0950	5.7	1001	99	44914	5611	39303	NW	Barton 3
10-3-16	1220	5.6	996	99	45823	5670	40105	NW	Barton 3

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:	44-10
Serial No.:	196086
Cal. Due Date:	7-9-17

DETECTOR	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	PR295014
Cal. Due Date:	7-9-17

Comments:

NNEAT

Source: Cs-137
Serial No.: 333-94
Activity: 5.12 uCi
Emission Rate: NA cpm/emissions
Source Date: 6-16-94
Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project Reference Points
9-27-16	1121	5.7	1100	100	45851	6762	39089	NW	NA-0904
9-27-16	1619	5.6	1094	99	45492	6313	39179	NW	NA-0904
9-28-16	1026	5.7	1100	100	44929	6287	38642	NW	NA-0904
9-28-16	1754	5.6	1098	100	44643	6434	38209	NW	Comfort Suites Parking Lot
9-29-16	0940	5.6	1100	99	43453	5654	37799	NW	NA-0928
9-29-16	1603	5.5	1101	100	44586	6525	38061	NW	Comfort Suites Parking Lot
9-30-16	0915	5.5	1102	100	44975	5236	39739	NW	NA-0928
9-30-16	1433	5.4	1096	100	44003	5827	38176	NW	NA-0904
10-1-16	0925	5.5	1102	100	42929	5140	37789	NW	Oak 124/125
10-1-16	1605	5.3	1092	100	44650	6271	38379	NW	Mongo
10-3-16	0946	5.5	1100	100	43679	4995	38684	NW	Barton 3
10-3-16	1225	5.4	1099	100	45921	5361	40560	NW	Barton 3

Reviewed by:

Review Date: 11/29/16

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	254772
Cal. Due Date:	7-19-17

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

Comments:
NNERT

Source: Cs-137

Serial No.: 333-94

Activity: 5.12 uCi

Emission Rate: NA cpm/emissions

Source Date: 6-6-94

Distance to Source: 6 Inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project reference points
10-4-16	0925	5.7	1003	99	45635	6378	39254	NW	Tsosie 1
10-4-16	1720	5.6	1008	99	46987	6720	40267	NW	Comfort Suites Parking lot
10-5-16	0620	5.7	1007	99	47335	6804	40531	NW	Comfort Suites Parking lot
10-5-16	1542	5.5	999	99	45375	6342	39033	NW	Tsosie 1
10-6-16	0900	5.5	1003	99	43705	6364	37341	NW	Tsosie 1
10-6-16	1713	5.5	1000	99	44279	6053	38226	NW	Comfort Suites Parking Lot
10-7-16	0902	5.5	1006	99	44457	6007	38404	NW	Oak 124/125
10-7-16	1627	5.5	999	99	46103	6751	39352	NW	Comfort Suites Parking Lot
10-8-16	0903	5.6	1003	99	45434	6365	39069	NW	Red Valley Intersection
10-8-16	1653	5.5	999	99	45185	6467	38718	NW	Comfort Suites Parking Lot
10-10-16	0858	5.5	1004	100	42755	5579	37176	NW	Oak 124/125
10-10-16	1919	5.5	999	99	51651	6930	44721	NW	Oak 124/125

Reviewed by:

Review Date: 11/29/16

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ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	196086
Cal. Due Date:	7-9-17

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DETECTOR	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	PR 295014
Cal. Due Date:	7-9-17

Comments:
NNEAT

Source: Cs-137
Serial No.: 333-94
Activity: 5.12 uCi
Emission Rate: NA cpm/emissions
Source Date: 6-16-94
Distance to Source: 6 Inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project Reference Points
10-4-16	0936	5.5	1102	100	46804	6042	40762	NW	Tsosie 1
10-4-16	1720	5.4	1106	100	46032	6898	39134	NW	Comfort Suites Parking Lot
10-5-16	0622	5.4	1109	101	45794	6834	38960	NW	Comfort Suites Parking Lot
10-5-16	1548	5.3	1097	99	46608	6021	40587	NW	Tsosie 1
10-6-16	0904	5.4	1103	100	44521	6273	38248	NW	Comfort Suites Parking Lot
10-6-16	1718	5.3	1099	100	45178	6311	38867	NW	Comfort Suites Parking Lot
10-7-16	0859	5.4	1104	100	44101	5226	38875	NW	Oak 124/125
10-7-16	1633	5.4	1098	99	44930	6832	38098	NW	Comfort Suites Parking Lot
10-8-16	0908	5.4	1104	100	45110	6201	38909	NW	Red Valley Intersection
10-8-16	1658	5.3	1098	99	45810	6196	39614	NW	Comfort Suites Parking Lot
10-12-16	1331	5.4	1099	99	46496	6519	39977	NW	Barton 3
10-12-16	1614	5.4	1097	100	44509	6060	38449	NW	Comfort Suites Parking Lot

Reviewed by: MNR

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:	7-19-17

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

Comments: NNSRT

Source: Cs-137

Serial No.: 333-94

Activity: 5.12 uCi

Emission Rate: NA cpm/emissions

Source Date: 6-6-94

Distance to Source: 6 Inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project reference points
10-11-16	0927	5.5	1002	99	45599	6141	39858	NW	NA-0904
10-11-16	1720	5.5	998	99	48630	6576	42054	NW	Comfort Suites Parking Lot
10-12-16	0858	5.5	1003	99	44780	5306	39474	NW	NA-0928
10-12-16	1618	5.5	998	99	43779	6289	37490	NW	Comfort Suites Parking Lot
10-13-16	0911	5.5	1003	99	46726	7375	39351	NW	Alongo
10-13-16	1910	5.5	990	99	45235	6618	38617	NW	Comfort Suites Parking Lot
10-14-16	0926	5.5	1004	99	45657	7242	38415	NW	Barton 3
10-14-16	1540	5.4	998	99	44751	6480	38271	NW	Comfort Suites Parking Lot
10-15-16	0927	5.5	1001	99	45697	6933	38764	NW	Harvey Blackwater
10-15-16	1824	5.4	996	99	42528	4945	37583	NW	Hat Rock Inn Parking Lot
a 10-24-16	0800	6.2	1005	100	48507	9260	39239	NW	Boyd Tisi
10-24-16	1207	6.0	1001	99	46290	8126	38164	NW	Boyd Tisi

a changed battery

Reviewed by:

Review Date: 11/29/16

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ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	254772
Cal. Due Date:	2-28-18

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

Comments:
NNERT

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

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

Reviewed by:

Review Date: 11/06/17

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ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	196086
Cal. Due Date:	2-28-18

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR295014
Cal. Due Date:	2-28-18

Comments:
NNEAT

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):
3-20-17	0905	5.7	1003	101	40471	8507	31964	NW	Claim 28
3-20-17	1547	5.6	996	101	36470	5494	30976	NW	Chinle lot
3-21-17	0641	5.7	1004	101	37904	5597	32307	NW	Chinle lot
3-21-17	1654	5.6	999	101	36212	4929	31283	NW	Goulding's lot
3-22-17	0702	5.6	1001	101	35714	5119	30595	NW	Goulding's lot
3-22-17	1437	5.4	995	101	35087	4539	30548	NW	Charles Keith shooting range
3-23-17	0907	5.6	1004	101	36031	4879	31152	NW	NA-0928
3-23-17	1922	5.5	1004	101	41793	9955	31838	NW	Gallup lot
3-24-17	0810	5.5	1007	101	35608	4282	31326	NW	Eunice Becenti
3-24-17	1735	5.5	1000	101	41923	10785	31138	NW	Gallup lot
3-27-17	0833	5.5	1005	101	36943	4282	32661	NW	Eunice Becenti
3-27-17	1235	5.4	1000	101	35141	4013	31128	NW	Eunice Becenti

Reviewed by:

Review Date: 10/19/17

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

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

Comments:
NNEAT

Source: Cs-137

Serial No.: 544-96

Activity: 4 uCi

Emission Rate: NA cpm/emissions

Source Date: 4-18-96

Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
3-22-17	0705	5.6	1050	100	35820	5210	30610	NW	Goulding's lot
3-22-17	1425	5.5	1049	101	36169	4648	31521	NW	Charles Keith shooting range
3-23-17	0908	5.6	1056	102	35972	4828	31144	NW	NA-0928
3-23-17	1915	5.5	1055	102	41686	10757	30929	NW	Gallup lot
3-24-17	0805	5.5	1060	102	36151	4442	31709	NW	Eunice Becenti
3-24-17	1744	5.4	1051	101	41975	10973	31002	NW	Gallup lot
3-25-17	0908	5.5	1057	102	37581	5827	31754		Section 26
3-25-17				DID NOT USE					

4-2-17

Reviewed by:

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

ERG Form ITC.201.A

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	254772
Cal. Due Date:	2-28-17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR303727
Cal. Due Date:	2-28-17

Comments:

NNERT

Source: Cs-137

Serial No.: 544-96

Activity: 4 uCi

Emission Rate: NA cpm/emissions

Source Date: 4·18·96

Distance to Source: 6 Inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
4·11·17	0920	5.7	1000	101	36807	5626	31181	NW	NA-0928
4·11·17	1607	5.1	994	100	35724	5073	30651	NW	NA-0904 upper
4·14·17	0910	5.3	999	100	37554	5361	32193	NW	NA-0928
4·14·17	1050	5.3	997	100	37119	5165	31954	NW	NA-0928
4·17-17	0926	5.6	1000	101	37381	5937	31444	NW	NA-0928
4·17·17	1314	5.5	993	100	37712	5579	32133	NW	Barton 3
4·18·17	1400	5.6	997	100	40901	8541	32360	NW	Claim 28
4·18·17	1633	5.5	996	100	38299	8808	29491	NW	Claim 28
					4.19.17				

Reviewed by:

Review Date: 11/08/17

ERG

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

Single-Channel Function Check Log

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	282971
Cal. Due Date:	3-13-18

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR320678
Cal. Due Date:	3-13-18

Comments:

NNCRT

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):
4-11-17	0926	5.7	1050	101	38755	5977	32778	NW	NA-0928
4-11-17	1604	5.2	1044	102	37323	5938	31385	NW	NA-0904 (upper)
a. 4-12-17	0855	5.9	1049	100	37623	6131	31492	NW	NA-0928
4-12-17	1506	6.1	1049	100	37644	6078	31566	NW	NA-0904 (lower)
4-13-17	0900	6.1	1050	101	38810	6436	32374	NW	NA-0928
4-13-17	1651	6.1	1045	102	38853	6098	32755	NW	NA-0904
4-14-17	0907	6.1	1050	101	37885	5998	31887	NW	NA-0928
4-14-17	1045	6.0	1046	100	38070	6036	32034	NW	NA-0928
4-15-17	0844	6.0	1050	100	38257	6419	31838	NW	NA-0928
4-15-17	1615	5.9	1044	100	37604	6764	30840	NW	Barton 3
4-17-17	0931	5.9	1049	100	38546	6044	32502	NW	NA-0928
			4-24-17						

a. Changed batteries

Reviewed by: _______________ Review Date: 10/9/17

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	196086
Cal. Due Date:	2-28-17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR 295014
Cal. Due Date:	2-28-17

Comments:

NNERT

Source: Cs-137

Serial No.: 544-96

Activity: 4 uCi

Emission Rate: NA cpm/emissions

Source Date: 4-18-96

Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
4-11-17	0932	5.5	1100	100 NW	36776	5404		NW	NA-0928
4-11-17	1601	5.4	1094	100	36796	5031		NW	NA-0904 (upper)
4-12-17	0850	5.4	1100	101	37067	5050		NW	NA-0928
4-12-17	1510	5.3	1092	100	36453	5524		NW	NA-0904
4-13-17	0855	5.4	1101	101	36895	5793		NW	NA-0928
4-13-17	1648	5.3	1092	100	38916	5572		NW	NA-0904
4-15-17	0840	5.4	1100	101	37457	5291		NW	NA-0928
4-15-17	1612	5.2	1090	100	38092	6045		NW	Barton 3
4-17-17	0921	5.4	1101	101	38591	5561		NW	NA-0928
4-17-17	1317	5.3	1090	100	37050	5496		NW	Barton 3
4-18-17	1354	5.4	1098	101	40983	8497		NW	Claim 28
4-18-17	1642	5.2	1091	101	39900	8193		NW	Claim 28

Reviewed by: MW

Review Date: 10/9/17

ERG Form ITC.201.A

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	138368
Cal. Due Date:	9-17-18

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR355763
Cal. Due Date:	9-17-18

Comments:

NNZRT

Source: Cs-137

Serial No.: 544-96

Activity: 4 uCi

Emission Rate: NA cpm/emissions

Source Date: 4-18-96

Distance to Source: 6 Inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
9-12-17	0914	5.4	950	101	36935	6331	30604	NW	Barton 3
9-12-17	1432	5.3	944	99	38043	6468	31575	NW	Tsosie 1
9-13-17	0906	5.4	951	99	37146	6538	30608	NW	Alonzo
9-13-17	1600	5.3	944	99	35587	5991	29596	NW	Barton 3
9-14-17	0909	5.4	950	100	36080	6176	29904	NW	NA-0909
9-14-17	1255	5.3	948	100	36099	5764	30335	NW	NA-0904
9-15-17	0926	5.4	954	101	35208	5551	29657	NW	Eunice Becenti
9-15-17	1729	5.3	957	109	35937	5261	30676	NW	Eunice Becenti
9-14-17	0831	5.4	958	105	36467	6034	30433	NW	Section 26@ trailer
9-16-17	1453	5.3	946	99	44454	14748	29706	NW	Section 26 @ corral
9-20-17	0736	5.3	953	102	37676	6987	30689	NW	Mexican Hat
9-20-17	1611	5.2	947	100	36842	6252	30590	NW	Mexican Hat

Reviewed by: MM

Review Date: 10/9/17

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	GE
Model:	RSS-131
Serial No.:	07700km1
Cal. Due Date:	6-29-17

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

Comments:
NNERT

Source: Cs-137
Serial No.: 333-94
Activity: 5.12 uCi
Emission Rate: NA cpm/emissions
Source Date: 6-16-94
Distance to Source: Contact - housing

μR/h

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project reference points,
10-7-16	0545	~ 6.14	~ 400	~ NA -	~ 26.7	~ 9.5	~ 17.2	NW	Comfort Suites Room - Farmingt
10-7-16	2040	~ 6.16	~ 400	NA	~ 26.5	~ 8.7	~ 17.8	NW	Comfort Suites Room - Farmington
10-11-16	0634	~ 6.2	~ 400	NA	~ 25	~ 10.5	~ 14.5	NW	Comfort Suites Room - Farmington
10-11-16	1801	~ 6.3	~ 400	NA	~ 25.5	~ 10.1	~ 14.4	NW	Comfort Suites Room - Farmington
10-12-16	0548	~ 6.3	~ 400	NA	~ 26.5	~ 10	~ 16.5	NW	Comfort Suites Room - Farmington
10-12-16	1640	~ 6.3	~ 400	NA	~ 26.4	~ 10	~ 16.4	NW	Comfort Suites Room - Farmington
10-13-16	0608	~ 6.3	~ 400	NA	~ 27	~ 9.8	~ 17.2	NW	Comfort Suites Room - Farmington
10-13-16	1950	~ 6.3	~ 400	NA	~ 26.3	~ 9.5	~ 16.8	NW	Comfort Suites Room - Farmington
10-14-16	0630	~ 6.4	~ 400	NA	~ 26.4	~ 9.5	~ 16.9	NW	Comfort Suites Room - Farmington
10-14-16	1547	~ 6.2	~ 400	NA	~ 30	~ 12	~ 18	NW	Comfort Suites Room - Farmington
10-25-16	0539	~ 6.3	~ 400	NA	~ 29	~ 11	~ 18	NW	Best Western Room - Flagstaff
10-25-16	1755				DID	NOT	USE		

Reviewed by:

Review Date: 11-29-16

Appendix B 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.

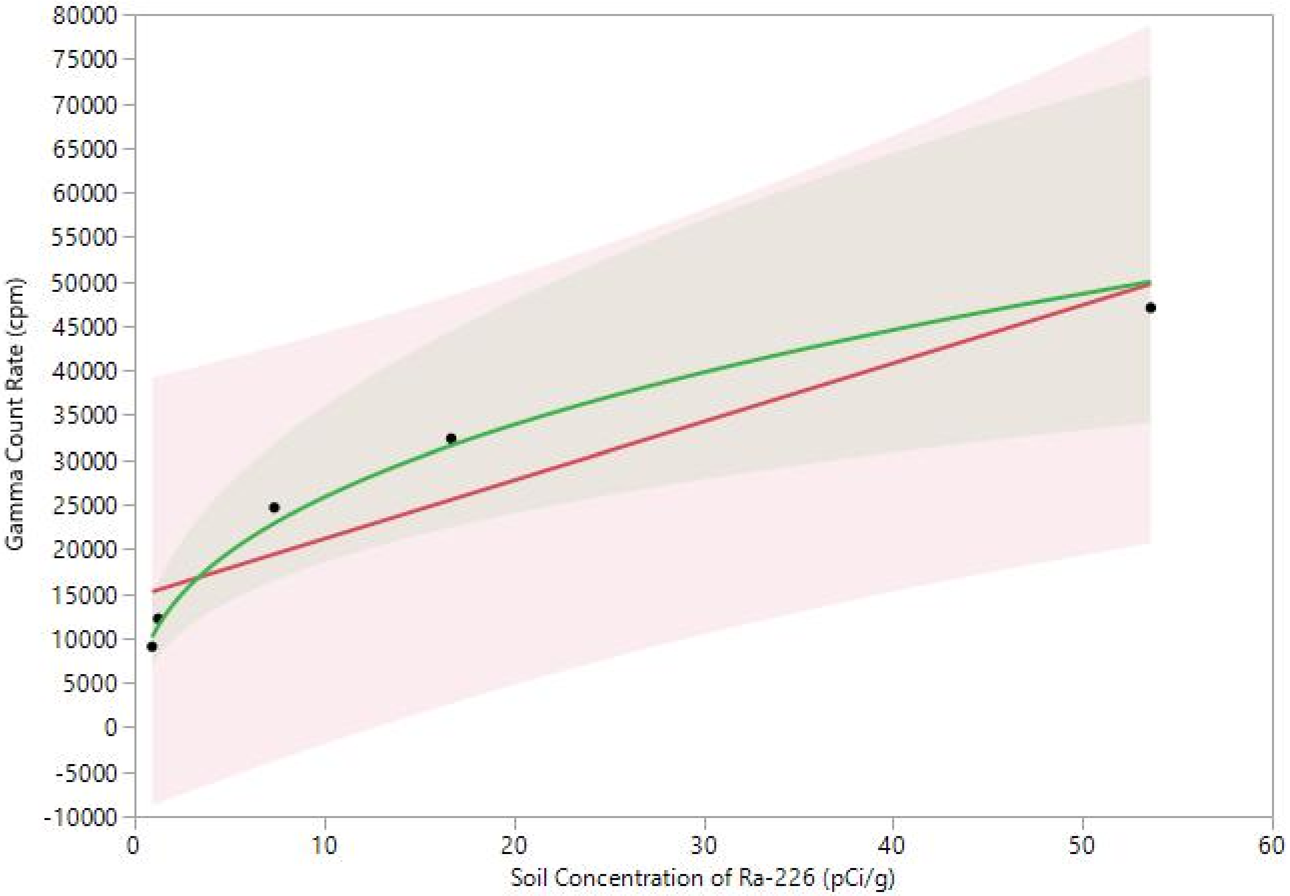

Figure 1. Regression models (linear versus power curve) for gamma count rate regressed on radium-226 showing 95% UPLs (upper prediction limits). Both models meet the study DQO for adjusted R^2 (greater than 0.8). Gamma count rate is not an especially strong predictor of soil concentration of radium-226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

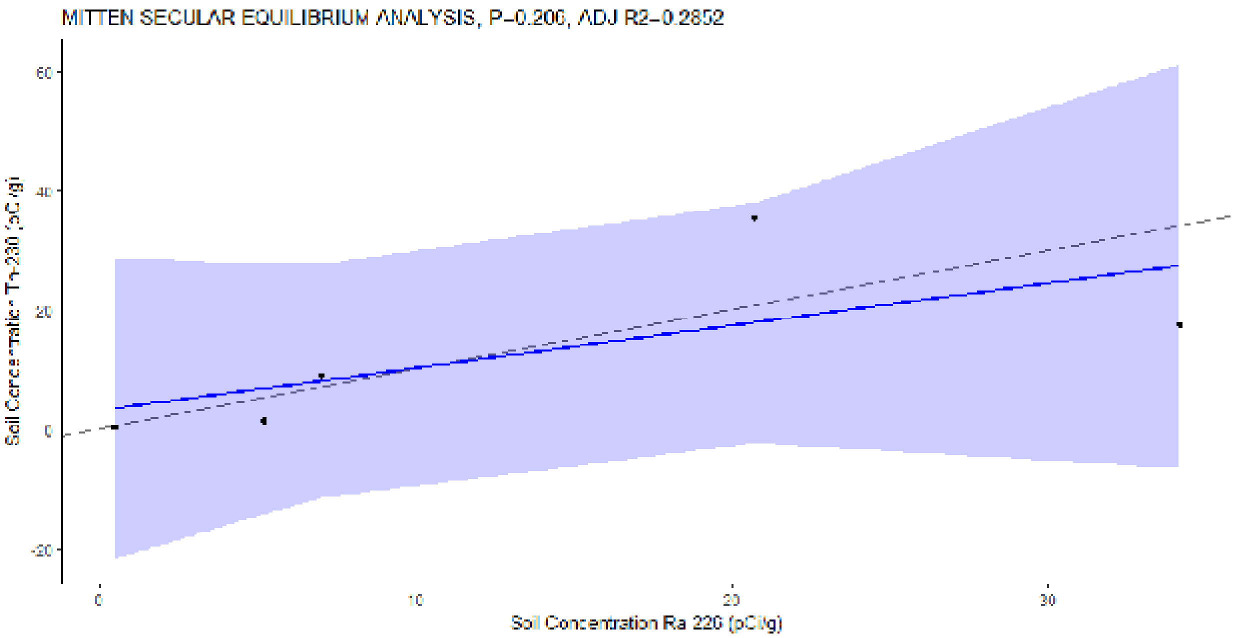

Figure 2. Result for Mitten secular equilibrium analysis, showing failure to meet p-value and adjusted R^2 criteria, i.e., the data are poorly correlated.

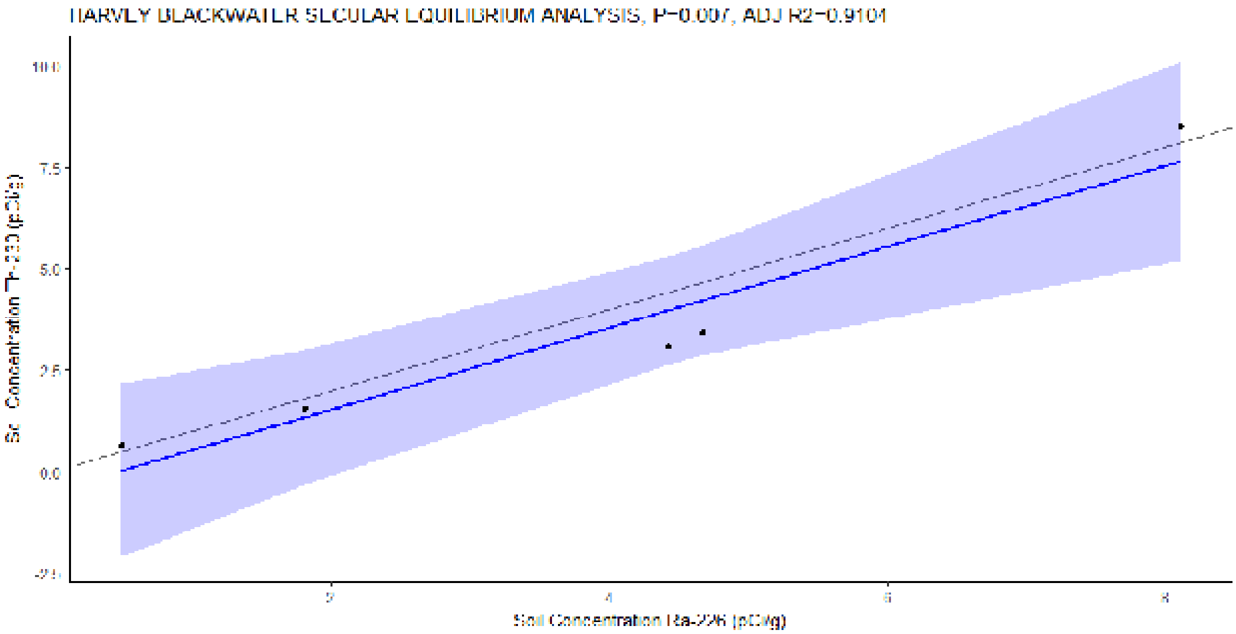

Figure 3. Result for Harvey Blackwater secular equilibrium analysis, showing excellent correlation between the data and the y=x line, i.e., Th-230 and Ra-226 are in secular equilibrium.

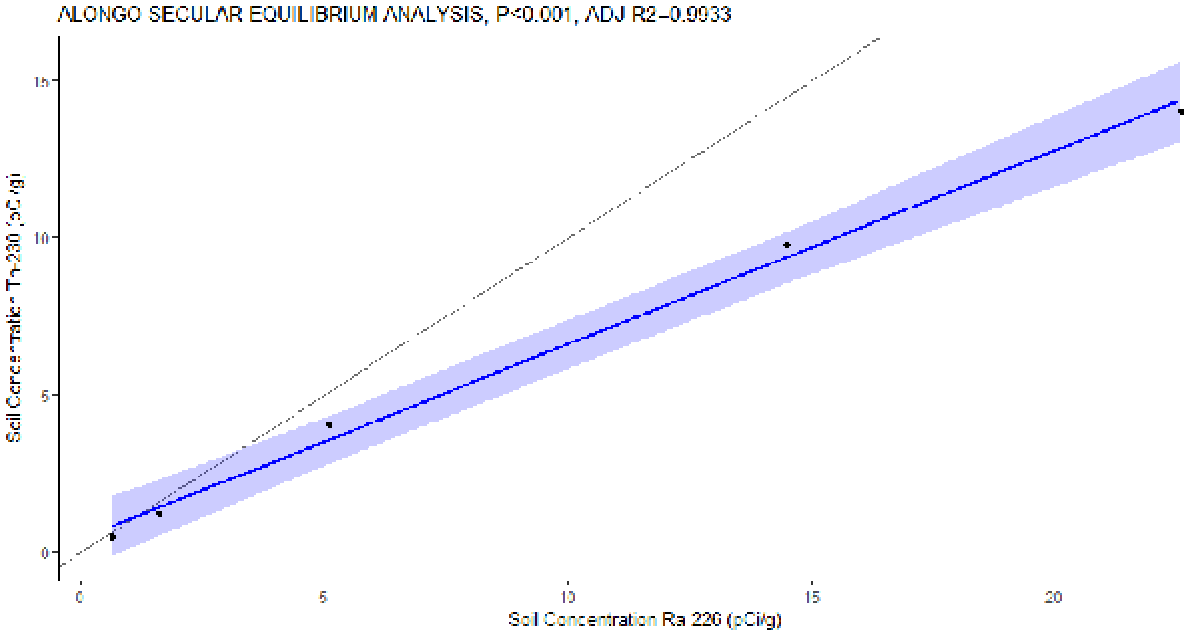

Figure 4. Result for Alongo Mines secular equilibrium analysis, showing excellent correlation between the data, but poor agreement with the y=x line, i.e., Th-230 and Ra-226 are in equilibrium, but not secular equilibrium.

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 C Preliminary Report "Radiological Characterization of the NA-0928 Abandoned Uranium Mine "

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

Radiological Characterization of the NA-0928 Abandoned Uranium Mine

Preliminary

January 23, 2018

prepared for:

Stantec Consulting Services Inc.

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Contents

Tables

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Appendices

Acronyms

ANSI	American National Standards Institute
AUM	abandoned uranium mine
BG2	Background Reference Area 2
BG3	Background Reference Area 3
BG4	Background Reference Area 4
cpm	counts per minute
DQOs	data quality objectives
ERG	Environmental Restoration Group, Inc.
ft	foot
GPS	global positioning system
MDL	method detection limit
µR/h	microRoentgens per hour
pCi/g	picocuries per gram
R^2	Pearson's Correlation Coefficient
RSE	removal site evaluation
σ	standard deviation
Stantec	Stantec Consulting Services Inc.

Executive Summary

This report addresses the radiological characterization of the NA-0928 abandoned uranium mine (AUM) located in the Sweetwater Chapter of the Navajo Nation near Red Mesa, Arizona. 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 Stantec Consulting Services Inc. (Stantec) on behalf of 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 3, September 29 and 30, and October 4 and 12, 2016; and March 23, April 11 and 14, and September 12 and 14, 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 “NA-0928 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 in several small areas in the mine claim and on waste rock immediately east of the mine claim. In addition, elevated count rates were associated with naturally occurring materials extending northwest away from the northeast corner of 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:

$$\text{Radium-226 Concentration (picocuries per gram [pCi/g])} = 3\text{x}10^{-7}\,(\text{Gamma Count Rate}^{1.6897}\text{ in counts per minute [cpm]})$$

- 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 0.5 to 90, with a central tendency (median) of 1.1 pCi/g.

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

- The uranium series radionuclides appear not to be in secular equilibrium.

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

  Exposure Rate (microRoentgens per hour [μR/h]) = Gamma Count Rate (cpm) x $4\text{x}10^{-4}$ + 7.895

- The distribution of exposure rates predicted using this model resembles a lognormal distribution. The values in the Survey Area range from 9.7 to 50, with a central tendency (median) of 11.0 μR/h.

1.0 Introduction

This report addresses the radiological characterization of the NA-0928 abandoned uranium mine (AUM) located in the Sweetwater Chapter of the Navajo Nation near Red Mesa, Arizona. 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 Stantec Consulting Services Inc. (Stantec) on behalf of 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 3, September 29 and 30, and October 4 and 12, 2016; and March 23, April 11 and 14, and September 12 and 14, 2017. They included a GPS-based radiological survey of land surfaces over an approximately 35-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 RSE are addressed in “NA-0928 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 “NA-0928 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, 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.

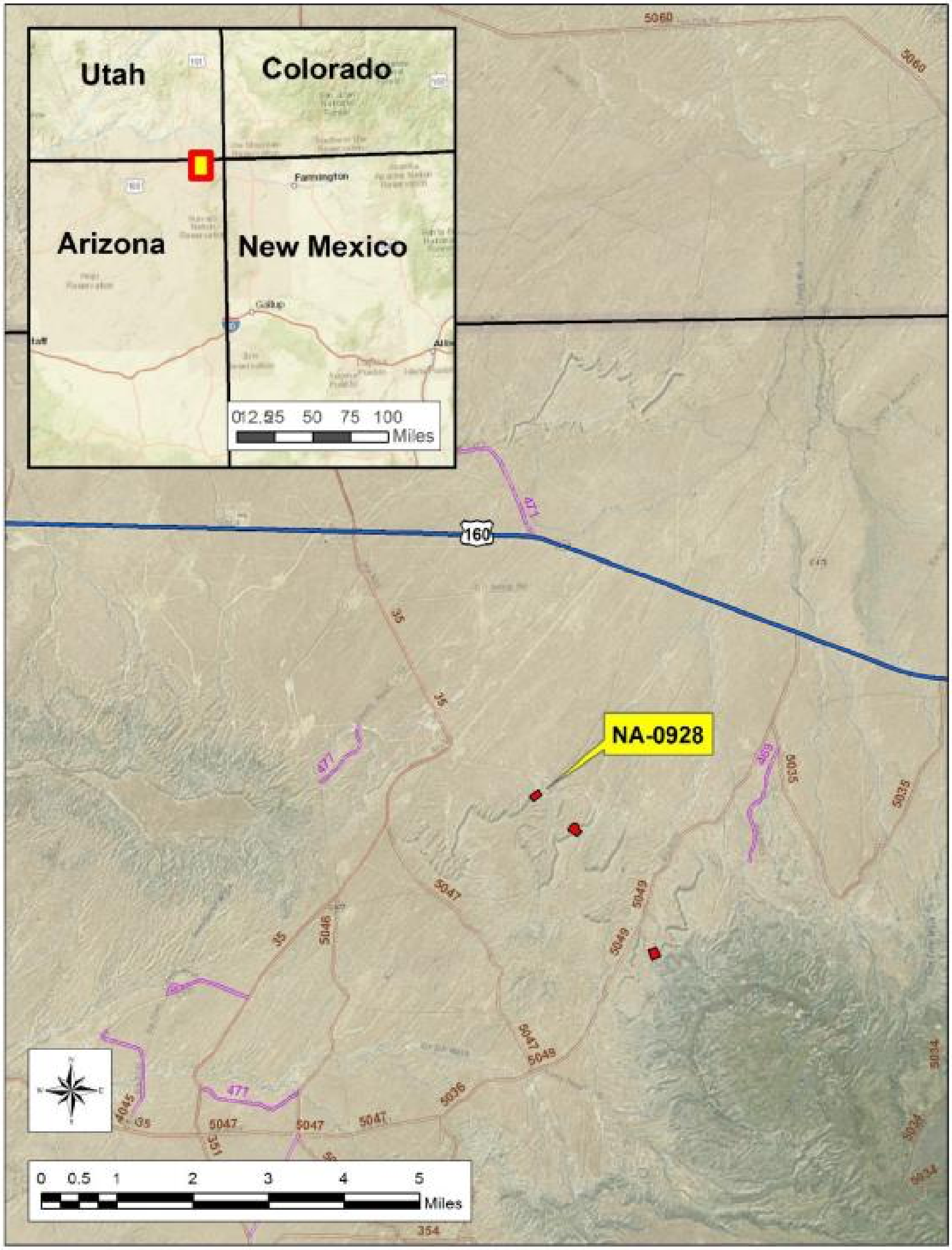


Figure 1. Location of the NA-0928 Abandoned Uranium Mine

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

Survey Area	Ludlum Model 44-10	Ludlum Model 2221 Ratemeter/Scaler
Potential Background Reference Areas	PR303727[a]	254772[a]
	PR355763	138368
Survey Area	PR295014	196086
	PR295017	271435
	PR303727[a]	254772[a]
	PR320678	282971
	PR355763	138368

Notes:

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

2.1 Potential Background Reference Areas

Three potential Background Reference Areas were surveyed, the locations and results of which are depicted on Figure 2. BG2, BG3, and BG4 in the figure are Background Reference Areas 2, 3, and 4, respectively. These potential Background Reference Areas are the same as those used for AUM NA-0904, which is shown in the figure for its proximity to NA-0928.Table 2 lists a summary of the gamma count rates, which in:

- BG2 ranged from 7,118 to 13,741 counts per minute (cpm), with a mean and median of 9,369 and 9,310 cpm, respectively.
- BG3 ranged from 5,599 to 12,226 cpm, with a mean and median of 8,668 and 8,490 cpm, respectively.
- BG4 ranged from 7,158 to 10,204 cpm, with a mean and median of 8,463 and 8,430 cpm, respectively.

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

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

	Gamma Count Rate (cpm)					
Potential Background Reference Area	n	Minimum	Maximum	Mean	Median	Standard Deviation
2	328	7,118	13,741	9,369	9,310	948
3	378	5,599	12,226	8,668	8,490	999
4	70	7,158	10,204	8,463	8,430	729

Notes:

cpm = counts per minute

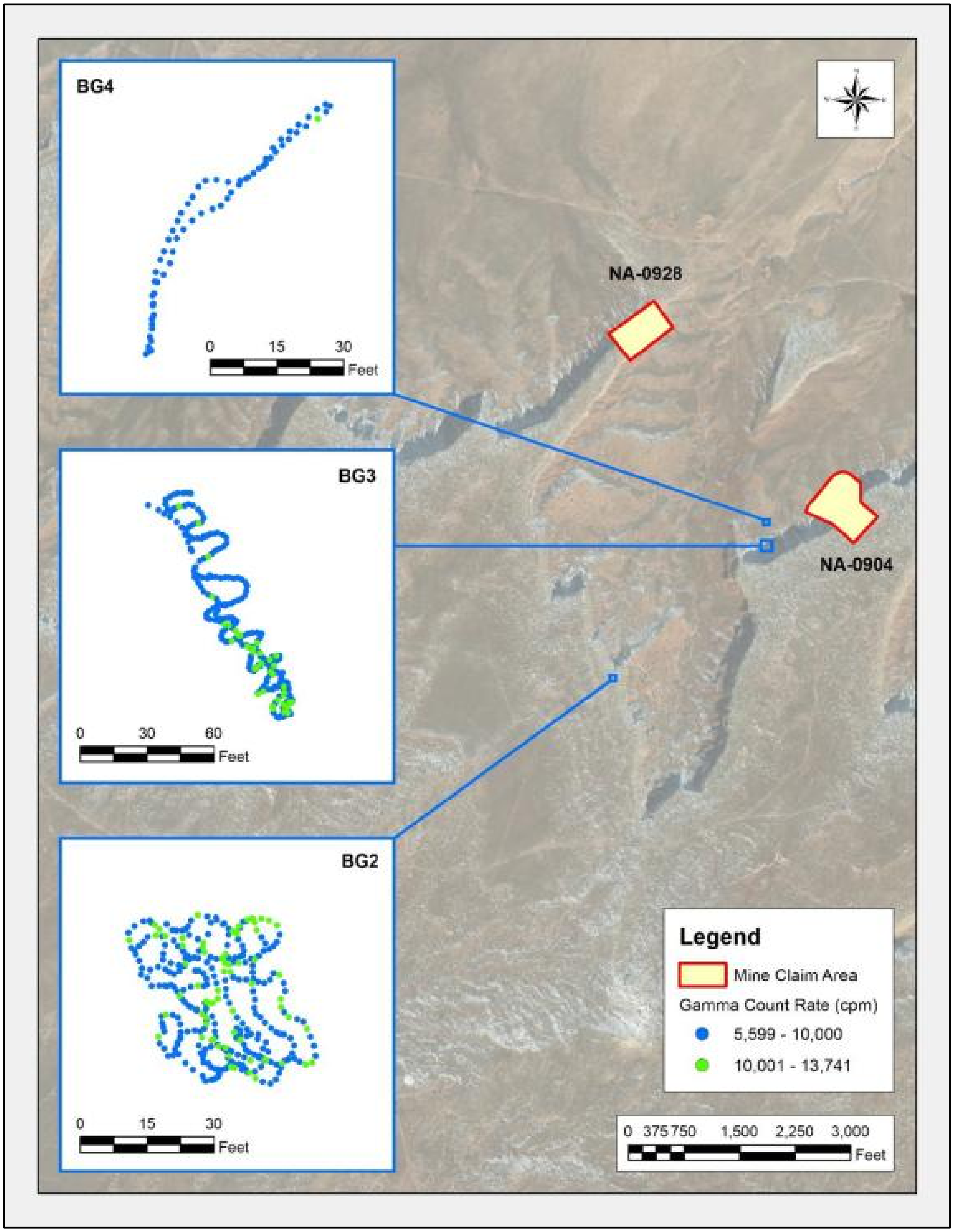
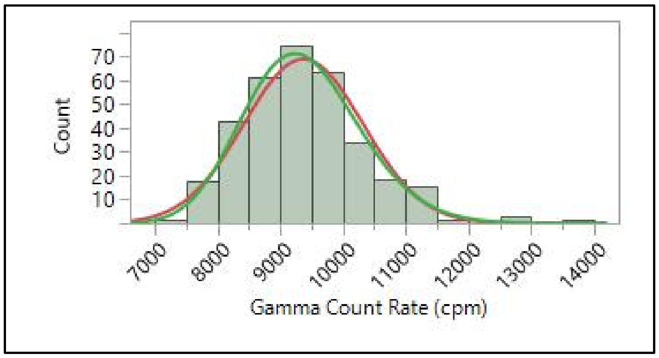
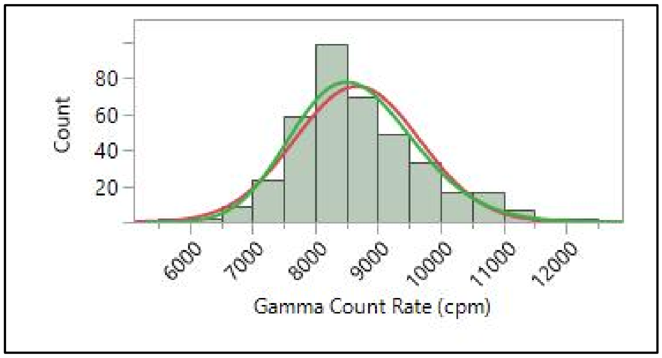


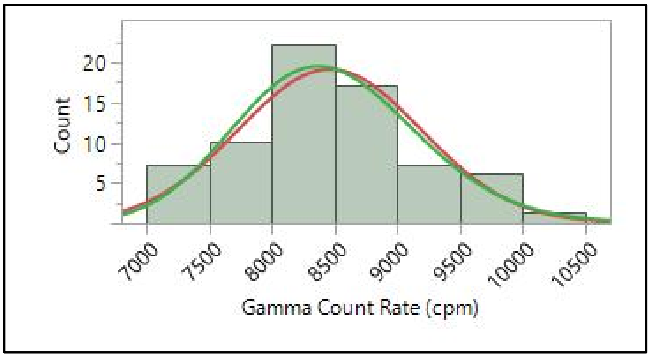
Figure 2. Gamma count rates in the potential Background Reference Areas.



a. **Background Reference Area 2**



b. **Background Reference Area 3**



a. **Background Reference Area 4**

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

2.2 Survey Area

The gamma count rates observed in the Survey Area are depicted in Figure 4. Elevated count rates were observed in several small areas in the mine claim and on waste rock immediately east of the mine claim. In addition, elevated count rates were associated with naturally occurring materials extending northwest away from the northeast corner of 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 (version 5.1.002), is not defined; i.e., neither normal or logarithmic. The box plot in Figure 6 depicts cutoffs as horizontal bars, from bottom to top, for the following values or percentiles: minimum, 0.5, 2.5, 10, 25, 50, 75, 90, 97.5, 99.5, and maximum. The 25th, 50th, and 75th percentiles (the three horizontal lines of the box inside the box plot) are 7,003, 7,758, and 8,865 cpm, respectively.

Table 3 is a statistical summary of the measurements, which range from 4,640 to 104,004 cpm and have a central tendency (median) of 7,758 cpm.

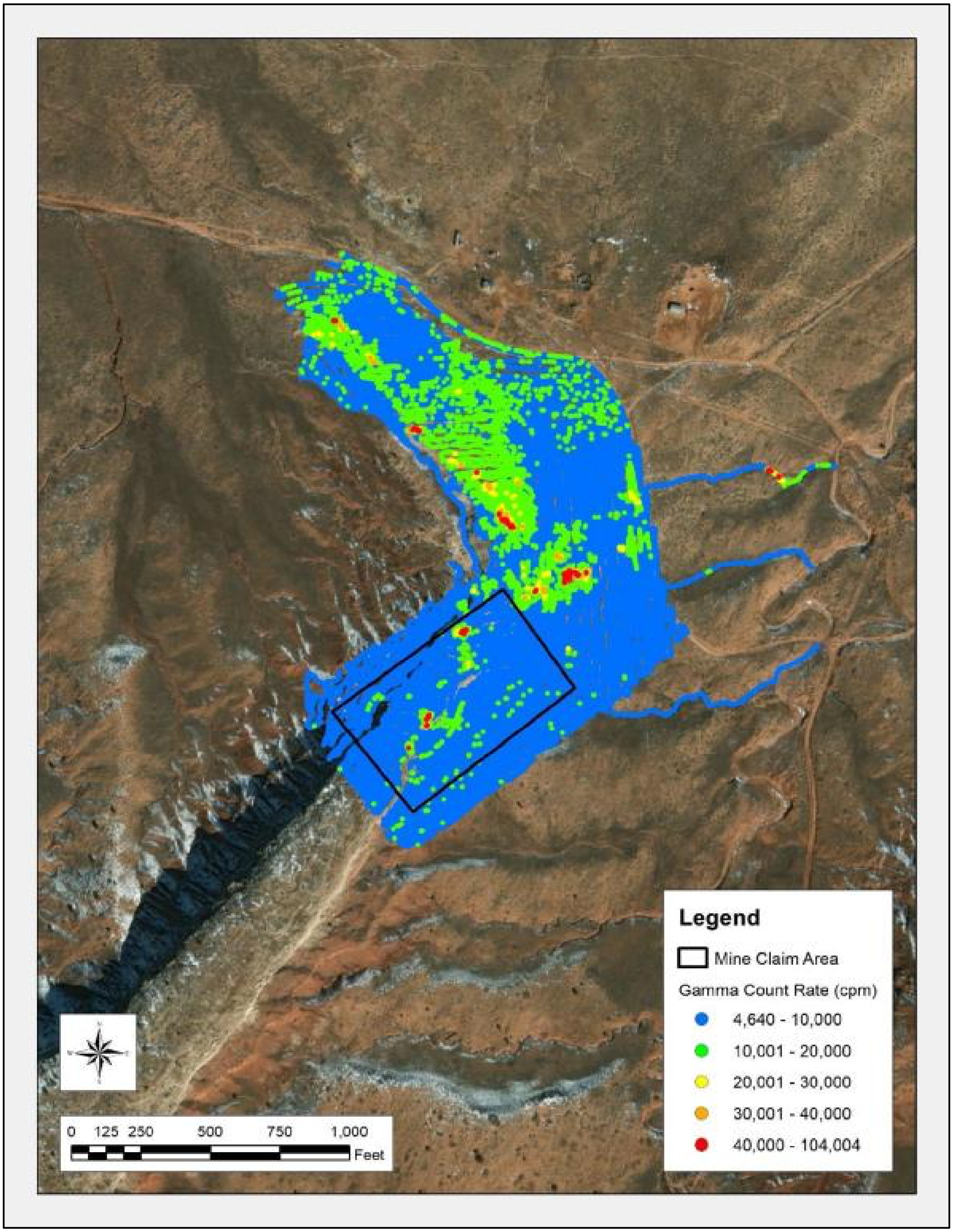


Figure 4. Gamma count rates in the Survey Area.

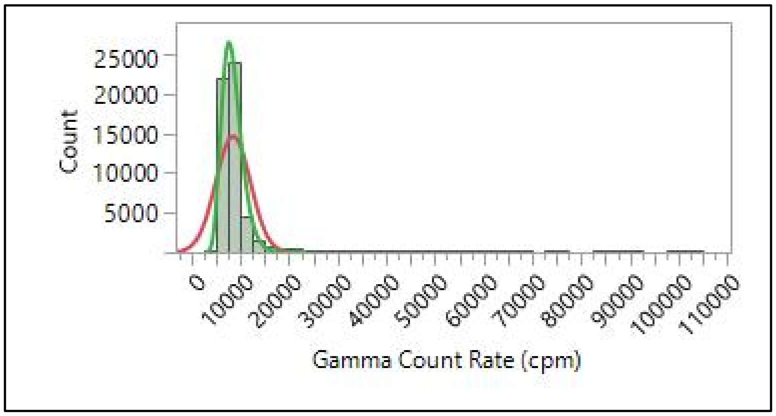


Figure 5. Histogram of gamma count rates in the Survey Area.

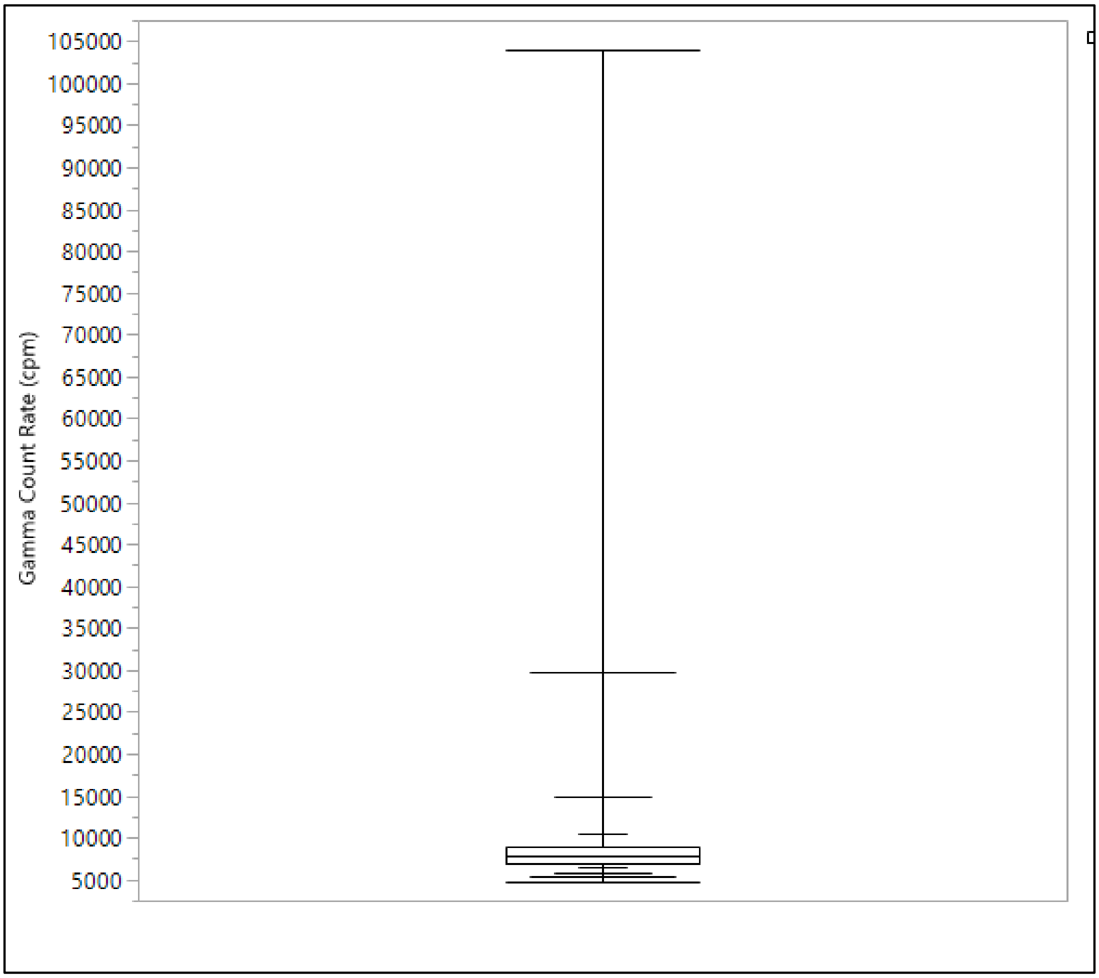


Figure 6. Box plot of gamma count rates in the Survey Area.

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

Parameter	Gamma Count Rate (cpm)
n	52,265
Minimum	4,640
Maximum	104,004
Mean	8,448
Median	7,758
Standard Deviation	3,572

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 12, 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 gamma count rate measurements and radium-226 concentrations in the soil samples. The means of the gamma count rate measurements range from 10,068 to 73,334 cpm. The concentrations of radium-226 in the soil samples range from 1.73 to 49.1 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 “NA-0928 Removal Site Evaluation Report” (Stantec, 2018).

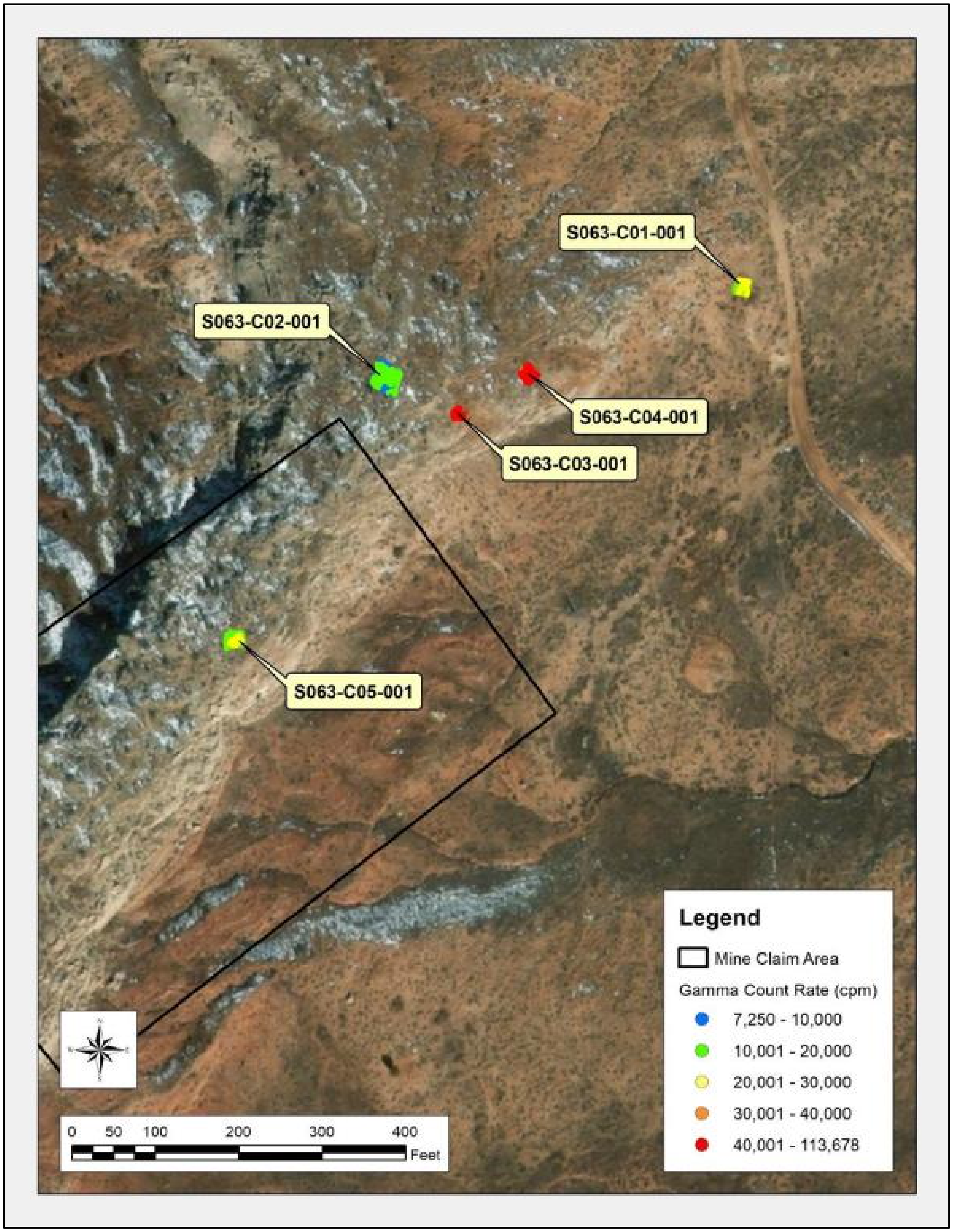


Figure 7. GPS-based gamma count rate measurements made for the correlation study.

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**
S063-C01-001	20,191	12,689	29,666	3,617	6.25	0.82	0.43
S063-C02-001	10,068	7,250	18,570	1,389	1.73	0.35	0.49
S063-C03-001	73,334	38,231	113,678	21,319	34	4.1	0.7
S063-C04-001	51,942	36,915	64,425	6,867	49.1	5.9	0.9
S063-C05-001	18,094	10,407	27,553	3,549	4.3	0.62	0.44

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**
S063-C01-001	0.453	0.096	0.046	4.51	0.72	0.07	0.497	0.099	0.014
S063-C02-001	0.242	0.063	0.053	1.5	0.25	0.07	0.284	0.063	0.016
S063-C03-001	0.288	0.069	0.048	23.4	3.6	0.1	0.342	0.072	0.019
S063-C04-001	0.454	0.094	0.051	44.9	6.9	0.1	0.54	0.1	0.01
S063-C05-001	0.364	0.082	0.056	2.97	0.48	0.07	0.328	0.07	0.013

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 0.9404, as expressed in the equation:

$$\text{Radium-226 concentration (pCi/g)} = 3 \times 10^{-7} \times \text{Gamma Count Rate (cpm)}^{1.6897}$$

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 0.399532 and 0.0063, respectively; these parameters are not data quality objectives (DQOs) and are included only as information.

The concentrations of thorium-232 and thorium-228, isotopes in the thorium series, in the correlation samples are similar and at most 0.54 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 0.5 to 90 pCi/g, with a mean and median of 1.4 and 1.1 pCi/g, respectively. Note that the radium-226 concentrations predicted from gamma count rate measurements exceeding approximately 75,000 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.

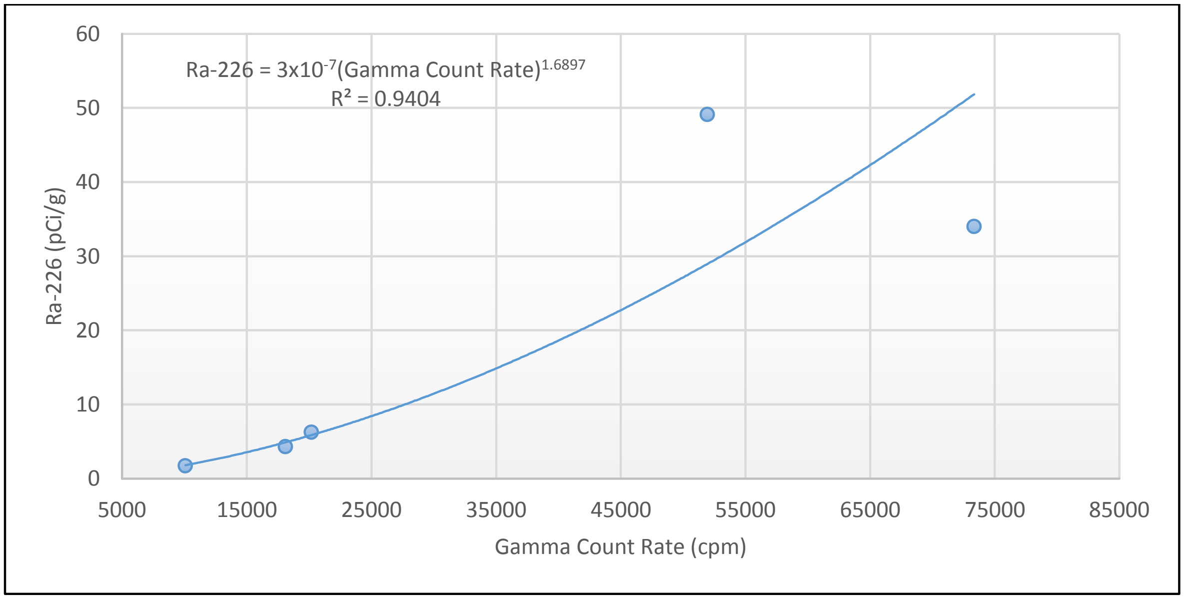


Figure 8. Correlation of gamma count rates and concentrations of radium-226 in surface soils.

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

Parameter	Radium-226 (pCi/g)
n	52,265
Minimum	0.5
Maximum	90
Mean	1.4
Median	1.1
Standard Deviation	2.0

Notes:
pCi/g = picocuries per gram

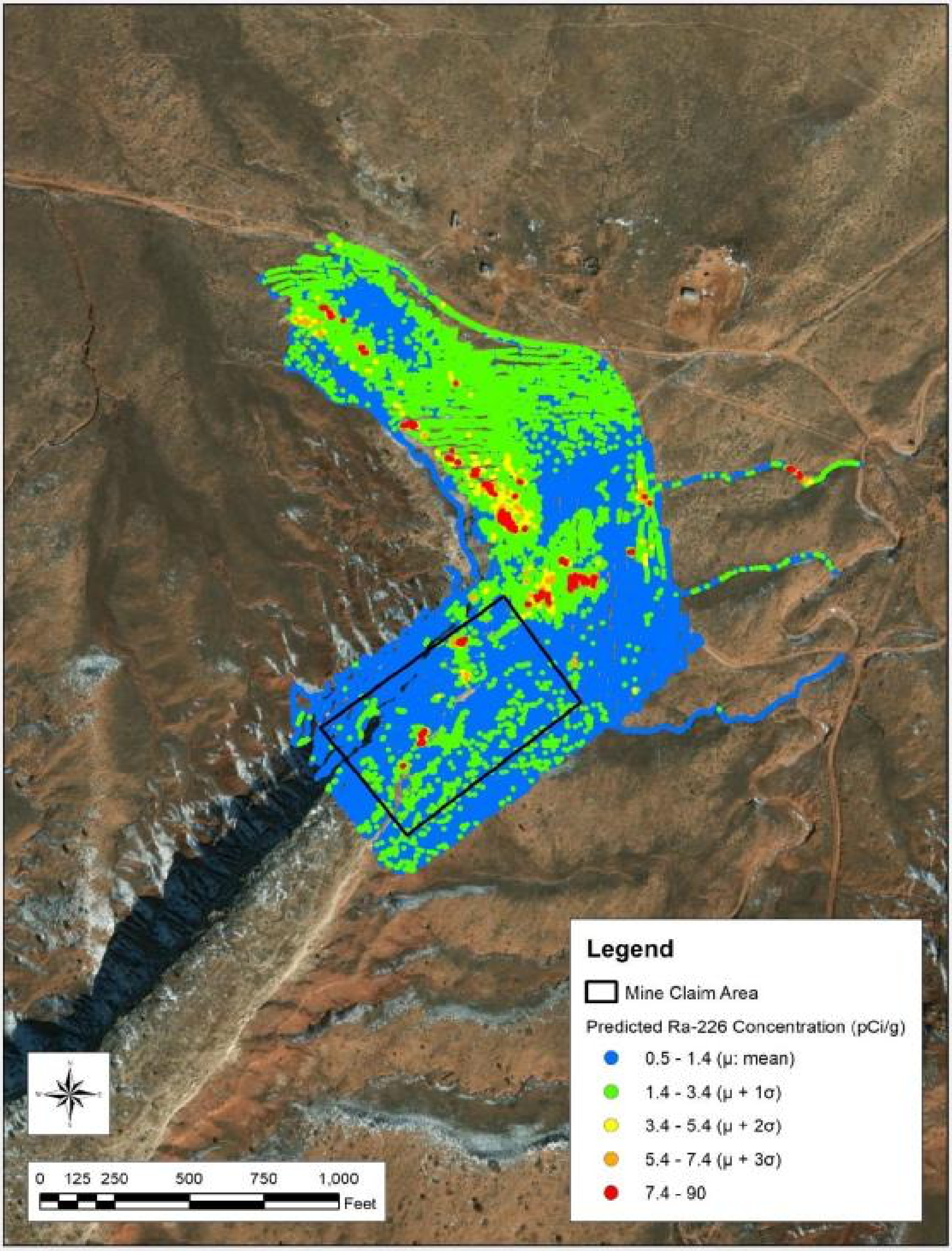


Figure 9. Predicted concentrations of radium-226 in the Survey Area.

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 1.4 (Sample S063-C01-001), 1.2 (Sample S063-C02-001), 1.5 (Sample S063-C03-001), 1.1 (Sample S063-C04-001), and 1.4 (Sample S063-C05-001) indicating that thorium-230 is depleted in relation to radium-226 and, by extrapolation, the uranium series itself is not in secular equilibrium.

Note this observation is based on the results of five samples, subject to differing analytical methods. Gamma spectroscopy, the method used to determine the concentration of radium-226, assesses an intact portion of the whole sample as it was collected. The concentration of thorium-230 was determined by alpha spectroscopy of an acid-leached aliquot of the sample.

This evaluation is not related to the correlation of radium-226 concentrations in surface soils and gamma count rates. It may be used for a future risk assessment.

3.3 Exposure rates and gamma count rates

On October 12, 2016 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 at 0.5 m and 1 m above the ground surface, respectively. The gamma count rate measurements were made with one of the sodium iodide detection systems used in the GPS-based gamma survey of the AUM (Serial Number PR303727/254772). The exposure rate measurements were made using a Reuter Stokes Model RSS-131 (Serial Number 07J00KM1) high pressure ionization chamber (HPIC) at six-second intervals for about 10 minutes. The exposure rates 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. The individual (one second) exposure rate measurements are not presented in this report, given that the data were lost.

The best predictive relationship between the measurements is linear with a R^2 of 0.9901 indicating a strong, positive correlation. The root mean square error and p-value for the model are 1.64873 and less than 0.0004, respectively; these parameters are not DQOs and are included only as information.

The following equation is the linear regression (shown in **Figure 10**) between the mean exposure rate and gamma count rate results in Table 7 that was generated using MS Excel:

Exposure Rate (microRoentgens per hour [µR/h]) = $4\text{x}10^{-4}$ x Gamma Count Rate (cpm) + 7.895

Figure 11 presents the exposure rates predicted from the gamma count rate measurements, the spatial and numerical distribution of which mirror those depicted in Figure 4.

Tables 8 and 9 present summary statistics for the predicted exposure rates in the three Background Reference Areas and AUM, respectively.

The range of predicted exposure rates at:

- BG2 is 10.7 to 13.4 µR/h, with a mean and median of 11.6 µR/h
- BG3 is 10.1 to 12.8 µR/h, with a mean and median of 11.4 and 11.3 µR/h, respectively
- BG4 is 10.8 to 12.0 µR/h, with a mean and median of 11.3

The range of predicted exposure rates in the Survey Area is 9.7 to 50 µR/h, with a mean and median of 11.3 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)
S063-C01-001	26066	18
S063-C02-001	9998	11.7
S063-C03-001	94160	45.8
S063-C04-001	54791	33.1
S063-C05-001	17769	15

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

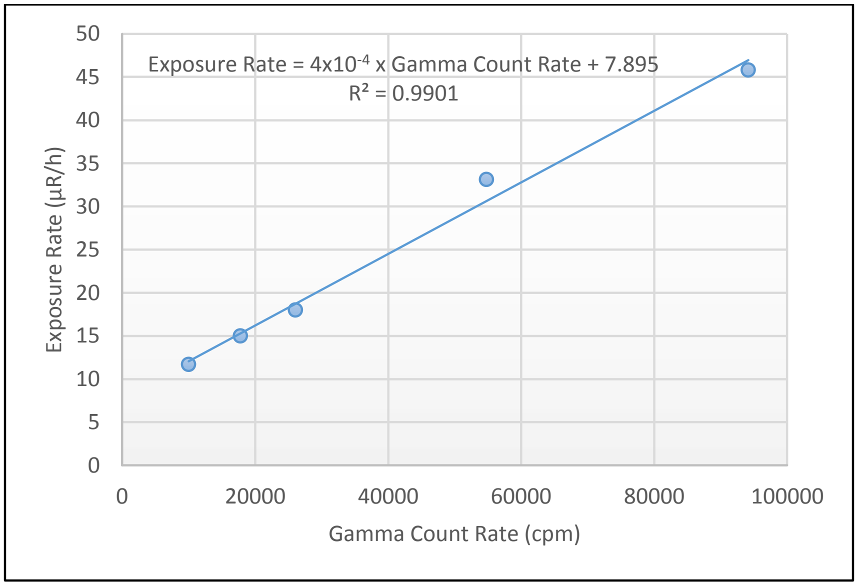


Figure 10. Correlation of gamma count rates and exposure rates.

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

Potential Background Reference Area	BG2	BG3	BG4
Parameter	Exposure Rate (µR/h)		
N	328	378	70
Minimum	10.7	10.1	10.8
Maximum	13.4	12.8	12.0
Mean	11.6	11.4	11.3
Median	11.6	11.3	11.3
Standard Deviation	0.4	0.4	0.3

Notes:
BG2 = Background Reference Area 2
BG3 = Background Reference Area 3
BG4 = Background Reference Area 4
µR/h = microRoentgens per hour

Table 9. Predicted exposure rates in the Survey Area.

Parameter	Exposure Rate (µR/h)
n	52,265
Minimum	9.7
Maximum	50
Mean	11.3
Median	11.0
Standard Deviation	1.4

Notes:
µR/h = microRoentgens per hour

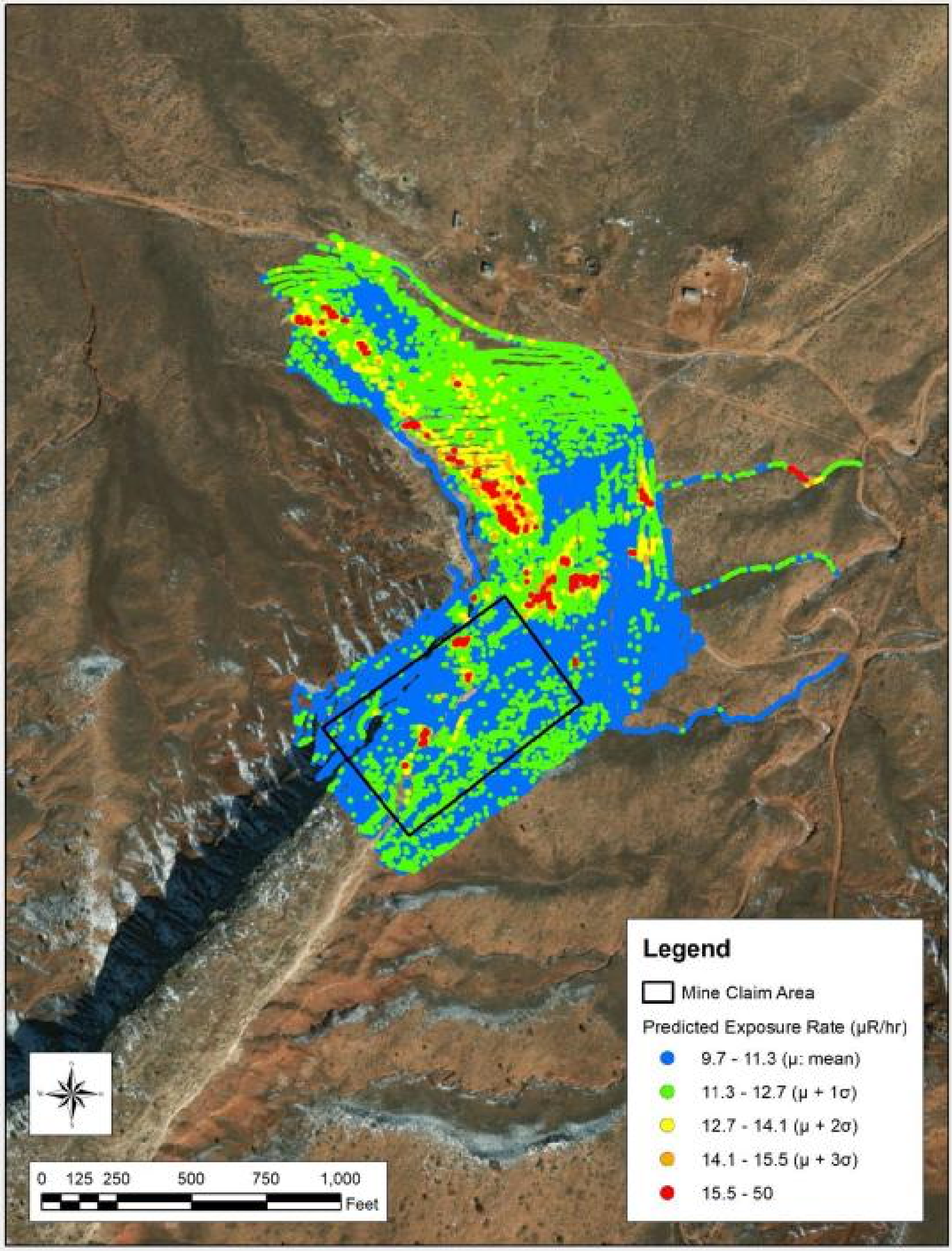


Figure 11. Predicted exposure rates in the Survey Area.

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 in several small areas in the mine claim and on waste rock immediately east of the mine claim. In addition, elevated count rates were associated with naturally occurring materials extending northwest away from the northeast corner of 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) = $3\text{x}10^{-7}$ (Gamma Count Rate$^{1.6897}$ in cpm)

- 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 0.5 to 90, with a central tendency (median) of 1.1 pCi/g.

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

- The uranium series radionuclides appear not to be in secular equilibrium.

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

  Exposure Rate (µR/h) = Gamma Count Rate (cpm) x $4\text{x}10^{-4}$ + 7.895

- The distribution of exposure rates predicted using this model resembles a lognormal distribution. The values in the Survey Area range from 9.7 to 50, 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. NA-0928 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:

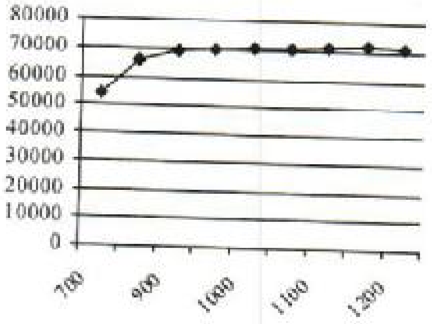
Barometric Pressure: 24.6 inches Hg
Temperature: 73 °F
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Cour
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:
Reviewed By:

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

Calibration Due 1-20-17

ERG Form ITC. 101.A

This calibration conforms to the requirements and acceptable

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:

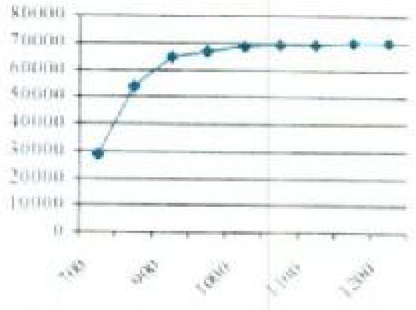
Barometric Pressure: 24.78 inches Hg
Temperature: 74 °F
Relative Humidity: 20 %

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	39989	400
x 100	100	100	100		100
x 10	400	400	400	3999	400
x 10	100	100	100		100
x 1	400	400	400	400	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	28456	
800	53330	
900	64430	
950	66209	
1000	68333	
1050	69077	
1100	69121	8924
1150	69973	
1200	70155	

Voltage Plateau



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

Reference Instruments and/or Sources:

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

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

Calibrated By:
Calibration Date: 7/[illegible]/16
Calibration Due: 7/[illegible]/17

Reviewed By:
Date: 7/20/16

ERG Form ITC. 101.A

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

ERG

Certificate of Calibration

Calibration and Voltage Plateau

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

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

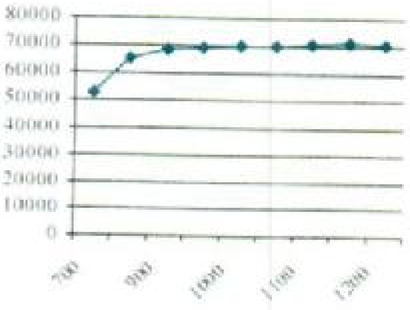
Barometric Pressure: 24.24 inches Hg
Temperature: 78 °F
Relative Humidity: 20 %

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

☑ Mechanical Check
☑ F/S Response Check
☑ Geotropism
☑ Meter Zeroed

☑ THR/WIN Operation
☑ Reset Check
☑ Audio Check
☑ Battery Check (Min 4.4 VDC)

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

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

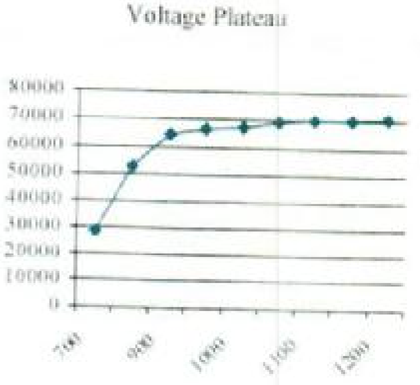
Threshold: 10 mV
Window:

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

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400	400	400	399386	400
x 1000	100	100	100		100
x 100	400	400	400	39949	400
x 100	100	100	100		100
x 10	400	400	400	3995	400
x 10	100	100	100		100
x 1	400	400	400	399	400
x 1	100	100	100		100

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



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Reference Instruments and/or Sources:

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

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

Calibrated By:
Reviewed By:

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

Date: 3 1-17

ERG Form ITC. 101.A

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

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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:	271435
Detector:	Manufacturer:	Ludlum	Model Number:	44-10	Serial Number:	PR295017

☐ Mechanical Check
☐ F/S Response Check
☐ Geotropism
☐ Meter Zeroed

☐ THR/WIN Operation
☐ Reset Check
☐ Audio Check
☐ Battery Check (Min 4.4 VDC)

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

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

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

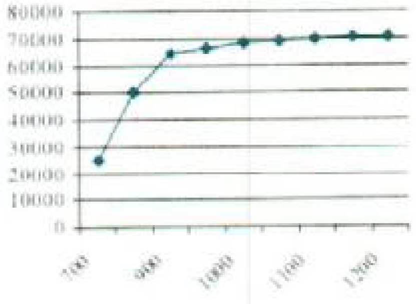
Threshold: 10 mV
Window:

Instrument found within tolerance: ✔ Yes ☐ No

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

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

Voltage Plateau



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

Reference Instruments and/or Sources:

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

Calibrated By:
Calibration Date: 3 13-17
Calibration Due: 3-13-18

Reviewed By:
Date: 14 March 2017

ERG Form ITC. 101.A

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

Certificate of Calibration

Calibration and Voltage Plateau

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

Meter:	Manufacturer:	Ludlum	Model Number:	2221r	Serial Number:	138368
Detector:	Manufacturer:	Ludlum	Model Number:	44-10	Serial Number:	PR355763

☑ Mechanical Check
☑ F/S Response Check
☑ Geotropism
☑ Meter Zeroed

☑ THR/WIN Operation
☑ Reset Check
☑ Audio Check
☑ Battery Check (Min 4.4 VDC)

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

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

Threshold: 10 mV
Window:

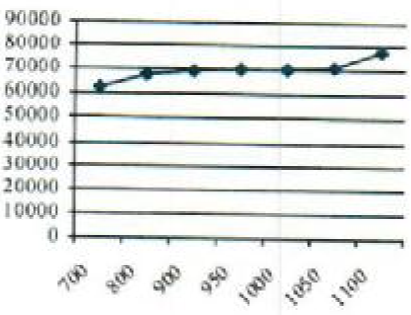
Barometric Pressure: 24.75 inches Hg
Temperature: 76 °F
Relative Humidity: 20 %

Instrument found within tolerance: ☑ Yes ☐ No

Range/Multiplier	Reference Setting	"As Found Reading"	Meter Reading	Integrated 1-Min. Count	Log Scale Count
x 1000	400	400	400	398875	400
x 1000	100	100	100		100
x 100	400	400	400	39883	400
x 100	100	100	100		100
x 10	400	400	400	3988	400
x 10	100	100	100		100
x 1	400	400	400	398	400
x 1	100	100	100		100

High Voltage	Source Counts	Background
700	62275	
800	68049	
900	69726	
950	70112	9509
1000	70068	
1050	71042	
1100	77619	

Voltage Plateau



Comments: Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV = 950

Reference Instruments and/or Sources:

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

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

Reviewed By:
Date: 09/08/17

ERG Form ITC. 101.A

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

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

ACCREDITED
CALIBRATION CERT #1866.01

CALIBRATION REPORT

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

INSTRUMENT: Reuter Stokes RSS-131, #07J00KM1

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

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

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

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

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

ACCREDITED

CALIBRATION CERTIFICATE

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

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

Sensor Type: 100 mR/h

Serial Number: 07J00KM1

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

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

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

Found RAC: 2.169e-8

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

Calibrated By: Richard Hardison
Richard Hardison
Title: Calibration Technician

Reviewed By: Angela Royer
Angela Royer
Title: Calibration Physicist

Log: M-53 Page: 73

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

ACCREDITED
CALIBRATION CERT #1866.11

AS FOUND DATA
Reuter-Stokes Chamber Calibration

June 27, 2016 *Test Number M161588*

CHAMBER:

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

SUBMITTED BY:

ERG

Albuquerque, NM

ORIENTATION/CONDITIONS:

Serial number away from source

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

ATMOSPHERIC COMMUNICATION: SEALED

POLARIZING POTENTIAL 401V

LEAKAGE: negligible

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

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

Calibrated By Richard Hardison
Richard Hardison
Title: Calibration Technician

Reviewed By:
Title: Calibration [illegible]

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:
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 Inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project Reference Point,
9-27-16	1126	6.1	1002	99	45928	6844	39144	NW	NA-0904
9-27-16	1619	5.9	997	99	44136	6788	37348	NW	NA-0904
9-28-16	1022	5.9	1001	99	44612	6242	38370	NW	Comfort Suites Parking lot
9-28-16	1754	5.9	1000	99	43583	6742	36841	NW	NA-0928
9-29-16	0936	5.9	1001	100	44695	5574	39121	NW	Comfort Suites Parking Lot
9-29-16	1600	5.8	1002	99	46024	6760	39264	NW	NA-0928
9-30-16	0920	5.8	1002	99	44958	5748	39210	NW	NA-0904
9-30-16	1436	5.7	998	99	44138	6240	37898	NW	NA-0504
10-1-16	0915	5.7	1002	100	43656	5047	38609	NW	Oak 124/125
10-1-16	1605	5.6	995	99	43105	6275	36830	NW	Alonzo
10-3-16	0950	5.7	1001	99	44914	5611	39303	NW	Barton 3
10-3-16	1220	5.6	998	99	45823	5670	40105	NW	Barton 3

Reviewed by:

Review Date: 11-29-16

ERG Form ITC.201.A

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	196086
Cal. Due Date:	7-9-17

DETECTOR	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	PR295014
Cal. Due Date:	7-9-17

Comments:

MNCAT

Source: Cs-137

Serial No.: 333-94

Activity: 5.12 uCi

Emission Rate: NA cpm/emissions

Source Date: 6-16-94

Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project Reference Points
9-27-16	1121	5.7	1100	100	45851	6762	39089	NW	NA-0904
9-27-16	1619	5.6	1094	99	45492	6313	39179	NW	NA-0904
9-28-16	1026	5.7	1100	100	44929	6287	38642	NW	NA-0904
9-28-16	1754	5.6	1098	100	44643	6434	38209	NW	Comfort Suites Parking Lot
9-29-16	0940	5.6	1100	99	43453	5654	37799	NW	NA-0928
9-29-16	1603	5.5	1101	100	44586	6525	38061	NW	Comfort Suites Parking Lot
9-30-16	0915	5.5	1102	100	44975	5236	39739	NW	NA-0928
9-30-16	1433	5.4	1096	100	44003	5827	38176	NW	NA-0904
10-1-16	0925	5.5	1102	100	42929	5140	37789	NW	Oak 124/125
10-1-16	1605	5.3	1092	100	44650	6271	38379	NW	Mongo
10-3-16	0946	5.5	1100	100	43679	4995	38684	NW	Barton 3
10-3-16	1225	5.4	1099	100	45921	5361	40560	NW	Barton 3

Reviewed by: MA

Review Date: 11/29/16

ERG Form ITC.201.A

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ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	254772
Cal. Due Date:	7-19-17

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

Comments:

NNERT

Source: Cs-137

Serial No.: 333-94

Activity: 5.12 uCi

Emission Rate: NA cpm/emissions

Source Date: 6-6-94

Distance to Source: 6 Inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
									Project reference points
10-4-16	0925	5.7	1003	99	45635	6378	39254	NW	Tsosie 1
10-4-16	1720	5.6	1008	99	46987	6720	40267	NW	Comfort Suites Parking lot
10-5-16	0620	5.7	1007	99	47335	6804	40531	NW	Comfort Suites Parking lot
10-5-16	1542	5.5	999	99	45375	6342	39033	NW	Tsosie 1
10-6-16	0900	5.5	1003	99	43705	6364	37341	NW	Tsosie 1
10-6-16	1713	5.5	1000	99	44279	6053	38226	NW	Comfort Suites Parking Lot
10-7-16	0902	5.5	1006	99	44457	6007	38404	NW	Oak 124/125
10-7-16	1627	5.5	999	99	46103	6751	39352	NW	Comfort Suites Parking Lot
10-8-16	0903	5.6	1003	99	45434	6365	39069	NW	Red Valley Intersection
10-8-16	1653	5.5	999	99	45185	6467	38718	NW	Comfort Suites Parking Lot
10-10-16	0858	5.5	1004	100	42755	5579	37176	NW	Oak 124/125
10-10-16	1919	5.5	999	99	51651	6930	44721	NW	Oak 124/125

Reviewed by:

Review Date: 11/29/16

②

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	196086
Cal. Due Date:	7-9-17

↔

DETECTOR	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	PR 295014
Cal. Due Date:	7-9-17

Comments:
NNEAT

Source: Cs-137
Serial No.: 333-94
Activity: 5.12 uCi
Emission Rate: NA cpm/emissions
Source Date: 6-16-94
Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project Reference Points
10-4-16	0936	5.5	1102	100	46804	6042	40762	NW	Tsosie 1
10-4-16	1720	5.4	1106	100	46032	6898	39134	NW	Comfort Suites Parking Lot
10-5-16	0622	5.4	1109	101	45794	6834	38960	NW	Comfort Suites Parking Lot
10-5-16	1548	5.3	1097	99	46608	6021	40587	NW	Tsosie 1
10-6-16	0904	5.4	1103	100	44521	6273	38248	NW	Comfort Suites Parking Lot
10-6-16	1318	5.3	1099	100	45178	6311	38867	NW	Comfort Suites Parking Lot
10-7-16	0859	5.4	1104	100	44101	5226	38875	NW	Oak 124/125
10-7-16	1633	5.4	1098	99	44930	6832	38098	NW	Comfort Suites Parking Lot
10-8-16	0908	5.4	1104	100	45110	6201	38909	NW	Red Valley Intersection
10-8-16	1658	5.3	1098	99	45810	6196	39614	NW	Comfort Suites Parking Lot
10-12-16	1331	5.4	1099	99	46496	6519	39977	NW	Barton 3
10-12-16	1614	5.4	1097	100	44509	6060	38449	NW	Comfort Suites Parking Lot

Reviewed by: MW

Review Date: 11/29/16

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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:

NNSRT

Source: Cs-137

Serial No.: 333-94

Activity: 5.12 uCi

Emission Rate: NA cpm/emissions

Source Date: 6-6-94

Distance to Source: 6 Inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s): Project reference points
10-11-16	0927	5.5	1002	99	45599	6141	39458	NW	NA-0904
10-11-16	1720	5.5	998	99	48630	6576	42054	NW	Comfort Suites Parking Lot
10-12-16	0858	5.5	1003	99	44980	5506	39474	NW	NA-0928
10-12-16	1618	5.5	998	99	43779	6289	37490	NW	Comfort Suites Parking Lot
10-13-16	0911	5.5	1003	99	46726	7375	39351	NW	Alonga
10-13-16	1910	5.5	990	99	45235	6618	38617	NW	Comfort Suites Parking Lot
10-14-16	0926	5.5	1004	99	45657	7242	38415	NW	Barton 3
10-14-16	1540	5.4	998	99	44751	6480	38271	NW	Comfort Suites Parking Lot
10-15-16	0927	5.5	1001	99	45697	6933	38764	NW	Harvey Blackwater
10-15-16	1824	5.4	996	99	42528	4945	37583	NW	Hat Rock Inn Parking Lot
* 10-24-16	0800	6.2	1005	100	48507	9268	39239	NW	Boyd Tisi
10-24-16	1207	6.0	1001	99	46290	8126	38164	NW	Boyd Tisi

* changed battery

Reviewed by:

Review Date: 11/29/16

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	254772
Cal. Due Date:	2-28-18

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

Comments:

NNERT

Source: Cs-137

Serial No.: 544-96

Activity: 4 uCi

Emission Rate: N/A cpm/emissions

Source Date: 4-18-96

Distance to Source: 6 inches

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

4-2-17

Reviewed by:

Review Date: 11/06/17

ERG Form ITC.201.A

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	196086
Cal. Due Date:	2-28-18

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR295014
Cal. Due Date:	2-28-18

Comments:
NNEAT

Source: Cs-137

Serial No.: 544-96

Activity: 4 uCi

Emission Rate: NA cpm/emissions

Source Date: 4-18-96

Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
3-20-17	0905	5.7	1003	101	40471	8507	31964	NW	Claim 28
3-20-17	1547	5.6	996	101	36470	5494	30976	NW	Chinle lot
3-21-17	0641	5.7	1004	101	37904	5597	32307	NW	Chinle lot
3-21-17	1654	5.6	999	101	36212	4929	31283	NW	Goulding's lot
3-22-17	0702	5.6	1001	101	35714	5119	30595	NW	Goulding's lot
3-22-17	1437	5.4	995	101	35087	4539	30548	NW	Charles Keith shooting range
3-23-17	0907	5.6	1004	101	36031	4879	31152	NW	NA-0928
3-23-17	1922	5.5	1004	101	41793	9955	31838	NW	Gallup lot
3-24-17	0810	5.5	1007	101	35608	4282	31326	NW	Eunice Becenti
3-24-17	1735	5.5	1000	101	41923	10785	31138	NW	Gallup lot
3-27-17	0833	5.5	1005	101	36943	4282	32661	NW	Eunice Becenti
3-27-17	1235	5.4	1000	101	35141	4013	31128	NW	Eunice Becenti

Reviewed by:

Review Date: 10/19/17

(4)

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	271435
Cal. Due Date:	3-13-18

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

Comments:
NNEAT

Source: Cs-137

Serial No.: 544-96

Activity: 4 uCi

Emission Rate: NA cpm/emissions

Source Date: 4-18-96

Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
3-22-17	0705	5.6	1050	100	35820	5210	30610	NW	Goulding's lot
3-22-17	1425	5.5	1049	101	36169	4648	31521	NW	Charles Keith shooting range
3-23-17	0908	5.6	1056	102	35972	4828	31144	NW	NA-0928
3-23-17	1915	5.5	1055	102	41686	10757	30929	NW	Gallup lot
3-24-17	0805	5.5	1060	102	36151	4442	31709	NW	Eunice Becenti
3-24-17	1744	5.4	1051	101	41975	10973	31002	NW	Gallup lot
3-25-17	0908	5.5	1057	102	37581	5827	31754		Section 26
3-25-17				DID	NOT USE				
					4-2-17				

Reviewed by:

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

ERG Form ITC.201.A

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	254772
Cal. Due Date:	2-28-17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR303727
Cal. Due Date:	2-28-17

Comments:
NNERT

Source: Cs-137
Activity: 4 uCi
Source Date: 4.18.96
Distance to Source: 6 Inches
Serial No.: 544-96
Emission Rate: NA cpm/emissions

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
4.11.17	0920	5.7	1000	101	36807	5626	31181	NW	NA-0928
4.11.17	1607	5.1	994	100	35724	5073	30651	NW	NA-0804 upper
4.14.17	0910	5.3	999	100	37554	5361	32193	NW	NA-0928
4.14.17	1050	5.3	997	100	37119	5165	31954	NW	NA-0928
4.17.17	0926	5.6	1000	101	37381	5937	31444	NW	NA-0928
4.17.17	1314	5.5	993	100	37712	5579	32133	NW	Barton 3
4.18.17	1400	5.6	997	100	40901	8541	32360	NW	Claim 28
4.18.17	1633	5.5	996	100	38299	8808	29491	NW	Claim 28
					4.19.17				

Reviewed by:

Review Date: 11/08/17

ERG Form ITC.201.A

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	282971
Cal. Due Date:	3-13-18

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR320678
Cal. Due Date:	3-13-18

Comments:

NNCRT

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):
4-11-17	0926	5.7	1050	101	38755	5977	32778	NW	NA-0928
4-11-17	1604	5.2	1044	102	37323	5938	31385	NW	NA-0904 (upper)
a. 4-12-17	0855	5.9	1049	100	37623	6131	31492	NW	NA-0928
4-12-17	1506	6.1	1049	100	37644	6078	31566	NW	NA-0904 (lower)
4-13-17	0900	6.1	1050	101	38810	6436	32374	NW	NA-0928
4-13-17	1651	6.1	1045	102	38853	6098	32755	NW	NA-0904
4-14-17	0907	6.1	1050	101	37885	5998	31887	NW	NA-0928
4-14-17	1045	6.0	1046	100	38070	6036	32034	NW	NA-0928
4-15-17	0844	6.0	1050	100	38257	6419	31838	NW	NA-0928
4-15-17	1615	5.9	1044	100	37604	6764	30840	NW	Barton 3
4-17-17	0931	5.9	1049	100	38546	6044	32502	NW	NA-0928
			4-24-17						

a. Changed batteries

Reviewed by: ________________ Review Date: 10/9/17

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	196086
Cal. Due Date:	2-28-17

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR 295019
Cal. Due Date:	2-28-17

Comments:
NNERT

Source: Cs-137

Serial No.: 544-96

Activity: 4 uCi

Emission Rate: NA cpm/emissions

Source Date: 4-18-96

Distance to Source: 6 inches

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
4-11-17	0932	5.5	1100	100 NW	36776	5404		NW	NA-0928
4-11-17	1601	5.4	1094	100	36796	5031		NW	NA-0904 (upper)
4-12-17	0850	5.4	1100	101	37067	5050		NW	NA-0928
4-12-17	1510	5.3	1092	100	36453	5524		NW	NA-0904
4-13-17	0855	5.4	1101	101	36895	5793		NW	NA-0928
4-13-17	1648	5.3	1092	100	38916	5572		NW	NA-0904
4-15-17	0840	5.4	1100	101	37457	5291		NW	NA-0928
4-15-17	1612	5.2	1090	100	38092	6045		NW	Barton 3
4-17-17	0921	5.4	1101	101	38591	5561		NW	NA-0928
4-17-17	1317	5.3	1090	100	37050	5496		NW	Barton 3
4-18-17	1354	5.4	1098	101	40983	8497		NW	Claim 28
4-18-17	1642	5.2	1091	101	39900	8193		NW	Claim 28

Reviewed by:

Review Date: 10/9/17

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	Ludlum
Model:	2221
Serial No.:	138368
Cal. Due Date:	9-17-18

DETECTOR	
Manufacturer:	Ludlum
Model:	44-10
Serial No.:	PR355763
Cal. Due Date:	9-17-18

Comments:

NNZRT

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

Date	Time	Battery	High Voltage	Threshhold	Source Counts	BKG Counts	Net Counts	Initials	Note(s):
9-12-17	0914	5.4	950	101	36935	6331	30604	NW	Barton 3
9-12-17	1432	5.3	944	99	38043	6468	31575	NW	Tsosie 1
9-13-17	0906	5.4	951	99	37146	6538	30608	NW	Alonzo
9-13-17	1600	5.3	944	99	35587	5991	29596	NW	Barton 3
9-14-17	0909	5.4	950	100	36080	6176	29904	NW	NA-0904
9-14-17	1255	5.3	948	100	36099	5764	30335	NW	NA-0904
9-15-17	0920	5.4	954	101	35208	5551	29657	NW	Eunice Becenti
9-15-17	1729	5.3	957	109	35937	5261	30676	NW	Eunice Becenti
9-14-17	0831	5.4	958	105	36467	6034	30433	NW	Section 26 @ trailer
9-16-17	1453	5.3	946	99	44454	14748	29706	NW	Section 26 @ corral
9-20-17	0736	5.3	953	102	37676	6987	30689	NW	Mexican Hat
9-20-17	1611	5.2	947	100	36842	6252	30590	NW	Mexican Hat

Reviewed by:

Review Date: 10/9/17

ERG Form ITC.201.A

ERG

Single-Channel Function Check Log

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

METER	
Manufacturer:	GE
Model:	RSS-131
Serial No.:	07J00km1
Cal. Due Date:	6-29-17

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

Comments:
NNERT

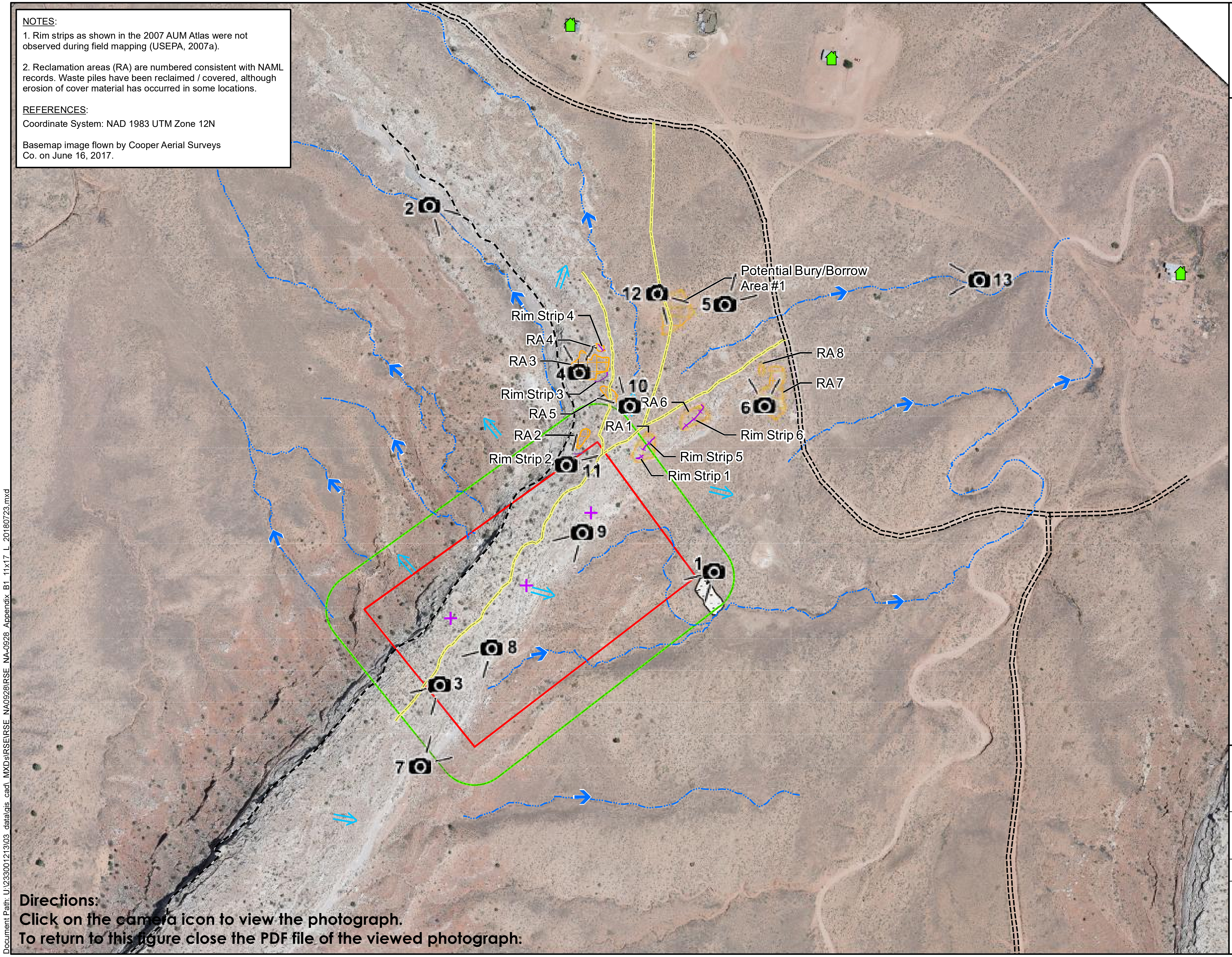
Source: Cs-137
Serial No.: 333-94
Activity: 5.12 uCi
Emission Rate: NA cpm/emissions
Source Date: 6-16-94
Distance to Source: Contact - housing

Date	Time	Battery	High Voltage	Threshhold	Source Counts µR/h	BKG Counts	Net Counts	Initials	Note(s): Project reference points,
10-7-16	0545	~6.14	~400	~ NA ~	~26.7	~9.5	~17.2	NW	Comfort Suites Room - Farmingt
10-7-16	2040	~6.16	~400	NA	~26.5	~8.7	~17.8	NW	Comfort Suites Room - Farmington
10-11-16	0634	~6.2	~400	NA	~25	~10.5	~14.5	NW	Comfort Suites Room - Farmington
10-11-16	1801	~6.3	~400	NA	~25.5	~10.1	~14.4	NW	Comfort Suites Room - Farmington
10-12-16	0548	~6.3	~400	NA	~26.5	~10	~16.5	NW	Comfort Suites Room - Farmington
10-12-16	1640	~6.3	~400	NA	~26.4	~10	~16.4	NW	Comfort Suites Room - Farmington
10-13-16	0608	~6.3	~400	NA	~27	~9.8	~17.2	NW	Comfort Suites Room - Farmington
10-13-16	1950	~6.3	~400	NA	~26.3	~9.5	~16.8	NW	Comfort Suites Room - Farmington
10-14-16	0630	~6.4	~400	NA	~26.4	~9.5	~16.9	NW	Comfort Suites Room - Farmington
10-14-16	1547	~6.2	~400	NA	~30	~12	~18	NW	Comfort Suites Room - Farmington
10-25-16	0539	~6.3	~400	NA	~29	~11	~18	NW	Best Western Room - Flagstaff
10-29-16	1755				DID	NOT	USE		

Reviewed by:

Review Date: 11-29-16

Appendix B Site Photographs



NOTES:

1. Rim strips as shown in the 2007 AUM Atlas were not observed during field mapping (USEPA, 2007a).

2. Reclamation areas (RA) are numbered consistent with NAML records. Waste piles have been reclaimed / covered, although erosion of cover material has occurred in some locations.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

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

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
- Flow Direction
- Approximate Overland Water Flow Direction
- Rim Strip Location per 2007 AUM Atlas¹
- Rim Strip (Buried - Location Approximate)
- Approximate Edge of Mesa
- Drainage
- Potential Haul Road
- Road
- Debris
- Mining / Reclaimed Disturbed Area
- Claim Boundary
- 100-Foot Claim Buffer

N
W E
S

0 250 500
Feet

TITLE:
Site Photographs

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 7/24/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB
REVIEWER: EDZ

FIGURE: Appendix B

Document Path: U:\233001213\03 data\gis cad\ MXDs\RSE\RSE NA0928\RSE NA-0928 Appendix B1 11x17 L 20180723.mxd

Appendix C Field Activity Forms

C.1 Soil Sample Field Forms

C.2 Drilling and Hand Auger Borehole Logs

C.3 Water Sample Field Forms

C.1 Soil Sample Field Forms

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME SO59 (NA-0904)

SAMPLE I.D. SU59-BG1-001 (201, dup)

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1210

SAMPLE COLLECTED BY KJJ

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS silty sand

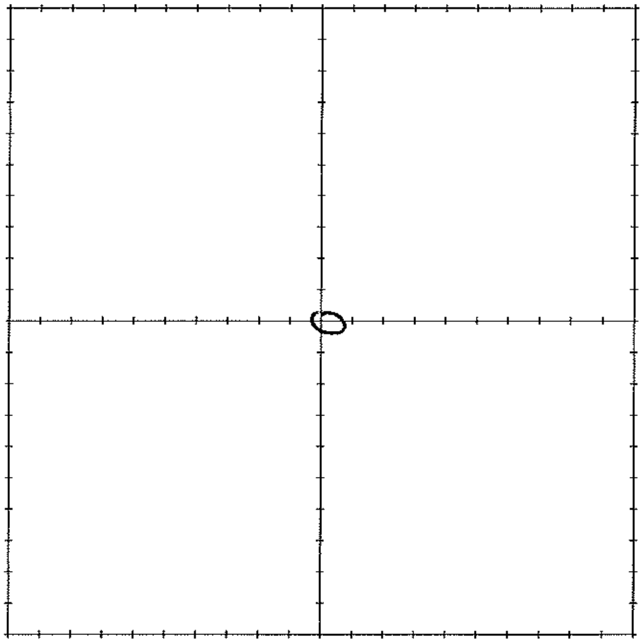
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME 8059 / HA-0904

SAMPLE I.D. 8059-BG1-002 (MS, MSD)

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1225

SAMPLE COLLECTED BY KJJ

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS silty sand

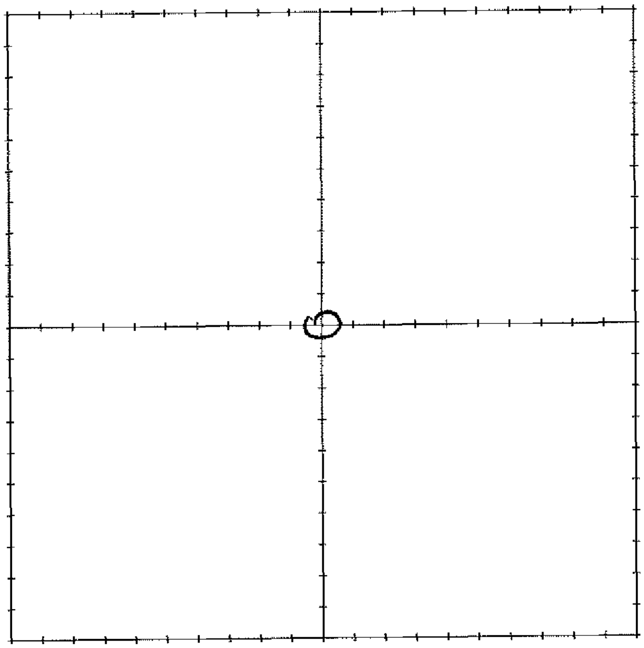
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (NA-0704)

SAMPLE I.D. S059-BG1-003

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1245

SAMPLE COLLECTED BY KJJ

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS silty sand, minor weathered shale frags

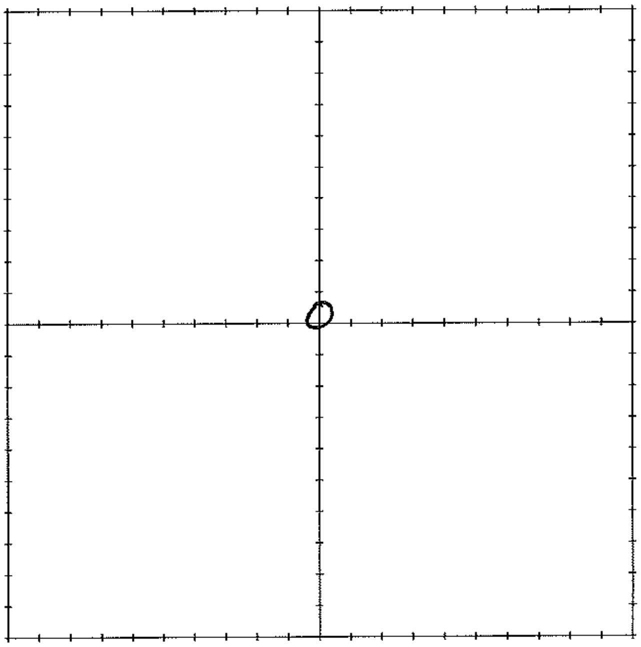
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME 8059 (HA-0704)

SAMPLE I.D. 8059-BG1-004

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1259

SAMPLE COLLECTED BY KJJ

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS Silt & Sand

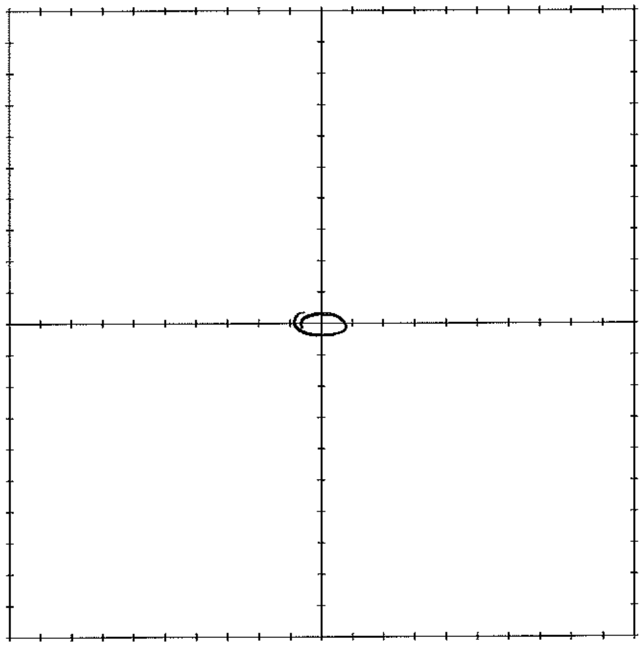
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (MA-0904)

SAMPLE I.D. S059-BG1-005

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1259

SAMPLE COLLECTED BY RJJ

WEATHER CONDITIONS 50's, Clear

FIELD USCS DESCRIPTIONS Silty sand

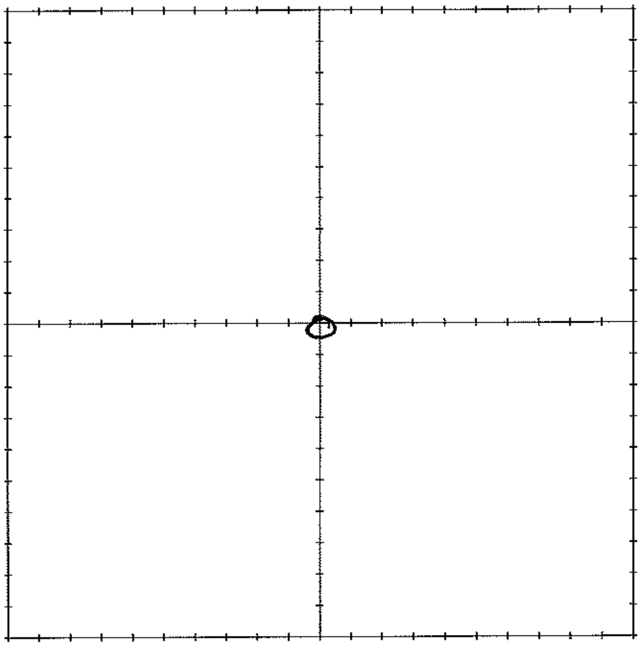
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME 5059 (HA-0904)

SAMPLE I.D. S059-BG1-006

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1306

SAMPLE COLLECTED BY KJJ

WEATHER CONDITIONS 50's, Clear

FIELD USCS DESCRIPTIONS Silty sand, trace weathered sandstone frags

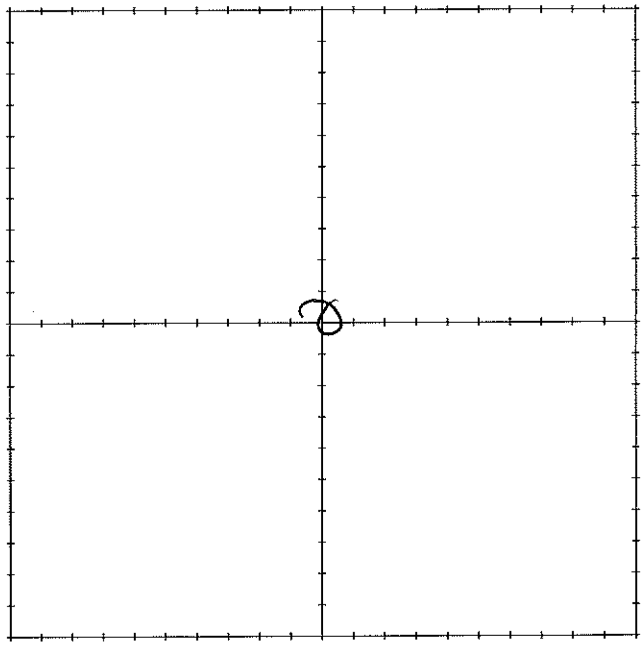
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (NA-0904)

SAMPLE I.D. S059-B91-007

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME ~~1112~~ 1312

SAMPLE COLLECTED BY K JJ

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS Silty Sand, some organic material

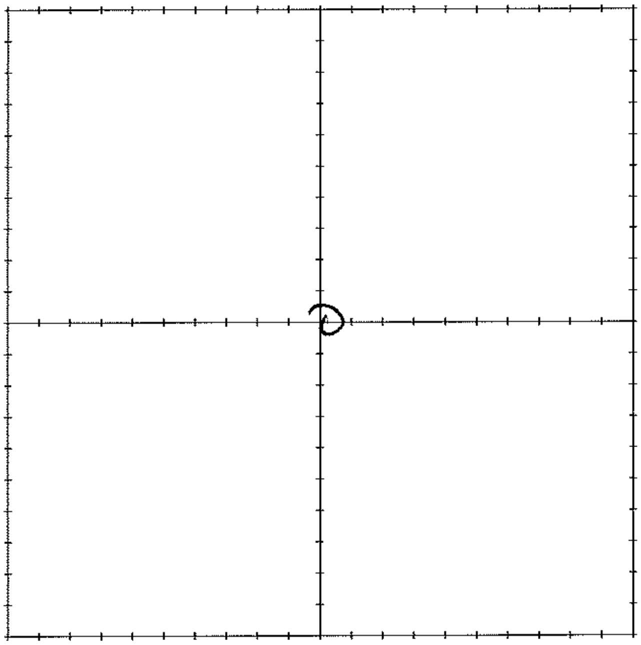
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (NA-0904)

SAMPLE I.D. S059-BG1-008

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1322

SAMPLE COLLECTED BY KJJ

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS silty sand, trace organic matter

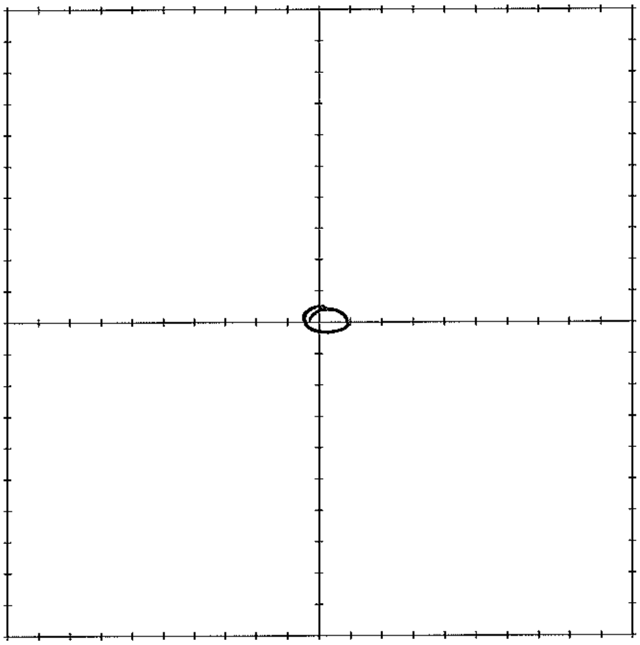
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals.



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 CHA-0904

SAMPLE I.D. S059-BG1-009

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1330

SAMPLE COLLECTED BY rc JS

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS silty sand

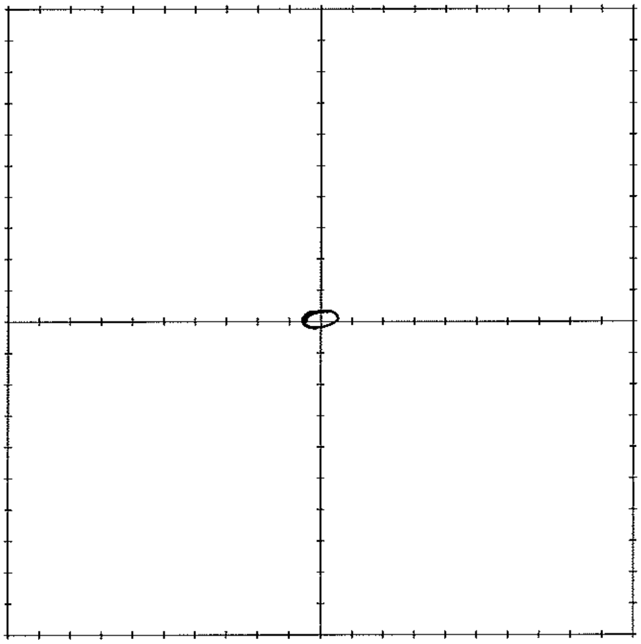
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (MA-0904)

SAMPLE I.D. S059-BG1-010

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1337

SAMPLE COLLECTED BY KJJ

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS silty sand

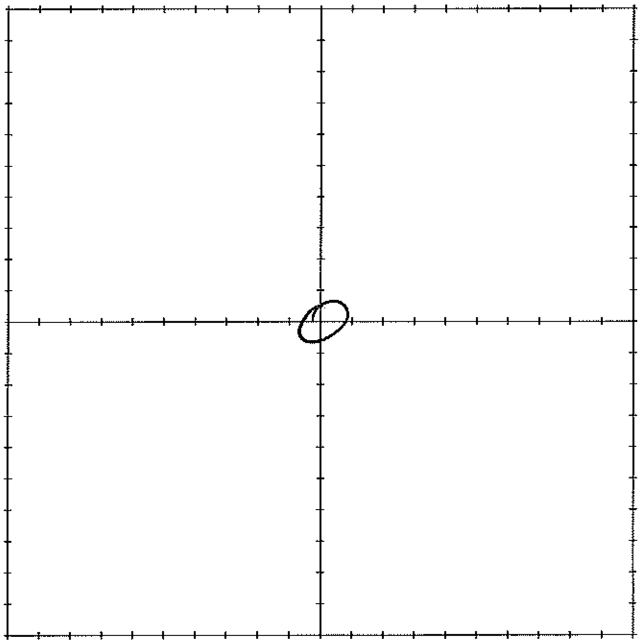
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (NA-09041)

SAMPLE I.D. S059 - BG2- 001 (201, dup)

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1352

SAMPLE COLLECTED BY KJJ

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS Silty Sand

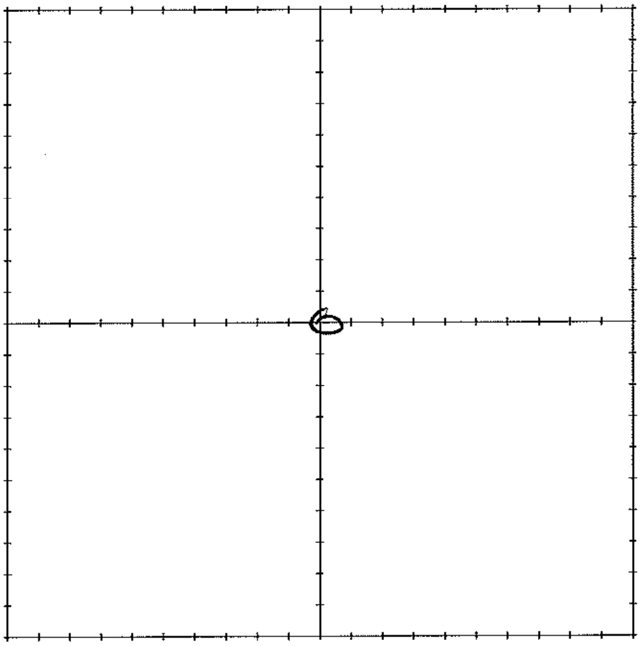
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME 8059 (NA-0904)

SAMPLE I.D. 8059-BG2-002

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1401

SAMPLE COLLECTED BY KJJ

WEATHER CONDITIONS 80's, Clear

FIELD USCS DESCRIPTIONS Silty sand, minor weathered slate

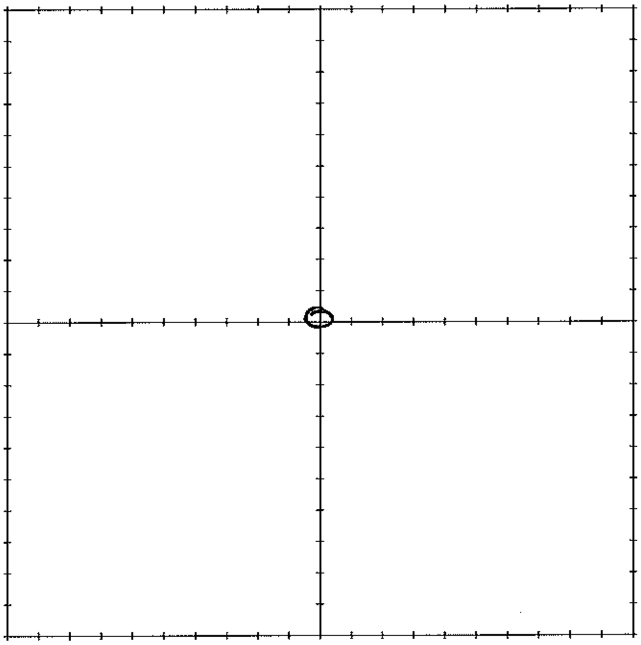
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME 5059 (HA-0904)

SAMPLE I.D. 5059-BG2-003

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1408

SAMPLE COLLECTED BY KJS

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS Silty sand

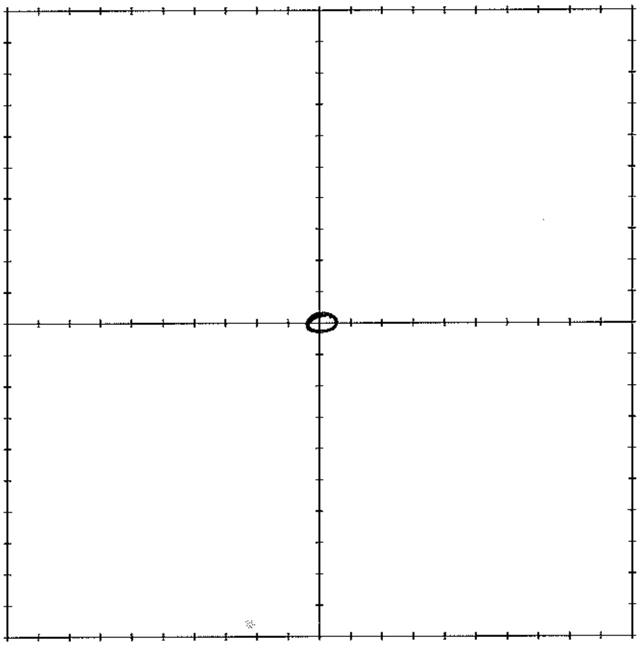
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (NA-0904)

SAMPLE I.D. S059-BG2-004

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1416

SAMPLE COLLECTED BY KJJ

WEATHER CONDITIONS 50's, Clear

FIELD USCS DESCRIPTIONS Silty sand, decomposed SS trace

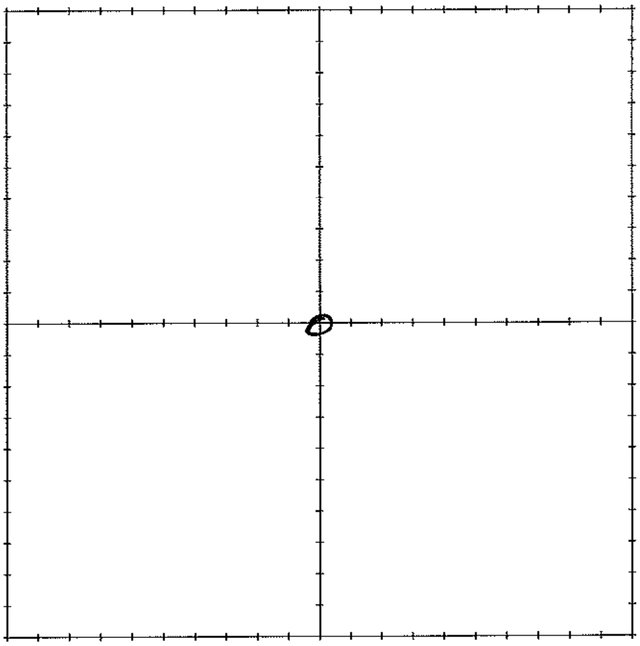
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (MA-0904)

SAMPLE I.D. S059-BG2-005

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1424

SAMPLE COLLECTED BY KJJ

WEATHER CONDITIONS 50's, Clear

FIELD USCS DESCRIPTIONS Fine sand, minor decomposed SS

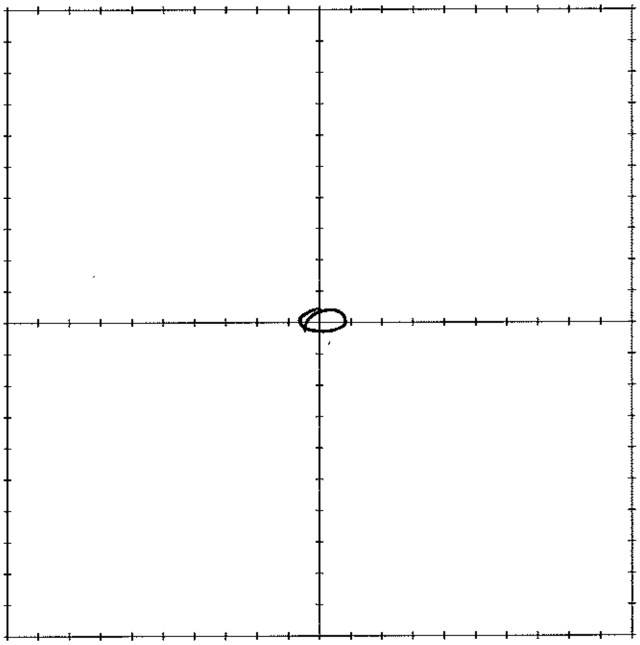
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (MA-0904)

SAMPLE I.D. S059-BG2-006

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1430

SAMPLE COLLECTED BY KJJ

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS Silty sand, decomposed SS minor

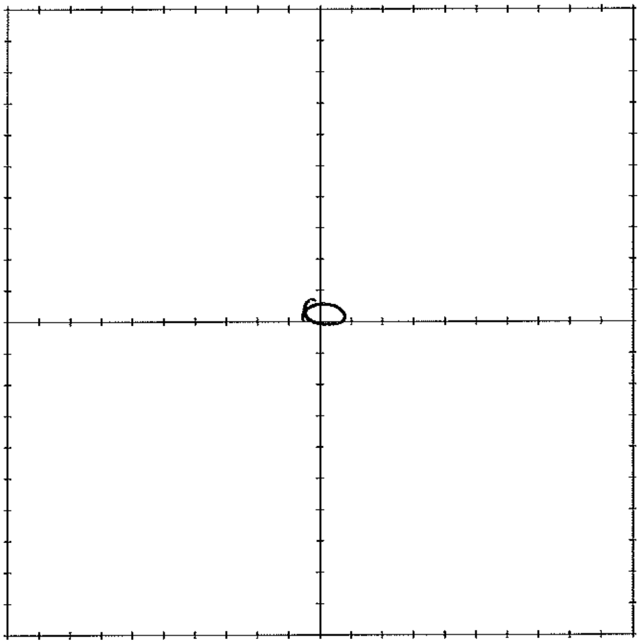
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (HA-0904)

SAMPLE I.D. S059-BG2-007

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1436

SAMPLE COLLECTED BY KJS

WEATHER CONDITIONS 50's, Clear

FIELD USCS DESCRIPTIONS Silty Sand

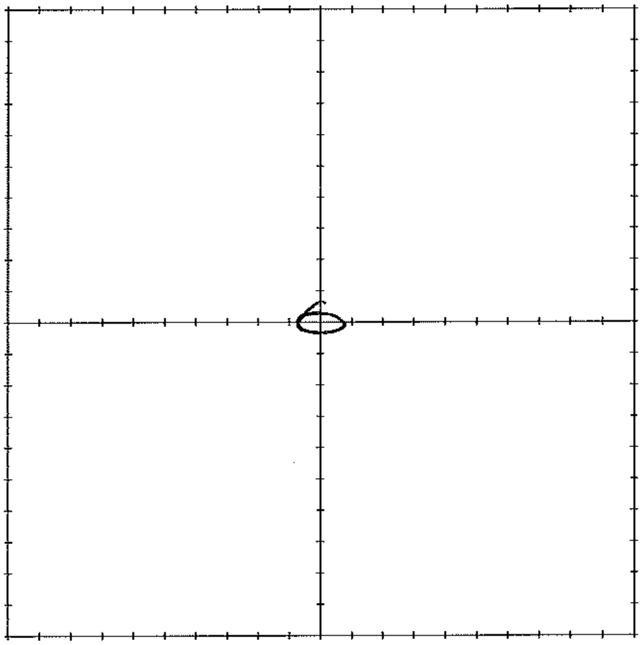
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (MA-0904)

SAMPLE I.D. S059-BG2-008

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1443

SAMPLE COLLECTED BY KJJ

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS Silty Sand

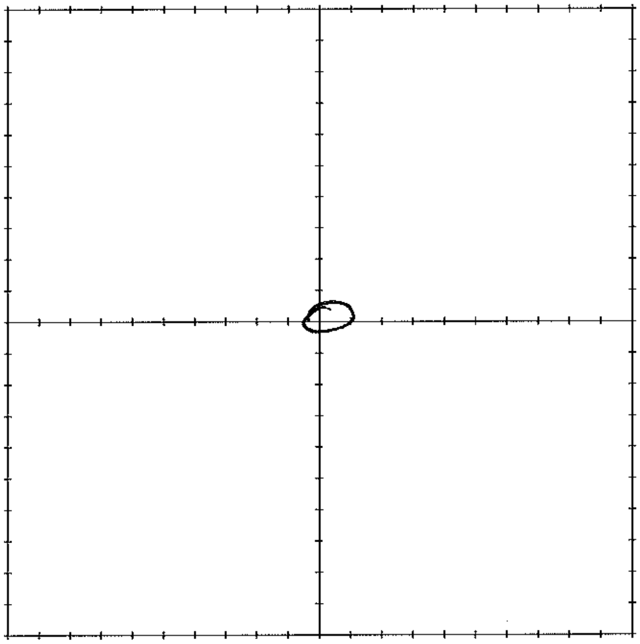
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (HA-0904)

SAMPLE I.D. S059-BG2-009

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1450

SAMPLE COLLECTED BY KJJ

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS silty sand

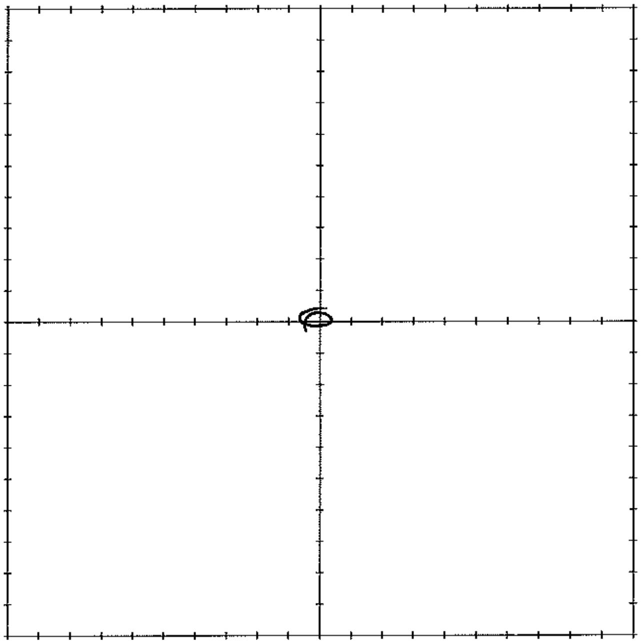
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (HA-0904)

SAMPLE I.D. S059 - BG2 - ~~00~~ 010 (210, dup)

SAMPLE COLLECTION DATE 10/5/16

SAMPLE COLLECTION TIME 1458

SAMPLE COLLECTED BY KJJ

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS Silty Sand

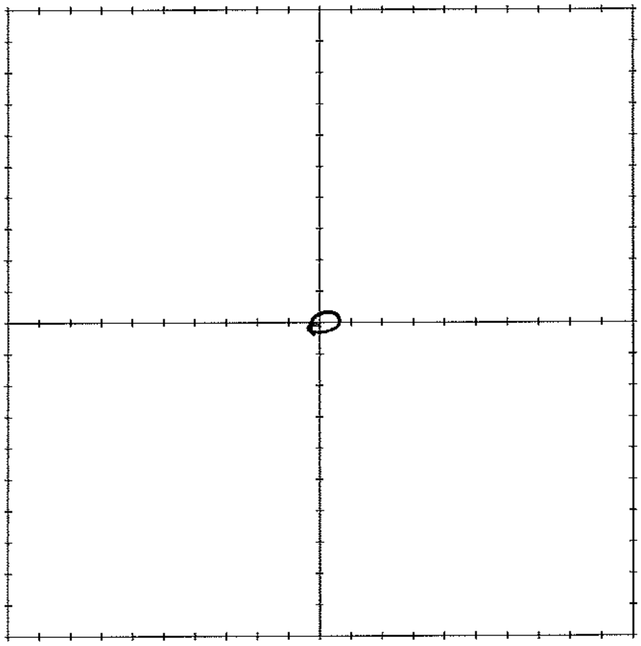
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (MA-0904)

SAMPLE I.D. S059-BG3-001

SAMPLE COLLECTION DATE 10/6/16

SAMPLE COLLECTION TIME 1205

SAMPLE COLLECTED BY C Lee

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS Clean sand

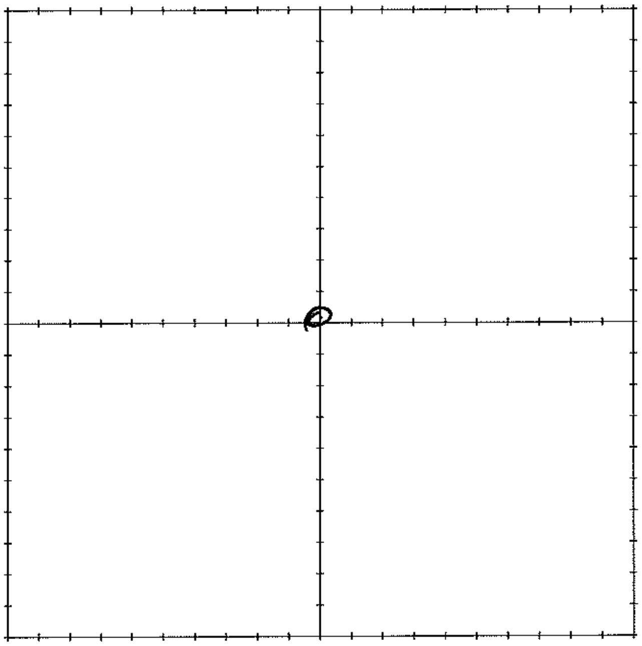
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (MA-0904)

SAMPLE I.D. S059-BG3-002

SAMPLE COLLECTION DATE 10/6/16

SAMPLE COLLECTION TIME 1212

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 50's, Clear

FIELD USCS DESCRIPTIONS Well sorted fine sand

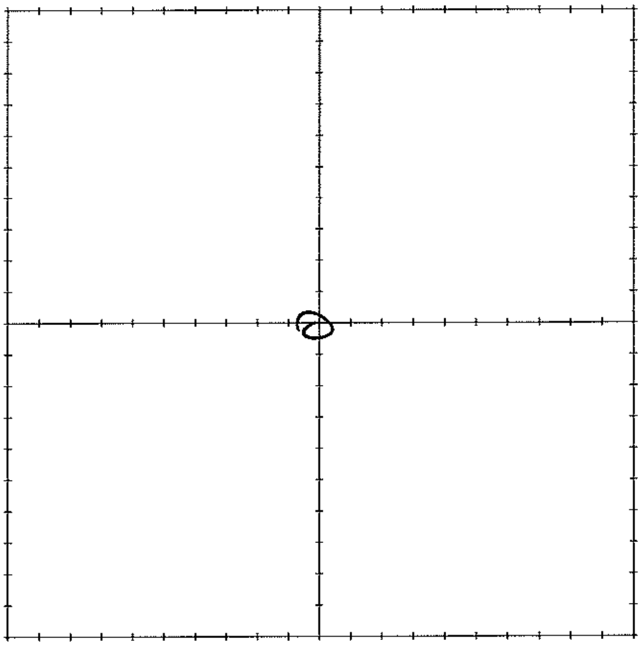
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (HA-0904)

SAMPLE I.D. S059-BG3-003

SAMPLE COLLECTION DATE 10/6/16

SAMPLE COLLECTION TIME 1216

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 50's, Clear

FIELD USCS DESCRIPTIONS Well-sorted fine Sand

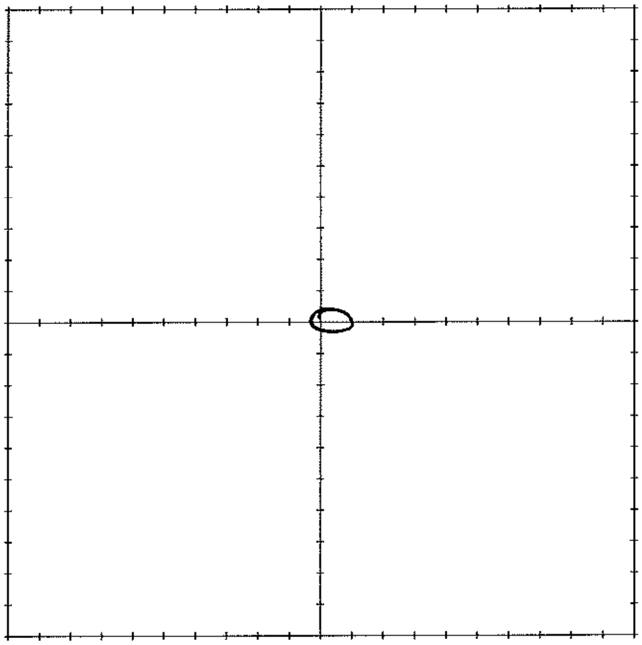
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (MA-0904)

SAMPLE I.D. S059-BG3-004 (MS, MSD)

SAMPLE COLLECTION DATE 10/6/16

SAMPLE COLLECTION TIME 1222

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 50's, Cler

FIELD USCS DESCRIPTIONS Well-sorted fine sand

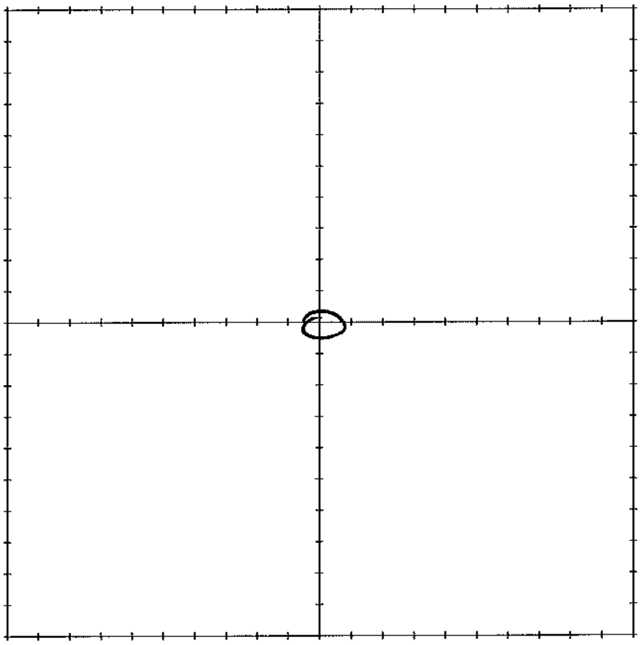
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (NA-09041)

SAMPLE I.D. S059-BG3-005

SAMPLE COLLECTION DATE 10/6/16

SAMPLE COLLECTION TIME 1238

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS Sands, decomposed SS trace

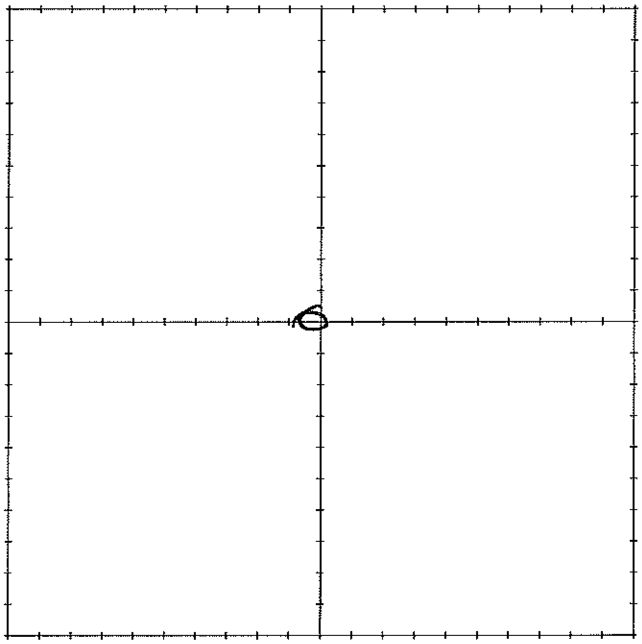
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (MA-0904)

SAMPLE I.D. S059-BG3-006

SAMPLE COLLECTION DATE 10/6/16

SAMPLE COLLECTION TIME 1243

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 50', clear

FIELD USCS DESCRIPTIONS Well-sorted sand

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

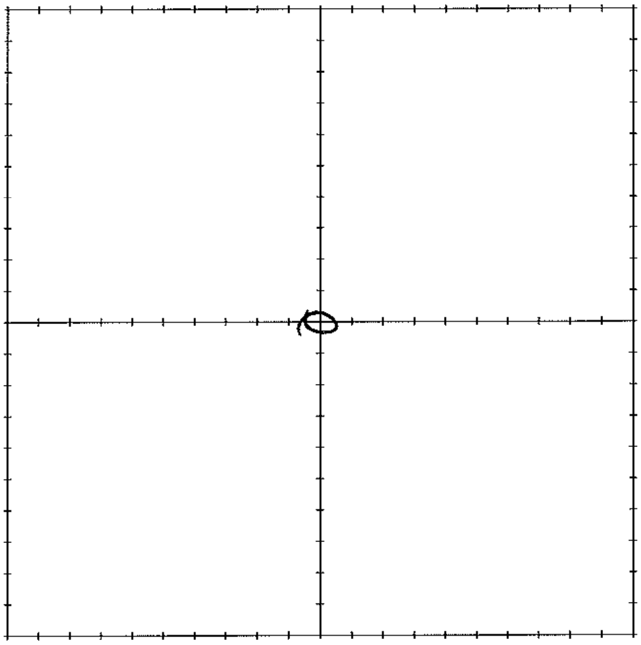
No Trace

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (MA-0904)

SAMPLE I.D. S059-BG3-007

SAMPLE COLLECTION DATE 10/6/16

SAMPLE COLLECTION TIME 1249

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS Well sorted sand

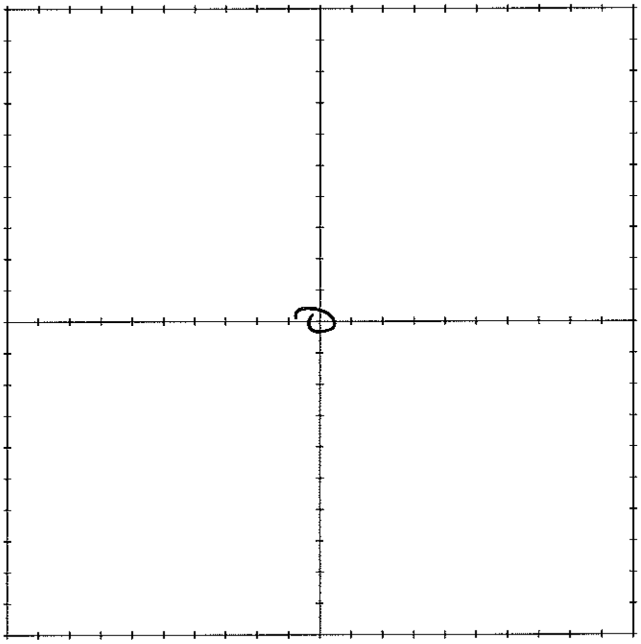
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (HA-0904)

SAMPLE I.D. S059-BG3-008

SAMPLE COLLECTION DATE 10/6/16

SAMPLE COLLECTION TIME 1255

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS Well-sorted sand

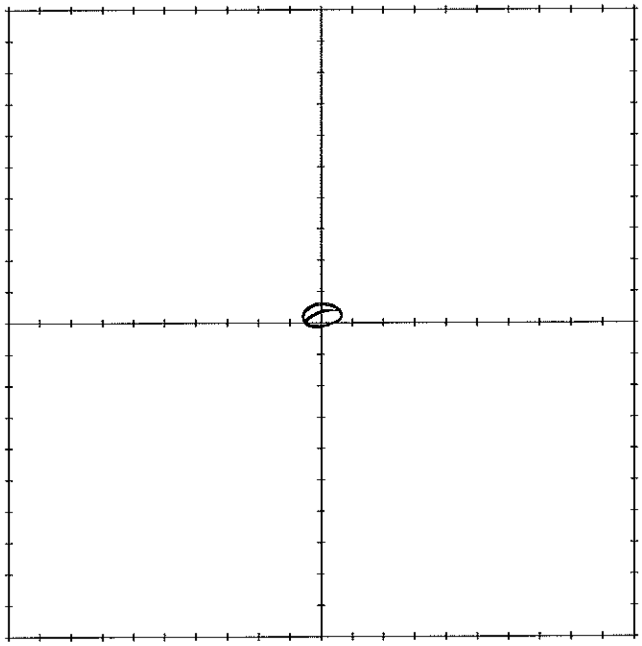
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (MA-0904)

SAMPLE I.D. S059-BG3-009

SAMPLE COLLECTION DATE 10/6/16

SAMPLE COLLECTION TIME 1303

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS Weathered fine-grained SS pebbles, Minor sand

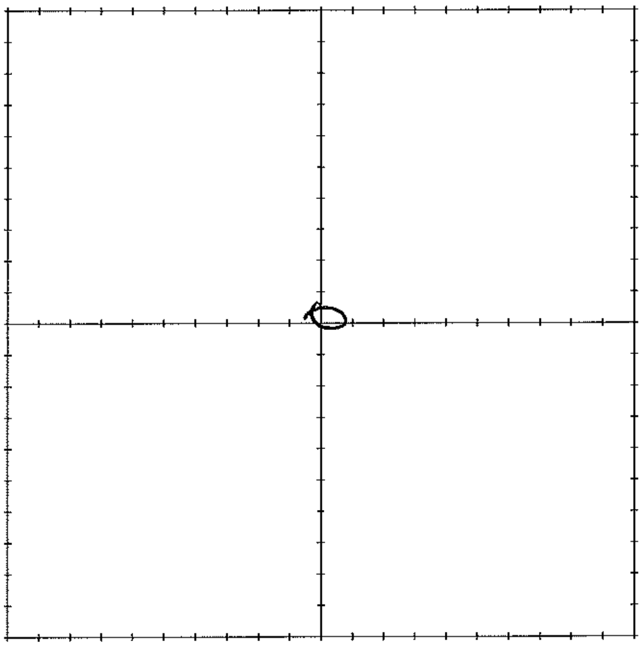
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☑ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2, ziploc

ANALYSES: Ra-224, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S059 (MA-0904)

SAMPLE I.D. S059-BG3-010 (210, dup)

SAMPLE COLLECTION DATE 10/6/16

SAMPLE COLLECTION TIME 1310

SAMPLE COLLECTED BY C Lee

WEATHER CONDITIONS 50's, clear

FIELD USCS DESCRIPTIONS well sorted sand

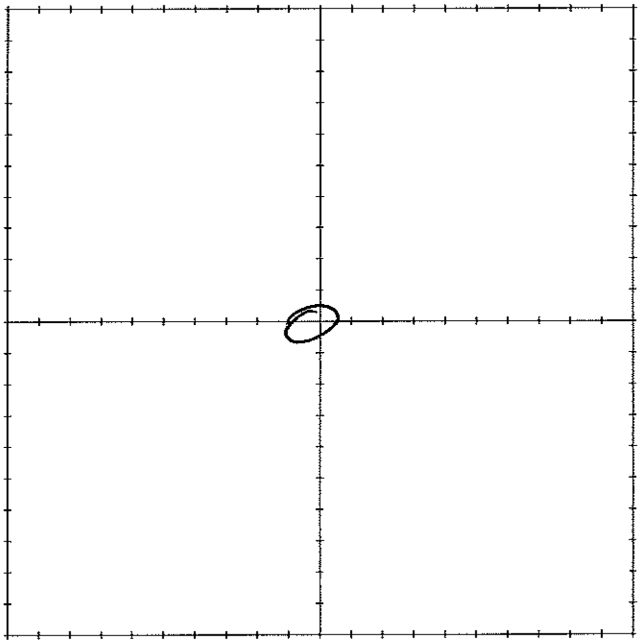
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals.



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S063-C01-001 (HA-0928)

SAMPLE I.D. S063-C01-001

SAMPLE COLLECTION DATE 10/12/16

SAMPLE COLLECTION TIME 0940

SAMPLE COLLECTED BY G Lee

WEATHER CONDITIONS 70's, cloudy

FIELD USCS DESCRIPTIONS Brown silt

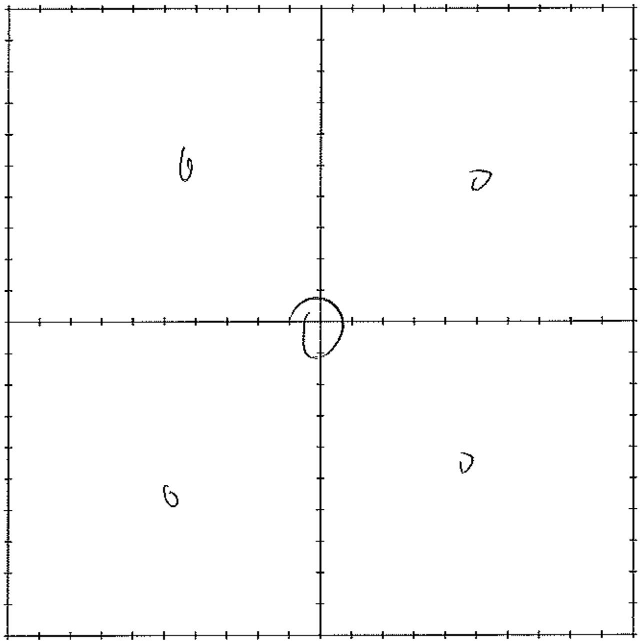
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziploc

ANALYSES: Ra226, Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S486-C01-201 (Oak 129, Oak 128)

SAMPLE I.D. S486-C01-201

SAMPLE COLLECTION DATE 10/7/16

SAMPLE COLLECTION TIME 1026

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 60's, Sunny

FIELD USCS DESCRIPTIONS Brown silt

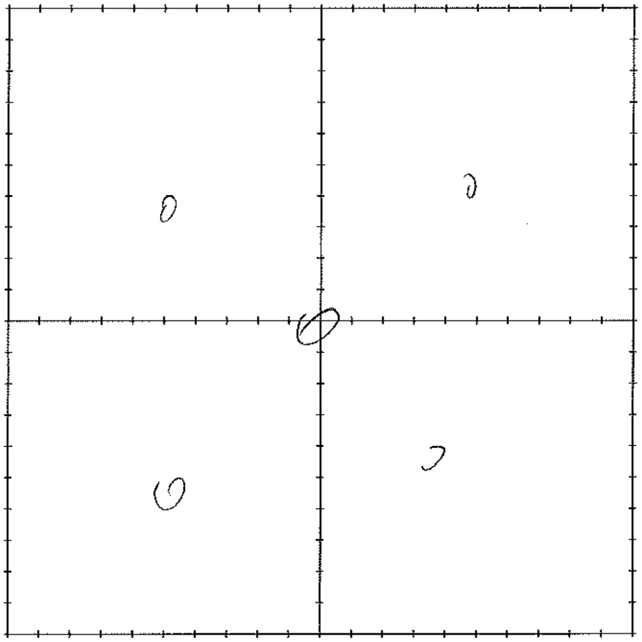
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziploc

ANALYSES: Ra-226, Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S063-C02-001 (HA-0928)

SAMPLE I.D. S063-C02-001

SAMPLE COLLECTION DATE 10/12/16

SAMPLE COLLECTION TIME 1015

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, cloudy

FIELD USCS DESCRIPTIONS Brown silt

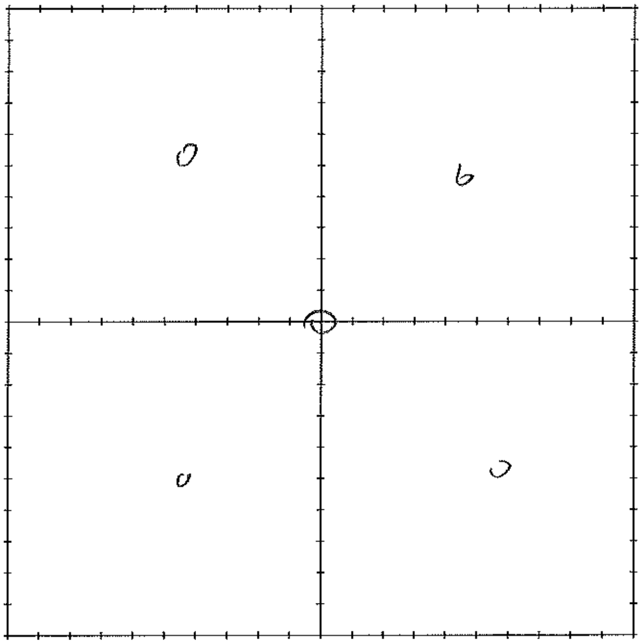
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziploc

ANALYSES: Ra-226, Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S063-C03-001 (NA-0920)

SAMPLE I.D. S063-C03-001

SAMPLE COLLECTION DATE 10/12/16

SAMPLE COLLECTION TIME 1115

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, cloudy

FIELD USCS DESCRIPTIONS Brown silt

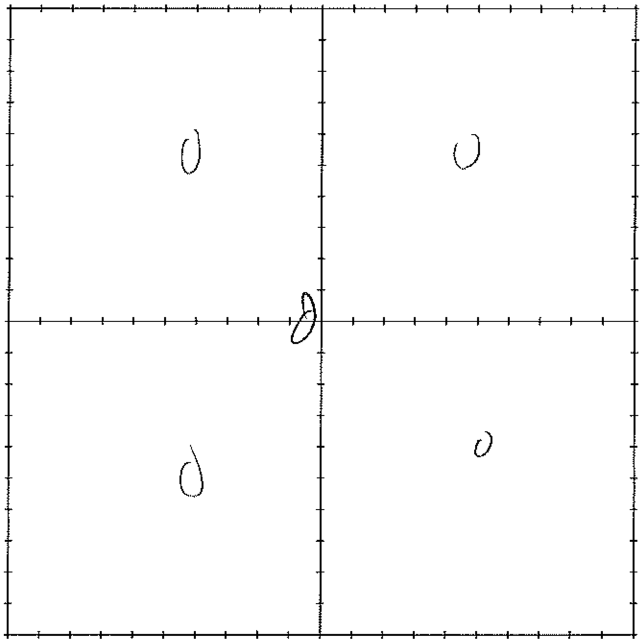
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziplock

ANALYSES: Ra-226, Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S063-C04-001 (KHA: 0928)

SAMPLE I.D. S063-C04-001

SAMPLE COLLECTION DATE 10/12/16

SAMPLE COLLECTION TIME 1142

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, cloudy

FIELD USCS DESCRIPTIONS Brown silt

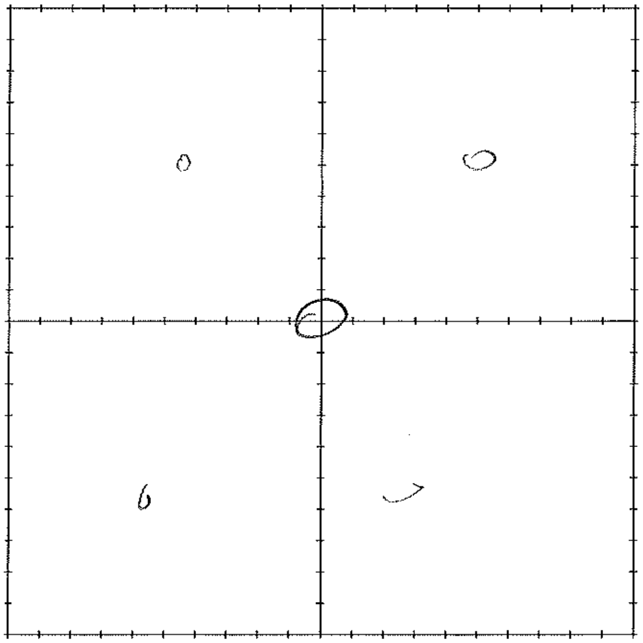
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziplock

ANALYSES: Ra-226, Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S063-C05-001 (NA-0928)

SAMPLE I.D. S063-C05-001

SAMPLE COLLECTION DATE 10/12/16

SAMPLE COLLECTION TIME 1210

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS 70's, cloudy

FIELD USCS DESCRIPTIONS Brown silt

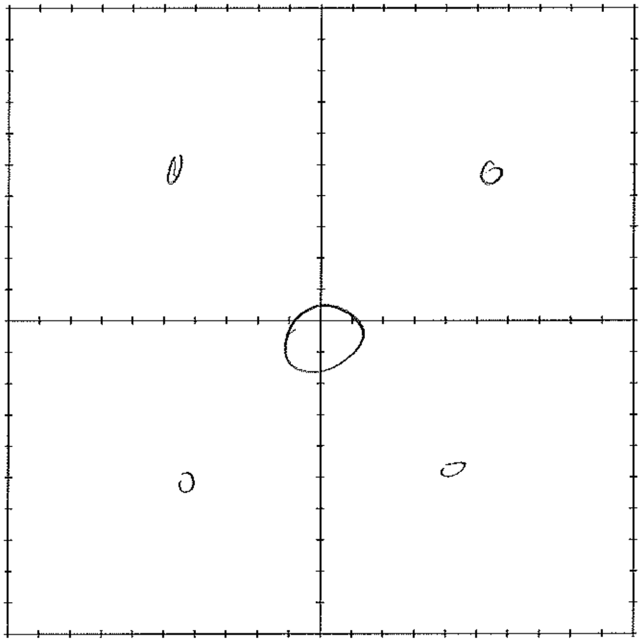
MAJOR DIVISIONS: ☐ OH ☐ CH ☒ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 1, ziplock

ANALYSES: Ra-226, Thorium



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S063-CX-001 NA-0928

SAMPLE I.D. S063-CX-001

SAMPLE COLLECTION DATE 4/15/17

SAMPLE COLLECTION TIME 0940

SAMPLE COLLECTED BY MW/LR

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine light brown sand, trace to few subangular gravels

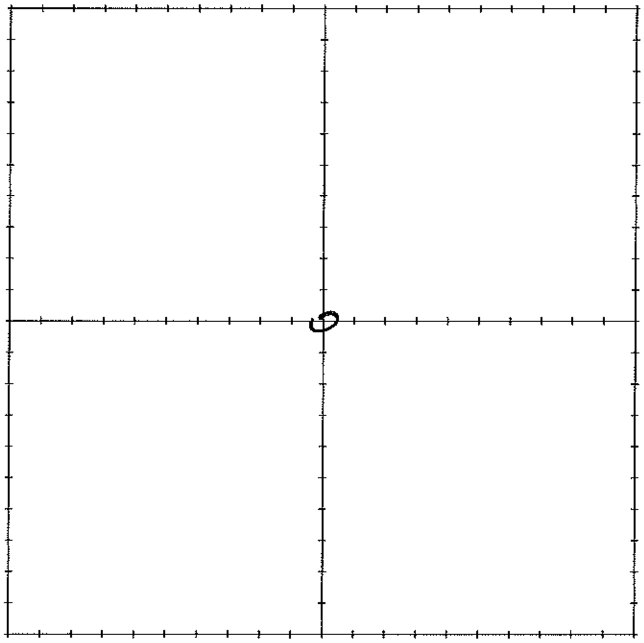
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S220-CX-002

SAMPLE I.D. S220-CX-002

SAMPLE COLLECTION DATE 4/15/17

SAMPLE COLLECTION TIME 0957

SAMPLE COLLECTED BY HW/LR

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine grained, poorly sorted, very fine, Dry

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

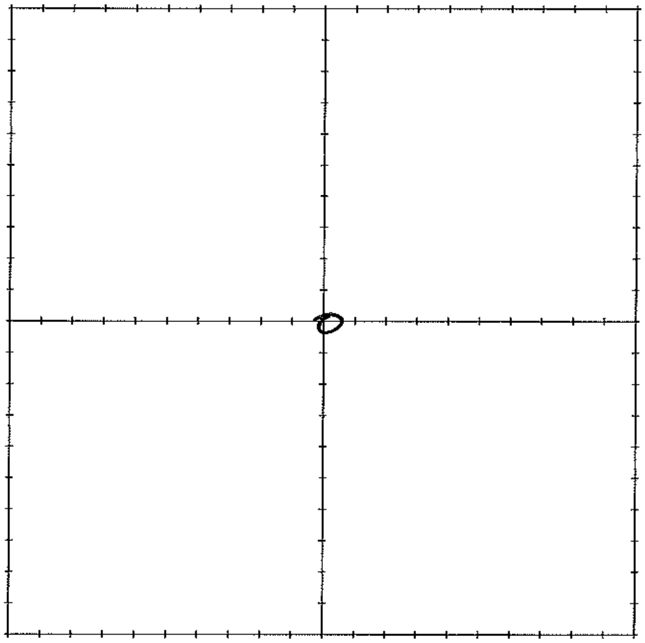
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziplocs

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S063-LX-003, 203

SAMPLE I.D. S063-LX-003

SAMPLE COLLECTION DATE 4/15/17

SAMPLE COLLECTION TIME 1020

SAMPLE COLLECTED BY HW/LR

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS AML cover material, fine red sand poorly graded

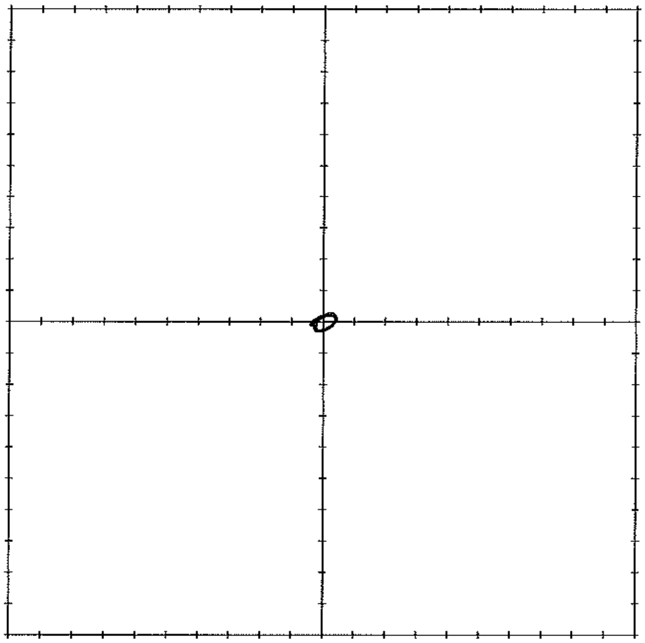
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S063-LX-004

SAMPLE I.D. S063-LX-004

SAMPLE COLLECTION DATE 4/15/17

SAMPLE COLLECTION TIME 1048

SAMPLE COLLECTED BY MW/LR

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Pewapwa SS unit, shaley grains, lt. gr green/tan, poorly graded

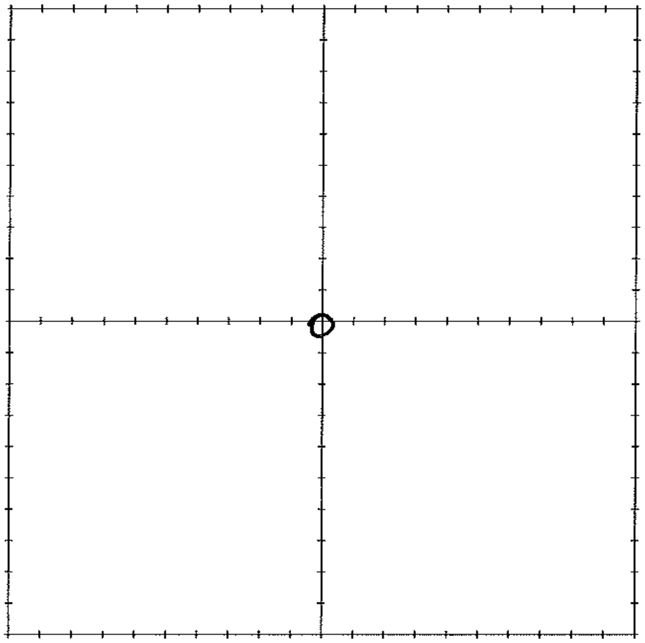
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S063-LX-005

SAMPLE I.D. S063-LX-005

SAMPLE COLLECTION DATE 4/15/17

SAMPLE COLLECTION TIME 1102

SAMPLE COLLECTED BY HW/LK

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine red sand, few to minor shaley grains, coarse sand, poorly graded

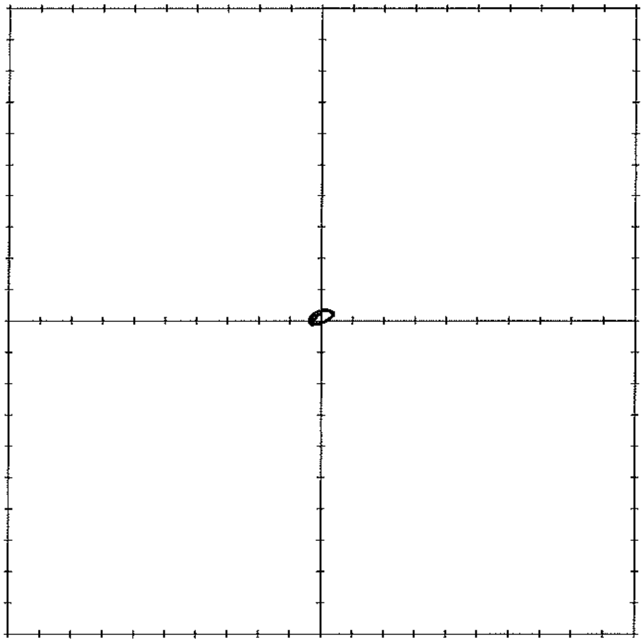
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziplock

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME NA-~~0904~~ 0928

SAMPLE I.D. ~~S059-cx~~ S063-cx-006

SAMPLE COLLECTION DATE ~~1129~~ 4/15/17

SAMPLE COLLECTION TIME 1129

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS Sunny

FIELD USCS DESCRIPTIONS Fine silty sand poorly graded Brownish Yellow

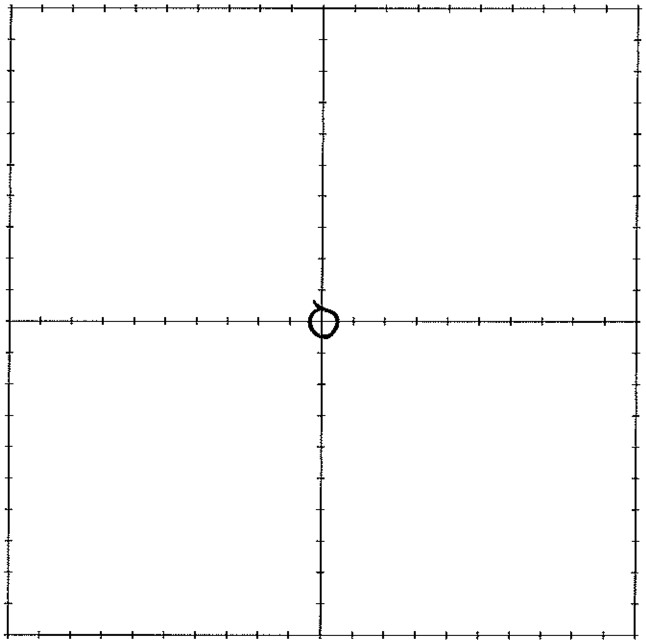
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziplock bags

ANALYSES: RA226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S220-CX-007

SAMPLE I.D. S220-CX-007

SAMPLE COLLECTION DATE 4/15/17

SAMPLE COLLECTION TIME 1133

SAMPLE COLLECTED BY HW/LR

WEATHER CONDITIONS ~~Fine tan/red sand, poorly graded~~ 70's, sunny

FIELD USCS DESCRIPTIONS Fine tan/red sand, poorly graded

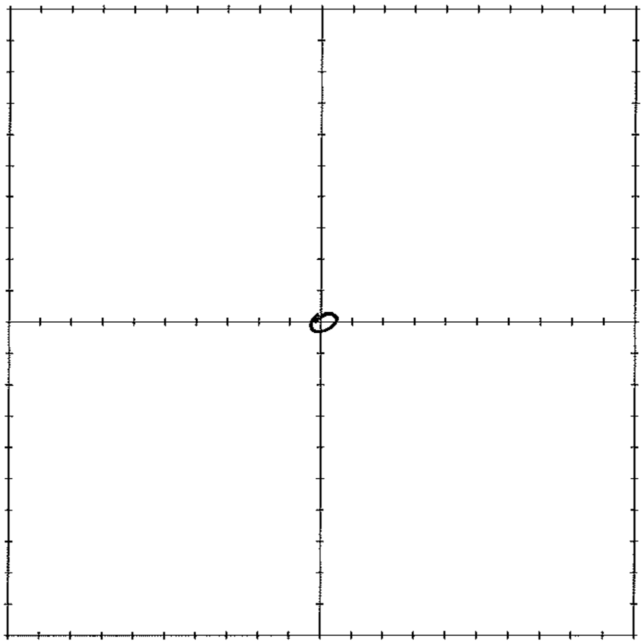
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziploc

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

MWH

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME NA-~~0904~~ 0928

SAMPLE I.D. ~~S059-CX~~ S063-CX-008

SAMPLE COLLECTION DATE 4/15/17

SAMPLE COLLECTION TIME 1206

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS Sunny

FIELD USCS DESCRIPTIONS Red Silty Sand with trace gravels

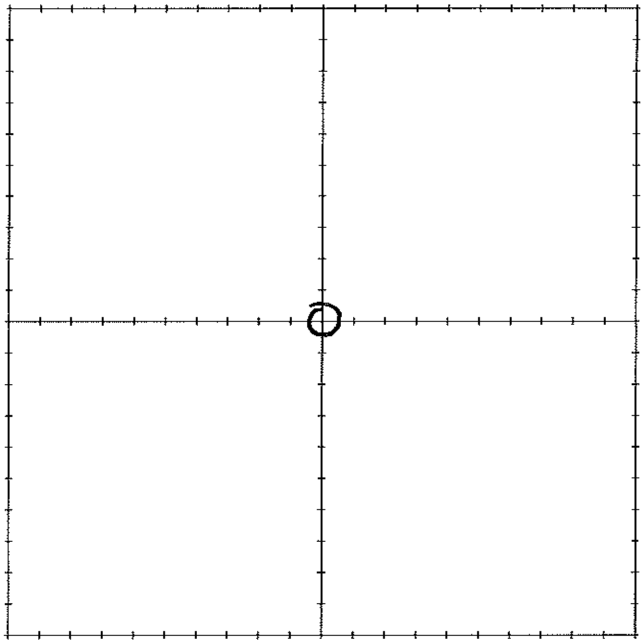
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☑ SM ☐ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziplock bags

ANALYSES: RA226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME ~~NA-0904~~ NA-0928

SAMPLE I.D. ~~S059-CX~~ S063-CX-009

SAMPLE COLLECTION DATE 4/15/17

SAMPLE COLLECTION TIME 1225

SAMPLE COLLECTED BY C. Lee

WEATHER CONDITIONS Sunny

FIELD USCS DESCRIPTIONS Red silty sand, poorly graded, odorless, Dry

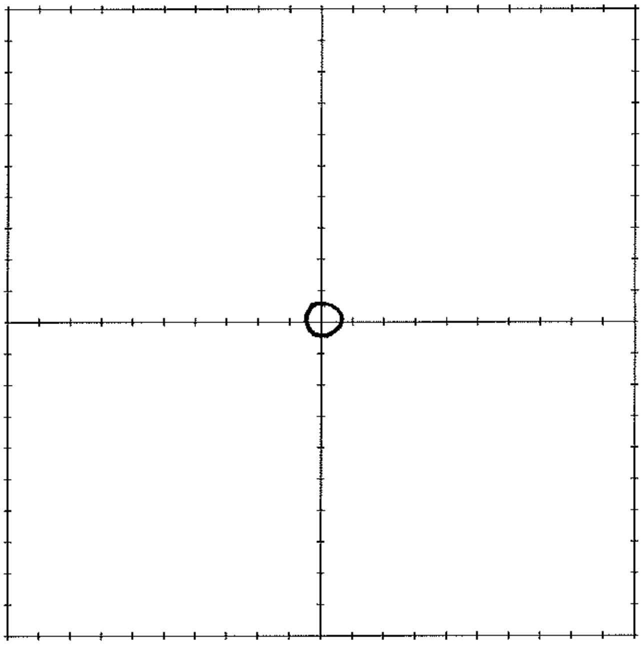
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☑ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziplock bags

ANALYSES: RA226, metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

SURFACE SOIL SAMPLE LOG FORM

AREA #/NAME S063-LX-010

SAMPLE I.D. S063-LX-010

SAMPLE COLLECTION DATE 4/15/17

SAMPLE COLLECTION TIME 1155

SAMPLE COLLECTED BY NW/LA

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine tan/light brown sand, 5-10% angular white frags (1/8"-3/4")

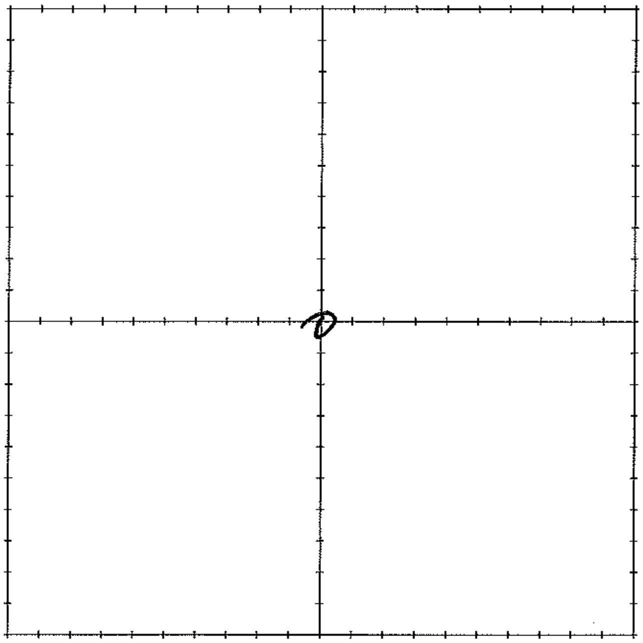
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☒ SP ☐ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☒ DRY ☐ MOIST ☐ WET

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 S063-CX-011

SAMPLE I.D. S063-CX-011

SAMPLE COLLECTION DATE 4/15/17

SAMPLE COLLECTION TIME 1227

SAMPLE COLLECTED BY HW/LK

WEATHER CONDITIONS 70's, sunny

FIELD USCS DESCRIPTIONS Fine-tan sand none to few subangular gravel, fine to coarse sand

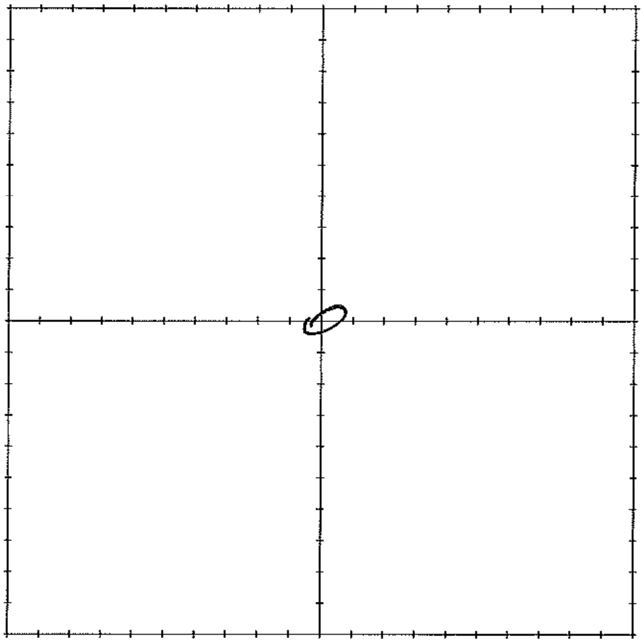
MAJOR DIVISIONS: ☐ OH ☐ CH ☐ MH ☐ OH ☐ CL ☐ ML ☐ SC
☐ SM ☐ SP ☒ SW ☐ GC ☐ GM ☐ GP ☐ GW

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

MOISTURE: ☑ DRY ☐ MOIST ☐ WET

SAMPLE CONTAINERS (NUMBER AND TYPE) 2 ziplock

ANALYSES: Ra-226, Metals



MARK INDIVIDUAL GRAB SAMPLE LOCATIONS IN GRID

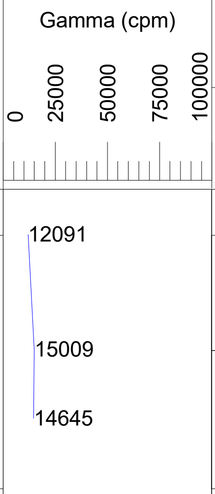
MWH

C.2 Drilling and Hand Auger Borehole Logs

BOREHOLE ID: **S059-SCX-002 (BG-1)**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0904

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: 650536.5 NORTHING: 4084639.09
DATE STARTED: 10/11/2016 DATE STARTED: 10/11/2016
TOTAL DEPTH (ft.): 1.1 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Luis Rodriguez



DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION	SUBSURFACE SAMPLE INFORMATION SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	▒	SILTY SAND (SM)	S059-SCX-002-1	0-0.5	grab	3.23
	▒		S059-SCX-002-2	0.5-1.1	grab	4.12
1		Terminated hand auger borehole at 1.1 ft. below ground surface. Terminated due to caving sands in borehole.				
2						
3						
4						
5						

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

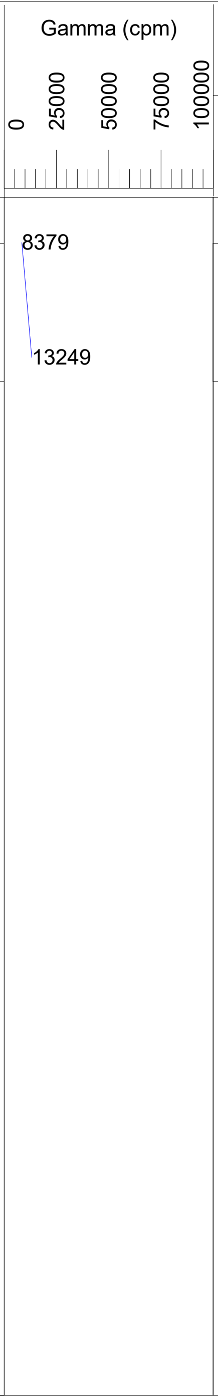
Stantec

NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S059-SCX-001 (BG-2)**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0904

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: 650513.05 NORTHING: 4084630.51
DATE STARTED: 10/11/2016 DATE STARTED: 10/11/2016
TOTAL DEPTH (ft.): 0.6 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Luis Rodriguez



SUBSURFACE SAMPLE INFORMATION

DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION	SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	▥	SANDY SILT (ML)	S059-SCX-001-1	0-0.6	grab	1.26
		Terminated hand auger borehole at 0.6 ft. below ground surface. Refusal on bedrock.				
1						
2						
3						
4						
5						

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

Stantec

NAVAJO NATION
AUM Environmental Response Trust-First Phase

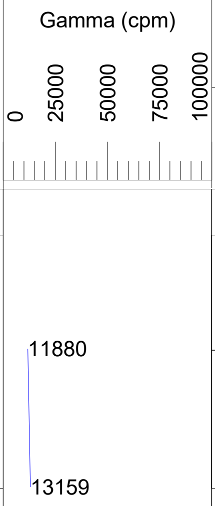
BOREHOLE ID: **S059-SCX-003 (BG-3)**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0904

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: 651152.99 NORTHING: 4085166.31
DATE STARTED: 10/11/2016 DATE STARTED: 10/11/2016
TOTAL DEPTH (ft.): 1.1 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Luis Rodriguez

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED SAND (SP): red, dry.
1.1	Terminated hand auger borehole at 1.1 ft. below ground surface. Reason for termination unknown.

Depth scale: 0, 1, 2, 3, 4, 5



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S059-SCX-003-1	0-0.5	grab	0.62
S059-SCX-003-2	0.5-1.1	grab	0.60

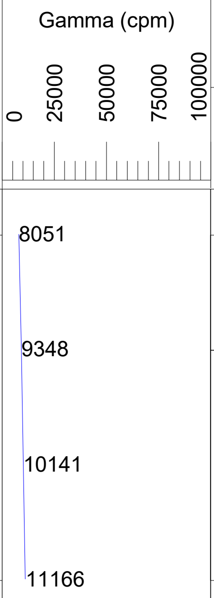
Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

BOREHOLE ID: **S059-BG4-011**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0904

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: 651150.09 NORTHING: 4085278.11
DATE STARTED: 9/14/2017 DATE STARTED: 9/14/2017
TOTAL DEPTH (ft.): 1.5 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Michael Ward

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED SAND WITH GRAVEL (SP), weak red (2.5 YR 5/4) fine to coarse sand 85%, dry loose, gravels are angular to subangular with trace white color. Borehole located in drainage
1.5	Terminated hand auger borehole at 1.5 ft. Refusal on hard rock.



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S059-BG4-011-01	0-0.5	grab	0.71
S059-BG4-011-02	0.5-1.5	grab	0.70

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

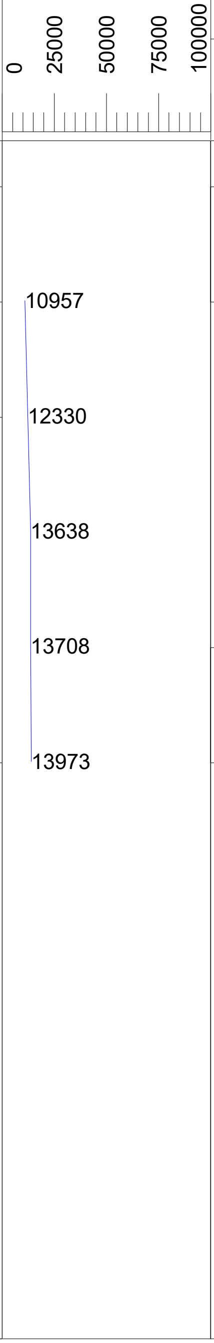
BOREHOLE ID: **S063-SCX-001**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

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: 650737.83 NORTHING: 4086081.65
DATE STARTED: 4/15/2017 DATE STARTED: 4/15/2017
TOTAL DEPTH (ft.): 2.5 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn

DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION
0		POORLY GRADED SAND WITH SILT (SP): red, dry, trace gravel, gravels are 0.25 inch to 2.0 inches in diameter.
		WELL GRADED SAND WITH GRAVEL (SW): moist, gravels are 0.25 inch to 1.0 inch.
1		POORLY GRADED SAND WITH SILT (SP): red, moist, fine sands, trace gravel.
2		
		Terminated hand auger borehole at 2.5 ft. below ground surface; gamma measurements recorded below initial background level. No refusal.
3		
4		
5		

Gamma (cpm)



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S063-SCX-001-01 S063-SCX-201-01	0-0.5	grab	0.72 0.91
S063-SCX-001-02	2-2.5	grab	0.47

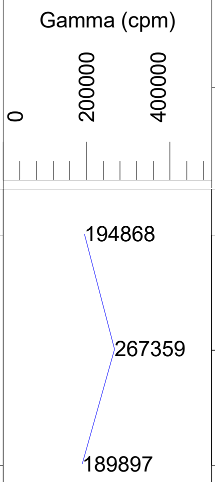
Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

BOREHOLE ID: **S063-SCX-002**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

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: 650641.64 NORTHING: 4086133.15
DATE STARTED: 4/15/2017 DATE STARTED: 4/15/2017
TOTAL DEPTH (ft.): 1 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED GRAVEL WITH SAND (GP): green, tan, dry, gravels are 0.25 inch to 1.0 inch in diameter, gravels are shale.
1	Terminated hand auger borehole at 1 ft. below ground surface. Refusal on hard surface or rock.



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S063-SCX-002-01	0-0.5	grab	175.00
S063-SCX-002-02	0.5-1	grab	71.20

Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

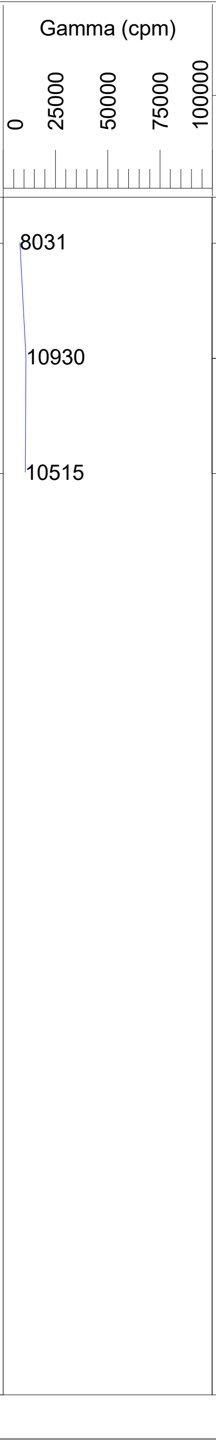
Stantec

NAVAJO NATION
AUM Environmental Response Trust - First Phase

BOREHOLE ID: **S063-SCX-003**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

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: 650564.56
NORTHING: 4086031.84
DATE STARTED: 4/15/2017
DATE STARTED: 4/15/2017
TOTAL DEPTH (ft.): 1
BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn



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 (SP): brown, fine sand, trace gravels, dry.	S063-SCX-003-01	0-0.5	grab	1.78
			S063-SCX-003-02	0.5-1	grab	1.97
1		Terminated hand auger borehole at 1 ft. below ground surface. Refusal on hard surface or rock.				
2						
3						
4						
5						

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

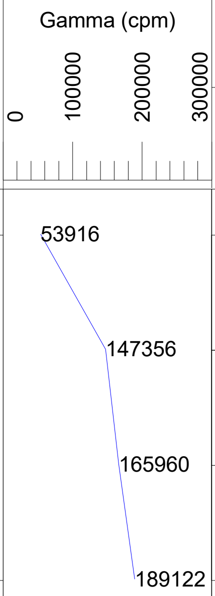
Stantec

NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S063-SCX-004**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

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: 650684.17 NORTHING: 4086256.44
DATE STARTED: 4/17/2017 DATE STARTED: 4/17/2017
TOTAL DEPTH (ft.): 1.5 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn



SUBSURFACE SAMPLE INFORMATION

DEPTH (feet)	LITHOLOGICAL GRAPHIC	LITHOLOGICAL DESCRIPTION	SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	▨	CLAYEY SAND (SC): tan, green, dry.	S063-SCX-004-01	0-0.5	grab	52.50
	▨		S063-SCX-004-02	0.5-1	grab	41.50
1	▨		S063-SCX-004-03	1-1.5	grab	105.00
		Terminated hand auger borehole at 1.5 ft. below ground surface. Refusal on hard surface or rock.				
2						
3						
4						
5						

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

Stantec

NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S063-SCX-005**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

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: 650611.76 NORTHING: 4086312.09
DATE STARTED: 4/17/2017 DATE STARTED: 4/17/2017
TOTAL DEPTH (ft.): 0.5 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn

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 (SP): light red, tan, dry, trace coarse sand.	7685	S063-SCX-005-01	0-0.5	grab	1.87
		Terminated hand auger borehole at 0.5 ft. below ground surface. Refusal on hard surface or rock.	8725				
1							
2							
3							
4							
5							

Notes: cpm = counts per minute
pCi/g = picocuries per gram

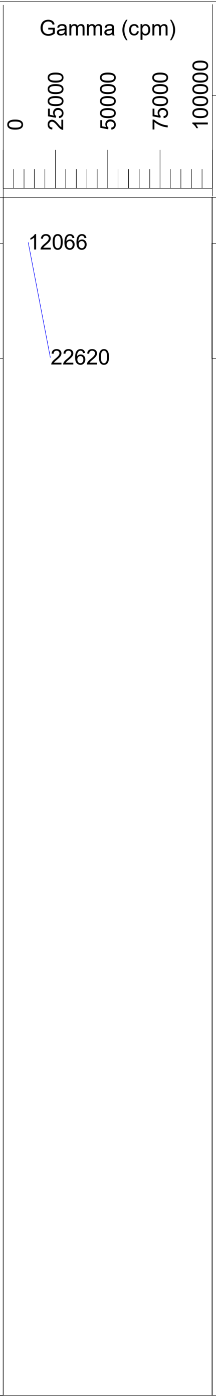
grab = grab sample
comp = composite sample

- - - - = approximate contact

BOREHOLE ID: **S063-SCX-006**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

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: 650666.54 NORTHING: 4086402.3
DATE STARTED: 4/17/2017 DATE STARTED: 4/17/2017
TOTAL DEPTH (ft.): 0.5 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn



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 (SP): light brown, red, dry, trace gravels, gravels are 0.5 inches to 2.0 inches in diameter, subrounded.	S063-SCX-006-01	0-0.5	grab	4.12
		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

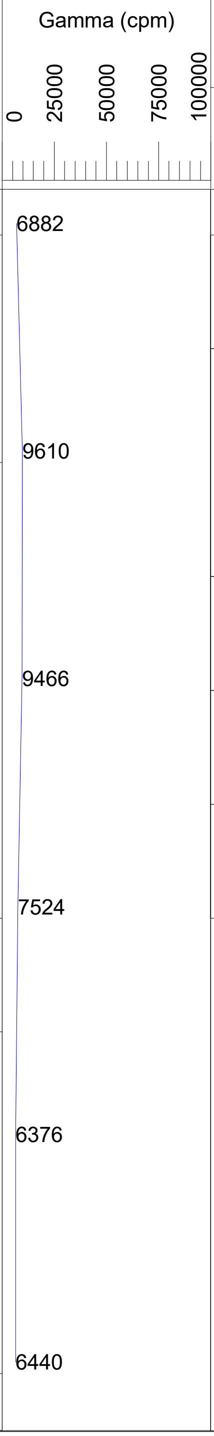
NAVAJO NATION
AUM Environmental Response Trust - First Phase

BOREHOLE ID: **S063-SCX-008**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD: Rotary Sonic
DRILLING EQUIPMENT: Geoprobe 8140LC
SAMPLING METHOD: Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 650817.12 NORTHING: 4086218.25
DATE STARTED: 6/3/2017 DATE STARTED: 6/3/2017
TOTAL DEPTH (ft.): 5 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED SAND (SP): red (2.5YR 5/8), sand 90%, gravel 5%, fines 5%, dry.
1	moist.
3	SANDSTONE: pale red (2.5YR 7/2) weathered bedrock. Fine sand and broken rock due to the vibration from the sonic rig. pale red (2.5YR 7/2).
3.5	SANDSTONE: white (2.5YR 7/2), becoming hard, fresh, cross bedded, fine grained sand matrix, calcium carbonate cement.
5	Terminated borehole at 5 ft. below ground surface in bedrock.



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S063-SCX-008-001	0-0.5	grab	0.49
S063-SCX-008-002	0.5-1.5	grab	0.71
S063-SCX-008-003	1.5-2	grab	0.62
S063-SCX-008-004	2-2.5	grab	0.96
S063-SCX-008-005	2.5-3	grab	0.85

Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

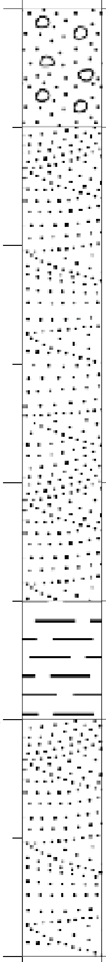
Stantec

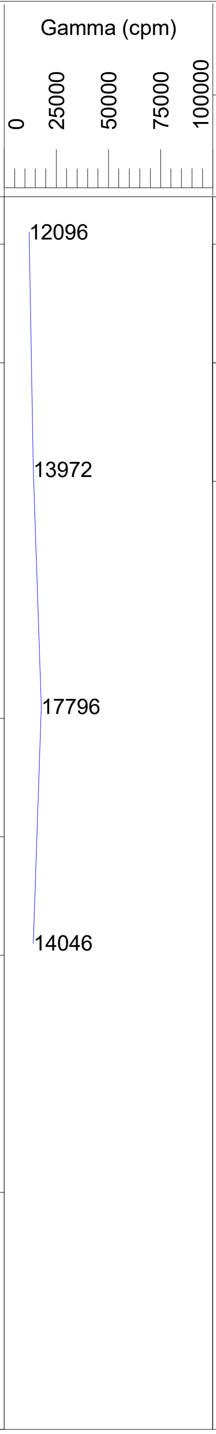
NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S063-SCX-009**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD: Rotary Sonic
DRILLING EQUIPMENT: Geoprobe 8140LC
SAMPLING METHOD: Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 650830.45 NORTHING: 4086232.98
DATE STARTED: 6/3/2017 DATE STARTED: 6/3/2017
TOTAL DEPTH (ft.): 4 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn





DEPTH (feet)	LITHOLOGICAL DESCRIPTION	SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	POORLY GRADED GRAVEL WITH SAND (GP): red (2.5YR 4/4), with little fines, dry.	S063-SCX-009-001	0-0.5	grab	4.36
	SANDSTONE: white, fine grained, cross bedded.	S063-SCX-009-002	0.5-1	grab	1.85
1					
2	light green, yellow, interbedded, mottled, calcium carbonate cement.				
	CLAYSTONE: dark red, bedded.				
3	SANDSTONE: white, fine grained, cross bedded, calcium carbonate cement.				
4	Terminated borehole at 4 ft. below ground surface in bedrock.				
5					

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

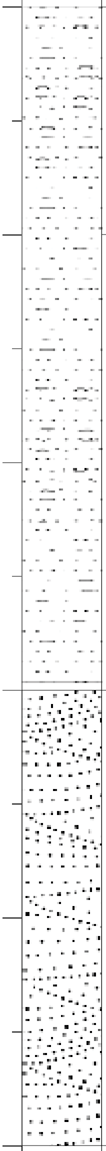
BOREHOLE ID: **S063-SCX-010**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD: Rotary Sonic
DRILLING EQUIPMENT: Geoprobe 8140LC
SAMPLING METHOD: Sonic Core Barrel, 4 inch diameter

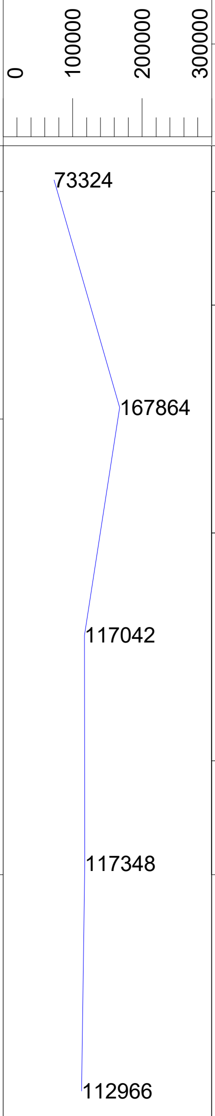
COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 650752.44 NORTHING: 4086196.87
DATE STARTED: 6/3/2017 DATE STARTED: 6/3/2017
TOTAL DEPTH (ft.): 5 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED GRAVEL WITH SAND (GP): weak red (10R 5/3), gravel 65%, sand 30%, fines 5%, subangular, 0.25 inch to 4 inch diameter.
1	pale red (10YR 7/4).
2	
3	SANDSTONE: white, fine grained, subrounded sand grains, calcium carbonate cement.
4	
5	Terminated borehole at 5 ft. below ground surface in bedrock.

LITHOLOGICAL GRAPHIC



Gamma (cpm)



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S063-SCX-010-001	0-0.5	grab	93.00
S063-SCX-010-002	0.5-1.5	grab	106.00
S063-SCX-010-003	1.5-2.5	grab	49.80
S063-SCX-010-004	2.5-3	grab	94.00

Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

Stantec

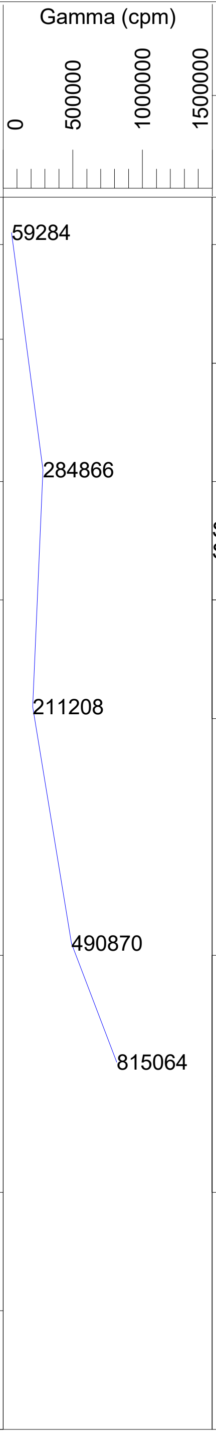
NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S063-SCX-011**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD: Rotary Sonic
DRILLING EQUIPMENT: Geoprobe 8140LC
SAMPLING METHOD: Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 650760.12 NORTHING: 4086198.66
DATE STARTED: 6/3/2017 DATE STARTED: 6/3/2017
TOTAL DEPTH (ft.): 4.5 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED GRAVEL (GP): pale red (2.5YR 7/3), subangular, 0.5 inch to 2 inch diameter.
	POORLY GRADED SAND WITH GRAVEL (SP): pale red (2.5YR 7/3), fine sands, subrounded, dry.
1	POORLY GRADED GRAVEL WITH SAND (GP): (10R 7/2), subangular to subrounded, dry.
	SANDSTONE: (7.5YR 7/2), boulder, white, fine grained, calcium carbonate cement.
2	
3	SHALE: brown, highly weathered.
4	SANDSTONE: gray (10YR 6/2), fine grained, calcium carbonate cement.
	Terminated borehole at 4.5 ft. below ground surface in bedrock.
5	



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S063-SCX-011-001	0-0.5	grab	51.40
S063-SCX-011-002	0.5-1	grab	53.90
S063-SCX-011-003 S063-SCX-011-203	1-1.5	grab	97.00 76.20
S063-SCX-011-004	1.5-2	grab	137.00
S063-SCX-011-005	3-4	grab	70.00

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

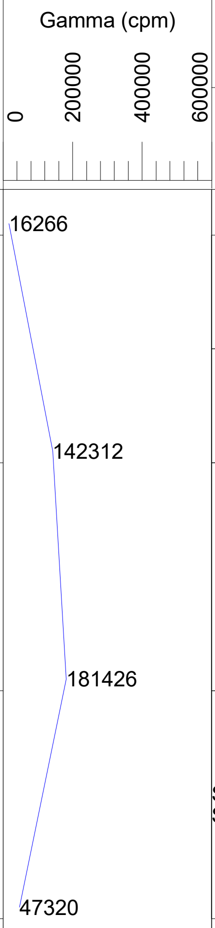
BOREHOLE ID: **S063-SCX-012**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD: Rotary Sonic
DRILLING EQUIPMENT: Geoprobe 8140LC
SAMPLING METHOD: Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 650762.22 NORTHING: 4086201.53
DATE STARTED: 6/4/2017 DATE STARTED: 6/4/2017
TOTAL DEPTH (ft.): 3.5 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0–1	POORLY GRADED SAND (SP): red (5YR 6/6), dry, trace gravel, minor grass and organics.
1–2	SILTY SAND WITH GRAVEL (SM): light red brown (7.5YR 6/4), gravels are subangular to subrounded, gravels are 0.25 inch to 2 inch diameter, dry.
2–3	light brown (7.5YR 6/3).
3–3.5	SANDSTONE: white, fine grained.
3.5	Terminated borehole at 3.5 ft. below ground surface in bedrock.

Gamma (cpm)



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S063-SCX-012-001	0-0.5	grab	11.40
S063-SCX-012-002	0.5-1	grab	10.70
S063-SCX-012-003	1-2	grab	22.70
S063-SCX-012-004 S063-SCX-012-204	2-3	grab	163.00 152.00

Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

Stantec

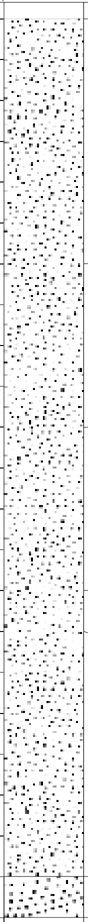
NAVAJO NATION
AUM Environmental Response Trust-First Phase

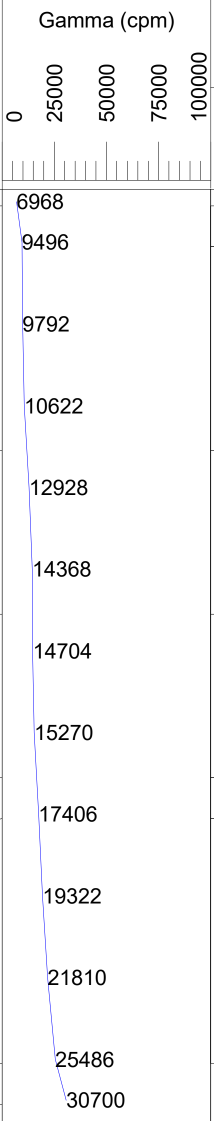
BOREHOLE ID:	**S063-SCX-013**
CLIENT:	NNAUMERT
PROJECT:	Removal Site Evaluation
SITE LOCATION:	NA-0928

DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD: Rotary Sonic
DRILLING EQUIPMENT: Geoprobe 8140LC
SAMPLING METHOD: Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 650746.28 NORTHING: 4086274.53
DATE STARTED: 6/4/2017 DATE STARTED: 6/4/2017
TOTAL DEPTH (ft.): 11 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED SAND (SP): red (5YR 5/6), fine sand, contains calcium carbonate.
3	red (2.5YR 6/4), minor calcite staining.
5	red (2.5YR 6/6).
7	POORLY GRADED SAND AND SILT (SP-SM): gray (10R 6/2).
7.5	POORLY GRADED SAND (SP): red (2.5YR 6/6), fine sand.
10.5	SANDSTONE: white, fine grained, massive.
11	Terminated borehole at 11 ft. below ground surface in bedrock.





SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE		LAB RESULTS RA-226 (pCi/g)
S063-SCX-013-001	0-0.5	grab	🟨	1.16
S063-SCX-013-002	0.5-3	comp	🟧	0.84
S063-SCX-013-003	3-5	comp	🟧	0.81
S063-SCX-013-004	5-7	comp	🟧	0.51
S063-SCX-013-005	7-7.5	grab	🟨	0.50
S063-SCX-013-006	7.5-10.5	comp	🟧	0.84

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

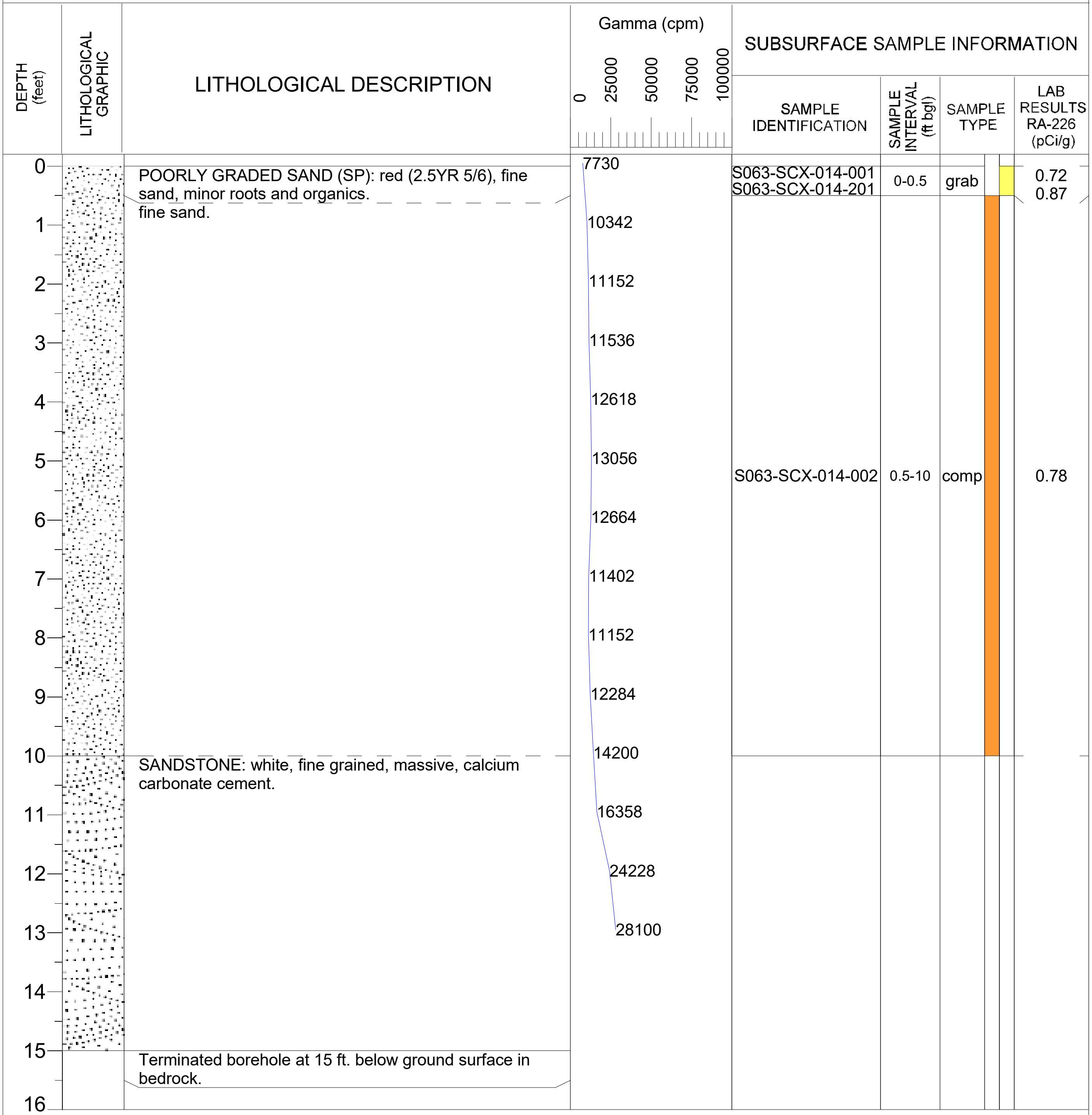
Stantec

NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S063-SCX-014**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD: Rotary Sonic
DRILLING EQUIPMENT: Geoprobe 8140LC
SAMPLING METHOD: Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 650753.25 NORTHING: 4086281.77
DATE STARTED: 6/4/2017 DATE STARTED: 6/4/2017
TOTAL DEPTH (ft.): 15 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn



Depth (feet)	Lithological description
0	POORLY GRADED SAND (SP): red (2.5YR 5/6), fine sand, minor roots and organics. fine sand.
10	SANDSTONE: white, fine grained, massive, calcium carbonate cement.
15	Terminated borehole at 15 ft. below ground surface in bedrock.

Depth (feet)	Gamma (cpm)
0	7730
1	10342
2	11152
3	11536
4	12618
5	13056
6	12664
7	11402
8	11152
9	12284
10	14200
11	16358
12	24228
13	28100

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S063-SCX-014-001 S063-SCX-014-201	0-0.5	grab	0.72 0.87
S063-SCX-014-002	0.5-10	comp	0.78

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: **S063-SCX-015**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD: Rotary Sonic
DRILLING EQUIPMENT: Geoprobe 8140LC
SAMPLING METHOD: Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 650744.84 NORTHING: 4086283.19
DATE STARTED: 6/4/2017 DATE STARTED: 6/4/2017
TOTAL DEPTH (ft.): 11.5 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn

DEPTH (feet)

LITHOLOGICAL GRAPHIC

LITHOLOGICAL DESCRIPTION

POORLY GRADED SAND (SP): red (2.5YR 5/6), fine sand, loose, dry, minor roots and organics.
becoming dense, trace organic debris.

SANDSTONE: boulder, white, fine grained.

POORLY GRADED SAND WITH GRAVEL (SP): light brown (5YR 7/3), sands 70%, gravel 30%, subangular, dry, gravels are 0.25 inch to 2 inch in diameter.

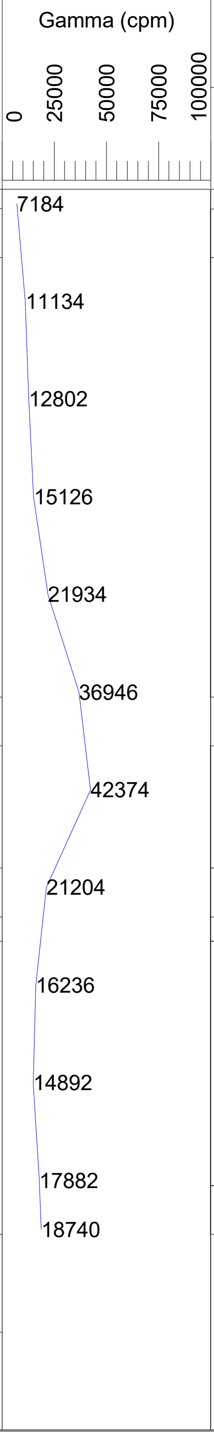
POORLY GRADED SAND (SP): red (2.5YR 6/4), fine sand.

SILTY SAND (SM): tan.

POORLY GRADED SAND (SP): red (2.5YR 5/6), fine sand.

SANDSTONE: white, fine grained.

Terminated borehole at 11.5 ft. below ground surface in bedrock.



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S063-SCX-015-001	0-0.5	grab	0.72
S063-SCX-015-002	0.5-5	comp	0.73
S063-SCX-015-003	5.5-6.75	comp	9.50
S063-SCX-015-004	6.75-7.25	grab	0.78
S063-SCX-015-005	7.25-7.5	grab	0.92
S063-SCX-015-006	7.5-10	comp	0.43
S063-SCX-015-007	10-10.5	grab	2.18

Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

Stantec

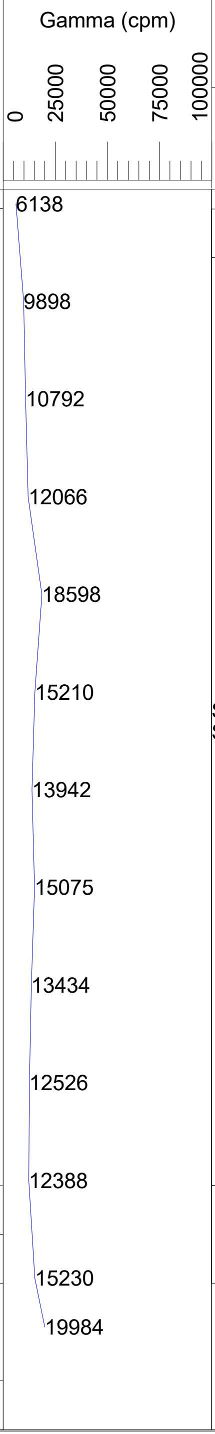
NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S063-SCX-016**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD: Rotary Sonic
DRILLING EQUIPMENT: Geoprobe 8140LC
SAMPLING METHOD: Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 650743.57
NORTHING: 4086291.39
DATE STARTED: 6/4/2017
DATE STARTED: 6/4/2017
TOTAL DEPTH (ft.): 12
BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0–10	POORLY GRADED SAND (SP): red (2.5YR 5/6), fine sand, sand 100%, loose, dry.
10–10.5	gray (5YR 6/2), very fine sand.
10.5–11	red (2.5YR 5/6), fine sand.
11–12	SANDSTONE: white, fine grained, massive, calcium carbonate cement.
12	Terminated borehole at 12 ft. below ground surface in bedrock.



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S063-SCX-016-001	0-0.5	grab	0.00
S063-SCX-016-002 S063-SCX-016-202	0.5-10	comp	0.52 0.51
S063-SCX-016-003	10-11	grab	0.38

Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

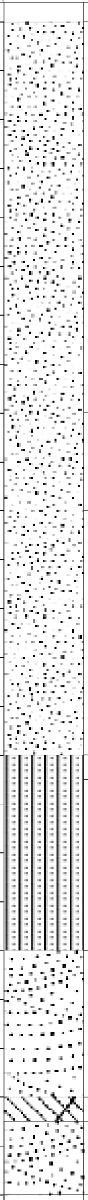
Stantec

NAVAJO NATION
AUM Environmental Response Trust-First Phase

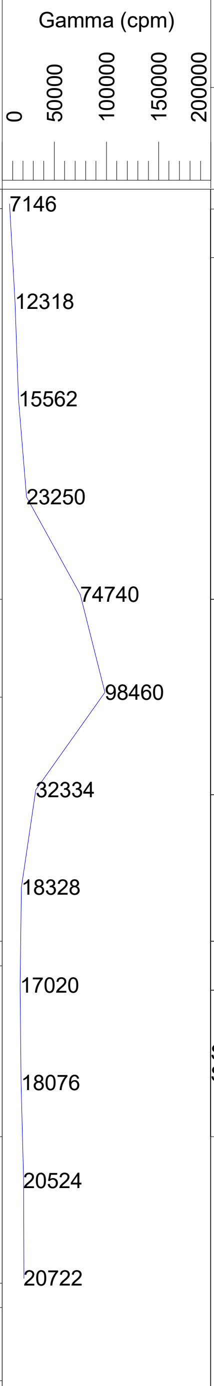
BOREHOLE ID: **S063-SCX-017**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD: Rotary Sonic
DRILLING EQUIPMENT: Geoprobe 8140LC
SAMPLING METHOD: Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 650739.47 NORTHING: 4086280.93
DATE STARTED: 6/4/2017 DATE STARTED: 6/4/2017
TOTAL DEPTH (ft.): 12 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn



DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED SAND (SP): red (2.5YR 5/6), fine sand, loose, dry, trace grass and organic debris.
4	red (2.5YR 5/6), fine to medium grained sand, slight dense, dry.
5	moderately dense.
7.5	SILTY SAND (SM): green gray (5B 5/1), fine sands.
7.75	red (2.5YR 5/6), fine sand.
9.5	SANDSTONE: white, fine grained.
11	SHALE: gray.
11.25	SANDSTONE: white, fine grained.
12	Terminated borehole at 12 ft. below ground surface in bedrock.



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S063-SCX-017-001	0-0.5	grab	0.64
S063-SCX-017-002	0.5-4	comp	0.57
S063-SCX-017-003	4-6	comp	27.40
S063-SCX-017-004	6-7.5	comp	0.55
S063-SCX-017-005	7.5-8	grab	1.02
S063-SCX-017-006 S063-SCX-017-206	8-9.5	comp	0.67 0.57

Notes: cpm = counts per minute
pCi/g = picocuries per gram

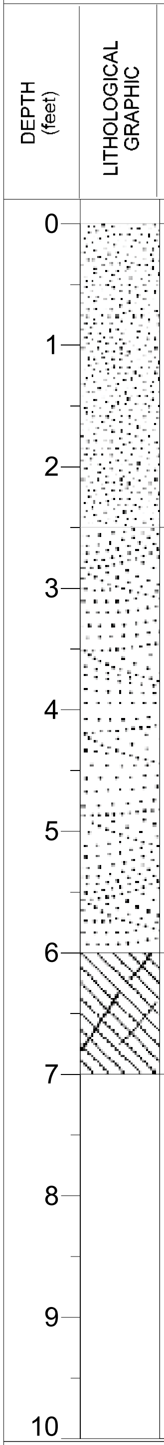
grab = grab sample
comp = composite sample

- - - - = approximate contact

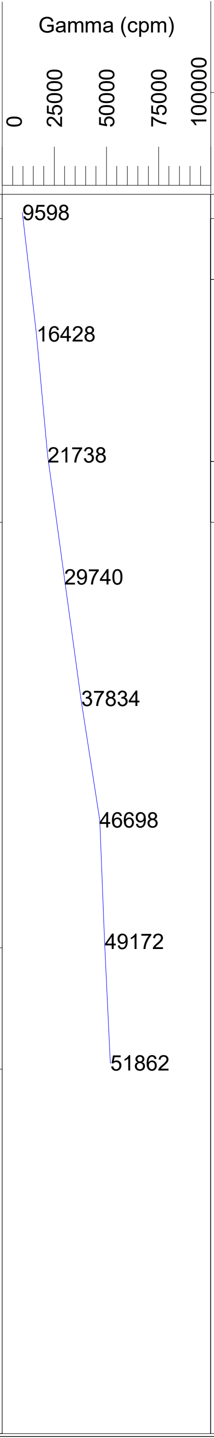
BOREHOLE ID:	**S063-SCX-018**
CLIENT:	NNAUMERT
PROJECT:	Removal Site Evaluation
SITE LOCATION:	NA-0928

DRILLING CONTRACTOR:	Cascade Drilling
DRILLING METHOD:	Rotary Sonic
DRILLING EQUIPMENT:	Geoprobe 8140LC
SAMPLING METHOD:	Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM:		NAD 1983 UTM Zone 12N	
EASTING:	650706.93	NORTHING:	4086275.26
DATE STARTED:	6/4/2017	DATE STARTED:	6/4/2017
TOTAL DEPTH (ft.):	7	BOREHOLE ANGLE:	90 degrees
LOGGED BY:	Tom Osborn		



DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED SAND (SP): red (2.5YR 5/6), fine sand.
2.5	SANDSTONE: with small interbedded shale, white, fine grained, shale lenses are green.
6	SHALE: brown, thinly laminated, mottled.
7	Terminated borehole at 7 ft. below ground surface in bedrock.



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE		LAB RESULTS RA-226 (pCi/g)
S063-SCX-018-001	0-0.5	grab	🟨	1.92
S063-SCX-018-002	0.5-2	comp	🟧	2.03
S063-SCX-018-003	2-2.5	grab	🟨	1.39

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

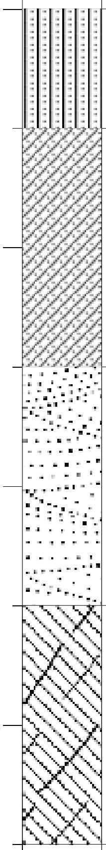
BOREHOLE ID: **S063-SCX-019**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

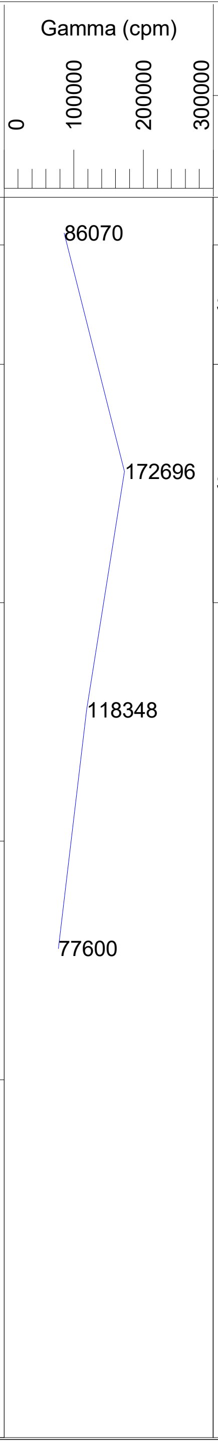
DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD: Rotary Sonic
DRILLING EQUIPMENT: Geoprobe 8140LC
SAMPLING METHOD: Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 650685.37 NORTHING: 4086256.31
DATE STARTED: 6/5/2017 DATE STARTED: 6/5/2017
TOTAL DEPTH (ft.): 3.5 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn

DEPTH (feet)	LITHOLOGICAL DESCRIPTION	SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
0	SILTY SAND (SM): gray (2.5YR 6/2), trace gravels, fines and clays, clays are green.	S063-SCX-019-001	0-0.5	grab	116.00
1	CLAYEY SAND (SC): light gray (5GY 5/1), with trace gravel.	S063-SCX-019-002	0.5-1.5	grab	50.60
2	SANDSTONE: white, fine grained, calcium carbonate cement.				
3	SHALE: brown, thinly laminated, laminations are wavy.				
4	Terminated borehole at 3.5 ft. below ground surface in bedrock.				
5					

LITHOLOGICAL GRAPHIC





Notes: cpm = counts per minute
pCi/g = picocuries per gram
grab = grab sample
comp = composite sample
- - - - = approximate contact

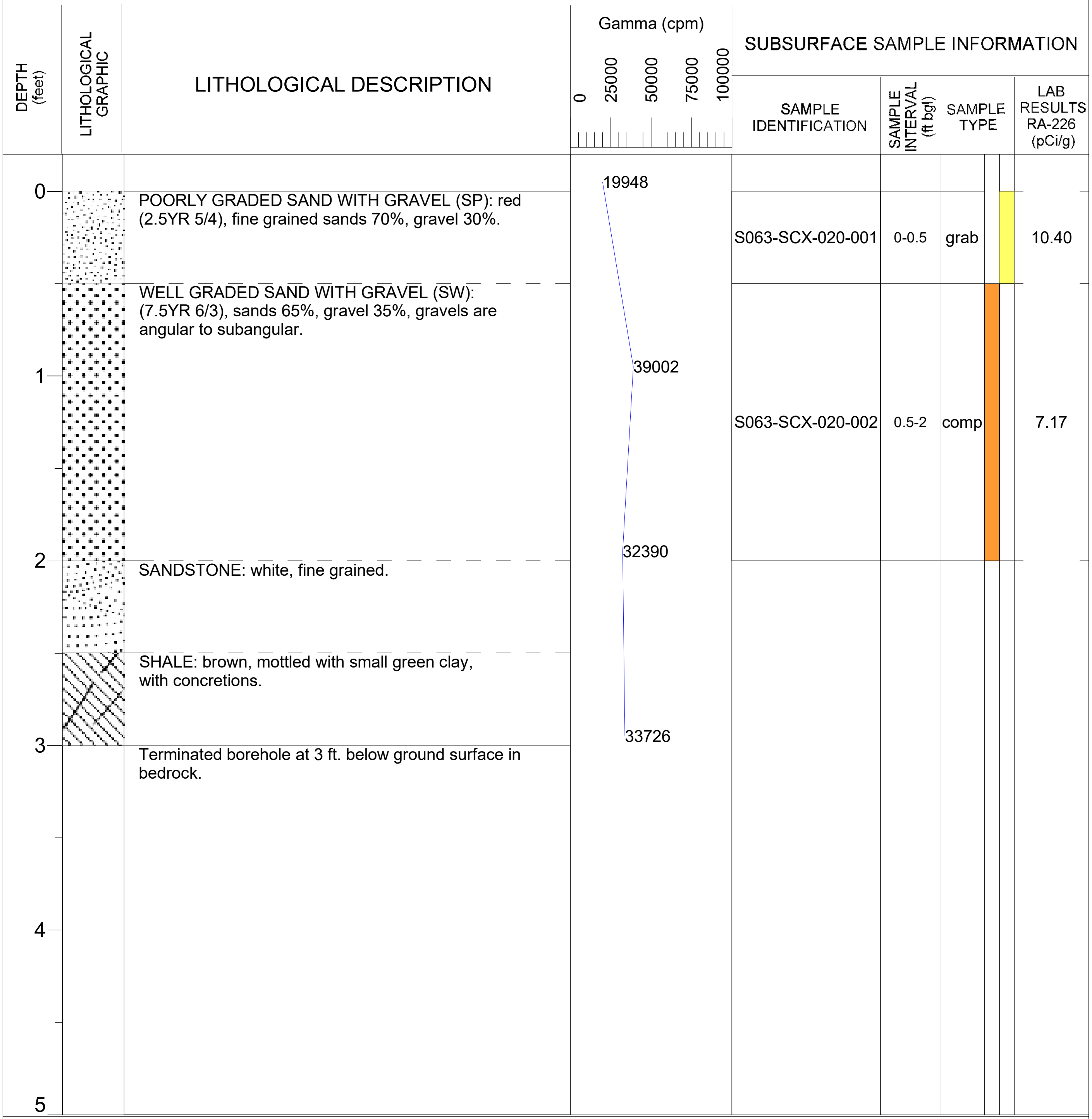
Stantec

NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S063-SCX-020**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD: Rotary Sonic
DRILLING EQUIPMENT: Geoprobe 8140LC
SAMPLING METHOD: Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 650672.62 NORTHING: 4086244.09
DATE STARTED: 6/5/2017 DATE STARTED: 6/5/2017
TOTAL DEPTH (ft.): 3 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn



LITHOLOGICAL DESCRIPTION

POORLY GRADED SAND WITH GRAVEL (SP): red (2.5YR 5/4), fine grained sands 70%, gravel 30%.

WELL GRADED SAND WITH GRAVEL (SW): (7.5YR 6/3), sands 65%, gravel 35%, gravels are angular to subangular.

SANDSTONE: white, fine grained.

SHALE: brown, mottled with small green clay, with concretions.

Terminated borehole at 3 ft. below ground surface in bedrock.

SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S063-SCX-020-001	0-0.5	grab	10.40
S063-SCX-020-002	0.5-2	comp	7.17

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

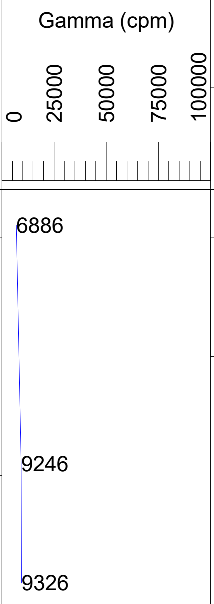
- - - - = approximate contact

BOREHOLE ID:	**S063-SCX-021**
CLIENT:	NNAUMERT
PROJECT:	Removal Site Evaluation
SITE LOCATION:	NA-0928

DRILLING CONTRACTOR:	Cascade Drilling
DRILLING METHOD:	Rotary Sonic
DRILLING EQUIPMENT:	Geoprobe 8140LC
SAMPLING METHOD:	Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM:		NAD 1983 UTM Zone 12N	
EASTING:	650674.72	NORTHING:	4086185.78
DATE STARTED:	6/5/2017	DATE STARTED:	6/5/2017
TOTAL DEPTH (ft.):	2	BOREHOLE ANGLE:	90 degrees
LOGGED BY:	Tom Osborn		

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED SAND (SP): red (5YR 5/6), fine sands.
1	SANDSTONE: white, fine grained.
2	Terminated borehole at 2 ft. below ground surface in bedrock.
3	
4	
5	



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S063-SCX-021-001	0-0.5	grab	0.92

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

Stantec

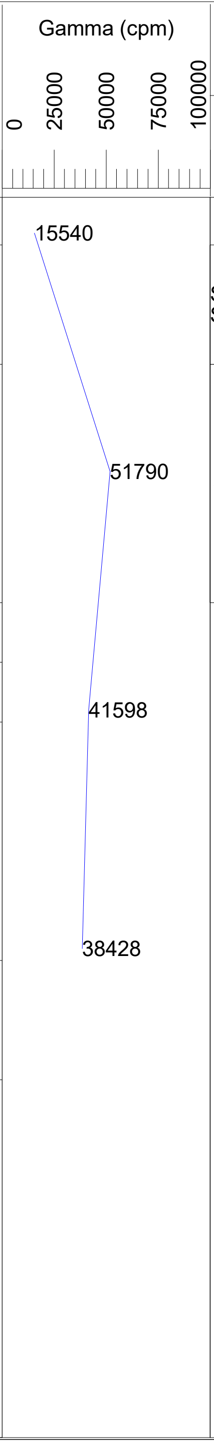
NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID:	**S063-SCX-022**
CLIENT:	NNAUMERT
PROJECT:	Removal Site Evaluation
SITE LOCATION:	NA-0928

DRILLING CONTRACTOR:	Cascade Drilling
DRILLING METHOD:	Rotary Sonic
DRILLING EQUIPMENT:	Geoprobe 8140LC
SAMPLING METHOD:	Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM:		NAD 1983 UTM Zone 12N	
EASTING:	650728.38	NORTHING:	4086179.27
DATE STARTED:	6/5/2017	DATE STARTED:	6/5/2017
TOTAL DEPTH (ft.):	3.5	BOREHOLE ANGLE:	90 degrees
LOGGED BY:	Tom Osborn		

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED SAND (SP): red (5YR 5/6), fine sands, dry.
0.5	POORLY GRADED GRAVEL AND SAND (GP): light red (2.5YR 5/4), 0.25 inch to 3 inch diameter, subangular to subrounded.
1.5	SHALE: pale green, thin laminations.
1.75	dark red, thin bedded with laminations.
2	SANDSTONE: white, fine grained, thinly bedded with laminations, with interbedded shale, thinly bedded shale.
3	SHALE: red and green, thin laminations.
3.5	Terminated borehole at 3.5 ft. below ground surface in bedrock.



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S063-SCX-022-001 S063-SCX-022-201	0-0.5	grab	1.03 1.24
S063-SCX-022-002	0.5-1.5	grab	16.6

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: **S063-SCX-023**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD: Rotary Sonic
DRILLING EQUIPMENT: Geoprobe 8140LC
SAMPLING METHOD: Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 650738.09 NORTHING: 4086271.3
DATE STARTED: 6/5/2017 DATE STARTED: 6/5/2017
TOTAL DEPTH (ft.): 11 BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn

DEPTH (feet) | LITHOLOGICAL GRAPHIC | LITHOLOGICAL DESCRIPTION

0 1 2 3 4 5 6 7 8 9 10 11 12

POORLY GRADED SAND (SP): red (5YR 5/6), fine sands, dry, minor grass and organics.

red (5YR 5/6), fine sands, dry.

becoming moderately dense.

red (5YR 5/6), fine sands, dry.

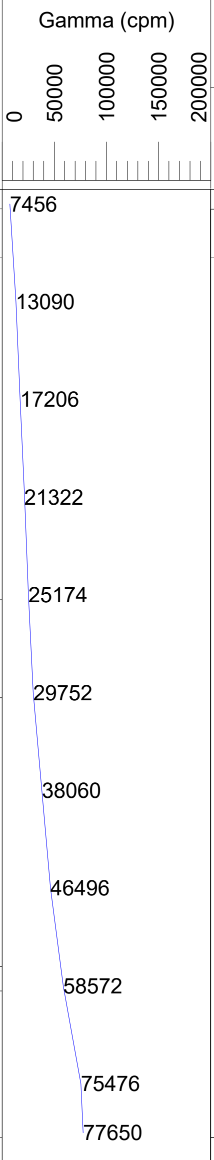
SANDSTONE: boulder or cobble, white.

POORLY GRADED SAND (SP): red (5YR 5/6), fine sands, dry.

SANDSTONE: brown, fine grained.

white, fine grained.

Terminated borehole at 11 ft. below ground surface in bedrock.



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE	LAB RESULTS RA-226 (pCi/g)
S063-SCX-023-001	0-0.5	grab	0.40
S063-SCX-023-002	0.5-9.5	comp	0.57
S063-SCX-023-003	9.5-10	grab	0.61

Notes: cpm = counts per minute
pCi/g = picocuries per gram

grab = grab sample
comp = composite sample

- - - - = approximate contact

Stantec

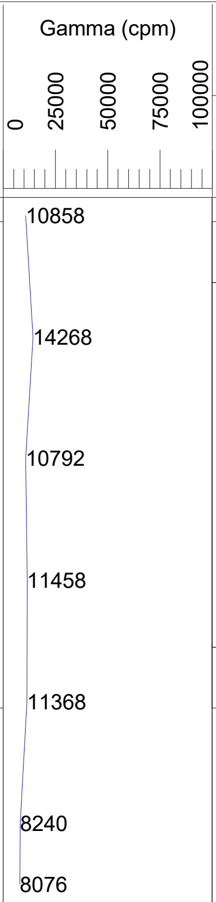
NAVAJO NATION
AUM Environmental Response Trust-First Phase

BOREHOLE ID: **S063-SCX-024**
CLIENT: NNAUMERT
PROJECT: Removal Site Evaluation
SITE LOCATION: NA-0928

DRILLING CONTRACTOR: Cascade Drilling
DRILLING METHOD: Rotary Sonic
DRILLING EQUIPMENT: Geoprobe 8140LC
SAMPLING METHOD: Sonic Core Barrel, 4 inch diameter

COORDINATE SYSTEM: NAD 1983 UTM Zone 12N
EASTING: 650779.6
NORTHING: 4086192.4
DATE STARTED: 6/5/2017
DATE STARTED: 6/5/2017
TOTAL DEPTH (ft.): 6
BOREHOLE ANGLE: 90 degrees
LOGGED BY: Tom Osborn

DEPTH (feet)	LITHOLOGICAL DESCRIPTION
0	POORLY GRADED SAND (SP): red (5YR 5/6), fine sands, dry, minor grass and organics.
1	
2	
3	
4	SANDSTONE: white, fine grained.
5	
6	Terminated borehole at 6 ft. below ground surface in bedrock.
7	
8	
9	
10	



SUBSURFACE SAMPLE INFORMATION

SAMPLE IDENTIFICATION	SAMPLE INTERVAL (ft bgl)	SAMPLE TYPE			LAB RESULTS RA-226 (pCi/g)
S063-SCX-024-001	0-0.5	grab		🟨	4.03
S063-SCX-024-002	0.5-3.5	comp	🟧		1.35
S063-SCX-024-003	3.5-4	grab		🟨	1.61

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 09/29/2016 **Arrival Time** 1445

Field Personnel

Chris Lee, Kelly Johnson, Linda Reeves (USEPA)

SITE DESCRIPTION

Entered 12/20/2016

Loc ID

Surface Water ☐ **Well Water** ☒

Station Name NA-0904 **Station Number** 09T-546

Site Description Windmill well, sampling at valve at water tank

Water Characteristics (color, odor, appearance): Clear, limited sulfur smell

SAMPLE COLLECTION

Collection Method: [✓ 1L bottle], Horizontal-bottle, Swing-sampler, Other(valve). Up-stream / Across-stream

Sample ID: S059-WL-001 **Sample Time:** ~~144~~ 1456

Field Measurements

Parameter	Sample 1 (normal sample)	Sample 2 (field dup or MS)	Sample 3 (MSD)
Time	~~1535~~ 1456		
pH	8.79		
Conductivity (µS/cm)	1215		
Turbidity (NTU)	13.3		
Water Temperature (°C)	18.2		
Salinity	0.30		
Oxidation Reduction Potential (mV)	105.9		

09/29/16

SURFACE WATER FLOW MEASUREMENT FORM

Project: Removal Site Evaluation Navajo Nation AUM Environmental Response Trust – First Phase

Date 09 29 /2016 **Time** 1445 **Station Number** NA-0904

Field Personnel: K. Johnson C. Lee 09T-549

Flow by Capture Method

Measurement Number	Time (sec)	Volume (L)
	NA	

No Flow Measurement At Spigot & Trough

WATER SAMPLE COLLECTION FORM

Project: Removal Site Evaluation Navajo Nation AUM Environmental Response Trust – First Phase

Date 5 / 24 / 17 **Arrival Time** 1141

Field Personnel

J. Koster K. Johnson

SITE DESCRIPTION

Surface Water ☐ **Well Water** ☒

Station Name NA-0904 windmill well **Station Number** S059-WL-001 ~~09-674~~ ~~09-16~~ 097-546

Site Description ~~Cattle~~ Trough associated with windmill well,

Dry on arrival

Water Characteristics (color, odor, appearance): Clear, odorless,

SAMPLE COLLECTION

Entered 6/16/2017

Collection Method: 1L bottle, Horizontal-bottle, Swing-sampler, Other( ). Up-stream / Across-stream

Sample ID: S059-WL-001 **Sample Time:** 1148

LOC ID S059-WL-001

Field Measurements

Parameter	Sample 1 (normal sample)	Sample 2 (field dup or MS)	Sample 3 (MSD)
Time	1148		
pH	8.99		
Conductivity (µS/cm)	589		
Turbidity (NTU)	3.16		
Water Temperature (°C)	17.2		
Salinity	—		
Oxidation Reduction Potential (mV)	138.6		

SURFACE WATER FLOW MEASUREMENT FORM

Project: Removal Site Evaluation Navajo Nation AUM Environmental Response Trust – First Phase

Date 5 24 17 **Time** 1141 **Station Number**

Field Personnel: K. Johnson J. Kester

NA-0904 windmill

Flow by Capture Method

Measurement Number	Time (sec)	Volume (L)

Entered 6/16/2017

NA-0928 (#63) REMOVAL SITE EVALUATION REPORT - FINAL

October 2, 2018

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 NA-0928 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 May 2016, three potential background reference areas (BG-1, BG-2, and BG-3) were identified to represent the geologic formations at the Site where mining-impacted material was assumed to be present. These formations include: (1) the Salt Wash Member of the Morrison Formation (Morrison Formation) on the mesa (BG-1 and BG-2); (2) the Summerville Formation, which extends from the mesa into the plains (BG-3); and (3) Quaternary deposits on the plains (BG-3). The surface gamma surveys at BG-1, BG-2, and BG-3 were completed in May 2016 and soil samples were collected in October 2016.

Upon review of the surface gamma survey data and soil samples locations, it was determined that the surface gamma survey did not align spatially with the areal extent of the soil sample locations in BG-1 and BG-2. Supplemental gamma surveys for BG-1 and BG-2 were conducted in April 2017. Following review of data collected at the Site, it was determined that an additional potential background reference area may be required to characterize sediments in the drainage downgradient from the Site. Three additional potential background reference areas were identified, and gamma surveys were conducted in September 2017. Three areas were surveyed within the same drainage and all three areas (BG-4, BG-5, and BG-6) represent Quaternary deposits, including alluvium, in the drainage. Multiple areas were surveyed in the drainage because the gamma survey data could not be reviewed in the field in real-time and needed to be downloaded from the data logger first. Multiple areas were surveyed in the drainage to allow the field team to review the data from different areas after completion of the survey to select the most representative area. During further review of the Baseline Studies data, it was determined that BG-1, BG-5, and BG-6 would not be used to represent the Site, as described in Section 3.0 below. Soil samples were collected at BG-4 in September 2017.

Geology at the Site and the predominant wind direction are shown in Figure D.1-1. The locations of the six potential background reference areas (BG-1 through BG-6) are shown along with the geology in Figure D.1-2. The wind rose on Figure D.1-1 depicts regional wind data from the Cortez, CO airport, approximately 50 miles northeast of the Site, and it shows the predominant wind direction is from the northeast. However, field personnel generally observed wind from the west at the Site, and the background descriptions below are based on the wind direction being from the west. The potential background reference areas are described below.

- BG-1 encompasses an area of 2,448 ft^2 (approximately 0.06 acres), is located 3,330 ft west of the claim boundary, and is cross-wind and hydrologically cross-gradient from the Site, and across a valley. The thin soils, colluvium-covered slopes, and bedrock outcrops represent the portions of the survey area that are within the Morrison Formation. The vegetation and ground cover at BG-1 are similar to the mesa sidewall portions of the Site.

- BG-2 encompasses an area of 1,499 ft^2 (approximately 0.03 acres), is located 3,410 ft west of the claim boundary, and is cross-wind and hydrologically cross-gradient from the Site, and across a valley. The thin soils, colluvium-covered slopes, and bedrock outcrops represent the portions of the survey area that are within the Morrison Formation. The vegetation and ground cover at BG-2 are similar to the mesa top and mesa sidewall portions of the Site.

- BG-3 encompasses an area of 2,411 ft^2 (approximately 0.06 acres), is located 670 ft west of the claim boundary, and is upwind and hydrologically cross-gradient from the Site, and across a drainage divide. The thicker soils deposits, colluvium-covered slopes, and bedrock outcrops represent the portions of the survey areas that are within the Summerville Formation and the Quaternary deposits. The vegetation and ground cover at BG-3 are similar to the area where the mesa sidewall transitions into the plains portions of the Site.

- BG-4 encompasses an area of 463 ft^2 (approximately 0.01 acres), is located 520 ft west of the claim boundary, and is upwind and hydrologically cross-gradient from the Site, and across a drainage divide. The sediments represent the portions of the survey area that consists of Quaternary deposits, including alluvium, in the drainages. The vegetation and ground cover at BG-4 are similar to the drainages that drain the Site to the north.

- BG-5 encompasses an area of 1,351ft^2 (approximately 0.03 acres), is located 430 ft west of the claim boundary, and is upwind and hydrologically cross-gradient from the Site, and across a drainage divide. The sediments represent the portions of the survey area that consist of Quaternary deposits, including alluvium, in the drainages. The vegetation and ground cover at BG-5 are similar to the drainages that drain the Site to the north.

- BG-6 encompasses an area of 583 ft^2 (approximately 0.01 acres), is located 570 ft west of the claim boundary, and is upwind and hydrologically cross-gradient from the Site, and across a valley. The sediments represent the portions of the survey area that consist of Quaternary deposits, including alluvium, in the drainages. The vegetation and ground cover at BG-6 are similar to the drainages that drain the Site to the north.

The potential background reference area evaluation included surface gamma surveys, surface and subsurface static gamma measurements, and collection of surface soil samples and subsurface soil samples as described below:

- BG-1 – 11 surface soil grab samples were collected from 11 locations; one subsurface soil grab sample, and surface and subsurface static gamma measurements, were collected from borehole location S059-SCX-002

- BG-2 – 10 surface soil grab samples were collected from 10 locations; one subsurface soil grab sample was collected from borehole location S059-SCX-001 where the depth ranged from 0.0-0.6 feet below ground surface (ft bgs); surface and subsurface static gamma measurements were also collected from borehole location S059-SCX-001

- BG-3 – 11 surface soil grab samples were collected from 11 locations; one subsurface soil grab sample, and subsurface static gamma measurements, were collected from borehole location S059-SCX-003

- BG-4 – 11 surface sediment grab samples were collected from 11 locations; one subsurface sediment grab sample, and surface and subsurface static gamma measurements, were collected from borehole location S059-BG4-011

- BG-5 – surface gamma survey only

- BG-6 – surface gamma survey only

The sample locations and surface gamma survey data for BG-1, BG-2, and BG-3 are shown in Figure D.1-3. The sample locations for BG-4 and the surface gamma survey data for BG-4, BG-5, and BG-6 are shown in Figure D.1-4. Samples were categorized as surface soil/sediment samples where sample depths were up to 0.5 ft bgs, and as subsurface samples where sample depths were greater than 0.5 ft bgs. Static gamma measurements were categorized as surface where static gamma was measured at the ground surface, and as subsurface where static gamma was measured at or greater than 0.1 ft bgs. Table D.1-1 provides a summary of the samples collected and Table D.1-2 includes the results of the sample analyses. Note that sample analyses for BG-1 are included in this appendix and not in the tables in the RSE report. Tables D.1-3 and D.1-4 provide descriptive statistics for the metals/Ra-226 concentrations and the surface gamma measurements, respectively. Field forms, including borehole logs, are provided in Appendix C of the RSE report.

The equipment used for the surface gamma survey were also used for static one-minute gamma measurements at the ground surface and for subsurface gamma measurements at the borehole location. Soil/sediment samples and gamma measurements were collected according to the methods described in the *Removal Site Evaluation Work Plan* (MWH, 2016).

3.0 SELECTION OF BACKGROUND REFERENCE AREA

Background reference areas were needed to represent the three geologic units present at or near the Site where mining-related impacts may have occurred: BG-1 and BG-2 were identified to represent portions of the survey area within the Morrison Formation; BG-3 was selected to represent portions of the survey area within the Summerville Formation and Quaternary deposits; and BG-4, BG-5, and BG-6 were identified to represent portions of the survey area within Quaternary deposits, including alluvium. Upon review of the gamma survey and soil sample data collected for BG-1 and BG-2, (refer to Figure D.1-3 and Tables D.1-3 and D.1-4), BG-2 was selected over BG-1 to represent areas of the Site within the Morrison Formation because BG-1 contained elevated gamma measurements that were not representative of some areas of the Site (e.g., the northeast-southwest trending portion of the mesa). However, BG-1 does provide a valuable comparison to BG-2 regarding the variation in gamma measurements that may occur in background areas and the heterogeneity present within the Morrison Formation. It is also applicable to some areas of the portion of the mesa that trends northwest-southeast; however, mining-related disturbances were not observed in those areas. As a result, BG-1 is included in the RSE report for discussion purposes. BG-3 was selected to represent the areas of the Site within the Summerville Formation specifically the area of the Site where the mesa transitions to the plains. BG-4 was selected over BG-5 and BG-6 to represent the areas of the Site within the drainages that contain Quaternary deposits, including alluvium. BG-4 was selected because it was the middle of the three potential background reference areas, and the magnitude of the gamma survey measurements for BG-4 were between those for BG-5 and BG-6. BG-4 was also selected to represent the portions of the survey area within the Quaternary deposits that are outside the drainage channel (e.g., the eastern portion of the Site). Both BG-3 and BG-4 were considered for this area because the Summerville formation is generally covered by limited Quaternary deposits. Comparing the BG-3 and BG-4 statistical values, the sediments in BG-4 had lower gamma measurements and Ra-226 values than BG-3 (refer to Tables D.1-3 and D.1-4).

Gamma survey measurements, soil/sediment sample results and subsurface static gamma measurements collected from BG-2, BG-3, and BG-4 were used for the remainder of the Removal Site Evaluation of the Site.

4.0 REFERENCES

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

USEPA, 2000. *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM), EPA 402-R-97-016, Rev. 1.

Table D.1-1
Potential Background Reference Area Soil and Sediment Sampling Summary
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								Sample Types	
Sample Location	Sample Depth (ft bgs)	Sample Media	Sample Category	Sample Collection Method	Sample Date	Easting [1]	Northing [1]	Metals, Total	Ra-226
Potential Background Reference Area Study - Background Area 1 - Morrison Formation*									
S059-BG1-001	0 - 0.5	soil	SF	grab	10/5/2016	650536.63	4084650.95	N;FD	N;FD
S059-BG1-002	0 - 0.5	soil	SF	grab	10/5/2016	650534.60	4084649.06	N;MS;MSD	N
S059-BG1-003	0 - 0.5	soil	SF	grab	10/5/2016	650530.89	4084652.00	N	N
S059-BG1-004	0 - 0.5	soil	SF	grab	10/5/2016	650528.11	4084649.12	N	N
S059-BG1-005	0 - 0.5	soil	SF	grab	10/5/2016	650527.05	4084646.03	N	N
S059-BG1-006	0 - 0.5	soil	SF	grab	10/5/2016	650530.38	4084644.41	N	N
S059-BG1-007	0 - 0.5	soil	SF	grab	10/5/2016	650530.43	4084640.20	N	N
S059-BG1-008	0 - 0.5	soil	SF	grab	10/5/2016	650532.69	4084644.27	N	N
S059-BG1-009	0 - 0.5	soil	SF	grab	10/5/2016	650536.63	4084643.84	N;MS;MSD	N
S059-BG1-010	0 - 0.5	soil	SF	grab	10/5/2016	650539.69	4084646.17	N	N
S059-SCX-002	0 - 0.5	soil	SF	grab	10/11/2016	650536.50	4084639.09	N	N
S059-SCX-002	0.5 - 1.1	soil	SB	grab	10/11/2016	650536.50	4084639.09	N	N
Potential Background Reference Area Study - Background Area 2 - Morrison Formation*									
S059-BG2-001	0 - 0.5	soil	SF	grab	10/5/2016	650513.41	4084635.51	N;FD	N;FD
S059-BG2-002	0 - 0.5	soil	SF	grab	10/5/2016	650510.96	4084633.92	N	N
S059-BG2-003	0 - 0.5	soil	SF	grab	10/5/2016	650511.44	4084631.57	N	N
S059-BG2-004	0 - 0.5	soil	SF	grab	10/5/2016	650513.19	4084630.23	N	N
S059-BG2-005	0 - 0.5	soil	SF	grab	10/5/2016	650516.29	4084634.25	N	N
S059-BG2-006	0 - 0.5	soil	SF	grab	10/5/2016	650515.81	4084631.17	N	N
S059-BG2-007	0 - 0.5	soil	SF	grab	10/5/2016	650518.59	4084629.54	N	N
S059-BG2-008	0 - 0.5	soil	SF	grab	10/5/2016	650518.56	4084626.43	N	N
S059-BG2-009	0 - 0.5	soil	SF	grab	10/5/2016	650513.06	4084625.85	N	N
S059-BG2-010	0 - 0.5	soil	SF	grab	10/5/2016	650516.93	4084624.85	N;FD	N;FD
S059-SCX-001	0 - 0.6	soil	SF	grab	10/11/2016	650513.05	4084630.51	N	N
Potential Background Reference Area Study - Background Area 3 - Summerville Formation and Quaternary Deposits*									
S059-BG3-001	0 - 0.5	soil	SF	grab	10/6/2016	651139.20	4085183.03	N	N
S059-BG3-002	0 - 0.5	soil	SF	grab	10/6/2016	651142.96	4085181.59	N	N
S059-BG3-003	0 - 0.5	soil	SF	grab	10/6/2016	651145.92	4085184.25	N	N
S059-BG3-004	0 - 0.5	soil	SF	grab	10/6/2016	651143.92	4085177.81	N;MS;MSD	N
S059-BG3-005	0 - 0.5	soil	SF	grab	10/6/2016	651146.45	4085176.00	N	N
S059-BG3-006	0 - 0.5	soil	SF	grab	10/6/2016	651149.62	4085178.17	N	N
S059-BG3-007	0 - 0.5	soil	SF	grab	10/6/2016	651146.08	4085172.25	N	N
S059-BG3-008	0 - 0.5	soil	SF	grab	10/6/2016	651149.88	4085170.76	N	N
S059-BG3-009	0 - 0.5	soil	SF	grab	10/6/2016	651150.91	4085167.27	N	N
S059-BG3-010	0 - 0.5	soil	SF	grab	10/6/2016	651153.79	4085166.11	N;FD	N;FD
S059-SCX-003	0 - 0.5	soil	SF	grab	10/11/2016	651152.99	4085166.31	N	N
S059-SCX-003	0.5 - 1.2	soil	SB	grab	10/11/2016	651152.99	4085166.31	N	N
Potential Background Reference Area Study - Background Area 4 - Quaternary Deposits*									
S059-BG4-001	0 - 0.5	sediment	SF	grab	9/14/2017	651140.63	4085261.30	N	N
S059-BG4-002	0 - 0.5	sediment	SF	grab	9/14/2017	651141.30	4085262.68	N;FD	N;FD
S059-BG4-003	0 - 0.5	sediment	SF	grab	9/14/2017	651141.30	4085265.84	N	N
S059-BG4-004	0 - 0.5	sediment	SF	grab	9/14/2017	651141.36	4085268.74	N;FD	N;FD
S059-BG4-005	0 - 0.5	sediment	SF	grab	9/14/2017	651143.27	4085270.56	N	N
S059-BG4-006	0 - 0.5	sediment	SF	grab	9/14/2017	651143.44	4085271.66	N;FD	N;FD
S059-BG4-007	0 - 0.5	sediment	SF	grab	9/14/2017	651145.58	4085272.25	N	N
S059-BG4-008	0 - 0.5	sediment	SF	grab	9/14/2017	651146.59	4085274.17	N;FD	N;FD
S059-BG4-009	0 - 0.5	sediment	SF	grab	9/14/2017	651149.95	4085276.61	N	N
S059-BG4-010	0 - 0.5	sediment	SF	grab	9/14/2017	651151.11	4085277.83	N	N
S059-BG4-011	0 - 0.5	sediment	SF	grab	9/14/2017	651151.68	4085277.53	N	N
S059-BG4-011	0.5 - 1.5	sediment	SB	grab	9/14/2017	651151.68	4085277.53	N	N

Notes

*	Background Reference Areas from NA-0904 were used for NA-0928
N	Normal
FD	Field Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
Ra-226	Radium 226
SB	Subsurface Sample
SF	Surface Sample
ft bgs	feet below ground surface

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

Table D.1-2
Potential Background Reference Area Soil and Sediment Sample Analytical Results
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Location Identification*	S059-BG1-001 Dup	S059-BG1-001	S059-BG1-002	S059-BG1-003	S059-BG1-004	S059-BG1-005	S059-BG1-006	S059-BG1-007	S059-BG1-008	S059-BG1-009	S059-BG1-010	S059-SCX-002	S059-SCX-002
Date Collected	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/11/2016	10/11/2016
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	0 - 0.5	0.5 - 1.1
Analyte (Units)													
Metals[1] (mg/kg)													
Arsenic	<0.19	14	19 J+	23	2	2.1	2.1	8.4	12	6.5	10	23	35
Molybdenum	<0.19	1.3	1.7	2.2	<0.19	<0.2	<0.19	<0.19	0.61	0.37	1.1	0.75	1.1
Selenium	<0.94	<0.99	1.1	1.5	<0.93	<0.98	<0.96	<0.96	<0.89	<0.96	<0.96	<0.98	<0.93
Uranium	<0.0094	7.6	9.3 J-	13	2.8	2.3	3.9	3.5	2.5	3.3 J+	6	4.4	5.4
Vanadium	<0.47	9.8	12 J	18	7.5	10	6.7	17	9.5	7.4	10	7.7	9.7
Radionuclides (pCi/g)													
Radium-226	4.94 ± 0.67	5.13 ± 0.72 J-	6.26 ± 0.86	5.95 ± 0.8	2.15 ± 0.38	1.99 ± 0.36	2.41 ± 0.38	4.24 ± 0.62	2.44 ± 0.42	2.93 ± 0.46	4.36 ± 0.61	3.23 ± 0.51	4.12 ± 0.58

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
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
J+	Data are estimated and are potentially biased high due to associated quality control data
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
<	Result not detected above associated laboratory reporting limit
*	Background Reference Areas from NA-0904 were used for NA-0928

Table D.1-2
Potential Background Reference Area Soil and Sediment Sample Analytical Results
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Location Identification*	S059-BG2-001	S059-BG2-001 Dup	S059-BG2-002	S059-BG2-003	S059-BG2-004	S059-BG2-005	S059-BG2-006	S059-BG2-007	S059-BG2-008	S059-BG2-009	S059-BG2-010	S059-BG2-010 Dup	S059-SCX-001
Date Collected	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/5/2016	10/11/2016
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	0 - 0.5	0 - 0.6
Analyte (Units)													
Metals[1] (mg/kg)													
Arsenic	1.4	1.2	2	1.5	1.4	1.7	4.2	1.7	2.1	2.1	1.6	1.5	2.2
Molybdenum	<0.18	<0.19	<0.21	<0.2	<0.2	<0.19	<0.18	<0.2	<0.18	<0.18	<0.18	<0.2	<0.19
Selenium	<0.92	<0.93	<1	<0.98	<0.99	<0.95	<0.92	<1	<0.9	<0.9	<0.92	<0.99	<0.96
Uranium	2.3	2.3	1.2	1.6	1.2	2	2.4	1.8	1.3	1.2	2.5	2.6	1.5
Vanadium	6.8	6.6	15	7.9	8.2	13	14	9.3	9.1	12	10	10	12
Radionuclides (pCi/g)													
Radium-226	1.58 ± 0.31	1.27 ± 0.28	1.79 ± 0.33	1.23 ± 0.27	1.18 ± 0.27	1.98 ± 0.33	2.94 ± 0.49	1.26 ± 0.28	0.92 ± 0.23	1.57 ± 0.31	2.04 ± 0.37	1.62 ± 0.3	1.26 ± 0.29

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
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
J+	Data are estimated and are potentially biased high due to associated quality control data
1	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
<	Result not detected above associated laboratory reporting limit
*	Background Reference Areas from NA-0904 were used for NA-0928

Table D.1-2
Potential Background Reference Area Soil and Sediment Sample Analytical Results
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Location Identification*	S059-BG3-001	S059-BG3-002	S059-BG3-003	S059-BG3-004	S059-BG3-005	S059-BG3-006	S059-BG3-007	S059-BG3-008	S059-BG3-009	S059-BG3-010	S059-BG3-010 Dup	S059-SCX-003	S059-SCX-003
Date Collected	10/6/2016	10/6/2016	10/6/2016	10/6/2016	10/6/2016	10/6/2016	10/6/2016	10/6/2016	10/6/2016	10/6/2016	10/6/2016	10/11/2016	10/11/2016
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	0 - 0.5	0.5 - 1.2
Analyte (Units)													
Metals^1 (mg/kg)													
Arsenic	1.4	1.3	1.5	1.3 J+	1.4	1.4	1.4	1.5	1.7	2	2	2	1.9
Molybdenum	<0.17	<0.18	0.24	<0.18	<0.19	<0.2	<0.2	<0.19	<0.18	<0.19	<0.19	<0.2	<0.21
Selenium	<0.85	<0.89	<0.95	<0.88	<0.95	<0.98	<1	<0.94	<0.91	<0.95	<0.93	<0.98	<1
Uranium	0.4	0.45	0.59	0.6 J+	0.61	0.51	0.78	0.56	0.58	0.56	0.56	0.55	0.48
Vanadium	6.3	6.9	7.3	7.8 J+	8.2	9.5	9.3	11	17	12	12	9.4	7.8
Radionuclides (pCi/g)													
Radium-226	0.5 ± 0.23	0.43 ± 0.19	0.84 ± 0.23	0.86 ± 0.24	0.68 ± 0.2	0.49 ± 0.2	0.58 ± 0.21	0.61 ± 0.27	0.44 ± 0.17	0.79 ± 0.24 J-	0.61 ± 0.2 J-	0.62 ± 0.19	0.6 ± 0.2

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
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
J+	Data are estimated and are potentially biased high due to associated quality control data
¹	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
<	Result not detected above associated laboratory reporting limit
*	Background Reference Areas from NA-0904 were used for NA-0928

Table D.1-2
Potential Background Reference Area Soil and Sediment Sample Analytical Results
NA-0928
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Navajo Nation AUM Environmental Response Trust - First Phase

Location Identification*	S059-BG4-001	S059-BG4-002	S059-BG4-002 Dup	S059-BG4-003	S059-BG4-004	S059-BG4-004 Dup	S059-BG4-005	S059-BG4-006	S059-BG4-006 Dup	S059-BG4-007	S059-BG4-008	S059-BG4-008 Dup
Date Collected	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017	9/14/2017
Depth (feet)	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5	0 - 0.5
Analyte (Units)												
Metals[1] (mg/kg)												
Arsenic	1.5	1.5	5.1	2.2	2.4	2	1.6	1.8	3.9	1.5	1.8	1.8
Molybdenum	0.27	<0.2	<0.19	0.28	<0.19	<0.2	<0.2	<0.2	0.61	<0.2	<0.19	0.21
Selenium	<0.98	<1	<0.97	<1	<0.95	<1	<0.99	<0.99	<1	<1	<0.96	<0.95
Uranium	0.69	0.67	1	0.66	0.85	0.72	0.69	0.71	0.77	0.59	0.7	0.71
Vanadium	5.9	6.5	7.8	6.6	8.2	7.4	6.9	6	6.9	5.9	6	6.2
Radionuclides (pCi/g)												
Radium-226	0.81 ± 0.22	0.61 ± 0.17 J-	0.52 ± 0.18 J-	0.56 ± 0.17	0.75 ± 0.19	0.8 ± 0.21	0.67 ± 0.19 J-	0.7 ± 0.19	0.76 ± 0.22	0.77 ± 0.21	0.67 ± 0.24	0.91 ± 0.21

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
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
J+	Data are estimated and are potentially biased high due to associated quality control data
[1]	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
<	Result not detected above associated laboratory reporting limit
*	Background Reference Areas from NA-0904 were used for NA-0928

Table D.1-2
Potential Background Reference Area Soil and Sediment Sample Analytical Results
NA-0928
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase

Location Identification*	S059-BG4-009	S059-BG4-010	S059-BG4-011	S059-BG4-011
Date Collected	9/14/2017	9/14/2017	9/14/2017	9/14/2017
Depth (feet)	0 - 0.5	0 - 0.5	0 - 0.5	0.5 - 1.5
Analyte (Units)				
Metals[1] (mg/kg)				
Arsenic	2.5	1.5	1.7	1.8
Molybdenum	0.3	<0.19	<0.2	<0.21
Selenium	<0.99	<0.96	<0.99	<1.1
Uranium	0.87	0.66	0.76	0.76
Vanadium	7	7.2	7	6.8
Radionuclides (pCi/g)				
Radium-226	0.62 ± 0.17 J-	0.7 ± 0.2	0.71 ± 0.2 J-	0.7 ± 0.22

Notes

Bold	Bolded result indicates positively identified compound
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
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
J+	Data are estimated and are potentially biased high due to associated quality control data
[1]	Analysis required a standard sample dilution of 10 times; reported values have been converted to non-dilute value
<	Result not detected above associated laboratory reporting limit
*	Background Reference Areas from NA-0904 were used for NA-0928

Table D.1-3
Soil and Sediment Sampling Summary
NA-0928
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 2

Statistic	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Uranium (mg/kg)	Vanadium (mg/kg)	Radium-226 (pCi/g)
Background Reference Area Study - Background Area 1 - Morrison Formation						
Total Number of Observations	11	11	11	11	11	11
Percent Non-Detects	--	36%	82%	--	--	--
Minimum[1]	2	--	--	2.30	6.70	1.99
Minimum Detect[2]	--	0.370	1.10	--	--	--
Mean[1]	11.1	--	--	5.33	10.5	3.74
Mean Detects[2]	--	1.15	1.30	--	--	--
Median[1]	10.0	--	--	3.90	9.80	3.23
Median Detects[2]	--	1.10	1.30	--	--	--
Maximum[1]	23.0	--	--	13.0	18.0	6.26
Maximum Detect[2]	--	2.2	1.50	--	--	--
Distribution	Normal	Normal	Normal	Normal	Gamma	Normal
Coefficient of Variation[1]	0.715	--	--	0.634	0.361	0.413
CV Detects[2]	--	0.562	0.218	--	--	--
UCL Type	95% Student's-t UCL	95% KM (t) UCL	95% KM (t) UCL	95% Student's-t UCL	95% Adjusted Gamma UCL	95% Student's-t UCL
UCL Result	15.4	1.166	0.66	7.17	13.2	4.58
UTL Type	UTL Normal	UTL KM Normal	UTL KM Normal	UTL Normal	UTL Gamma WH	UTL Normal
UTL Result	33.4	2.76	1.65	14.8	23.2	8.08
Background Reference Area Study - Background Area 2 - Morrison Formation						
Total Number of Observations	10	10	10	10	10	10
Percent Non-Detects	--	100%	100%	--	--	--
Minimum[1]	1.40	--	--	1.20	6.80	0.920
Minimum Detect[2]	--	--	--	--	--	--
Mean[1]	1.97	--	--	1.75	10.5	1.65
Mean Detects[2]	--	--	--	--	--	--
Median[1]	1.70	--	--	1.70	9.65	1.58
Maximum[1]	4.20	--	--	2.50	15.0	2.94
Maximum Detect[2]	--	--	--	--	--	--
Distribution	Normal	Not Calculated	Not Calculated	Normal	Normal	Normal
Coefficient of Variation[1]	0.420	--	--	0.3	0.266	0.352
UCL Type	95% Student's-t UCL	Not Calculated	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL
UCL Result	2.45	Not Calculated	Not Calculated	2.06	12.2	1.99
UTL Type	UTL Normal	Not Calculated	Not Calculated	UTL Normal	UTL Normal	UTL Normal
UTL Result	4.38	Not Calculated	Not Calculated	3.28	18.7	3.34

Table D.1-3
Soil and Sediment Sampling Summary
NA-0928
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 2 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 3 - Summerville Formation and Quaternary Deposits						
Total Number of Observations	11	11	11	11	11	11
Percent Non-Detects	--	91%	100%	--	--	--
Minimum[1]	1.30	--	--	0.40	6.30	0.430
Minimum Detect[2]	--	0.240	--	--	--	--
Mean[1]	1.54	--	--	0.563	9.52	0.622
Mean Detects[2]	--	0.240	--	--	--	--
Median[1]	1.40	--	--	0.560	9.30	0.610
Maximum[1]	2.00	--	--	0.780	17.0	0.860
Maximum Detect[2]	--	0.240	--	--	--	--
Distribution	Normal	Not Calculated	Not Calculated	Normal	Normal	Normal
Coefficient of Variation[1]	0.165	--	--	0.172	0.317	0.249
UCL Type	95% Student's-t UCL	Not Calculated	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL
UCL Result	1.68	Not Calculated	Not Calculated	0.616	11.2	0.706
UTL Type	UTL Normal	Not Calculated	Not Calculated	UTL Normal	UTL Normal	UTL Normal
UTL Result	2.25	Not Calculated	Not Calculated	0.836	18.0	1.06
Background Reference Area Study - Background Area 4 - Quaternary Deposits						
Total Number of Observations	11	11	11	11	11	11
Percent Non-Detects	--	73%	100%	--	--	--
Minimum[1]	1.50	--	--	0.590	5.90	0.56
Minimum Detect[2]	--	0.270	--	--	--	--
Mean[1]	1.82	--	--	0.714	6.66	0.688
Mean Detects[2]	--	0.283	--	--	--	--
Median[1]	1.70	--	--	0.690	6.60	0.700
Median Detects[2]	--	0.280	--	--	--	--
Maximum[1]	2.50	--	--	0.870	8.20	0.810
Maximum Detect[2]	--	0.300	--	--	--	--
Distribution	Normal	Normal	Not Calculated	Normal	Normal	Normal
Coefficient of Variation[1]	0.207	--	--	0.117	0.106	0.107
CV Detects[2]	--	0.054	--	--	--	--
UCL Type	95% Student's-t UCL	95% KM (t) UCL	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL
UCL Result	2.02	0.244	Not Calculated	0.759	7.04	0.728
UTL Type	UTL Normal	UTL KM Normal	Not Calculated	UTL Normal	UTL Normal	UTL Normal
UTL Result	2.88	0.334	Not Calculated	0.948	8.65	0.895

Notes

[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.

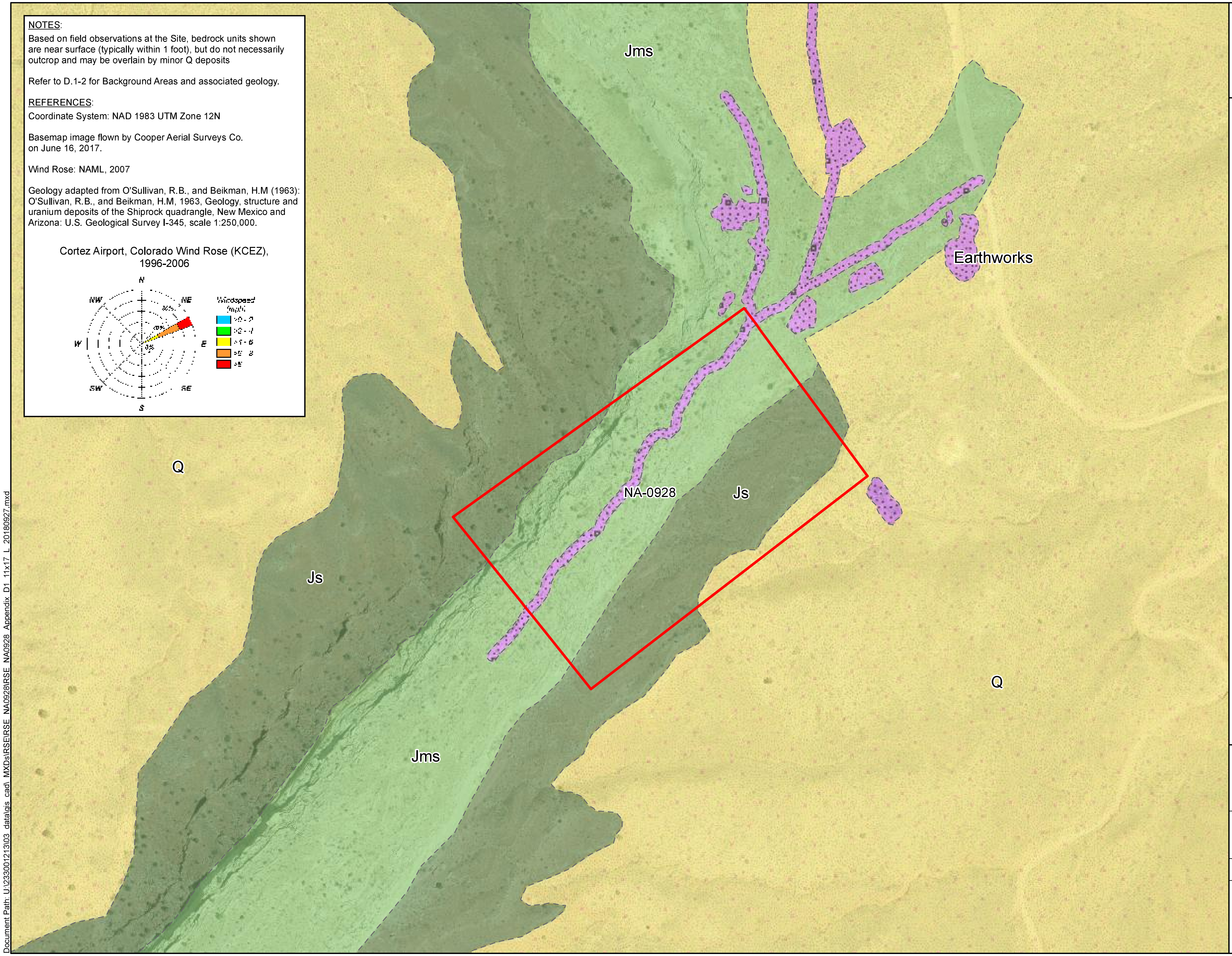
CV	Coefficient of variation
KM	Kaplan Meier
mg/kg	Milligrams per kilogram
--	Not applicable
pCi/g	Picocuries per gram
WH	Wilson Hilferty

Table D.1-4
Surface Gamma Survey Summary
NA-0928
Removal Site Evaluation Report - Final
Navajo Nation AUM Environmental Response Trust - First Phase
Page 1 of 1

Statistic	Background Reference Area 1 (BG-1) Morrison Formation	Background Reference Area 2 (BG-2) Morrison Formation	Background Reference Area 3 (BG-3) Summerville Formation & Quaternary Deposits	Background Reference Area 4 (BG-4) Quaternary Deposits	Background Reference Area 5 (BG-5) Quaternary Deposits	Background Reference Area 6 (BG-6) Quaternary Deposits
Total Number of Observations	420	328	378	70	114	65
Minimum	7,875	7,118	5,599	7,158	6,818	7,305
Mean	12,994	9,369	8,668	8,463	8,392	8,901
Median	11,702	9,310	8,490	8,430	8,318	8,733
Maximum	27,166	13,741	12,226	10,204	10,301	10,535
Distribution	Normal	Normal	Normal	Normal	Normal	Normal
Coefficient of Variation	0.278	0.101	0.115	0.086	0.0816	0.082
UCL Type	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL
UCL Result	13,285	9,455	8,753	8,608	8499	9,052
UTL Type	UTL Normal	UTL Normal	UTL Normal	UTL Normal	UTL Normal	UTL Normal
UTL Result	19,403	11,068	10,447	9,911	9696	10,361

Notes

cpm	Counts per minute
UCL	Upper confidence limit
UTL	Upper tolerance limit
WH	Wilson Hilferty



NOTES:

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

Refer to D.1-2 for Background Areas and associated geology.

REFERENCES:

Coordinate System: NAD 1983 UTM Zone 12N

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

Wind Rose: NAML, 2007

Geology adapted from O'Sullivan, R.B., and Beikman, H.M (1963): O'Sullivan, R.B., and Beikman, H.M, 1963, Geology, structure and uranium deposits of the Shiprock quadrangle, New Mexico and Arizona: U.S. Geological Survey I-345, scale 1:250,000.

Cortez Airport, Colorado Wind Rose (KCEZ), 1996-2006

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

🟥 Claim Boundary

- - - Geologic Contact (Inferred)

Site Geology

HOLOCENE

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

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

JURASSIC

🟩 Jms: Salt Wash Member of the Morrison Formation (Upper Jurassic) – white and moderate-orange, very fine- to medium-grained sandstone, and grayish-red shale.

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

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TITLE:

Geologic Map

PROJECT:

Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

AUTHOR: CBB

REVIEWER: EDZ

Stantec

FIGURE: D.1-1

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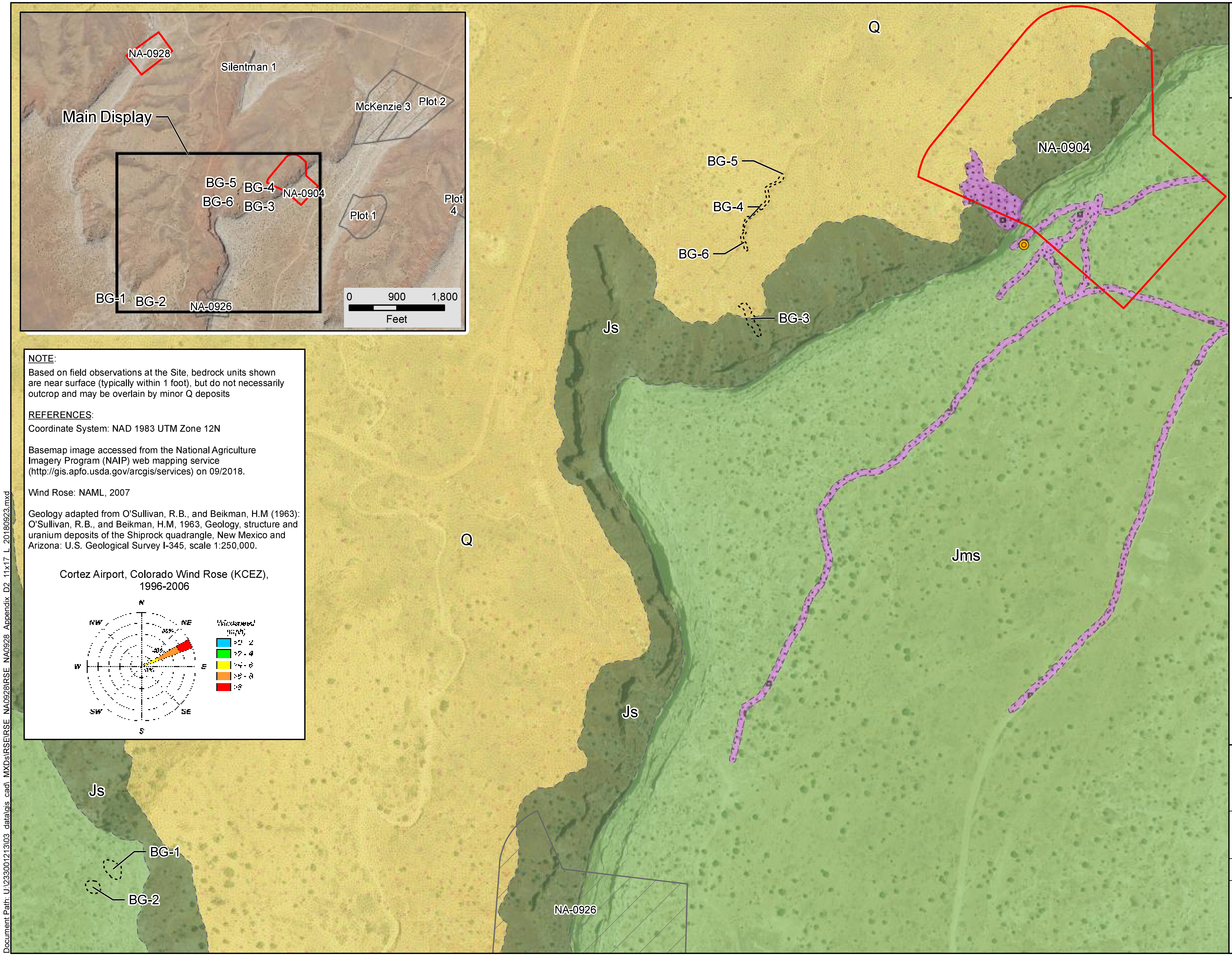

NOTE:
Based on field observations at the Site, bedrock units shown are near surface (typically within 1 foot), but do not necessarily outcrop and may be overlain by minor Q deposits

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Basemap image accessed from the National Agriculture Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 09/2018.

Wind Rose: NAML, 2007

Geology adapted from O'Sullivan, R.B., and Beikman, H.M (1963): O'Sullivan, R.B., and Beikman, H.M, 1963, Geology, structure and uranium deposits of the Shiprock quadrangle, New Mexico and Arizona: U.S. Geological Survey I-345, scale 1:250,000.

Cortez Airport, Colorado Wind Rose (KCEZ), 1996-2006

NAVAJO NATION
AUM Environmental Response Trust

LEGEND

- ● Portal
- ⬚ Potential Background Reference Area
- 🟥 Claim Boundary
- ☐ Other Claim Boundary
- ╌ Geologic Contact (Inferred)

Site Geology

HOLOCENE / PLEISTOCENE

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

JURASSIC

- 🟩 Jms: Salt Wash Member of the Morrison Formation (Upper Jurassic) – white and moderate-orange, very fine- to medium-grained sandstone, and grayish-red shale.
- 🟩 Js: Summerville Formation (Upper Jurassic) – Reddish-brown to light-orange very fine- to fine-grained flat bedded silty sandstone and reddish brown thin-bedded silty sandstone, siltstone, and claystone; forms banded steep slopes and cliffs.

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TITLE:
Geologic Map and Potential Background Reference Areas

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/27/2018
DOCUMENT NAME: Removal Site Evaluation Report
AUTHOR: EDZ
REVIEWER: CBB
FIGURE: D.1-2

Stantec

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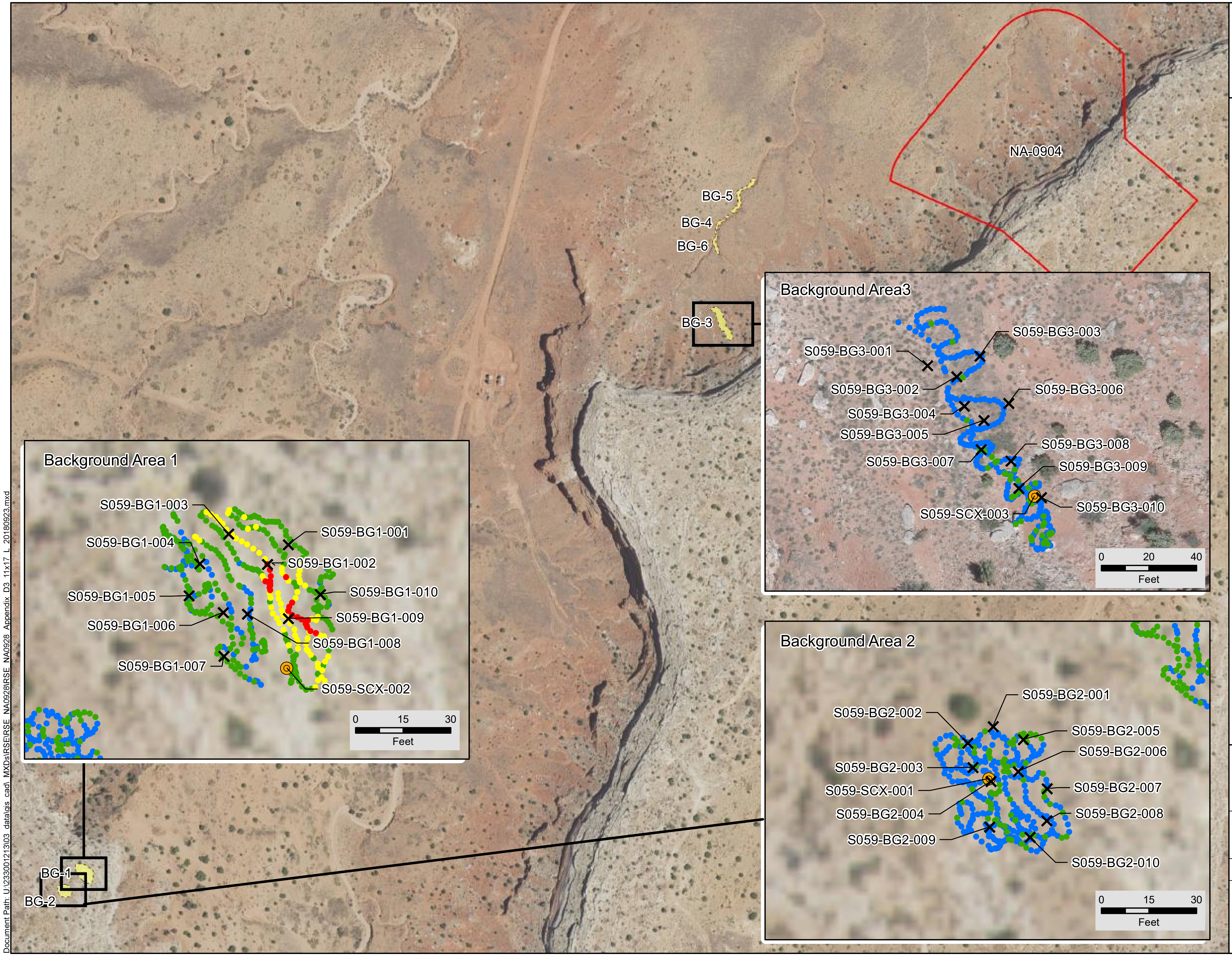

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕	Surface Sample Location
◎	Subsurface Borehole Location for Background Reference
▨	Potential Background Reference Area
☐	Claim Boundary

Gamma Survey

Counts per Minute (CPM)

●	5,599 - 10,000
●	10,001 - 15,000
●	15,001 - 20,000
●	20,001 - 27,166

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Main display and Background Areas 1 and 2 basemap image insets accessed from the National Agriculture Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 09/2018.

Background Area 3 basemap image insets flown by Cooper Aerial Surveys Co. on June 16, 2017.

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Feet

TITLE:
Potential Background Reference Area
Gamma Radiation Survey Results and
Soil Sample Locations

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

Stantec

AUTHOR: CBB

REVIEWER: EDZ

FIGURE: D.1-3

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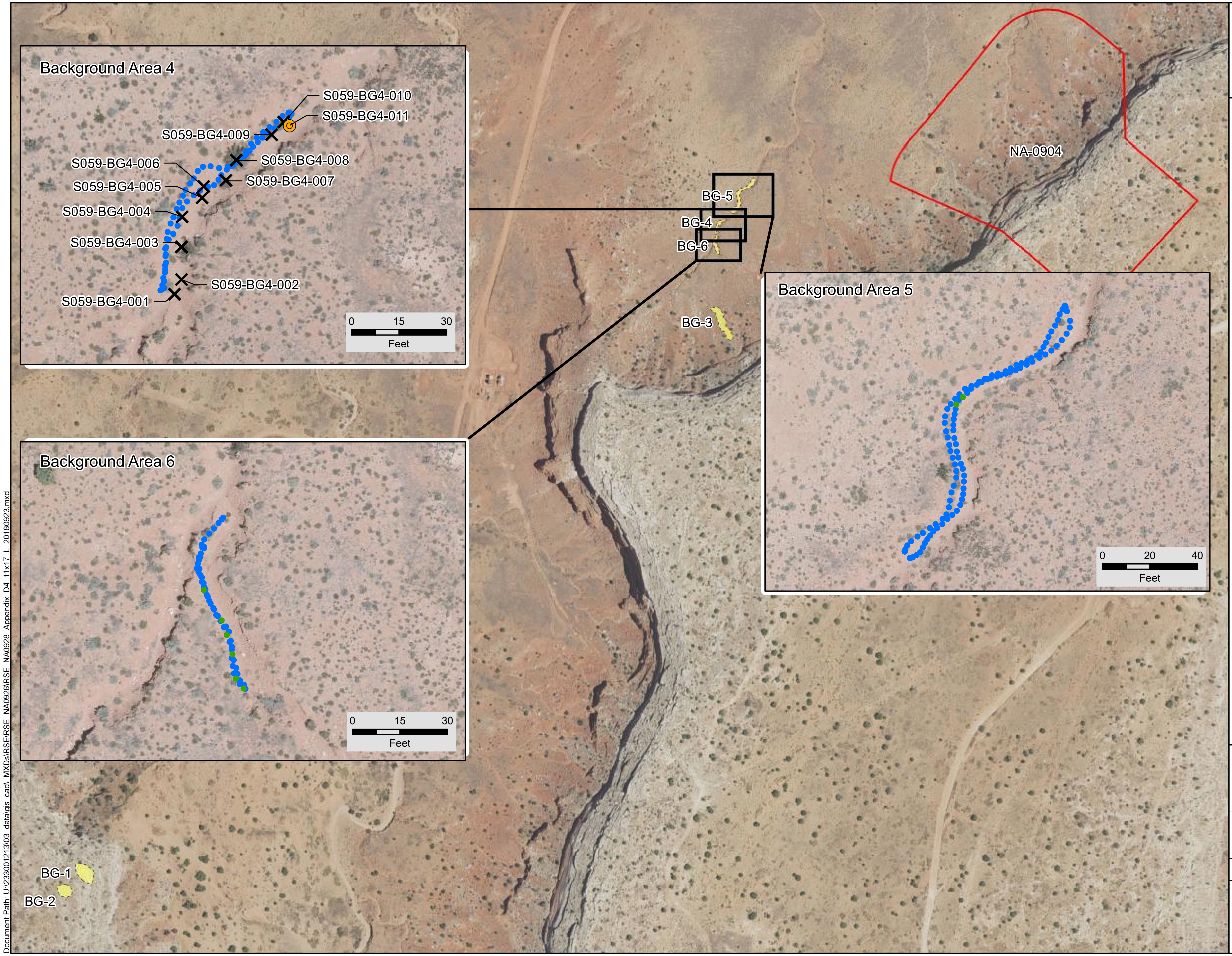

NAVAJO NATION
AUM Environmental
Response Trust-First Phase

LEGEND

✕ Surface Sample Location

◎ Subsurface Borehole Location for Background Reference

▨ Potential Background Reference Area

□ Claim Boundary

Gamma Survey

Counts per Minute (CPM)

● 5,599 - 10,000

● 10,001 - 15,000

● 15,001 - 20,000

● 20,001 - 27,166

REFERENCES:
Coordinate System: NAD 1983 UTM Zone 12N

Main display basemap image accessed from the National Agriculture Imagery Program (NAIP) web mapping service (http://gis.apfo.usda.gov/arcgis/services) on 09/2018.

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

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Feet

TITLE:
Potential Background Reference Area
Gamma Radiation Survey Results and
Soil Sample Locations

PROJECT:
Removal Site Evaluation
NA-0928 Mine Site

DATE: 9/27/2018

DOCUMENT NAME: Removal Site Evaluation Report

AUTHOR: CBB

REVIEWER: EDZ

Stantec

FIGURE: D.1-4

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 NA-0928 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 reference areas and three Survey Areas. These areas are designated Background Reference Area 2 (BG-2), Background Reference Area 3 (BG-3), Background Reference Area 4 (BG-4), Survey Area A, Survey Area B, and Survey Area C. The Background Reference Areas BG-2, BG-3 and BG-4 were selected to represent the Site’s natural conditions, as described in Appendix D.1. The gamma radiation survey data and soil sample analytical results for the background reference areas and Survey Areas were evaluated to determine the appropriate ILs for the Site as follows:

1. Identify and examine potential outlier values. Potential outlier values were identified statistically and, if justified upon further examination, removed from a dataset prior to further evaluation and calculations. No data were removed from the dataset for the calculations presented in this appendix.

2. Compare data populations between BG-2 and Survey Area A, BG-3 and Survey Area B, and BG-4 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-2 and Survey Area A, BG-3 and Survey Area B, and BG-4 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 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).

At BG-2, BG-3, and BG-4, soil samples were collected randomly. Potential outliers in the BG-2, BG-3, and BG-4 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.

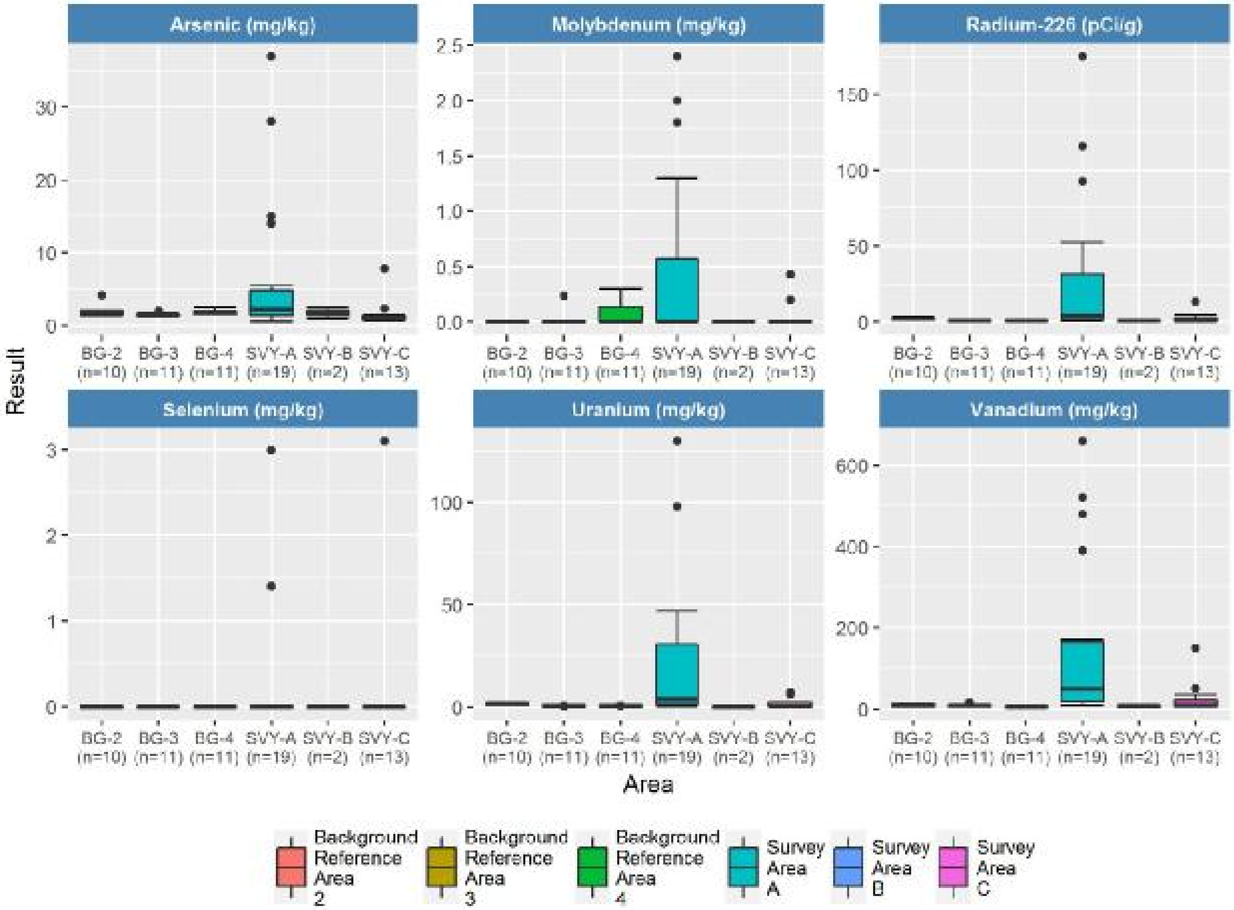
In Survey Areas A, B, and C soil samples were collected using a judgmental sampling approach. Specifically, some sample locations were selected to characterize areas of higher gamma radiation and, as a result, potential outlier values are not unexpected in the Survey Area sample statistics. Potential 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 and comparisons of the Survey Areas to BG-2, BG-3, and BG-4 are still presented for qualitative assessment. However, potential outlier values in the Survey Areas are not evaluated further nor removed from the dataset.

3.1.1 Box plots

Box plots depict descriptive statistics from a group of data (Figure 1A). The interquartile range is represented by the bounds of the box, the minimum and maximum values, not including potential outlier values (extreme values), are depicted by the whiskers (vertical lines), and any potential outliers are identified as singular dots. Potential outliers in this context are defined as values outside 1.5 times the interquartile range above or below the box.

3.1.1.1 Soil Sample Results Boxplots

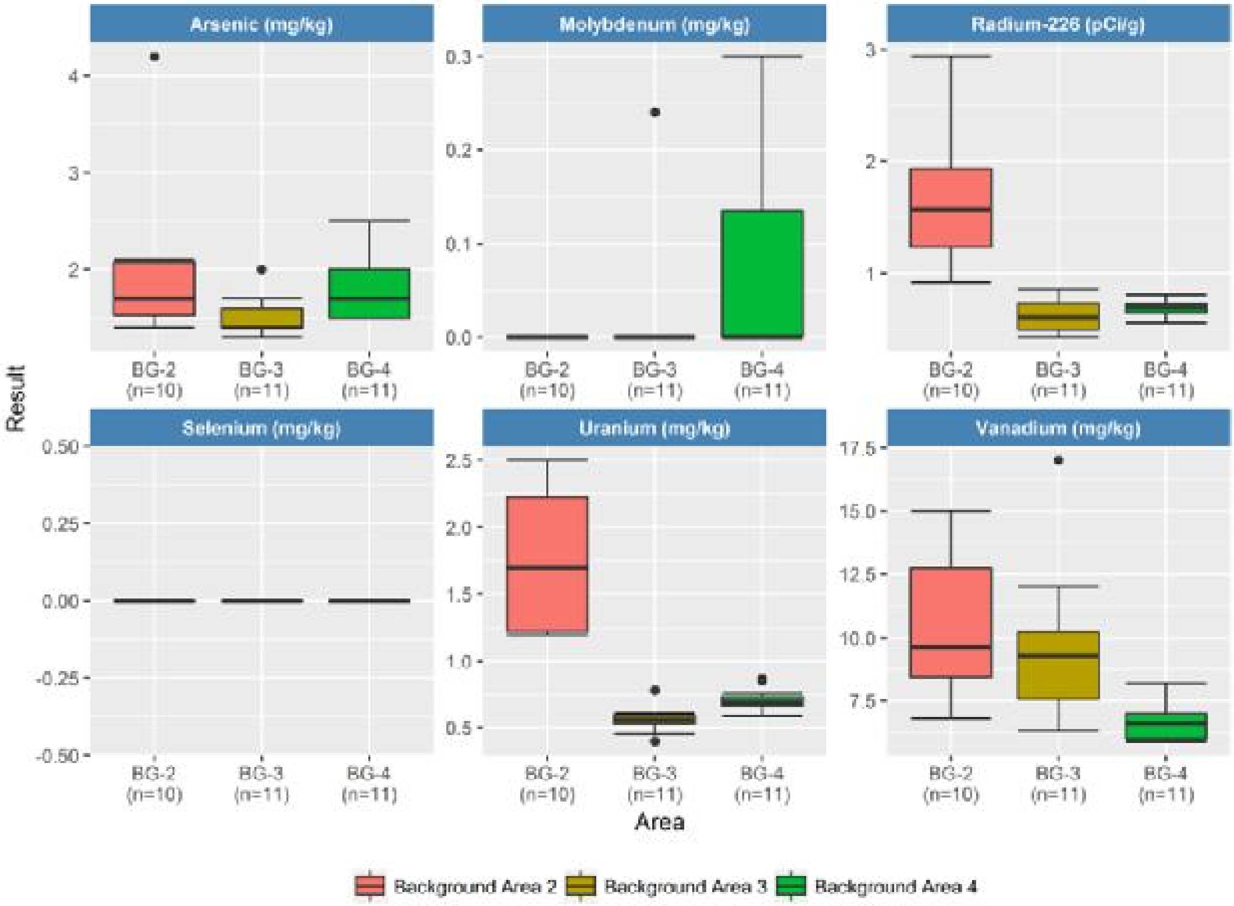
Figure 1A. Survey Areas A, B, C and Background Reference Areas 2 (BG-2), 3 (BG-3) and 4 (BG-4) Soil Sample Boxplots



The soil sample box plots shown on Figure 1A depict differences in the data distribution for analytical constituent concentrations between background reference areas and Survey Areas. Some potential outlier values are shown for both background reference areas and the Survey Areas at the Site.

Potential outlier values are of greatest concern in the background reference area datasets as the data from background reference areas are used to determine the ILs. Background reference area data are presented alone in Figure 1B.

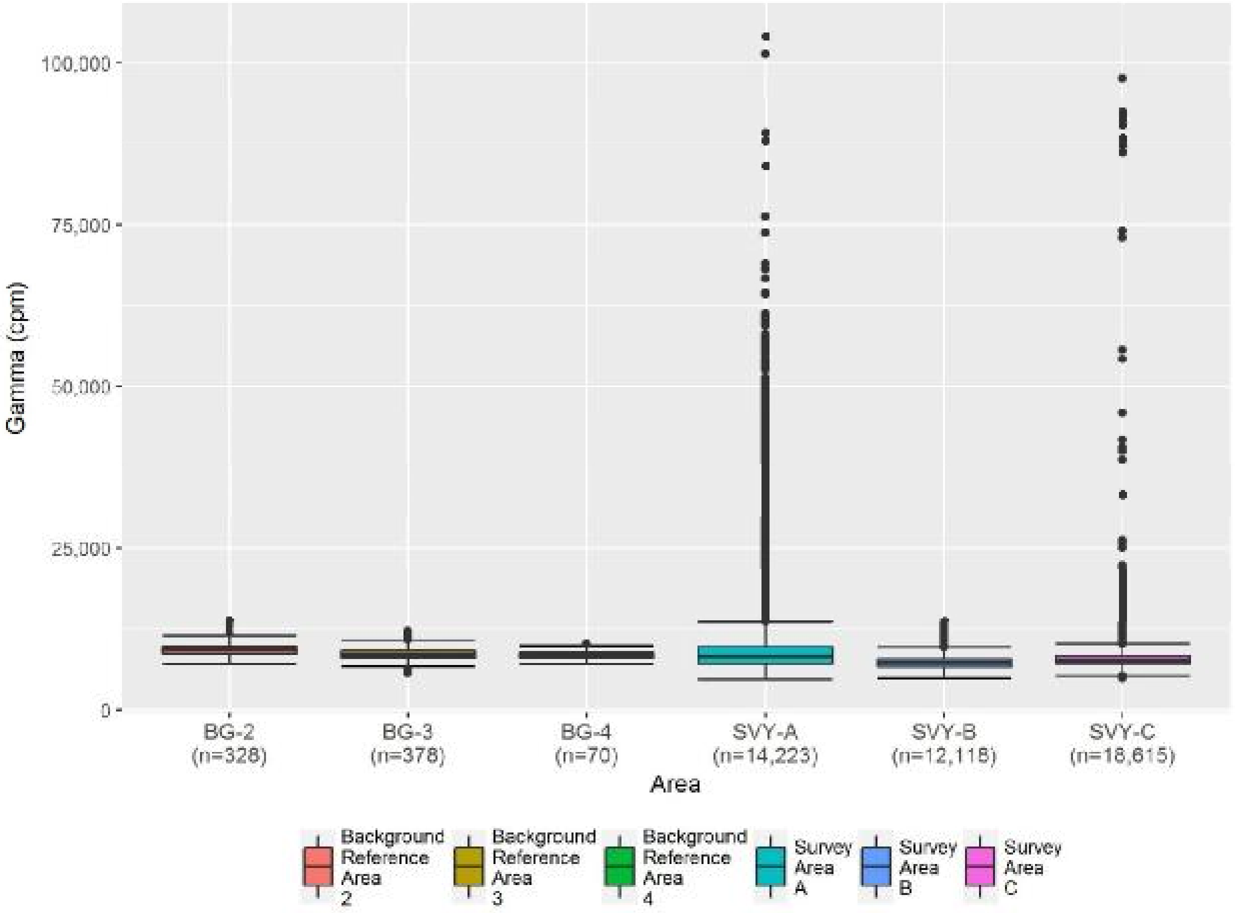
Figure 1B. Background Reference Areas 2 (BG-2), 3 (BG-3) and 4 (BG-4) Soil Sample Boxplots



As shown in the Figure 1B box plots, several potential outlier values are identified (i.e., outside 1.5 times the interquartile range). For arsenic (As), one high value at BG-2 and two high values and BG-3, molybdenum (Mo) (one high value at BG-3), uranium (one high value and one low value at BG-3, and two high values at BG-4. One high value for vanadium (V) can also be seen at BG-3. These potential outliers are further evaluated with the use of probability plots in Section 3.1.2 and statistical outlier testing in Section 3.1.3.

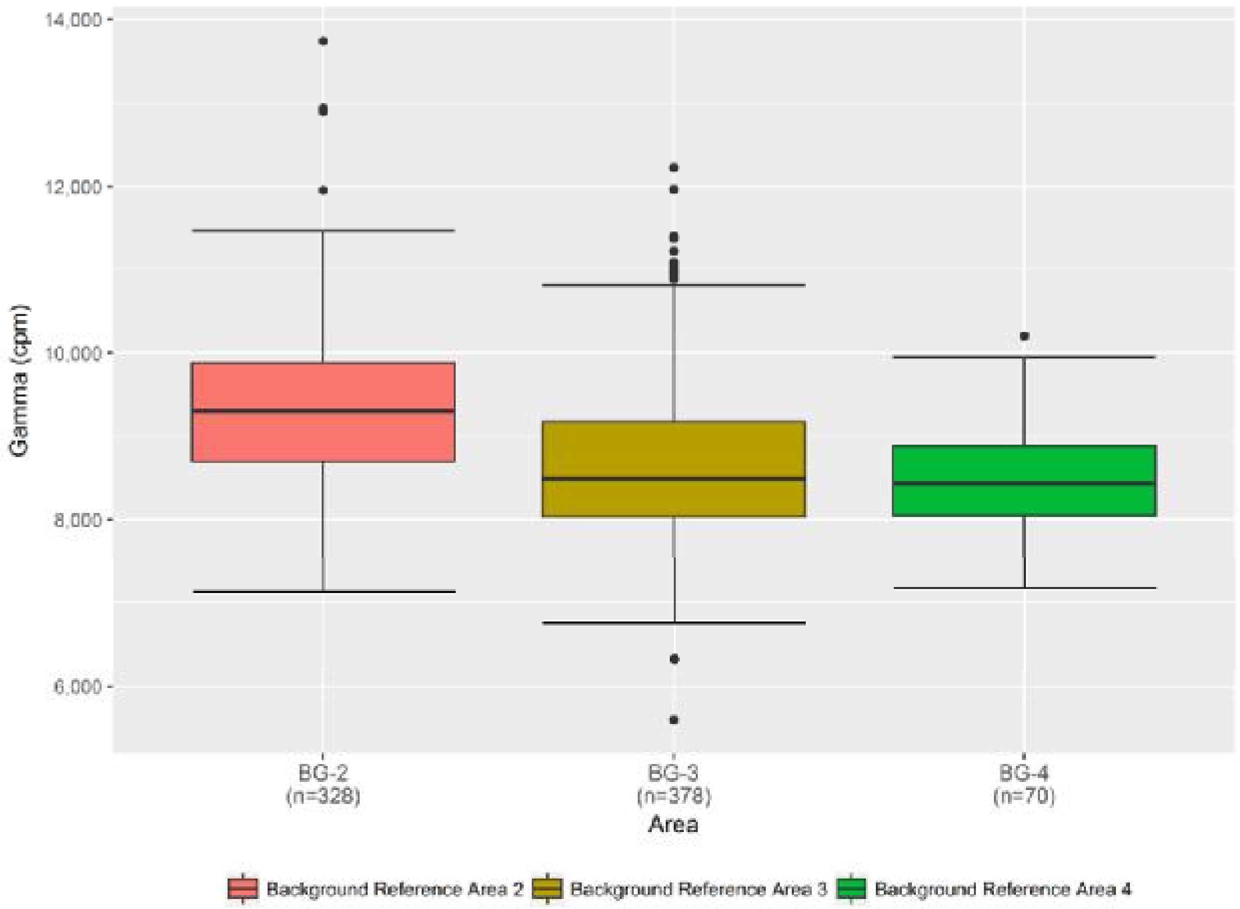
3.1.1.2 Gamma Radiation Results Boxplots

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 background reference areas and Survey Areas. There are a number of potential outlier values in the box plots for the Survey Areas, which may indicate skewness or possibly non-normally distributed data, instead of outlier values. This has been further evaluated with the use of probability plots in Section 3.1.2 and statistical testing in Section 3.1.4. Based on a review of the Site geology, the gamma radiation potential outlier values observed for the Survey Area data on Figure 2A represent localized areas of higher gamma radiation with respect to other parts of the Survey Areas, as would be expected in areas with varying levels of mineralization, naturally occurring radioactive material (NORM), and potential TENORM.

Figure 2B. Background Reference Area Gamma Radiation Box Plots



Additionally, there are four, 16, and one potential outlier values shown for gamma data in the BG-2, BG-3, and BG-4 datasets, respectively (refer to Figure 2B). However, these potential outlier values are not very high, represent a very small proportion of the total BG-2, BG-3, and BG-4 gamma datasets, and there is no other compelling rationale to reject these data based on the box plot evaluations alone.

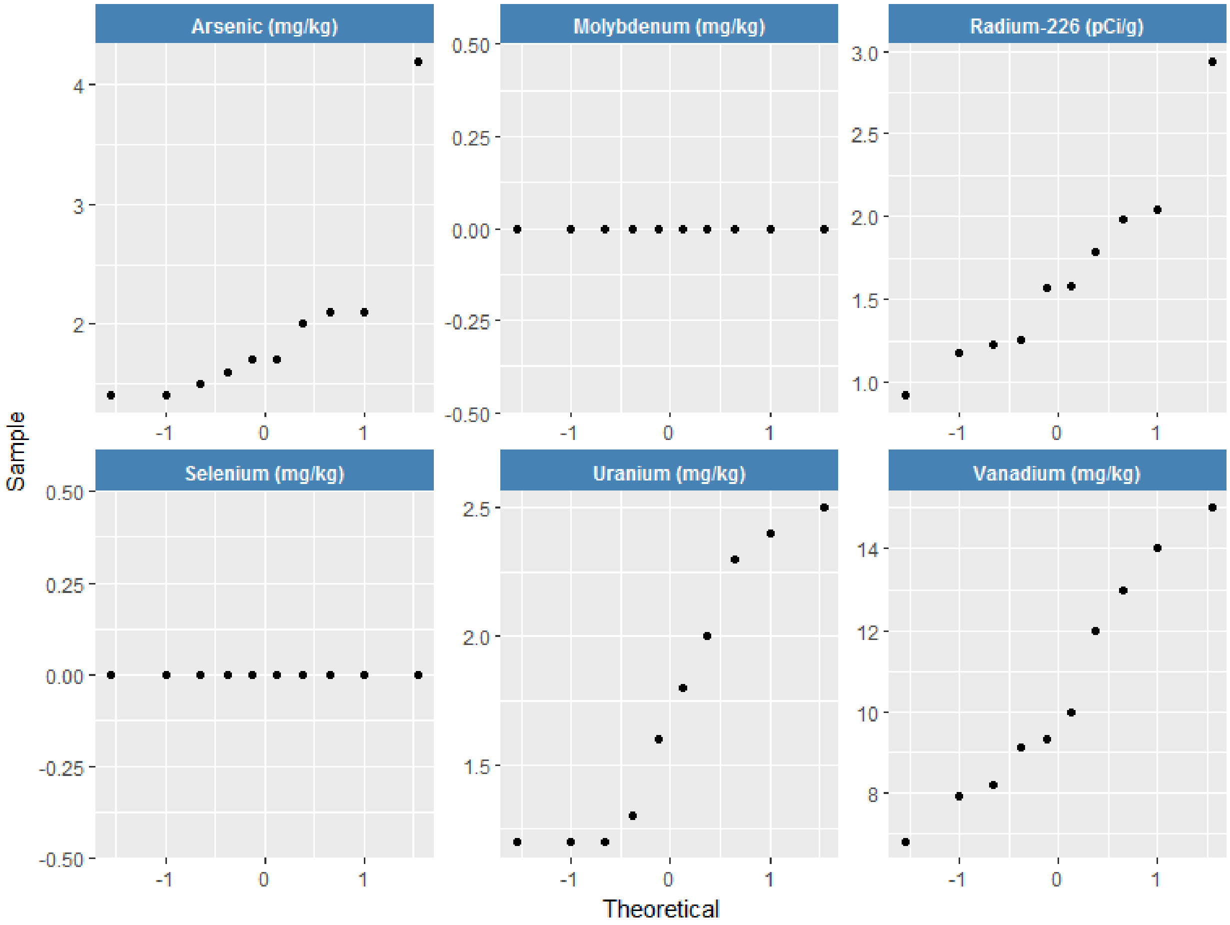
3.1.2 Probability Plots

The normal probability plot is a graphical technique for assessing whether or not a dataset 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 lognormally distributed data, and "S"-shaped lines may indicate two distinct groups within the dataset.

3.1.2.1 Soil Sample Results Probability Plots

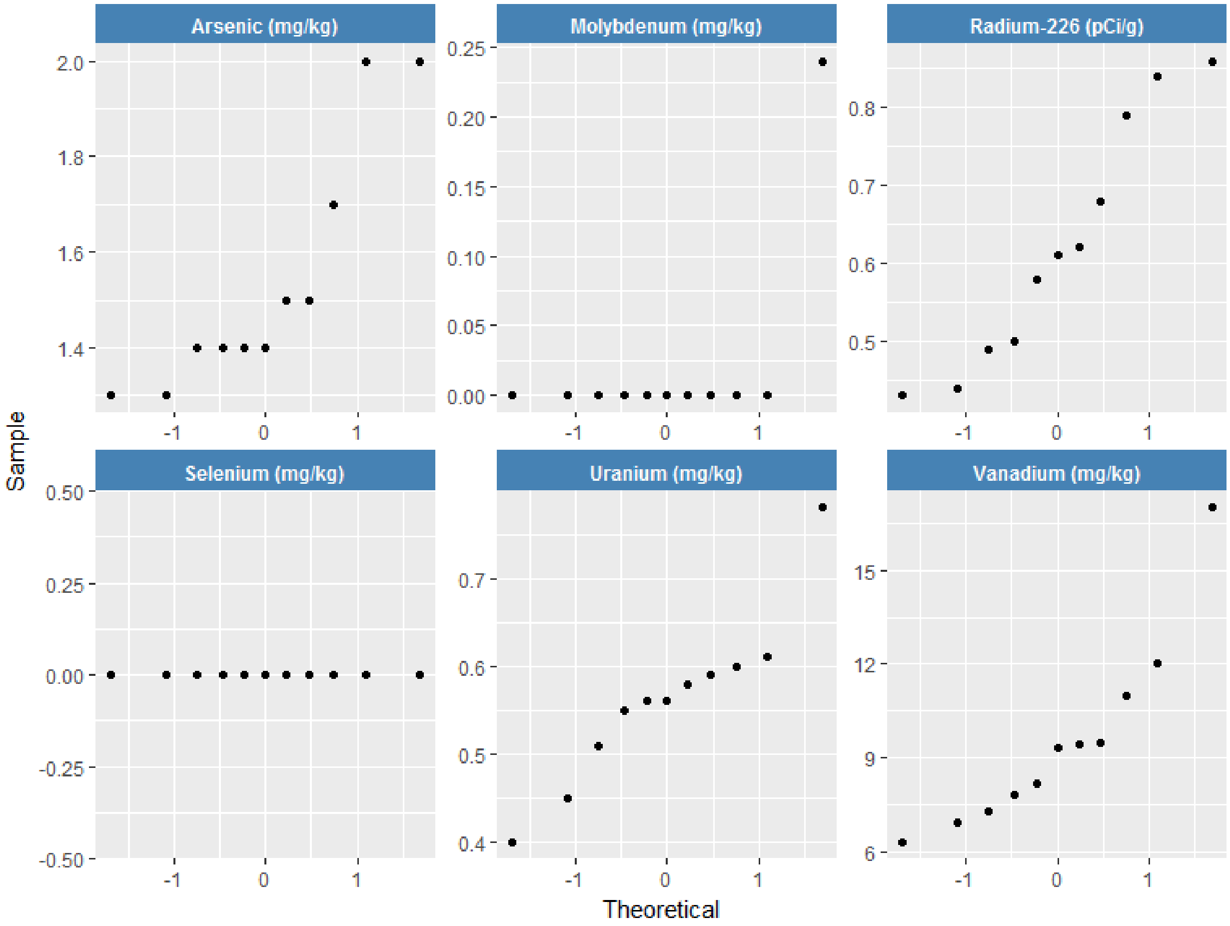
Figures 3 through 5 depict the probability plots for metals and Ra-226 results at BG-2, BG-3, and BG-4.

Figure 3. Background Reference Area 2 (BG-2) Soil Sample Probability Plots



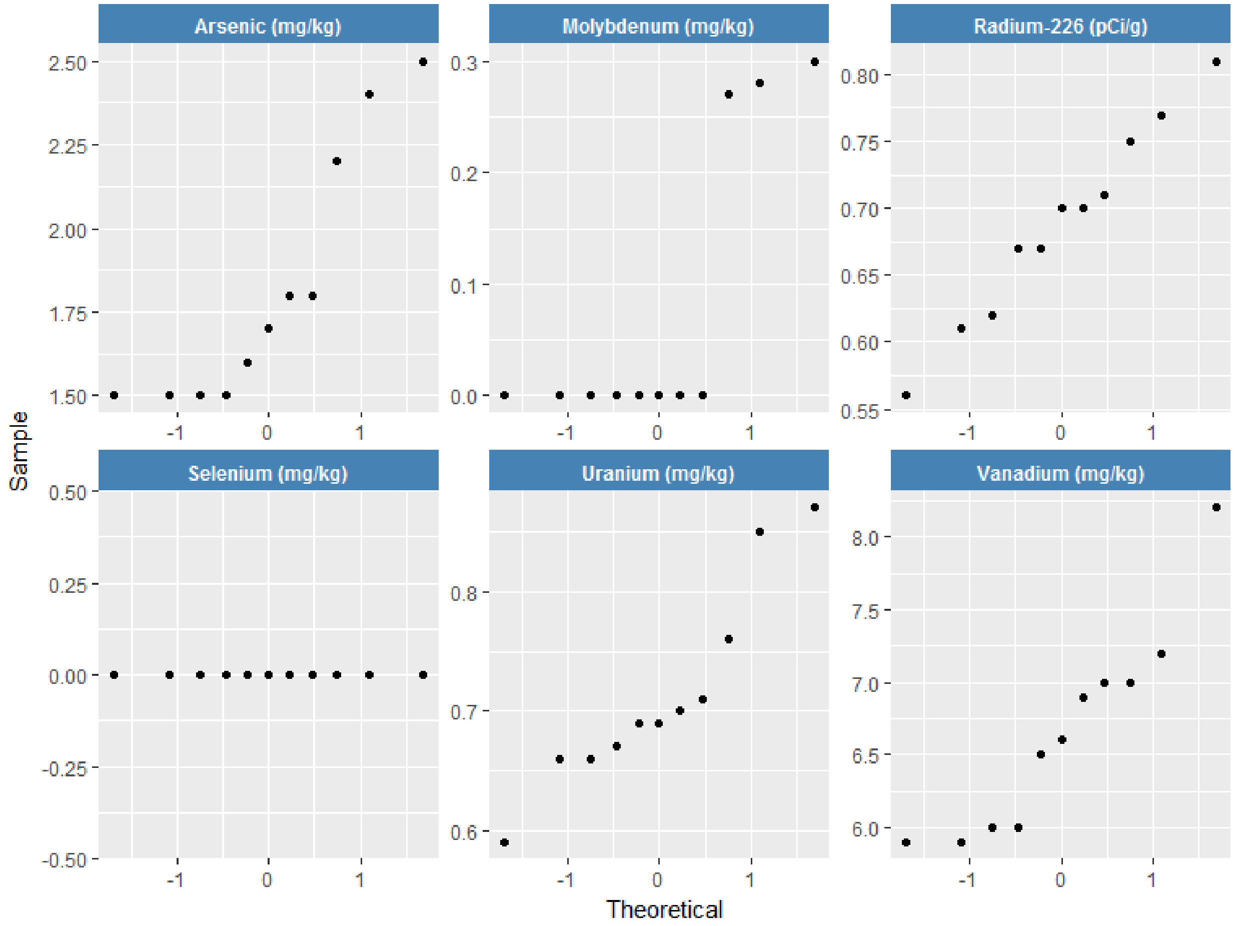
One value for arsenic was identified as a potential outlier in the box plots in Figure 1B. When viewed in the probability plots in Figure 3, this value does appear to be higher than, and out of line with, the rest of the arsenic dataset. This value was tested for statistical significance as a potential outlier in Section 3.1.3. All 10 soil samples collected from BG-2 were non-detect for both molybdenum and selenium.

Figure 4. Background Reference Area 3 (BG-3) Soil Sample Probability Plots



Two high values in the arsenic dataset, one high value in the molybdenum dataset, one high value and one low value in the uranium dataset, and one high value in the vanadium dataset were identified as potential outliers in the box plots in Figure 1B. When viewed in the probability plots in Figure 4, the highest two arsenic values do appear to be higher than the rest of the arsenic values, but still conform to the general shape of the dataset. The highest molybdenum value is substantially higher than the rest of the dataset; however, the other 10 sample results at BG-3 were non-detect for molybdenum and the non-detect values were each plotted using an assigned value of 0 mg/kg. As a result, the single detection appears artificially elevated. The single detect in the molybdenum dataset is anomalous, but as the remaining non-detect values cannot be evaluated statistically it is not considered further as a potential outlier. The highest uranium value does appear to be substantially higher than the rest of the vanadium values, while the low value potential outlier conforms more closely to the general shape of the dataset. The high vanadium value also appears to be substantially higher than the rest of the vanadium dataset, but conforms to the general shape of the data distribution. These values were tested for statistical significance as potential outliers in Section 3.1.3. All 11 soil samples collected from BG-3 were non-detect for selenium.

Figure 5. Background Reference Area 4 (BG-4) Soil Sample Probability Plots

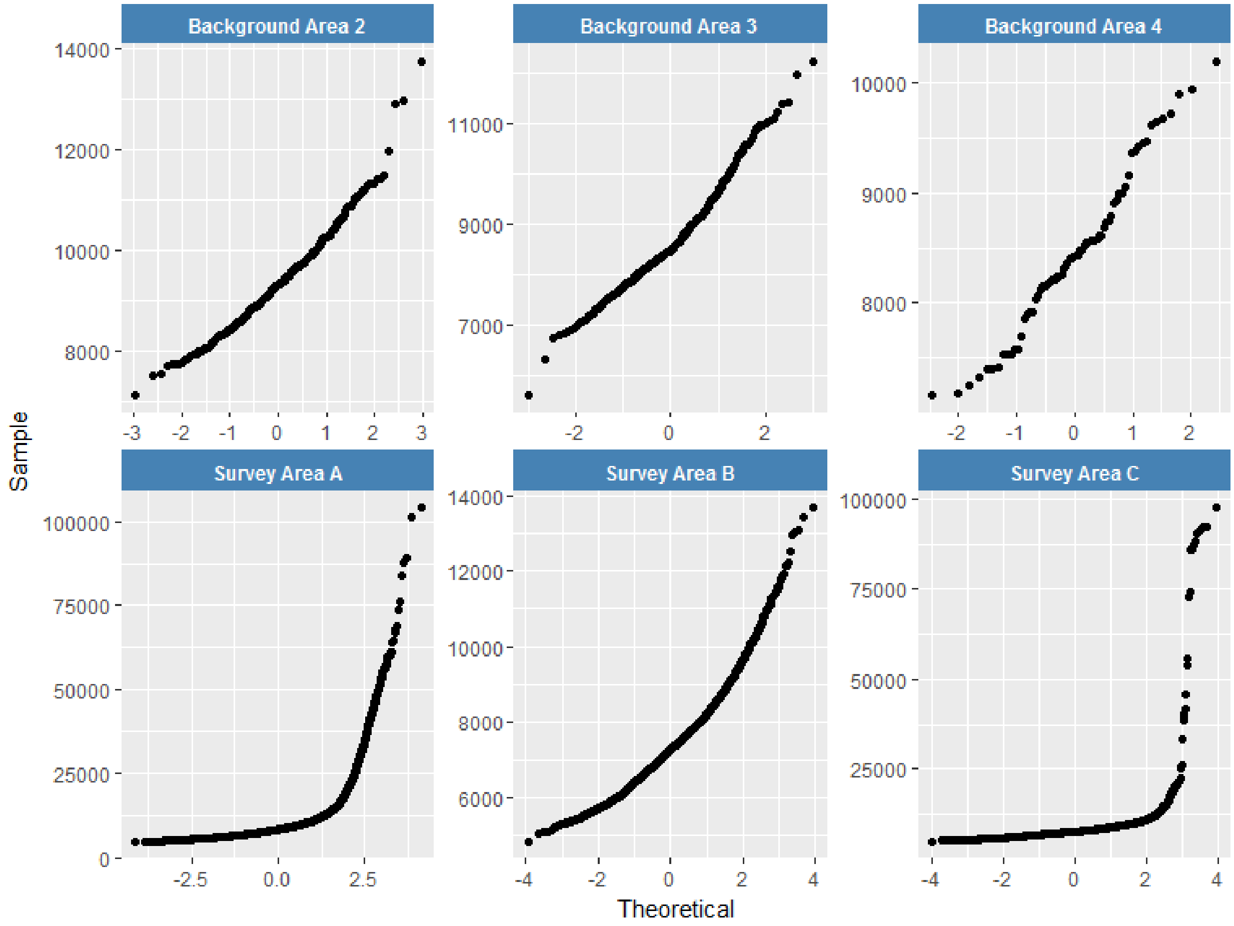


Two values for uranium were identified as potential high outliers in the box plots in Figure 1B. When viewed in the probability plot in Figure 5, these values do appear to be substantially higher than the rest of the values in this dataset. These values were tested for statistical significance as potential outliers in Section 3.1.3. All 11 soil samples at BG-4 were non-detect for selenium.

3.1.2.2 Gamma Survey Results Probability Plots

Figure 6 depicts the probability plots for gamma radiation results at the background reference areas and the Survey Areas.

Figure 6. Survey Area and Background Reference Area Gamma Probability Plots



Gamma survey results indicate a generally normal distribution in the background reference area datasets, and likely a non-normal distribution in the Survey Area datasets (Figure 6). When viewed in the probability plots, the values identified as potential outliers in the BG-2 gamma dataset do not appear to conform to the general shape of the distribution of the BG-2 gamma data, while the potential outliers in the BG-3 and BG-4 datasets do conform. Potential outliers at all three background reference areas do appear elevated in the Figure 6 probability plots, and these values are further evaluated with the use of statistical testing in Section 3.1.4.

The shape and smoothness of the probability plots for the Survey Area gamma results confirms that the gamma radiation data are more log-normally distributed than the background reference area gamma results. This suggests that these higher values are not potential outliers but rather are representative of the spatial variability of gamma radiation in the Survey Areas.

3.1.3 Potential Soil Sample Data Outliers

Seven high results and one low result are identified as potential outlier values in the background reference area datasets in the box plots in Figure 1B and probability plots in Figures 3 through 5.

These values are:

Background Reference Area 2 (BG-2)

- Arsenic: 4.20 mg/kg

Background Reference Area 3 (BG-3)

- Arsenic: 2.00 mg/kg, 2.00 mg/kg
- Uranium: 0.400 mg/kg (low); 0.780 mg/kg
- Vanadium: 17.0 mg/kg

Background Reference Area 4 (BG-4)

- Uranium: 0.870 mg/kg, 0.850 mg/kg

Dixon's Test (Dixon, 1953) is designed to be used for datasets containing only one or two potential outlier values. Therefore, Dixon's Test was performed to the 95% confidence level on each of the eight 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
Background Reference Area 2 (BG-2)	As	S059-BG2-006	Dixon test for potential outliers	High value 4.20 is a potential outlier	< 0.05	Hypothesis accepted
Background Reference Area 3 (BG-3)	V	S059-BG3-009	Dixon test for potential outliers	High value 17.0 is a potential outlier	> 0.05	Hypothesis rejected
	As	S059-BG3-010	Dixon test for potential outliers	High value 2.00 is a potential outlier	> 0.05	Hypothesis rejected
		S059-SCX-003	Dixon test for potential outliers	High value 2.00 is a potential outlier	> 0.05	Hypothesis rejected
	U	S059-BG3-007	Dixon test for potential outliers	High value 0.780 is a potential outlier	> 0.05	Hypothesis rejected
		S059-BG3-001	Dixon test for potential outliers	Low value 0.400 is a potential outlier	> 0.05	Hypothesis rejected
Background Reference Area 4 (BG-4)	U	S059-BG4-009	Dixon test for potential outliers	High value 0.870 is a potential outlier	> 0.05	Hypothesis rejected
		S059-BG4-004	Dixon test for potential outliers	High value 0.850 is a potential outlier	> 0.05	Hypothesis rejected

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

The test confirms that one of the eight potential outlier values tested, is statistically significant (p value <0.05). The statistically significant potential outlier value for arsenic in BG-2 was further investigated by reviewing sample forms, field notes and laboratory reports. Field staff and field notes indicated nothing abnormal about the location where this sample was collected, and the laboratory dataset does not show any data quality flags were applied to this value that would call its accuracy into question. Therefore, while this value is: 1) outside the interquartile range of the dataset (Figure 1B), 2) might not conform with the dataset distribution in the probability plot (Figure 4), and 3) is deemed a potential outlier by Dixon's Test, it was not removed from the background reference area dataset because no scientific reason was found to justify removing it. The value is considered representative of the natural variation at BG-2. However, descriptive statistics were calculated with and without this value for comparison (Section 3.3.1).

3.1.4 Potential Gamma Data Outliers

A total of 21 potential gamma survey outliers were observed among the background reference area gamma datasets; the 19 high and two low values were initially identified in the box plots in Figure 2B. When viewed in the probability plots in Figure 6, the highest BG-2 values do not appear to conform to the general distribution of the BG-2 gamma dataset. Likewise, for BG-3 and BG-4, the highest and lowest potential outlier values do not appear to conform to their respective general distributions in Figure 6.

Because the number of values in the background reference area gamma datasets is each >30, Dixon’s Test was not appropriate for potential outlier testing. Instead, because the values appear to be generally normally distributed, it was appropriate to identify potential outliers using Z, t and chi squared scoring methods at the 95% confidence level. These tests were performed in the 'Outliers' package in R (Lukasz Komsta, 2011), and the results are summarized in Table 2. The R programming language complements ProUCL in its ability to provide more meaningful and useful graphics and summarizes the results equivalent to ProUCL. Because ProUCL and R packages follow similar statistical procedures, the results are comparable. The interquartile range evaluation (values outside 1.5 times the interquartile range) results are also provided in Table 2.

The potential outlier values presented in Table 2 represent 21 out of 776 data points (3 percent). One possible reason for the potential outliers in the gamma radiation dataset may be the presence of a localized source of radiation within the background reference areas. This was evaluated by examining the relative position of the potential outlier values relative to each other.

In BG-2, the four potential outlier values occur within an approximately 400 square foot area in the southern portion of BG-2. The values are not clustered together to any further extent. In BG-3, the fourteen high and two low potential outlier values are located in the southern portion of BG-3. These values are not clustered together to any extent. In BG-4, there is only one potential outlier value.

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 2 (BG-2)	13,741	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,945	High	Potential Outlier	Potential Outlier	Potential Outlier
	12,900	High	Potential Outlier	Potential Outlier	Potential Outlier
	11,959	High	Potential Outlier	Potential Outlier	Potential Outlier
Background Reference Area 3 (BG-3)	12,226	High	Potential Outlier	Potential Outlier	Potential Outlier
	11,966	High	Potential Outlier	Potential Outlier	Potential Outlier
	11,399	High	Potential Outlier	Potential Outlier	Potential Outlier
	11,370	High	Potential Outlier	Potential Outlier	Potential Outlier
	11,219	High	Potential Outlier	Potential Outlier	Potential Outlier
	11,083	High	Potential Outlier	Potential Outlier	Potential Outlier
	11,067	High	Potential Outlier	Potential Outlier	Potential Outlier
	11,019	High	Potential Outlier	Potential Outlier	Potential Outlier
	10,991	High	Potential Outlier	Potential Outlier	Potential Outlier
	10,964	High	Potential Outlier	Potential Outlier	Potential Outlier
	10,958	High	Potential Outlier	Potential Outlier	Potential Outlier
	10,946	High	Potential Outlier	Potential Outlier	Potential Outlier
	10,910	High	Potential Outlier	Potential Outlier	Potential Outlier
	10,893	High	Potential Outlier	Potential Outlier	Potential Outlier
	6,318	Low	Potential Outlier	Potential Outlier	Potential Outlier
	5,599	Low	Potential Outlier	Potential Outlier	Potential Outlier
Background Reference Area 4 (BG-4)	10,204	High	Potential Outlier	Potential Outlier	Potential Outlier

cpm Counts per minute

While the potential outlier observations for the values presented in Table 2 explain the presence and position of these values in the dataset, nothing in field notes or the gamma data records indicates a scientific reason for these values to be excluded from the dataset (e.g., data handling error, equipment malfunction), and there is no record of anomalous soil or other material at BG-2, BG-3 or BG-4. Therefore, the values are considered representative of the natural variation present in these background reference areas, and there is no basis to remove them from the gamma dataset. However, descriptive statistics were calculated with and without these values for comparison (Section 3.3.2).

Potential outlier values in the gamma dataset for the Survey Areas appear in the Figure 2A box plots. However, because of the non-linear shape and continuous distribution of gamma results shown in the probability plot in Figure 6, these values are thought to be representative of the heterogeneous nature of radioactive materials within the Survey Areas and are not outlier values. Indeed, Figure 4-1 of the RSE Report shows that while gamma results for the majority of each of the Survey Areas are within the range of background, localized areas of elevated gamma results associated with mineralized areas are also present.

3.2 COMPARE DATA POPULATIONS

Group comparison analyses provide insight into the relative concentrations of constituents between background reference areas and the Survey Areas. Observations made during these analyses may indicate the need for further evaluation or discussion regarding the influence of potential outlier values, and the use of background data. For instance, if two or more background reference areas were determined to be statistically similar to each other, these data could be combined to calculate more robust statistics (not a factor in this evaluation, as one background area each was selected to represent the three Survey Areas). 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, topographic gradient, distance from the site being represented, wind direction and non-impacted condition 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 BG-2, BG-3, and BG-4 and the Survey Areas. Relative data distributions were investigated by evaluating the box plots 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 Boxplots

3.2.1.1 Soil Sample Boxplots

When interpreting the soil sample box plots in Figures 1A and 1B, it is important to note that samples at background reference areas were collected randomly, while samples in the Survey Areas were collected judgmentally from areas of suspected contamination. Analytic constituent results from background reference areas tend to be lower than, or similar to, analytical results from the Survey Areas. Arsenic, molybdenum, Ra-226, uranium, and vanadium concentrations are all lower at BG-2 than at Survey Area A, which generally showed the highest metal concentrations across the three Survey Areas. In comparing BG-3 to Survey Area B, and BG-4 to Survey Area C, results were generally similar, and low.

Analytical constituent-specific observations from the box plots in Figures 1A and 1B indicate:

- Arsenic. Arsenic results are similar across all background reference areas and Survey Areas, with Survey Area A showing the highest range of values.
- Molybdenum. Molybdenum results are similar across BG-2, BG-3, BG-4, and Survey Areas B and C, and are elevated at Survey Area A.
- Ra-226. Ra-226 results are similarly low at BG-2, BG-3, BG-4 and Survey Areas B and C. Concentrations of Ra-226 at Survey Area A are elevated.
- Selenium. Selenium was detected at Survey Area A and C only.
- Uranium. Uranium results appear similar amongst BG-2, BG-3, and BG-4, and Survey Areas B and C. Concentrations of uranium are elevated at Survey Area A.
- Vanadium. Vanadium results are similar across BG-2, BG-3, and BG-4, and Survey Areas B and C. Concentrations are elevated at Survey Area A.

3.2.1.2 Gamma Radiation Boxplots and Probability Plots

The box plot comparison in Figures 2A and 2B suggests that median values are similar between background reference areas and Survey Areas. Gamma radiation data distributions between background reference areas and Survey Areas shown on Figure 6 are not similar (normal vs. non-normal, respectively). These observations are verified in Section 3.2.2 using the non-parametric Mann-Whitney test.

3.2.2 Mann-Whitney Testing

The Mann-Whitney test (Bain and Engelhardt, 1992) is a nonparametric test used for determining whether a difference exists between two or more population distributions. This test is also known as the Wilcoxon Rank Sum (WRS) test. This test evaluates whether measurements from one population consistently tend to be larger (or smaller) than those from another population. This test was selected over other comparative tests such as the Student's t test and analysis of variance (ANOVA) because it remains robust in the absence of required assumptions that these two tests require, such as normally distributed data and equality of variances.

Soil samples at the background reference areas were collected randomly, while soil samples in the Survey Areas were collected judgmentally (see Section 3.1). Mann-Whitney testing is not appropriate for comparative analysis if one or both groups contain data collected using a judgmental approach. Therefore, the Mann-Whitney tests were not performed with soil sample data from BG-2, BG-3, and BG-4 or the Survey Areas. The gamma radiation data, however, do represent non-judgmental sampling, and so the Mann-Whitney test was appropriate for comparison between BG-2, BG-3, and BG-4 and the Survey Areas (Table 3). Therefore, the test was performed 2-sided between background areas, with and without potential outlier values, and the Survey Areas. The two-sided test accounts for results from one group being lower or higher than any other group (i.e., 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 2 (BG-2) vs Survey Area A	<0.05	Significant Difference
Background Reference Area 2 (BG-2) Potential Outliers Excluded vs Background Reference Area 2 (BG-2)	0.788	No Significant Difference
Background Reference Area 2 (BG-2) Potential Outliers Excluded vs Survey Area A	<0.05	Significant Difference
Background Reference Area 3 (BG-3) vs Survey Area B	<0.05	Significant Difference
Background Reference Area 3 (BG-3) Potential Outliers Excluded vs Background Reference Area 3 (BG-3)	0.455	No Significant Difference
Background Reference Area 3 (BG-3) Potential Outliers Excluded vs Survey Area B	<0.05	Significant Difference
Background Reference Area 4 (BG-4) vs Survey Area C	<0.05	Significant Difference
Background Reference Area 4 (BG-4) Potential Outliers Excluded vs Background Reference Area 4 (BG-4)	0.886	No Significant Difference
Background Reference Area 4 (BG-4) Potential Outliers Excluded vs Survey Area C	<0.05	Significant Difference
Background Reference Area 2 (BG-2) vs Background Reference Area 3 (BG-3)	<0.05	Significant Difference
Background Reference Area 2 (BG-2) vs Background Reference Area 4 (BG-4)	<0.05	Significant Difference
Background Reference Area 3 (BG-3) vs Background Reference Area 4 (BG-4)	0.205	No 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 each of the background reference areas with respect to their respective Survey Areas; this observation is valid both with and without inclusion of potential outliers in each of the background reference area datasets.
- Additionally, gamma results are statistically elevated at Survey Area A relative to Survey Areas B and C, and at Survey Area C relative to Survey Area B. Gamma results at BG-2 are statistically elevated relative to BG-3 and BG-4; however, gamma results at BG-3 are not statistically elevated relative to BG-4.
- Although the mean gamma results are higher at all three of the background reference areas relative to their respective Survey Areas, maximum gamma results are higher at each of the Survey Areas when compared to their respective background reference areas. This observation is likely attributable to the fact that background reference area datasets may not represent the full degree of natural mineralization present at the Survey Areas, but are approximately representative of the central tendency of that mineralization.

- The inclusion or removal of potential outlier values has no effect on the results of the Mann-Whitney test between BG-2 and Survey Area A, BG-3 and Survey Area B, or BG-4 and Survey Area C (i.e., there is a statistically significant difference in gamma results between the background reference areas and the Survey Areas, with and without potential outlier values included).

3.3 DESCRIPTIVE STATISTICS

Descriptive statistics, including the upper confidence limit (UCL) of the mean and the 95-95 upper tolerance limit (UTL), were calculated from gamma survey data and soil sample results. Descriptive statistics are important for any data evaluation to present the basic statistics of a dataset with regards to its limits (maximum and minimum), central tendencies (mean and median) as well as data dispersion (coefficient of variance). The ILs for the Site 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 potential outlier values previously identified, as applicable. Select descriptive statistics for these constituents are presented in Tables 4 and 5.

3.3.1 Soil Sample Analytical Results Summary

Table 4 presents the descriptive statistics output from the ProUCL software for the soil sample results.

As described in Section 3.2.1.1, results for all analytical constituents appear elevated at Survey Area A relative to Survey Areas B and C and the background reference areas. Selenium was detected only at Survey Areas A and C. An important consideration when comparing concentrations of metals and Ra-226 between background reference areas and Survey Areas is that selection of background reference areas is intended to identify areas that are 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). In addition, soil sampling for metals and Ra-226 in background reference areas was conducted in a random manner, whereas soil sampling for metals and Ra-226 in Survey Areas was judgmental. As a result, it is not surprising that some metals and Ra-226 concentrations in the Survey Areas appear to be elevated relative to concentrations in background reference areas. It should be noted, however, that concentrations of several of the metals analyzed for 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, mean detected concentrations of the metals in the Survey Areas (when detected) are within typical ranges reported for Western U.S soils, and may not be related to the uranium mineralization. The exceptions to the above are the elevated arsenic, uranium and vanadium concentrations at Survey Area A, which are likely attributable to historical 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 2 (BG-2) All Data	Total Number of Observations	10	10	10	10	10	10
	Percent Non-Detects	--	100%	100%	--	--	--
	Minimum[1]	1.40	--	--	1.20	6.80	0.920
	Minimum Detect[2]	--	--	--	--	--	--
	Mean[1]	1.97	--	--	1.75	10.5	1.65
	Mean Detects[2]	--	--	--	--	--	--
	Median[1]	1.70	--	--	1.70	9.65	1.58
	Maximum[1]	4.20	--	--	2.50	15.0	2.94
	Maximum Detect[2]	--	--	--	--	--	--
	Distribution	Normal	Not Calculated	Not Calculated	Normal	Normal	Normal
	Coefficient of Variation[1]	0.420	--	--	0.300	0.266	0.352
	UCL Type	95% Student's-t UCL	Not Calculated	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL
	UCL Result	2.45	Not Calculated	Not Calculated	2.06	12.2	1.99
	UTL Type	UTL Normal	Not Calculated	Not Calculated	UTL Normal	UTL Normal	UTL Normal
	UTL Result	4.38	Not Calculated	Not Calculated	3.28	18.7	3.34
Background Reference Area 2 (BG-2) Excluding Potential Outliers [3]	Total Number of Observations	9	--	--	--	--	--
	Minimum[1]	1.40	--	--	--	--	--
	Mean[1]	1.72	--	--	--	--	--
	Median[1]	1.70	--	--	--	--	--
	Maximum[1]	2.10	--	--	--	--	--
	Distribution	Normal	--	--	--	--	--
	Coefficient of Variation[1]	0.164	--	--	--	--	--
	UCL Type	95% Student's-t UCL	--	--	--	--	--
	UCL Result	1.90	--	--	--	--	--
	UTL Type	UTL Normal	--	--	--	--	--
	UTL Result	2.58	--	--	--	--	--
Background Reference Area 3 (BG-3) All Data	Total Number of Observations	11	11	11	11	11	11
	Percent Non-Detects	--	91%	100%	--	--	--
	Minimum[1]	1.30	--	--	0.400	6.30	0.430
	Minimum Detect[2]	--	0.240	--	--	--	--
	Mean[1]	1.54	--	--	0.563	9.52	0.622
	Mean Detects[2]	--	0.240	--	--	--	--
	Median[1]	1.40	--	--	0.560	9.30	0.610
	Maximum[1]	2.00	--	--	0.780	17.0	0.860
	Maximum Detect[2]	--	0.240	--	--	--	--
	Distribution	Normal	Not Calculated	Not Calculated	Normal	Normal	Normal
	Coefficient of Variation[1]	0.165	--	--	0.172	0.317	0.249
	UCL Type	95% Student's-t UCL	Not Calculated	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL
	UCL Result	1.68	Not Calculated	Not Calculated	0.616	11.2	0.706
	UTL Type	UTL Normal	Not Calculated	Not Calculated	UTL Normal	UTL Normal	UTL Normal
	UTL Result	2.25	Not Calculated	Not Calculated	0.836	18.0	1.06

Area	Statistic	Arsenic (mg/kg)	Molybdenum (mg/kg)	Selenium (mg/kg)	Uranium (mg/kg)	Vanadium (mg/kg)	Radium-226 (pCi/g)
Background Reference Area 4 (BG-4) All Data	Total Number of Observations	11	11	11	11	11	11
	Percent Non-Detects	--	73%	100%	--	--	--
	Minimum[1]	1.50	--	--	0.590	5.90	0.560
	Minimum Detect[2]	--	0.270	--	--	--	--
	Mean[1]	1.82	--	--	0.714	6.66	0.688
	Mean Detects[2]	--	0.283	--	--	--	--
	Median[1]	1.70	--	--	0.690	6.60	0.700
	Median Detects[2]	--	0.280	--	--	--	--
	Maximum[1]	2.50	--	--	0.870	8.20	0.810
	Maximum Detect[2]	--	0.300	--	--	--	--
	Distribution	Normal	Normal	Not Calculated	Normal	Normal	Normal
	Coefficient of Variation[1]	0.207	--	--	0.117	0.106	0.107
	CV Detects[2]	--	0.054	--	--	--	--
	UCL Type	95% Student's-t UCL	95% KM (t) UCL	Not Calculated	95% Student's-t UCL	95% Student's-t UCL	95% Student's-t UCL
	UCL Result	2.02	0.244	Not Calculated	0.759	7.04	0.728
	UTL Type	UTL Normal	UTL KM Normal	Not Calculated	UTL Normal	UTL Normal	UTL Normal
	UTL Result	2.88	0.334	Not Calculated	0.948	8.65	0.895
Survey Area A	Total Number of Observations	19	19	19	19	19	19
	Percent Non-Detects	--	63%	84%	--	--	--
	Minimum[1]	0.510	--	--	0.530	9.40	0.540
	Minimum Detect[2]	--	0.320	1.40	--	--	--
	Mean[1]	6.65	--	--	22.3	151	28.5
	Mean Detects[2]	--	1.28	1.93	--	--	--
	Median[1]	2.20	--	--	4.00	50.0	4.12
	Median Detects[2]	--	1.30	1.40	--	--	--
	Maximum[1]	37.0	--	--	130	660	175
	Maximum Detect[2]	--	2.40	3.00	--	--	--
	Distribution	Unknown	Normal	Normal	Gamma	Unknown	Unknown
	Coefficient of Variation[1]	1.52	--	--	1.60	1.34	1.72
	CV Detects[2]	--	0.639	0.478	--	--	--
	UCL Type	95% Chebyshev (Mean, Sd) UCL	95% KM (t) UCL	95% KM (t) UCL	95% Adjusted Gamma UCL	95% Chebyshev (Mean, Sd) UCL	99% Chebyshev (Mean, Sd) UCL
	UCL Result	16.7	0.892	1.33	46.4	354	140
	UTL Type	UTL Non-Parametric	UTL KM Normal	UTL KM Normal	UTL Gamma WH	UTL Non-Parametric	UTL Non-Parametric
	UTL Result	37.0	2.28	2.24	151	660	175
Survey Area B	Total Number of Observations	2	2	2	2	2	2
	Percent Non-Detects	--	100%	100%	--	--	--
	Minimum[1]	0.910	--	--	0.250	6.40	0.460
	Minimum Detect[2]	--	--	--	--	--	--
	Mean[1]	1.76	--	--	0.340	7.45	0.590
	Mean Detects[2]	--	--	--	--	--	--
	Median[1]	1.76	--	--	0.340	7.45	0.590
	Maximum[1]	2.60	--	--	0.430	8.50	0.720
	Maximum Detect[2]	--	--	--	--	--	--
	Distribution	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated
	Coefficient of Variation[1]	0.681	--	--	0.374	0.199	0.312
	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	13	13	13	13	13	13
	Percent Non-Detects	--	85%	92%	--	--	8%
	Minimum[1]	0.660	--	--	0.430	7.10	--
	Minimum Detect[2]	--	0.200	3.10	--	--	0.400
	Mean[1]	1.61	--	--	2.26	26.3	--
	Mean Detects[2]	--	0.315	3.10	--	--	2.50
	Median[1]	0.960	--	--	0.550	8.80	--
	Median Detects[2]	--	0.315	--	--	--	0.720
	Maximum[1]	7.80	--	--	7.30	150	--
	Maximum Detect[2]	--	0.430	3.10	--	--	13.8
	Distribution	Unknown	Unknown	Not Calculated	Unknown	Unknown	Unknown
	Coefficient of Variation[1]	1.19	--	--	1.18	1.51	--
	CV Detects[2]	--	0.516	--	--	--	1.53
	UCL Type	95% Chebyshev (Mean, Sd) UCL	95% KM (Chebyshev) UCL	Not Calculated	95% Chebyshev (Mean, Sd) UCL	95% Chebyshev (Mean, Sd) UCL	95% KM (Chebyshev) UCL
	UCL Result	3.92	0.322	Not Calculated	5.48	74.1	6.83
	UTL Type	UTL Non-Parametric	Non-Parametric -Max	Not Calculated	UTL Non-Parametric	UTL Non-Parametric	Non-Parametric -Max
	UTL Result	7.80	0.430	Not Calculated	7.30	150	13.8

[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 potential outliers were identified, calculated with the potential 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 2 (BG-2) All Data	Total Number of Observations	328
	Minimum	7,118
	Mean	9,369
	Median	9,310
	Maximum	13,741
	Distribution	Normal
	Coefficient of Variation	0.101
	UCL Type	95% Student's-t UCL
	UCL Result	9,455
	UTL Type	UTL Normal
	UTL Result	11,068
Background Reference Area 2 (BG-2) Excluding Potential Outliers	Total Number of Observations	324
	Minimum	7,118
	Mean	9,326
	Median	9,300
	Maximum	11,463
	Distribution	Normal
	Coefficient of Variation	0.093
	UCL Type	95% Student's-t UCL
	UCL Result	9,405
	UTL Type	UTL Normal
	UTL Result	10,879
Background Reference Area 3 (BG-3) All Data	Total Number of Observations	378
	Minimum	5,599
	Mean	8,668
	Median	8,490
	Maximum	12,226
	Distribution	Normal
	Coefficient of Variation	0.115
	UCL Type	95% Student's-t UCL
	UCL Result	8,753
	UTL Type	UTL Normal
	UTL Result	10,447
Background Reference Area 3 (BG-3) Excluding Potential Outliers	Total Number of Observations	362
	Minimum	6,749
	Mean	8,585
	Median	8,453
	Maximum	10,817
	Distribution	Normal
	Coefficient of Variation	0.100
	UCL Type	95% Student's-t UCL
	UCL Result	8,659
	UTL Type	UTL Normal
	UTL Result	10,115

Area	Statistic	Gamma (cpm)
Background Reference Area 4 (BG-4) All Data	Total Number of Observations	70
	Minimum	7,158
	Mean	8,463
	Median	8,430
	Maximum	10,204
	Distribution	Normal
	Coefficient of Variation	0.086
	UCL Type	95% Student's-t UCL
	UCL Result	8,608
	UTL Type	UTL Normal
	UTL Result	9,911
Background Reference Area 4 (BG-4) Excluding Potential Outliers	Total Number of Observations	69
	Minimum	7,158
	Mean	8,437
	Median	8,422
	Maximum	9,948
	Distribution	Normal
	Coefficient of Variation	0.083
	UCL Type	95% Student's-t UCL
	UCL Result	8,579
	UTL Type	UTL Normal
	UTL Result	9,835
Survey Area A	Total Number of Observations	26,123
	Minimum	4,640
	Mean	9,221
	Median	8,278
	Maximum	104,004
	Distribution	Normal
	Coefficient of Variation	0.482
	UCL Type	95% Student's-t UCL
	UCL Result	9,266
	UTL Type	UTL Normal
	UTL Result	16,596
Survey Area B	Total Number of Observations	12,058
	Minimum	4,847
	Mean	7,352
	Median	7,278
	Maximum	13,662
	Distribution	Normal
	Coefficient of Variation	0.133
	UCL Type	95% Student's-t UCL
	UCL Result	7,367
	UTL Type	UTL Normal
	UTL Result	8,986
Survey Area C	Total Number of Observations	14,084
	Minimum	4,871
	Mean	7,953
	Median	7,651
	Maximum	97,546
	Distribution	Normal
	Coefficient of Variation	0.346
	UCL Type	95% Student's-t UCL
	UCL Result	7,991
	UTL Type	UTL Normal
	UTL Result	12,536

CPM	Counts per minute

The Mann-Whitney test indicated that gamma results measured within the Survey Areas are statistically elevated relative to gamma results measured in their respective background reference areas. This is to be expected, since 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 historic waste piles, as well as a higher degree of natural mineralization within the Survey Areas relative to the background reference areas.

4.0 INVESTIGATION LEVELS

The calculated 95-95 UTL values described in Section 3.3 are used as the ILs for gamma measurement results and soil sampling results because they reflect the natural variability in the background data, and provide an upper limit from background data to be used for single-point comparisons to Survey Area data. The ILs for analytical results of soil samples and gamma radiation results in Survey Areas A, B, and C are based on Background Reference Areas BG-2, BG-3, and BG-4, respectively.

4.1 SURVEY AREA A INVESTIGATION LEVELS

- Arsenic (mg/kg): 4.38
- Molybdenum (mg/kg): None (all results non-detect)
- Selenium (mg/kg): None (all results non-detect)
- Uranium (mg/kg): 3.28
- Vanadium (mg/kg): 18.7
- Ra-226 (pCi/g): 3.34
- Gamma radiation measurements (cpm): 11,068

4.2 SURVEY AREA B INVESTIGATION LEVELS

- Arsenic (mg/kg): 2.25
- Molybdenum (mg/kg): None (91% of results non-detect)
- Selenium (mg/kg): None (all results non-detect)
- Uranium (mg/kg): 0.836

- Vanadium (mg/kg): 18.0
- Ra-226 (pCi/g): 1.06
- Gamma radiation measurements (cpm): 10,447

4.3 SURVEY AREA C INVESTIGATION LEVELS

- Arsenic (mg/kg): 2.88
- Molybdenum (mg/kg): 0.334
- Selenium (mg/kg): None (all results non-detect)
- Uranium (mg/kg): 0.948
- Vanadium (mg/kg): 8.65
- Ra-226 (pCi/g): 0.895
- Gamma radiation measurements (cpm): 9,911

5.0 REFERENCES

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Appendix E Cultural and Biological Resource Clearance Documents

BIOLOGICAL EVALUATION

For the Proposed:

NA-0928
Abandon Uranium Mine - Environmental Response Trust Project

Sponsored by:

MWH Global / Stantec

Prepared by:

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180 East 12th Street, Unit 5
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Revised August 2016
June 2016

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1. INTRODUCTION AND PROJECT BACKGROUND

The federal Endangered Species Act (ESA) of 1973, 16 U.S.C. §1531 et seq., requires all federal departments and agencies to conserve threatened, endangered, and critical and sensitive species and the habitats on which they depend, and to consult with the U.S. Fish and Wildlife Service (USFWS) on all actions authorized, funded, or carried out by each agency to ensure that the action will not likely jeopardize the continued existence of any threatened and endangered species or adversely modify critical habitat [USFWS 1998]. This report describes the potential for federal ESA-listed species and Navajo Nation Endangered Species List (NESL) endangered, threatened, candidate, or otherwise designated sensitive flora and fauna to occur in the proposed action area. The action area with regard to the ESA is defined as any area that may be directly or indirectly impacted by the proposed action [50 CFR §402.02]. This report is intended to provide the responsible official with information to make determinations of effect on species with special conservation status.

As the result of settlement by the United States, the Navajo Nation AUM Environmental Response Trust—First Phase was established to evaluate certain abandoned uranium mines located across the Navajo Nation. The project requires investigation of these sites prior to potential remediation activities in the future. MWH Global, a division of Stantec (MWH), will conduct exploratory activities at the NA-0928 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 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

NA-0928 is located in Apache County Arizona, approximately 81 miles west of Farmington, New Mexico at an elevation of approximately 5,675 feet. Global Positioning System coordinates are 36º 54' 36" N by 109º 18' 36" W (NAD83 datum). The site is located on Navajo Tribal Trust Lands within the Bureau of Indian Affairs (BIA) Shiprock Agency. The legal description of the project surface location is as follows: Section 35, Township 41 North, Range 28 East, Gila and Salt River Principle Meridian. Project area maps are provided in Appendix A.

2.2. Estimated Disturbance

MWH proposes a phased approach to scientific investigations at the NA-0928 AUM. The study area encompasses the claim boundary and a 100-foot perimeter buffer zone for a total of approximately 13.9 acres. Please refer to Appendix A for maps delineating the mine claim boundary and buffer zone.

- 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 NA-0928 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 northeastern Arizona located within the USEPA designated Arizona/New Mexico Plateau Level III Ecoregion. The Arizona/New Mexico Plateau occurs primarily in Arizona, Colorado, and New Mexico, with a small portion in Nevada. This ecoregion is approximately 45,870,500 acres, and the elevation ranges from 2,165 to 11,949 feet. The ecoregion’s landscapes include low mountains, hills, mesas, foothills, irregular plains, alkaline basins, some sand dunes, and wetlands. This ecoregion is a large transitional region between the semiarid grasslands to the east, the drier shrublands and woodlands to the north, and the lower, hotter, less vegetated areas to the west and south.

NA-0928 is situated approximately 4 miles northwest of Chezhindeza Mesa. The western portion of the site consists of rocky shrubland with scattered pinon-juniper and continues up a sandstone cliff face onto a narrow ridge. The eastern portion of the site continues down the other side of the narrow ridge onto a flat shrubland valley. The eastern side consists of sandy soils, scattered pinon juniper, and shallow ephemeral drainages. A site specific description is presented below which is added with permission from the Redente site investigation report *Plant Survey Report for Species of Concern at NA-0928 Project Site* (Redente 2016) found in Appendix C.

> *Climate*
>
> The climate of the NA-0928 site is classified as semi-arid, with an average annual precipitation in the Teec Nos Pos area of 216 mm with the greatest precipitation months occurring in July and August. Average annual temperature is 13.3^{o} C.
>
> *Soils*

The U.S. Department of Agriculture (USDA) Soil Survey for Apache County was published in 2011 in cooperation with the Bureau of Indian Affairs and the Navajo Nation. This area of Apache County is mainly escarpments separated by terraces and riverwashes, with slopes that range from 15 to 65%. The general mapping unit for the area is most likely Rock Outcrop-Shinume Complex and the soil type is Shinume; an eolian soil derived from sandstone (USDA 2011). Typical features include exposures of steep bedrock and cliffs with small exposures of flat or rolling bedrock, typically barren but may have sparse vegetation growing in cracks and crevices or in thin layers of eolian, alluvial, or colluvial material.

Land Use

The land type on the NA-0928 site is rangeland and the principal land use is wildlife habitat.

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 NA-0928 site is sparsely vegetated grassland with sporadic shrubs. Vegetative cover is estimated to be approximately 25 percent.

A site specific description is presented below which is added with permission from the Redente site investigation report *Plant Survey Report for Species of Concern at NA-0928 Project Site* (Redente 2016) found in Appendix C.

> *Plant Community Type*
>
> The vegetation on the NA 0928 site is part of the Colorado Plateau Shrub-Gralssland type (USDA 2011). The most common species on the site include broom snakeweed (*Gutierrizia sarathrae*), cliffrose (*Purshia stansburiana*), rubber rabbitbrush (*Ericameria nauseosa*), Utah serviceberry (*Amelanchier utahensis*), shadscale saltbush (Atriplex confertifolia), yucca (*Yucca baileyi*), Mormon tea (*Ephedra viridis*), (blue grama (*Bouteloua gracilis*), spike dropseed (*Sporobolus contractus*), galleta (*Pleuraphis jamesii*), and Indian ricegrass (*Achnatherum hymenoides*).

Fauna

Wildlife or evidence of wildlife observed within the PPA included common raven (*Corvus corax*), cottontail rabbit (S*ylvilagus* sp.), coyote (*Canis latrans*), mule deer (*Odocoileus hemionus*), turkey vulture (*Cathartes aura*), and prairie falcon (*Falco mexicanus*). On several occasions surveyors observed, a prairie falcon perched in the vicinity of the PPA.

The steep sandstone cliffs surrounding the site may provide potential nesting habitat for several raptor species. 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 northeast for 8 miles through unnamed washes to Tsitah Wash. Tsitah Wash joins the San Juan River approximately 5 miles southeast of Aneth, Utah. The San Juan River, located approximately 20 miles northeast of the project area, is the nearest perennial water source. 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.

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 (02EAAZ00-2016-SLI-0360) 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 April 2016 by ACI personnel permitted 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 cloudy with light rain.

Follow up surveys were conducted at the site specifically targeting Golden eagle (*Aquila chrysaetos*), Ferruginous hawk (*Buteo regalis*), and American peregrine falcon (*Falco peregrinus*) following Navajo Natural Heritage Program (NNHP) guidelines. All plant and wildlife species observed in the action area were recorded, and digital photos were taken (Appendix B). Follow up survey details including date, site conditions and methods can be found on summary sheets attached as Appendix E.

Redente conducted surveys for plant species of concern. The results of the 2016 Redente biological investigations will be incorporated in Sections 4.2 and 4.3 of this report and can be found in entirety attached as Appendix C.

4.2. ESA-Listed Species Analysis and Results

4.2.1. *Species from the USFWS IPaC Official Species List*

Table 1 includes ESA-listed species that have the potential to occur in the project area based on the USFWS IPaC Official Species List. Biologists evaluated habitat suitability within and surrounding the PPA for the species in Table 1.

Table 1: USFWS IPaC Official Species List for the NA-0904 Project

Species	**Status**	**Occurrence Within Region**	**Habitat**	**Potential to Occur within Action Area**
BIRDS				
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.
FISHES				
Roundtail chub (*Gila robusta*)	Proposed Threatened	San Juan and Mancos Rivers. Rarely encountered in recent surveys; some found from Shiprock to near Lake Powell with most between Shiprock and Aneth. [2,3]	Rocky runs, rapids, and pools of creeks and small to large rivers; also large reservoirs in the upper Colorado River system.[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.

Table 1: USFWS IPaC Official Species List for the NA-0904 Project

Species	**Status**	**Occurrence Within Region**	**Habitat**	**Potential to Occur within Action Area**
Zuni Bluehead Sucker (*Catostomus discobolus yarrowi*)	Endangered	Native to headwater streams of the Little Colorado River in east-central AZ and west-central NM; current range in NM is limited to the upper Río Nutria drainage.[2]	Low-velocity pools and pool-runs with seasonally dense perilithic and periphytic algae, particularly shady, cobble/boulder/bedrock substrates in streams with frequent runs and pools.[2]	No potential. Action area does not provide suitable habitat for species to occur.
MAMMALS				
Black-footed ferret (*Mustela nigripes*)	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.[2]	No potential. Action area does not provide suitable habitat for species to occur. Action area does not provide prairie dog colonies of sufficient size
Gray wolf (*Canus lupus*)	Proposed Experimental	In NE AZ, South of Hwy 60 in Apache, Coconino, and Navajo County; In NW NM, south of I-40 in Cibola, McKinley and Catron County.[2]	Not limited to any particular habitat type. Viable populations occur only where human population density and persecution level are low and prey densities are high. Birthing dens may be on bluffs or slopes among rocks or in enlarged badger holes. In Arizona and New Mexico, diet includes primarily elk and sometimes livestock, deer, rodents, or lagomorphs.[2]	No potential. Action area is outside of range for this species. No dens suitable for this species were found in the action area.
REPTILES				

Table 1: USFWS IPaC Official Species List for the NA-0904 Project

Species	Status	Occurrence Within Region	Habitat	Potential to Occur within Action Area
Northern Mexican gartersnake (*Thamnophis eques megalops*)	Threatened	Most of AZ; In SE NM including Catron, Grant and Hildago County [2]	Considered a riparian obligate except during dispersal behavior. Occurs chiefly in the following general habitat types: (1) Source-area wetlands [e.g., cienegas (mid-elevation wetlands with highly organic, reducing (basic, or alkaline) soils), stock tanks (small earthen impoundment), etc.]; (2) large river riparian woodlands and forests; and (3) streamside gallery forests (as defined by well-developed broadleaf deciduous riparian forests with limited, if any, herbaceous ground cover or dense grass). Occurs at elevations from 130 to 8,497 (ft)	No potential. Action area does not provide suitable habitat for species to occur.

[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 seven (7) 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 E, there is no record of species of concern occurring on or near the project site. Biologists evaluated the potential for the 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			
Northern Leopard Frog (*Lithobates pipiens*)	NESL G2	Springs, slow streams, marshes, bogs, ponds, canals, flood plains, reservoirs, and lakes; usually permanent water with	No potential. Action area does not provide suitable habitat for species to occur.

Species	Status	Habitat Associations	Potential to Occur in Project or Action Area
		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.[2,3,4]	
Colorado pikeminnow (*Ptychocheilus lucius)*	NESL G2 USFWS-E	Warm-water rivers and tributaries of the Colorado River basin.[3,4] Known to occur in San Juan River from Shiprock to Lake Powel. [3,4]	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.
Southwestern Willow Flycatcher (*Empidonax traillii extimus*)	NESL G2 USFWS-E	Breeds in dense riparian habitat. [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.
Golden eagle (*Aquila chrysaetos*)	NESL G3	In the west, mostly open habitats in mountainous, canyon terrain. Nests primarily on cliffs. [3]	Action area provides potential foraging habitat for species to occur. Sandstone cliffs approximately 0.25 mile south of the PPA provide potential nesting habitat.
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 approximately 0.25 mile south of the PPA provide potential nesting habitat.
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	Action area provides marginal foraging habitat for species to occur. Sandstone cliffs approximately 0.25 mile south of the PPA provide marginal nesting habitat.

Species	Status	Habitat Associations	Potential to Occur in Project or Action Area
		riparian woodlands, coniferous & deciduous forests, shrublands, prairies. [3]	
Western burrowing owl (*Athene cunicularia hypugaea*)	NESL G4	Open grasslands and sometimes other open areas (such as vacant lots). Nests in abandoned burrows, such as those dug by prairie dogs. [2,3]	No potential. Action area does not provide suitable habitat for species to occur.
PLANTS			
Parish's alkali grass (*Puccinellia parishii*)	NESL G4 NM-E	Alkaline springs, seeps, and seasonally wet areas that occur at the heads of drainages or on gentle slopes. Elevation: 2600-7200 feet.[2,3]	No potential. Action area does not provide suitable alkaline soils for species to occur.[5]
Zuni Fleabane (*Erigeron rhizomatus*)	NESL G2 USFWS-T	Found on fine textured clay hillsides of mid to high elevation between 7000 and 8300ft. It is known from clays derived from the Chinle Formation in the Zuni and Chuska Mountains, and to similar clays of the Baca Formation in the Datil and Sawtooth ranges in New Mexico.[3]	No potential. Action area does not provide suitable vegetation community.[5]

Species are listed by the NESL as; Group 2: Endangered (survival or recruitment in jeopardy); Group 3: Endangered (survival or recruitment in jeopardy in foreseeable future); and Group 4: Species of Consideration. NESL Species with New Mexico State Endangered or Threatened status are labeled as NM-T or NM-E.

Sources: Sources: [1]New Mexico Natural Heritage Program 2010, [2]NatureServe Explorer; [3]Navajo Endangered Species List, Species Accounts 2008, [4] IUCN Red List, [5]Redente 2016, [6] Hammerson et al 2004.

4.3.2. NESL Species Eliminated From Further Consideration

Table 2.a includes ten (10) NESL and Navajo Species of Concern that have the potential to occur in the project area based on the general geographical association. The following species have been eliminated from further discussion in this report because the action area does not provide suitable habitat for them to occur: Northern Leopard Frog (*Lithobates pipiens*), Colorado pikeminnow (*Ptychocheilus lucius),* Southwestern Willow Flycatcher (*Empidonax traillii extimus*), Mountain plover *(Charadrius montanus)*, Western burrowing owl (*Athene cunicularia hypugaea*), Zuni Fleabane (*Erigeron rhizomatus*), 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.

Habitat potential was assessed for the American peregrine falcon (*Falco peregrinus*) within the action area. ACI biologists determined the sandstone cliffs surrounding the site to be marginal potential nesting habitat for this species and conducted follow up surveys to closely examine the cliff faces for any signs of use. Sixteen hours of observation following Navajo Natural Heritage Program (NNHP) protocol were conducted during April 2016. ACI biologists saw no sign of use by this species and concluded the habitat was not likely to be used by American peregrine falcon based on this detailed study. Survey results were discussed with Chad Smith, NNDFW zoologist, and with his concurrence, no further surveys were conducted. The project site was eliminated as potential nesting habitat for the following reasons: Cliff walls are approximately 100 to 200 feet in height but are somewhat sloped and ledged instead of sheer, the surrounding area does not provide the preferred riparian or forested foraging habitat for this species, and the presence of prairie falcon typically distinguishes habitat from that of American peregrine falcon on Navajo lands (Chad Smith--NNDFW zoologist, personal communication, May 9th, 2016).

4.3.3. NESL Species Warranting Further Analysis

Table 2.b lists NESL and Navajo Species of Concern with potential to occur within the proposed project area based on habitat suitability or actual record of observation.

Table 2.b: NESL and Navajo Species of Concern Warranting Further Analysis

Species	Status	Habitat Associations	Potential to Occur in Project or Action Area
ANIMALS			
Golden eagle (*Aquila chrysaetos*)	NESL G3	In the west, mostly open habitats in mountainous, canyon terrain. Nests primarily on cliffs. [3]	Action area provides potential foraging habitat for species to occur. Sandstone cliffs approximately 0.25 miles south of the PPA provide potential nesting habitat.
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 approximately 0.25 miles south of the PPA 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	Closely associated with sagebrush,	No suitable habitat is present within

(*Spizella breweri*)	preferring dense stands broken up with grassy areas.	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.	Suitable habitat is present within the action area for species to occur.
Mountain bluebird (*Sialia currucoides*)	Open piñon-juniper woodlands, mountain meadows, and sagebrush shrublands; requires larger trees and snags for cavity nesting.	No suitable habitat is present within the action area for species to occur.
Mourning dove (*Zenaida macroura*)	Open country, scattered trees, and woodland edges. Feeds on ground in grasslands and agricultural fields. Roost in woodlands in the winter. Nests in trees or on ground.	No suitable habitat is present within the action area for species to occur.
Sage sparrow (*Amphispiza belli*)	Large and contiguous areas of tall and dense sagebrush. Negatively associated with seral mosaics and patchy shrublands and abundance of greasewood.	No suitable habitat is present within the action area for species to occur.
Sage thrasher (*Oreoscoptes montanus*)	Shrub-steppe dominated by big sagebrush.	No suitable habitat is 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. Lack of diverse grass composition with varied forbs likely a limiting factor.
Swainson's hawk (*Buteo swainsoni*)	A mixture of grassland, cropland, and shrub vegetation; nests on utility poles and in isolated trees in rangeland. Nest densities higher in agricultural areas.	Marginal habitat is present within the action area for species to occur.
Vesper sparrow (*Pooecetes gramineus*)	Dry montane meadows, grasslands, prairie, and sagebrush steppe with grass component; nests on ground at base of grass clumps.	No suitable habitat present within the action area for species to occur. Lack of significant grassland/prairie component a limiting factor.
Bald eagle (*Haliaeetus leucocephalus*)	Near lakes, rivers and cottonwood galleries. Nests near surface water in large trees. May forage terrestrially in winter	No suitable habitat present within the action area for species to occur.
Bendire's thrasher (*Toxostoma bendirei*)	Typically inhabits sparse desert shrubland & open woodland with scattered shrubs; breeds in scattered locations in central & western portions of NM; most common in southwest NM.	Suitable habitat is present within the action area for species to occur.

Piñon jay (*Gymnorhinus cyanocephalus*)	Foothills throughout CO and NM wherever large blocks of piñon-juniper woodland habitat occurs.	No suitable habitat present within the action area for species to occur.
Prairie falcon (*Falco mexicanus*)	Arid, open country, grasslands or desert scrub, rangeland; nests on cliff ledges, trees, power structures.	Action area provides potential foraging and nesting habitat for species to occur. A prairie falcon perched in the action area during the April 2016 survey of the PPA.

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 includes the claim boundary and a 100-foot perimeter buffer zone for a total of approximately 13.9 acres. 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, Ferruginous hawk

Habitat potential was assessed for the golden eagle and ferruginous hawk within the action area. ACI biologists determined the sandstone cliffs approximately 0.25 mile south of the PPA provide potential nesting habitat for this species and conducted follow up surveys to closely examine 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 these species including old or inactive nests.

Phase I:
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 impact nesting behavior. Direct and indirect effects from Phase I are expected to be short term and negligible.

Phase II:
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. As of April 2016, the nesting habitat within 0.25 mile of the PPA boundary was not occupied by golden eagle or ferruginous hawk. Phase II activities that may occur within the breeding season are unlikely to impact potential nesting activity in the nearby cliffs due to the distance from the PPA, the short term nature of the disturbance, and the relatively moderate noise level that may occur.

5.1.2. Migratory Birds

The PPA encompasses approximately 13.9 acres of potential migratory bird habitat in the form of Great Basin Desert scrub. During the April 2016 survey of the PPA surveyors observed a prairie falcon perched in the vicinity of PPA.

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. No active nests within the PPA are expected to be directly impacted during Phase II if activities occur outside of the typical migratory bird breeding season. 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. Direct impacts are more likely if surface disturbing activities occur during the breeding season (April 1 through August 15).

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. Local plant and animal pest control are also activities that occur in the vicinity. These foreseeable actions would cumulatively impact raptors through habitat loss or contamination. Human activity may also increase available prey base if the activity leads to an increase in rodent population numbers. The intensity of indirect effects would be dependent upon the species, its life history, time of year and/or day and the type and level of human and vehicular activity is occurring.

5.2.2. Migratory Birds

With the implementation of BMPs discussed in Section 5.1, the cumulative impact of the proposed action on migratory birds would be low based on the minimal surface disturbance involved 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 varying degrees of noise and surface disturbance within approximately 13.9 acres of potential migratory bird habitat in the form of Great Basin Desert scrub. 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. There is no suitable habitat for ESA-listed fish, nor critical habitats thereof, within 20 miles of the PPA.

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 and nesting habitat for the following: golden eagle and ferruginous hawk.

Potential effects to these species are discussed in detail in Section 5 above. Phase II activities that may occur within the breeding season are unlikely to impact potential nesting activity in the nearby cliffs due to the distance from the PPA, the short term nature of the disturbance, and the relatively moderate noise level that may occur. 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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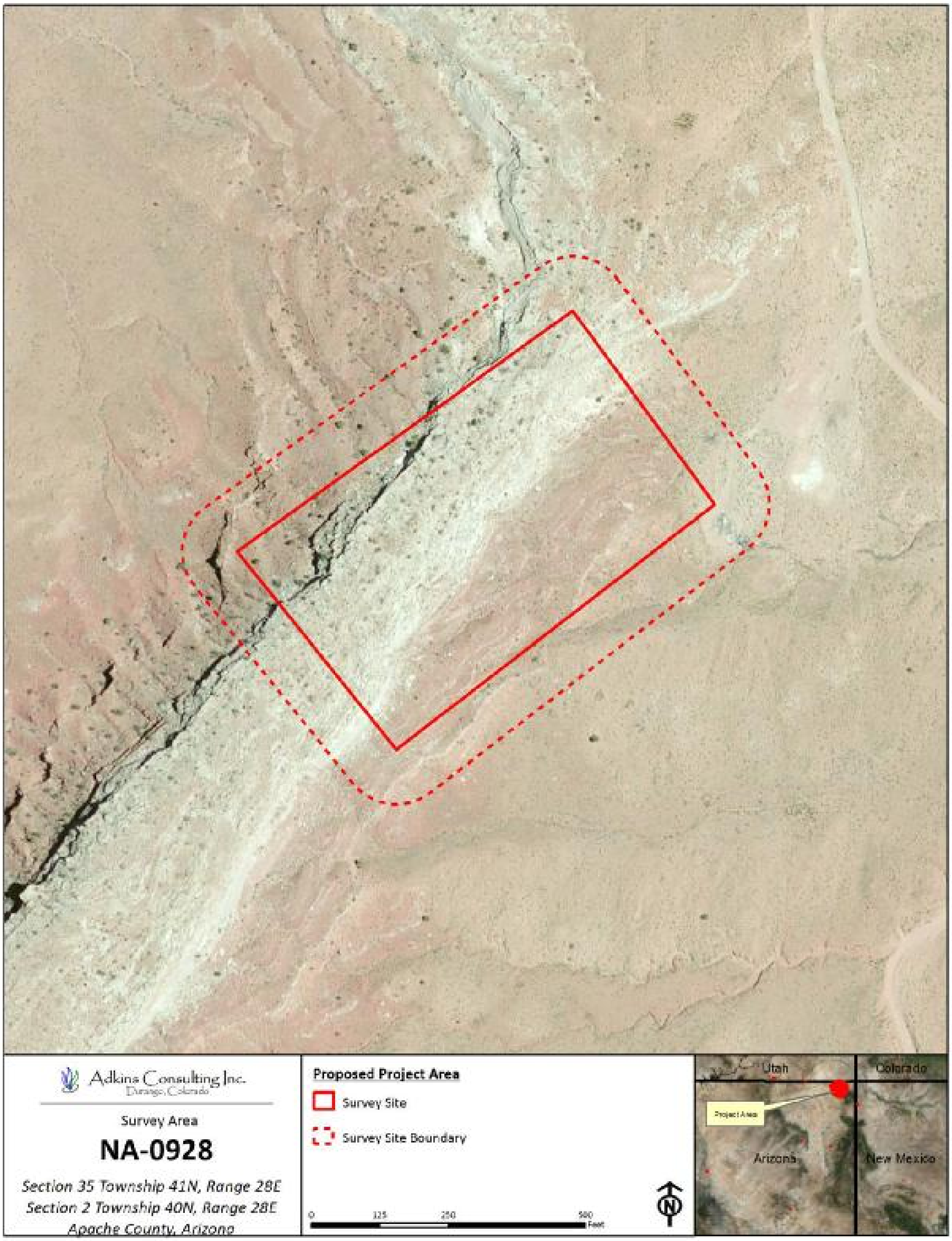
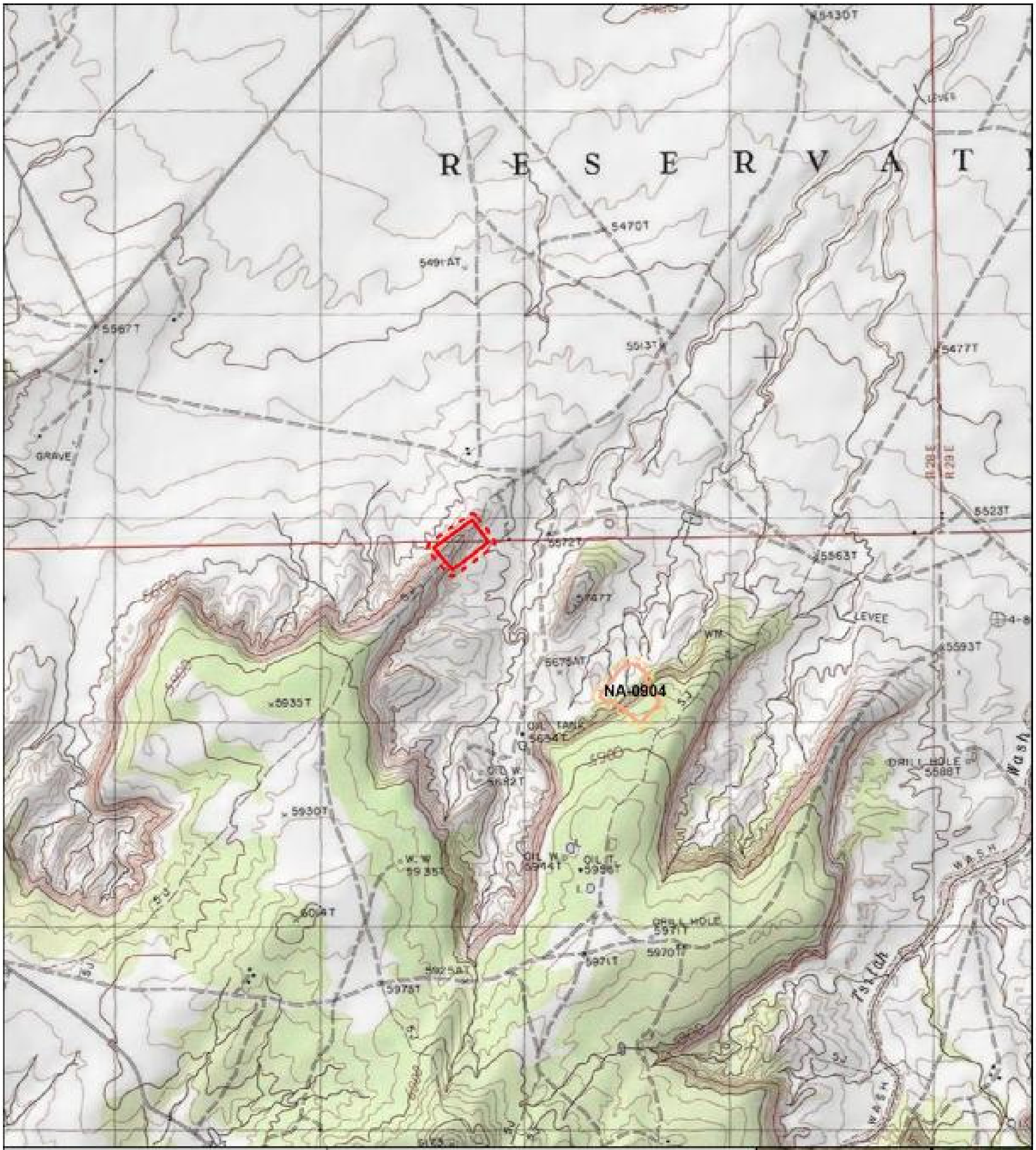
APPENDIX A. MAPS





Adkins Consulting Inc.
Durango, Colorado

Survey Area

NA-0928

Section 35 Township 41N, Range 28E
Section 2 Township 40N, Range 28E
Apache County, Arizona

Proposed Project Area

🟥 Survey Site

⬚ Survey Site Boundary

0 0.25 0.5 1 Miles

N

APPENDIX B. PHOTOGRAPHS


Overview from top of location looking south


Overview looking west from bottom of east side of site


View north from west side of location


View northwest from 0.25 mile south side of site boundary looking at eastern facing wall

View south from the northeast side of northern portion of site

View southeast from northern portion of site

APPENDIX C. REDENTE PLANT SURVEY REPORT

Navajo Nation AUM Environmental Response Trust

Plant Survey Report for Species of Concern
At NA-0928 Project Site
Apache County, Arizona
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 NA-0928 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

NA-0928 is located in located in Apache County Arizona, approximately 130 km (81 miles) west of Farmington, New Mexico at an elevation of approximately 1,730 m (5,676 ft) Global Positioning System coordinates are 36° 54' 36" N by 109° 18' 36" W (North American Datum of 1983). The site is located on Tribal Trust Land (TTL).

Environmental Setting

Climate

The climate of the NA-0928 site is classified as semi-arid, with an average annual precipitation of 216 mm (8.5 in) with the greatest precipitation months occurring in July and August. Average annual temperature is 13.3° C (56° F).

Soils

The U.S. Department of Agriculture (USDA) Soil Survey for Apache County was published in 2011 in cooperation with the Bureau of Indian Affairs and the Navajo Nation. This area of Apache County is mainly escarpments separated by terraces and riverwashes, with slopes that range from 15 to 65%. The general mapping unit for the area is most likely Rock Outcrop-Shinume Complex and the soil type is Shinume; an eolian soil derived from sandstone (USDA 2011). Typical features include exposures of steep bedrock and cliffs with small exposures of flat or rolling bedrock, typically barren but may have sparse vegetation growing in cracks and crevices or in thin layers of eolian, alluvial, or colluvial material.

Plant Community Type

The vegetation on the NA-0928 site is part of the Colorado Plateau Shrub-Grassland type (USDA 2011). The most common species on the site include broom snakeweed (*Gutierrizia sarathrae*), cliffrose (*Purshia stansburiana*), rubber rabbitbrush (*Ericameria nauseosa*), Utah serviceberry (*Amelanchier utahensis*), shadscale saltbush (Atriplex confertifolia), yucca (*Yucca baileyi*), Mormon tea (*Ephedra viridis*), (blue grama (*Bouteloua gracilis*), spike dropseed (*Sporobolus contractus*), galleta (*Pleuraphis jamesii*), and Indian ricegrass (*Achnatherum hymenoides*).

Land Use

The land type on the NA-0928 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 identified one endangered plant species that may occur in the project area—Parish's alkaligrass (*Puccinellia parishii*). The USFWS listed Zuni fleabane (*Erigeron rhizomatus*) as an additional threatened species that may occur in the area.

METHODS

Study Area

The area evaluated for plant species of concern was defined by the claim boundary, with an additional 100 foot buffer around all sides.

Database Queries and Literature Review

Prior to initiating field surveys, a target list of all potentially occurring species of concern identified by NNHP and the USFWS was compiled. Ecologic and taxonomic information was reviewed for each species prior to initiating field work to better understand ecological characteristics of the species, habitat requirements and key taxonomic indicators for proper identification (ANPS 2000).

Rare Plant Survey Protocols

The plant survey followed currently accepted resource agency protocols and guidelines, for conducting and reporting botanical inventories for special status plant species (USFWS 1996). According to these protocols, rare plant surveys were conducted by botanists with considerable experience with the local flora. All species observed during the surveys were identified to the degree necessary to correctly identify the species and determine if the plant had special status. The survey was conducted in the spring 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 Trimble GeoExplorer 6000 Series. The GPS operator was also instructed in sight identification of species of concern to help delineate points or polygons and other data collection and data management tasks. GPS units were preloaded for the plant team with background and data files that showed the aerial photographic base map, the site boundaries, and the study area, so team members could clearly identify their exact location in the field at all times.

2016 Field Survey

The project site was surveyed by a field botanist. The botanist walked meandering "transect" lines through each area and looked for suitable habitat for these species, such as alkali seeps for *Puccinellia parishii* and fine-textured clay hillsides for *Erigeron rhizomatus.* 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 in some to document site conditions (Photos #1 and #2).

RESULTS

A total of 2 plant species of concern were identified as potentially occurring within the proximity of the project area. These species included *Puccinellia parishii and Erigeron rhizomatus*. *Puccinellia parishii* is a native annual grass that grows in a series of widely disjunct populations ranging from southern California to eastern Arizona and western New Mexico in alkaline seeps, springs and seasonally wet areas and washes at elevations between 1,525 and 2,195 m (5,003 and 7,201 ft). *Erigeron rhizomatus* is a native perennial forb found in Apache County. It is found growing on fine textured clay hillsides primarily in Pinyon-Juniper type. It occurs at elevation ranges between 2,135 and 2,530 m (7,005 and 8,301 ft).

The survey at NA-0928 on May 7, 2016 did not identify any of the two species that have been listed as potential species of concern for this site. There was appropriate habitat at NA-0928 for *Puccinellia parishii*, in that seasonally wet areas and washes were identified but there was no evidence of alkalinity on the soil surface from salt accumulation. Habitat at NA-0928 may not be appropriate for the occurrence of *Erigeron rhizomatus* because the primary plant community type of Pinyon-Juniper occurs outside of the NA-0928 site.

Photo #1—Overview of general landscape and plant community at NA-0928.

Photo #2—Overview of general landscape and plant community at NA-0928.

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. 2011. Soil Survey of the Chinle Area, Parts of Apache and Navajo Counties, Arizona and San Juan County, New Mexico. USDA, Natural Resource Conservation Service. 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

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Window Rock, AZ
86515

P 928.871.6472
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http://nnhp.nndfw.org

15mwh101

19-November-2015

Eileen Dornfest - Project Manager
MWH Americas
3665 John F Kennedy Parkway
Bldg 1, Suite 206
Ft. Collins, CO 80525

SUBJECT: Navajo Nation AUM Environmental Response Trust (ERT) Project - 16 Abandoned Uranium Mine (AUM) Sites

Eileen Dornfest,

NNHP has performed an analysis of your project in comparison to known biological resources of the Navajo Nation and has included the findings in this letter. The letter is composed of seven parts. The sections as they appear in the letter are:

1. **Known Species** – a list of all species within relative proximity to the project
2. **Potential Species** – a list of potential species based on project proximity to respective suitable habitat
3. **Quadrangles** – an exhaustive list of quads containing the project
4. **Project Summary** – a categorized list of biological resources within relative proximity to the project grouped by individual project site(s) or quads
5. **Conditional Criteria Notes** – additional details concerning various species, habitat, etc.
6. **Personnel Contacts** – a list of employee contacts
7. **Resources** – identifies sources for further information

Known Species lists “species of concern” known to occur within proximity to the project area. Planning for avoidance of these species is expected. If no species are displayed then based upon the records of the Navajo Nation Department of Fish and Wildlife (NNDFW) there are no “species of concern” within proximity to the project. Refer to the Navajo Endangered Species List (NESL) Species Accounts for recommended avoidance measures, biology, and distribution of NESL species on the Navajo Nation (http://nnhp.nndfw.org/sp_account.htm).

Potential Species lists species that are potentially within proximity to the project area and need to be evaluated for presence/absence. If no species are found within the Known or Potential Species lists, the project is not expected to affect any federally listed species, nor significantly impact any tribally listed species or other species of concern. Potential for species has been determined primarily on habitat characteristics and species range information. A thorough habitat analysis, and if necessary, species specific surveys, are required to determine the potential for each species.

Species of concern include protected, candidate, and other rare or otherwise sensitive species, including certain native species and species of economic or cultural significance. For legally protected species, the following tribal and federal statuses are indicated: NESL, federal Endangered Species Act (ESA), Migratory

Bird Treaty Act (MBTA), and Eagle Protection Act (EPA). No legal protection is afforded species with only ESA candidate, NESL group 4 status, and species listed on the Sensitive Species List. Please be aware of these species during surveys and inform the NNDFW of observations. Reported observations of these species and documenting them in project planning and management is important for conservation and may contribute to ensuring they will not be up listed in the future.

In any and all correspondence with NNDFW or NNHP concerning this project please cite the Data Request Code associated with this document. It can be found in this report on the top right corner of the every page. Additionally please cite this code in any biological evaluation documents returned to our office.

1. Known Species *(NESL=Navajo Endangered Species List, FE=Federally Endangered, FT=Federally Threatened, FC=Federal Candidate)*

Species

AMPE = Amsonia peeblesii / Peebles' Blue-star NESL G4
AQCH = Aquila chrysaetos / Golden Eagle NESL G3
CASP = Carex specuicola / Navajo Sedge NESL G3 FT
LIPI = Lithobates pipiens / Northern Leopard Frog NESL G2
PEAMCI = Perognathus amplus cineris / Wupatki Pocket Mouse NESL G4
PUPA = Puccinellia parishii / Parish's Alkali Grass NESL G4

**All or parts of this project currently are within areas protected by the Golden and Bald Eagle Nest Protection Regulations; consult with NNDFW zoologist or EA Reviewer for more information and recommendations.

2. Potential Species

Species

ALGO = Allium gooddingii / Gooding's Onion NESL G3
AMPE = Amsonia peeblesii / Peebles' Blue-star NESL G4
AQCH = Aquila chrysaetos / Golden Eagle NESL G3
ASBE = Astragalus beathii / Beath Milk-vetch NESL G4
ASNA = Astragalus naturitensis / Naturita Milk-vetch NESL G3
ASWE = Asclepias welshii / Welsh's Milkweed NESL G3 FT
ATCU = Athene cunicularia / Burrowing Owl NESL G4
BURE = Buteo regalis / Ferruginous Hawk NESL G3
CASP = Carex specuicola / Navajo Sedge NESL G3 FT
CHMO = Charadrius montanus / Mountain Plover NESL G4
CIME = Cinclus mexicanus / American Dipper NESL G3
CIRY = Cirsium rydbergii / Rydberg's Thistle NESL G4
CYUT = Cystopteris utahensis / Utah Bladder-fern NESL G4
EMTREX = Empidonax traillii extimus / Southwestern Willow Flycatcher NESL G2 FE
ERAC = Erigeron acomanus / Acoma Fleabane NESL G3
ERRH = Erigeron rhizomatus / Rhizome Fleabane/zuni Fleabane NESL G2 FT
ERRO = Errazurizia rotundata / Round Dunebroom NESL G3
ERSI = Erigeron sivinskii / Sivinski's Fleabane NESL G4
FAPE = Falco peregrinus / Peregrine Falcon NESL G4
GIRO = Gila robusta / Roundtail Chub NESL G2
LENA = Lesquerella navajoensis / Navajo Bladderpod NESL G3
LIPI = Lithobates pipiens / Northern Leopard Frog NESL G2
MUNI = Mustela nigripes / Black-footed Ferret NESL G2 FE

PEAMCI = Perognathus amplus cineris / Wupatki Pocket Mouse NESL G4
PLZO = Platanthera zothecina / Alcove Bog-orchid NESL G3
PRSP = Primula specuicola / Cave Primrose NESL G4
PTLU = Ptchocheilus lucius / Colorado Pikeminnow NESL G2
PUPA = Puccinellia parishii / Parish's Alkali Grass NESL G4
SAPAER = Salvia pachyphylla ssp eremopictus / Arizona Rose Sage NESL G4
STOCLU = Strix occidentalis lucida / Mexican Spotted Owl NESL G3 FT
VUMA = Vulpes macrotis / Kit Fox NESL G4
ZIVA = Zigadenus vaginatus / Alcove Death Camass NESL G3

3. Quadrangles (7.5 Minute)

Quadrangles

Cameron SE (35111-G3) / AZ
Dalton Pass (35108-F3) / NM
Del Muerto (36109-B4) / AZ
Dos Lomas (35107-C7) / NM
Gallup East (35108-E6) / NM
Garnet Ridge (36109-H7) / AZ, UT
Horse Mesa (36109-F1) / AZ, NM
Indian Wells (35110-D1) / AZ
Mexican Hat SE (37109-A7) / UT, AZ
Oljeto (37110-A3) / UT, AZ
Toh Atin Mesa East (36109-H3) / AZ, UT
Toh Atin Mesa West (36109-H4) / AZ, UT

4. Project Summary *(EO1 Mile/EO 3 Miles=elements occuring within 1 & 3 miles., MSO=mexican spotted owl PACs, POTS=potential species, RCP=Biological Areas)*

SITE	EO1MI	EO3MI	QUAD	MSO	POTS	AREAS
Alongo Mines	None	AQCH	Horse Mesa (36109-F1) / AZ, NM	None	LIPI, FAPE, EMTREX, CHMO, BURE, ATCU, AQCH, ZIVA, PUPA, PLZO, CIRY, CASP	Area 3
Barton 3	None	None	Toh Atin Mesa West (36109-H4) / AZ, UT	None	PTLU, GIRO, EMTREX, CHMO, BURE, ATCU, AQCH, ZIVA, PLZO, CIRY, CASP	Area 3
Boyd Tisi No. 2 Western	None	AMPE, PEAMCI, LIPI	Cameron SE (35111-G3) / AZ	None	LIPI, PEAMCI, FAPE, EMTREX, BURE, AQCH, ERRO, ASBE, AMPE	Area 3
Charles Keith	None	None	Oljeto (37110-A3) / UT, AZ	None	LIPI, FAPE, EMTREX, CHMO, BURE, AQCH	Area 1, Area 3

SITE	EO1MI	EO3MI	QUAD	MSO	POTS	AREAS
Eunice Becenti	None	None	Gallup East (35108-E6) / NM	None	FAPE, EMTREX, ATCU, AQCH, LENA, ERSI, ERRH, ERAC	Area 3
Harvey Blackwater No. 3	AQCH	AQCH, PUPA	Garnet Ridge (36109-H7) / AZ, UT	None	VUMA, LIPI, FAPE, EMTREX, CIME, BURE, ATCU, AQCH, ZIVA, PUPA, PRSP, PLZO, CIRY, CASP, ASWE	Area 3
Harvey Blackwater No. 3	AQCH	AQCH, PUPA	Mexican Hat SE (37109-A7) / UT, AZ	None	VUMA, FAPE, EMTREX, ATCU, AQCH, ZIVA, PLZO, CIRY, CASP, ASWE	Area 1
Hoskie Tso No. 1	AQCH	AQCH	Indian Wells (35110-D1) / AZ	None	FAPE, CHMO, BURE, ATCU, AQCH, SAPAER	Area 3
Mitten No. 3	None	AQCH	Oljeto (37110-A3) / UT, AZ	None	LIPI, FAPE, EMTREX, CHMO, BURE, AQCH	Area 3
NA-0904	None	AQCH	Toh Atin Mesa East (36109-H3) / AZ, UT	None	STOCLU, LIPI, PTLU, GIRO, FAPE, EMTREX, CHMO, ATCU, AQCH, PUPA	Area 3
NA-0928	None	None	Toh Atin Mesa East (36109-H3) / AZ, UT	None	STOCLU, LIPI, PTLU, GIRO, FAPE, EMTREX, CHMO, ATCU, AQCH, PUPA	Area 3
Oak124, Oak125	AQCH	AQCH	Horse Mesa (36109-F1) / AZ, NM	None	LIPI, FAPE, EMTREX, CHMO, BURE, AQCH, ZIVA, PUPA, PLZO, CIRY, CASP	Area 3
Occurrence B	None	AQCH, CASP	Del Muerto (36109-B4) / AZ	None	LIPI, FAPE, EMTREX, CIME, AQCH, ZIVA, PLZO, CYUT, CIRY, CASP, ALGO	Area 3
Section 26 (Desiddero Group)	None	None	Dos Lomas (35107-C7) / NM	None	FAPE, CHMO, ATCU, AQCH	Area 3
Standing Rock	None	None	Dalton Pass (35108-F3) / NM	None	VUMA, MUNI, FAPE, CHMO, BURE, ATCU, AQCH, ERSI, ASNA	Area 3

SITE	EO1MI	EO3MI	QUAD	MSO	POTS	AREAS
Tsosie 1	AQCH	AQCH	Toh Atin Mesa East (36109-H3) / AZ, UT	None	STOCLU, LIPI, PTLU, GIRO, FAPE, EMTREX, CHMO, AQCH, PUPA	Area 1, Area 3

5. Conditional Criteria Notes *(Recent revisions made please read thoroughly. For certain species, and/or circumstances, please read and comply)*

A. **Biological Resource Land Use Clearance Policies and Procedures (RCP)** - The purpose of the RCP is to assist the Navajo Nation government and chapters ensure compliance with federal and Navajo laws which protect, wildlife resources, including plants, and their habitat resulting in an expedited land use clearance process. After years of research and study, the NNDFW has identified and mapped wildlife habitat and sensitive areas that cover the entire Navajo Nation.
The following is a brief summary of six (6) wildlife areas:
1.***Highly Sensitive Area*** – recommended no development with few exceptions.
2.***Moderately Sensitive Area*** – moderate restrictions on development to avoid sensitive species/habitats.
3.***Less Sensitive Area*** – fewest restrictions on development.
4.***Community Development Area*** – areas in and around towns with few or no restrictions on development.
5.***Biological Preserve*** – no development unless compatible with the purpose of this area.
6.***Recreation Area*** – no development unless compatible with the purpose of this area.
None - outside the boundaries of the Navajo Nation
This is not intended to be a full description of the RCP please refer to the our website for additional information at http://www.nndfw.org/clup.htm.

B. **Raptors** – If raptors are known to occur within 1 mile of project location: Contact Chad Smith at 871-7070 regarding your evaluation of potential impacts and mitigation.
o **Golden and Bald Eagles**- If Golden or Bald Eagle are known to occur within 1 mile of the project, decision makers need to ensure that they are not in violation of the Golden and Bald Eagle Nest Protection Regulations found at http://nnhp.nndfw.org/docs_reps/gben.pdf.
o **Ferruginous Hawks** – Refer to “Navajo Nation Department of Fish and Wildlife’s Ferruginous Hawk Management Guidelines for Nest Protection” http://nnhp.nndfw.org/docs_reps.htm for relevant information on avoiding impacts to Ferruginous Hawks within 1 mile of project location.
o **Mexican Spotted Owl** - Please refer to the Navajo Nation Mexican Spotted Owl Management Plan http://nnhp.nndfw.org/docs_reps.htm for relevant information on proper project planning near/within spotted owl protected activity centers and habitat.

C. **Surveys** – Biological surveys need to be conducted during the appropriate season to ensure they are complete and accurate please refer to NN Species Accounts http://nnhp.nndfw.org/sp_account.htm. Surveyors on the Navajo Nation must be permitted by the Director, NNDFW. Contact Jeff Cole at (928) 871-7068 for permitting procedures. Questions pertaining to surveys should be directed to the NNDFW Zoologist (Chad Smith) for animals at 871-7070, and Botanist (Andrea Hazelton) for plants at (928)523-3221. Questions regarding biological evaluation should be directed to Jeff Cole at 871-7068.

D. **Oil/Gas Lease Sales** – Any settling or evaporation pits that could hold contaminants should be lined and covered. Covering pits, with a net or other material, will deter waterfowl and other migratory bird use. Lining pits will protect ground water quality.

E. **Power line Projects** – These projects need to ensure that they do not violate the regulations set forth in the Navajo Nation Raptor Electrocution Prevention Regulations found at http://nnhp.nndfw.org/docs_reps/repr.pdf.

F. **Guy Wires** – Does the project design include guy wires for structural support? If so, and if bird species may occur in relatively high concentrations in the project area, then guy wires should be equipped with highly visual markers to reduce the potential mortality due to bird-guy wire collisions. Examples of visual markers include aviation balls and bird flight diverters. Birds can be expected to occur in relatively high concentrations along migration routes (e.g., rivers, ridges or other distinctive linear topographic features) or where important habitat for breeding, feeding, roosting, etc. occurs. The U.S. Fish and Wildlife Service recommends marking guy wires with at least one marker per 100 meters of wire.

G. **San Juan River** – On 21 March 1994 (Federal Register, Vol. 59, No. 54), the U.S. Fish and Wildlife Service designated portions of the San Juan River (SJR) as critical habitat for Ptychocheilus lucius (Colorado pikeminnow) and Xyrauchen texanus (Razorback sucker). Colorado pikeminnow critical habitat includes the SJR and its 100-year floodplain from the State Route 371 Bridge in T29N, R13W, sec. 17 (New Mexico Meridian) to Neskahai Canyon in the San Juan arm of Lake Powell in T41S, R11E, sec. 26 (Salt Lake Meridian) up to the full pool elevation. Razorback sucker critical habitat includes the SJR and its 100-year floodplain from the Hogback Diversion in T29N, R16W, sec. 9 (New Mexico Meridian) to the full pool elevation at the mouth of Neskahai Canyon on the San Juan arm of Lake Powell in T41S, R11E, sec. 26 (Salt Lake Meridian). All actions carried out, funded or authorized by a federal agency which may alter the constituent elements of critical habitat must undergo section 7 consultation under the Endangered Species Act of 1973, as amended. Constituent elements are those physical and biological attributes essential to a species conservation and include, but are not limited to, water, physical habitat, and biological environment as required for each particular life stage of a species.

H. **Little Colorado River** - On 21 March 1994 (Federal Register, Vol. 59, No. 54) the U.S. Fish and Wildlife Service designated Critical Habitat along portions of the Colorado and Little Colorado Rivers (LCR) for Gila cypha (humpback chub). Within or adjacent to the Navajo Nation this critical habitat includes the LCR and its 100-year floodplain from river mile 8 in T32N R6E, sec. 12 (Salt and Gila River Meridian) to its confluence with the Colorado River in T32N R5E sec. 1 (S&GRM) and the Colorado River and 100-year floodplain from Nautuloid Canyon (River Mile 34) T36N R5E sec. 35 (S&GRM) to its confluence with the LCR. All actions carried out, funded or authorized by a federal agency which may alter the constituent elements of Critical Habitat must undergo section 7 consultation under the Endangered Species Act of 1973, as amended. Constituent elements are those physical and biological attributes essential to a species conservation and include, but are not limited to, water, physical habitat, and biological environment as required for each particular life stage of a species.

I. **Wetlands** – In Arizona and New Mexico, potential impacts to wetlands should also be evaluated. The U.S. Fish & Wildlife Service's National Wetlands Inventory (NWI) maps should be examined to determine whether areas classified as wetlands are located close enough to the project site(s) to be impacted. In cases where the maps are inconclusive (e.g., due to their small scale), field surveys must be completed. For field surveys, wetlands identification and delineation methodology contained in the "Corps of Engineers Wetlands Delineation Manual" (Technical Report Y-87-1) should be used. When wetlands are present, potential impacts must be addressed in an environmental assessment and the Army Corps of Engineers, Phoenix office, must be contacted. NWI maps are available for examination at the Navajo Natural Heritage Program (NNHP) office, or may be purchased through the U.S. Geological Survey (order forms are available through the NNHP). The NNHP has complete coverage of the Navajo Nation, excluding Utah, at 1:100,000 scale; and coverage at 1:24,000 scale in the southwestern portion of the Navajo Nation. In Utah, the U.S. Fish & Wildlife Service's National Wetlands Inventory maps are not yet available for the Utah portion of the Navajo Nation, therefore, field surveys should be completed to determine whether wetlands are located close enough to the project site(s) to be impacted. For field surveys, wetlands identification and delineation methodology contained in the "Corps of Engineers Wetlands Delineation Manual" (Technical Report Y-87-1) should be used. When wetlands are present, potential impacts must be addressed in an environmental assessment and the Army Corps of Engineers, Phoenix office, must be contacted. For more information contact the Navajo Environmental Protection Agency's Water Quality Program.

J. **Life Length of Data Request** – The information in this report was identified by the NNHP and NNDFW's biologists and computerized database, and is based on data available at the time of this response. If project planning takes more than two (02) years from the date of this response, verification of the information provided herein is necessary. It should not be regarded as the final statement on the occurrence of any species, nor should it substitute for on-site surveys. Also, because the NNDFW information is continually updated, any given information response is only wholly appropriate for its respective request.

K. **Ground Water Pumping** - Projects involving the ground water pumping for mining operations, agricultural projects or commercial wells (including municipal wells) will have to provide an analysis on the effects to surface water and address potential impacts on all aquatic and/or wetlands species listed below. NESL Species potentially impacted by ground water pumping: Carex specuicola (Navajo Sedge), Cirsium rydbergii (Rydberg's Thistle), Primula specuicola (Cave Primrose), Platanthera zothecina (Alcove Bog Orchid), Puccinellia parishii (Parish Alkali Grass), Zigadenus vaginatus (Alcove Death Camas), Perityle specuicola (Alcove Rock Daisy), Symphyotrichum welshii (Welsh's American-aster), Coccyzus americanus (Yellow-billed Cuckoo), Empidonax traillii extimus (Southwestern Willow Flycatcher), Rana pipiens (Northern Leopard Frog), Gila cypha (Humpback Chub), Gila robusta (Roundtail Chub), Ptychocheilus lucius (Colorado Pikeminnow), Xyrauchen texanus (Razorback Sucker), Cinclus mexicanus (American Dipper), Speyeria nokomis (Western Seep Fritillary), Aechmophorus clarkia (Clark's Grebe), Ceryle alcyon (Belted Kingfisher), Dendroica petechia (Yellow Warbler), Porzana carolina (Sora), Catostomus discobolus (Bluehead Sucker), Cottus bairdi (Mottled Sculpin), Oxyloma kanabense (Kanab Ambersnail)

6. Personnel Contacts

Wildlife Manager
Sam Diswood
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Botanist
Vacant

Biological Reviewer
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GIS Supervisor
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Wildlife Tech
Sonja Detsoi
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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, 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

TOPOGRAPHIC MAPS ATTACHED:

- Blue Gap Quadrangle, Arizona-Apache Co.
- Cameron SE Quadrangle, Arizona-Coconino Co.
- Cameron South Quadrangle, Arizona-Coconino Co.
- Del Muerto Quadrangel, Arizona-Apache Co.
- Five Buttes Quadrangle, Arizona-Navajo Co.
- Garnet Ridge Quadrangle, Arizona-Utah
- Horse Mesa Quadrangle, Arizona-New Mexico
- Indian Wells Quadrangle, Arizona-Navajo Co.
- Tah Chee Wash Quadrangle, Arizona-Apache Co.
- Toh Atin Mesa East Quadrangle, Arizona-Utah
- Toh Atin Mesa West Quadrangle, Arizona-Utah
- Bluewater Quadrangle, New Mexico
- Bread Springs Quadrangle, New Mexico-McKinley Co.
- Dalton Pass Quadrangle, New Mexico-McKinley Co.
- Dos Lomas Quadrangle, New Mexico
- Gallup East Quadrangle, New Mexico-McKinley Co.
- Sand Spring Quadrangle, New Mexico-San Juan Co.
- Standing Rock Quadrangle, New Mexico-McKinley Co.
- Mexican Hat SE Quadrangle, Utah-San Juan Co.
- Oljato Quadrangle, Utah-San Juan Co.

APPENDIX E. NOTES FROM SPECIES SPECIFIC SURVEYS

Adkins Consulting Inc.
Environmental Permitting Services

180 East 12 Street Suite #5
Durango, CO 81301
Phone: 505-793-1140

DAILY REPORT

Field Surveys

PROJECT NAME: NN AUM SITE: NA-0928

DATE: 4/18/16

WEATHER: Partly cloudy, calm, temps mid 50’s

PERSONNEL ONSITE: Sarah McCloskey (Principal Biologist), Sarah Cowley (Field Assistant)

==

CONTRACTORS ONSITE NOTES:

Background: During the previous habitat assessment survey, habitat was documented for Golden Eagles, Peregrine Falcons, and Burrowing Owls.

Purpose: In areas where suitable habitat occurs, a formal survey of the species is to be performed following Navajo Nation survey protocols[1] outlined below:

Golden Eagle – A single pedestrian survey with high-power optics for nest sites or breeding adults from 1 MAR-15 JUN.

Peregrine Falcons - Two 8 hours surveys (4 hours before sunset and 4 hours after sunrise the following day) during each period: 1 FEB-30 APR (surveys during egg-laying/incubation discouraged) & 1 MAY-31 JUL (2 survey preferably prior to JUL). Productivity surveys require >=1 additional visits.

Methods: Surveys were performed for Peregrine Falcon and Golden Eagle. Surveyors arrived at the project site at 4:20 p.m. and conducted a thorough survey of the project area. Surveys included establishing appropriate vantage points, remaining at those points for 20 to 30 minutes listening for calls and using high powered binoculars to examine cliff faces for signs of nesting (ex. whitewash, nests, single or pairs of adults remaining in the area, etc.) and continuing father down the canyon until dark. Surveyors left the site at 8:25 p.m.

Additional Information: This concludes the required surveys for the Golden Eagle at the NA-0928 site. Surveyors will revisit site tomorrow (4/19/16) to complete the morning portion of the Peregrine Falcon survey.

Adkins Consulting Inc.
Environmental Permitting Services

180 East 12 Street Suite #5
Durango, CO 81301
Phone: 505-793-1140

DAILY REPORT
Field Surveys

PROJECT NAME: NN AUM SITE: NA-0928

DATE: 4/19/16

WEATHER: Partly cloudy, calm, temps mid 40's to high 40's

PERSONNEL ONSITE: Arnold Clifford (Principal Biologist), Sarah McCloskey (Field Assistant), Sarah Cowley (Field Assistant)

==

CONTRACTORS ONSITE NOTES:

Background: During the previous habitat assessment survey, habitat was documented for Golden Eagles, Peregrine Falcons and Burrowing Owls. Surveys were completed for Golden Eagle last night (4/18/16). The evening portion of the first Peregrine Falcon survey was also completed the last night.

Purpose: To perform the morning portion of the first Peregrine Falcon survey per Navajo Nation survey protocols[1] outlined below:

Peregrine Falcons - Two 8 hours surveys (4 hours before sunset and 4 hours after sunrise the following day) during each period: 1 FEB-30 APR (surveys during egg-laying/incubation discouraged) & 1 MAY-31 JUL (2 survey preferably prior to JUL). Productivity surveys require >=1 additional visits.

Methods: Surveyors arrived at the project site at 6:25 a.m. at first light and conducted a thorough survey of the project area. Surveys included establishing appropriate vantage points, remaining at those points for 20 to 30 minutes listening for calls and using high powered binoculars to examine cliff faces for signs of nesting (ex. whitewash, nests, single or pairs of adults remaining in the area, etc.) and continuing father down the canyon until the 4 hour survey time limit expired. Surveyors left the site at 10:30 a.m.

Adkins Consulting Inc.
Environmental Permitting Services
180 East 12 Street Suite #5
Durango, CO 81301
Phone: 505-793-1140

DAILY REPORT

Field Surveys

PROJECT NAME: NN AUM SITE: NA-0928

DATE: 4/21/16

WEATHER: Partly cloudy, calm, temps mid 40's to high 40's

PERSONNEL ONSITE: Arnold Clifford (Principal Biologist), Sarah Cowley (Field Assistant),

==

CONTRACTORS ONSITE NOTES:

Background: During the previous habitat assessment survey, habitat was documented for Golden Eagles, Peregrine Falcons and Burrowing Owls. Surveys were completed for Golden Eagle on (4/18/16). The evening portion of the second Peregrine Falcon survey was also completed the last night.

Purpose: To perform the morning portion of the first Peregrine Falcon survey per Navajo Nation survey protocols[1] outlined below:

Peregrine Falcons - Two 8 hours surveys (4 hours before sunset and 4 hours after sunrise the following day) during each period: 1 FEB-30 APR (surveys during egg-laying/incubation discouraged) & 1 MAY-31 JUL (2 survey preferably prior to JUL). Productivity surveys require >=1 additional visits.

Methods: Surveyors arrived at the project site at 6:25 a.m. at first light and conducted a thorough survey of the project area. Surveys included establishing appropriate vantage points, remaining at those points for 20 to 30 minutes listening for calls and using high powered binoculars to examine cliff faces for signs of nesting (ex. whitewash, nests, single or pairs of adults remaining in the area, etc.) and continuing father down the canyon until the 4 hour survey time limit expired. Surveyors left the site at 10:30 a.m.

Additional Information: This concludes the second of two required surveys for Peregrine Falcons during the 1 FEB-30 APR period.

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:

Sites: UT-B-59-8, UT-C-63-12, AZ-I-5-25, AZ- I-7-72, AZ-I-6-79, NM-I-24-87, NM-I-24-89:

1. Prior to any construction, the site boundaries will be flagged and/or temporarily fenced under the direction of a qualified archaeologist & shown to the construction foreman.

2. All ground disturbance within the 50 ft. of the site boundaries will be monitored by a qualified archaeologist.

3. No construction, equipment or vehicular traffic will be allowed within the site boundaries.

4. A brief letter/report documenting the result of the monitoring will be submitted to NNHPD within 30 days of monitoring activities.

5. All future maintenance activities shall avoid the site by a minimum of 50 ft. from the site boundaries.

Site NM-I-24-88:

Given the environmental hazards the mine possesses, and the thorough extent of the ethnographic information, all research potential has been exhausted. No further work is warranted.

TCPs.

No effect by proposed undertaking.

In the event of a discovery [*"discovery"* means any previously unidentified or incorrectly identified cultural resources including but not limited to archaeological deposits, human remains, or locations reportedly associated with Native American religious/traditional beliefs or practices], all operations in the immediate vicinity of the discovery must cease, and the Navajo Nation Historic Preservation Department must be notified at (928) 871-7198.

FORM PREPARED BY: **Tamara Billie**
FINALIZED: September 9, 2016

Notification to Proceed Recommended ☑ Yes ☐ No
Conditions: ☑ Yes ☐ No

Tamara Bill 9/9/16
The Navajo Nation Historic Preservation Office
Date

b 11/27/16
Navajo Region Approval ✓ Yes ☐ No
SEP 2 8 2016
Acting
BIA - Navajo Regional Office
Date

THE NAVAJO NATION
HERITAGE & HISTORIC PRESERVATION DEPARTMENT
PO Box 4950, Window Rock, Arizona 86515
TEL: (928) 871-7198 **FAX:** (928) 871-7886

CULTURAL RESOURCES COMPLIANCE FORM

ROUTE COPIES TO:
☑ DCRM

NNHPD NO.: **HPD-16-588.1**
OTHER PROJECT NO.: **DCRM 2016-06/Add. 1**

PROJECT TITLE: Addendum 1: Recording of Site AZ-I-6-81, Discovered during Drilling Operations at the Abandoned NA-0928 Uranium Mine

LEAD AGENCY: BIA/NR

SPONSOR: Sadie Hoskie, Trustee, Navajo National AUM, Environmental Response Trust, P.O. Box 3330, Window Rock, AZ 86515

PROJECT DESCRIPTION: During testing activities at the former NA-0928 uranium mine area, an archaeological site was discovered. Additional clearance was needed to complete additional contamination assessments of the project area(s). The area of effect is 0.49-acre.

LAND STATUS: Navajo Tribal Trust
CHAPTER: Sweetwater
LOCATION: T. 41 N., R. 28 E- Sec. 35; Toh Atin Mesa East Quadrangle, Apache County Arizona G&SRPM

PROJECT ARCHAEOLOGIST: Clifford Werito, Patrick Alfred & Tristin Moone
NAVAJO ANTIQUITIES PERMIT NO.: B16728
DATE INSPECTED: 06/03/17 – 06/05/17
DATE OF REPORT: 07/07/2016
TOTAL ACREAGE INSPECTED: 0.49 – ac
METHOD OF INVESTIGATION: Class III pedestrian inventory with transects spaced 10 m apart.
LIST OF CULTURAL RESOURCES FOUND: **(1) Site (AZ-I-6-81); (2) Isolated Occurrences (IO)**
LIST OF ELIGIBLE PROPERTIES: **(1) Site (AZ-I-6-81)**
LIST OF NON-ELIGIBLE PROPERTIES: **(2) IOs**
LIST OF ARCHAEOLOGICAL RESOURCES: **(1) Site (AZ-I-6-81)**

EFFECT/CONDITIONS OF COMPLIANCE: No historic properties affected with the following conditions:

Site AZ-I-6-81:

1. Site boundary flagging, monitoring and site recording was conducted by a qualified archaeologist.
2. All traffic/ground disturbing activities avoided the site by a minimum of 50-ft from the established site boundaries.
3. All future maintenance activities shall avoid the site by a minimum of 50 ft. from the site boundaries.

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: August 1, 2017

Notification to Proceed Recommended ☑ Yes ☐ No
Conditions: ☑ Yes ☐ No

8/1/2017
Richard M. Begay, Dept. Mgr./THPO Date
The Navajo Nation
Heritage & Historic Preservation
Department

Navajo Region Approval ☒ Yes ☐ No
8/7/2017

8/8/2017
BIA – Navajo Regional Office Date

NNDFW Review No. 15mwh101-na0928

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.: NA-0928 AML Environmental Response Trust Project

DESCRIPTION: Proposed scientific investigations and remediation activities will take place within an area of approximately 13.9 acres. The project will take place in 2 phases. Phase I would entail biological investigations and land surveying. Surface disturbance and noise would be minimal. During Phase II, an excavator or small mobile drilling unit may be used to collect soil samples. There may be up to 8 people onsite daily for up to 1 week. Surface disturbance will be light to moderate and confined within the project footprint.

LOCATION: 36°54'36"N 109°18'36"W, Sweetwater Chapter, Apache County, Arizona

REPRESENTATIVE: Lori Gregory, Adkins Consulting, Inc. for MWH Global

ACTION AGENCY: U.S. Environmental Protection Agency and Navajo Nation

B.R. REPORT TITLE / DATE / PREPARER: BE-NA-0928/JUN 2016/Lori Gregory, Plant Survey Report for Species of Concern At NA-0928 Project Site/AUG 2016/Redente Ecological Consultants

SIGNIFICANT BIOLOGICAL RESOURCES FOUND: Area 3. Suitable nesting habitat is present in the proposed 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: NA

CONDITIONS OF COMPLIANCE*: NA

FORM PREPARED BY / DATE: Pamela A. Kyselka/20 OCT 2016

COPIES TO: (add categories as necessary)

☐ ______________________ ☐ ______________________

2 NTC § 164 Recommendation: Signature Date 10/21/16

☒Approval
☐Conditional Approval (with memo)
☐Disapproval (with memo) Gloria M. Tom, Director, Navajo Nation Department of Fish and Wildlife
☐Categorical Exclusion (with request letter)
☐None (with memo)

*I understand and accept the conditions of compliance, and acknowledge that lack of signature may be grounds for the Department not recommending the above described project for approval to the Tribal Decision-maker.

Representative's signature Date

THE NAVAJO NATION

RUSSELL BEGAYE PRESIDENT
JONATHAN NEZ VICE PRESIDENT

MEMORANDUM

TO : Joe Begay Jr, Senior Animal Control Officer
Department of Fish and Wildlife
DIVISION OF NATURAL RESOURCES

FROM : Gloria M. Tom/
Gloria M. Tom, Director
Department of Fish and Wildlife
DIVISION OF NATURAL RESOURCES

DATE : October 21, 2016

SUBJECT : **DELEGATION OF AUTHORITY**

I will be on leave on Friday, October 21, 2016. Therefore, I am delegating you to act in the capacity of the Director, Department of Fish and Wildlife, effective at 8:00 am, October 21, 2016 and ending at 5:00 p.m., October 21, 2016.

Your authority will cover the review and signing off of all routine documents pertaining to the Department of Fish and Wildlife, except for issues that you feel should have the attention of the Director.

ACKNOWLEDGEMENT:

Joe Begay Jr, Senior Animal Control Officer
Department of Fish and Wildlife
DIVISION OF NATURAL RESOURCE

xc: File

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.1Data 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 NA-0928 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 12, 2016 and June 5, 2017 and were analyzed by ALS Environmental of Ft. Collins, Colorado, for all methods. Samples were analyzed for one or more of the following:

- Radium-226 in soil by United States Environmental Protection Agency (USEPA) Method 901.1
- Metals in soil by USEPA Method SW6020
- Isotopic thorium in soil by USDOEAS-06/EMSL/LV

Samples were collected and analyzed according to the procedures and specific criteria presented in the *Quality Assurance Project Plan, Navajo Nation AUM Environmental Response Trust (QAPP)* (MWH, 2016).

Project data were validated as follows:

- Laboratory Data Consultants, Inc. (LDC) of Carlsbad, California, performed validation of all radiological soil data, plus ten percent of the non-radiological data (Level IV only)
- All non-radiological soil data were validated by the Stantec Consulting Services Inc. (Stantec; formerly MWH) Project Chemist (Level III only)
- All samples received Level III data validation
- Ten percent of the sample results for all methods received a more detailed Level IV validation

The analytical data were validated based on the results of the following data evaluation parameters or quality control (QC) samples:

- Compliance with the QAPP
- Sample preservation
- Sample extraction and analytical holding times

- Initial calibration (ICAL), initial calibration verification (ICV), and continuing calibration verification (CCV) results
- Method and initial/continuing calibration blank (ICB/CCB) sample results
- Matrix spike/matrix spike duplicate (MS/MSD) sample results
- Laboratory duplicate results
- Serial dilution (metals analysis only)
- Interference check samples (ICS) (metals analysis only)
- Laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) results
- Field duplicate sample results
- Minimum detectable concentration (radiological analyses only)
- Reporting limits
- Sample result verification
- Completeness evaluation
- Comparability evaluation

Sample results that were qualified due to quality control parameters outside of acceptance criteria are listed on Table F.1-1.

2.0 DATA VALIDATION RESULTS

Stantec reviewed the data validation reports and assessed the qualified data against the DQOs for the project. The following summarizes the data validation findings for each of the data evaluation parameters.

2.1 QUALITY ASSURANCE PROJECT PLAN COMPLIANCE EVALUATION

Based on the data validation, all samples were analyzed following the quality control criteria specified in the QAPP, with the following exception: ALS routinely dilutes all metals samples by a factor of 10 times in order to protect their ICP-MS instrument from the adverse effects of running samples with high total dissolved solids. This also includes running a long series of samples (as is common in a production laboratory) with intermediate dissolved solids. The vulnerable parts of the instrument are the nebulizer, which produces an aerosol, and the cones, which disperse the aerosol. These areas form scaly deposits from the samples in the sample solution, despite the nitric acid and other acids present in the digestate. These parts of the instrument periodically need to be taken apart and cleaned, but in a production setting the laboratory wants to avoid any downtime as much as possible. As an ameliorating factor, the laboratory also takes account of this dilution factor up front in the project planning stages. The laboratory will not quote a reporting limit for this instrument that cannot be achieved after the 10 times dilution required for the instrument. Not all of the requested reporting limits can be met using the laboratory's routine protocol. The dilution is narrated by the laboratory merely as a matter of transparency, as well as for the validator's information. The dilution should have no impact on the project's sensitivity goals.

Sample Preservation Evaluation. All samples were preserved as specified in the QAPP.

Holding Time Evaluation. All analytical holding times were met.

Initial Calibration, Initial Calibration Verification, and Continuing Calibration Verification Evaluation. All ICAL, ICV, and CCV results were within acceptance criteria.

Method Blank Evaluation. No sample data were qualified due to method blank results.

Initial and Continuing Calibration Blank Evaluation. No sample data were qualified due to ICB/CCB data.

Matrix Spike/Matrix Spike Duplicate Samples Evaluation. All MS/MSD recoveries were within acceptance criteria with the exception of one MS and MSD recovery for the analysis of vanadium. Table F.1-1 lists the analyte where an MS and MSD percent recovery was outside the acceptance criteria. The sample result was qualified with a "J+" flag to indicate the data were estimated and potentially biased high. 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. All RPDs were within acceptance criteria except one sample for the analysis of vanadium. The result was qualified with a "J" flag to indicate an estimated result.

Serial Dilution Evaluation. All serial dilution percent differences were within acceptance criteria.

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 five metals. The primary cause for RPDs exceeding 30 percent for some duplicate pairs is assumed to be the heterogeneity/variability of soil samples. The sample IDs, sample results, and RPDs for those results that did not meet the guidance RPD are listed in Table F.1-2. Sample results were not qualified due to RPDs exceeding the guidance criteria, as described in the QAPP.

Minimum Detectable Concentration Evaluation. All minimum detectable concentrations met reporting limits with the exception of nine samples for the analysis of radium-226. However, the reported activity for each of these samples was greater than the achieved minimum detectable concentration and no qualification was needed.

Reporting Limit Evaluation. All sample data were reported to the reporting limit established in the QAPP, with the exception of the metals, as discussed at the beginning of this section related to dilution.

Sample Result Verification. All sample result verifications were acceptable with the exception of ten samples analyzed for radium-226. Cases that exceed the limit of +/- 15% of the density of the calibration standard were qualified with a "J+" flag for those results that may be biased high and a "J-" flag for those results that may be 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 reported.

Accuracy. Based on the ICAL, ICV, CCV, MS/MSD, and LCS, the data are accurate as qualified.

Representativeness. Based on the results of the sample preservation and holding time evaluation; the method and ICB/CCB blank sample results; the field duplicate sample evaluation; and the RL evaluation the data are considered representative of the Site as reported.

Completeness. All media and QC sample results were valid and collected as scheduled; therefore, completeness for this RSE is 100 percent.

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

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

Table F.1-1
Summary of Qualified Data
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Field Sample Identification	Sample Date	Analysis Code	Analyte	Sample Result	Units	QC Type	QC Result	QC Limit	Added Flag	Comment
S063-SCX-001-01	4/15/17	E901.1	Radium-226	0.72	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S063-SCX-201-01	4/15/17	E901.1	Radium-226	0.91	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S063-SCX-001-02	4/15/17	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.
S063-SCX-003-01	4/15/17	E901.1	Radium-226	1.78	pCi/g	Result Verification		±15%	J+	Result is estimated, potentially biased high. Sample density differs by more than 15% of LCS density.
S063-SCX-003-02	4/15/17	E901.1	Radium-226	1.97	pCi/g	Result Verification		±15%	J+	Result is estimated, potentially biased high. Sample density differs by more than 15% of LCS density.
S063-SCX-004-01	4/17/17	E901.1	Radium-226	52.5	pCi/g	Result Verification		±15%	J+	Result is estimated, potentially biased high. Sample density differs by more than 15% of LCS density.
S063-SCX-004-02	4/17/17	E901.1	Radium-226	41.5	pCi/g	Result Verification		±15%	J+	Result is estimated, potentially biased high. Sample density differs by more than 15% of LCS density.
S063-SCX-004-03	4/17/17	E901.1	Radium-226	105	pCi/g	Result Verification		±15%	J+	Result is estimated, potentially biased high. Sample density differs by more than 15% of LCS density.
S063-CX-010	4/15/17	SW6020	Vanadium	18	mg/kg	MS MSD	175% 155%	75% - 125% 75% - 125%	J+	Result is estimated, potentially biased high. MS and MSD recoveries above acceptance criteria.
S063-SCX-015-005	6/4/17	E901.1	Radium-226	0.92	pCi/g	Result Verification		±15%	J-	Result is estimated, potentially biased low. Sample density differs by more than 15% of LCS density.
S063-SCX-019-002	6/5/17	E901.1	Radium-226	50.6	pCi/g	Result Verification		±15%	J+	Result is estimated, potentially biased high. Sample density differs by more than 15% of LCS density.
S063-SCX-022-002	6/5/17	SW6020	Vanadium	280	mg/kg	LR	69%	20%	J	Result is estimated, bias unknown. LR RPD outside acceptance criteria.

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.1-2
Results that did not Meet the Relative Percent Difference Guidance
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Primary Sample / Duplicate Indentification	Sample Date	Parameter	Primary Result	Duplicate Result	Units	RPD (%)
S063-SCX-017-006/S063-SCX-017-206	6/4/2017	Vanadium	5.1	7.1	mg/kg	33%
S063-SCX-022-001/S063-SCX-022-201	6/5/2017	Uranium	0.92	1.5	mg/kg	48%
S063-SCX-011-003/S063-SCX-011-203	6/3/2017	Uranium	210	420	mg/kg	67%
S063-SCX-012-004/S063-SCX-012-204	6/4/2017	Selenium	2.2	1.6	mg/kg	32%
S063-SCX-012-004/S063-SCX-012-204	6/4/2017	Uranium	410	290	mg/kg	34%

Notes
mg/kg milligrams per kilogram
RPD relative percent difference