Section 32 and 33 Mines

Casamero Lake Chapter
Navajo Nation, New Mexico

Final
Engineering Evaluation/Cost Analysis

March 2024

TETRA TECH

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ACRONYMS AND ABBREVIATIONS

§	Section
°F	Degree Fahrenheit
ARAR	Applicable or relevant and appropriate requirement
AUM	Abandoned uranium mine
bgs	Below ground surface
BSA	Background study area
BTV	Background threshold value
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CO_2e	carbon dioxide equivalent
COC	Contaminant of concern
COEC	Contaminant of ecological concern
COPC	Contaminant of potential concern
COPEC	Contaminant of potential ecological concern
CSM	Conceptual site model
E&E	Ecology and Environment, Inc.
EE/CA	Engineering evaluation/cost analysis
EPC	Exposure point concentration
ERA	Ecological risk assessment
ET	Evapotranspiration
EU	Exposure unit
FOD	Frequency of detection
HELP	Hydrologic Evaluation of Landfill Performance
HHRA	Human health risk assessment
IC	Institutional control
Kerr-McGee	Kerr-McGee Corporation
LLRW	Low-level radioactive waste
MARSSIM	*Multi-Agency Radiation Survey and Site Investigation Manual*
NAMLRD	Navajo Nation Abandoned Mine Lands Reclamation Department
NAUM	Navajo abandoned uranium mine
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NNDFW	Navajo Nation Department of Fish and Wildlife
NNEPA	Navajo Nation Environmental Protection Agency

ACRONYMS AND ABBREVIATIONS (CONTINUED)

NORM	Naturally occurring radioactive material
NRC	U.S. Nuclear Regulatory Commission
NTUA	Navajo Tribal Utility Authority
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
pCi/g	Picocurie per gram
PERG	Preliminary ecological removal goal
PRG	Preliminary removal goal
psf	Pound per square foot
Ra-226	Radium-226
RAG	Removal action goal
RAO	Removal action objective
RCRA	Resource Conservation and Recovery Act
RME	Reasonable maximum exposure
RSE	Removal site evaluation
SE	Secular equilibrium
SLERA	Screening-level risk assessment
SPLP	Synthetic precipitation leaching procedure
SWPPP	Stormwater pollution prevention plan
TBC	To be considered
TCLP	Toxicity characteristic leaching procedure
TENORM	Technologically enhanced naturally occurring radioactive material
Tetra Tech	Tetra Tech, Inc.
U-234	Uranium-234
U-238	Uranium-238
UCL95	95 percent upper confidence level
UMTRCA	Uranium Mill Tailings Radiation Control Act
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
WCS	Waste Control Specialists
Weston	Weston Solutions, Inc.
WRS	Wilcoxon rank sum

1.0 EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (USEPA) prepared this engineering evaluation/cost analysis (EE/CA) report regarding the Section 32 and 33 Mines near Gallup, New Mexico, in the Navajo Nation.

1.1 PURPOSE OF THE ENGINEERING EVALUATION/COST ALTERNATIVES ANALYSIS

The EE/CA **develops and evaluates cleanup alternatives for addressing the risks to human health and the environment** associated with mine waste and contaminated soils remaining at the Section 32 and 33 Mines. These cleanup alternatives are developed and evaluated in the context of the Fundamental Laws of the Diné and in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

1.2 SITE CHARACTERIZATION

The **Section 32 and 33 Mines** are located in northwestern New Mexico, within the Casamero Lake Chapter of the Navajo Nation and adjacent private land, approximately 9 miles north of Prewitt, New Mexico (Figure 1). The Section 32 and 33 Mines are former underground uranium mines with an associated transfer station in the Grants Mining District. The Section 32 Mine is administered by the Casamero Lake Chapter of the Navajo Nation, and the Section 33 Mine is privately owned. The Section 32 Mine produced 20,117 tons of ore between 1960 and 1969, and the Section 33 Mine produced 4,243 tons of ore between 1960 and 1964. In 2012, USEPA Region 9 closed three mine shafts and excavated and consolidated waste rock from the Section 32 Mine and Section 32/33 Transfer Station in a temporary stockpile as part of a CERCLA Superfund cleanup action. The features at the Section 32 and 33 Mines include **three closed mine shafts, five unreclaimed waste piles, one reclaimed transfer station, and one temporary stockpile** (Weston Solutions, Inc. [Weston] 2019). No mine waste has been removed from the Section 32 and 33 Mines.

The Section 32 and 33 Mines are near several rural residences and 1.2 miles southeast of the Casamero Lake Chapter House. The Section 32 and 33 Mines area is currently used for grazing and recreation. All areas are easily accessible and relatively flat. The likely future land use is **Kee'da'whíí tééh (Navajo residential)** at the Section 32 Mine and **residential (non-Navajo)** at the Section 33 Mine.

The nature and extent of contamination at the Section 32 and 33 Mines were assessed with various technologies during a removal site evaluation (RSE) conducted in June 2019 (Weston 2019) and a data gap investigation in November 2022 (Tetra Tech 2023). **Most of the waste at the site is within the temporary stockpile and unreclaimed waste piles.**

As part of this EE/CA, risk assessments at the site were conducted to evaluate the potential risk posed to human and ecological health by mine-related contamination. **The results of the human health risk assessment (HHRA) and ecological risk assessment (ERA) indicate that risks are present above acceptable levels at the Section 32 and 33 Mines for human and ecological receptors. At the Section 32 Mine, uranium-238 (U-238) in secular equilibrium (SE), manganese, and uranium metal are contaminants of concern (COC) for**

human health. At the Section 33 Mine, U-238 in SE and uranium metal are COCs for human health. Site-wide at the Section 32 and 33 Mines, U-238 in SE and selenium are contaminants of ecological concern (COEC). A removal action is recommended for contamination associated with COCs and COECs at the Section 32 and 33 Mines.

Human health and ecological removal action goals (RAG) were derived for COCs and COECs. The RAG is the lesser of the human health preliminary remediation goal (PRG) or preliminary ecological removal goal (PERG). When one or both PRGs or PERGs are less than the background threshold value (BTV), the BTV becomes the RAG. For purposes of the final EE/CA, the BTV is used to represent background for delineating contaminated areas.

Multiple lines of evidence were used to develop the removal action extent at the Section 32 and 33 Mines, including the extent of radium-226 (Ra-226) in surface soil, extent of contamination of other COCs and COECs not co-located with Ra-226, surface waste areas, transport pathways, and risk management considerations. The removal action extent covers 22 acres at the Section 32 and 33 Mines. **An estimated 67,000 bank cubic yards of mine waste and contaminated soil will be addressed by removal action.**

1.3 REMOVAL ACTION OBJECTIVES

The first step in developing removal alternatives is to establish removal action objectives (RAO). Taking current and potential future land use and Navajo cultural considerations into account, the RAOs are to:

- Prevent exposure to soil with contaminants at levels above background concentrations and above concentrations that would pose an unacceptable risk to human health with residential use and traditional Diné Lifeways outside of any potential capped area
- Prevent exposure to soil with contaminants that would pose an unacceptable risk to human health with traditional Diné Lifeways on any potential capped area, which may include exposures that occur during activities such as livestock grazing, hunting, and plant gathering and use
- Prevent exposure to soil with contaminants that would pose an unacceptable risk to plants, animals, and other ecological receptors
- Prevent migration of contaminants to surface water or groundwater that pose an unacceptable risk to human health
- Prevent offsite migration of contaminants above background concentrations and at concentrations that could pose a risk to human health or the environment

The scope of the removal action will be to address all solid media contamination at the Section 32 and 33 Mines and to be the final action for solid media at the site. These RAOs have been developed to be considerate of Diné Lifeways.

1.4 IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES

The following removal action alternatives were developed and evaluated as part of this EE/CA. Each alternative was evaluated against the criteria of effectiveness, implementability, and cost.

- **Alternative 1: No Action (this must always be evaluated to provide a baseline for comparison)** – No treatment or removal action would occur at the site. In this case, all threats would remain unchanged. Mine waste and contaminated soils would continue to threaten human and ecological receptors. Gamma radiation and physical hazards would still be present.
- **Alternative 2: Consolidate and Cap All Waste at Onsite Repository** – Addresses RAOs by excavating residual waste rock and contaminated soils; consolidating the waste in an onsite repository including the existing stockpile; and capping the repository. An evapotranspiration (ET) cap would be used that is protective and would limit contaminant migration. The repository would be inspected and maintained in perpetuity. Land use restrictions would exist on the repository.
- **Alternative 3: Dispose of All Mine Waste Off Site at Red Rocks Disposal Facility** – Addresses RAOs by excavating the stockpile contents, residual waste rock, and contaminated soils and hauling the waste to and disposing of the waste off site at the Red Rocks disposal facility near Thoreau, New Mexico. Off-Navajo Nation disposal is protective and would not require long-term maintenance or land use restrictions.
- **Alternative 4: Dispose of All Mine Waste Off Site at a Resource Conservation and Recovery Act (RCRA) C or Low-Level Radioactive Waste (LLRW) Facility** – Addresses RAOs by excavating the stockpile contents, residual waste rock, and contaminated soils; and hauling and disposing of the waste at an offsite RCRA facility, such as the Clean Harbors Deer Trail facility in Deer Trail, Colorado, or an LLRW facility licensed by the U.S. Nuclear Regulatory Commission (NRC), such as the Waste Control Specialists (WCS) in Andrews, Texas. Off-Navajo Nation disposal is protective and would not require long-term maintenance or land use restrictions.

For the applicable removal action alternatives, plant life that matches the natural landscape will be planted on the installed covers of excavated material. All temporary roads built for construction will also be removed, and the site will be restored. The surface of the site will be recontoured and revegetated to match the natural landscape.

1.5 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

The removal action alternatives were evaluated individually and in relation to each other using three broad criteria: effectiveness, implementability, and cost. Exhibit 1 presents an overview of the comparative analysis results.

The recommended alternative for the Section 32 and 33 Mines is Alternative 3 (disposal of all mine waste off site at Red Rocks disposal facility). While the alternative is 2.5 times the cost of Alternative 2 (consolidate and cap all waste at onsite repository), it removes the waste from the Casamero Lake community and consolidates the waste at a dedicated facility capable of long-term management of the waste.

Exhibit 1. Summary of Alternative Ratings

Removal Action Alternative		Attainment of Threshold Criteria[a]	Effectiveness	Implementability	Cost Rating (Million)[b]
1	No Action	Fail	Short-Term: Average Long-Term: Very Poor	Tech: Very Good Admin: Very Good	Very Good $0
2	Consolidate and Cap All Waste at Onsite Repository	Pass	Short-Term: Good Long-Term: Good	Tech: Good Admin: Good	Very Good ($4.4)
3	Dispose of All Mine Waste Off Site at Red Rocks Disposal Facility	Pass	Short-Term: Poor Long-Term: Very Good	Tech: Very Good Admin: Average	Average ($9.8)
4	Dispose of All Mine Waste Off Site at a RCRA C or LLRW Facility	Pass	Short-Term: Very Poor Long-Term: Very Good	Tech: Very Good Admin: Good	Very Poor ($36.4)

Notes:
a Threshold criteria are (a) overall protection and (b) compliance with applicable or relevant and appropriate requirements.
b Estimated costs are net present value.
Admin Administrative feasibility
LLRW Low-level radioactive waste
RCRA Resource Conservation and Recovery Act
Tech Technical feasibility

Though USEPA has recommended Alternative 3, USEPA will solicit input from Navajo Nation officials, regulators, chapter representatives, other stakeholders, and the community on the final EE/CA and recommended alternative during a public comment period. USEPA and the Navajo Nation Environmental Protection Agency (NNEPA) will hold a public meeting during the comment period to listen to input.

2.0 SITE CHARACTERIZATION

This section presents the site description and background; previous reclamation and removal actions; previous site investigations; source, nature, and extent of contamination; and risk assessment of the Section 32 and 33 Mines.

2.1 SITE DESCRIPTION AND BACKGROUND

The Section 32 and 33 Mines site covers 56 acres and contains waste rock and other mine debris placed on relatively flat valley floor around closed mining shafts and a transfer station approximately 1,000 feet south of the Section 32 Mine area.

The following subsections describe the site location, type of mines and operational status, regulatory history, features and landscape, geology and hydrology, land use and populations, sensitive ecosystems and habitat, and meteorology and climate. Appendix A contains site images that show the current condition of the complex.

2.1.1 Site Location

The Section 32 and 33 Mines site is within the Casamero Lake Chapter community of the Navajo Nation in the Eastern Abandoned Uranium Mine (AUM) Region. The site is 9 miles north of the Prewitt, New Mexico, exit on Interstate 40 at 35.490 degrees latitude and -108.017 degrees longitude in McKinley County, New Mexico. The elevation is approximately 7,000 feet above mean sea level. The Section 32 Mine is within Navajo Allotment Land, and the Section 33 Mine is privately owned.

The site is accessed from Prewitt, New Mexico, by traveling north on paved County Road 19 and then east on an unpaved access road. The unpaved access road passes by multiple residences and ends along the south boundary of the Section 32 Mine temporary stockpile. A fence borders the private property on the Section 33 Mine along the west boundary of the Section 33 Mine (Figure 2) (Tetra Tech, Inc. [Tetra Tech] 2022a).

2.1.2 Type of Mine and Operational Status

The Section 32 and 33 Mines were deep, dry underground mines accessed through near-vertical mine shafts. The mines were likely developed using underground room-and-pillar mining techniques to extract lenticular ore bodies containing uranium and vanadium (New Mexico Energy and Minerals Department 1979). Whether the pillars were salvaged and the rooms blasted closed is unknown. The Section 32/33 Transfer Station south of the main mining area was used for both mines.

Much of the waste produced at the Section 32 and 33 Mines is overburden that was piled near the mine shafts. Overburden is low-grade native material that miners had to get through to access the ore. No surface features such as subsidence, fissures, or cracks that may indicate mine collapse were observed during the Weston RSE investigation (Weston 2019).

The Section 32 and 33 Mines were developed in the early 1960s by the Kerr-McGee Corporation (Kerr-McGee), a predecessor of Tronox. The Section 32 Mine was operated by Kerr-McGee from 1960 to 1969 and produced 20,117 tons of uranium ore (McLemore and Chenoweth 1991). The Section 33 Mine was operated by Kerr-McGee from 1960 to 1964 and produced 4,242 tons of uranium ore (McLemore and Chenoweth 1991). Both mines are reported to be last operated by the Cobb Nuclear Company.

Site features, haul and exploratory roads, exploratory boreholes, and reclamation features are shown on Figure 3.

2.1.3 Regulatory History

The Section 32 and 33 Mines are part of the 2015 Kerr-McGee/Tronox Settlement Agreement (*In re: Tronox Incorporated, No. 09-10156* [Bankruptcy Court for the Southern District of New York, November 23, 2010]). The Section 32 Mine is within Navajo Allotment Land, and the Section 33 Mine is privately owned. The Section 32 and 33 Mines site remediation is being completed under CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

2.1.4 Site Features and Landscape

The Section 32 and 33 Mines site is on gently to moderately sloping terrain. The vegetation communities on the site include plains-mesa grassland, great basin desert shrub, juniper woodland, and arroyo riparian. The site has 37 percent vegetation cover with large areas disturbed from human activity (NV5, Inc. 2019a). Appendix A contains photographs of the site vegetation.

Mine features at the Section 32 and 33 Mines include mine shafts and unmapped underground workings, waste piles, mine debris, a transfer station, and a haul road (Figure 3). Reclamation of some of these mine features occurred during the 2012 removal action described in Section 2.2.

Mine waste at the Section 32 Mine and Section 32/33 Transfer Station was consolidated in a temporary stockpile at the Section 32 Mine immediately west of the Section 33 Mine. Mine waste at the Section 33 Mine is stockpiled in five piles on flat terrain above a 1- to 3-foot slope. Surface water flow on the Section 33 Mine converges into a small ephemeral drainage that flows west toward the waste stockpiles and is head-cutting into the Section 33 Mine area. The relatively flat terrain slopes 3 degrees to the west, starting at the base of a ridge 0.64 mile east of the Section 32 and 33 Mines.

Table 1 presents the reclamation status, reclamation description, and dimensions for each mine feature at the Section 32 and 33 Mines; reclamation activities are discussed in Section 2.2. The mine features are:

- Mine Shaft S32-01 is in the southeast corner of the Section 32 Mine.
- Mine Shaft S32-02 is in the southeast corner of the Section 32 Mine and adjacent to Mine Shaft S32-01.
- Mine Shaft S32-03 is in the southwest corner of the reclaimed Section 32/33 Transfer Station.

- Waste Pile S33-01, Waste Pile S33-02, Waste Pile S33-03, Waste Pile S33-04, and Waste Pile S33-05 are within the Section 33 Mine and numbered from north to south.
- Section 32/33 Transfer Station is approximately 1,000 feet south of the Section 32 Mine on a 2- to 4-degree north-dipping slope and has a sealed vent hole.

Mine feature locations and extents were mapped during the 2012 removal action (Ecology and Environment, Inc. [E&E] 2014), with an additional waste pile (Waste Pile S32-02) mapped during the Tetra Tech 2022 field reconnaissance (Tetra Tech 2022a).

A cultural resource inventory survey of the Section 32 Mine and the western half of the Section 33 Mine (NV5, Inc. 2019b) was completed as part of the 2019 Weston RSE (Weston 2019). The survey found various resources, some of which are in the project area, and recommended for avoidance.

2.1.5 Geology and Hydrology

The following subsections describe the geology, hydrogeology, and hydrology of the Section 32 and 33 Mines.

2.1.5.1 Geology

The Section 32 and 33 Mines are within the Smith Lake subdistrict of the Grants Mining District. The Grants Mining District is a belt of sandstone-hosted uranium deposits that stretches from the Pueblo of Laguna to the area of Gallup, New Mexico. Most uranium deposits in the Grants Mining District are found in sandstone members of the Jurassic-age (199 to 145 million years ago) Morrison Formation. In the Section 32 and 33 Mines area, the Morrison Formation is covered by younger Cretaceous-age (145 to 65 million years ago) sandstones and mudstones. Quaternary-age (1.8 million years ago to present) sand, sediment, and soil deposits fill small stream valleys and cover floodplains. Figure 4 presents the geology at the site and in the surrounding areas. The important geological units in and near the Section 32 and 33 Mines are listed in stratigraphic order (oldest to youngest) and described below:

- Morrison Formation
    - Recapture Member consists of sandstone and claystone.
    - Westwater Canyon Member consists of sandstone and is the main host of uranium deposits in the portion of the Grants Mining District where the Section 32 and 33 Mines are located (Santos 1970). The Westwater Canyon Member interfingers with both the Recapture and Brushy Basin Members. One of the larger fingers of the Westwater Canyon Member in the overlying Brushy Basin Member is the Poison Canyon Sandstone, which includes the ore horizon mined through the Section 32 and 33 Mines. The Poison Canyon Sandstone varies in thickness, and ore is known to be where the sandstone is 30 to 90 feet thick (Santos 1970).
    - Brushy Basin Member consists of green/gray mudstones and a minor amount of sandstone.

- Dakota Sandstone consists of sandstone with a minor amount of mudstone, coal, and conglomerate, and interfingers with the overlying Mancos Shale. The mesa to the south of the Section 32 and 33 Mines is primarily Dakota Sandstone.
- Mancos Shale consists of mudstone, claystone, and siltstone. A small amount of Mancos Shale outcrops at the surface within the Section 32 and 33 Mines area. The mesa to the east is primarily Mancos Shale.
- Alluvium is the silt, sand, and gravel in small stream valleys and floodplains. Most of the surface geology at the Section 32 and 33 Mines is alluvium.

Though a discussion of the geology, soils, and aquifers in the Lukachukai Mountains Navajo area uranium mines characterization conceptual site model (CSM) is under development, no corresponding version for the Eastern AUM Region that would include the Section 32 and 33 Mines is currently planned.

2.1.5.2 Hydrogeology

A series of arroyos, formed from surface water flow from the surrounding mesas, are the main drainage pathways in the area. These arroyos are dry most of the year and flood during monsoon season. The closest arroyo is a shallow southwest-flowing arroyo approximately 200 feet north of the Section 32 and 33 Mines. Figure 2 shows the topography and hydrology at the site and surrounding areas, and Figure 5 shows the regional aquifers and wells.

Groundwater depth and information on nearby water wells used for drinking water were not available during the 2019 Weston RSE (Weston 2019). No drinking water wells were identified within 4 miles of the site during the 2009 Weston site screening investigation (Weston 2009).

2.1.6 Land Use and Populations

Several residences are near the Section 32 and 33 Mines with the closest residence 0.5 mile to the west. The closest population center is the community surrounding the Casamero Lake Chapter House, which is 1.4 miles northwest of the site.

The area containing the Section 32 and 33 Mines is fenced off from active cattle grazing on the Section 33 Mine private property. Resident use of the Section 32/33 Transfer Station area is evidenced by recently used access roads and a trash dump site. The likely future land use at the Section 32 Mine is **Kee'da'whíí tééh (Navajo residential)**, while at Section 33 Mine the likely future land use is **residential (non-Navajo)** (Figure 6).

The flat terrain of the Section 32 and 33 Mines provides more potential locations for the siting of houses, hogans, corrals, or stock loading ramps. Future land uses could include agricultural activities, commercial activities, and/or residential areas.

2.1.7 Sensitive Ecosystems and Habitat

The Section 32 and 33 Mines are within an Area 3 wildlife sensitive area as identified by the Navajo Nation Department of Fish and Wildlife (NNDFW) and classified as a less sensitive area containing a low and fragmented concentration of endangered and rare plant, animal, and game species on the Navajo Nation (NNDFW 2008). Therefore, development can proceed as recommended by NNDFW with few exceptions.

Most of the habitat at the Section 32 and 33 Mines is terrestrial/upland, and the primary impacted environmental medium is soil. Several small arroyos pass through the Section 32 and 33 Mines but do not support wetlands or a riparian corridor and appear to convey insufficient flows to justify augmentation (NV5, Inc. 2019a) (Figure 7). Stock ponds are also near the site but are not surrounded by vegetation. Riparian and wetland habitats are particularly important for ecological health in arid ecosystems, such as that at the Section 32 and 33 Mines area.

A natural resources survey was performed in November 2018 to identify protected species and general wildlife habitat and general vegetation and vegetative community types for the Section 32 and 33 Mines area (NV5, Inc. 2019a). The survey found that shrub and grassland communities dominate the area around the Section 32 and 33 Mines and most closely resemble the plains-mesa grassland community. The shrubby areas consist of Great Basin desert shrub saltbush communities. Arroyo riparian vegetation is confined to the bottom of the ephemeral waterways that cross through the study area but constitute less than 2 percent of the overall area.

Documented vegetative communities around the mines were Great Basin desert scrub (saltbush/blue grama/galleta/western wheat grass), Great Basin desert scrub (saltbush/kochia/gumweed/various weeds), and arroyo riparian (rabbitbrush/saltbush/galleta). All are lowland communities that occur on mostly flat open ground. Most of the area has been heavily disturbed in the past and is still impacted by cattle grazing. As a result, the overall vegetative cover and species diversity across much of this area is low (NV5, Inc. 2019a). Vegetated areas at the site are expected to provide better habitat for terrestrial receptors because plants serve as a food source and provide areas of refuge.

In general, wildlife was not common across the site with fewer than 20 vertebrate species documented during the survey. Overall, birds were scarce in species diversity and numbers. Signs to indicate presence of large mammals were found only in the wooded areas around the periphery of the site. Small mammals were also uncommon. Some of this lack of diversity and abundance is likely because of the time of year the survey was conducted (winter). However, many of the lowland Great Basin desert scrub communities were in poor condition with stunted shrub growth and little herbaceous ground cover. Additionally, a substantial portion of the north half of the Section 32 Mine is impacted by human activities and domestic predators, such as dogs. All of these factors can reduce the quality of habitat for vertebrate species.

Tetra Tech (2022b) conducted a habitat assessment during the data gap investigation on November 18 and 20, 2022, to assess the potential for the project to affect Endangered Species Act-listed species or critical habitats, migratory birds protected by the Migratory Bird Treaty Act, and NNDFW sensitive species potentially occurring within 0.5 mile of the facility disturbance footprint of the project. The assessment found no rare plant species, plant species of management interest, habitats in which rare plant species occur, or federally listed or sensitive species in the project area. All suitable nesting areas were surveyed, and no active raptor species nests were documented. Some suitable habitat was observed for mountain plover. Several areas of barren ground xeric habitat were observed across the site. No prairie dog colony habitat that could be used by burrowing owls was observed during the site assessment. Other avian and wildlife species observed included common raven (*Corvus corax*), house finch (*Haemorphous mexicanus*), rock wren (*Salpinctes obsoletus*), and American kestrel (*Falco sparverius*).

2.1.8 Meteorology and Climate

Climate at the Section 32 and 33 Mines area and surrounding mesas is semiarid with low precipitation, high temperatures, and strong winds. Daily temperature and precipitation data from the Western Regional Climate Center (2024) station in nearby Thoreau, New Mexico, were examined for years 1971 to 2010. Data from 2010 to the present from this station and other stations near the Section 32 and 33 Mines were not available. The station data indicate the following weather trends:

- Average annual precipitation (recorded) is 10.71 inches.
- Average monthly maximum temperatures range from 43.2 degrees Fahrenheit (°F) in January to 85.5 °F in July.
- Average minimum monthly temperatures range from 18.6 °F in January to 55.8 °F in July with freezing being common from November through April.
- In the summer, seasonal monsoon rains can occur from July until October, limiting access to use of access roads.

Figure 7 shows the Thoreau, New Mexico, average monthly precipitation, snowfall, and temperature. Figure 8 shows that the wind in Thoreau, New Mexico, typically originates from the southwest.

Exhibit 2 provides precipitation frequency estimates over several average recurrence intervals for the City of Gallup (approximately 40 miles west of the site) from the National Oceanic and Atmospheric Administration (2006). For example, a 10-minute storm in this area that deposits 0.994 inch of rain is likely to occur once every 100 years. These estimates provide a better description of precipitation event intensities and how durations could affect the Section 32 and 33 Mines and surrounding drainages.

Exhibit 2. Precipitation Frequency Estimates

Duration	Average Recurrence Interval			
	1 Year	5 Years	100 Years	1,000 Years
5 Minutes	0.195	0.338	0.654	0.955
10 Minutes	0.296	0.515	0.994	1.45
30 Minutes	0.494	0.859	1.66	2.43
2 Hours	0.725	1.23	2.44	3.66

Note:
Precipitation frequency estimates in inches based on frequency analysis of partial duration series. Estimates have an upper bound confidence interval at 90 percent. Estimates are from the National Oceanic and Atmospheric Administration (2006).

2.2 PREVIOUS RECLAMATION AND REMOVAL ACTIONS

USEPA Region 6 began a removal action and conducted reclamation work at the Section 32 and 33 Mines in 2012. Three mine shafts were closed, and waste rock from the Section 32 Mine and Section 32/33 Transfer Station was placed in a temporary onsite stockpile (E&E 2012). USEPA Region 9 was not granted access to conduct remediation at the Section 33 Mine by the landowner in 2012 (Weston 2019). Table 1 presents descriptions and dimensions for each mine and reclamation feature, and Figure 3 presents the reclamation features.

2.3 PREVIOUS SITE INVESTIGATIONS

Previous environmental investigations for the Section 32 and 33 Mines include:

- Preliminary assessment in 2009 to verify the location and type of waste present at each mine site (Weston 2009).
- Removal assessment in 2012 to determine contamination extent and removal area. Activities included gamma scan surveys of soil and waste piles, sampling of soil and waste piles, and assessment of homesites near the site (E&E 2012). A cultural resource inventory survey was completed as part of the removal assessment, which included field surveys and review of records at the Navajo Nation Heritage and Historic Preservation Department (CSWTA, Inc. 2012).
- RSE field investigations in 2019 that included gamma radiation surveys and collection and analysis of surface soil samples. The gamma investigation included the mine sites, haul road, and surrounding mesas (Weston 2019). A cultural resource inventory survey (NV5, Inc. 2019b) was completed on the Section 32 Mine and the western half of the Section 33 Mine and included with the RSE. The survey found various resources, some of which are in the project area, and recommended for avoidance.
- Data gaps field investigation in 2022 that included gamma radiation surveys, collection and analysis of surface soil samples, establishment of background study areas, and a biological survey. The investigation covered the mine sites, haul road, and former transfer station (Tetra Tech 2023).

2.4 SOURCE, NATURE, AND EXTENT OF CONTAMINATION

The source, nature, and extent of waste materials at the Section 32 and 33 Mines were characterized during the 2019 Weston RSE investigation (Weston 2019) and the 2022 Tetra Tech data gaps investigation (Tetra Tech 2023). The following subsections present the calculation of BTVs, results of the investigations and identification of constituents of interest (COI), sources and nature of contamination, extent of contamination, and identification of exposure units (EU).

2.4.1 Background Threshold Values

The 2019 Weston RSE established a background study area (BSA) in the Quaternary alluvium, the geologic unit present at the surface of the Section 33 and 33 Mines (Weston 2019). However, only gamma data were collected at the 2019 BSA and site-specific assessment of the geology found the BSA was in proximity to the geologic contact between Quaternary alluvium and Mancos Shale Lower Body (Tetra Tech 2023).

Consequently, as part of the data gap investigation in November 2022, a desktop study identified a new site-specific Quaternary alluvium BSA (Figure 3) located away from mining impacts with geology similar to the Section 32 and 33 Mines. The desktop study evaluated the geology, soils, and hydrology of the Section 32 and 33 Mines and AUM-related areas and identified an appropriate strategy for establishing background and siting locations of potential BSAs.

Background samples were analyzed for total metals (including thorium and uranium) via USEPA SW-846 Method 6020 and Ra-226, radium-228, and potassium-40 via USEPA Method 901.1. Ten percent of the background samples were analyzed for isotopic thorium and uranium via ASTM International Method D3972 and lead-210 via Eichrom Method.

BTVs for were calculated (Exhibit 3) based on the 95 percent upper tolerance limit with 95 percent coverage. The limit represents a 95 percent probability (or confidence) that 95 percent of samples from background are below that value.

Exhibit 3. Background Threshold Values

Analyte	Unit	BTV
Radium-226	pCi/g	1.9
Gamma	cpm	16,100
Aluminum	mg/kg	28,800
Antimony	mg/kg	0.34
Arsenic	mg/kg	8.1
Barium	mg/kg	104
Beryllium	mg/kg	1.1
Cadmium	mg/kg	0.23
Chromium	mg/kg	21
Cobalt	mg/kg	9.5
Copper	mg/kg	18
Iron	mg/kg	28,700
Lead	mg/kg	19
Manganese	mg/kg	279
Molybdenum	mg/kg	1.4
Nickel	mg/kg	19
Selenium	mg/kg	2.5
Silver	mg/kg	0.34
Thallium	mg/kg	0.47
Uranium	mg/kg	1.5
Vanadium	mg/kg	40
Zinc	mg/kg	73

Notes:
BTV Background threshold value
cpm Counts per minute
pCi/g Picocurie per gram
mg/kg Milligram per kilogram

2.4.2 Source and Nature of Contamination

The main source of contamination at the Section 32 and 33 Mines is waste rock derived from the Poison Canyon Sandstone and overburden (overlying rock) that was dumped at the mine. The waste rock was produced from driving shafts through sandstone and mudstone to reach and extract the ore bodies. During the 2012 removal action, some of the waste rock was placed into a stockpile. The waste rock is characterized as clayey silty sand with larger-sized rock (greater than 6 inches in diameter) originating from the mine workings. Geotechnical analysis of soils at the site indicated that the soil types include clayey sand, clayey silty sand, and silty sand. Such soil types are more susceptible to erosion, especially during precipitation and snow melt events.

The main contaminant transport pathway at the site is erosion of waste or contaminated soil by surface water and redeposition downstream. Wind erosion of waste may also move contamination from the surface of the mine waste to adjacent areas. Fluvial and aeolian waste deposits may be remobilized and transported off site. Radon gas emanation and the leaching and dissolution of metals and radionuclides from waste may also occur. The CSM wire diagram presented in Figure 9 shows the sources of contamination, release mechanisms, and exposure media, as well as potential human health and ecological receptors and exposure pathways (see Section 2.5).

2.4.2.1 Waste Characteristics

Metals leachability data pertaining to the Section 32 and 33 Mines were collected during the 2022 data gap investigation (Tetra Tech 2023) for metals leachability analysis via both the toxicity characteristic leaching procedure (TCLP) and the synthetic precipitation leaching procedure (SPLP). All TCLP results were below detection limits and regulatory criteria, indicating that the waste does not exhibit a RCRA toxicity characteristic for hazardous waste if sent for disposal off site.

SPLP metals and radionuclide results were compared to USEPA and Navajo surface water quality criteria. Ra-226, aluminum, barium, lead, selenium, and uranium in leachate from waste exceeded surface water quality criteria, indicating that leachate generated could impact surface water quality at the Section 32 and 33 Mines. Groundwater is not present in waste rock or alluvium at the Section 32 and 33 Mines.

2.4.2.2 Geotechnical Characteristics

Geotechnical data pertaining to the Section 32 and 33 Mines were collected during the 2022 data gap investigation (Tetra Tech 2023) and will be used during the design phase.

Geotechnical samples were analyzed for dry and wet bulk density, porosity, constant and falling head conductivity, particle size distribution, Atterberg limits, standard Proctor compaction, direct shear, and swell or collapse. The borrow soil samples were also analyzed for agronomic viability. The purpose of the geotechnical testing was to understand the physical characteristics of the waste and borrow soil to support radon and hydraulic modeling, suitability of the borrow soil for use as cover material, waste and borrow soil compaction requirements, plasticity of the waste and borrow soil, and loading limits before failure.

Results for the mine waste were:

- Bulk densities: 1.82 to 1.88 grams per cubic centimeter
- Porosities: 38.3 to 42.3 percent
- Saturated hydraulic conductivities: 6.4 x 10^{-5} to 6.1 x 10^{-6} indicative of fine sand to loams
- Particle size distributions: silty sands to a sandy lean clay
- Atterberg testing: liquid limit of 41 to 43, plastic limit of 19 to 23, and plasticity index of 18 to 24
- Proctor compaction: optimum moisture contents of 16.8 to 21.4 percent with maximum dry bulk densities of 1.60 to 1.72 grams per cubic centimeter
- Direct shear friction: angles from 31 degrees (111 pounds per square foot [psf] cohesion) to 33 degrees (144 psf cohesion) under loads ranging from 200 to 6,000 psf
- Soils classified as sandy lean clay and lean clay that exhibited a moderate amount of cohesiveness with no concern for swelling or collapse

2.4.2.3 Metals and Radionuclides in Surface and Subsurface Soils

At the Section 32 and 33 Mines, mapped site features and the raw Ra-226 concentrations (as converted from Section 32 and 33 Mines gamma survey data [Tetra Tech 2023]) were used as the primary lines of evidence for delineating technologically enhanced naturally occurring radioactive material (TENORM). Uranium is a naturally occurring radioactive material (NORM) and effects of mining can lead to TENORM. Appendix D includes figures presenting the estimated Ra-226 soil concentrations (Figure D-1), barium soil concentrations, (Figure D-2), manganese soil concentrations (Figure D-3), selenium soil concentrations (Figure D-4), and uranium soil concentrations (Figure D-5). All mine and reclamation features, including the haul road leading into the site, closed mine shafts, and the stockpile are mapped as TENORM.

The Section 32 and 33 Mines lies within Quaternary alluvium, which consists of loose sediment and soil deposits on valley floor, with outcrops of the underlying Mancos Shale to the south. Underlying the Mancos Shale is the Morrison Formation and the Poison Canyon Sandstone within the middle Morrison Formation, which is considered the host rock unit for uranium. No Poison Canyon Sandstone is exposed at the surface in the Section 32 and 33 Mines area.

Metals sampling in subsurface soils at the Section 32 and 33 Mines is limited. Most subsurface sampling was completed in the November 2022 data gap investigation and confirmed that TENORM had not been historically transported away from the surface waste and down drainages, and subsequently buried in sediment. No evidence of transport of mine waste contamination was found in surface water pathways downgradient of the site (Tetra Tech 2023; Weston 2019).

In summary, the following features and areas are considered TENORM at the Section 32 and 33 Mines:

- Unreclaimed Section 33 Mine waste piles

- The Section 32 Mine stockpile
- Reclaimed mine shafts (included in the footprint of other site features)
- Contaminated surface soils surrounding site features resulting from transport of mine waste
- Haul road leading to the site

Not all TENORM features contain measured concentrations of Ra-226 above the BTV, which is the RAG at the Section 32 and 33 Mines. Only TENORM areas with Ra-226 concentrations above the BTV or that are considered sources of contamination are recommended for cleanup.

2.4.3 Extent of Contamination

Data characterizing the extent of contamination (radiation intensity through gamma scan surveys and metals during the 2019 Weston RSE investigation and 2022 Tetra Tech data gaps investigation) is used to identify contamination migration pathways and support the risk assessment and removal decisions.

Uranium is a naturally occurring radioactive material (NORM) and effects of mining can lead to TENORM. Examples of TENORM at the Section 32 and 33 Mines include all waste rock, soil disturbed around the mine shafts, waste in the stockpile, and waste that has migrated into surrounding soils and the haul road.

Areas undisturbed by mining activity are considered NORM and may include bedrock outcrops outside the area of mining activity, as well as areas impacted by transport of material from undisturbed areas. At the Section 32 and 33 Mines, bedrock outcrops of Mancos Shale may be NORM; downwind transport or erosion from these NORM areas may contribute to elevated gamma levels and Ra-226 and metals concentrations downslope of these outcrops. Figure 10 presents the extent of NORM and TENORM at the Section 32 and 33 Mines, and Appendix B presents the lines of evidence for determining the TENORM boundary.

At the Section 32 and 33 Mines, the areas that consistently have the highest Ra-226 and metals concentrations above the BTV are waste piles, soil surrounding the stockpile, intermittent areas along the haul road, and small areas in the reclaimed transfer station footprint (Figure 11).

2.5 RISK ASSESSMENT

Appendix C presents the complete risk assessment. The risk assessment uses laboratory sampling data from the Section 32 and 33 Mines to identify the candidate COCs and COECs, provide an estimate of how and to what extent human and ecological receptors might be exposed to these contaminants, and describe whether the exposures pose unacceptable risk to the receptors. Appendix C, Table C-1, provides a summary of the analytical data used in the risk assessment for the Section 32 and 33 Mines, and Appendix C, Attachment C-1, provides the full dataset used in the risk assessment. Appendix C, Figure C-2 and Figure C-3, present the locations of the soil samples used in the risk assessment. The following subsections present the purpose of the risk assessment, describe the EUs, and summarize the risk assessment methodology and results.

2.5.1 Purpose

The purpose of the risk assessment is to estimate current and future human health risk under appropriate reasonable maximum exposure (RME) scenarios and ecological risk focused on the known ecosystems for the region. This risk assessment was performed using procedures in USEPA (2001) guidance on risk assessment and focuses on the completed exposure pathways, primary risk drivers, and source material as indicated in the "Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA" (USEPA 1993). The results of the risk assessment are used to assist in removal action decisions for a site. The HHRA estimates the risk posed to human health by contaminants at the site and identifies human health candidate COCs in each EU. The ERA identifies the risks posed to ecological receptors by contaminants at the site and candidate COECs on a site-wide bases. The methodology for the HHRA and ERA is presented in the NAUM risk assessment methodology (USEPA 2024a).

2.5.2 Exposure Units

An EU is a geographic area where receptors (a person or animal) may reasonably be assumed to move at random and where contact across the EU is equally likely over the course of an exposure duration. The Section 32 and 33 Mines EUs were developed by identifying areas of contiguous TENORM contamination and anticipated future land use. The risk assessment boundary (the entirety of all areas evaluated within EUs) was established via soil sampling and augmented through examination of gamma survey data. Areas of NORM, such as natural mineralized outcrops and nonimpacted areas, although not included in the TENORM boundary, were also included within the risk assessment boundary and as part of the EU because a receptor would also be exposed to NORM areas when at the site. Appendix C, Table C-2, Figure C-2 and Figure C-3, present the EUs identified at the site and provide the areas and samples available for each EU; land uses are described in Section 2.1.6. Based on the site evaluation, two EUs were identified at the Section 32 and 33 Mines. The ERA is conducted on a site-wide basis; all HHRA EUs were combined to create the site-wide EU.

- **Section 32 Mine** – The Section 32 Mine is allotment land of the Navajo Nation. Several residences are on the Section 32 Mine with the nearest residence approximately 2,000 feet from the former mine site. Therefore, Kee'da'whíí tééh (full-time Navajo resident) was selected as the RME receptor for the HHRA.
- **Section 33 Mine** – The Section 33 Mine is privately-owned land that is currently used for livestock grazing. Most of the active mining took place at the Section 33 Mine, and waste piles are present on site. The property could be used for a residence in the future; therefore, the default resident (non-Navajo) was selected as the RME receptor for the HHRA.
- **Site-wide** – A 490-acre area that encompasses all the human health EUs for evaluation of the ecological receptors at the Section 32 and 33 Mines.

2.5.3 Human Health Risk Assessment

This subsection describes the key elements of the HHRA methodology. An HHRA is the process for evaluating how people are impacted by exposure to one or more environmental stressors, such as metals or radiation. Exposure is how a contaminant can enter a body (for example, by eating produce that absorbed contaminants, breathing contaminated dust, touching contaminated materials, or being exposed to radiation emanating from soil). This risk assessment uses Navajo-specific exposure scenarios, as explained below, to identify how a person can be exposed to contamination at AUMs on the Navajo Nation. For areas on private property, a default residential receptor was used in the risk assessment. This HHRA focuses on soil contamination only. The HHRA does not include ingestion of surface water or groundwater by people or animals. Safe drinking water is supplied to residents in the Section 32 and 33 Mines area. Wells used for livestock have been tested and are upgradient of known groundwater contamination in the area.

The HHRA evaluates whether site-related contaminants of potential concern (COPC) detected in soil pose unacceptable risks to potential current and future people at a site under conditions at the time of the EE/CA (unremediated conditions) (USEPA 1989, 1993). The HHRA includes the following components: data evaluation and selection of COPCs, exposure assessment, toxicity assessment, and risk characterization.

Any contaminant with a maximum detected value exceeding its COPC screening level is retained as a COPC for the HHRA risk calculations. The COPC screening levels are based on a $1x10^{-6}$ cancer risk and a hazard index of 0.1 for a Navajo resident. Appendix C, Table C-1, provides the COPC screening. Based on the screening, the following contaminants were identified as COPCs and are included in the risk estimates in the HHRA: Ra-226, aluminum, antimony, arsenic, barium, cadmium, cobalt, copper, iron, manganese, selenium, thallium, uranium, and vanadium.

The exposure assessment is the process of measuring or estimating intensity, frequency, and duration of human exposure to a contaminant in the environment. The CSM describes the exposure setting and identifies potentially complete exposure pathways by which receptors (both people and ecological) could contact site-related contaminants. The CSM is provided on Figure 9.

Exhibit 4 presents a brief description of each receptor along with the associated geographic distribution. The specific exposure pathways and inputs for these receptors evaluated in the HHRA are provided in Appendix C, Table C-3.

The toxicity assessment identifies the toxicity parameters needed for the risk assessment. The toxicity values used in the streamlined HHRA are all standard values provided by USEPA. Risk characterization proceeds by combining the results of the exposure and toxicity assessments. For the NAUM program HHRAs, the risk characterization process described in Appendix C was used.

The intake factors used in the HHRA were obtained from the NAUM risk assessment methodology (USEPA 2024a).

Exhibit 4. Section 32 and 33 Mines Receptors

Exposure Unit	Receptor Name	Receptor Description
Section 32 Mine	Kee'da'whíí tééh (Full-Time Navajo Resident)	Members of the Navajo Nation that live full time at a site. Includes external exposure to radiation, incidental ingestion of soil, dermal exposure to soil (metals only), inhalation of soil (or dust), ingestion of homegrown produce and gathered wild plants, and consumption of animal products from raised animals (meat, milk, and eggs) and hunted animals (meat), as well as plant exposures (ingestion, dermal, and inhalation) from Diné Lifeways practices including medicinal and ceremonial exposures.
Section 33 Mine	Default Resident (Non-Navajo)	Non-Navajo people that live full time at a site. Exposure pathways evaluated include external exposure to radiation, incidental ingestion of soil, dermal exposure to soil (metals only), and inhalation of soil or dust.

The cumulative cancer risk for the age-adjusted adult and child and noncancer hazard for the child receptor for each EU and soil interval are provided in Appendix C, Table C-7, and summarized in Exhibit 5.

Exhibit 5. Cancer Risks and Noncancer Hazards

Exposure Unit	Soil Interval	Cancer Risk	Adult Noncancer Hazard	Child Noncancer Hazard
Section 32 Mine	Surface	**1×10^{-2}**	**10**	**20**
	Subsurface	**2×10^{-2}**	**10**	**20**
Section 33 Mine	Surface	**2×10^{-3}**	0.5	**5**
	Subsurface	**3×10^{-3}**	0.5	**5**

Notes:
Bolded values exceed the target cancer risk or target hazard quotient.

Candidate COCs are identified based on the cancer risk exceeding the target cancer risk of $1\text{x}10^{-4}$ or a noncancer hazard of 1 for the RME receptor at the EU. Exhibit 6 presents the candidate COCs for each EU and soil interval as identified in Appendix C, Table C-7.

Exhibit 6. Candidate COCs Identified Based on Cancer Risks and Noncancer Hazards

Exposure Unit	Soil Interval	Cancer Risk	Noncancer Hazard
Section 32 Mine	Surface and Subsurface	Uranium-238 in SE Arsenic	Arsenic Cobalt Iron Manganese Thallium Uranium
Section 33 Mine	Surface and Subsurface	Uranium-238 in SE	Uranium

Notes:
COC Contaminant of concern
SE Secular equilibrium

2.5.4 Ecological Risk Assessment

An ERA is the process for evaluating how likely the environment will be impacted as a result of exposure to one or more environmental stressors, such as radionuclides or metals. The objective of the ERA is to evaluate whether ecological receptors may be adversely affected by exposure to contaminants. The ERA is intended to provide input for risk management decision-making at each site while maintaining a conservative approach protective of ecological populations and communities. This ERA follows the guidelines in the NAUM risk assessment methodology (USEPA 2024a).

As described in USEPA (1993a) EE/CA guidance, a risk assessment is used to help justify a removal action, identify what current or potential exposures should be prevented, and focus on the specific problem that the removal action is intended to address. NAUM ERAs include a screening-level risk assessment (SLERA) and SLERA refinement. The SLERA includes Steps 1 and 2 of USEPA's eight-step ERA process (USEPA 1997) and is intended to provide a conservative estimate using maximum site concentrations of potential ecological risks and compensate for uncertainty in a precautionary manner by incorporating conservative assumptions. The SLERA refinement includes a refinement of Steps 1 and 2 and is intended to provide additional information for risk managers. Candidate COECs are identified based on the results of the SLERA refinement for soil.

The ERA evaluated the Section 32 and 33 Mines as a single site-wide EU. The SLERA contaminants of potential ecological concern (COPEC) for soil at the Section 32 and 33 Mines are presented in Appendix C, Table C-8. Contaminants in soil for which the hazard quotient was greater than or equal to 1.0 were U-238 in SE, antimony, arsenic, barium, chromium, lead, manganese, nickel, selenium, thallium, uranium, vanadium, and zinc.

Candidate COECs and the calculated hazard quotient risk estimates are listed in Appendix C, Table C-10 for plants and invertebrates, Table C-11 for birds, and Table C-12 for mammals. The candidate COECs are summarized in Exhibit 7.

Exhibit 7. Site-Wide Candidate COECs

Receptor	Soil Interval	Candidate COEC												
		Uranium-238 in SE	Antimony	Arsenic	Barium	Chromium	Lead	Manganese	Nickel	Selenium	Thallium	Uranium	Vanadium	Zinc
Plants	Surface	X	--	--	X	X	--	X	--	X	X	X	X	--
	Subsurface	X	--	--	X	X	--	X	--	X	X	X	--	--
Invertebrates	Surface	--	--	X	--	X	--	--	--	X	--	--	--	--
Birds	Surface	--	--	--	--	--	X	--	--	X	--	--	X	X

Exhibit 7. Site-Wide Candidate COECs (Continued)

Receptor	Soil Interval	Candidate COEC												
		Uranium-238 in SE	Antimony	Arsenic	Barium	Chromium	Lead	Manganese	Nickel	Selenium	Thallium	Uranium	Vanadium	Zinc
Mammals	Surface	X	X	--	--	--	--	--	X	X	--	--	--	--
	Subsurface	X	X	--	--	--	--	--	X	X	--	--	--	--

Notes:
-- Not a candidate COEC
X Candidate COEC
COEC Contaminant of ecological concern
SE Secular equilibrium

2.5.5 Risk Assessment Results Summary

Candidate COCs and COECs were identified based on available laboratory data. The HHRA and ERA results indicate that risk is above a level of concern for the contaminants listed in Exhibit 8.

Exhibit 8. Candidate COCs and Candidate COECs Recommended for Further Evaluation

Exposure Unit	Media	Contaminant														
		Uranium-238 in SE	Antimony	Arsenic	Barium	Chromium	Cobalt	Iron	Lead	Manganese	Nickel	Selenium	Thallium	Uranium	Vanadium	Zinc
Section 32 Mine	Surface/ Subsurface Soil	X	--	X	--	X	X	X	--	X	--	--	X	X	--	--
Section 33 Mine	Surface/ Subsurface Soil	X	--	--	--	--	--	--	--	--	--	--	--	X	--	--
Site-wide (Ecological Risk)	Surface Soil	X	X	X	X	X	--	--	X	X	X	X	X	X	X	X
	Subsurface Soil	X	X	--	X	X	--	--	--	X	X	X	X	X	--	--

Notes:
-- Not a candidate COC or COEC. Not recommended for further evaluation in this EE/CA.
X Candidate COC and/or COEC. Recommended for further evaluation in this EE/CA.
COC Contaminant of concern
COEC Contaminant of ecological concern
EE/CA Engineering evaluation/cost analysis
SE Secular equilibrium

2.6 RISK MANAGEMENT ANALYSIS

Risk management is a different process from risk assessment. The risk assessment establishes whether a risk is present and defines the magnitude of the risk. In risk management, the results of the risk assessment are integrated with other considerations to make and justify risk management decisions. Risk managers must understand the risk assessment, including its uncertainties and assumptions. By understanding the potential adverse effects posed by candidate COCs and COECs and the removal actions themselves, risk managers can balance the costs and benefits of the available removal alternatives. Understanding the uncertainties associated with risk assessment is critical to evaluating the overall protectiveness of any remedy (USEPA 1997a).

U-238 and its decay products is the primary COC at the Section 32 and 33 Mines. U-238, U-234, thorium-230, and Ra-226 in SE were evaluated in the risk assessment to include toxicity from all radionuclides in the U-238 decay chain. For risk management, site data for Ra-226 were used to represent the soil concentration of U-238; however, the human health PRGs for the full-time Navajo resident and the default resident (non-Navajo) and the NAUM PERG use toxicity values that include toxicity from the entire U-238 decay chain. Use of Ra-226 for risk management reduces the number of radionuclides evaluated when establishing the extent of radiological contamination.

The risk assessment for the Section 32 and 33 Mines identified numerous candidate COCs and COECs. Radiological contamination is the predominant risk driver at the Section 32 and 33 Mines; thus, the extent of Ra-226 above the selected RAG will primarily be used to establish the extent of the removal action. In addition to Ra-226, candidate COCs at the site are arsenic, chromium, cobalt, iron, manganese, thallium, and uranium, and candidate COECs are antimony, arsenic, barium, chromium, lead, manganese, nickel, selenium, thallium, uranium, vanadium, and zinc. The risk management analysis is focused on understanding the excess risk from metals that were identified as candidate COCs and COECs in soil.

The NAUM risk management process involves assessment of various lines of evidence for candidate COCs and COECs. Lines of evidence considered in the risk management process include:

- Refinement of candidate COCs and COECs:
  - Comparison of site concentrations to background concentrations (Table 2). Candidate COCs and COECs below background are removed from further analysis.
  - Assessment of co-location via a comparison of the metals distribution to the Ra-226 preliminary removal action extent. Metal COCs and COECs with concentrations above human health PRGs and NAUM PERGs that are fully co-located with the Ra-226 preliminary removal action extent are removed from further analysis.
- Refinement of candidate COECs only:
  - Potential impacts of site risks for candidate COECs based on a comparison of site concentrations to NAUM PERGs (USEPA 2024c)
  - Analysis of contaminant distribution

- Assessment of other uncertainties

Refinement of the exposures, inputs, and uncertainties for candidate COCs is not warranted because the HHRA was developed using Navajo-specific exposure scenarios and a site-specific scenario for private property. Refinement of the exposures, inputs, and uncertainties for the ERA is warranted because the ERA was completed using literature-based assumptions and inputs.

Section 2.6.1 presents the background comparison, Section 2.6.2 presents and describes the human health PRGs and NAUM PERGs, Section 2.6.3 presents the co-location analysis, Section 2.6.4 presents the refinement of candidate COECs, and Section 2.6.5 presents a summary of risk management conclusions and decisions.

Table 3 presents the results of the risk management analysis and identifies the final analytes recommended for removal action, as well as the rationale for refinement of each candidate COC or COEC that is not considered for removal action.

2.6.1 Comparison of Site Concentrations of Candidate Contaminants of Concern and Contaminants of Ecological Concern to Background Concentrations

The candidate COCs and COECs were compared to background concentrations to identify any contaminants present at background levels. For the Section 32 and 33 Mines, the background comparison used the Quaternary Alluvium (BSA-1) results per the discussion in Section 2.4.1. Two-population statistical tests were performed to compare concentrations in soil at the site for candidate COCs and COECs. All methods followed USEPA (2002a, 2010, 2022) statistical guidance for evaluating background concentrations of chemicals in soil. The background comparison results are presented in Table 2 for each human health and ecological risk EU.

A tiered approach employing one or more statistical methods was used to conduct two-population tests. The first tier in this approach compares the median concentrations between the site and background populations using the Wilcoxon-Mann-Whitney test for datasets having all detected data. For datasets with nondetect results, Gehan's modification to the Wilcoxon rank-sum (WRS) test (Gehan test) and the Tarone-Ware test were used. These two-population tests are available in ProUCL (USEPA 2022).

If the first-tier tests indicated that the site concentrations are greater than background concentrations, no further testing was conducted. If the first-tier tests indicated that the site concentrations are less than or equivalent to background concentrations, a second-tier test was used to compare the right-hand tails or upper quantiles of the site and background populations using the Quantile test (USEPA 1994, 2002c, 2010). Two-sided statistical tests are used in all cases and employ a Type I error rate of 0.05 (5 percent).

The following null and alternative hypotheses were tested:

- **Null hypothesis:** The median metal concentration for the site is less than or equal to the median concentration in the background population.
- **Alternative hypothesis:** The median metal concentration for the site is greater than the median concentration in the background population.

The Quantile test (Johnson, Verrill, and Moore II 1987; USEPA 1994, 2000b, 2002b, 2010) was conducted for all metals where the Gehan, Tarone-Ware, and Wilcoxon-Mann-Whitney tests did not reject the null hypothesis (that is, when the median site and background concentrations were concluded not to be significantly different).

The Quantile test is a nonparametric two-population test developed for comparing the right-hand tails or upper quantiles of two distributions. The Quantile test can be used when some proportion of high-value measurements (rather than the entire distribution) of one population has shifted relative to a second population. The Quantile test is not as powerful as the WRS test when the distribution of site concentrations is shifted in its entirety to the right of the background distribution. However, the Quantile test is more powerful than the WRS test for detecting cases where only a small number of high-value measurements are present in the upper quantile of the site distribution. For this reason, USEPA (1994, 2002c, 2010) guidance recommends the Quantile test be used in conjunction with the WRS test. When applied together, these tests have more power to detect true differences between two population distributions.

Exhibit 9 presents the background comparison results for the Section 32 and 33 Mines EUs. In addition to Ra-226, candidate COCs manganese and uranium and candidate COECs barium, manganese, selenium, and uranium were found at concentrations greater than background at the Section 32 and 33 Mines, and are recommended for further evaluation in the EE/CA.

Exhibit 9. Background Comparison Results Summary

Exposure Unit	Candidate COC or COEC Background Comparison Result															
	Radium-226	**Aluminum**	**Antimony**	**Arsenic**	**Barium**	**Chromium**	**Cobalt**	**Iron**	**Lead**	**Manganese**	**Nickel**	**Selenium**	**Thallium**	**Uranium**	**Vanadium**	**Zinc**
Section 32 Mine	**>BG**	<BG	--	<BG	--	<BG	<BG	<BG	--	**>BG**	--	--	<BG	**>BG**	--	--
Section 33 Mine	**>BG**	--	--	--	--	--	--	--	--	--	--	--	--	**>BG**	--	--
Site-Wide (Ecological Risk)	**>BG**	--	<BG	<BG	**>BG**	<BG	--	--	<BG	**>BG**	<BG	**>BG**	<BG	**>BG**	<BG	<BG

Notes:
The background comparison was conducted using site and background surface soil data only. The background comparisons for surface soil are assumed valid for subsurface soil. For analytes calculated to be less than background, site subsurface results were compared to site surface results to confirm that no subsurface areas with concentrations above surface concentrations warrant further evaluation.

-- Not a candidate COC or COEC for exposure unit/receptor combination.
<BG Site concentrations are less than background concentrations. Candidate COC or COEC is not recommended for further evaluation in the EE/CA.
>BG Site concentrations are greater than background concentrations. Candidate COC or COEC is recommended for further evaluation in the EE/CA.
COC Contaminant of concern
COEC Contaminant of ecological concern
EE/CA Engineering evaluation/cost analysis

2.6.2 Preliminary Removal Goals for Human Health and Ecological Health

Human health PRGs and NAUM PERGs were developed for use in risk management decision-making and determination of RAGs.

Human health PRGs are land-use specific and calculated using the NAUM Risk Calculator (USEPA 2024b) with the same target cancer and noncancer risk level used to identify candidate COCs. PRGs for carcinogenic metals and radionuclides are based on a target cancer risk of $1x10^{-4}$, and PRGs for noncarcinogenic metals are based on a target noncancer hazard quotient of 1.0.

PERGs for radionuclides and metals were developed for NAUM sites by USEPA (2024c). USEPA (1999) guidance recommends designing remedial actions to protect local populations and communities of biota rather than protect organisms on an individual basis except for threatened and endangered species. NAUM PERGs establish analyte-specific thresholds that correspond to minimal disruption on wildlife communities and populations. Reducing or maintaining site concentrations to levels below the PERG will support the recovery and maintenance of healthy local populations and communities of biota.

NAUM PERGs for radionuclides were based on dose assessments using the ERICA Tool (Brown and others 2008) for terrestrial animals and plants (USEPA 2024a, 2024c). NAUM PERGs for radionuclides were identified based on the radionuclide concentration corresponding to a dose rate where individuals have a higher probability to be adversely affected but the population is still protected (USEPA 2024c). NAUM PERGs for metals were developed using average exposure parameters for food ingestion rates, toxicity reference values, soil intake factors, and body weights (USEPA 2024c).

Exhibit 10 presents the human health PRGs and NAUM PERGs for soil for candidate COCs and COCs greater than background.

Exhibit 10. Human Health Preliminary Removal Goals and NAUM Preliminary Ecological Removal Goals for Candidate COC and COECs in Soil Above Background

Candidate COC/COEC	Unit	Human Health PRG Navajo Resident[1]	Human Health PRG Default Resident (Non-Navajo)[1]	NAUM PERG[2]
Radium-226[3]	pCi/g	0.050	1.3	40
Barium	mg/kg	--	--	1,400
Manganese	mg/kg	45	--	1,100
Selenium	mg/kg	--	--	3.4
Uranium	mg/kg	3.2	16	250

Notes:

1 Human health PRGs are from the NAUM Risk Calculator (USEPA 2024b). PRGs for carcinogenic contaminants are based on a target cancer risk of $1x10^{-4}$, and PRGs for noncarcinogenic contaminants are based on a target noncancer hazard quotient of 1.0.

2 NAUM PERGs are based on the most sensitive ecological receptor (USEPA 2024c). The NAUM PERG is applicable site-wide.

Exhibit 10. Human Health Preliminary Removal Goals and NAUM Preliminary Ecological Removal Goals for Candidate COC and COECs in Soil Above Background (Continued)

Notes (Continued):

3	Site data for radium-226 are used to evaluate the extent of radionuclides above human health PRGs and NAUM PERGs. The human health PRG for radium-226 is the PRG for uranium-238 in SE. The radium-226 NAUM PERG is the minimum PERG for uranium-238 in SE for all feeding guilds (USEPA 2024c) and is based on the individual radium-226 PERG adjusted to include doses from all progeny of uranium-238 in SE as described in Appendix F of USEPA (2024a).
--	Not a candidate COC
COC	Contaminant of concern
COEC	Contaminant of ecological concern
mg/kg	Milligram per kilogram
NAUM	Navajo abandoned uranium mine
pCi/g	Picocurie per gram
PERG	Preliminary ecological removal goal
PRG	Preliminary removal goal
SE	Secular equilibrium
USEPA	U.S. Environmental Protection Agency

2.6.3 Co-Location Assessment

The Ra-226 removal action extent encompasses a large portion of the TENORM area at the Section 32 and 33 Mines (Appendix D, Figure D-1). The source of the contamination is from historical uranium mining activities, and the mining waste and contaminated soil is expected to exhibit similar characteristics in all areas of contamination. Areas where estimated Ra-226 levels exceed BTVs is a strong indicator of areas with mine waste, and concentrations of other elevated metals are expected to be co-located in those areas. Section 2.6.3.1 defines the Ra-226 removal action extent, and Section 2.6.3.2 assesses whether metals candidate COCs and COECs exceeding background concentrations are co-located with Ra-226 via a comparison of the metals distribution to the Ra-226 preliminary removal action extent.

2.6.3.1 Development of Radium-226 Removal Action Extent

The Ra-226 RAG for all EUs is the lesser of the human health PRG and the NAUM PERG unless either of the preliminary goals is less than the BTV. At the Section 32 and 33 Mines, the RAGs are based on the BTV because the human health PRGs for the residential receptors are lower than the geology-specific BTV. No cleanup is recommended in the site-wide EU to address risk to ecological receptors per the evaluation presented in Section 2.6.4.1. The Ra-226 exposure point concentration (EPC) in the site-wide EU is 14 picocuries per gram (pCi/g), which does not exceed the NAUM PERG of 40 pCi/g; therefore, Ra-226 is not a COEC. Exhibit 11 presents the comparison of the human health PRGs, NAUM PERGs, and geology-specific BTVs for Ra-226 that were considered to establish the RAG.

The estimated Ra-226 interpolated surface was generated using gamma survey data from the Section 32 and 33 Mines as discussed in Section 2.4.2.3. Gamma survey results were converted from counts per minute to estimated Ra-226 concentrations in picocuries per gram. For each EU, the Ra-226 preliminary removal action extent for the site was developed using geospatial tools based on the area estimated to exceed the RAG within the TENORM boundary.

Exhibit 11. Radium-226 Removal Action Goal Development

Exposure Unit	Human Health PRG[1]		NAUM PERG[2]	BTV[3]	Radium-226 RAG	Basis for RAG
	Navajo Resident	Default Resident (Non-Navajo)				
Section 32 Mine	0.050	--	40	1.9	1.9	BTV
Section 33 Mine	--	1.3	40	1.9	1.9	BTV

Notes:
Units are in picocuries per gram.

1 Human health PRGs are the PRGs for uranium-238 in SE from the NAUM Risk Calculator (USEPA 2024b) and are based on a target cancer risk of $1x10^{-4}$. Site data for radium-226 are used to evaluate the extent of radionuclides above PRGs.

2 The NAUM PERG is applicable site-wide. The NAUM PERG presented is the minimum PERG for uranium-238 in SE for all feeding guilds (USEPA 2024c). The NAUM PERG for uranium-238 in SE is based on the individual radium-226 NAUM PERG that is adjusted to include doses from all progeny of uranium-238 in SE as described in Appendix F of USEPA (2024a). Site data for radium-226 are used to evaluate the extent of radionuclides above the NAUM PERG.

3 The BTV is the UTL95-95 for nonduplicate analytical data. If outliers are removed, the BTV is the UTL95-95 for the dataset with extreme outliers removed (Tetra Tech, Inc. 2023).

-- Not applicable
BTV Background threshold value
NAUM Navajo abandoned uranium mine
PERG Preliminary ecological removal goal
PRG Preliminary removal goal
RAG Removal action goal
SE Secular equilibrium
USEPA U.S. Environmental Protection Agency
UTL95-95 95 percent upper tolerance limit with 95 percent coverage

2.6.3.2 *Assessment of Metals Co-Location with the Radium-226 Preliminary Removal Action Extent*

The distribution of candidate metal COCs and COECs was compared with the Ra-226 preliminary removal action extent to identify whether concentrations of candidate COCs and COECs at concentrations above background are co-located with the Ra-226 preliminary removal action extent. Appendix D, Figure D-2 through Figure D-7, present the soil sample results for each candidate metal COC and COEC above background overlain with the Ra-226 preliminary removal action extent with results screened against relevant BTVs, human health PRGs, and NAUM PERGs, as applicable. For candidate COCs and COECs for which RAGs are developed in Section 2.7.1, the results are also screened against the RAG.

At the Section 32 and 33 Mines, the extent of barium (Appendix D, Figure D-2) above the NAUM PERG or BTV is entirely co-located within the preliminary Ra-226 removal action extent or the waste rock stockpile that is planned for removal. Further assessment of the extent of barium will not result in a change in the removal action extent and, therefore, barium will not be considered for further evaluation and is not identified as a COEC recommended for removal action.

2.6.4 Refinement of the Ecological Risk Assessment Candidate Contaminants of Ecological Concern

Per USEPA (1999), ecological risk management decisions should be based on sound science and clear rationale. As described in USEPA (1999) guidance, establishing preliminary removal goals for ecological receptors is difficult because of the following:

- Lack of broadly applicable and quantifiable toxicological data
- Number and variety of species potentially present at an EU
- Differences in susceptibility of different species at different life stages to COECs
- Recuperative potential of different species following exposure
- Variation in environmental bioavailability of the candidate COECs

The selected remedies should be protective of ecological receptors in both the short and long term. Because ecological receptors at an EU are within a larger ecosystem, remedies selected for protection of these receptors should also assume protection of the ecosystem components upon which they depend or support. Removal actions should not be designed to protect organisms on an individual basis but, instead, should be designed to protect local populations and communities of biota. Evaluation of these factors will be incorporated in the EC/CA in the evaluation of the effectiveness of the removal action in Section 4.3.6.1.

Risk managers should consider the following principles when making ecological management decisions.

- **The potential impact of site risks.** When evaluating ecological risks and the potential for response alternatives to achieve acceptable levels of protection, managers should consider the following:
  - Magnitude or degree of the predicted responses of receptors to the range of COEC levels
  - Severity of the impact (for example, how many species will be affected)
  - Areal extent and duration over which effects may occur
  - Potential for recovery of the affected receptors
- **Actions that will reduce ecological risks to levels that will result in the recovery and maintenance of healthy local populations and communities of biota.** Managers should consider the actions that will result in an ability for the site to sustain an ecological structure and function of the local populations, communities, and habitats. The benefit of risk reduction should be weighed against the ecological cost of habitat destruction. Excavation destroys plant cover and removes valuable topsoil, which leads to the degradation of biologically rich areas (Whicker and others 2004). This consideration is particularly important in vegetated areas because those areas may be used by ecological receptors and revegetation may be difficult to establish and slow to mature once established.

- **Input from the public and stakeholders.** Through the EE/CA Superfund public comment process and NNEPA review, managers should consider the input or issues voiced from stakeholders, such as community groups, on any perceived negative short- or long-term impact of the removal action.

To support managers in understanding the site risks and to provide managers with a balanced recommendation so that the ecological structure and function can recover and be sustainable for the long-term risk, risk management should include:

- Development of NAUM PERGs using average exposure assumptions instead of conversative assumptions and comparison with representative site concentrations (for example, the 95 percent upper confidence level [UCL95])
- Evaluation of analytical data uncertainties, such as frequency of detection (FOD)
- Inclusion of other lines of evidence, including bioavailability, area use factors, and seasonality of exposures (Appendix C contains more information on these uncertainties)

2.6.4.1 Comparison of Metals Site Concentrations with Preliminary Ecological Removal Goals for Candidate Contaminants of Ecological Concern

To refine site risks associated with candidate COECs for soil above background, estimates of the site-wide EPC (using UCL95 concentrations) at the Section 32 and 33 Mines were compared with NAUM PERGs. Exhibit 12 presents the results of the comparison of the site-wide EPCs to the NAUM PERGs.

Exhibit 12. Comparison of Site-Wide EPCs to NAUM PERGs for Soil

Candidate COEC	Unit	Site-Wide EPC[1] – Surface Soil	Site-Wide EPC[1] – Subsurface Soil	NAUM PERG[2]	Candidate COEC EPC > PERG
Radium-226	pCi/g	14	14	40	No
Manganese	mg/kg	259	250	1,100	No
Selenium	mg/kg	9.2	9.2	3.4	**Yes**
Uranium	mg/kg	20	21	250	No

Notes:
Bold values indicate that the EPC exceeds the NAUM PERG.
1 EPC as indicated in Appendix C, Table C-9.
2 NAUM PERGs are based on the most sensitive ecological receptor
COEC Contaminant of ecological concern
EPC Exposure point concentration
mg/kg Milligram per kilogram
NAUM Navajo abandoned uranium mine
pCi/g Picocurie per gram
PERG Preliminary ecological removal goal

As shown in the exhibit, the site-wide EPCs for Ra-226, manganese, and uranium are less than the NAUM PERGs; therefore, these candidate COECS are not recommended for removal action. Selenium is recommended for further evaluation in this EE/CA.

2.6.4.2 Assessment of Contaminant Distribution

An analyte could be identified as a candidate COC or COEC and be only detected infrequently in an EU (for example, less than 5 percent with at least 20 samples). Because of low FOD, the exposure and resulting risk could be unreasonably elevated and overly conservative. COCs and COECs should not be removed simply based on the FOD of less than 5 percent, but each case should be reviewed for analytical certainty and if low FOD potentially indicates a unique hot spot for risk management consideration. At the Section 32 and 33 Mines, FOD is greater than 5 percent for all candidate COCs and COECs.

Risk managers should also consider the assessment of nonmobile ecological receptors (for example, plant and soil invertebrate communities). Plants and soil invertebrates represent the basis of the ecological food chain and site concentrations were evaluated in the ERA against the no observed effect concentration or environmental screening level on a point-by-point basis (see Appendix C, Table C-10). Although the use of literature-based soil toxicity values protective of soil invertebrates and plants is conservative, risk managers should compare the areas under consideration for removal action with those locations that have concentrations that exceed a risk-based soil concentration. Appendix D presents the distribution of all candidate COECs within the TENORM boundary compared to the NAUM PERGs and geology-specific BTVs. At the Section 32 and 33 Mines, candidate COECs greater than background concentrations based on exceedance of a plant or invertebrate no observed effect concentration are Ra-226, barium, manganese, selenium, and uranium.

2.6.5 Risk Management Summary and Conclusions for Metals

Based on the HHRA and ERA for the Section 32 and 33 Mines, candidate COCs for soil are Ra-226, arsenic, chromium, cobalt, iron, manganese, thallium, and uranium, and candidate COECs for soil are Ra-226, antimony, arsenic, barium, chromium, lead, manganese, nickel, selenium, thallium, uranium, vanadium, and zinc. Following the lines of evidence considered in the risk management analysis in the prior subsections, removal action is recommended as follows:

- To address excess human health risk from Ra-226 contamination at Section 32 and 33 Mines, removal of Ra-226 above the applicable RAG is recommended.
- To address excess human health risk at the Section 32 and 33 Mines, removal of uranium above the applicable RAG is recommended.
- To address excess human health risk at the Section 32 Mine only, removal of manganese above the applicable RAG is recommended.
- To address excess ecological risk at the Section 32 and 33 Mines, removal of selenium above the applicable RAG is recommended.

The conclusions for candidate COCs are based on the results of the risk assessment, background comparison, and co-location analysis. Conclusions for candidate COECs also include consideration of the results of a comparison of the site-wide EPCs with the NAUM PERGs, and are supported by the assessment of uncertainties that are likely to overestimate risk estimates in the ERA. Exhibit 13 provides the COCs and COEC recommended for removal at each EU.

No COECs were identified at the site-wide EU, and no removal action is recommended to address ecological risk at the Section 32 and 33 Mines. Table 3 presents the results of the risk management analysis and identifies the final COCs recommended for removal action, as well as the rationale for refinement of each candidate COC or COEC, which are not considered for removal action.

Exhibit 13. COCs and COECs Recommended for Removal Action

Exposure Unit	Receptor	Surface Soil COCs/COECs	Subsurface Soil COCs/COECs
Section 32 Mine	Kee'da'whíí téého (Full-time Navajo Resident)	Radium-226 Manganese Uranium	Radium-226 Manganese Uranium
Section 33 Mine	Default Resident (Non-Navajo)	Radium-226 Uranium	Radium-226 Uranium
Site-Wide (Ecological Risk)	Plants, Invertebrates, Birds, and Mammals	Selenium	Selenium

Notes:
COC Contaminant of concern
COEC Contaminant of ecological concern

2.7 REMOVAL ACTION EXTENT

Multiple lines of evidence were used to develop the removal action extent at the Section 32 and 33 Mines, including the extent of Ra-226 in surface soil, extent of contamination of other COCs and COECs outside the Ra-226 extent, risk management considerations, surface and subsurface waste areas, transport pathways, and disturbed mineralized areas.

2.7.1 Numerical Removal Action Goals

Following the risk management assessment, removal action is recommended for soil for Ra-226, manganese, selenium, and uranium at the Section 32 Mine and Ra-226, selenium, and uranium at the Section 33 Mine. RAGs were derived for each applicable receptor, EU, and COC or COEC recommended for removal action. COCs and COECs were identified based on available laboratory data, comparison to background levels, and other lines of evidence as summarized in Section 2.4.

Table 4 presents the comparison of inputs used to develop the final RAGs for each COC in soil. The final RAG is the lesser of the human health PRG and the NAUM PERG, when applicable, unless either is less than the BTV. If the BTV is greater than the human health PRG or NAUM PERG, the final RAG is to address material that is distinguishable from background. For purposes of this EE/CA, the BTV calculated for the Quaternary Alluvium BSA-1 is used to represent background for delineating contaminated areas. Exhibit 14 provides the selected numerical RAG for each COC and COEC recommended for removal at each EU.

Exhibit 14. Selected RAG for Each COC and COEC

COC/COEC	Unit	Exposure Unit	RAG	RAG Basis
Radium-226	pCi/g	Section 32 Mine, Section 33 Mine	1.9	BTV
Manganese	mg/kg	Section 32 Mine	279	BTV
Selenium	mg/kg	Section 32 Mine, Section 33 Mine	3.4	PERG
Uranium	mg/kg	Section 32 Mine	3.2	HH PRG (Navajo Resident)
		Section 33 Mine	16	HH PRG (Default Resident, Non-Navajo)

Notes:

[1] The BTV is used to represent background for delineating contaminated areas.
BTV Background threshold value
COC Contaminant of concern
COEC Contaminant of ecological concern
HH Human health
mg/kg Milligram per kilogram
pCi/g Picocurie per gram
RAG Removal action goal
PRG Preliminary removal goal

2.7.2 Other Removal Action Extent Considerations

The preliminary removal action extent was modified based on the evaluation of additional lines of evidence as follows:

- **Extent of contamination of other COCs and COECs not co-located with Ra-226:** Areas outside the Ra-226 removal action extent with elevated concentrations of other COCs and COECs were added to the preliminary removal action extent.
- **Surface and subsurface waste areas:** Waste rock piles and subsurface reclamation mine features (such as stockpiles) were added to the preliminary removal action extent.
- **Transport pathways:** No additional mine features and areas with potential for future transport of waste material downgradient to other geologic units with lower RAGs were identified.
- **Risk management considerations:** Areas where disturbance may result in destabilization of slopes (by removing vegetation), excessive erosion, and sedimentation.

Figure 12 presents the proposed removal action extent at the Section 32 and 33 Mines. The total calculated surface area is about 24 acres, and the total estimated volume is approximately 67,000 bank cubic yards within the proposed removal action. The extent broken down by the stockpile and other contaminated surface areas is as follows:

- Section 33 Mine Waste Piles: 0.64 acre; estimated 3,000 bank cubic yards
- Section 33 Mine Class 1 Remainder: 2.81 acres; estimated 9,000 bank cubic yards
- Section 33 Mine Class 2: 1.21 acres; estimated 2,000 bank cubic yards

- Section 32 Mine Stockpile: 2.39 acres; estimated 41,000 bank cubic yards
- Section 32 Mine Class 1: 5.87 acres; estimated 9,500 bank cubic yards
- Section 32 Mine Class 2: 10.44 acres; estimated 3,500 bank cubic yards

A description of the excavation area, including excavation depths, is included in Section 4.2.1.1.

3.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

This section presents the RAOs, statutory limits on removal actions, removal scope, and removal schedule.

3.1 REMOVAL ACTION OBJECTIVES

An early step in developing removal action alternatives is to establish RAOs. CERCLA does not allow removal action alternatives to require remediation of NORM or soil to concentrations below background levels. Taking current and potential future land use (residential) and Navajo cultural considerations into account, the RAOs for the soil removal action are to:

- Prevent exposure to soil with contaminants from mining activities that would pose an unacceptable risk to human health with the reasonably anticipated future land use and traditional Diné Lifeways.
- Prevent exposure to soil with contaminants from mining activities that would pose an unacceptable risk to plants, animals, and other ecological receptors.
- Prevent offsite migration of contaminants from mining activities to surface water, groundwater, or air that pose an unacceptable risk to human health.

USEPA identified general response actions, screened potential technologies, and developed alternatives in Section 4.1 that will satisfy the RAOs listed above. Section 4.2 describes the retained removal action alternatives for the Section 32 and 33 Mines, and Section 4.3 presents a detailed analysis of the removal action alternatives with respect to NCP effectiveness, implementability, and cost criteria. Section 5.0 presents a comparative analysis of the removal action alternatives.

3.2 STATUTORY LIMITS ON REMOVAL ACTIONS

Pursuant to CERCLA Section (§) 104(c)(1), the normal statutory limits for CERCLA removal actions of $2 million and 12 months do not apply since the selected action will be funded by a responsible party and not by Superfund.

3.3 REMOVAL SCOPE

The scope of the removal action will be to address all solid media contamination at the Section 32 and 33 Mines and to be the final action for solid media at the site. The removal action will also protect against potential future impacts to groundwater and surface water. Post-removal site controls will be part of the analysis for a removal action alternative that does not include the complete removal of contaminants to an offsite location.

3.4 REMOVAL SCHEDULE

NCP requires a minimum public comment period of 30 days following release of the proposed final EE/CA by USEPA. USEPA, NNEPA, and State of New Mexico will work together to respond to comments received during the public comment period and publish an action memorandum following the response to comments. USEPA will provide public notification of the removal action schedule upon issuance of the action memorandum.

During the implementation of the selected removal action alternative(s), several factors may affect the removal action schedule, including removal action planning and design, cultural and biological clearances and mitigation, seasonal weather-related restrictions, and access for construction equipment. Depending on the removal action alternative(s) selected in the final EE/CA, design and implementation of the construction activities will likely require between 4 and 18 months potentially over more than one construction season, which is limited to March through October, depending on schedule-limiting factors such as truck availability, monsoon rains, and snowfall. Inspections and maintenance of restored areas will be required at the site for at least the first 30 years after restoration because of the long time frame required to reestablish native vegetation. Annual inspections and maintenance of a repository cap, if selected, will be conducted as specified in a site-specific long-term surveillance plan (10 *Code of Federal Regulations* [CFR] § 40.28) with inspection frequencies adjusted based on cover or cap stability and inspection findings. A 100-year maintenance period is used for the onsite repository alternative cost estimate and for comparison purposes.

4.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section identifies and analyzes the removal action alternatives for the Section 32 and 33 Mines. Section 4.1 summarizes the process of screening potential technologies and identifies the removal action alternatives that may be effective and implementable at the site, Section 4.2 describes in detail the retained removal action alternatives, and Section 4.3 provides a detailed analysis of the removal action alternatives based on the NCP evaluation criteria of effectiveness, implementability, and cost.

4.1 DEVELOPMENT AND SCREENING OF ALTERNATIVES

This subsection identifies general response actions, identifies and screens technologies, develops and describes potential removal action alternatives, and identifies the applicable or relevant and appropriate requirements (ARAR).

4.1.1 Summary of Technology Identification and Screening

The removal action alternative development process involves identifying general response actions, technology types, and process options that may satisfy RAOs. Table 5 presents the general response actions that were considered for the AUMs and includes institutional controls (IC), engineering controls, disposal, and ex situ and in situ treatment. The initial screening below eliminates infeasible technologies and process options and retains potentially feasible technologies and process options.

A technology or process option can be eliminated from further consideration if it does not meet the effectiveness threshold criteria (protection and compliance with ARARs) or substantive implementability criteria (technical, administrative, availability, and local acceptance), details of which are conveyed in Section 4.3. In addition, a technology or process option can be eliminated if its cost is substantially higher than other technologies or process options and at least one other technology or process option is retained that is protective.

Institutional Controls. ICs include the implementation of access restrictions to control current and future land use, including traditional Diné Lifeways. ICs would not reduce waste migration from the site but could be used to protect human health and the environment by administratively restricting access to affected areas. In addition, these restrictions may be used in conjunction with other technologies to protect an implemented action. While the ICs are not effective as stand-alone remedies, they are retained as components of alternatives that include capping waste on Navajo lands. Potentially applicable ICs consist of land use and access restrictions that are described below.

- **Chapter Land Use Plans** – Land use plans are used on Navajo lands similar to zoning on private lands to control current and future land uses.
- **Deed Restrictions** – Deed restrictions do not exist on Navajo lands.
- **Navajo Land Department Homesite Lease Approvals –** Building a home on Navajo lands requires a homesite lease from the Navajo Land Department. The Navajo Land

Department may restrict homesite leases on or near areas with hazardous conditions from mining activities.

- **Environmental Control Easements** – Environmental control easements are intended for use at sites that contain or may contain hazardous wastes or substances that may threaten public health, safety, or welfare, or the environment if certain land uses are permitted or if certain activities are performed on these sites. Environmental control easements are primarily used to address residual contamination.

Engineering Controls. Engineering controls are used primarily to reduce exposure to contaminants. These goals are accomplished by creating a barrier that prevents direct exposure to or transport of waste from the contaminated sources to the surrounding lands. Engineering controls include surface controls, physical barriers, soil sorting, containment, consolidation, capping, onsite backfilling of pits and highwalls, and backfilling of underground voids.

- **Surface controls** – Surface control measures are used primarily to reduce contaminant transport, direct exposure, and the overall exposure area. Surface controls could be appropriate in more remote areas where direct human contact is not a primary concern or as a component of a containment alternative. Surface control process options include consolidation, grading, revegetation, and erosion controls. These measures are retained at the Section 32 and 33 Mines for use in conjunction with other technologies.
- **Physical barriers** – Physical barriers may include portal closure or site access controls such as fencing and signage. These process options are usually integrated with other technologies to various degrees based on site characteristics and are not effective as a stand-alone technology. The vertical shafts at the Section 32 and 33 Mines were closed during reclamation but will be closed again if disturbed during remedy implementation.
- **Sorting** – Soil and waste sorting is a standard process applied as an intermediate step between soil or waste excavation and onsite or off-Navajo Nation treatment or disposal methods. The process goal is to segregate highly contaminated material from less contaminated material, allowing for different treatment or disposal options. Sorting reduces the waste volume requiring treatment or disposal, increases the volume of material that can remain on site with limited or no treatment or containment, and allows classification of waste to reduce the volume requiring more costly treatment or disposal options. A full-scale study is planned as part of a time-critical removal action at the Cove Chapter. The goal of the study is to segregate material at or below cleanup goals from waste requiring offsite disposal. Sorting is retained and may be considered in conjunction with onsite consolidation and containment at the Section 32 and 33 Mines to remove higher concentration waste for offsite disposal.
- **Onsite consolidation and containment** – Mine waste can be consolidated and capped to prevent exposure. Waste from all areas of the site is gathered together, or consolidated, and then capped. Typically, the cap is an ET cover designed to minimize water infiltration and leaching of contaminants, control erosion, control radon emissions, and limit exposure to contaminants. The containment may be directly on site or waste from multiple mines can be consolidated and capped at one mine site as a combined action under CERCLA § 104(d)(4). Combined actions are considered "on site" and, thus, retain

the CERCLA permit exemption for onsite actions. Consolidation and containment are retained at the Section 32 and 33 Mines.

- **Backfilling of cuts, benches, and pits** – Backfilling of aboveground mine workings with mine waste occurs when mine waste is excavated and consolidated in cuts, benches, and pits in isolated areas. The mine waste can be either treated to stabilize or solidify as needed. Placement of mine waste would need to consider surrounding slope steepness and minimize slope with engineered rock walls to strengthen the slope. Placing a soil cover over the waste (containment) would be required to reduce erosion and promote vegetative growth. These mine features do not exist at the Section 32 and 33 Mines; therefore, backfilling is not retained.
- **Backfilling of underground voids** – Backfilling of underground mine workings with mine waste occurs when mine waste is pushed or pumped down vertical mine workings (shafts, stopes, and vents) or injection wells, or transported or pumped into and placed within horizontal workings (adits, drifts, and stopes) and underground vertical workings (shafts, chutes, raises, winzes, and declines). Mine waste can be place dry or wet, depending on access to and whether the mine workings are flooded. Dry placement requires reopening and rehabilitating adits and shafts for entry and providing a means for material movement (conveyor). Dry placement at the Section 32 and 33 Mines is not retained because all waste requiring disposal would likely not fit into accessible mine workings.

  Wet placement requires creating a slurry that can flow or be pumped into the underground mine workings. Approximately 4,000 gallons of water per cubic yard of waste is typically required to create a 5 percent solids slurry. Forming a paste mixture with less water (about 670 gallons of water per cubic yard of waste) is possible, but directional placement would be required. Locating mine voids and drilling of multiple large diameter boreholes would also be required to inject slurry. Once injected, the slurry could partially separate back into solid and water, and this contaminated water could migrate to surface water or groundwater. Cement or another solidifying agent could be added to the slurry to reduce separation but would increase the volume of imported materials and decrease the amount of waste that could be disposed of in the workings. Wet placement is retained at the Section 32 and 33 Mines; however, the mine shafts are already backfilled, requiring drilling of multiple deep injection wells to reach workings.

Disposal. Mine waste can be excavated and disposed of on or off site as a potential remedy. Onsite disposal may be applicable at mines where waste is consolidated or for locations where a separate onsite repository would be constructed. Offsite disposal may be applicable if the disposal site is accessible to a large volume of truck traffic and the waste can be hauled to an on- or off-Navajo Nation regional repository or a RCRA C or LLRW facility licensed to receive radiological waste. Pretreatment of waste using solidification or stabilization to address potential leachability may be considered where repository design does not address the potential for leachate generation. On- or offsite disposal and on- or off-Navajo Nation disposal are retained for the Section 32 and 33 Mines.

Treatment. CERCLA and NCP prefer treatment of waste that significantly and permanently reduces the volume, toxicity, or mobility of contaminants in selecting remedial actions.

CERCLA § 121(b), 40 CFR § 300.430(a)(1)(iii), and USEPA (1991a) guidance on principal threat and low-level threat waste describe how to identify wastes that may be appropriate for treatment. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur.

USEPA has fully considered whether the site contained any principal threat waste, whether that waste could safely be contained using engineering controls, and whether any treatment options may be practicable for the waste at the site. As a result of its investigation and analysis, USEPA concluded that, while individual samples at the site contained higher levels of contaminants that might be considered principal threat waste, the waste at the site is extremely variable and heterogeneous. USEPA found no distinct areas of waste rock that were distinguishable as meeting the definitions of principal threat waste in USEPA (1991a) guidance. However, to be consistent with USEPA's preference for treatment, USEPA did fully evaluate a complete range of treatment options. A summary of the treatment evaluation is discussed below.

Ex Situ Treatment. Excavation and treatment involve the removal of waste from a source area and subsequent treatment using processes that chemically, physically, or thermally reduce contaminant toxicity, mobility, or volume. Treatment processes have the primary objective of either (1) concentrating chemicals for additional treatment, disposal, or recovery of valuable constituents or (2) reducing the mobility of the chemicals. A short screening summary of different ex situ treatment classes is described below.

- **Physical and Chemical Treatments** – Physical treatment processes use physical separation and the characteristics of materials to concentrate constituents into a relatively smaller volume for disposal or further treatment. Chemical treatment processes act by adding a chemical reagent that either removes contaminants from the material or fixates contaminants within the material matrix. The net result of chemical treatment processes is a reduction of toxicity and mobility of contaminants in the solid media. Different types of physical and chemical treatments screened include soil washing, acid extraction, ablation, milling, solidification, and stabilization.
    - **Soil washing** is a treatment process that involves washing the contaminated waste (with water) in a heap, vat, or agitated vessel to dissolve water-soluble contaminants. The most common forms of uranium oxides attached to sand particles in waste rock at the site have low solubility in water, rendering soil washing ineffective for removal to below cleanup goals. Dewatered precipitates and sludge must be disposed of at a mill or RCRA C or LLRW facility licensed to receive radiological waste because of the concentrating of radionuclides. Because of the low concentrations of uranium in the waste rock, varying solubilities at different pH ranges for radionuclides and metals, and limited demonstrated application for AUM wastes, soil washing likely would not meet cleanup goals and was not retained.
    - **Acid extraction** is similar to soil washing except an acidic solution instead of water is applied to the waste rock or other contaminated media in a heap, vat, or agitated vessel. Acid extraction would dissolve a portion of the mineralized uranium attached to the sand particles; however, some percentage could remain bound in the sand particles. Dissolved contaminants are subsequently precipitated for additional

treatment and disposal. Based on the uranium mineralization in the waste rock and varying solubilities of radionuclides and metals at different pH ranges, acid extraction likely would not decrease concentrations of all contaminants below cleanup goals and was not retained.

- **Ablation** can be applied to sandstone-hosted uranium mineralization where the uranium minerals form a crust on the sand grains. The ablation process mixes water and waste rock into a slurry and impacts opposing slurry streams, causing collisions between the sandstone particles and fragments and removing the uranium minerals coating the sand grains. Uranium mass then shifts from coarse-grain to fine-grain fraction, resulting in a much smaller volume of waste requiring disposal. Pilot-scale studies at three sites on the Navajo Nation has shown that up to 95 percent removal of uranium mass from the coarse sand fraction can be achieved, that the treated materials are not RCRA hazardous, and do not generate leachable metals or radionuclides above USEPA and Navajo Nation water quality standards. Concentrates are disposed of offsite at a RCRA C or LLRW facility licensed to receive radiological waste. However, ablation has not been able to achieve low cleanup goals for unrestricted use, such as those established for the Quivira Mines and Section 32 and 33 Mines. Instead, ablation can be used to reduce uranium mass for waste consolidated on site and to reduce migration potential. Ablation was not retained as a standalone or pretreatment treatment technology because it would increase costs without significantly reducing risk.
- **Milling** is an offsite commercial process that removes uranium by a combination of several methods, including pulverization and acid extraction. Concentrations of uranium in the waste rock at the site are low, so any processing would, therefore, yield only a minimal amount of uranium. Additionally, milling does not remove radium and the resulting mill waste is neither less toxic nor less mobile than the source material. Thus, milling was not retained for treatment of uranium mine waste. Milling may be considered as a pretreatment step for recovering uranium before disposal in a tailings disposal facility; however, an operational mill that is in compliance with the CERCLA Off-Site Rule is not located within the region and milling alone as a pretreatment step was also not retained.
- **Solidification and Stabilization** are processes that either physically encapsulates or chemically alters mine waste to reduce contaminant leachability, mobility, or toxicity. Neither process addresses radiation concerns. Solidification involves mixing waste with a binder material such as cement, fly ash, clay, or geopolymers. Stabilization involves mixing waste with a neutralizing material such as lime/fly ash and pozzolan/cement. The binder or neutralizing material would have to be hauled to the site, and a batch plant would need to be set up to mix the material with waste. The mixing process requires a large quantity of water for binding to occur; therefore, a water source must be developed or water must be imported from off site. Once the material is solidified or stabilized, it may be placed into a repository or in aboveground mine workings as stackable blocks or gravel admixture; however, the volume of waste requiring disposal greatly increases because of the addition of binding and neutralizing agents. Furthermore, unless placed in a disposal cell or repository, the solidified or stabilized material may break apart when exposed to

freeze-thaw and precipitation, potentially increasing leachability. On- or offsite disposal options are protective and use fewer resources. As a result, solidification and stabilization were not retained.

- **Thermal treatment** – Thermal treatment technologies apply very high levels of heat to the excavated soil in a reactor to volatilize and oxidize contaminants and render them amenable to additional processing. Thermal treatment is typically used for organic contaminants and is not effective on radionuclides and metals in soils.

In Situ Treatment. In situ treatment involves treating the contaminated medium where it is currently located. In situ technologies reduce the mobility and toxicity of the contaminated medium and may reduce exposure to the contaminated materials; however, they allow a lesser degree of control, in general, in comparison to ex situ treatment options. A short screening summary of different in situ treatment classes is described below.

- **Physical and chemical treatments** – Potentially applicable in situ physical and chemical treatment technologies include soil stabilization and solidification. In situ stabilization and solidification are similar to conventional ex situ stabilization in that a solidifying agent (or combination of agents) induces a chemical or physical change in the mobility or toxicity of the contaminants. The in situ process uses deep-mixing techniques to allow maximum contact of the solidifying agents with the contaminated medium. The technologies were not retained because the waste pile depth would make the in situ approach problematic. In addition, exposure to external irradiation by treated materials would remain unless covered with a calculated depth of soil.
- **Thermal treatment** – In situ vitrification is a process used to melt contaminated solid media in situ to immobilize radionuclides and metals into a glass-like, inert, non-leachable solid matrix. Vitrification requires significant energy to generate sufficient current to force the solid medium to act as a continuous electrical conductor. In situ vitrification has been demonstrated only at the pilot scale, and treatment costs are extremely high compared with other treatment technologies. The technology does not address exposure from external irradiation from treated materials and is not considered a feasible option because the infrastructure necessary to deliver high-voltage electricity to a site is unavailable and portable generators cannot provide sufficient voltage, which makes the startup and treatment cost prohibitive. Therefore, in situ verification was not retained.
- **Vegetative treatment** – Vegetation treatment (also known as phytoremediation) is an innovative process that uses plants to remove, transfer, stabilize, or destroy contaminants in soil or sediment. Phytoremediation methods applicable to AUM waste are limited to phytoextraction and phytostabilization. Much of the contamination at the site is located in 30- to 60-foot-deep piles and not all of the waste would be easily accessible by plant roots. Moreover, because radionuclides and metals cannot be biodegraded, plants used in phytoremediation must be harvested and sent for disposal as a radioactive waste and prevention of human or animal consumption of the plants would be necessary. Because of the depth of waste, limited depth of root penetration, and harvested material handling requirements, phytoremediation was not retained.

If the treatments discussed above or any other treatment methods are shown to be effective and practicable before selection of a remedy, USEPA will amend this analysis and consider such treatments.

4.1.2 Summary of Alternative Development

After an initial screening of general response actions and technologies, containment, consolidation, and capping along with various disposal process options were the only technologies identified as being protective, effective, and implementable for the Section 32 and 33 Mines. ICs, surface controls, and access controls are feasible but not as stand-alone responses and may be combined with containment and disposal options. A list of analyzed but excluded disposal process options for the site is included below and is followed by a list of retained alternatives comprising excavation and other disposal process options.

The following site-specific disposal alternatives were removed from consideration as infeasible during development of this EE/CA for the Section 32 and 33 Mines:

- **Excavation, Onsite Ablation, Onsite Capping of Treated Material, and Offsite Disposal of Concentrates.** Ablation may not be able to attain background levels for all waste, therefore, this potential future disposal alternative would utilize ablation as pretreatment step to reduce Ra-226 and uranium concentrations posing a risk to people and ecological receptors and volume before treated material is consolidated and covered onsite. The pretreatment step offers more contaminant removal than simple onsite consolidation and capping as contaminant mass remaining on site is reduced by up to 95 percent. Ablation pretreatment could be retained after additional scalability testing and where a viable offsite disposal alternative at a similar cost is not available and the community would like contaminant mass and volume reduction before onsite consolidation and capping.
- **Excavation and Disposal at Uranium Mill Tailings Radiation Control Act (UMTRCA) Sites.** Several UMTRCA sites, including the United Nuclear Corporation Mill Facility discussed below, assessed for disposal of the Section 32 and 33 Mines waste were considered infeasible because those sites were closed, had insufficient capacity to receive the waste, or had groundwater contamination issues that could prohibit disposal under the CERCLA Off-Site Rule.
- **Excavation and Disposal at Unlicensed Disposal Facilities.** Use of two currently unlicensed locations for new disposal facilities at abandoned coal mines near Grants and Fort Wingate was considered infeasible because of limitations under 10 *United States Code* 2692. Factors included the long time required to license new disposal facilities, whether the coal mines could meet licensing requirements, and contamination issues at both sites that could prohibit disposal under the CERCLA Off-Site Rule.
- **Excavation and Disposal at White Mesa Mill.** The White Mesa Mill facility was considered for extraction of uranium from waste rock and subsequent disposal in the adjacent tailings facility. However, disposal at the tailings facility was determined to be infeasible at this time because of potential contamination issues that would prohibit disposal under the CERCLA Off-Site Rule. This may be an option in the future if

compliance with the CERCLA Off-Site Rule can be documented and concurrence obtained from USEPA.

- **Use of Both Upper and Lower Synthetic Liners for Repositories.** Onsite disposal was evaluated as a removal alternative. Each onsite disposal alternative involves two cover options: (1) using a store-and-release (also known as ET) cover, and (2) using an upper synthetic liner with a store-and-release cover. Use of both an upper and lower liner has been screened out as an option because this would add significant additional cost without adding any additional protection. A Hydrologic Evaluation of Landfill Performance (HELP) model was used to evaluate the difference in percolation through 3- and 4-feet deep ET cover systems. The models showed annual percolation through the cover at amounts less than the accuracy of the model (0.002453 inches for the ET cover of 3 feet and 0.001598 inches for the ET cover of 4 feet). Because precipitation measurement inputs into the model are only accurate to 0.1 or 0.01 inch, the modeled percolation value is zero. This modeling indicates that no liners are necessary to prevent infiltration into the wastes with an ET cover ranging from 3 to 4 feet in depth.
- **Evaluation of Rail Transport of Waste to Disposal Facilities.** Two off-Navajo Nation disposal facilities are set up to receive railcars containing waste rock: a RCRA C landfill in Deer Trail, Colorado, and a LLRW facility in Andrews, Texas. Rail transport was evaluated considering two options: (1) trucking to a rail spur along the Interstate 40 corridor and (2) extending a rail line from Gallup to the Section 32 and 33 Mines. The relative volume requiring transport was compared against the costs to purchase land along a right of way, bridge construction across arroyos, long permitting lead times, and a cost of construction of $3 to $4 million per mile. As a result, the option to extend a rail line to the Section 32 and 33 Mines was assessed to not be viable. USEPA also visited potential rail spur sites in the Gallup area (11 miles) and in the Thoreau area (48 miles) and determined that transloading facilities would need to be constructed and operated to receive the waste from trucks to transfer into railcars and would create another area requiring clean up at the end of the project. USEPA determined that trucking the waste through the communities would be no different than hauling waste to the Red Rocks disposal facility. Waste transfer and scheduling would also add additional construction duration to the cleanup. Therefore, USEPA determined that trucking and rail transport would have limited benefit to the local community and was assessed to not be viable.

Retained Removal Action Alternatives. The following alternatives were retained for further evaluation in this EE/CA and have been tailored to address site-specific conditions and other local requirements.

- **Alternative 1: No Action** – No new treatment, containment, or response action would occur at the site. Maintenance of the existing soil cover and site controls would continue. Alternative 1 has been included as a requirement of NCP and to provide a basis for comparison of the remaining alternatives. Exposure to COCs by human and ecological receptors would not be reduced.
- **Alternative 2: Consolidate and Cap All Waste at Onsite Repository** – All waste rock and contaminated soils from the Section 32 and 33 Mines with concentrations above the action levels would be consolidated and capped in an onsite repository. A store-and-

release cover (ET cover) will be used. The cover would be designed to meet performance criteria to achieve specified radon flux attenuation goals.

- **Alternative 3: Dispose of All Mine Waste Off Site at Red Rocks Disposal Facility** – Waste rock and contaminated soils with concentrations above the action levels would be excavated and disposed of at a State of New Mexico permitted offsite disposal facility located adjacent to but managed separately from the Red Rocks municipal landfill near Thoreau, New Mexico. Waste would be transported from the Section 32 and 33 Mines south on County Road 19 and then west on Ranch Road to Red Rocks Landfill, only passing through the Casamero Lake community.
- **Alternative 4: Dispose of All Mine Waste Off Site at a RCRA C or LLRW Facility** – Waste rock and contaminated soils with concentrations above the action levels would be excavated and disposed of at a RCRA C permitted and State of Colorado radiological licensed facility, such as the Clean Harbors RCRA C facility in Deer Trail, Colorado, or an NRC licensed LLRW facility, such as the WCS facility in Andrews, Texas. Waste would be transported south to Interstate 40, east to Interstate 25, north on Interstate 25, northeast on State Highway 24, and north on State Highway 71 to Deer Trail.

Retained removal action alternatives listed above are fully described in Section 4.2.2 and are carried through a detailed analysis in Section 4.3.

4.1.3 Applicable or Relevant and Appropriate Requirements

Pursuant to NCP at 40 CFR § 300.415(j), USEPA has promulgated a requirement that removal actions attain federal and state ARARs to the extent practicable considering the exigencies of the situation. The ARARs evaluation completed for the Section 32 and 33 Mines was comprehensive, and no ARARs were rejected based on the exigencies of the situation. The Section 32 and 33 Mines are located on Navajo Nation and private lands. Pursuant to NCP at 40 CFR § 300.5, the term “state” includes American Indian tribes. Therefore, for the purposes of evaluating potential ARARs, Navajo requirements will be treated the same as state requirements. The identification of ARARs is an iterative process; therefore, ARARs are referred to as potential until the final determination is made by USEPA in the action memorandum.

NCP at 40 CFR § 300.5 identifies ARARs and other “To Be Considered” (TBC) criteria as follows:

- **Applicable requirements** are defined as “those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance found at a CERCLA site.”
- **Relevant and appropriate requirements** are defined as “those cleanup standards, standards of control, and other substantive requirements, criteria, or limitation promulgated under federal or state environmental facility siting laws that, while not ‘applicable’ address problems or situations sufficiently similar to those encountered at the CERCLA site and that is well suited to the particular site.”

- **TBC criteria** consist of advisories, criteria, or guidance that were developed by USEPA, other federal agencies, or states that may be useful in developing CERCLA remedies and include non-promulgated guidance or advisories that are not legally binding and that do not have the status of potential ARARs. TBCs generally fall within three categories: health effects information with a high degree of credibility, technical information on how to perform or evaluate site investigations or response actions, and policy.

ARARs apply to onsite actions completed as part of a removal action. The onsite actions evaluated in this EE/CA will occur on Navajo Nation as well as on private lands. Navajo Nation statutory and regulatory requirements were evaluated as potential ARARs for Navajo Nation lands (USEPA 1991b). State of New Mexico has regulatory jurisdiction on private lands but not on Navajo Nation lands. Compliance with ARARs requires compliance only with the substantive requirements contained within the statute or regulation and, pursuant to CERCLA § 121(e)(1), does not require compliance with procedural requirements, such as permitting or recordkeeping. ARARs do not apply to offsite response actions. Instead, offsite response actions must comply with independently applicable requirements (not relevant and appropriate) and must comply with both substantive and procedural components of the requirements.

USEPA, as the lead agency, is responsible for identifying potential federal ARARs and evaluating potential State of New Mexico ARARs and Navajo Nation ARARs. For a State of New Mexico or Navajo Nation requirement to be identified as a potential ARAR, the requirement must be more stringent than the corresponding federal ARARs.

USEPA has divided ARARs into three categories: chemical specific, location specific, and action specific. The three categories are described below:

- **Chemical-Specific ARARs** are usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment.
- **Location-Specific ARARs** apply to the geographical or physical location of a site. These requirements limit where and how the response action can be implemented.
- **Action-Specific ARARs** include performance, design, or other controls on the specific activities to be performed as part of the response action for a site.

The potential ARARs for this response action are presented and analyzed in Table 6 by ARAR category and address requirements specific to the alternatives for the Section 32 and 33 Mines.

4.2 DESCRIPTION OF ALTERNATIVES

Section 4.2.1 provides a summary of common site construction and restoration elements applicable to all alternatives. A detailed description of removal action alternatives and associated costs, which focuses on the different waste disposal options, is presented in Section 4.2.2.

4.2.1 Common Elements

To reduce repetitive discussion in the detailed alternative analyses, common removal action elements for Alternatives 2 through 4 are provided in the following subsections.

4.2.1.1 Common Elements for Construction and Restoration

Common removal action elements at the Section 32 and 33 Mines for construction and restoration for Alternatives 2 through 4 are described below.

Site Preparation. Laydown areas would be established after biological and cultural resource clearances near the onsite repository location near the Section 32 and 33 Mines, depending on the alternative chosen. Laydown areas may include port-a-potties, wash water, refuse pickup, decontamination station, temporary offices, temporary Wi-Fi and radio, and potentially a construction water well and tank stand. The laydown areas would also include security personnel and temporary fencing and signage for access controls. Laydown areas would remain until completion of the remedy.

No power is available at the Section 32 and 33 Mines; therefore, power for the project would be provided by diesel generators for the temporary work site (laydown) and well site location (if constructed). The diesel generators would require bulk fuel storage at the laydown area, as well as daily storage on the project site. A secondary containment area would be constructed around generators, storage tanks, and fueling area. The generators would provide power for various types of construction equipment, lighting systems, and pumps.

A sufficient water supply is not available for construction near the Section 32 and 33 Mines. Purchase of water from the Navajo Tribal Utility Authority (NTUA) or construction of a new construction supply well near the onsite repository would be needed to provide water for the project. Utility water could be obtained from NTUA hydrants depending upon existing infrastructure and the volume of water available. Well depths would likely range from 500 to 700 feet bgs if utility water is not available. Generators for site power would be used to run the well pump. A water storage tank for the water trucks would also be required. If a well is constructed, it could be left for use by the Navajo community for irrigation or livestock.

Cultural and Biological Exclusion and Timing. Cultural resource investigations were completed within the Section 32 and 33 Mines boundary in 2019 by NV5, Inc. as a subcontractor for Weston (NV5, Inc. 2019b; Weston 2019). The presence of cultural resources could impose limitations on removal actions. The cultural resources survey of the Section 32 Mine and the western half of the Section 33 Mine was completed (NV5, Inc. 2019b) and included with the RSE. The survey found various resources, some of which are in the project area, and recommended for avoidance.

The Section 32 and 33 Mines are within an Area 3 wildlife sensitive area, which is classified as a less sensitive area containing a low and fragmented concentration of endangered and rare plant, animal, and game species on the Navajo Nation (see Section 2.1.7). Most of the habitat at the Section 32 and 33 Mines is terrestrial/upland and has been highly disturbed by mining activity. Additional biological surveys would be conducted before any intrusive field work.

Site Access. The Section 32 and 33 Mines are located on gently to moderately sloping terrain. The site waste piles and stockpile are accessible from an existing but dilapidated and partially obliterated dirt road and residential access dirt road in poor condition. Both roads are close to residences; therefore, a temporary haul road would be constructed away from residences. Road placement would be determined after community and applicable agency input. Figure 13 shows a proposed haul road north of the site and residences. Access road construction and maintenance, including grading of uneven surfaces and installation of culverts, would be necessary. Temporary fencing would be required during removal activities, and access to the work area would be marked and signed. Traffic controls may be required for ingress and egress on haul roads, depending on residential traffic.

Air Monitoring. A sampling and analysis plan would be prepared that describes the methods and procedures for collecting, analyzing, and evaluating air samples within and at the perimeter of work zones. A minimum of three air monitoring stations would be positioned and operated to monitor dust and airborne contaminant concentrations during grubbing, excavation, stockpiling, loading of trucks, and site restoration. Air monitoring results would be used to document that onsite and offsite migration of contaminants at unacceptable concentrations does not occur. Workers nearby dirt moving and loading activities would also wear real-time dust monitoring equipment to identify the need for respiratory protection upgrades.

Dust Control. Off-road haul routes and site excavation and restoration areas would be wetted so that dust generation is minimized. Frequent water spraying would be used during soil moving activities at all work zones for dust suppression. Rock fields and grating would also be used to reduce the track out of dirt onto paved surfaces. Water used for dust control and to clean paved surfaces would be imported or pumped from a new construction well as described above. Dust control would be used to maintain compliant air quality conditions and a safe working environment and would also protect the health of nearby residents, workers, the general public, and the environment. Use of binding agents such as magnesium chloride and polymers would be considered to reduce water use for dust suppression.

Stormwater Control. Excavated areas would be graded to pre-mining contours when possible and oriented to reduce scouring with low-energy flow rates and patterns. The drainage system would be integrated with the topography and existing drainage patterns to the extent possible. Activities at the site must be evaluated for potential impacts on federally listed species and critical habitat and for certification to meet the substantive requirements of the National Pollutant Discharge Elimination System Multi-Sector General Permit. Once the site has been stabilized, post-removal action site controls would be initiated.

Excavation Approach. Waste rock within the stockpile, unreclaimed waste rock, and contaminated soils at the reclaimed transfer station and haul road above RAGs are the removal areas of concern at the site (Figure 13). The estimated 67,000 bank cubic yards of waste is easily accessible. Waste excavation methods considered for the Section 32 and 33 Mines include standard- to large-size excavators and loaders. Waste rock and contaminated soils would be temporarily stockpiled for load out. Borrow material, if needed, would first be obtained from on site; additional imported borrow material may be needed.

Waste Handling and Transfer. For cost estimating purposes, 22-cubic-yard (33-ton) articulated haul trucks were assumed for onsite transport, and 16.5-cubic-yard (25-ton)-covered on-highway dump trucks were assumed for onsite transport. For Alternative 2, waste will be consolidated and capped in place. For Alternatives 3 and 4, waste will be loaded and hauled to an offsite disposal facility. No transfer station would be required because the Section 32 and 33 Mines can be accessed with multiple types of trucks. Dry brushing of all truck bed and wheels would occur before each truck leaves the site. During muddy conditions, scraping and rinsing of truck tires will also be conducted. Traffic control planning and implementation would be required for Alternatives 3 and 4.

Surficial Restoration Activities. Disturbed areas along the mine access road were identified as needing surficial restoration because of a lack of vegetation. USEPA developed a matrix in the "Navajo Nation Abandoned Uranium Mines Surficial Restoration Approaches Technical Memorandum" (Tetra Tech, Forthcoming[b]) to identify different features and areas of mine sites requiring restoration and the corresponding typical restoration approaches. Table 1 identifies the mine features and areas present at the Section 32 and 33 Mines along with general restoration approaches. Further details regarding each feature and area requiring restoration are described below:

- **Existing haul road.** A 0.8-mile dilapidated dirt road exists from the main access road to the Section 32 Mine stockpile (Figure 2). The road would be contour graded to match surrounding grade and seeded using local grasses and forbs. A soil berm would be used to block vehicular access. Any construction-related damage to the existing paved road would be repaired.
- **Temporary access road.** A temporary road would be constructed to facilitate construction access and removal of waste from the Section 32 and 33 Mines. Following construction, the temporary access road would be obliterated. This road would be restored by contour grading to match surrounding grade, covered with biodegradable matting and coir logs, and seeded using local grasses and forbs. Drainage swales would be covered with rock to reduce erosion. A soil berm would be used to block vehicular access to the temporary access road.

Site Restoration Activities. USEPA has developed a matrix to identify the different features and areas of mine sites requiring restoration and the typical restoration approaches for each feature and area. Table 1 identifies the mine features at the Section 32 and 33 Mines along with general restoration approaches. Further details regarding each feature and area requiring restoration are described below:

- **Mine shafts.** The mine shafts have been closed by USEPA (Figure 3). The mine shafts would be inspected and repaired as necessary.
- **Boreholes and vent shafts.** No boreholes or vent shafts were identified during a review of historical documents and during the RSE. If identified during construction, boreholes would be closed by placing an inflatable bladder at a depth of 6 feet below grade and grouting to ground surface.

- **Stockpile.** USEPA constructed a temporary stockpile at the Section 32 Mine (Figure 3). Under Alternative 2, the existing stockpile would be included in a new onsite repository. Under Alternatives 3 and 4, the existing stockpile would be excavated and restored.
- **Waste excavation areas.** Excavated areas would be contour graded to match adjacent topography (Figure 14). The areas within the drainages leading from the mine sites would be graded to flow along the topographically lowest path. The drainage pathways would be excavated to form a channel and lined with rock. Fencing and signage would be erected around the restored area (site and borrow area) to protect revegetation efforts from grazing over a period of up to 30 years.
- **Fencing.** Domestic livestock would not be allowed to enter the site until it is fully restored. Once vegetation is restored and the site has stabilized, perimeter fencing at the Section 32 and 33 Mines may be removed except where a repository is present. Repository perimeter fencing and signage would remain indefinitely. Restoration activities may take 30 years or more before adequate vegetation is in place and final stabilization is achieved.
- **Livestock controls.** In addition to fencing, berms or barricades would be constructed on temporary access roads and benches to reduce ease of access for livestock over the short term and to allow for successful revegetation.
- **Drainage channel restoration.** Disturbance of drainage channels would be required. Restoration of the channels would require restoring a natural energy grade line and planting of shrubs and forbs within the riparian zone.
- **Runoff from above the site.** Sheet flow runoff from upslope of the site would be intercepted and diverted to the restored drainage pathways using rock and soil berms (Figure 14).

4.2.1.2 Common Elements for Maintenance

Common removal action elements at the Section 32 and 33 Mines for maintenance for Alternatives 2 through 4 are described below.

This cost assumes maintenance of the ET cap would be required in perpetuity, but for cost estimating purposes was assumed to include cap inspections, erosion repairs, and revegetation for 30 years and cap inspections for up to 100 years. USEPA would be responsible for the long-term maintenance of the repository. Restoration maintenance at the Section 32 and 33 Mines would consist of 10 years of erosion repairs and inspections and 30 years of vegetation surveys and maintenance of revegetation efforts.

Maintenance after Site Restoration. Maintenance at the Section 32 and 33 Mines would consist of 10 years of erosion repairs with inspections, vegetation surveys, and maintenance of revegetation efforts extending up to 30 years for restored areas of the site, including excavation areas, removed roads, and borrow areas. For cost estimating purposes, maintenance would include:

- Inspection and vegetation survey in late spring (up to 30 years)

- Vegetation maintenance, including reseedings and removing weeds (first 10 years and as needed up to 30 years)
- Erosion control inspection and maintenance survey after the monsoon season (first 10 years)
- Maintenance of the access road until vegetation and restored areas have stabilized (first 10 years)
- Repairs to erosional features and water control berms (first 10 years)

CERCLA Off-Site Rule. Alternatives that involve transportation off site for disposal would require compliance with the CERCLA Off-Site Rule. In general, the Off-Site Rule requires that facilities that accept contaminated or hazardous wastes from a CERCLA site must follow all applicable regulations and laws (that is, they must be approved to take those wastes and be in compliance with the applicable federal, state, and local requirements to do so). The permitted disposal facilities considered for any alternatives involving offsite disposal would be required to have existing approval under the CERCLA Off-Site Rule.

4.2.1.3 Potential Unavoidable Impacts

Except for Alternative 1 (no action), each of the removal action alternatives would result in an overall improvement to the local environment. However, for Alternatives 2 through 4, unavoidable impacts are expected and include:

- Moderate existing vegetation coverage in the Section 32 and 33 Mines area is terrestrial/upland and depending on the degree of mining disturbance, includes scrub brush and grasses. Construction activities would generally be limited to areas of mining disturbance within the Section 32 and 33 Mines boundaries, reclaimed Section 32/33 Transfer Station, and contaminated soils surrounding site features and portions of the haul road. Disturbed areas would be reclaimed, but reestablishing the existing grasses and forbs vegetation would take up to 30 years.
- A new temporary access road would need to be constructed to provide access for construction equipment and to haul out waste. The road would be removed, and disturbed slopes would be restored to the extent possible.
- Local populations using County Road 19 would be inconvenienced by heavy equipment activity for the 1- to 9-month active construction period and by increased truck traffic on Interstate 40 and County Road 19. Generation of dust on access roads would be minimized through spraying with water during construction and hauling activities. Noise would be limited to normal work hours to avoid disturbing local residents.
- Disruption of sensitive species and habitat during construction activities may occur at the Section 32 and 33 Mines. If sensitive species are identified during a biological survey, the timing of construction activities would be adjusted to limit disturbance and biological monitoring would be conducted during construction activities.
- Cultural resources have previously been identified at the Section 32 and 33 Mines. A cultural resource specialist would be consulted during the removal design to avoid sensitive areas during proposed construction activities. Cultural resource monitors

would be on site during construction activities to oversee any work areas beyond those already cleared.

- Disruption of wildlife and livestock access to the restored site is estimated for 30 years after completion of site work to establish and stabilize vegetation. Livestock access to the onsite cover would be restricted with range fencing, depending on the cap design, to limit damage to the cap.
- Increased risk of traffic accidents and fatalities and greenhouse gas emissions is anticipated because of the trucking of fill, cover material, and waste. As the haul distance increases, the potential risks also increase. Water would be required for dust control during excavation, waste compaction, and restoration, and on roads during waste hauling. Water use, trucking mileage, greenhouse gas emissions, and traffic accident and fatalities are discussed for each alternative in Section 4.3.

4.2.2 Description of Removal Action Alternatives

The following subsections present descriptions of the four removal action alternatives identified in Section 4.1. If any treatment technologies as identified in Section 4.1.1 are shown to be viable alternatives, these technologies will be incorporated into the removal action alternatives.

4.2.2.1 Alternative 1: No Action

Under Alternative 1, radionuclide and metal COCs and COECs in the stockpile, waste pile, and surrounding soils would not be addressed. No land use controls, signage, range fencing, or barriers would be used to limit access to a site. Existing fencing around the Section 32 Mine stockpile would remain. No removal or site stabilization activities would occur.

4.2.2.2 Alternative 2: Consolidate and Cap All Waste at Onsite Repository

Under Alternative 2, the RAOs would be accomplished through excavation of residual waste and contaminated soils and containment of waste with an existing stockpile in a new onsite repository in a new location on the Section 33 Mine (Figure 15). The estimated 67,000 bank cubic yards (83,750 loose cubic yards) of waste from the Section 32 and 33 Mines, including the existing stockpile, would be excavated and consolidated with the current stockpile and capped.

The new onsite repository would be protected from erosion through upslope surface water diversion berms and ditches. Other components of the alternative would include land use and access controls to protect the repository cover and site restoration process (Figure 15). Site excavation and restoration elements common to alternatives are described in Section 4.2.1.1.

Site restoration activities include grading of waste excavation areas, erosion controls, and revegetation. Permanent fencing and signage would be installed around the repository to prevent damage to the cap. Site restoration activities are described further in Section 4.2.1.1. A risk assessment of the Section 32 and 33 Mines is included in Appendix C.

Removal Action Components

Additional information regarding individual components is provided in Section 4.2.1.1. Components of the removal action include:

- Construction of the access road for haul trucks
- Excavation of waste and contaminated soils exceeding RAGs using both a standard excavator and loader (Figure 13)
- Excavation of the existing Section 32 Mine stockpile
- Regrading and contouring excavated areas to match surrounding topography and reestablishing surface water drainage to minimize erosion
- Consolidation of waste and contaminated soils in a new location on the Section 33 Mine
- Construction of the ET cap over the compacted waste
- Site restoration with short-term erosion and stormwater controls, grading, and revegetation
- Long-term cover maintenance of the onsite repository

4.2.2.3 Alternative 3: Dispose of All Mine Waste Off Site at Red Rocks Disposal Facility

Alternative 3 requires the disposal of waste off site at the Red Rocks disposal facility in McKinley County, New Mexico. Under Alternative 3, the RAOs would be accomplished through excavation, transport, and off-Navajo Nation disposal of mine waste and contaminated soil. The site would be reclaimed through implementation of restoration measures followed by maintenance of restored features and use of access controls to protect the site restoration process. Site excavation and restoration elements common to alternatives are described in Section 4.2.1.1.

The estimated 67,000 bank cubic yards of waste (83,750 loose cubic yards) from the Section 32 and 33 Mines would be hauled off the Navajo Nation and disposed of at a specially designed and managed disposal area at the Red Rocks disposal facility. The hauling of waste would comply with applicable state permitting requirements for the transport of radioactive materials. TCLP metals results would be collected and analyzed to verify that no toxicity characteristic levels are exceeded and that the waste does not exhibit RCRA hazardous waste characteristics.

The waste also falls under the Bevill Amendment exclusion and would not be regulated as a RCRA waste in this scenario. In general, the CERCLA Off-Site Rule requires that facilities that accept contaminated or hazardous wastes from a CERCLA site must follow all applicable regulations and laws (that is, they must be approved to take those wastes and be in compliance with the applicable federal, state, and local requirements to do so). The waste disposal facility would be located on the same property but separate from the Red Rocks Landfill and operated under State of New Mexico Groundwater Discharge and Mining permits.

Alternative 3 can only be chosen and implemented if disposal at the Red Rocks disposal facility is also the chosen alternative for the Quivira Mines Site removal action. Sufficient waste volume to be disposed of is required to license the Red Rocks disposal facility to receive mine waste, and this can only be achieved for the Section 32 and 33 Mines if combined with the significantly larger waste quantity from the Quivira Mines Site (estimated at over 1 million bank cubic yards).

Site restoration activities include backfilling and grading of waste excavation areas, erosion controls, and revegetation. Site restoration activities are described further in Section 4.2.1.1. A risk assessment of the Section 32 and 33 Mines is included in Appendix C. The Red Rocks disposal facility is 15.4 miles from the site and does not currently contain a license for radioactive waste disposal. A Stennett analysis was prepared by the U.S. Army Corps of Engineers (USACE) to evaluate the safety for site workers at the proposed Red Rocks disposal facility during waste tipping, consolidation, and capping. The Stennett analysis indicated that facility workers would be safe under the exposure scenario used to develop the analysis. Considerations of the analysis included the characteristics of the waste including contaminant concentrations, as well as construction equipment, methods, and durations of worker exposure (USACE 2022).

Figure 16 shows the recommended haul route to the Red Rocks disposal facility. The overall estimated duration of the project is 4.7 months.

Removal Action Components

Additional information regarding individual components is provided in Section 4.2.1.1. Components of the removal action include:

- Construction of access roads
- Excavation of waste and contaminated soils exceeding RAGs using both a standard excavator and loader (Figure 13)
- Hauling and disposal of waste to the Red Rocks disposal facility
- Excavation of the existing Section 32 Mine stockpile
- Regrading and contouring excavated areas to match surrounding topography and reestablishing surface water drainage to minimize erosion
- Restoration of temporary construction access roads
- Placement of biodegradable matting and coir logs where applicable and revegetation of soil covered areas
- Construction of run-on and runoff controls above and below excavation areas using soil and rock berms and drainage ditches, armoring the drainage swales passing through excavation areas, and construction of detention basins to intercept eroding soils
- Maintenance of surficial restoration areas

4.2.2.4 Alternative 4: Dispose of All Mine Waste Off Site at a Resource Conservation and Recovery Act C or Low-Level Radioactive Waste Facility

Alternative 4 requires the disposal of waste off site at a RCRA C and State of Colorado radiological licensed facility, such as Clean Harbors facility in Deer Trail, Colorado, or an NRC licensed LLRW facility, such as the WCS facility in Andrews, Texas, depending on waste concentration and acceptance limits. Under Alternative 4, RAOs would be accomplished through excavation, transport, and off-Navajo Nation disposal of mine waste and contaminated soil at a hazardous waste or LLRW facility. The Section 32 and 33 Mines would be reclaimed through implementation of site restoration measures followed by short-term maintenance of restored features and use of access controls to protect the site restoration process. Site excavation and restoration elements common to alternatives are described in Section 4.2.1.1.

The estimated 67,000 bank cubic yards (83,750 loose cubic yards) of waste from the Section 32 and 33 Mines would be hauled off the Navajo Nation and disposed of at the Clean Harbors facility in Colorado or the WCS facility in Texas. The hauling of waste would comply with applicable state permitting requirements for the transport of radioactive materials.

Site restoration activities include road closure, grading of waste excavation areas, and controlling runoff from above the site (Figure 14). Roads required for maintenance activities would be reclaimed once the site has stabilized (30 years). Site restoration activities are described further in Section 4.2.1.1. A risk assessment of the Section 32 and 33 Mines is included in Appendix C.

The Clean Harbors facility, permitted to receive RCRA Class C hazardous waste and licensed by the state of Colorado to receive radioactive material, and the WCS facility, licensed by NRC to receive LLRW, are both in compliance with the CERCLA Off-Site Rule. In general, the CERCLA Off-Site Rule requires that facilities that accept contaminated or hazardous wastes from a CERCLA site must follow all applicable regulations and laws (that is, they must be approved to take those wastes and be in compliance with the applicable federal, state, and local requirements to do so). The disposal facilities considered for any alternatives involving offsite disposal would be required to have existing approval under the CERCLA Off-Site Rule.

Disposal at a permitted or licensed facility is a standard disposal method involving transport to and disposal at the applicable waste disposal facility. Licensed or permitted facilities are generally constructed to prevent the release of hazardous or radioactive materials and include engineered cells and liners that exceed requirements for municipal or commercial solid waste disposal facilities.

TCLP metals concentrations would be assessed before selection of an alternative to profile the waste for disposed of at a RCRA-permitted disposal facility. No pretreatment of the waste would be required before disposal.

Figure 13 and Figure 14 show the proposed waste excavation and restoration areas at the Section 32 and 33 Mines. For Alternative 4, waste would be transported to and disposed of at the Clean Harbors RCRA C hazardous waste disposal facility in Deer Trail, Colorado, or the WCS facility licensed by NRC to receive LLRW in Andrews, Texas. The selected disposal facility could be changed in the action memorandum if necessary. Figure 17 shows the recommended haul routes from the site to the Clean Harbors facility in Colorado and the WCS facility in Texas. The overall estimated duration of the project is 15 to 18 months.

Removal Action Components

Additional information regarding individual components is provided in Section 4.2.1.1. Components of the removal action include:

- Construction of access roads
- Excavation of waste and contaminated soils exceeding RAGs using both a standard excavator and loader (Figure 13)
- Excavation of the existing Section 32 Mine stockpile
- Regrading and contouring excavated areas to match surrounding topography and reestablishing surface water drainage to minimize erosion
- Load out and hauling of waste to the Clean Harbors RCRA C hazardous waste disposal facility or the WCS LLRW facility
- Off-Navajo Nation disposal of waste at the Clean Harbors RCRA C hazardous waste disposal facility near Deer Trail, Colorado, or the WCS facility in Andrews, Texas
- Restoration of temporary construction access roads
- Placement of biodegradable matting and coir logs where applicable and revegetation of soil covered areas
- Construction of run-on and runoff controls above and below excavation areas using soil and rock berms and drainage ditches, armoring the drainage swales passing through excavation areas, and construction of detention basins to intercept eroding soils
- Maintenance of surficial restoration areas

4.3 DETAILED ANALYSIS OF ALTERNATIVES

As required by NCP and described in the "Guidance on Conducting Non-Time Critical Removal Actions under CERCLA" (USEPA 1993a), retained removal action alternatives are evaluated individually against three broad criteria: effectiveness, implementability, and cost. The individual alternative analysis ranks the three criteria of each alternative qualitatively as very poor, poor, average, good, or very good.

In addition, based on USEPA (2016) guidance, five key elements in environmental metrics activities should be considered throughout the remedy selection process:

- Minimize total energy use and maximize renewable energy use
- Minimize air pollutants and carbon dioxide equivalent (CO_2e) emissions
- Minimize water use and negative impacts to water resources
- Improve materials management and waste reduction efforts by reducing, reusing, or recycling whenever feasible

- Protect ecosystem services

For the purposes of alternative evaluation in this EE/CA, these five elements were considered, but a quantitative analysis will not completed until a preferred remedy is selected. NCP evaluation criteria are described below.

4.3.1 Effectiveness Criterion

This criterion evaluates the threshold criteria of protection and compliance with ARARs, short-term effectiveness, long-term effectiveness and permanence, and reduction in toxicity, mobility, or volume of waste.

- **Overall Protection of Human Health and the Environment** – This threshold criterion evaluates whether each alternative provides adequate protection of human health and the environment. The assessment of overall protection focuses on whether a specific alternative achieves adequate protection and how site risks posed through each pathway addressed by the EE/CA are eliminated, reduced, or controlled through treatment, engineering, or land use controls. Based on effectiveness and ARAR compliance, alternatives are either considered protective or not protective.
- **Compliance with ARARs** – This threshold criterion evaluates whether each alternative would meet the identified ARARs. Alternatives are either in compliance with ARARs or not in compliance.
- **Short-Term Effectiveness (during Removal Action)** – This criterion evaluates the effects that the alternative would have on human health and the environment under current conditions prior to the action and during its construction and implementation phase. The evaluation includes both radiation risks from exposure to the contaminated soils and risks to the workers and communities under current conditions and from construction work, fuel consumption, greenhouse gas emissions, water use, waste and materials management, ecosystem protection, and traffic accident and fatality risk during implementation, and also takes into account the time necessary to complete the action. An environmental metrics analysis was completed for each alternative to evaluate energy requirements, emissions, water resources, materials management, land management, and ecosystem protection. Short-term effectiveness was rated from very poor to very good.
- **Long-Term Effectiveness and Permanence (after Removal Action)** – This criterion evaluates the results of the removal action in terms of the risk remaining at the site after response objectives have been met. The primary focus of this evaluation is on the extent and effectiveness of the controls used to manage the risk posed by wastes remaining at the site. Long-term effectiveness and permanence was rated from very poor to very good.
- **Reduction of Toxicity, Mobility, or Volume through Treatment** – This criterion addresses the statutory preference for remedies that employ treatment as a principal element by assessing the relative performances of treatment technologies for reducing toxicity, mobility, or volume of the contaminated media. Specifically, the analysis should examine the magnitude, significance, and irreversibility of each estimated reduction. Reduction of toxicity, mobility, or volume through treatment was rated from very poor to very good.

4.3.2 Implementability Criterion

This criterion evaluates the technical and administrative feasibility of implementing an alternative and the availability of required services and materials.

- **Technical Feasibility** – This criterion takes into account construction considerations, demonstrated performance, adaptability to environmental conditions, and timing. Technical feasibility was rated from very poor to very good.
- **Availability of Required Services and Materials** – This criterion evaluates whether staff, equipment services, disposal locations, and any other required services and materials are available in the necessary time frames for construction and maintenance activities. This criterion was combined with technical feasibility for this EE/CA.
- **Administrative Feasibility** – This criterion considers regulatory approval and scheduling constraints. Administrative feasibility was rated from very poor to very good.
- **Tribal, Supporting Agency, and Community Acceptance** – These criteria are initially addressed in this final EE/CA after input from Navajo Nation and supporting agencies. Additional input will be received during the public comment period on the final EE/CA and addressed in the responsiveness summary of the action memorandum.

4.3.3 Cost Criterion

The types of costs assessed include the following:

- Capital costs, including both direct and indirect costs
- Annual post-removal site control costs (termed maintenance within this EE/CA for brevity)
- Net present value of capital and maintenance costs

In accordance with USEPA (1993a, 2000b) guidance, engineering costs are estimates within plus 50 to minus 30 percent of the actual project cost (based on year 2023 dollars).

4.3.4 Cost Estimating Process

Cost estimates were prepared in accordance with USEPA (2000b) guidelines using engineer's estimates, unit costs (cubic yard, linear feet, and square foot quantities) from RSMeans 2023 cost estimating software (Gordian 2023), and vendor quotes. Gallup, New Mexico, was used as the reference city in the RSMeans software to ensure unit costs for labor, equipment, and supplies where applicable to work in the region. Unit costs were validated and adjusted where necessary by verifying that the crew size, equipment, and time allotted for an activity (production rate) were applicable to earthwork at a large mining construction site in the region.

In accordance with USEPA (1993a, 2000c) guidance, the engineering costs are estimates that are expected to be within plus 50 to minus 30 percent of the actual project cost (based on year 2023 dollars). Only the rolled up construction and capital costs, maintenance costs for site restoration, long-term maintenance costs for repositories, and net present values are presented for each alternative. Cost details and assumptions are presented in Appendix F.

Other construction-related costs were identified and included in the cost approach, including mobilization and demobilization, contractor site overhead, travel and lodging, third-party oversight, Navajo Nation tax for on-Navajo Nation activities, and a 20 percent contingency. Non-construction-related costs required before and during construction activities were also identified and included in the cost approach, including design, planning, resource surveys, confirmation sampling, and reporting.

Contingency costs for construction are based on the extra time, equipment, and personnel required to safely work with radioactive materials; remote location of the site; differences in labor pool costs between RSMeans estimating software reference cities and the project area; and potential for changes in material and transportation costs. Changes in the cost elements are likely as commodity prices change and new information and data are collected during the engineering design and construction pre-bid and walk-through meetings.

The needs for maintenance costs were identified, including the need for site restoration for a period of 10 years to address any erosion and 30 years to conduct vegetation surveys and address any revegetation efforts, and including the need for cap and cover inspection and maintenance for a period of 30 years and inspection from 31 to 100 years for onsite consolidation and capping. Project duration (30 years versus 100 years) varies depending on the alternative being evaluated and will be addressed in the cost discussion for each alternative.

Common capital and maintenance costs for each removal action alternative include access road construction, access road reclamation, site restoration, and annual maintenance of site restoration efforts over 30 years. Annual inspection and maintenance of the repository cap (erosion repairs and vegetation replanting) would be intensive for the first 30 years because of erosion and revegetation efforts but would decrease after vegetation is established and consist of inspection only for years 30 to 100. Maintenance of site restoration and cap restoration efforts is addressed in Section 4.2.1.2 in more detail. The net present value of each removal action alternative provides the basis for the cost comparison. The net present value represents the amount of money that, if invested in the initial year of the removal action at a given interest rate, would provide the funds required to make future payments to cover all maintenance costs associated with the removal action over its planned life.

To assess the required funds to be set aside for implementing maintenance activities in the future, this EE/CA uses a 7 percent discount rate as specified in USEPA (1993a) guidance.

4.3.5 Alternative 1: No Action

Under Alternative 1, no actions would be performed at the Section 32 and 33 Mines. The conditions that are currently found at the site would remain unchanged. No action does not meet the threshold criteria of protectiveness and will not be evaluated further.

4.3.5.1 Effectiveness

Overall Protection of Public Health and the Environment – Alternative 1 is not protective and would not achieve RAOs. This alternative would not minimize potential exposure to or transport of COCs or COECs from the site or control radiation and physical hazards at the site. This alternative would not reduce risk to human health or the environment. Therefore, protection of human health and the environment would not be achieved under Alternative 1.

Compliance with ARARs – Under Alternative 1, no ARARs would exist with which to comply per CERCLA § 121(d). ARARs are triggered by an action and are, therefore, not pertinent if no cleanup occurs.

Short-Term Effectiveness – Alternative 1 has no action, so no short-term risks would exist for the community or workers from construction activities. However, threats to human and ecological receptors would persist in the short term. Because no construction activities would occur, no additional energy use, greenhouse gas emissions, water use, waste and materials management, and ecosystem protection requirements would be triggered. No additional traffic volume or potential accidents and fatalities associated with construction would occur.

Long-Term Effectiveness and Permanence – No controls or long-term measures would be implemented to control COCs or COECs at the site under Alternative 1. Under this alternative, waste would continue to be accessible by humans and animals and subject to potential migration to uncontaminated or less contaminated areas. Risks at the site are currently unacceptable and would continue to be unacceptable under Alternative 1. Over time, the site risks may increase, decrease, or remain the same as exposure to and migration of waste would not be controlled.

Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 1 employs no treatment, so no reductions in toxicity, mobility, or volume through active treatment would occur.

4.3.5.2 Implementability

Technical Feasibility and Availability of Services and Materials – Alternative 1 is readily implementable because no construction is involved. This alternative would not impact the ability to conduct removal or remedial actions in the future. No services or materials would be needed to implement Alternative 1.

Administrative Feasibility – Alternative 1 is administratively feasible as taking no action is always feasible.

4.3.5.3 Costs

No removal action costs would be incurred for Alternative 1 as it involves no removal activities and no legal or administrative activities.

4.3.6 Alternative 2: Consolidate and Cap All Waste at Onsite Repository

Alternative 2 involves the excavation of mine waste and contaminated soil above the action levels would be excavated and placed into an onsite repository. An estimated 3,855 truckloads of waste would be transported to the onsite repository using haul trucks holding 22 cubic yards (33 tons) of waste.

4.3.6.1 Effectiveness

Overall Protection of Public Health and the Environment – Alternative 2 is protective of human health and the environment as the soil and mine waste that contain radionuclide and metal COCs and COECs would be capped within an onsite repository.

The capped area would be covered with a soil ET cap. The engineered cap is a physical barrier that offers protection from water infiltration and percolation into the contaminated soils, protects groundwater resources, and provides adequate shielding from ionizing radiation to protect human health and the environment. The cover would prevent direct contact between the wastes and the public or the environment. Proper construction and design of the cover includes the establishment of vegetation, which reduces erosion. Proper stormwater controls and maintenance of the cover would prevent release of the contaminated soils back into the environment. A 100-year maintenance period is used for onsite capping alternative cost estimating and comparison purposes. Additional maintenance costs beyond 100 years will depend on inspection results and updates to the long-term surveillance plan.

Compliance with ARARs – Alternative 2 would meet Federal and Navajo ARARs identified in Table 6 for the Section 32 and 33 Mines.

Short-Term Effectiveness – The short-term impacts to the community, workers, and environment under Alternative 2 are described below.

- **Protection of the Community during Removal Action** – Under Alternative 2, increased truck traffic to the site would have a short-term impact on traffic safety and air quality on dirt access and haul roads.

  Truck traffic would be coordinated under a transportation plan for routes, times of operation, and onsite traffic rules. Emergency spill containment and cleanup contingencies would also be included in the transportation plan. Over the short term, Alternative 2 would involve 15,405 transport miles and is estimated to result in 0.0050 traffic accidents and 0.0002 traffic fatalities and create less than 1 metric ton of CO_2e. Risks remain low because waste hauling between the Section 32 and 33 Mines and the onsite repository is only on onsite unpaved haul roads rather than on the highway.

- **Protection of Workers** – Short-term risks of physical injury exist for site workers. All workers would require standard 40-hour Occupational Safety and Health Administration (OSHA) hazardous materials and radiation awareness training and would be adequately protected by using appropriate personal protective equipment and following safe work practices and standards. Radiation exposure monitoring would be required. Short-term impacts to air quality in the surrounding environment may occur during excavation and loading of waste for offsite transport. Dust suppression and monitoring would be required to ensure that workers are not exposed to radionuclides in particulates. Decontamination of workers and equipment would be required before exiting the site.

Under Alternative 2, heavy equipment would be used to clear and grub, excavate, transfer, load, and transport waste to a facility, as well as reclaim the site by grading the footprints of the removal areas, applying growth media, and applying native seed and soil amendments for local vegetation establishment. Potential exposure and protection procedures for workers engaged in these activities would be addressed in detail under a site health and safety plan. During excavation and material handling activities, measures would be taken to reduce fugitive dust emissions and associated impacts to workers. Water would be imported for dust control, and workers in the controlled area would don the appropriate safety equipment and implement safety practices, such as air monitoring. Work areas would be secured (for example, marked or fenced) to limit access to authorized personnel only.

- **Environmental Impacts** – Even with control measures, short-term environmental impacts could occur from excavation and placement of waste in an onsite repository. These environmental impacts may include sedimentation of local drainages, residual track-in and track-out effects of soil and mud, noise, disturbed vegetation, and dust generation. Other environmental impacts include fuel burning and releasing of emissions that would lead to climate impacts. However, the threat to the environment is moderate because the waste rock would be consolidated and capped within 1 to 2 months. In addition, revegetation would expedite the return of native flora once cleanup actions are complete. However, revegetation may not occur immediately. The short-term threat posed by exposure to uranium and radionuclides would be minimal. Impacts from hauling waste and importing materials are discussed in Section 4.3.6.2.
- **Environmental Metrics Analysis** – A qualitative evaluation of all environmental metrics was conducted for this EE/CA. The results are presented in Appendix E. The analysis estimates that Alternative 2 would involve 15,405 transport miles, consume 2,656 gallons of diesel, and create less than 1 metric ton of CO_2e. Alternative 2 was assessed as having a **small** environmental footprint.
- **Time until Removal Action Objectives Are Achieved** – The construction time required to achieve preliminary RAOs for Alternative 2 would be 4 to 5 months following 1 year of design, planning, and permitting. Construction may be extended depending on schedule-limiting factors such as monsoon rains and snowfall.

Long-Term Effectiveness and Permanence – Alternative 2 would safely and reliably contain all waste in an onsite repository with an ET cap, and RAOs would be achieved at all areas at the Section 32 and 33 Mines. Landfills and mines in the southwestern U.S. are routinely closed on site with ET covers and a maintenance plan. The Navajo Nation Abandoned Mine Lands Reclamation Department (NAMLRD) has a demonstration repository in the Tse Tah area, and Tetra Tech (2021) has prepared a white paper that provides additional support for the use of ET covers. Cover maintenance is a well-established practice. Since contaminated soils would remain on the site, potential exposure reductions to those accessing the site would be dependent on the maintenance of the cover. Drainage features and stormwater controls would be included in the design so that surface water would be diverted from the capped areas and aid in prolonging the integrity of the cover. Alternative 2 is expected to effectively mitigate the long-term effects on potential human and ecological receptors for as long as the cover and permanent fencing and signage are maintained. An engineered ET cover would meet the RAOs and ARARs and be protective of human health and the environment for at least 200 years.

Land use controls would be necessary to limit access to and disturbance of the site and onsite repository during restoration. For the areas at the site where all waste has been removed, short-term monitoring and repair of revegetation and erosion controls would also be required for up to 30 years.

Force majeure events, such as earthquakes, climate change, or large floods, could impact the remedy or waste left in place, but design criteria for the removal action would take these into account to the extent practicable.

Finally, the uncertainties of disposing of waste in an onsite repository under Alternative 2 are considered low because of the stable nature of the waste, design of the repository and ET cap, use of conventional materials and methods, and long track record of repositories as an accepted remedy.

Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 2 employs no treatment, so no reductions in toxicity, mobility, or volume through active treatment would occur.

4.3.6.2 Implementability

Technical Feasibility and Availability of Services and Materials – Alternative 2 involves earthwork and material hauling that is technically feasible and would use conventional techniques, materials, and labor for the excavation and associated activities.

Construction and environmental monitoring equipment and services are all readily available. Labor would be available both on the Navajo Nation and in the regional market. A sufficient volume of water for dust suppression may be obtained through construction of an onsite water well or imported water.

Local sources of borrow material are enough to meet the needs for fill, topsoil, and gravel for capping options under all potential cap designs and for restoration after excavation. Riprap would need to be imported from Durango, Colorado, to meet engineering specifications for armoring drainage channels.

Alternative 2 would be completed as a single phase, and no future removal actions are anticipated. Maintenance of the repository cap would be required for up to a 100-year period and reevaluated thereafter. The expertise and equipment needed for long-term monitoring and maintenance of the onsite repository cap, erosional features and controls, and revegetation are available. Run-on water control berms and drainage ditches at the repository would be repaired as necessary. Permanent range fencing and warning signs around the repository would also be checked and repaired or replaced as necessary.

Administrative Feasibility – Coordination between USEPA, NNEPA, NAMLRD, and the State of New Mexico to address federal, state and Navajo ARARs would be easily implemented. Federal, state, tribal, and local permits for onsite actions under CERCLA at the site and the proposed onsite repository are not required because this is an onsite location in a mining-disturbed area (drilled and explored extensively) and within a mine lease boundary. Transportation permits would not be necessary. Environmental reviews may be required from the Navajo Nation and would be easily implemented. Finally, negotiations with the Navajo Nation or other landowners with potential offsite soil borrow sources and repository areas would need to be conducted and agreements crafted.

The entity responsible for the long-term surveillance plan would maintain various plans and conduct periodic inspections and reviews, including:

- A stormwater pollution prevention plan (SWPPP) overseen by NNEPA (to verify that restoration is protective of surface water quality)
- A long-term surveillance plan implemented after repository cap construction and overseen by NNEPA and USEPA

Land use controls for waste placed in the repository would require coordination with NNEPA, the Navajo Land Department, and the Cove Chapter because deed restrictions are not possible on the Navajo Nation.

4.3.6.3 Costs

Overall, Alternative 2 has the lowest costs of the alternatives because of onsite hauling and disposal at the onsite repository even after both short-term (30-year) site restoration maintenance costs and long-term (100-year) onsite repository maintenance costs are considered. USEPA would be responsible for long-term maintenance of the repository. Alternative 2 would also require less earthwork as the stockpile would not be excavated and instead included in the onsite repository footprint.

A breakdown of the major cost categories associated with implementing Alternative 2 is presented in Exhibit 15. Detailed cost estimates are provided in Appendix F, Table F-1.

Exhibit 15. Alternative 2 Cost Breakdown

Cost Component	Section 32 and 33 Mines
Excavated Surface Area (acres)	24
Excavated Volume (bank cubic yards)	67,000
Capital Costs	
Field Overhead and Oversight	$306,000
General Site Work	$187,900
Earthwork	$1,432,000
Transportation and Disposal	$0
Subtotal Direct Capital Costs	**$1,926,000**
Indirect Capital Costs	$404,000

Exhibit 15. Alternative 2 Cost Breakdown (Continued)

Cost Component	Section 32 and 33 Mines
Contingency Allowance (15%)	$349,500
Total Capital Costs	**$2,680,000**
Maintenance Costs	
Present Worth of 100 Years Maintenance at a Discount Rate of 3.5%	$1,342,000
Contingency Allowance (25%)	$335,000
Total Maintenance Costs	**$1,677,000**
Total Costs	**$4,358,000**

4.3.7 Alternative 3: Dispose of All Mine Waste Off Site at Red Rocks Disposal Facility

Alternative 3 assumes that contaminated soils with concentrations above the action levels would be excavated and disposed of at the Red Rocks state-permitted disposal facility in McKinley County, New Mexico. Exhibit 16 presents the processing and transportation costs for the Red Rocks disposal facility. An estimated 5,140 truckloads of waste would be transported to the Red Rocks disposal facility using on-highway haul trucks holding 16.5 cubic yards (25 tons) of waste.

Exhibit 16. Red Rocks Transportation and Tipping Costs

Receiving Facility	Processing and Transportation Costs
Red Rocks Disposal Facility	$62 per loose cubic yard*

Note:
* Exact costs have not obtained for the Red Rocks disposal facility yet. This placeholder cost is for the Red Rocks Landfill and will be updated with information from the facility when available.

The Red Rocks disposal facility is currently a RCRA D landfill and is not licensed to accept LLRW. However, the facility has additional adjacent land where a State of New Mexico permit for a new facility that can accept LLRW for permanent disposal is planned. The State of New Mexico is not opposed to the facility development and has provided guidance on how such a facility would be permitted. USACE (2022) evaluated the operations of the facility in a Stennett analysis and determined that, under the operating conditions assumed, the facility would be safe for workers.

The Red Rocks disposal facility is currently evaluating the costs of permit and facility modification to accept this type and volume of waste. The cost for the landfill currently is a placeholder and will be updated when the facility provides a quote.

Alternative 3 can only be chosen and implemented if disposal at the Red Rocks disposal facility is also the chosen alternative for the Quivira Mines Site removal action. Sufficient waste volume to be disposed of is required to license the Red Rocks disposal facility to receive mine waste, and this can only be achieved for the Section 32 and 33 Mines if combined with the significantly larger waste quantity from the Quivira Mines Site (estimated at over 1 million bank cubic yards).

4.3.7.1 Effectiveness

Overall Protection of Public Health and the Environment – Alternative 3 would protect human health and the environment as the contaminated soils exceeding the action level at the Section 32 and 33 Mines would be removed for offsite transportation and disposal at a permitted facility designed to manage radioactive waste. This alternative would significantly minimize potential long-term exposure to contaminated soils from the Section 32 and 33 Mines. Potential short-term exposures during excavation, transport, and at the final disposal site would be managed through engineering controls.

From a COPC exposure perspective, the Alternative 3 actions are protective of human health and the environment. However, highway fatality calculations indicate shipping soils to the Red Rocks disposal facility for disposal have a significant risk of a highway traffic fatality. Chemically, disposal at the Red Rocks disposal facility is protective, but, physically, this may not be the case. This is discussed further in the evaluation of short-term effectiveness.

Compliance with ARARs – Alternative 3 would meet federal, state, and Navajo Nation ARARs for the Section 32 and 33 Mines. Common ARARs across Alternatives 2 through 4 are found in Table 6.

Short-Term Effectiveness – Alternative 3 involves excavation of all waste for offsite disposal at the Red Rocks disposal facility. The short-term impacts to the community, workers, and environment under Alternative 3 are as described below.

- **Protection of the Community during Removal Action** – Under Alternative 3, increased truck traffic to the site would have a short-term impact on traffic safety and air quality on dirt access and haul roads.

  For Alternative 3, bulk carriers hauling the containerized wastes off site would be covered, secured, and weighed to document compliance with total and axle load limits. Truck traffic would be coordinated under a transportation plan for routes, times of operation, and onsite traffic rules. Emergency spill containment and cleanup contingencies would also be included in the transportation plan. A new access and haul road would be constructed to avoid nearby residents and extend from the site north for approximately 0.2 mile and then west for 0.65 mile to connect with County Road 19.

  Alternative 3 would involve 134,660 transport miles and is estimated to result in 0.044 traffic accidents and 0.0020 traffic fatalities and create 200 metric tons of CO_2e. This alternative also leaves the waste in place for the 3 to 5 years of state permitting, design, and facility construction.

- **Protection of Workers during Removal Action** – Short-term risks of physical injury exist for site workers. All workers would require standard 40-hour OSHA hazardous materials and radiation awareness training and would be adequately protected by using appropriate personal protective equipment and following safe work practices and standards. Radiation exposure monitoring would be required. Short-term impacts to air quality in the surrounding environment may occur during excavation and loading of waste for offsite transport. Dust suppression and monitoring would be required to ensure that workers are not exposed to or inhale radionuclides in particulates. Decontamination of workers and equipment would be required before exiting the site.

Under Alternative 3, heavy equipment would be used to clear and grub, excavate, transfer, load, and transport waste to a facility, as well as reclaim the site by grading the footprints of the removal areas, applying growth media, and applying native seed and soil amendments for local vegetation establishment. Potential exposure and protection procedures for workers engaged in these activities would be addressed in detail under a site health and safety plan. During excavation and material handling activities, measures would be taken to reduce fugitive dust emissions and associated impacts to workers. Water would be imported for dust control, and workers in the controlled area would don the appropriate safety equipment and implement safety practices, such as air monitoring. Work areas would be secured (for example, marked or fenced) to limit access to authorized personnel only.

- **Environmental Impacts** – Even with control measures, short-term environmental impacts could occur. These environmental impacts may include residual track-in and track-out effects of soil and mud, noise, disturbed vegetation, and dust generation. Other environmental impacts include fuel burning and releasing of emissions that would lead to climate impacts. However, the threat to the environment is moderate because the mine waste could be consolidated and capped within 4 to 5 months. In addition, revegetation would expedite the return of native flora once cleanup actions are complete. The short-term threat posed by exposure to uranium and radionuclides would be minimal. Impacts from hauling waste and importing materials are discussed in Section 4.3.7.2.
- **Environmental Metrics Analysis** – A qualitative evaluation of all environmental metrics was conducted and presented in Appendix E. The analysis estimates Alternative 3 would involve 134,660 transport miles, consume 23,217 gallons of diesel, and create 200 metric ton of CO_2e.
- **Time until Removal Action Objectives Are Achieved** – Excavation, hauling off the Navajo Nation, and disposal of waste at the Red Rocks disposal facility would meet preliminary RAOs in the short term. The construction time required to achieve RAOs for Alternative 3 would be approximately 4 to 5 months. Construction may be extended depending on schedule-limiting factors such as truck availability, monsoon rains, and snowfall.

Long-Term Effectiveness and Permanence – Since all contaminated soils would be excavated and removed from the site, potential exposure reductions to receptors accessing the site would be permanent. Long-term maintenance is lowest under this alternative because it focuses on native vegetation reestablishment only and does not require repository maintenance. Alternative 3 is expected to mitigate the long-term effects on potential onsite human and ecological receptors.

Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 3 employs no treatment, so no reductions in toxicity, mobility, or volume through active treatment would occur.

Managing waste at landfills reduces the overall mobility of bulk waste but does not treat the waste. Alternative 3 does not reduce COC or COPC toxicity, mobility, or volume through treatment. Under Alternative 3, waste would be disposed of at the Red Rocks disposal facility near Gallup, New Mexico, which is or would be permitted for LLRW disposal.

4.3.7.2 Implementability

Technical Feasibility and Availability of Services and Materials – Alternative 3 is technically feasible and would use conventional techniques, materials, and labor for the excavation and associated activities. The Section 32 and 33 Mines are readily accessible. Excavation would be scheduled and performed to maximize direct loading and ensure worker and public safety. Engineering controls for fugitive dust and site monitoring would be used to control potential exposures to sensitive receptors. Profiling and manifesting of the material would be done in coordination with the transporters and the offsite disposal facility.

Alternative 3 consists mainly of simple earthwork and material hauling. Alternative 3 requires a contractor experienced in the excavation of mine waste, drainage channel reconstruction, biodegradable erosion control matting and wattles, and stormwater diversion berms and ditches, hazardous substances, and traffic, dust, and stormwater management. The equipment required for the work is readily available and consists of scrapers, loaders, dozers, crushing and screening plant for borrow materials, and on-highway haul trucks. The disposal of waste at the Red Rocks disposal facility has a haul distance of 13 miles.

Construction and environmental monitoring equipment and services are all readily available. Labor would be available both on the Navajo Nation and in the regional market. Access to a sufficient volume of water for dust suppression is necessary, which would be obtained through construction of an onsite water well or trucked in from the Gallup municipal supply.

Sources of borrow material are adequate to meet the needs for fill and topsoil for restoration after excavation.

Alternative 3 would be completed as a single phase, and no future removal actions are anticipated. Long-term monitoring and maintenance would not be required; however, short-term maintenance of erosional controls and revegetation efforts would be required. Run-on water control berms, drainage ditches, and sediment detention basins would be repaired as necessary. Temporary range fencing would also be checked and repaired as necessary.

The Red Rocks disposal facility does not currently have an operating permit. Because all waste would be disposed of off site, reliance on the ability to obtain an operating permit and future disposal capacity of the Red Rocks disposal facility brings some uncertainty to the availability of services at the time of the removal action. However, the State of New Mexico has indicated that the facility could be permitted and estimated a time frame for permitting of 1 to 2 years. An overall 3-to-5-year time frame is estimated for permitting and facility design.

Administrative Feasibility – Implementation of Alternative 3 would require coordination between USEPA, NNEPA, NAMLRD, and the State of New Mexico to address federal, State, and tribal ARARs, but federal permits for onsite actions under CERCLA are not required. The Red Rocks disposal facility would be required to undergo a Stennett analysis and obtain a Groundwater Discharge Permit from the State of New Mexico. General construction permits and environmental reviews may be required from the Navajo Nation. Finally, negotiations with the Navajo Nation or other landowners with potential offsite soil borrow sources would need to be conducted and agreements crafted.

Alternative 3 can only be chosen and implemented if disposal at the Red Rocks disposal facility is also the chosen removal action alternative for the Quivira Mines Site and the waste from the Section 32 and 33 Mines is combined with the significantly larger waste quantity from the Quivira Mines Site (estimated at over 1 million bank cubic yards).

Alternative 3 is rated average for administrative feasibility since it would require a Stennett analysis and state permitting. All contaminated soil is anticipated to be accepted by permitted facilities. However, Alternative 3 is currently rated average for administrative feasibility because the Red Rocks disposal facility is not currently permitted for radioactive waste disposal. The permitting options are being identified by the facility, but the permit would take time to obtain through permitting and due diligence evaluation, including local input. The overall time frame for this process has not been clarified but would be included in this EE/CA when available.

The entity responsible for the short-term surveillance of site restoration features would maintain various plans and conduct periodic inspections and reviews, including a SWPPP overseen by NNEPA (to verify that restoration is protective of surface water quality).

4.3.7.3 Costs

Alternative 3 overall has the second highest costs of the alternatives because of facility disposal fees. Costs assume that all material above screening levels would be removed from the site and disposed of at the Red Rocks disposal facility. This cost assumes the Red Rocks disposal facility would be responsible for the long-term maintenance of the wastes it receives. Restoration maintenance at the Section 32 and 33 Mines would consist of 10 years of erosion repairs and inspections and 30 years of vegetation surveys and maintenance of revegetation efforts.

A breakdown of the major cost categories associated with implementing Alternative 3 is presented in Exhibit 17. Detailed cost estimates are provided in Appendix F, Table F-2.

Exhibit 17. Alternative 3 Cost Breakdown

Cost Component	Section 32 and 33 Mines
Excavated Surface Area (acres)	24
Excavated Volume (bank cubic yards)	67,000
Capital Costs	
Field Overhead and Oversight	$306,000
General Site Work	$286,800
Earthwork	$783,000
Transportation and Disposal	$5,567,000
Subtotal Direct Capital Costs	$6,944,000
Indirect Capital Costs	$405,000
Contingency Allowance (15%)	$1,102,350
Total Capital Costs	**$8,451,000**

Exhibit 17. Alternative 3 Cost Breakdown (Continued)

Cost Component	Section 32 and 33 Mines
Maintenance Costs	
Present Worth of 30 Years Maintenance at a Discount Rate of 3.5%	$1,091,000
Contingency Allowance (25%)	$273,000
Total Maintenance Costs	$1,364,000
Total Costs	**$9,815,000**

4.3.8 Alternative 4: Dispose of All Mine Waste Off Site at a Resource Conservation and Recovery Act C or Low-Level Radioactive Waste Facility

Alternative 4 involves the excavation of mine waste and contaminated soil, loading into highway legal trucks, and transport and disposal of waste at the Deer Trail RCRA-permitted and State of Colorado radiological-licensed facility in Deer Trail, Colorado, or an NRC-licensed LLRW facility, such as the WCS in Andrews, Texas. Disposal at the WCS LLRW facility in Andrews, Texas, may be considered where Ra-226 concentration in waste or contaminated soil exceeds 222 pCi/g, or the annual acceptance limit at the Clean Harbors facility is reached. An estimated 5,140 truckloads of waste (24 truckloads per day) would be transported to the Clean Harbors or WCS facilities using on-highway haul trucks holding 16.5 cubic yards (25 tons) of waste.

Exhibit 18 presents the processing and transportation costs for the Clean Harbors and WCS facilities. The Deer Trail facility currently has the appropriate permitting, licensing, bonding, and CERCLA Off-Site Rule approvals. A change to the disposal facility could be selected in the action memorandum if necessary.

Exhibit 18. Disposal Facility Transportation and Tipping Costs

Receiving Facility	Transportation and Tipping Costs
Clean Harbors RCRA C Deer Trail facility	$285 per loose cubic yard
Waste Control Specialist LLRW facility	$375 per loose cubic yard

Notes:
LLRW Low-level radioactive waste
RCRA Resource Conservation and Recovery Act

4.3.8.1 Effectiveness

Overall Protection of Public Health and the Environment – Alternative 4 is protective of human health and the environment as the soil and mine waste that contain radionuclide and metal COCs and COECs would be disposed of at an off-Navajo Nation hazardous waste disposal facility. This alternative would significantly minimize potential long-term exposure to contaminated soils from the Section 32 and 33 Mines. Potential short-term exposures during excavation, transport, and at the final disposal site would be managed through engineering controls.

From a contaminant exposure perspective, Alternative 4 is protective of human health and the environment. However, highway fatality calculations indicate shipping soils to Deer Trail for disposal would result in a large increase in highway traffic accidents and fatalities. This is discussed further in the evaluation of short-term effectiveness.

Compliance with ARARs – Alternative 4 will meet federal, state, and tribal ARARs identified in Table 6. ARARs do not apply to offsite actions, but offsite actions must comply with independently applicable requirements (not relevant and appropriate). Independently applicable requirements cannot be waived, and all components, both substantive and procedural, must be complied with at all times.

Short-Term Effectiveness – Alternative 4 involves excavation of all waste for offsite disposal at a RCRA-permitted facility. The short-term impacts to the community, workers, and environment under Alternative 4 are described below.

- **Protection of the Community**– Dust generation is unavoidable, but dust mitigation measures should prevent most unacceptable exposures to the community. Air monitors would be placed around the construction zone at the mine sites and the transfer station to measure potential risks to the community and to trigger additional dust control if necessary.

  Increased truck traffic would have a short-term impact on traffic safety within the area around the site and air quality on dirt access roads. Hauling waste from the site to the off-Navajo Nation Clean Harbors RCRA C hazardous waste disposal facility near Deer Trail, Colorado, would lead to increased traffic on County Road 19 and other state highways along the route to the disposal facility for 8 to 9 months.

  Over the short term, Alternative 4 would involve 5,832,180 transport miles and is estimated to result in 1.89 traffic accidents and 0.0881 traffic fatalities and create 10,400 metric tons CO_2e. The estimates are greater than those for Alternative 3 because of the 567-mile haul distance between the Section 32 and 33 Mines and the Clean Harbors RCRA C hazardous waste disposal facility.

- **Protection of Workers** – Short-term impacts to air quality in the surrounding environment may occur. Dust suppression and monitoring would keep worker exposure to dust within acceptable levels. Decontamination of workers and equipment would be required before exiting the site.

  Short-term risks of physical injury would exist for site workers. All workers would be required to wear personal dosimeters to monitor that exposure does not exceed OSHA limits. The risk to truck drivers would be greater than that for Alternatives 2 and 3 because of the increase in time and miles required for transport.

- **Environmental Impacts** – Even with control measures, short-term environmental impacts could occur. These environmental impacts may include sedimentation of the local drainages, residual track-in and track-out effects of soil and mud, noise, disturbed vegetation, and dust generation. However, the threat to the environment is very high because the mine waste would be cleaned up within 8 to 9 months. In addition, revegetation would expedite the return of native flora. The short-term threat posed by exposure to uranium and radionuclides would be minimal.

- **Environmental Metrics Analysis** – A qualitative evaluation of all environmental metrics was conducted and presented in Appendix E. The analysis estimates Alternative 4 would involve 5,832,180 transport miles, consume 1,005,548 gallons of diesel, and create 10,400 metric ton of CO_2e.
- **Time until Removal Action Objectives Are Achieved** – Excavation, hauling off Navajo Nation, and disposal of waste at the Clean Harbors disposal facility would meet preliminary RAOs in the short term. The construction time required to achieve preliminary RAOs for Alternative 4 would be 15 to 18 months at the Section 32 and 33 Mines because of the 3-day truck cycle time. Construction may be extended depending on schedule-limiting factors such as truck availability, monsoon rains, and snowfall.

Long-Term Effectiveness and Permanence – Alternative 4 would relocate and safely dispose of all waste in a hazardous waste disposal facility, and RAOs would be achieved at the site. No sources of mining-related residual risk would remain at the Section 32 and 33 Mines.

No long-term maintenance is required for Alternatives 4 because no waste would remain on site. Therefore, Alternative 4 has a substantial advantage over on-Navajo Nation actions of Alternative 2, which would require up to 100 years of onsite repository cap inspections and maintenance.

Land use controls would be necessary to limit access to and disturbance of the site during restoration. For the areas at the site where all waste has been removed, short-term monitoring of revegetation efforts and erosion controls would also be required.

Finally, the uncertainties of disposing of waste off site under Alternative 4 are considered low because of the use of conventional materials and methods and the long track record of hazardous waste disposal facilities as an accepted remedy.

Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 4 employs no treatment, so no reductions in toxicity, mobility, or volume through active treatment would occur.

Managing waste at landfills reduces the overall mobility of bulk waste but does not treat the waste. Alternative 4 does not reduce COC or COPC toxicity, mobility, or volume through treatment. Under Alternative 4, waste would be disposed of at permitted RCRA facility in Deer Trail, Colorado, which is permitted and licensed for uranium mine waste disposal.

4.3.8.2 Implementability

Technical Feasibility and Availability of Services and Materials – Alternative 4 consists mainly of earthwork and material hauling. The equipment required for the work is readily available and consists of conventional excavators, scrapers, loaders, dozers, crushing and screening plant for borrow materials, and on-highway haul trucks.

Construction and environmental monitoring equipment and services are all readily available. Labor would be available both on the Navajo Nation and in the regional market. Availability of on-highway haul trucks may be a limiting factor and increase project duration. Access to a sufficient volume of water for dust suppression is necessary, which would be obtained through construction of an onsite water well or imported.

Local sources of borrow material are enough to meet the needs for fill and topsoil for restoration after excavation. Riprap would need to be imported from Durango, Colorado, to meet engineering specifications for armoring drainage channels.

No future removal actions are anticipated. Long-term monitoring and maintenance would not be required; however, short-term maintenance of erosional controls and revegetation efforts would be required.

The Clean Harbors hazardous waste disposal facility is currently in compliance with its operating permit and with the CERCLA Off-Site Rule. Because all waste would be disposed of off site, reliance on the disposal capacity of the Clean Harbors facility brings uncertainty to the availability of services at the time of the removal action. A change to the disposal facility or additional disposal facilities could be selected in the action memorandum if necessary.

Administrative Feasibility – Coordination between USEPA, NNEPA, NAMLRD, and the State of New Mexico to address federal, state, and Navajo ARARs would be easily implemented. Federal, state, tribal, and local permits for onsite actions under CERCLA are not required. Environmental reviews may be required from the Navajo Nation and would be easily implemented. Finally, negotiations with the Navajo Nation or other landowners with potential offsite soil borrow sources would need to be conducted and agreements crafted.

Offsite disposal of materials from a CERCLA site must comply with the CERCLA Off-Site Rule. The Clean Harbors hazardous waste disposal facility currently has approval under the Off-Site Rule and would need to maintain such approval.

The entity responsible for the short-term surveillance of site restoration features would maintain various plans and conduct periodic inspections and reviews, including a SWPPP overseen by NNEPA (to verify that restoration is protective of surface water quality).

4.3.8.3 Costs

Overall, Alternative 4 has the highest costs of all the alternatives because of trucking costs and facility disposal fees. Costs assume that all material above screening levels would be removed from the site and disposed of at a RCRA-permitted facility. The facility would be responsible for long-term operation and maintenance of the wastes it receives.

A breakdown of the major cost categories associated with implementing Alternative 4 for the Section 32 and 33 Mines is presented in Exhibit 19. Detailed cost estimates are provided in Appendix F, Table F-3.

Exhibit 19. Alternative 4 Cost Breakdown

Cost Component	Section 32 and 33 Mines
Excavated Surface Area (acres)	24
Excavated Volume (bank cubic yards)	67,000
Capital Costs	
Field Overhead and Oversight	$568,000
General Site Work	$73,000
Earthwork	$800,000
Transportation and Disposal	$25,443,200
Subtotal Direct Capital Costs	**$26,887,000**
Indirect Capital Costs	$3,596,000
Contingency Allowance (15%)	$4,572,450
Total Capital Costs	**$37,796,000**
Maintenance Costs	
Present Worth of 30 Years Maintenance at a Discount Rate of 3.5%	$1,091,000
Contingency Allowance (25%)	$272,800
Total Maintenance Costs	$1,364,000
Total Costs	**$36,419,000**

5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section presents the approach for the comparative analysis of alternatives and a summary of the analysis. The comparative analysis includes evaluation of the relative effectiveness, implementability, and cost between alternatives.

5.1 COMPARATIVE ANALYSIS APPROACH

The final step of the draft EE/CA is to conduct a comparative analysis of the removal action alternatives. This analysis will discuss each alternative's strengths and weaknesses relative to the other alternatives in achieving RAOs. An explanation of the evaluation and ranking criteria is presented in Section 4.3. Navajo Nation, supporting agency, and public acceptance will be evaluated after stakeholder comments have been received on the draft EE/CA.

5.2 SUMMARY OF COMPARATIVE ANALYSIS

All alternatives except Alternative 1 meet the threshold criterion of being protective of public health and the environment. Exhibit 20 presents a comparative rating of alternatives.

Exhibit 20. Comparative Rating of Alternatives

Alternative	Attainment of Threshold Criteria[a]	Effectiveness	Implementability	Cost Rating (Million)[b]
Alternative 1: No Action	Fail	Short-Term: Average Long-Term: Very Poor	Tech: Very Good Admin: Very Good	Very Good ($0)
Alternative 2: Consolidate and Cap All Waste at Onsite Repository	**Pass**	Short-Term: Good Long-Term: Good	Tech: Good Admin: Good	Very Good ($4.4)
Alternative 3: Disposal of All Mine Waste Off Site at Red Rocks Disposal Facility	**Pass**	Short-Term: Poor Long-Term: Very Good	Tech: Very Good Admin: Average	Average ($9.8)
Alternative 4: Disposal of All Mine Waste Off Site at a RCRA C or LLRW Facility	**Pass**	Short-Term: Very Poor Long-Term: Very Good	Tech: Very Good Admin: Good	Very Poor ($36.4)

Notes:
a Threshold criteria are (a) overall protection and (b) compliance with applicable or relevant and appropriate requirements.
b Estimated costs are net present value
Admin Administrative feasibility
LLRW Low-level radioactive waste
RCRA Resource Conservation and Recovery Act
Tech Technical feasibility

5.2.1 Effectiveness

Effectiveness comprises two threshold criteria (protection and compliance with ARARs) and includes short-term effectiveness (during removal action) and long-term effectiveness and permanence (after removal action).

5.2.1.1 Protection of Human Health and the Environment

All alternatives except Alternative 1 are protective of public health and the environment.

5.2.1.2 Compliance with ARARs

All alternatives would be performed in compliance with the federal, state, and Navajo Nation ARARs identified in Table 6.

5.2.1.3 Short-Term Effectiveness (during Removal Action)

Short-term effectiveness comprises four criteria (discussed below): protection of the community, protection of workers, environmental impacts, and time to meet RAOs. Overall short-term effectiveness is rated, **Good** for Alternative 2, **Poor** for Alternative 3, and **Very Poor** for Alternative 4.

Protection of the Community

Alternative 2 is rated **Good**. This alternative creates the least traffic and dust impacts to the community as truck traffic would only be increased on the main access road to transport equipment and construction materials for excavation and repository construction. No excavated waste would be hauled through the community. Dust impacts would be limited to the dirt haul road to the onsite repository with no impacts to the community. Fewer haul miles through the community would also result in less traffic accidents.

Alternative 3 (haul route to Red Rocks disposal facility in McKinley, New Mexico) is rated **Average**. Excavated waste from the Section 32 and 33 Mines will be hauled south on County Road 19 and then west on Ranch Road to Red Rocks Landfill, only passing through the Casamero Lake community. This alternative would lead to more traffic impacts to the Casamero Lake community than Alternative 2 because excavated waste would be hauled a longer distance (13 miles) through the community to the Red Rocks disposal facility.

Alternative 4 (haul route to RCRA-permitted facility in Deer Trail, Colorado) has the highest impact on traffic, largest increase in truck emissions, and largest increase in potential traffic accidents and fatalities. Dust impacts would occur along dirt haul roads. Excavated waste from the Section 32 and 33 Mines will be hauled on County Road 19, Interstate 40, and on state highways to an off-Navajo Nation disposal facility located 567 miles away. Alternative 4 is rated **Very Poor** because of the longer roundtrip distances to the disposal facilities and the greater potential impacts to communities.

Protection of Workers

Worker protection primarily involves radiation exposure, dust inhalation hazards, physical injury, and traffic accidents. All action alternatives involve the same degree of excavation work; therefore, all action alternatives have equal amounts of potential radiation exposure, potential dust inhalation hazards, and potential for injury to workers. However, Alternative 2 involves construction of a repository, which introduces an additional level of threat to workers because of additional handling activities and duration of exposure during consolidation and capping.

However, the risk associated with repository construction are greatly exceeded by risk associated with hauling waste off site.

The rate of traffic accidents and fatalities is proportional to the amount of hauling for that alternative. For the action alternatives, the total haul distance on all roadways for Alternative 2 is approximately 0.5 mile, Alternative 3 is 13 miles (disposal at Red Rocks disposal facility), and Alternative 4 is 567 miles (disposal at Clean Harbors hazardous waste facility). Risks associated with each alternative are addressed in Exhibit 21.

Exhibit 21. Potential Community Impacts from Trucking

Alternative	Transport Miles	Project Duration	Accident Injury Risk	Fatality Risk
Alternative 1: No Action	0	0	0	0
Alternative 2: Consolidate and Cap All Waste at Onsite Repository	15,405	4 to 5 months	Very Low (0.5 in 100)	Low (0.2 in 1,000)
Alternative 3: Disposal of All Mine Waste Off Site at Red Rocks Disposal Facility	134,660	4 to 5 months	Low (4.4 in 100)	Average (2 in 1,000
Alternative 4: Disposal of All Mine Waste Off Site at a RCRA C or LLRW Facility	5,832,180	15 to 18 months	Very High (1.51 accidents)	Very High (7 in 1,000)

Notes:
LLRW Low-level radioactive waste
RCRA Resource Conservation and Recovery Act

Environmental Impacts

Shorter haul distances and construction durations minimize the potential for construction-related environmental impacts to occur both on public roads and off road and in the construction areas that would require mitigation. These impacts may include residual track-out effects of soil and mud, noise, nuisance soil spills during waste hauling, sedimentation of local drainages, and harmful emissions. In addition, construction of a repository increases the amount of construction activities and, therefore, increases environmental impacts while offsite disposal increases fuel consumption and greenhouse gas emissions. Site inspections and maintenance activities are expected to have an impact on alternative environmental footprints. Exhibit 22 presents the environmental impacts of each alternative.

Environmental Metrics Analysis – A qualitative evaluation of environmental metrics for each action alternative was conducted. The metrics do not include post-removal site maintenance activities. The results are presented in Appendix E, Table E-1. Exhibit 22 presents the environmental impacts of the alternatives, including water use, greenhouse gas metrics, and a qualitative greenness score, for each alternative.

Exhibit 22. Environmental Impacts of Alternatives

Alternative	Estimated Diesel Use (gallon)	Miles Traveled[a]	Greenhouse Gas Emissions (metric ton CO2e)	Greenness Score[b]
Alternative 1: No Action	Low (0)	Low (0)	Low (0)	Very Good (48/48)
Alternative 2: Consolidate and Cap All Waste at Onsite Repository	Moderate (2,656)	Moderate (15,405)	Low (<1)	Good (28/48)
Alternative 3: Disposal of All Mine Waste Off Site at Red Rocks Disposal Facility	High (23,217)	High (134,660)	Moderate (200)	Average (21/48)
Alternative 4: Disposal of All Mine Waste Off Site at a RCRA C or LLRW Facility	Very High (1,005,548)	Very High (5.83 million)	Very High (10,400)	Very Poor (11/48)

Notes:
a Truckloads and mileage include mine waste, backfill, and water truckloads.
b The higher the greenness score, the less impact the alternative has on the environment. See Appendix E, Table E-2.
CO2e Carbon dioxide equivalent
LLRW Low-level radioactive waste
RCRA Resource Conservation and Recovery Act

Alternative 2 is rated **Good** because of the least amount of water used, least amount of species disturbance because of the shortest project durations, shorter haul distances that require less energy, and smaller greenhouse gas footprint than offsite hauling under Alternatives 3 and 4. However, Alternative 2 could limit future land uses because of the need to protect repository caps. Alternatives 3 and 4 are rated **Poor** and **Very Poor** because of the increased water use for dust control and species disturbance over moderate to very long project durations and moderate and to very large energy requirements and greenhouse gases produced by the truckloads of waste hauled off site to local and regional disposal facilities. Alternative 1 is rated **Very Good** as no removal action would be performed.

Time until Removal Action Objectives Are Achieved

A summary of the construction completion time for each alternative is presented in Exhibit 23. All action alternatives could be completed between 1 to 9 months. Alternatives 3 to 4 is limited by the number of trucks and the turnaround time for the haul trucks.

Exhibit 23. Construction Completion Time for Alternatives

Alternative	Construction Completion Time
Alternative 1: No Action	0 month
Alternative 2: Consolidate and Cap All Waste at Onsite Repository	4 to 5 months
Alternative 3: Disposal of All Mine Waste Off Site at Red Rocks Disposal Facility	4 to 5 months
Alternative 4: Disposal of All Mine Waste Off Site at a RCRA C or LLRW Facility	15 to 18 months

Notes:
LLRW Low-level radioactive waste
RCRA Resource Conservation and Recovery Act

5.2.1.4 Long-Term Effectiveness and Permanence (after Removal Action)

For all action alternatives, waste removal or containment from source areas would reduce the magnitude of residual risk to background levels for radionuclides. Noncancer hazards would be removed, and risk to ecological receptors would be reduced to levels below known effects concentrations and background levels. None of the alternatives reduce the toxicity, mobility, or volume through treatment.

Alternatives 3 and 4 are rated **Very Good** as sources of risk at the site would be removed and disposed of off the Navajo Nation. The cap and liner at the disposal facility would limit exposure pathways. Alternatives 3 and 4 would also allow for unrestricted future use of the site. Removing waste from the Navajo Nation eliminates the long-term surveillance requirements and long-term environmental footprints associated with the repositories under Alternative 2. Alternatives 3 and 4 would not require long-term site inspections or repairs but have increased possibility of traffic accidents in comparison to Alternative 2.

Alternatives 2 would consolidate all waste in a repository. Permanence of risk reduction would rely on the repository design standards to minimize long-term maintenance, but long-term surveillance of the repositories would still be required. Alternative 2 is rated **Good** and because the repository with the waste contained above ground will reduce potential infiltration from the sides.

Although the Alternative 2 repository is expected to be protective in both the short and long term, the ET cap will require a long-term maintenance and monitoring commitment. Replacement of repository components would not be required because their lifespan is indefinite, especially under a monitoring and maintenance regime. Over the long term, additional accidents and fatalities could also result from site inspections and repairs during long-term maintenance of the onsite repository cap. Alternative 2 would have an additional small energy and greenhouse gas footprint associated with annual maintenance inspections and maintenance over the 100-year maintenance duration.

Alternative 1 is rated **Very Poor** because no removal action would be performed. Human health risk may be partially reduced through increased awareness of risks, but no reduction in risk to the ecosystem would occur. Uncontrolled and untreated waste would remain and continue to be accessible by humans and animals and subject to potential migration to uncontaminated or less contaminated areas.

5.2.2 Implementability

Implementability comprises two criteria: (1) technical feasibility and availability of services and materials, and (2) administrative feasibility.

5.2.2.1 Technical Feasibility and Availability of Services and Materials

Action alternatives consist mainly of earthwork and material hauling. The alternatives are technically feasible with labor available through the local and regional markets and equipment and materials.

The action alternatives would be completed as a single phase, and no future remedial actions are anticipated. Short-term monitoring of site restoration features will occur under all action alternatives while long-term monitoring and maintenance, particularly the inspection and repair of erosional features and controls and revegetation, would be required for the repository. Experienced contractors, construction equipment, and materials are available within the region.

Alternatives 3 and 4 are both technically feasible to implement as all waste is removed from the Section 32 and 33 Mines. Therefore, Alternatives 3 and 4 are rated **Very Good.**

Alternative 2 is technically feasible to implement as waste is consolidated in an onsite repository. Design methods, construction practices, and engineering requirements are well documented and understood. However, more resources would be required than for Alternatives 3 and 4; therefore, Alternative 2 is rated **Good.**

Alternative 1 is rated **Very Good** as it is readily implementable and no construction is involved. Alternative 1 would not impact the ability to conduct removal or remedial actions in the future. No services or materials would be needed because no removal action would be performed.

5.2.2.2 Administrative Feasibility

Administratively, Alternative 4 is rated **Good** as the least amount of design, permitting, and approvals from and coordination with agencies is required because no on-Navajo Nation disposal would be involved. Post-remedy inspections, reviews, and land use controls would be limited in comparison with alternatives that involve constructed repositories. However, limitations and delays on waste acceptance at off-Navajo Nation facilities are possible because of the volume of waste or disposal facility permit limitations.

Alternative 3 is rated **Average** because of additional permitting requirement for the Red Rocks disposal facility.

Alternative 2 is rated **Very Good** as less design, permitting, and approvals from and coordination with agencies is required for onsite repository cap construction in comparison to Alternatives 3 and 4.

Alternative 1 is rated **Very Good** as taking no action is feasible.

5.2.2.3 Tribal, Supporting Agency Acceptance, and Community Acceptance

USEPA and NNEPA believe that Alternative 3 (dispose of all mine waste off site at Red Rocks disposal facility) has the highest likelihood of acceptance by the Navajo Nation, State of New Mexico, and Casamero Lake community. Community acceptance may be reduced by a 3- to 5-year delay for permitting, design, and facility construction and a 4- to 5-month waste hauling period with increased community disruption, noise, and haul truck traffic volume on local highways.

USEPA and NNEPA believe that Alternative 2 (consolidate and cap all waste in onsite repository) may not receive acceptance from the Navajo Nation and the local communities because it does not require removal of all wastes from the communities. Alternative 2 is more easily implementable (1 to 2 years of design and 1 to 2 months of hauling) and will have significantly lower community disruption, noise, and truck traffic impacts because of limited hauling of waste through the community than Alternative 3.

USEPA and NNEPA believe that Alternative 4 (dispose of all mine waste off site at a RCRA C or LLRW facility) might be acceptable to the Navajo Nation and the community because all waste would be removed from the community and approximately double the construction period and the associated community disruption, noise, and haul truck traffic because of the 3-day turnaround time and long roundtrip distance (up to 612 miles) to the RCRA C or LLRW disposal facility. Navajo Nation, State of New Mexico, and community acceptance will be further addressed through the public comment process.

Alternatives 2 and 3 would provide potential job opportunities during construction and short-term monitoring and maintenance. Alternative 2 would provide additional opportunities during the required long-term inspection and maintenance of the ET cap. Alternatives 3 and 4 would provide additional job opportunities for truck drivers hauling waste to the offsite disposal facilities. No long-term maintenance would occur under Alternatives 3 and 4.

Community input received during informal community meetings and workshops have identified concerns related to moving radioactive materials through the community, traffic, and safety of leaving the waste on site or placing the waste in the Red Rocks disposal facility. The following potential mitigations could address community concerns:

- Dust will be controlled using water during loading and on haul roads. Air monitoring will evaluate dust leaving the site to identify changes required, including applying more water or stopping work on a windy day.
- Before leaving the site, each truck will be inspected to ensure loads are covered and loose material has been cleaned and removed to avoid tracking material off site. Each truck will be scanned for radioactivity to safely pass through communities.
- Strict limits will be set for truck load volume and weight leaving the site to reduce damage to road surfaces.
- Protection will be achieved through a combination of time and distance. For example, the exposure from a truck passing by on a road or highway is lower as exposure time decreases with the truck's speed. Distance also minimizes exposure, where low levels of gamma activity from waste rock decrease rapidly when measuring from even several feet away.
- A traffic control plan will be prepared to control haul routes, haul times, and days and to identify and avoid locations of schools or other sensitive populations.
- An accident contingency plan will be prepared to plan for responding to a haul truck accident. Typically, an accidental spill of waste rock presents a smaller danger compared to an accident involving gasoline, propane, or other chemical. A waste rock spill can be quickly contained and cleaned up with a front-end loader and a gamma detector.
- Waste material will be transferred from trucks only at a controlled area at the Red Rocks disposal facility designed for material handling and with dust control and spill response

materials. Waste rock will not be mixed with other municipal waste. Dust will be controlled using water. Air monitoring will evaluate dust leaving the site to identify any changes required, including applying more water or stopping work on a windy day.

- Long-term risk to the community around the Red Rocks disposal facility is low because the disposal cell is isolated from the community, waste rock will be covered daily during operation, wastes will be closed with an engineered cap, and monitoring wells in shallow groundwater will detect any potential releases.

This EE/CA will be available to the public for a 30-day public comment period to give community members an opportunity to review and comment on the documents, especially the recommended alternative proposed in the EE/CA. During the public comment period, a public meeting will be held to present information contained in the EE/CA and to solicit questions and comments from the community. USEPA will coordinate scheduling and provide formal announcement of the public comment period and meeting. This process offers the community and other stakeholders the opportunity to provide input and comment for the USEPA to take into consideration when making decisions about the site cleanup.

5.2.3 Projected Costs

Exhibit 24 presents a summary of the cost for each alternative. Alternative costs are assigned a rating by comparing each alternative to the others based on 2022 price evaluations.

Present values, including maintenance costs, were calculated for each alternative using a baseline 10-year project duration for site restoration and 100-year cap project duration for onsite and regional repositories (required under UMTRCA 40 CFR § 192[d] Part A) (Alternatives 2 and 3, respectively) at a 7 percent discount rate as specified in USEPA (1993) guidance.

Exhibit 24. Alternative Costs and Ratings

Alternative	Capital Cost	Onsite Maintenance (Present Value at 7% Discount Rate)	Cost Rating	Total Estimated Cost (2022 Million Dollars)
1	$0	$0	$0	Very Good
2	$1.96 MM	$1.68 MM (100 years)	Very Good	$4.4 MM
3	$6.94 MM	$1.36 MM (30 years)	Average	$9.8 MM
4	$35.1 MM	$1.36 MM (30 years)	Very Poor	$36.4 MM

Note:
Higher cost alternatives rate lower in cost ratings, which is consistent with the rating scheme where high = less desirable.

Alternative 1 is the least expensive because no construction and maintenance costs are incurred and is rated **Very Good**. Alternative 2 costs are based on the overall costs for construction and 100-year maintenance of the onsite repository. Alternative 3 has a greater cost because of a hauling waste off site a distance at 13 miles and facility fees. Alternative 4 has the highest cost of because of the longest hauling distance at 567 miles. Overall, Alternative 2 is rated **Very Good**, Alternative 3 is rated **Average**, and Alternative 4 is rated **Very Poor**.

6.0 RECOMMENDED ALTERNATIVE

As required by NCP and described in USEPA (1993a) guidance, alternatives were evaluated individually against the following three broad criteria: effectiveness, implementability, and cost (see Section 4.3). Section 5.0 includes a comparative analysis evaluating the strengths and weaknesses of each alternative relative to the other alternatives with respect to the three criteria and in achieving RAOs.

For the Section 32 and 33 Mines, USEPA recommends Alternative 3 (dispose of all mine wastes at Red Rocks disposal facility). The primary elements of the recommended alternative are:

- Excavation of uranium mine waste from the Section 32 and 33 Mines to the cleanup goals
- Completion of permitting, design, and construction of the Red Rocks disposal facility, which is expected to take 3 to 5 years
- Transportation of the waste using the recommended Ranch Road haul route in covered trucks to the Red Rocks disposal facility over 4 to 5 months for disposal in a separate facility and disposal cell from the municipal landfill
- Site restoration by regrading, implementing erosion and stormwater controls, and amending and revegetating the area
- Preparation of a short-term monitoring and maintenance plan after the remedy is identified in the action memorandum
- Short-term monitoring and maintenance of the site restoration areas for 30 years
- Long-term monitoring and maintenance of the Red Rocks disposal facility, which would be the responsibility of the Northwest New Mexico Regional Solid Waste Authority supported by financial assurance bonding

The largest capital costs for Alternative 3 are excavation, transportation, and disposal of the mine wastes at the Red Rocks disposal facility. A Stennett analysis showed this alternative to be safe for disposal facility workers receiving waste under the parameters of the analysis (USACE 2022). RAOs and cleanup levels for surface soil, air, and radiation would be achieved at the completion of the remedy construction. A 10- to 30-year period of recovery would be needed to achieve site vegetative restoration, depending on precipitation patterns.

The total cost for Alternative 3 is estimated to be $9.8 million, which is 2.5 times as much as Alternative 2 (consolidate and cap all waste at onsite repository) and about 0.25 the cost of Alternative 4 (dispose of all mine waste at a RCRA C or LLRW facility).

All action alternatives are protective. Alternative 3 and Alternative 4 remove waste from the Casamero Lake community while the capped waste remains in the community in Alternative 2. Alternative 3 transports the waste 13 miles for disposal compared to 567 miles in Alternative 4. The shorter distance would produce significantly lower diesel exhaust emissions from long-haul transportation and also significantly reduce community disruption from noise and potential traffic accidents and fatalities.

USEPA and NNEPA expect that Alternative 3 will be more acceptable to the Navajo Nation and the local communities than Alternatives 1 and 2 because all waste would be removed from the site, resulting in unrestricted land use once vegetation is reestablished. All alternatives would provide job opportunities to the community during construction, waste hauling, and short-term maintenance while Alternative 2 and 3 would provide long-term inspection and maintenance job opportunities at on- and offsite repositories. Training programs would be used to develop job skills to allow the local community to participate in both short- and long-term construction and maintenance opportunities.

Though USEPA has identified a recommended alternative, USEPA will solicit input from Navajo Nation officials, regulators, chapter representatives, other stakeholders, and the community on this final EE/CA and recommended alternative during a public comment period. USEPA and NNEPA will hold a public meeting during the comment period to listen to input. USEPA will select a final removal action alternative after reviewing and considering all information submitted during the public comment period. Comments received at the public meeting and the final removal action alternative will be documented in an action memorandum. USEPA may modify the recommended alternative or select another alternative presented in this EE/CA based on new information or public comments. Therefore, interested parties are encouraged to review and comment on all of the removal action alternatives presented in this EE/CA. USEPA will carefully consider Navajo Nation Fundamental Law and Diné Lifeways in its restoration approach.

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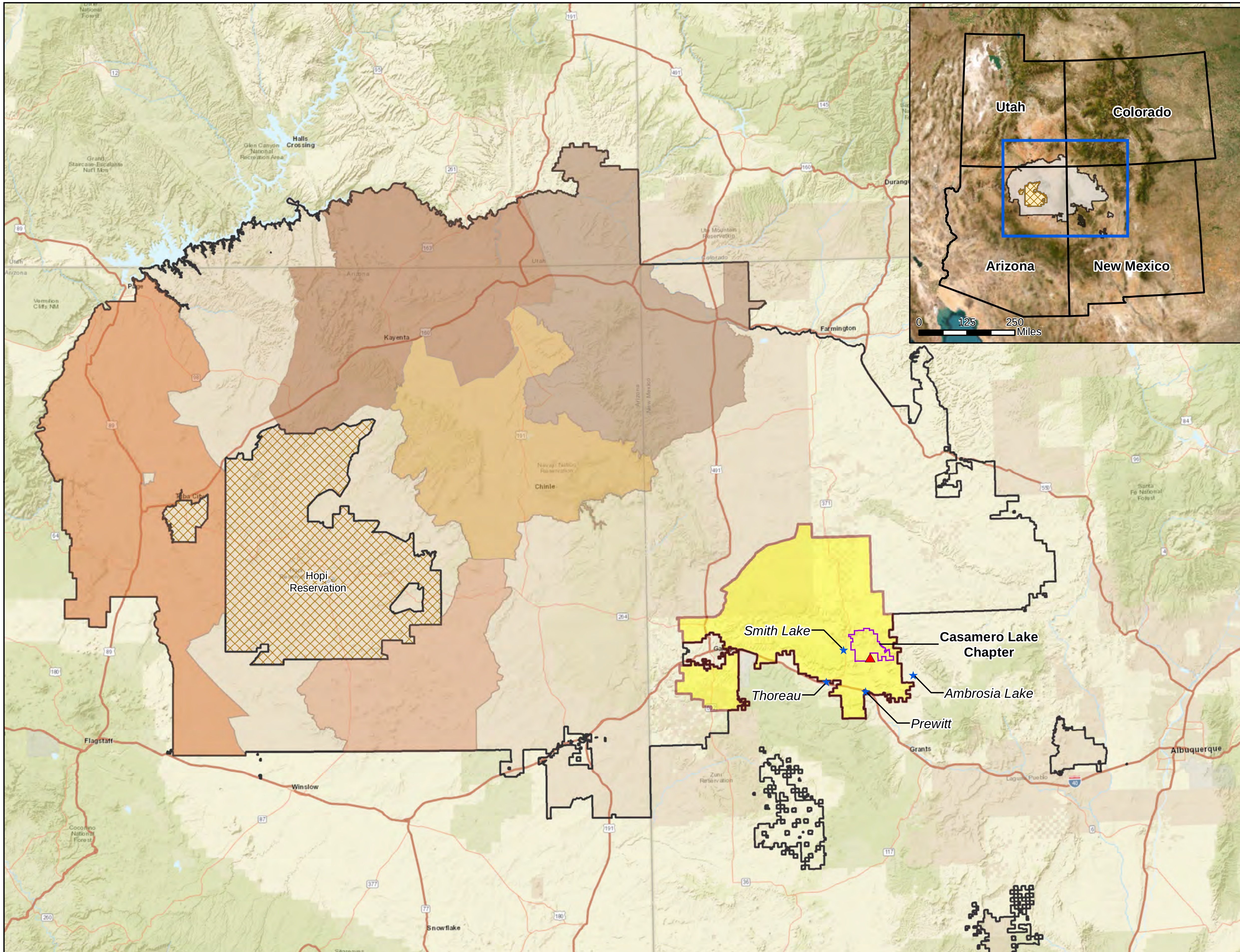
FIGURES



Populated Place

Section 32 / 33 Site Location

Affected Chapter Boundary

Navajo Nation Boundary

Hopi Reservation

Navajo Nation Abandoned Uranium Mine Regions

Eastern Region

Central Region

Northern Region

North Central Region

Southern Region

Western Region

1 inch = 25 miles

1:1,584,000

25 12.5 0 25 Miles

N W E S

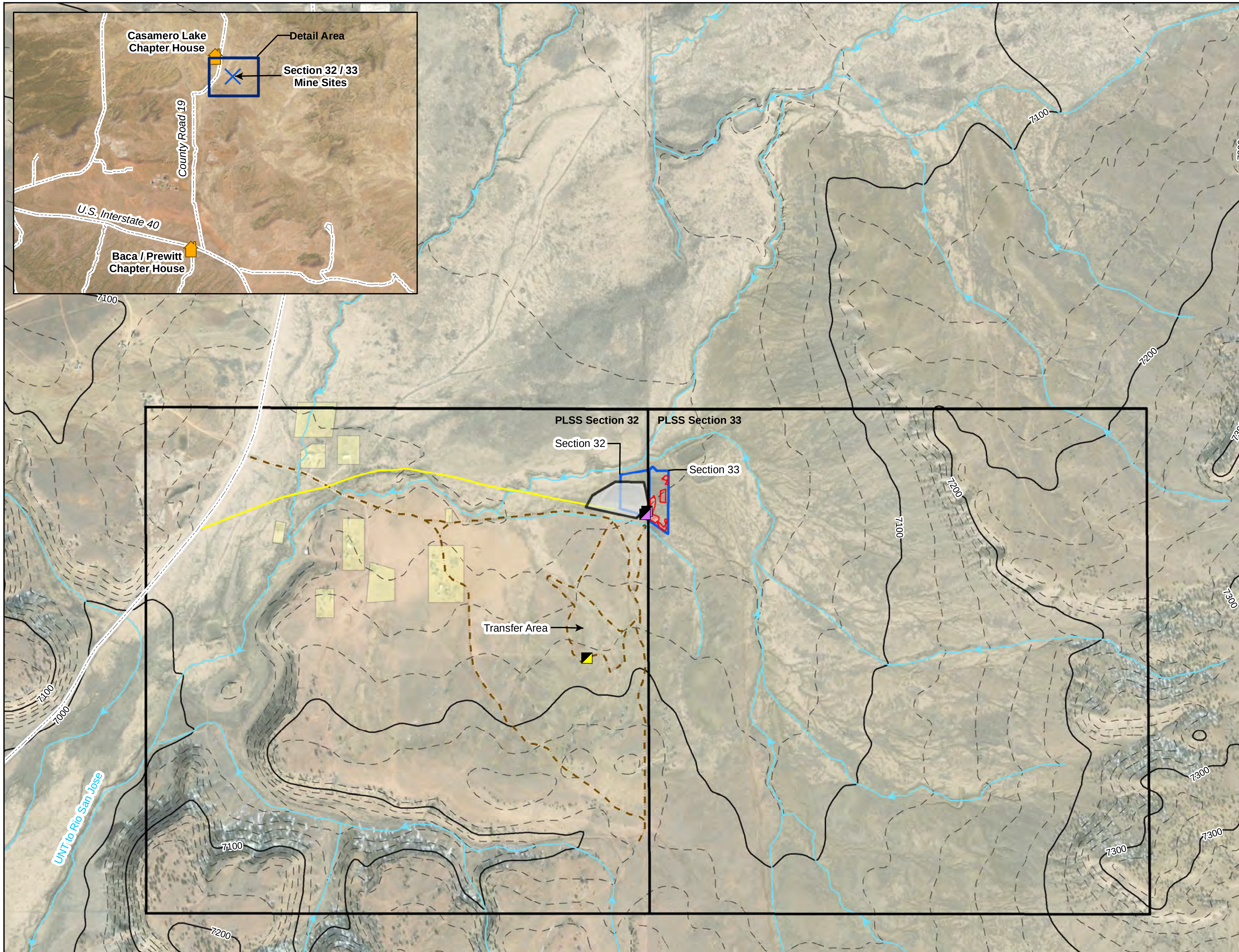
REGIONAL LOCATION

Prepared For: U.S. EPA Region 9

Prepared By:

TETRA TECH
1999 Harrison Street, Suite 500
Oakland, CA 94612

Task Order No.:	Contract No.:
0003	68HE0923D0002
Location: NAVAJO NATION	Date: 3/4/2024
Coordinate System: NAD 1983 UTM Zone 12N Transverse Mercator	Figure No.: 1



- 100-Foot Contour
- 20-Foot Contour
- Drainage
- Tronox AUM Site[1]
- PLSS Section Boundary / RSE Survey Area

Site Features

- Closed Mine Shaft
- Closed Mine Vent
- Historic Haul Road
- Residential Feature
- Waste Stockpile Footprint
- Waste Pile
- County Road
- Local Road

Notes:
[1] Boudary is from TSG (2007).

AUM	Abandoned uranium mine
PLSS	Public Land Survey System
RSE	Removal site evaluation
TSG	TerraSpectra Geomatics
UNT	Unnamed tributary

1 inch = 1,000 feet

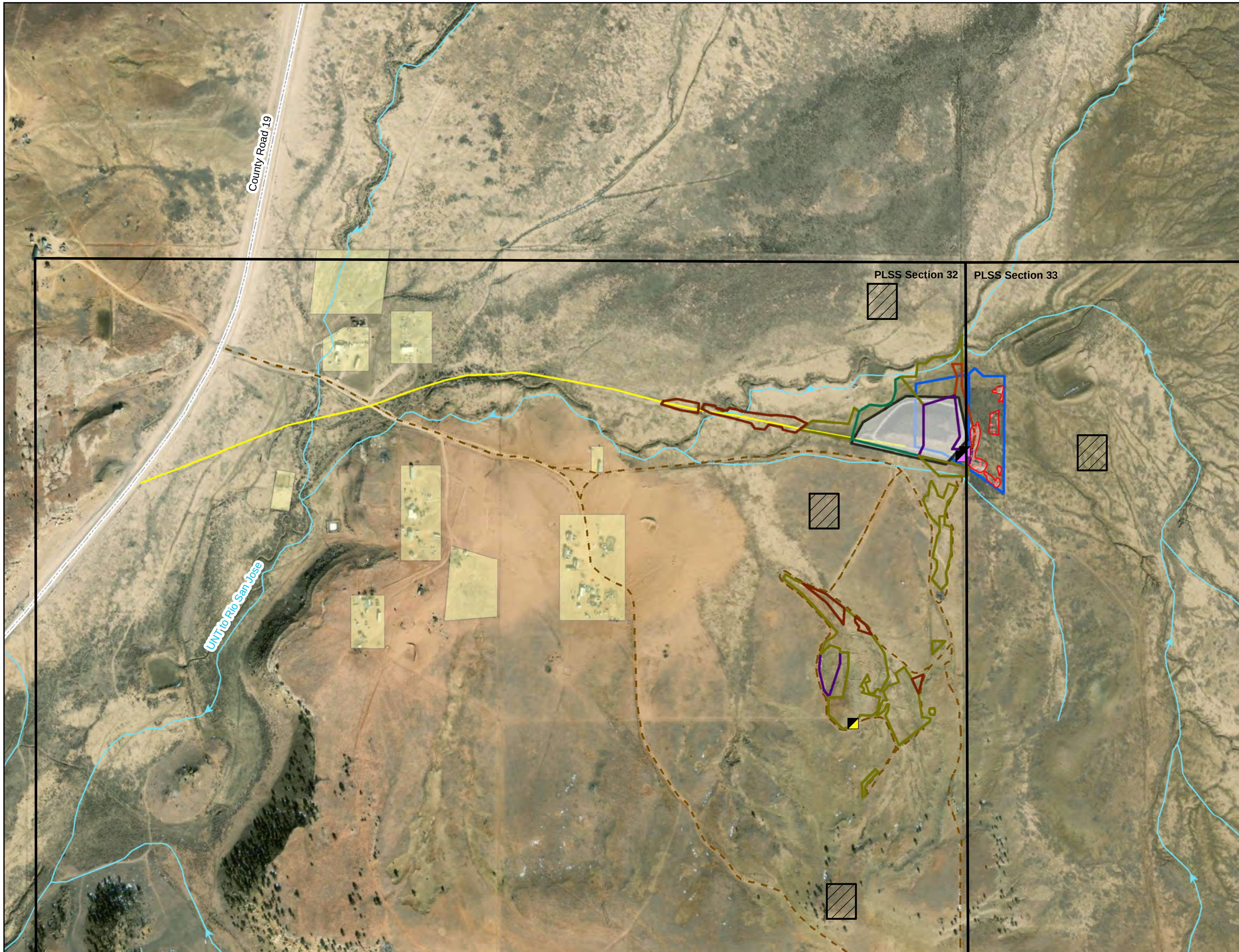
1:12,000

0 500 1,000 2,000 Feet

N W E S

SECTION 32 AND 33 MINES ACCESS

Prepared For: U.S. EPA Region 9	Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612
Task Order No.: 0003	Contract No.: 68HE0923D0002
Location: NAVAJO NATION	Date: 3/4/2024
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: 2



Site Features
- Closed Mine Shaft
- Closed Mine Vent
- Historic Haul Road
- Residential Feature
- Waste Stockpile Footprint
- Waste Pile

2012 Removal Action Areas

Excavation Depth (ft)
- 0.5 ft bgs
- 1 ft bgs
- 2 ft bgs
- 3 ft bgs
- 4 ft bgs
- Tronox AUM Site[1]
- Background Study Area
- PLSS Section Boundary / RSE Survey Area
- County Road
- Local Road
- Drainage

Notes:
[1] Boudary is from TSG (2007).

AUM	Abandoned uranium mine
bgs	Below ground surface
ft	Foot
PLSS	Public Land Survey System
RSE	Removal site evaluation
TSG	TerraSpectra Geomatics
UNT	Unnamed tributary

1 inch = 540 feet

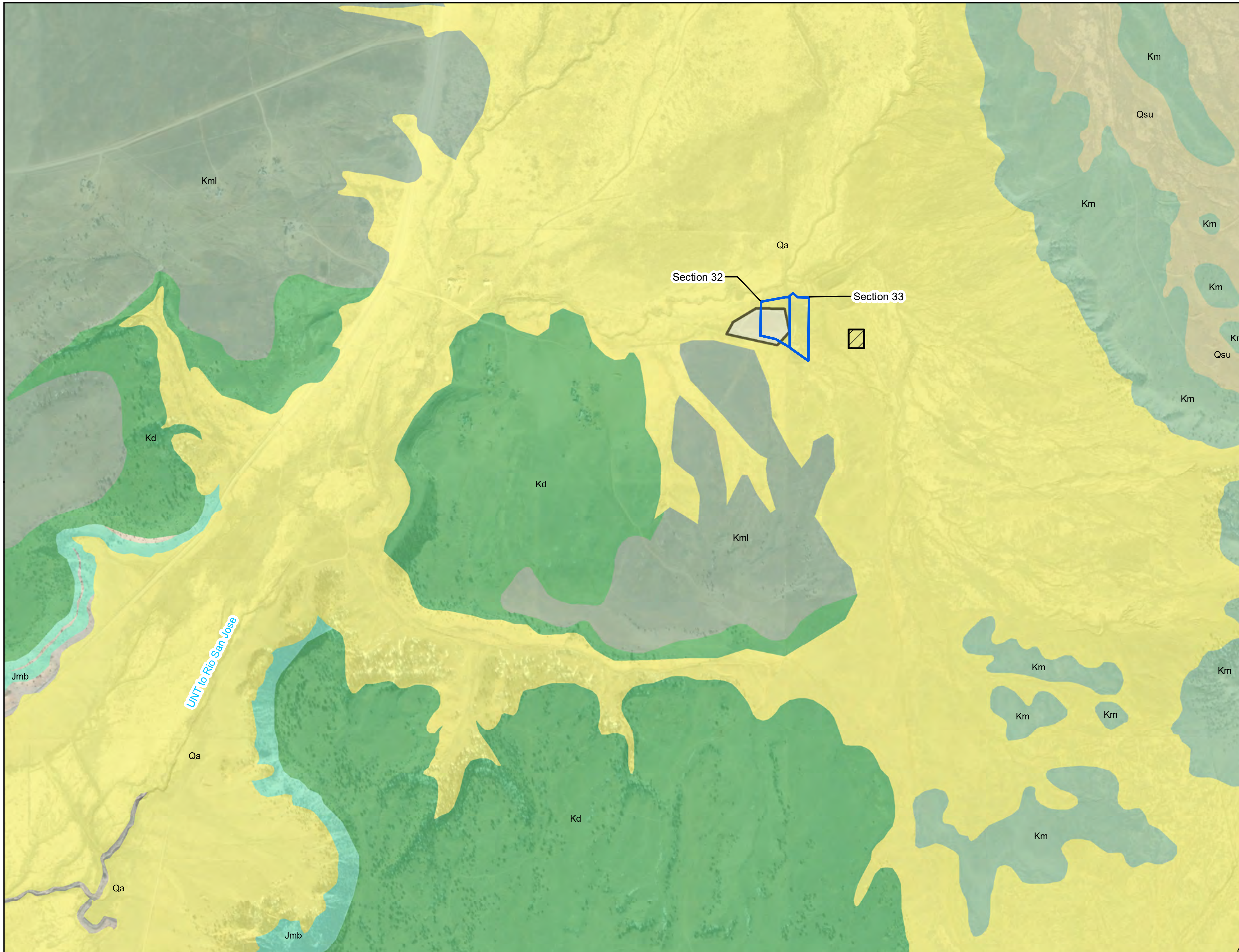
1:6,476

0 270 540 1,080 Feet

N W E S

SECTION 32 AND 33 MINES
SITE FEATURES

Prepared For: U.S. EPA Region 9	Prepared By: TETRA TECH, 1999 Harrison Street, Suite 500, Oakland, CA 94612
Task Order No.: 0003	Contract No.: 68HE0923D0002
Location: NAVAJO NATION	Date: 3/4/2024
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: 3



Geologic Units

Surficial Deposits

- Qa—Quaternary Alluvium
- Qsu—Upland Deposits

Cretaceous

- Km—Main body of Mancos Shale
- Kml—Lower part of Mancos Shale
- Kd—Dakota Sandstone

Jurassic

- Jmb—Brushy Basin Member of Morrison Formation
- Tronox AUM Site[1]
- Waste Stockpile Footprint
- Background Study Area

Notes:

[1] Boudary is from TSG (2007).

AUM Abandoned uranium mine

TSG TerraSpectra Geomatics

UNT Unnamed tributary

1 inch = 1,000 feet

1:12,000

N S E W

0 500 1,000 2,000 Feet

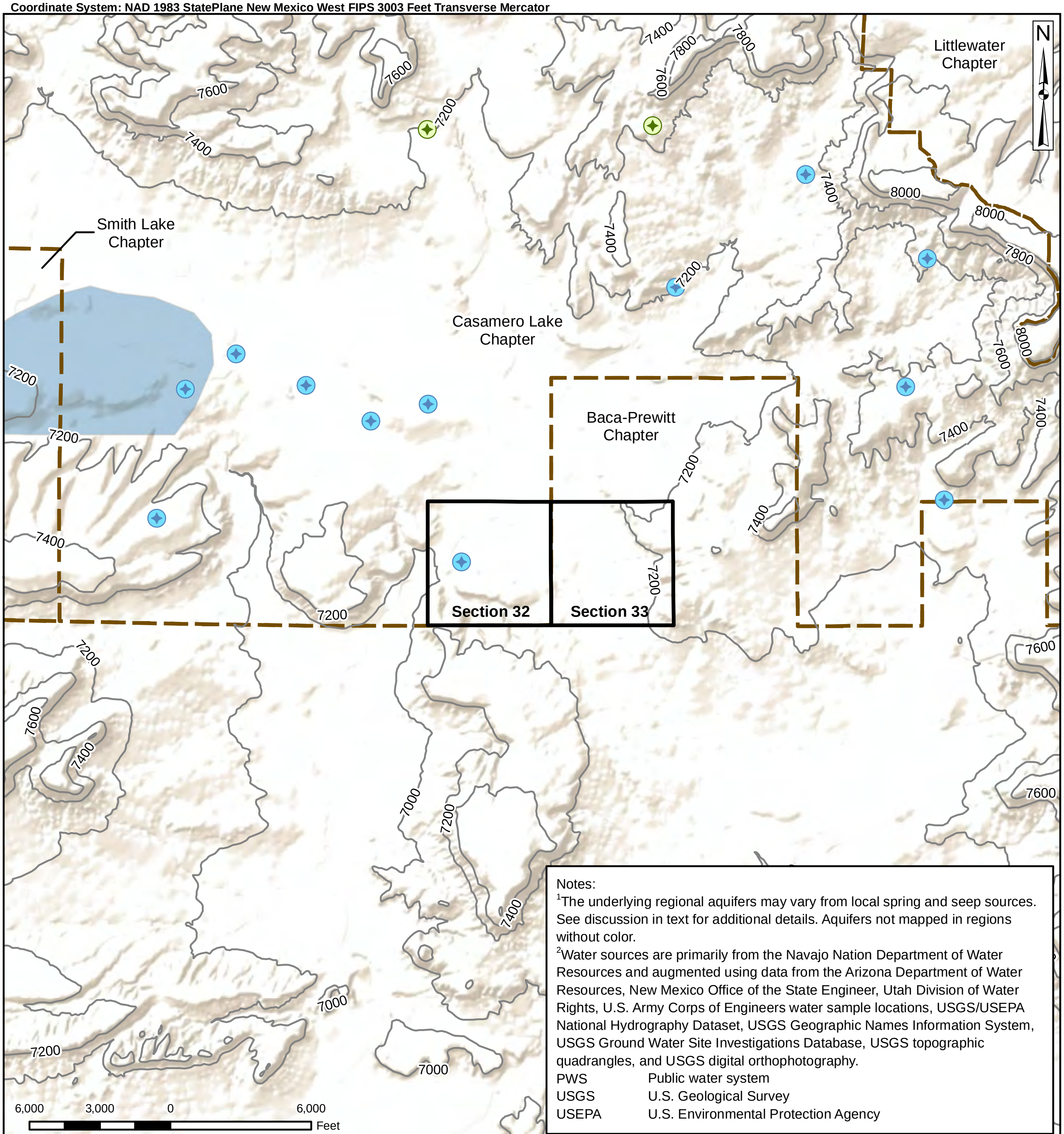
SECTION 32 AND 33 MINES GEOLOGY

Prepared For: U.S. EPA Region 9

Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612

Task Order No.: 0003	Contract No.: 68HE0923D0002
Location: NAVAJO NATION	Date: 3/4/2024
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: 4

Coordinate System: NAD 1983 StatePlane New Mexico West FIPS 3003 Feet Transverse Mercator



Notes:
[1]The underlying regional aquifers may vary from local spring and seep sources. See discussion in text for additional details. Aquifers not mapped in regions without color.
[2]Water sources are primarily from the Navajo Nation Department of Water Resources and augmented using data from the Arizona Department of Water Resources, New Mexico Office of the State Engineer, Utah Division of Water Rights, U.S. Army Corps of Engineers water sample locations, USGS/USEPA National Hydrography Dataset, USGS Geographic Names Information System, USGS Ground Water Site Investigations Database, USGS topographic quadrangles, and USGS digital orthophotography.

PWS	Public water system
USGS	U.S. Geological Survey
USEPA	U.S. Environmental Protection Agency

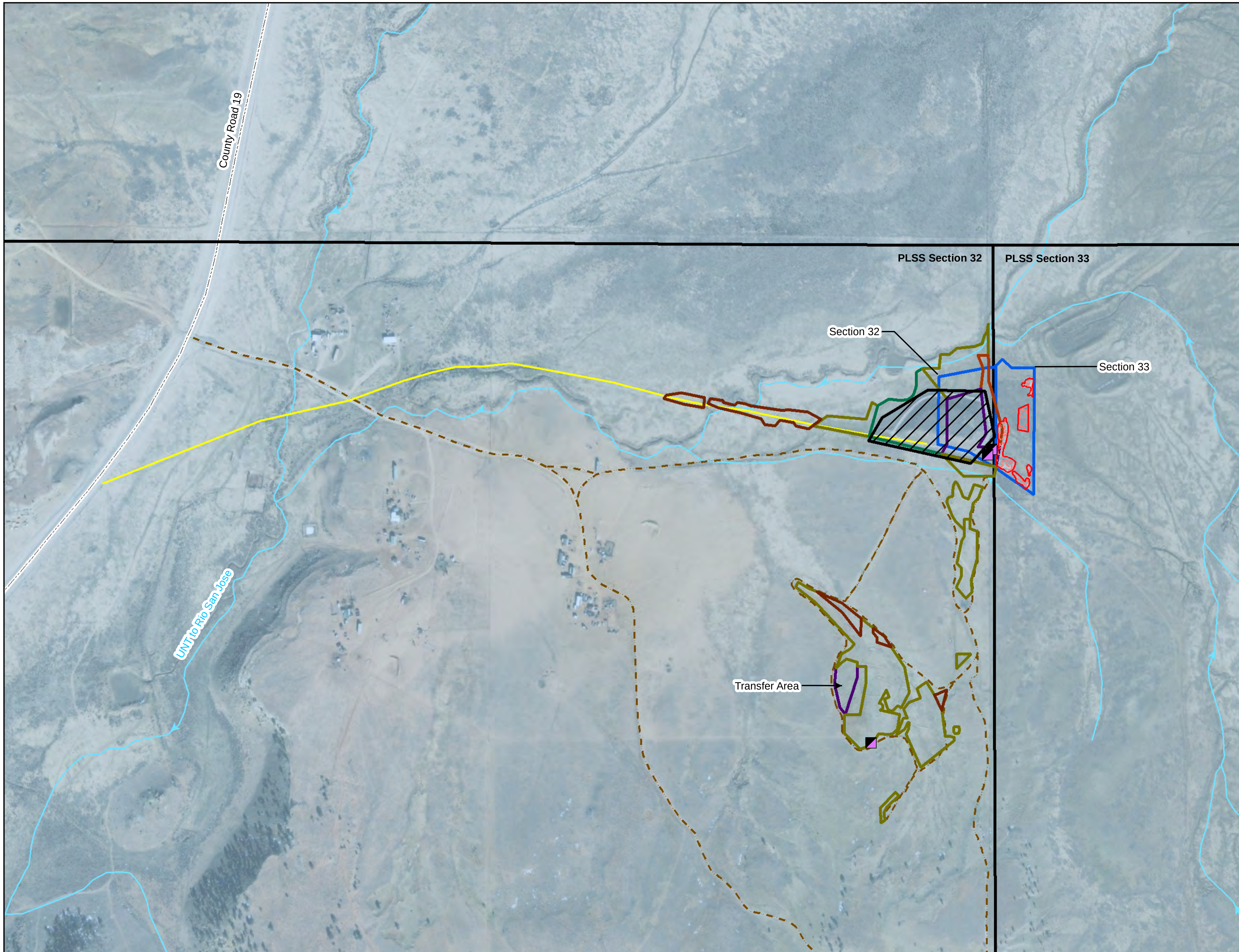
D Aquifer[1]
PWS Well Location[2]
Non-PWS Well Location[2]
PLSS Section Boundary / RSE Survey Area
Navajo Nation Chapter Boundary
200 ft Contour Surface

Prepared for: U.S. EPA Region 9

Prepared By: TETRA TECH, 1999 Harrison Street, Suite 500, Oakland, CA 94612

REGIONAL AQUIFERS AND WELLS

Task Order No.:	Contract No.:	Figure No.:
003	68HE0923D0002	5
Location:	Date:	
NAVAJO NATION	7/6/2022	



Land Use Type - Full-Time Residential
Tronox AUM Site[1]
PLSS Section Boundary / RSE Survey Area
County Road
Local Road
Drainage

Site Features

Closed Mine Shaft
Historic Haul Road
Waste Stockpile Footprint
Waste Pile

2012 Removal Action Areas

Excavation Depth (ft)

0.5 ft bgs
1 ft bgs
2 ft bgs
3 ft bgs
4 ft bgs

Notes:

[1] Boudary is from TSG (2007).

AUM	Abandoned uranium mine
bgs	Below ground surface
ft	Foot
PLSS	Public Land Survey System
RSE	Removal site evaluation
TSG	TerraSpectra Geomatics
UNT	Unnamed tributary

1 inch = 500 feet

1:6,000

0 250 500 1,000 Feet

N S E W

SECTION 32 AND 33 MINES
PROPOSED FUTURE LAND USE

Prepared For: U.S. EPA Region 9

Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612

Task Order No.: 003

Contract No.: 68HE0923D0002

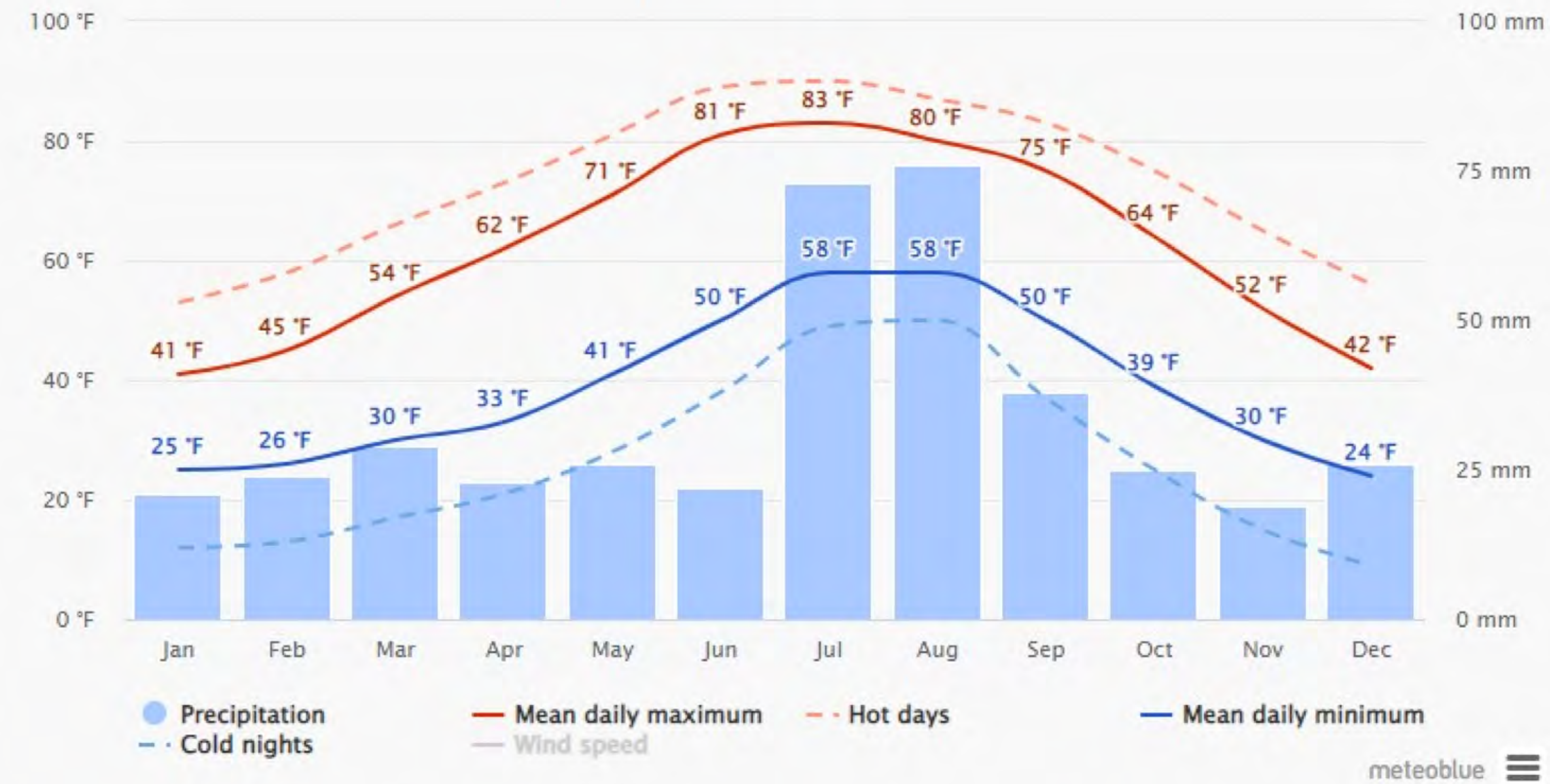
Location: NAVAJO NATION

Date: 6/7/2023

Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse

Figure No.: 6

Average temperatures and precipitation



Unofficial values based on averages/sums of smoothed daily data. Information is computed from available daily data during the 1973-2016 period. Smoothing, missing data, and observation-time changes may cause these 1973-2016 values to differ from official National Climatic Data Center (NCDC) values. This table is presented for use at locations that don't have official NCDC data. No adjustments were made for missing data or time of observation.

Data taken from https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/thoreau_united-states_5494395

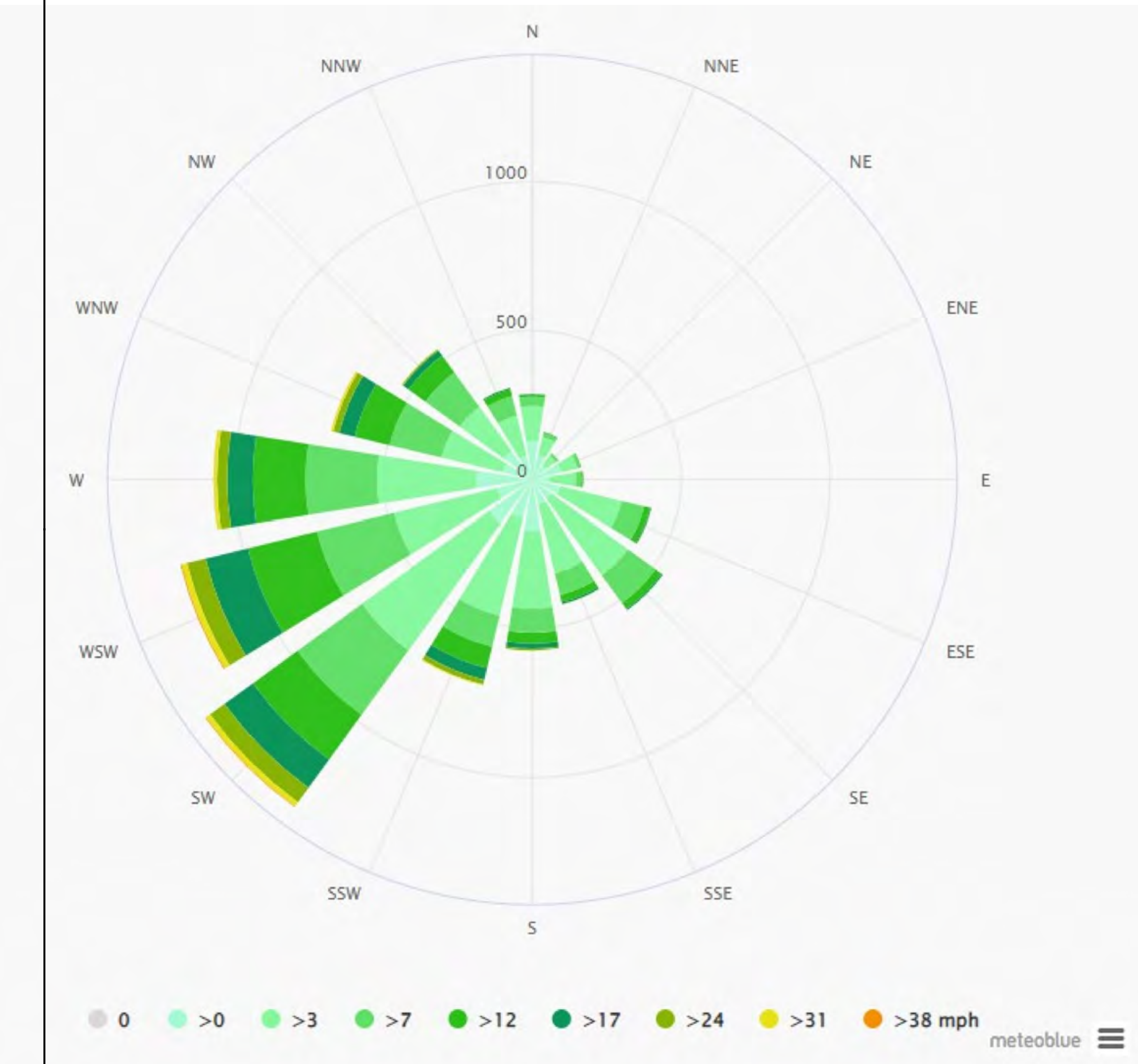
Prepared for: U.S. EPA Region 9

THOREAU, NEW MEXICO
AVERAGE MONTHLY PRECIPITATION, SNOWFALL, AND TEMPERATURE

Prepared By: TETRA TECH

Task Order No.:	Contract No.:	Figure No.:
TO0003	68HE0923D0002	7
Location: NAVAJO NATION	Date: 7/22/2020	

Date Saved: 11/1/2022



Source: https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/thoreau_united-states_5494395

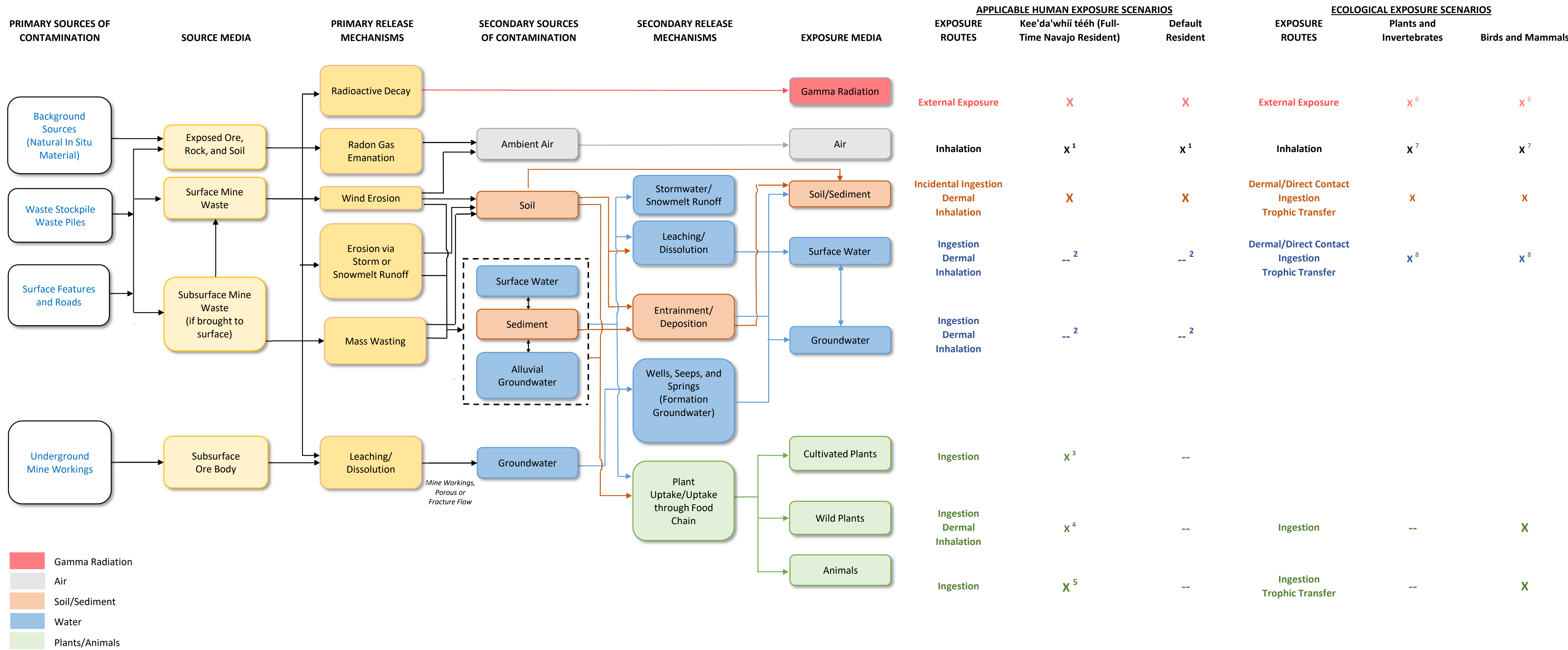
Prepared for: U.S. EPA Region 9

Prepared By:

TETRA TECH
1999 Harrison Street, Suite 500
Oakland, CA 94612

THOREAU, NEW MEXICO
WIND ROSE DIAGRAM

Task Order No.:	Contract No.:	Figure No.:
TO0003	68HE0923D0002	8
Location: NAVAJO NATION	Date: 10/21/2022	



Notes:

X Indicates the exposure pathway is potentially complete and is evaluated in the risk assessment except as noted.

-- Indicates the exposure pathway is not complete or *de minimis* and is not evaluated in the risk assessment

[1] The human health risk evaluation does not include inhalation of radon by humans or animals. Because radon is a gas and readily disperses in outdoor air, the risk in outdoor air is minimal. Radon in indoor air is a potential risk for future residential receptors; however, radon exposure is building-specific and the buildings are not currently present and, thus, cannot be evaluated. Furthermore, because radon is a known risk in the area, any future buildings would likely be constructed to mitigate this known risk.

[2] The human health risk evaluation does not include ingestion of surface water or groundwater by humans or animals. Safe drinking water is supplied to residents in the area. Wells used for livestock have been tested and are upgradient of the known groundwater contamination in the area.

[3] The human health risk evaluation includes ingestion of select cultivated plants (crops) by this receptor. Scenario inputs were provided by the Navajo Nation Environmental Protection Agency (NNEPA) (2021).

[4] The human health risk evaluation includes ingestion, dermal (metals only), and inhalation of select wild herbs and medicinal plants by this receptor. Scenario inputs were provided by NNEPA (2021).

[5] The human health risk evaluation includes ingestion of home-raised animals (meat, milk, and eggs) and hunted animals (meat only) for this receptor. Scenario inputs were provided by NNEPA (2021).

[6] The ecological risk evaluation includes evaluation of external radiation based on exposure to gamma-emitting radionuclides from contaminated soil and evaluation of internal radiation through plant uptake, incidental soil ingestion, and food web uptake (Los Alamos National Laboratory [LANL] 2015).

[7] Potential exposures include inhalation of ambient air and air in burrows and underground mines. The ecological risk evaluation does not include evaluation of the inhalation pathway.

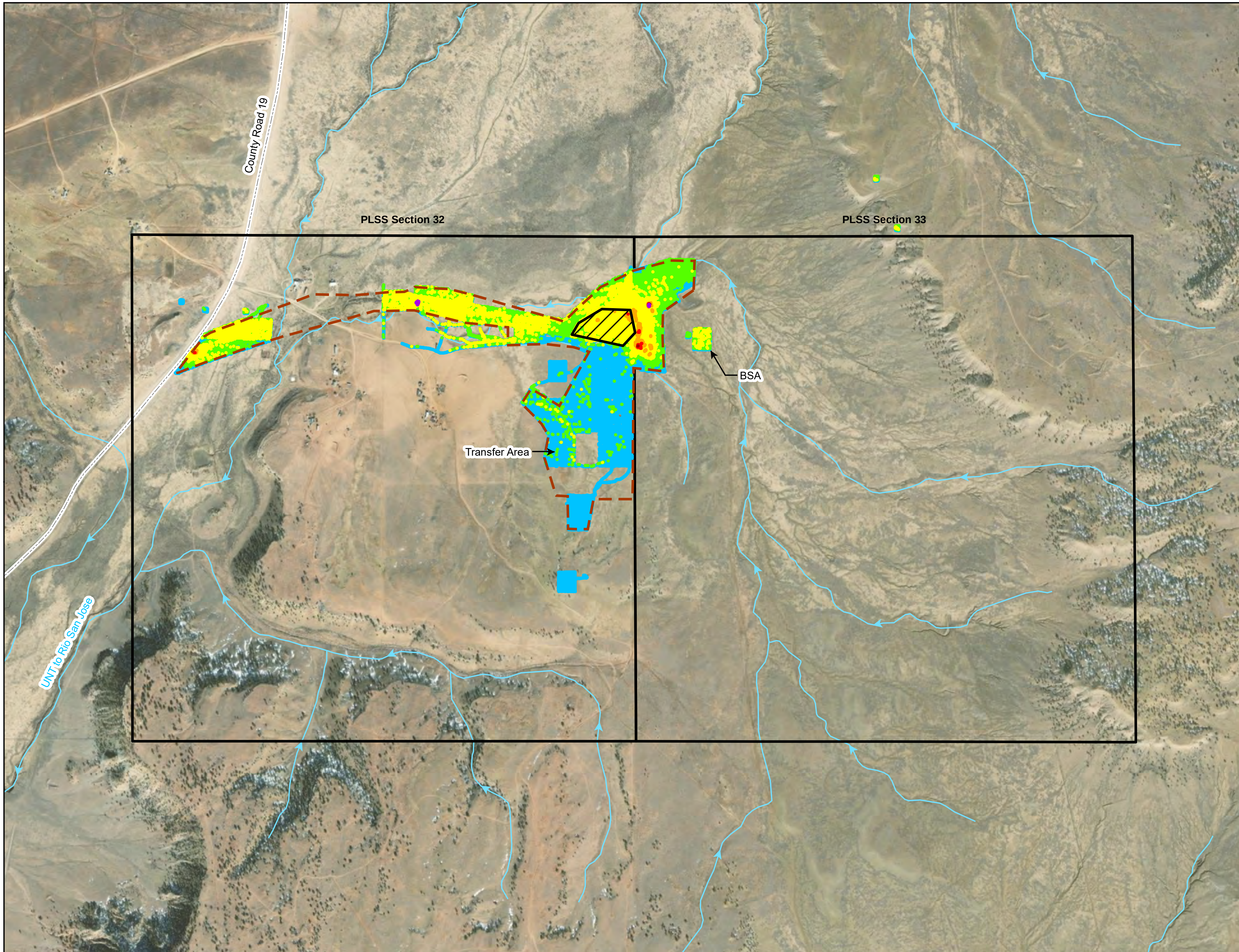
[8] The ecological risk evaluation does not include evaluation of direct contact with or ingestion of surface water.

References:

Los Alamos National Laboratory (LANL). 2015. “Screening-Level Ecological Risk Assessment Methods.” Revision 4. EP2015-0174. October 29.

Navajo Nation Environmental Protection Agency (NNEPA). 2021. "Navajo Tribe Provisional Reasonable Maximum Exposures RME for the Navajo Risk Assessments." Draft. September 15.

Figure 9. Section 32 and 33 Mines Risk Assessment Conceptual Site Model



Gamma Exposure Rate (μR/hr)

≤ 17.8	≤ UCL
17.8 - 18.8	UCL - BTV[1]
18.8 - 35.6	BTV - 2 x UCL
35.6 - 53.4	2 x UCL - 3 x UCL
53.4 - 71.2	3 x UCL - 4 x UCL
71.2 - 89.0	4 x UCL - 5 x UCL
> 89.0	> 5 x UCL

TENORM Boundary

Waste Stockpile Footprint

PLSS Section Boundary / RSE Survey Area

Note:

[1]BTV is based on the 95 percent upper tolerance limit with 95 percent coverage of the background dataset.

μR/hr	Microroentgen per hour
BSA	Background survey area
BTV	Background threshold value
PLSS	Public Land Survey System
RSE	Removal site evaluation
TENORM	Technologically enhanced naturally occurring radioactive material
UCL	95 percent upper confidence limit on the mean of the background dataset
UNT	Unnamed tributary

1 inch = 1,000 feet

1:12,000

1,000 500 0 1,000 Feet

N W E S

SECTION 32 AND 33 MINES GAMMA RADIATION SURVEY

Prepared For: U.S. EPA Region 9

Prepared By: TETRA TECH, 1999 Harrison Street, Suite 500, Oakland, CA 94612

Task Order No.: 0003

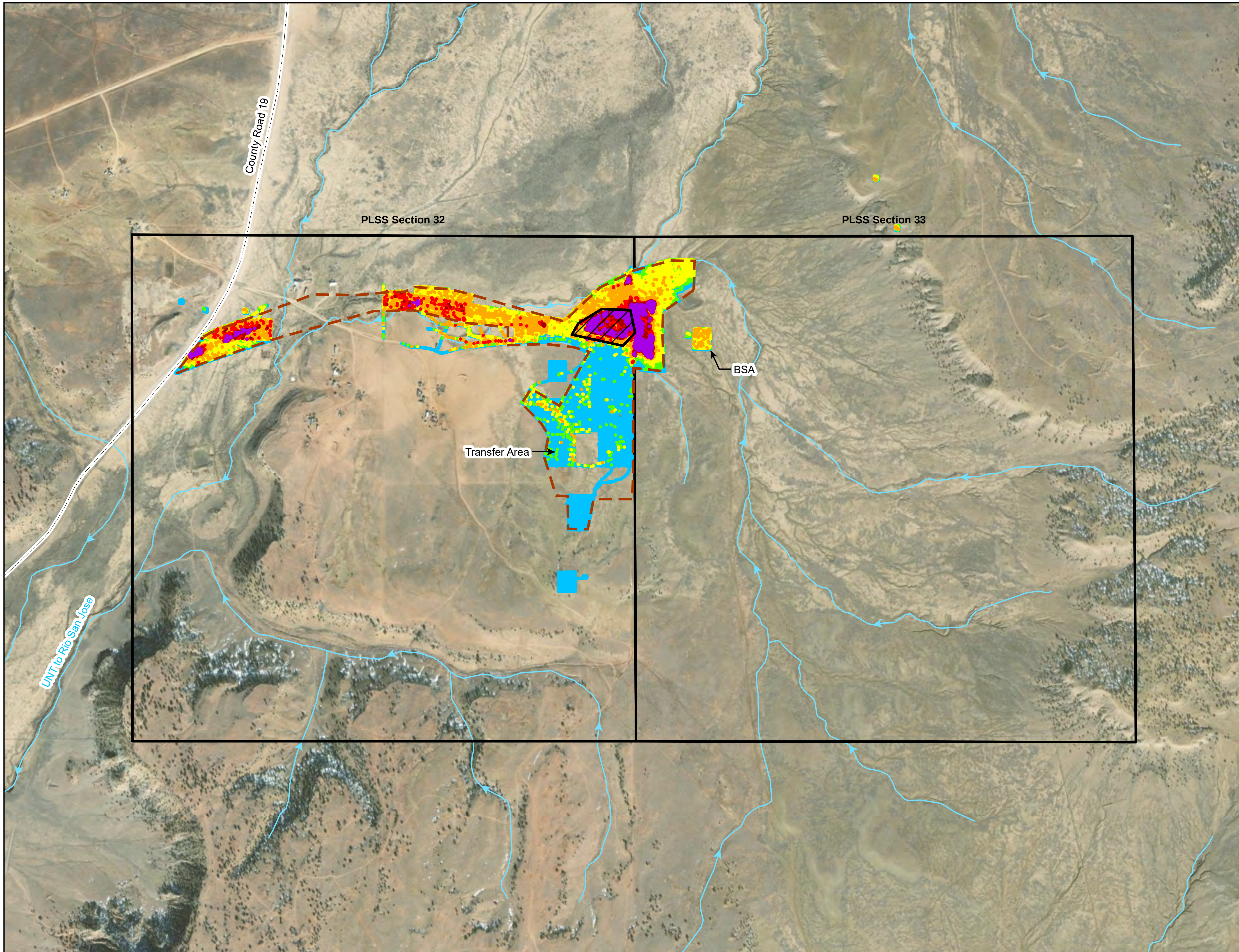
Contract No.: 68HE0923D0002

Location: NAVAJO NATION

Date: 3/14/2024

Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse

Figure No.: 10



Estimated Radium-226 (pCi/g)[1]

≤ 1.66	≤ UCL
1.66 - 1.92	UCL - BTV (RAG)[2, 3]
1.92 - 3.32	BTV - 2 x UCL
3.32 - 4.98	2 x UCL - 3 x UCL
4.98 - 6.64	3 x UCL - 4 x UCL
6.64 - 8.30	4 x UCL - 5 x UCL
> 8.30	> 5 x UCL

TENORM Boundary

Waste Stockpile Footprint

PLSS Section Boundary / RSE Survey Area

Notes:

[1]The estimated radium-226 was generated using a hybrid gamma-radium model (Model 3).

[2]BTV is based on the 95 percent upper tolerance limit with 95 percent coverage of the background dataset.

[3]The RAG is equal to the BTV because the BTV is greater than the HH PRGs and NAUM PERG.

BSA	Background sruvey area
BTV	Background threshold value
HH	Human health
pCi/g	Picocurie per gram
PERG	Preliminary ecological removal goal
PLSS	Public land survey system
PRG	Preliminary removal goal
RAG	Removal action goal
RSE	Removal site evaluation
TENORM	Technologically enhanced naturally occurring radioactive material
UCL	95 percent upper confidence limit on the mean of the background dataset
UNT	Unnamed tributary

1 inch = 1,000 feet

1:12,000

N W E S

1,000 500 0 1,000 Feet

SECTION 32 AND 33 MINES ESTIMATED RADIUM-226 SURFACE SOIL CONCENTRATIONS

Prepared For: U.S. EPA Region 9

Prepared By: TETRA TECH
1999 Harrison Street, Suite 500
Oakland, CA 94612

Task Order No.: 0003

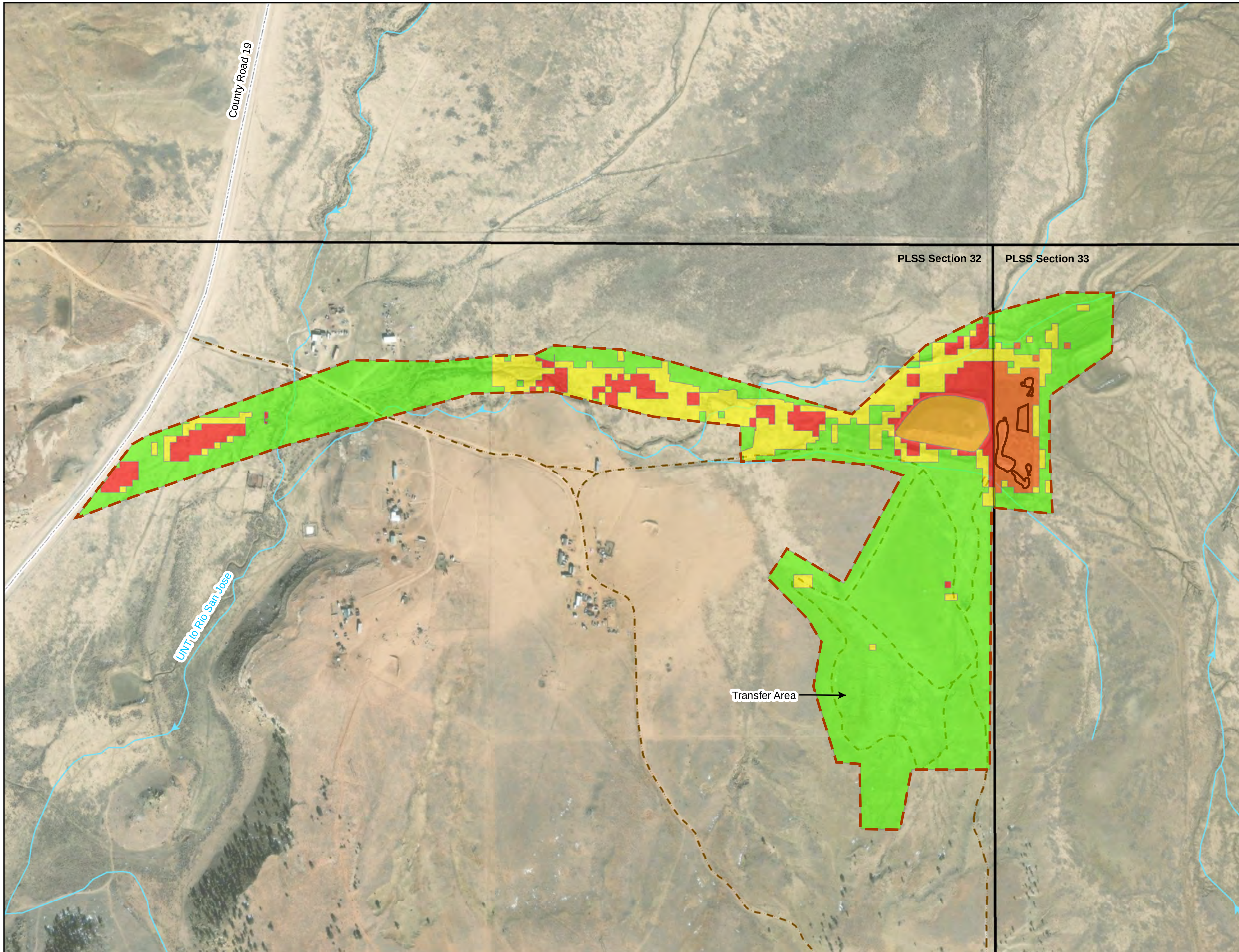
Contract No.: 68HE0923D0002

Location: NAVAJO NATION

Date: 3/14/2024

Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse

Figure No.: 11



Proposed Removal Action Extent

- Excavation - Section 32
- Excavation - Section 33
- Excavation - Waste Stockpile
- Excavation - 20% Additional Assumed
- No Cleanup
- TENORM Boundary
- PLSS Section Boundary / RSE Survey Area
- Waste Stockpile
- Waste Pile
- County Road
- Local Road
- Drainage

Notes:

PLSS	Public land survey system
RSE	Removal site evaluation
TENORM	Technologically enhanced naturally occurring radioactive material
UNT	Unnamed tributary

1 inch = 500 feet

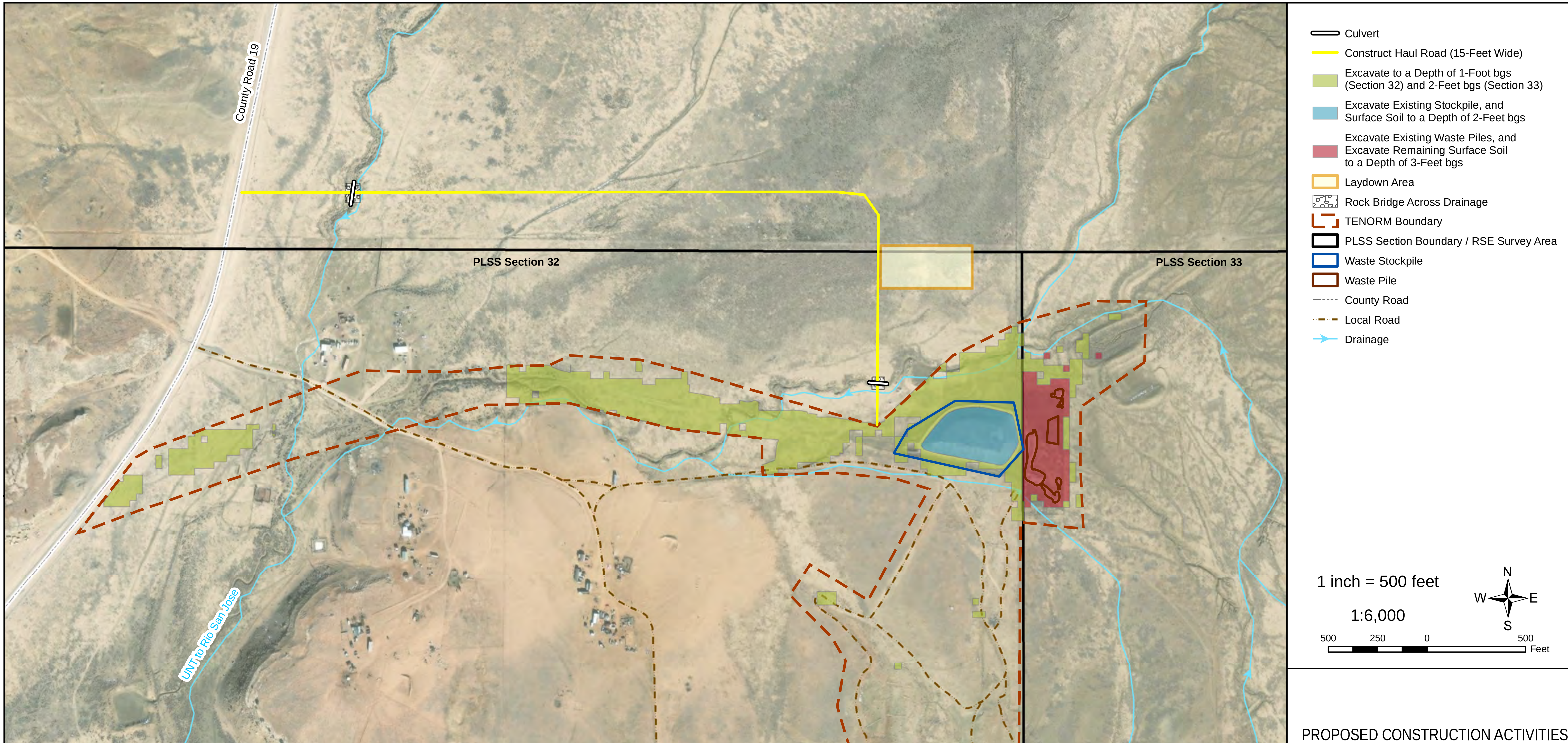
1:6,000

500 250 0 500 Feet

N W E S

SECTION 32 AND 33 MINES
PROPOSED REMOVAL ACTION EXTENT

Prepared For: U.S. EPA Region 9	Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612
Task Order No.: 0003	Contract No.: 68HE0923D0002
Location: NAVAJO NATION	Date: 3/14/2024
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: 12



Removal Category	Surface Area (ft^2)	Surface Area (Acres)	Excavation Depth (ft)	Estimated Volume (CY)
Section 33 Waste Piles	27,702	0.64	3	3,078
Section 33 Class 1 Remainder	122,380	2.81	2	9,065
Section 33 Class 2	52,831	1.21	1	1,957
Section 32 Stockpile	104,084	2.39	2	40,913
Section 32 Class 1	255,769	5.87	1	9,473
Section 32 Class 2	454,616	10.44	1	3,368
Totals	1,017,382	23.36	-	67,854

Notes:

bgs	Below ground surface
CY	Cubic yard
ft	Foot
ft^2	Square foot
PLSS	Public land survey system
RSE	Removal site evaluation
TENORM	Technologically enhanced naturally occurring radioactive material
UNT	Unnamed tributary

PROPOSED CONSTRUCTION ACTIVITIES

Prepared For: U.S. EPA Region 9

Prepared By: TETRA TECH, 1999 Harrison Street, Suite 500, Oakland, CA 94612

Task Order No.: 0003

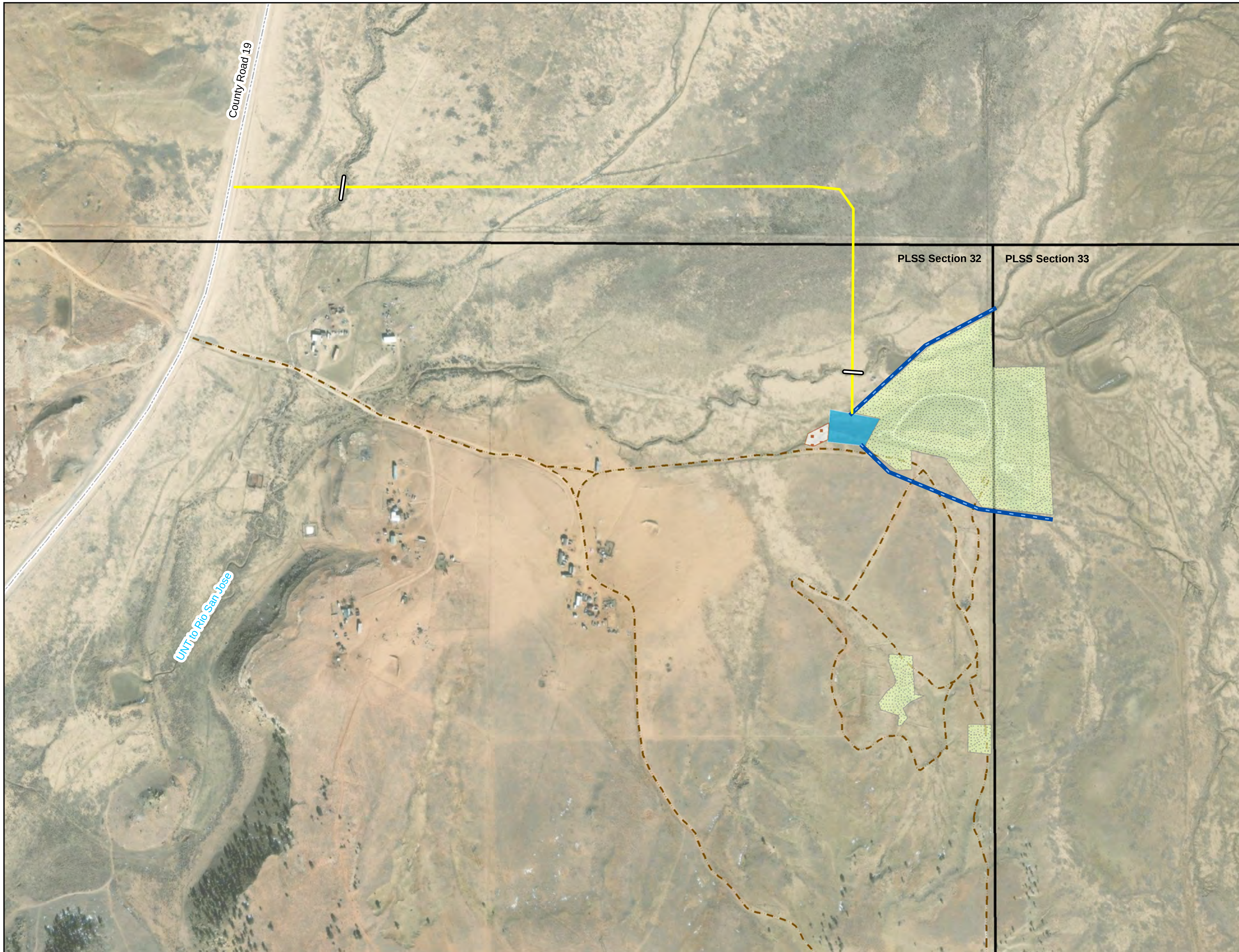
Contract No.: 68HE0923D0002

Location: NAVAJO NATION

Date: 3/14/2024

Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse

Figure No.: 13



Obliterate Haul Road After 10 Years (Pull Up Material, Grade, and Revegetate)
Remove Culvert
Rock-Lined Drainage Channel
Grade with Positive Drainage and Hydroseed
Rock Outfall
Sediment / Water Detention Basin
PLSS Section Boundary / RSE Survey Area
County Road
Local Road
Drainage

Notes:

PLSS	Public land survey system
RSE	Removal site evaluation
UNT	Unnamed tributary

1 inch = 500 feet

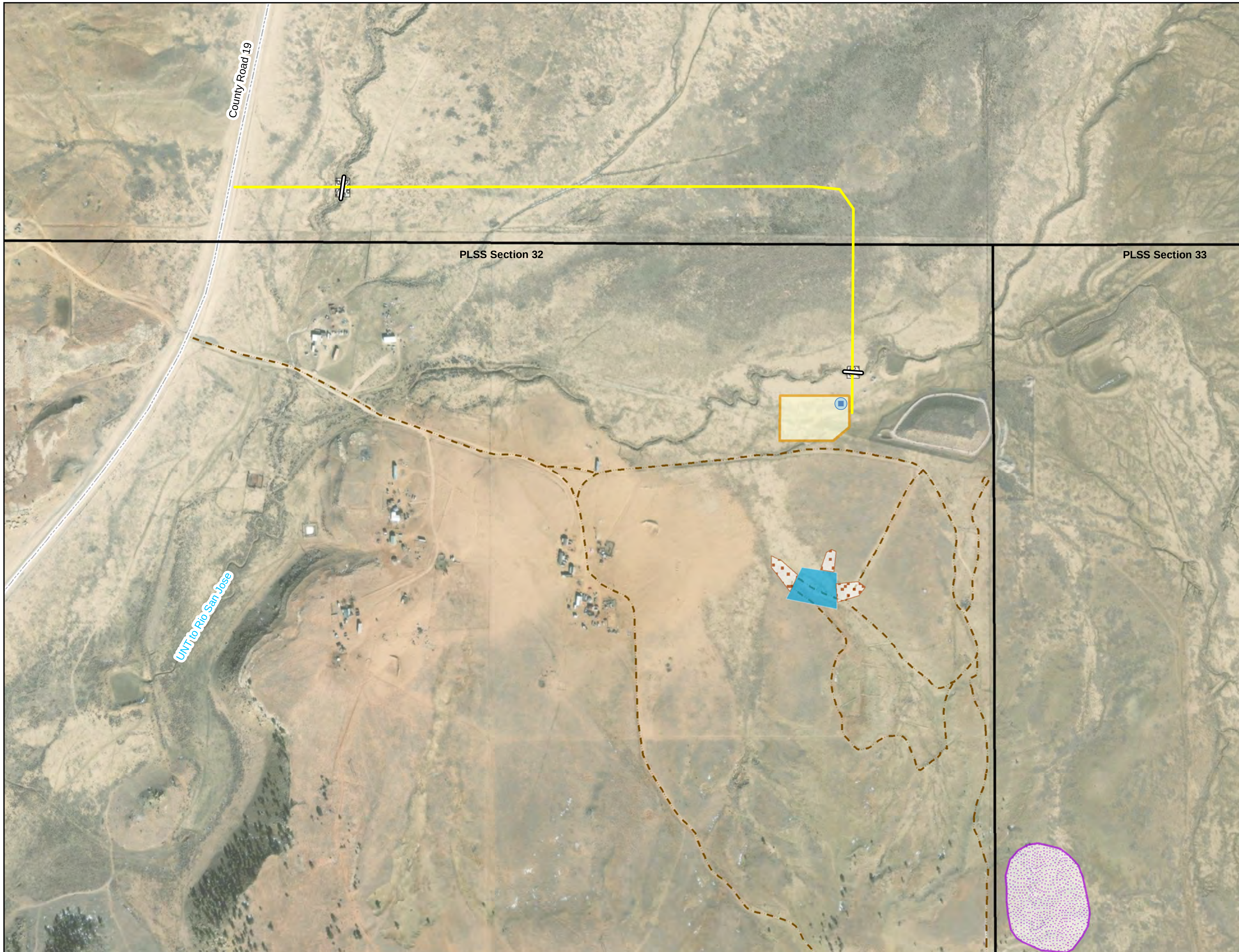
1:6,000

500 250 0 500 Feet

N E S W

PROPOSED SURFICIAL RESTORATION ACTIVITIES

Prepared For: U.S. EPA Region 9	Prepared By: TETRA TECH, 1999 Harrison Street, Suite 500, Oakland, CA 94612
Task Order No.: 0003	Contract No.: 68HE0923D0002
Location: NAVAJO NATION	Date: 3/4/2024
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: 14



- Proposed Construction Water Well Placement
- Culvert
- Construct Haul Road (15-Feet Wide)
- Proposed Laydown Area
- Proposed Sediment / Water Detention Basin
- Proposed Onsite Repository
- Proposed Rock Outfall
- Rock Bridge Accross Drainage
- PLSS Section Boundary / RSE Survey Area
- County Road
- Local Road

Notes:

PLSS	Public land survey system
RSE	Removal site evaluation
UNT	Unnamed tributary

1 inch = 500 feet

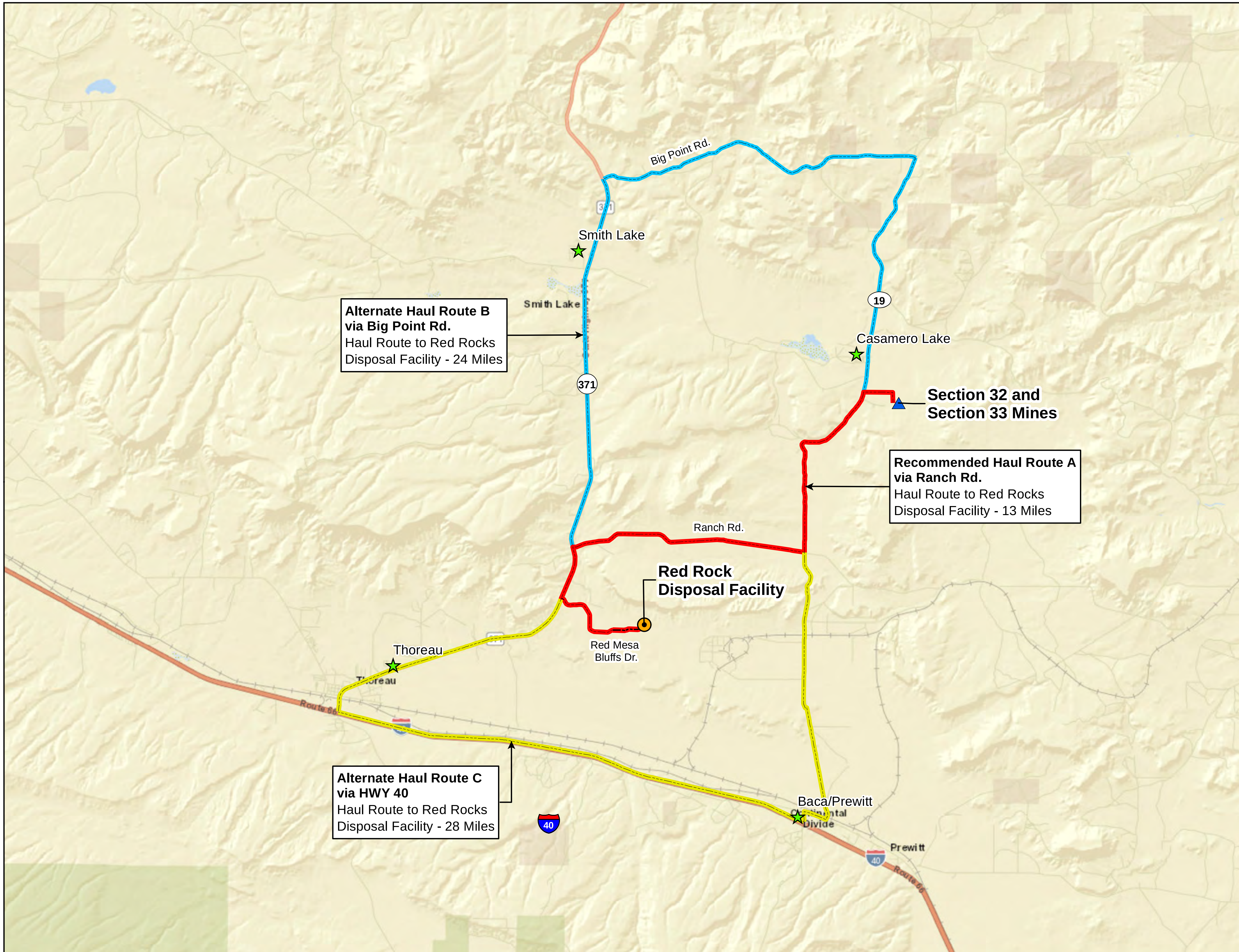
1:6,000

N W E S

500 250 0 500 Feet

ALTERNATIVE 2 - ONSITE REPOSITORY LOCATION AND FEATURES

Prepared For: U.S. EPA Region 9	Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612
Task Order No.: 0003	Contract No.: 68HE0923D0002
Location: NAVAJO NATION	Date: 3/14/2024
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: 15



Section 32 and 33 Mines
Red Rock Disposal Facility
Chapter House

Haul Routes

Recommended Haul Route A
Alternate Haul Route B
Alternate Haul Route C

1 inch = 2 miles

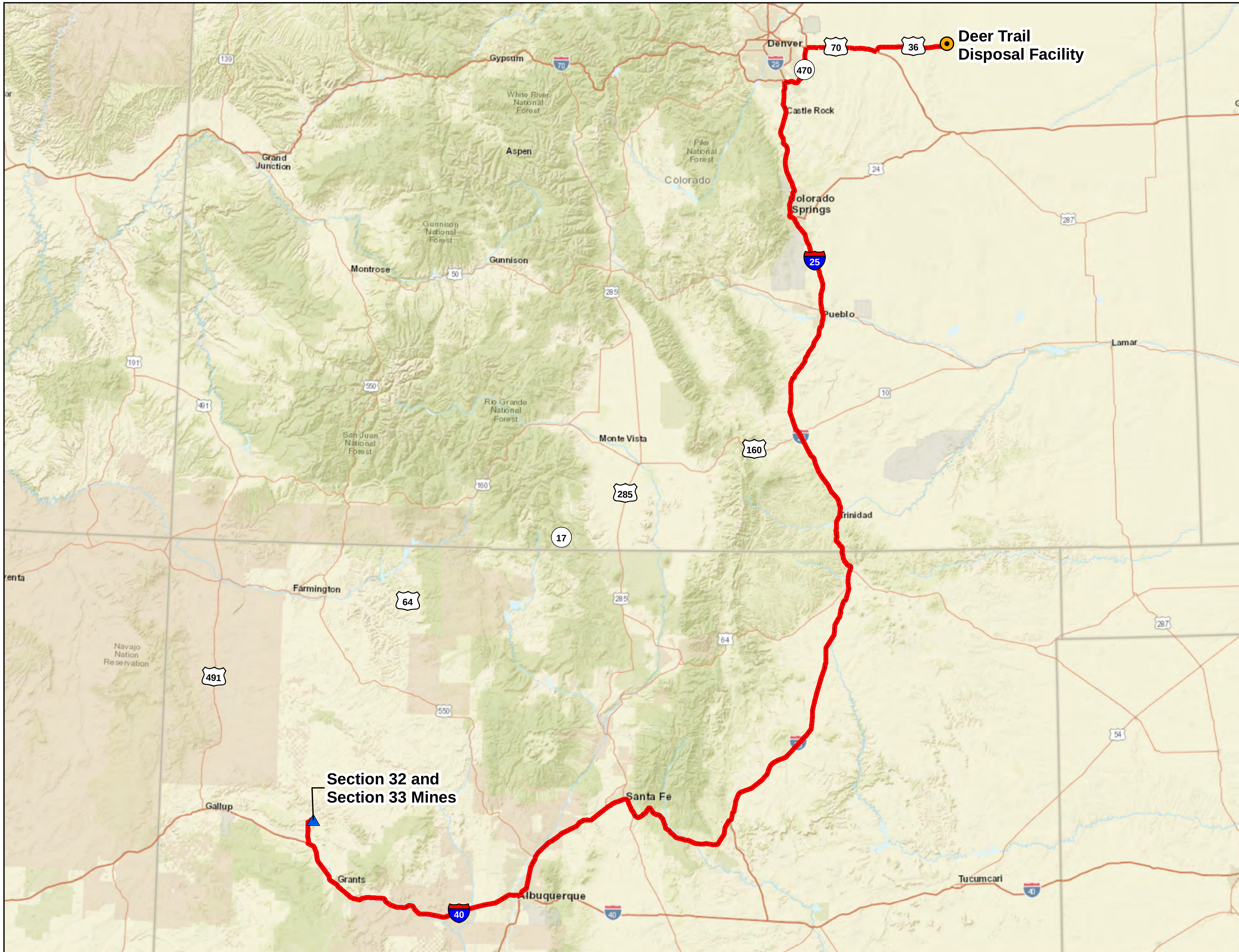
1:126,720

0 1 2 4 Miles

N W E S

ALTERNATIVE 3 — OFF-NAVAJO NATION DISPOSAL AT RED ROCK DISPOSAL FACILITY HAUL ROUTE

Prepared For: U.S. EPA Region 9	Prepared By: TETRA TECH, 1999 Harrison Street, Suite 500, Oakland, CA 94612
Task Order No.: 0003	Contract No.: 68HE0923D0002
Location: NAVAJO NATION	Date: 3/14/2024
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: 16



Section 32 and 33 Mines
Deer Trail Disposal Facility
Proposed Haul Route

Note:
RCRA Resource Conservation and Recovery Act

1 inch = 36 miles
1:2,282,671
0 18 36 72 Miles
N S E W

ALTERNATIVE 4 — OFF-NAVAJO NATION DISPOSAL AT CLEAN HARBORS RCRA C HAZARDOUS WASTE DISPOSAL FACILITY HAUL ROUTE

Prepared For: U.S. EPA Region 9	Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612
Task Order No.: 0003	Contract No.: 68HE0923D0002
Location: NAVAJO NATION	Date: 3/14/2024
Coordinate System: NAD 1983 UTM Zone 13 N Transverse Mercator	Figure No.: 17

TABLES

Table 1. Mine Features and Dimensions at the Section 32 and 33 Mines

Feature	Reclamation Status	Reclamation Description	Dimensions
Section 32 Mine			
Mine Shaft S32-01	Reclaimed	Excavated to 12 feet bgs and backfilled	Undocumented
Mine Shaft S32-02	Reclaimed	Excavated to 12 feet bgs and backfilled	Undocumented
Mine Shaft S32-03	Reclaimed	Excavated to 4 feet bgs and backfilled	5 feet by 5 feet
Section 32/33 Transfer Station	Reclaimed	Excavated and waste placed in stockpile. Transfer station serviced both the Section 32 Mine and Section 33 Mine.	267,432 square feet
Section 32 Stockpile	Reclamation Feature	Received waste from transfer station, over excavated mine shafts, and waste formerly at stockpile site. Includes a rock-lined drainage around stockpile and a rock-lined detention basin at the southwest corner.	317,064 square feet
Old Haul Road	Unreclaimed	None	0.84 mile
Vent Shaft	Unreclaimed	Identified during 2022 data gap investigation.	18 inches in diameter
Section 33 Mine			
Waste Pile S33-01	Unreclaimed	None	223,046 square feet
Waste Pile S33-02	Unreclaimed	None, mapped during Tetra Tech, Inc. field reconnaissance.	
Waste Pile S33-03	Unreclaimed	None	
Waste Pile S33-04	Unreclaimed	None	
Waste Pile S33-05	Unreclaimed	None	

Note:
bgs Below ground surface

Table 2. Comparison of Section 32 and 33 Mines Surface Soil with Quaternary Alluvium (BSA-1) Background Surface Soil

Candidate COC/COEC	Sections 32 and 33 Mines Qa Soil (0-6 inch bgs)			Sections 32 and 33 Mines BSA-1 Qa Soil (0-6 inch bgs)			Two-Population Statistical Tests				Final Conclusion for Background Screen
	Sample Size		Detection Frequency (Percent)	Sample Size		Detection Frequency (Percent)	Gehan[a]	Tarone-Ware[a]	Wilcoxon-Mann-Whitney[b]	Quantile[c]	
	Detected	Total		Detected	Total		Site > Background?	Site > Background?	Site > Background?	Site > Background?	Site > Background?
Radium-226	56	56	100%	30	30	100%	--	--	Yes	--	**Yes**
Antimony	6	56	11%	1	30	3%	No	No	--	--	No
Arsenic	56	56	100%	30	30	100%	--	--	No	No	No
Barium	56	56	100%	30	30	100%	--	--	Yes	--	**Yes**
Chromium	56	56	100%	30	30	100%	--	--	No	No	No
Cobalt	56	56	100%	30	30	100%	--	--	No	No	No
Iron	56	56	100%	30	30	100%	--	--	No	No	No
Lead	56	56	100%	30	30	100%	--	--	No	No	No
Manganese	56	56	100%	30	30	100%	--	--	No	Yes	**Yes**
Nickel	56	56	100%	30	30	100%	--	--	No	No	No
Selenium	56	56	100%	30	30	100%	--	--	No	Yes	**Yes**
Thallium	53	56	95%	30	30	100%	No	No	--	No	No
Uranium	56	56	100%	30	30	100%	--	--	Yes	--	**Yes**
Vanadium	56	56	100%	30	30	100%	--	--	No	No	No
Zinc	56	56	100%	30	30	100%	--	--	No	No	No

Notes:

Bold indicates site soil concentrations are greater than background concentrations from the Quaternary alluvium (BSA-1) as documented by Tetra Tech, Inc. (2023).

a Gehan and Tarone-Ware are tests of central tendency and only used when multiple nondetect results are present in the dataset (USEPA 2022).

b Wilcoxon-Mann-Whitney is a test of central tendency and can only be used when all data are detected or a single detection limit is identified for the nondetected results.

c Quantile is a test performed to confirm the conclusion that the upper tails of site concentrations are less than those for background. Quantile tests were not performed in cases where the two-population tests for central tendency indicated that the site concentrations are greater than background. Quantile tests were performed using ProUCL Version 4.1.01 (USEPA 2010).

-- Not applicable
bgs Below ground surface
BSA Background study area
COC Contaminant of concern
COEC Contaminant of ecological concern
Qa Quaternary Alluvium
USEPA U.S. Environmental Protection Agency

Table 2. Comparison of Section 32 and 33 Mines Surface Soil with Quaternary Alluvium (BSA-1) Background Surface Soil

References:

Tetra Tech, Inc. 2023. “Section 32 and 33 Mines Eastern Abandoned Uranium Mine Region Data Gap Investigation Report.” Response, Assessment, and Evaluation Services 2. Contract No. 68HE0923D0002. August.

U.S. Environmental Protection Agency (USEPA). 2010. “ProUCL Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observation." Version 4.1.01. Prepared by A. Singh and A.K. Singh. EPA/600/R-07/041. May.

USEPA. 2022. “ProUCL Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations." Version 5.2. June 14.

Table 3. Risk Management Summary

Exposure Unit	Land Use / Receptor	Soil Interval	Candidate COC or COEC														
			Radium-226	**Antimony**	**Arsenic**	**Barium**	**Chromium**	**Cobalt**	**Iron**	**Lead**	**Manganese**	**Nickel**	**Selenium**	**Thallium**	**Uranium**	**Vanadium**	**Zinc**
Section 32 Mine	Kee'da'whíí tééh (Full-Time Navajo Resident)	Surface	**COC**	--	< BG	--	< BG	< BG	< BG	--	**COC**	--	--	< BG	**COC**	--	--
		Subsurface	**COC**	--	< BG	--	< BG	< BG	< BG	--	**COC**	--	--	< BG	**COC**	--	--
Section 33 Mine	Default Resident (Non-Navajo)	Surface	**COC**	--	--	--	--	--	--	--	--	--	--	--	**COC**	--	--
		Subsurface	**COC**	--	--	--	--	--	--	--	--	--	--	--	**COC**	--	--
Site-Wide (Ecological Risk)	Plants, Invertebrates, Birds, and Mammals	Surface	EPC< PERG	< BG	< BG	Co-Loc	< BG	--	--	< BG	EPC< PERG	< BG	**COEC**	< BG	EPC< PERG	< BG	< BG
		Subsurface	EPC< PERG	< BG	--	Co-Loc	< BG	--	--	--	EPC< PERG	< BG	**COEC**	< BG	EPC< PERG	--	--

Notes:

Bold indicates an identified final COC or COEC recommended for removal action.

--	Contaminant is not a candidate COC or COEC in the exposure unit and depth interval.
< BG	Less than background
COC	Contaminant of concern
COEC	Contaminant of ecological concern
Co-Loc	Co-located with radium-226 preliminary removal action extent
EPC	Exposure point concentration
PERG	Preliminary ecological removal goal
SE	Secular equilibrium

Table 4. Section 32 and 33 Mines Selection of Soil Removal Action Goal for Each COC and COEC

COC / COEC	Units	Human Health PRG[1]	NAUM PERG[2]	BTV[3]	Removal Action Goal[4]	Basis for Removal Action Goal
Section 32 Mine (on the Navajo Nation)						
Surface Soil (0-6 inches bgs) and Subsurface Soil (0-72 inches bgs)						
Radium-226 [5]	pCi/g	0.050	--	1.9	1.9	BTV
Manganese	mg/kg	45	--	279	279	BTV
Selenium	mg/kg	--	3.4	2.5	3.4	PERG
Uranium	mg/kg	3.2	--	1.5	3.2	HH PRG
Section 33 Mine (on Private Property)						
Surface Soil (0-6 inches bgs) and Subsurface Soil (0-72 inches bgs)						
Radium-226 [5]	pCi/g	1.3	--	1.9	1.9	BTV
Selenium	mg/kg	--	3.4	2.5	3.4	PERG
Uranium	mg/kg	16	--	1.5	16	HH PRG

Notes:

[1] The human health PRG is based on the RME receptor assumed at each EU and calculated using the NAUM Risk Calculator (USEPA 2024b).

[2] Development of PERGs is described in USEPA (2024c).

[3] The BTVs for soil are UTL95-95s from the Quaternary Alluvium BSA-1.

[4] The RAG is the lesser of the human health PRG and NAUM PERG unless either is less than the BTV. If the BTV is higher than the human health PRG or NAUM PERG, the RAG is based on the BTV to address material distinguishable from background. The BTV is used to represent background for delineating contaminated areas.

[5] Assumption of secular equilibrium for radium-226 is protective for the calculation of risk-based screening levels. Adjusted toxicity values are used to incorporate all toxicity for the entire uranium-238 decay chain in the development of the PRG. Site data for radium-226 are used to evaluate the extent of radionuclides above RAGs.

--	Not a COC or not a COEC	NAUM	Navajo abandoned uranium mine
bgs	Below ground surface	pCi/g	Picocurie per gram
BSA	Background study area	PERG	Preliminary ecological removal goal
BTV	Background threshold value	PRG	Preliminary removal goal
COC	Contaminant of concern	RAG	Removal action goal
COEC	Contaminant of ecological concern	RME	Reasonable maximum exposure
EU	Exposure unit	UTL95-95	95% upper tolerance limit with 95% coverage
HH	Human health		
mg/kg	Milligram per kilogram	USEPA	U.S. Environmental Protection Agency

References:

U.S. Environmental Protection Agency (USEPA). 2024b. “Navajo Abandoned Uranium Mine Risk Calculator." Version 1.03. March.

USEPA. 2024c. "Navajo Abandoned Uranium Mines Program Preliminary Ecological Removal Goals for Metals and Radionuclides in Soil for Navajo Abandoned Uranium Mine Site." Draft. March.

Table 5. General Response Actions, Technologies, and Process Options

General Response Actions	Response Action Technology	Process Options
No Action	None	Not applicable
Institutional Controls	Land Use Controls	Chapter Land Use Plans
		Homesite Lease Approval
	Access Restrictions	Deed Restrictions
		Environmental Control Easements
Engineering Controls	Physical Barriers	Fencing/Barrier
	Surface Controls	Consolidation, Grading, Revegetation, and Erosion Protection
		Soil Binder
	Segregation	Soil Sorting
	Backfilling of Mine Workings	Backfilling of Cuts, Benches, and Pits
		Backfilling of Underground Voids
	Containment	Earthen Cover
		Earthen Cover with Upper HDPE or Geosynthetic Clay Liner
	Regional Disposal	On-Navajo Nation Regional Repository
		Off-Navajo Nation Regional Repository
	Off-Navajo Nation Disposal	Non-RCRA, Class A LLRW, or RCRA C Hazardous Waste Disposal Facility with State License to Receive Radioactive Material
Excavation and Treatment	Physical/ Chemical Treatment	Soil washing
		Acid Extraction
		Ablation
		Milling
		Solidification
		Stabilization
	Thermal Treatment	Vitrification
In-Place Treatment	Physical/ Chemical Treatment	Solidification
		Stabilization
	Thermal Treatment	Vitrification
	Vegetative Treatment	Phytoextraction/ Phytostabilization

Notes:
HDPE High-density polyethylene
LLRW Low-level radioactive waste
RCRA Resource Conservation and Recovery Act

Table 6. Applicable or Relevant and Appropriate Requirements and To Be Considered Requirements for the Section 32 and 33 Mines

Table 6a and Table 6b list the federal and Navajo Nation location- and action-specific applicable or relevant and appropriate requirements (ARAR) and "To Be Considered" (TBC) requirements, respectively, that have been identified for all the alternative response actions described in the engineering evaluation/cost analysis (EE/CA) for the Section 32 and 33 Mines. The U.S. Environmental Protection Agency (USEPA) did not identify chemical-specific ARARs or TBCs because potential federal, State of New Mexico, and Navajo Nation chemical-specific ARARs were not as conservative as the risk-based cleanup standards developed for this action. Chemical-related requirements tied to an action such as cap design were included in the action-specific table (Table 6b). Identification and evaluation of ARARs is an iterative process that continues throughout the response process. As site conditions, contaminants, and response alternatives at the Section 32 and 33 Mines are better understood, the ARARs and TBCs and their relevance to the removal action may change. ARARs and TBCs are finalized in the action memorandum for the selected response action.

Cleanup standards were derived through the USEPA risk assessment process in accordance with the following USEPA guidance.

- "Clarification of the Role of Applicable, or Relevant and Appropriate Requirements in Establishing Preliminary Remediation Goals under CERCLA" (USEPA 1997a)
- "Establishment of Cleanup Levels for CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act] Sites with Radioactive Contamination" (USEPA 1997b)
- "Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites" (USEPA 1998)
- "Radiation Risk Assessment at CERCLA Sites: Q&A" (USEPA 2014)

The following Navajo Nation laws, regulations, and guidance are not considered ARARs or TBCs for the response actions anticipated by this EE/CA; however, they are listed here because situations may arise during implementation of the alternatives discussed in the EE/CA or during future actions at the Section 32 and 33 Mines where these requirements may be applicable.

- Navajo Nation CERCLA, 4 *Navajo Nation Code* (N.N.C.) Sections (§§) 2101-2805 – The Navajo Nation CERCLA requirements must be complied with during implementation of the response action if petroleum contamination is discovered at the Section 32 and 33 Mines because Navajo Nation CERCLA Section (§) 2104.Q includes petroleum in the definition of hazardous substance. Based on site investigations thus far, petroleum contamination is not anticipated.
- Navajo Nation Underground and Aboveground Storage Tank Act of 2012 (NNSTA), 4 N.N.C. §§ 1501-1577 – If any permanent storage tanks are found at a site, including both underground and aboveground storage tanks and tanks holding not only petroleum but any hazardous substances, NNSTA § 1542(C)(1) requires removal of the tanks. (The guidance for temporary/mobile storage tanks brought on site is included in Table 6b as a TBC because that situation is anticipated to arise.)

Table 6. Applicable or Relevant and Appropriate Requirements and To Be Considered Requirements for the Section 32 and 33 Mines

- Navajo Nation Business Opportunity Act, 5 N.N.C. §§ 201-214, and the Navajo Preference in Employment Act, 15 N.N.C. §§ 601-619 – While these are not environmental regulations and, therefore, are not ARARs, these regulations give preference to Navajo Nation businesses and individuals when hiring employees and contractors to perform the response actions anticipated by this EE/CA.
- Navajo Nation Diné Radioactive Materials Transportation Act (RMTA), 18 N.N.C. §§ 1304-1307 – RMTA is not applicable to onsite activities; however, its requirements may be applicable to transportation on public roads on the Navajo Nation between sites that are subject to a combined action pursuant to CERCLA § 104(d)(4), as well as for shipment of radioactive materials through the Navajo Nation generally. RMTA § 1307 includes specific requirements that are not found in federal law, including advance notice of the transportation of radioactive and related substances, equipment, vehicles, persons, and materials over and across the Navajo Nation, as well as license fees, bonding requirements, route restrictions, and curfews.

The EE/CAs for which the ARARs tables below were prepared do not address groundwater and, therefore, ARARs for groundwater are not included. If any groundwater contamination is found at the Section 32 and 33 Mines, the related ARARs will be addressed at that time.

References:

U.S. Environmental Protection Agency (USEPA). 1997a. "Clarification of the Role of Applicable, or Relevant and Appropriate Requirements in Establishing Preliminary Remediation Goals under CERCLA." Office of Solid Waste and Emergency Response (OSWER) Directive No. 9200.4-23. August.

USEPA. 1997b. "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination." OSWER Directive No. 9200.4-18. August.

USEPA. 1998. "Use of Soil Cleanup Criteria in 40 CFR Part 192 as Remediation Goals for CERCLA Sites." OSWER Directive No. 9200.4-25. February.

USEPA. 2014. "Radiation Risk Assessment at CERCLA Sites: Q&A." OSWER Directive No. 9200.4-40. May.

Table 6a. Location-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
Cultural Resources	**FEDERAL** **The Native American Graves Protection and Repatriation Act** **25 U.S.C. §§ 3002(c) and (d)** 43 CFR §§ 10.3(b)-(c) and 10.4(b)-(e)	Protects Native American cultural items from unpermitted removal and excavation and requires the protection of such items in the event of inadvertent discovery. Excavation or removal of cultural items must be done under procedures required by this act and the Archaeological Resources Protection Act (Section 3 (c)(1)).	**Applicable** Substantive requirements are applicable if cultural items (meaning human remains and associated or unassociated funerary objects, sacred objects, or cultural patrimony) are inadvertently discovered or intentionally excavated or removed within the area to be disturbed. If cultural items are discovered, on-going activity in the area of discovery must stop, the relevant Indian tribe official must be notified immediately, and reasonable effort must be made to protect such cultural items.
Cultural Resources	**FEDERAL** **National Historic Preservation Act** **54 U.S.C. §§ 306101(a), 306102, 306107, and 306108** 36 CFR §§ 800.3(a) and (c); 800.4(a)-(c); 800.5(a)-(b); 800.6(a)-(b); 800.10(a); 800.13(b)-(d)	Federal agencies are required to consider the effects of federally funded (in whole or in part) activity on any historic property or objects and minimize harm to any National Historic Landmark. Federal agencies may be required to identify historic properties or objects, determine whether proposed activity will have an adverse effect on historic properties or objects, and develop alternatives or modifications to the proposed action that could avoid, minimize, or mitigate adverse effects through the National Historic Preservation Act's Section 106 process.	**Applicable** Substantive requirements are applicable if a federally funded activity could adversely affect historic property (meaning a prehistoric or historic district, site, building, structure, or object) included on, or eligible for inclusion on, the National Register of Historic Places.
Cultural Resources	**FEDERAL** **Preservation of Historical and Archaeological Data** **54 U.S.C. §§ 312502(a) and 312503**	Protects significant scientific, prehistorical, historical, and archaeological data. When a federal agency action may cause irreparable loss or destruction of significant data, the agency must notify DOI and either recover, protect, and preserve the data itself or request DOI to do so.	**Applicable** Substantive requirements are applicable if a federal agency action may cause irreparable loss or destruction to significant scientific, prehistorical, historical, or archaeological data.

Table 6a. Location-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
Cultural Resources	**FEDERAL** **Archaeological Resources Protection Act of 1979** **16 U.S.C. §§ 470cc(a)-(c) and 470ee(a)** 43 CFR §§ 7.4(a), 7.5(a), 7.7, 7.8(a), 7.9(c), and 7.35	Prohibits the excavation, removal, damage, or alteration or defacement of archaeological resources on public or Indian lands unless by permit or exception.	**Applicable** Substantive requirements are applicable if eligible archaeological resources are within the area to be disturbed.
Cultural Resources	**FEDERAL** **American Indian Religious Freedom Act** **42 U.S.C. § 1996**	Policy of the United States to protect access to and the use of religious, ceremonial, and burial sites and sacred objects by Native American groups.	**TBC** Policy should be followed if Native American sacred sites are identified within the area to be disturbed.
Biological Resources	**FEDERAL** **Migratory Bird Treaty Act** **16 U.S.C. § 703(a)** 50 CFR §§ 10.13 and 21.10	Prohibits the killing, capturing, taking, and incidental taking of protected migratory bird species, their parts, nests, and eggs without DOI's prior approval. Protected migratory birds species are listed at 50 CFR § 10.13.	**Applicable** Substantive requirements are applicable if migratory birds or their nests are present at or near the site.
Biological Resources	**FEDERAL** **Bald and Golden Eagle Protection Act** **16 U.S.C. §§ 668(a)** 50 CFR §§ 22.10; 22.80(a), (c)-(f); 22.85(a)-(b) and (d)-(e) 50 CFR § 13.21(b)	Prohibits the unpermitted taking, including the killing, disturbing, or incidental taking, of bald and golden eagles, their parts, nests, and eggs.	**Applicable** Substantive requirements are applicable if bald or golden eagles or their nests are identified at or near the site.

Table 6a. Location-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
Biological Resources	**FEDERAL** **Endangered Species Act** **16 U.S.C. §§ 1531(c); 1536(a)(2), (c)-(d), (g)-(h), and (I); 1538(a) and (g); 1539(a)** 50 CFR §§ 17.21(a)-(c);17.22(b); 17.31(a) and (c);17.32(b); 17.82; and 17.94(a) 50 CFR §§ 402.09; 402.12 (a)-(b) and (i); 402.14(a); 402.15(a)	Federal agencies must ensure that any activities funded, carried out, or authorized by them do not jeopardize the continued existence of any threatened or endangered species or result in the destruction or alteration of such species' habitats. Endangered and threatened species are listed at 50 CFR Part 17, Subpart B.	**Applicable** Substantive requirements are applicable if endangered or threatened species are identified at the site.
Cultural Resources	**NAVAJO NATION** **Navajo Nation Cultural Resources Protection Act** **11 N.N.C. §§ 1003(S); 1021; and 1031**	Prohibits alteration, damage, excavation, defacement, destruction, or removal of cultural properties.	**Applicable** Substantive requirements are applicable to activities at the AUM sites where cultural resources may be encountered.
Cultural Resources	**NAVAJO NATION** **Navajo Nation Policy for the Disposition of Cultural Resources Collections** **Sections 2 and 6.1** (These sections would trigger other provisions in the policy)	Establishes procedures and guidelines to be followed for excavation (as a last resort) and disposition of cultural resources recovered on the Navajo Nation, including the handling of inadvertent discovery.	**TBC** TBC for activities on AUM sites where cultural resources may be encountered.

Table 6a. Location-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
Cultural Resources	**NAVAJO NATION** **Navajo Nation Guidelines for the Treatment of Discovery Situations**	Establish procedures and guidelines to be followed in any situation involving the discovery of cultural or historic property, including historical and prehistoric archaeological sites and traditional cultural properties and human remains whether or not previously identified.	**TBC** NNHHPD performs these functions pursuant to a contract with BIA under which NNHHPD serves as the BIA's agent.
Cultural Resources	**NAVAJO NATION** **Navajo Nation Policy for the Protection of Jishchaá: Gravesites, Human Remains, and Funerary Items**	Establishes principles for locating and handling of gravesites, human remains, and associated artifacts and soil in the area to be disturbed by AUM removal activities. See in particular Section IV (Traditional Concerns), which contains requirements if the AUM activity comes into contact with gravesites, human remains, or funerary items. It imposes specific requirements for how to navigate around, prepare for, and respond to burial grounds and uncovered remains. See also Section V (Encountering Gravesites, Human Remains, and Funerary Items), which specifies the procedures when an inadvertent discovery is made. Sections VI and VII contain additional requirements in that event.	**TBC**
Biological Resources	**NAVAJO NATION** **Navajo Nation Endangered Species Act** **17 N.N.C. §§ 500-508** **Navajo Nation Endangered Species List – ** Resource Committee Resolution RCAU-103-05	NNESA § 507 makes it unlawful for any person to "take, possess, transport, export, process, sell or offer for sale or ship any species or subspecies of wildlife" listed as endangered or threatened on federal or Navajo Nation lists, which also protect those species' critical habitat. NNESA §§ 500-504 and 506-508 also protect, to various extents, game fish, game birds, songbirds, game animals, fur-bearing animals (all defined under § 500), and hawks, vultures, and owls from being taken. The Navajo Nation Endangered Species List includes species that are not on the federal list. It also provides broader criteria for when species would be listed based on their prospects of survival or recruitment within the Navajo Nation (see categories "G2" and "G3"). Category G4 provides a means for the Navajo Nation Department of Fish and Wildlife to include additional species (or exclude species), making it possible for the list to change during the course of work.	**Applicable** Substantive requirements applicable if protected species or habitat are identified within the area to be disturbed on AUM sites.

Table 6a. Location-Specific ARARs and TBC Information

Notes:

§	Section
§§	Sections
ARAR	Applicable or relevant and appropriate requirement
AUM	Abandoned uranium mine
BIA	Bureau of Indian Affairs
CFR	*Code of Federal Regulations*
DOI	U.S. Department of the Interior
N.N.C.	*Navajo Nation Code*
NNESA	Navajo Nation Endangered Species Act
NNHHPD	Navajo Nation Heritage and Historic Preservation Department
TBC	To be considered
U.S.C.	*United States Code*

Table 6b. Action-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
Air	**FEDERAL** **Clean Air Act** **42 U.S.C. §§ 7401, *et seq.*** 40 CFR § 61.92	Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 millirems per year.	**Relevant and Appropriate** This standard is applicable to a DOE facility. The site is not a DOE facility; therefore, this standard is not applicable. However, this standard has been determined to be relevant and appropriate during removal action activities because of potential emissions of radionuclides during excavation of the waste and movement of the waste.
Air	**FEDERAL** **Clean Air Act** **42 U.S.C. §§ 7401, *et seq.*** 40 CFR §§ 61.222(a)	Radon-222 emissions to the ambient air from a uranium mill tailings pile that is no longer operational shall not exceed 20 picocuries per square meter per second.	**Relevant and Appropriate** These requirements are applicable to nonoperational uranium mill tailings piles. The site's waste to be disposed of is not uranium mill tailings. These requirements have been determined to be relevant and appropriate to the design of the engineered cover to be constructed in Alternative 2, which consists of onsite containment of the contaminated soil and uranium waste rock.
Water	**FEDERAL** **Clean Water Act** **33 U.S.C. § 1342(p)(3)(A)** NPDES – Stormwater Discharges 40 CFR §§ 450.21	Requires BMPs to abate discharges of pollutants from stormwater discharges, including erosion and sediment control BMPs. All treatment and control systems and facilities will be properly operated and maintained.	**Applicable** If there are discharges to WOTUS. **Relevant and Appropriate** If there are discharges to Navajo Nation surface waters (as defined in Table 206.1 of Navajo Nation Surface Water Quality Standards 2015).

Table 6b. Action-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
Water	**FEDERAL** **Clean Water Act** **33 U.S.C. § 1342(p)** NPDES 2022 Construction General Permit for Stormwater Discharges from Construction Activities Part 2. Technology-Based Effluent Limitations. Section 2.2. Erosion and Sediment Control Requirements, Subsection 2.2.1.	Requires implementation of erosion and sediment controls to minimize the discharge of pollutants in stormwater from construction activities. Natural buffers or equivalent erosion and sediment controls must be provided and maintained for discharges to receiving waters within 50 feet of the site's earth disturbances. For any discharges to receiving waters within 50 feet of the site's earth disturbances, one of the following alternatives must be complied with: i. Provide and maintain a 50-foot undisturbed natural buffer ii. Provide and maintain an undisturbed natural buffer that is less than 50 feet and is supplemented by erosion and sediment controls that achieve, in combination, the sediment load reduction equivalent to a 50-foot undisturbed natural buffer iii. If infeasible to provide and maintain an undisturbed natural buffer of any size, implement erosion and sediment controls to achieve the sediment load reduction equivalent to a 50-foot undisturbed natural buffer.	**Applicable** For operators of construction activities if weather events necessitating stormwater runoff controls occur during onsite excavation, waste consolidation, and repository construction.
Repository	**FEDERAL** **Uranium Mill Tailings Radiation Control Act** **42 U.S.C. §§ 7918 and 2022** 40 CFR §§192.02(a) and (d)	Requires design of uranium mill tailings disposal sites to provide for control of residual radioactive materials for up to 1,000 years to the extent reasonably achievable and, in any case, for at least 200 years. The uranium mill tailings disposal site must also be designed and stabilized in a manner that minimizes the need for future maintenance.	**Relevant and Appropriate** These standards are applicable to UMTRCA Title I sites. The site is not a Title I site; therefore, these requirements are not applicable. These requirements have been determined to be relevant and appropriate to the design of the engineered cover to be constructed under Alternative 2, which consists of onsite containment of the contaminated soil and uranium waste rock.

Table 6b. Action-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
Repository	**FEDERAL** **Uranium Mill Tailings Radiation Control Act** **42 U.S.C. §§ 7918 and 2022** 10 CFR Part 40, Appendix A. Criterions 1, 4, 6(1), 6(3), 6(5) and 6(7)	In selecting and designing uranium mill tailings disposal sites, certain criteria must be considered, including remoteness, hydrologic and topographic features, potential for erosion, and vegetation. Disposal sites must be covered by an earthen cap, or approved alterative, that meets certain control requirements, including limiting the release of radon-222 to the atmosphere. When the final radon barrier is placed in phases, verification of the radon-222 release rate must be completed for each portion of the final radon barrier as it is emplaced. Waste or rock with elevated levels of radium must not be placed near the surface of disposal sites. Disposal sites must be closed in a manner that, to the extent necessary, controls, minimizes, or eliminates post-closure escape of non-radiological hazardous constituents, leachate, contaminated rainwater, or waste decomposition products to the ground or surface waters or atmosphere.	**Relevant and Appropriate** These standards are applicable to UMTRCA Title I sites. The site is not a Title I site; therefore, these requirements are not applicable. These requirements have been determined to be relevant and appropriate to the design of the engineered cover to be constructed in Alternative 2, which consists of onsite containment for the contaminated soil and uranium waste rock.
Repository	**FEDERAL** **NRC Regulations** **Protection of the General Population from Releases of Radioactivity** 10 CFR § 61.41	Concentrations of radioactive material that may be released to the general environment in groundwater, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable.	**Relevant and Appropriate** This standard is applicable to NRC sites. The site is not a NRC site; therefore, this requirement is not applicable. This standard was found to be relevant and appropriate to the design of the engineered cover to be constructed in Alternative 2, which consists of onsite containment of contaminated soil and uranium waste rock.
All	**NEW MEXICO** **NMAC § 20.3.13.1317**	Requires the protection of the general population from the release of radioactivity.	**Relevant and Appropriate** This regulation is the same as 40 CFR § 192. This requirement is not applicable to the site but is relevant and appropriate.

Table 6b. Action-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
All	**NEW MEXICO** **NMAC § 20.3.4**	Establishes standards for protection against radiation.	**Relevant and Appropriate** This regulation is the same as 10 CFR § 20. This requirement is not applicable to the site but is relevant and appropriate.
Soil	**NEW MEXICO** **NMAC §§ 19.10.5.507 and 19.10.5.508**	Establishes performance and reclamation standards and requirements for noncoal mining operations.	**Relevant and Appropriate** This regulation provides revegetation requirements for existing noncoal mining operations, as well as other reclamation requirements.
Soil and Water	**NEW MEXICO** **New Mexico Soil and Water Conservation District Act** New Mexico Statutes Annotated 73-20-25	Establishes state authority to control and prevent soil erosion, prevent floodwater and sediment damage to soil, and conserve natural resources.	**TBC** This regulation will be a TBC to the extent that it does not conflict with CERCLA, the National Contingency Plan, 40 CFR Part 300, or other federal requirements.
Soil	**NEW MEXICO** **Joint Guidance for the Cleanup and Reclamation of Existing Uranium Mining Operations in New Mexico (March 2016)**	This guidance is used to assist mine site responsible parties in addressing soil radiation at existing uranium mines as part of reclamation activities.	**TBC** This guidance will be a TBC to the extent that it does not conflict with CERCLA, the National Contingency Plan, 40 CFR Part 300, or other federal requirements.
Soil	**NEW MEXICO** **Guidance for Soil Suitability, Revegetation and Self Sustaining Ecosystem (1996)**	Used to implement and evaluate vegetation success and soil cover material properties and reclamation.	**TBC** This guidance will be a TBC for restoration of excavated or covered waste.

Table 6b. Action-Specific ARARs and TBC Information

Media	Requirement	Requirement Synopsis	Prerequisites, Status, and Rationale
All	**NAVAJO NATION** **Navajo Nation Fundamental Law 1 N.N.C. §§ 201-206** Navajo Nation Guidance on the Uniform Application of Fundamental Law to AUM Cleanup Activities (2022)	The Navajo people have an obligation under the Navajo Nation Fundamental Law to listen to elders and medicine people and respect, preserve, and protect Mother Earth as stewards and guardians for the benefit of future generations. The 2020 guidance explains the principles of the Navajo Nation Fundamental Law and how the principles would be applied at the various stages of AUM cleanup.	**TBC** Navajo Nation Fundamental Law and the 2022 guidance will be TBCs to the extent that they do not conflict with CERCLA, the National Contingency Plan, 40 CFR Part 300, or other federal requirements.
Soil and Water	**NAVAJO NATION** **Navajo Nation Underground and Aboveground Storage Tank Act of 2012 – 4 N.N.C. §§ 1501-1577, as amended** NNEPA Storage Tank Program Guidance No. 3 (ASTs at Construction Sites) – Section III (Operating Guidelines)	Regulates storage of petroleum and other regulated substances in underground tanks and ASTs. This guidance clarifies that the NNSTA applies to ASTs that are temporarily placed at construction sites within the Navajo Nation. It requires such ASTs to file tank information forms with NNEPA, locate the tank within a secondary containment area, secure the tank to prevent movement on the containment surface or mount it on metal skids (not on an elevated stilt rack), and contact the Navajo Nation Storage Tank Program for an inspection of the AST to check for evidence of soil contamination both before the first deposit of a regulated substance and when the AST is removed from the site.	**TBC** Guidance should be followed for AUM response activities requiring ASTs to be brought to sites (for example, for fuel needed for equipment and vehicles).

Notes:

§	Section
§§	Sections
ARAR	Applicable or relevant and appropriate requirement
AST	Aboveground storage tank
AUM	Abandoned uranium mine
BMP	Best management practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CWA	Clean Water Act
DOE	U.S. Department of Energy
NMAC	*New Mexico Administrative Code*
N.N.C.	*Navajo Nation Code*
NNCWA	Navajo Nation Clean Water Act
NNEPA	Navajo Nation Environmental Protection Agency
NNSTA	Navajo Nation Underground and Aboveground Storage Tank Act
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
TBC	To be considered
UMTRCA	Uranium Mill Tailings Radiation Control Act
U.S.C.	*United States Code*
WOTUS	Waters of the U.S.

APPENDIX A

SITE IMAGES

The following photos were taken during the Weston Solutions, Inc. removal site evaluation field investigation of the Section 32 and 33 Mines.

PHOTOGRAPH 1

Date: 7/19/17

Location: Section 32 and 33 Mines

Description: Section 32 and Section 33 Mines fenceline with the Section 33 Mine waste just beyond fence

PHOTOGRAPH 2

Date: 7/19/17

Location: Section 32 and 33 Mines

Description: Section 32 Mine waste repository

PHOTOGRAPH 3

Date: 7/19/17

Location: Section 32 and 33 Mines

Description: Section 33 Mine waste debris

PHOTOGRAPH 4

Date: 7/19/17

Location: Section 32 and 33 Mines

Description: Ludlum 2x2 reading at Section 32 and Section 33 Mines fence line

PHOTOGRAPH 5

Date: 7/19/17

Location: Section 32 and 33 Mines

Description: Erosion control between Section 33 Mine (left) and Section 32 Mine (right)

PHOTOGRAPH 6

Date: 7/19/17

Location: Section 32 and 33 Mines

Description: Section 32 Mine repository (left) and Section 33 Mine waste (right)

PHOTOGRAPH 7

Date: 6/17/17

Location: Section 32 and 33 Mines

Description: Mancos shale outcrop in the Section 33 Mine

The following photos were taken during the Tetra Tech, Inc. field reconnaissance of the Section 32 and Section 33 Mines.

PHOTOGRAPH 8

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Locked gate to Section 32 Mine waste stockpile facing northeast

PHOTOGRAPH 9

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Minor erosion of the southeast corner of Section 32 Mine waste stockpile cap facing northwest

PHOTOGRAPH 10

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Surface water pathway flowing west from Section 33 Mine towards the Section 32 Mine waste stockpile, flows west

PHOTOGRAPH 11

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Section 32 Mine waste stockpile facing northeast

PHOTOGRAPH 12

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Quaternanry alluvium material down to 6 inches in location approximately 300 feet south of Section 32 Mine waste stockpile

PHOTOGRAPH 13

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Facing north, sparse vegetation in area around the Section 32 and 33 Mines at northern boundary of the Section 32 Mine waste stockpile

PHOTOGRAPH 14

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Mancos Shale outcrop exposed by erosion from surface water pathway flowing south at location approximately 1,200 feet south of Section 32 Mine waste stockpile and east of transfer station

PHOTOGRAPH 15

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Mancos Shale outcrop in context (see photo 14) facing south

PHOTOGRAPH 16

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Section 33 Mine facing northeast

PHOTOGRAPH 17

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Facing north, surface water pathway from Section 33 Mine (right) and Section 32 Mine stockpile (left) headcutting into slope between the sites

PHOTOGRAPH 18

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Facing east, wood debris from demolished mining structures in Waste Pile S33-01

PHOTOGRAPH 19

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Facing west, distinct color difference (dry) between light grey waste piles (bottom) and red-brown Quaternary alluvium (top left)

PHOTOGRAPH 20

Date: 5/19/22

Location: Section 32 and 33 Mines

Description: Facing southeast, Waste Pile S33-02 mapped during Tetra Tech 2022 field event and severe mudcracks suggesting ponding during rain events (mudcracks are present throughout Section 33 Mine

APPENDIX B

SITE DELINEATION

Section 32 and 33 Mines

Casamero Lake Chapter, Navajo Nation, New Mexico

Final

Appendix B

Site Delineation

Response, Assessment, and Evaluation Services 2

Contract No. 68HE0923D0002

Task Order 003

March 2024

Submitted to

U.S. Environmental Protection Agency

Submitted by

Tetra Tech, Inc.

1999 Harrison Street, Suite 500

Oakland, CA 94612

TETRA TECH

TABLE OF CONTENTS

Section **Page**

FIGURES

ACRONYMS AND ABBREVIATIONS

AUM	Abandoned uranium mine
MARSSIM	*Multi-Agency Radiation Survey and Site Investigation Manual*
NORM	Naturally occurring radioactive material
Ra-226	Radium-226
TENORM	Technologically enhanced naturally occurring radioactive material
Tetra Tech	Tetra Tech, Inc.
USEPA	U.S. Environmental Protection Agency
Weston	Weston Solutions, Inc.

1.0 INTRODUCTION

The purpose of this appendix is to describe the methods and observations used to identify and delineate naturally occurring radioactive material (NORM) and technologically enhanced naturally occurring radioactive material (TENORM) at the Section 32 and 33 Mines.

NORM and TENORM boundaries are defined based on site reconnaissance observations and evaluation of data from the Weston Solutions, Inc. (Weston) (2019) removal site evaluation and a November 2022 data gaps investigation (Tetra Tech, Inc. [Tetra Tech] 2023) in accordance with the *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (U.S. Environmental Protection Agency [USEPA] 2000), "Technical Report on Technologically Enhanced Naturally Occurring Radioactive Materials from Uranium Mining" (USEPA 2008), "NORM-TENORM Determinations and Delineation" (USEPA 2021a), and "Mining Forensics and Physical Disturbance Guidance" (USEPA 2021b) at abandoned uranium mines (AUM). NORM and TENORM boundaries do not necessarily correspond to impacted and non-impacted areas at a site. Definitions for impacted and non-impacted areas and for NORM and TENORM in the above guidance documents are provided below.

MARSSIM (USEPA 2000) does not provide guidance on NORM and TENORM delineation but does provide guidance on categorizing site areas as follows:

> Categorization is the act or result of separating an area or survey unit into one of two categories: impacted or non-impacted. Areas that have no reasonable potential for residual radioactive material are categorized as non-impacted areas. These areas have no radiological impact from site operations and are typically identified early in the cleanup process. Areas with some reasonable potential for residual radioactive material are categorized as impacted areas.

USEPA (2008) defines TENORM as follows:

> 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." 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 (2008) defines NORM as follows:

> 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, such as radium and radon, that are undisturbed as a result of human activities.

According to USEPA (2021a), a feature is defined as TENORM at an AUM if it (1) has been processed, beneficiated, or otherwise disturbed (hereinafter referred to as disturbed) by mining activities; and (2) increases or could increase exposure to human health and the environment.

Based on the above definitions, an area that was physically disturbed can be classified as TENORM and non-impacted. Not all TENORM areas contain levels of radium-226 (Ra-226) or other contaminants of potential concern that require cleanup.

Disturbance at AUMs is divided into mechanical processes and transport processes (USEPA 2021b) as follows:

- Mechanical or geochemical disturbance of rock or soil and mechanical transport of those materials by direct mining activities. For example, dewatering ponds; excavating pits, adits, or shafts; pushing waste piles off cliffs; and ore spilling from haul trucks.
- Natural geologic or geomorphic disturbance of rock or soil and mechanical transport of those materials by gravity, wind, and water. For example, erosion triggered by mechanical disturbance that exposes contaminants not present at the surface before mining.

2.0 LINES OF EVIDENCE AND SITE DELINEATION METHODS

During the NORM-TENORM delineation at the Section 32 and 33 Mines, the following lines of evidence were examined using the processes described below:

- ***Mapped Mine Features:*** Mine features such as waste piles, mine shafts, and site-related transfer stations are defined as TENORM.
- ***Site History and Known Reclamation Activities:*** Reclamation features such as mine waste stockpiles are defined as TENORM.
- ***Transport Features:*** A downgradient assessment of transport from mine features toward surface water pathways where transport would be likely to occur.
- ***Gamma Radiation Data, Estimated Ra-226 Data, and Metals Data:*** Gamma radiation and estimated Ra-226 data were used to evaluate areas impacted by mining and where exposure to humans or the environment has increased. The distribution of concentrations of contaminants of concern and contaminants of ecological concern identified in the Section 32 and 33 Mines risk assessment was used to evaluate areas potentially impacted by mining and where potential exposure to humans or the environment has increased.
- ***Geologic Mapping:*** Undisturbed areas within the Poison Canyon Sandstone ore host rock unit are classified as NORM; no Poison Canyon Sandstone is exposed at the surface in the Section 32 and 33 Mines area.

3.0 SITE DELINEATION RESULTS

This section presents the results of the TENORM delineation. Figure B-1 through Figure B-10 show the lines of evidence, including supporting Section 32 and 33 Mines data and photographs, used to conduct the TENORM delineation.

At the Section 32 and 33 Mines, mapped site features and the raw Ra-226 concentrations (as converted from Section 32 and 33 Mines gamma survey data [Tetra Tech 2023]) were used as the primary lines of evidence for delineating TENORM. Figure B-1 presents the site features (including mine features, reclamation features, and transport features). Figure B-2 presents the estimated Ra-226 soil concentrations, and Figure B-3 and Figure B-4 present the selenium and uranium soil concentrations. All mine and reclamation features, including the haul road leading into the site, closed mine shafts, and the stockpile are mapped as TENORM.

The Section 32 and 33 Mines site lies within Quaternary alluvium, which consists of loose sediment and soil deposits on valley floor, with outcrops of the underlying Mancos Shale to the south. Underlying the Mancos Shale is the Morrison Formation and the Poison Canyon Sandstone within the middle Morrison Formation, which is considered the host rock unit for uranium. No Poison Canyon Sandstone is exposed at the surface in the Section 32 and 33 Mines area. Figure B-5 shows the different geologic units at the surface of the site.

No evidence of transport of mine waste contamination was found in surface water pathways downgradient of the site (Tetra Tech 2022, 2023; Weston 2019).

Figure B-6 through Figure B-8 show photographs of unreclaimed waste piles at the Section 33 Mine. The Section 32 stockpile is displayed in Figure B-9. Disturbed ground at the reclaimed Section 32/33 Transfer Station is shown in Figure B-10. All these site features are mining related and considered TENORM.

In summary, the following features and areas are considered TENORM at the Section 32 and 33 Mines:

- Unreclaimed waste piles
- The Section 32 stockpile
- Reclaimed mine shafts (included in the footprint of other site features)
- Contaminated surface soils surrounding site features resulting from transport of mine waste
- Haul road leading to the site

Not all TENORM features contain measured concentrations of Ra-226 above the background threshold value, which is the removal action goal at the Section 32 and 33 Mines. Only TENORM areas with Ra-226 concentrations above the background threshold value or that are considered sources of contamination are recommended for cleanup.

4.0 REFERENCES

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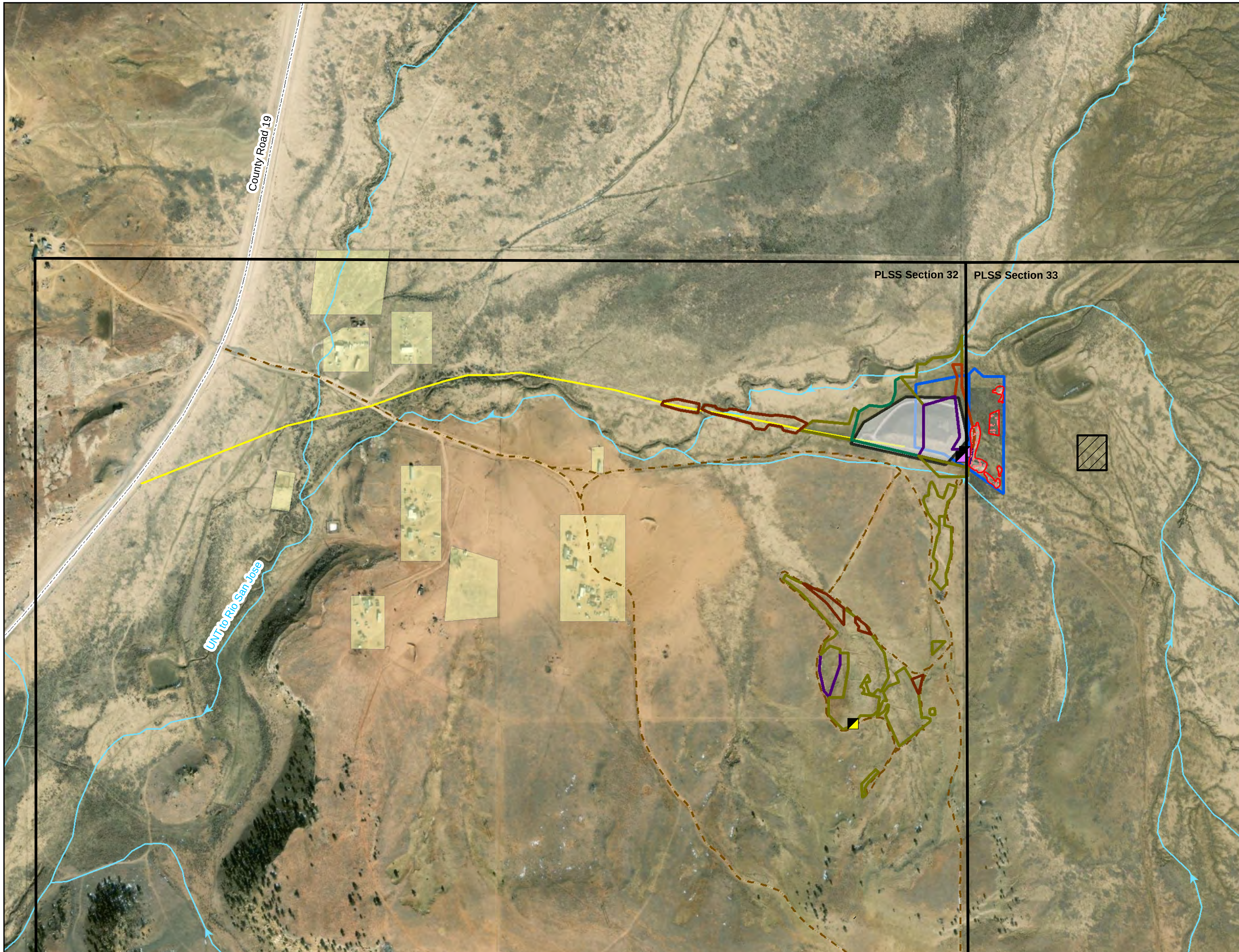
FIGURES



Site Features

- Closed Mine Shaft
- Closed Mine Vent
- Historic Haul Road
- Residential Feature
- Waste Stockpile Footprint
- Waste Pile

2012 Removal Action Areas

Excavation Depth (ft)

- 0.5 ft bgs
- 1 ft bgs
- 2 ft bgs
- 3 ft bgs
- 4 ft bgs
- Tronox AUM Site[1]
- Background Study Area
- PLSS Section Boundary / RSE Survey Area
- County Road
- Local Road
- Drainage

Notes:

[1] Boudary is from TSG (2007).

AUM	Abandoned uranium mine
bgs	Below ground surface
ft	Foot
PLSS	Public Land Survey System
RSE	Removal site evaluation
TSG	TerraSpectra Geomatics
UNT	Unnamed tributary

1 inch = 540 feet

1:6,476

0 250 500 1,000 Feet

N W E S

SECTION 32 AND 33 MINES SITE FEATURES

Prepared For: U.S. EPA Region 9

Prepared By: TETRA TECH, 1999 Harrison Street, Suite 500, Oakland, CA 94612

Task Order No.: 0031

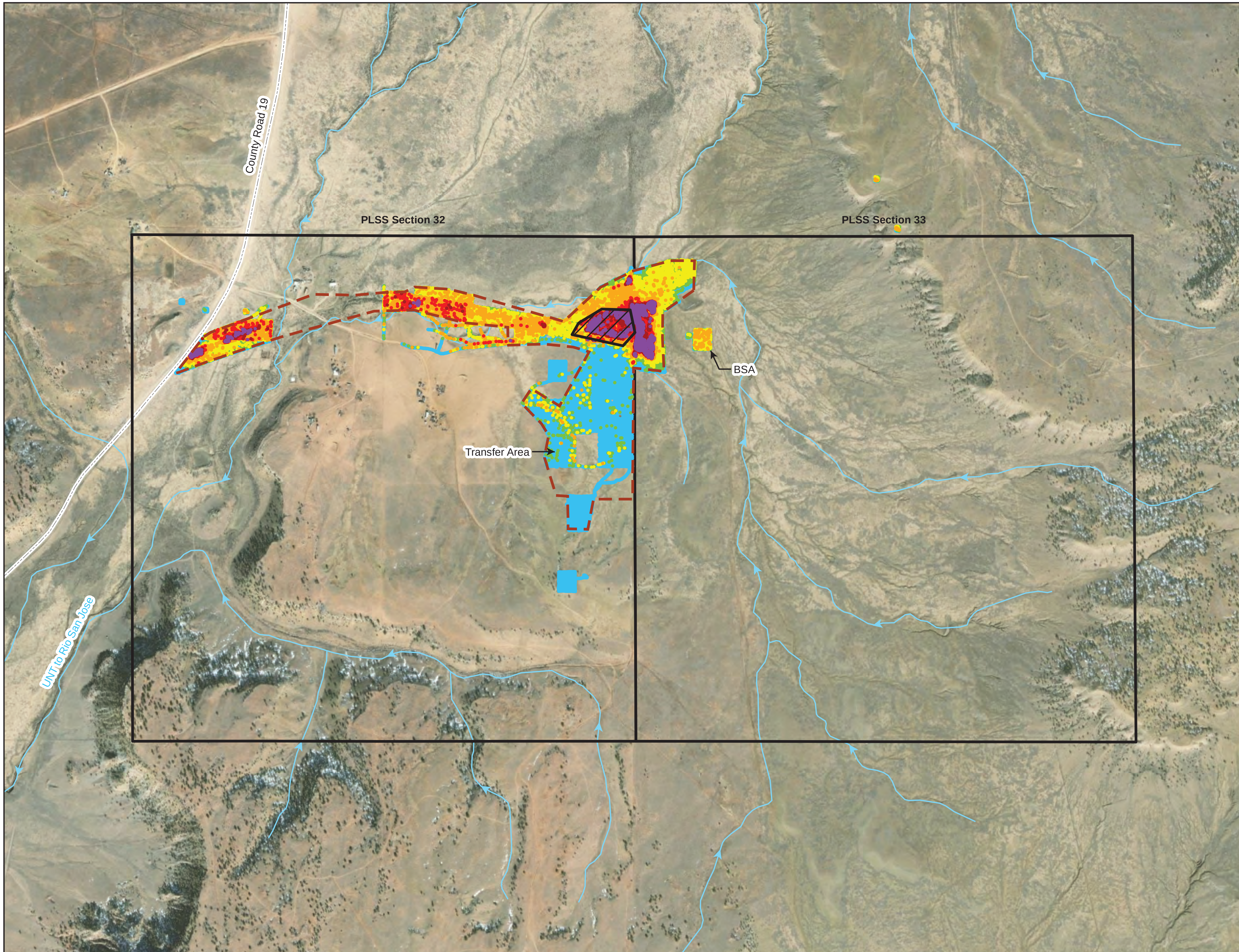
Contract No.: EP-S9-17-03

Location: NAVAJO NATION

Date: 6/7/2023

Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse

Figure No.: B-1



Estimated Radium-226 (pCi/g)[1]

≤ 1.66	≤ UCL
1.66 - 1.92	UCL - BTV (RAG)[2, 3]
1.92 - 3.32	BTV - 2 x UCL
3.32 - 4.98	2 x UCL - 3 x UCL
4.98 - 6.64	3 x UCL - 4 x UCL
6.64 - 8.30	4 x UCL - 5 x UCL
> 8.30	> 5 x UCL

TENORM Boundary
Waste Stockpile Footprint
PLSS Section Boundary / RSE Survey Area

Notes:
[1]Gamma survey data was collected by Weston Solutions, Inc. between June 26 and August 18, 2018.
[2]BTV is based on the 95 percent upper tolerance limit with 95 percent coverage of the background dataset.
[3]The RAG is equal to the BTV because the BTV is greater than the HH and Eco RBSLs.

BTV	Background threshold value
Eco	Ecological
HH	Human health
pCi/g	Picocurie per gram
PLSS	Public land survey system
RAG	Removal action goal
RBSL	Risk-based screening level
RSE	Removal site evaluation
TENORM	Technologically enhanced naturally occurring radioactive material
UCL	95 percent upper confidence limit on the mean of the background dataset
UNT	Unnamed tributary

1 inch = 1,000 feet

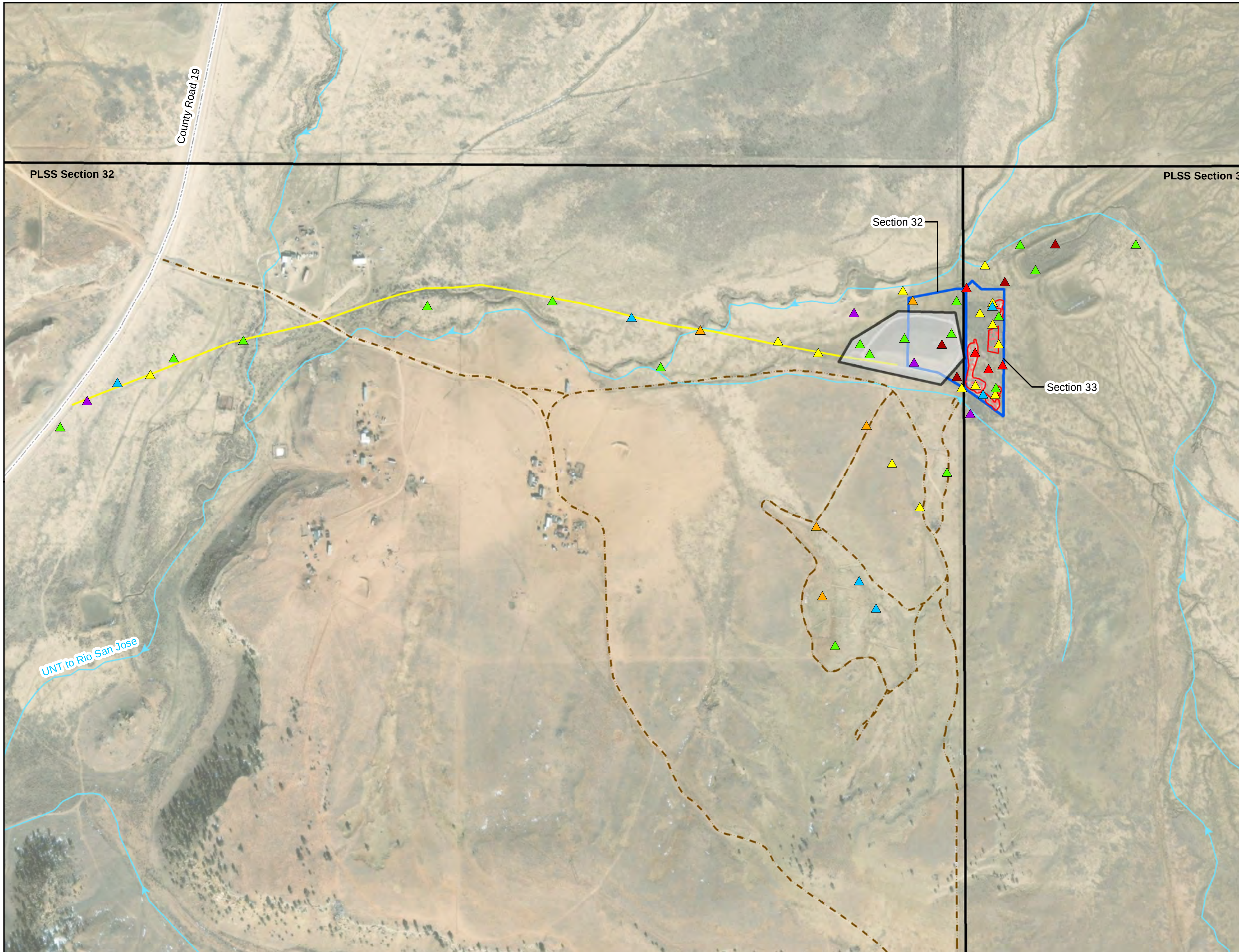
1:12,000

1,000 500 0 1,000 Feet

N W E S

SECTION 32 AND 33 MINES ESTIMATED RADIUM-226 SURFACE SOIL CONCENTRATIONS

Prepared For: U.S. EPA Region 9	Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612
Task Order No.: 0016	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 6/7/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: B-2



Selenium Surface Soil Concentration (mg/kg)

- 0.467000 - 1.050000
- 1.050001 - 1.670000
- 1.670001 - 2.260000
- 2.260001 - 3.420000
- 3.420001 - 4.750000
- 4.750001 - 10.500000
- 10.500001 - 16.800000
- Waste Stockpile Footprint
- Waste Pile
- Tronox AUM Site[1]
- PLSS Section Boundary / RSE Survey Area
- Historic Haul Road
- County Road
- Local Road
- Drainage

Notes:
[1] Boudary is from TSG (2007).

AUM	Abandoned uranium mine
mg/kg	Milligram per kilogram
PLSS	Public Land Survey System
RSE	Removal site evaluation
TSG	TerraSpectra Geomatics
UNT	Unnamed tributary

1 inch = 500 feet

1:6,000

0 250 500 1,000 Feet

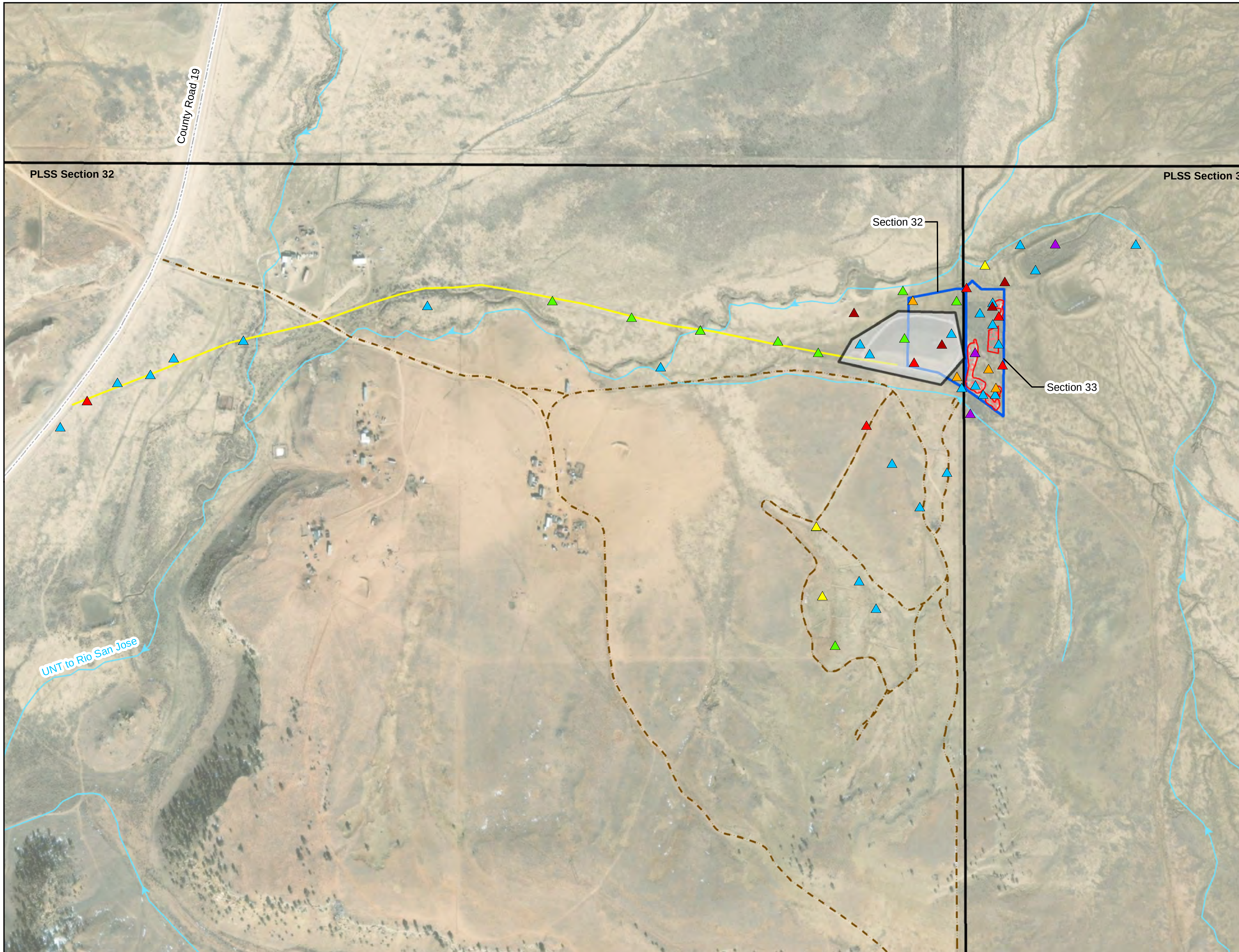
N S E W

SECTION 32 AND 33 MINES SELENIUM SURFACE SOIL DISTRIBUTION

Prepared For: U.S. EPA Region 9

Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612

Task Order No.: 0031	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 1/25/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: B-3



Uranium Surface Soil Concentration (mg/kg)

- 0.606000 - 1.610000
- 1.610001 - 2.740000
- 2.740001 - 4.760000
- 4.760001 - 9.410000
- 9.410001 - 18.800000
- 18.800001 - 32.400000
- 32.400001 - 78.000000
- Waste Stockpile Footprint
- Waste Pile
- Tronox AUM Site[1]
- PLSS Section Boundary / RSE Survey Area
- Historic Haul Road
- County Road
- Local Road
- Drainage

Notes:
[1] Boudary is from TSG (2007).

AUM	Abandoned uranium mine
mg/kg	Milligram per kilogram
PLSS	Public Land Survey System
RSE	Removal site evaluation
TSG	TerraSpectra Geomatics
UNT	Unnamed tributary

1 inch = 500 feet

1:6,000

0 250 500 1,000 Feet

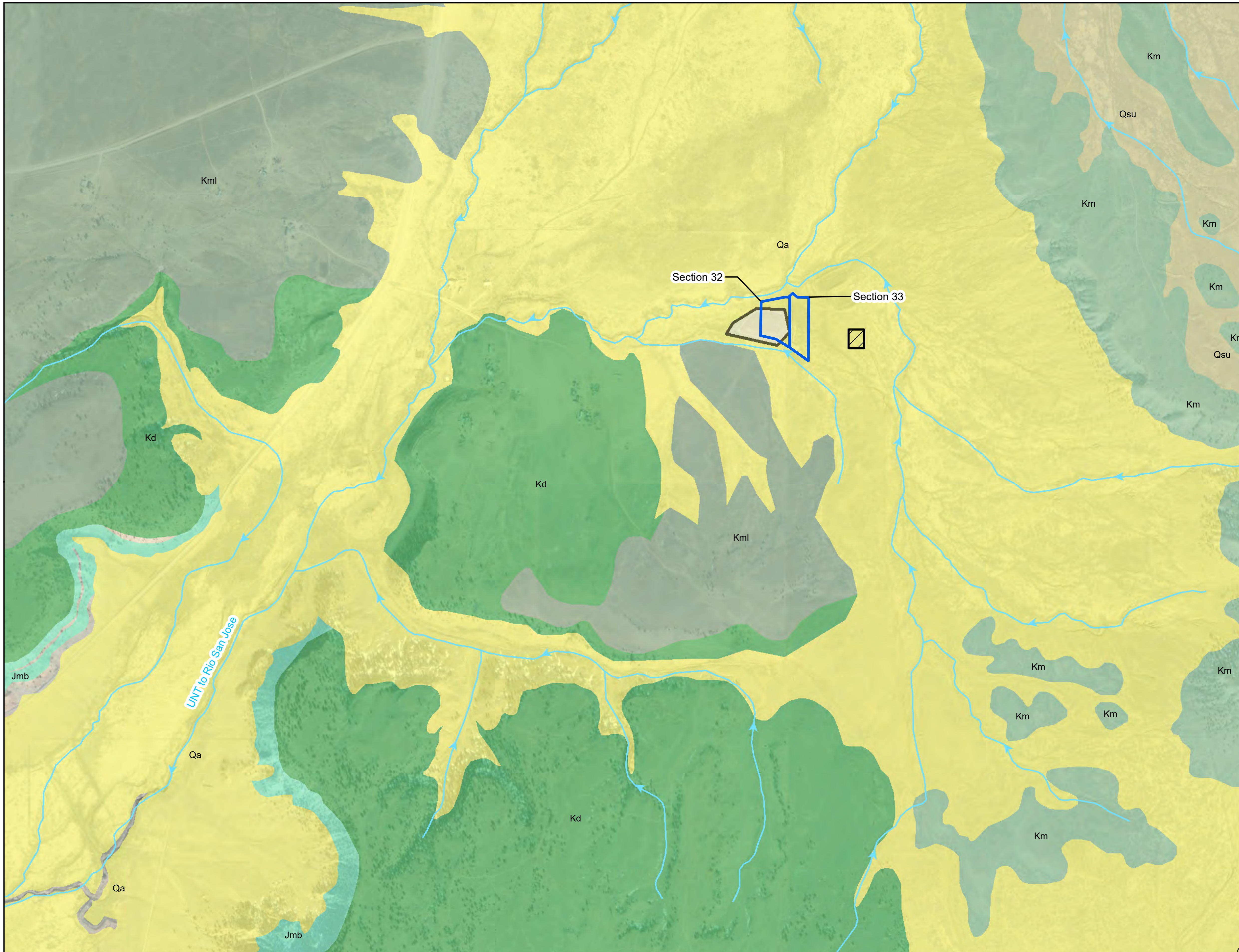
N S E W

SECTION 32 AND 33 MINES URANIUM SURFACE SOIL DISTRIBUTION

Prepared For: U.S. EPA Region 9

Prepared By: TETRA TECH, 1999 Harrison Street, Suite 500, Oakland, CA 94612

Task Order No.: 0031	Contract No.: EP-S9-17-03
Location: NAVAJO NATION	Date: 1/25/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: B-4



Geologic Units

Surficial Deposits

- Qa—Quaternary Alluvium
- Qsu—Upland Deposits

Cretaceous

- Km—Main body of Mancos Shale
- Kml—Lower part of Mancos Shale
- Kd—Dakota Sandstone

Jurassic

- Jmb—Brushy Basin Member of Morrison Formation
- Tronox AUM Site[1]
- Waste Stockpile Footprint
- Background Study Area
- Drainage

Notes:
[1] Boudary is from TSG (2007).
AUM Abandoned uranium mine
TSG TerraSpectra Geomatics
UNT Unnamed tributary

1 inch = 1,000 feet

1:12,000

0 500 1,000 2,000 Feet

N E S W

SECTION 32 AND 33 MINES

LOCAL GEOLOGY

Prepared For: U.S. EPA Region 9

Prepared By: TETRA TECH
1999 Harrison Street, Suite 500
Oakland, CA 94612

Task Order No.:	Contract No.:
0031	EP-S9-17-03
Location: NAVAJO NATION	Date: 6/7/2023
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: **B-5**

Figure B-6. Section 33 Mine Unreclaimed Waste Piles Facing Northeast

Figure B-7. Section 32 and 33 Mines Unreclaimed Waste Pile S33-01 Facing East

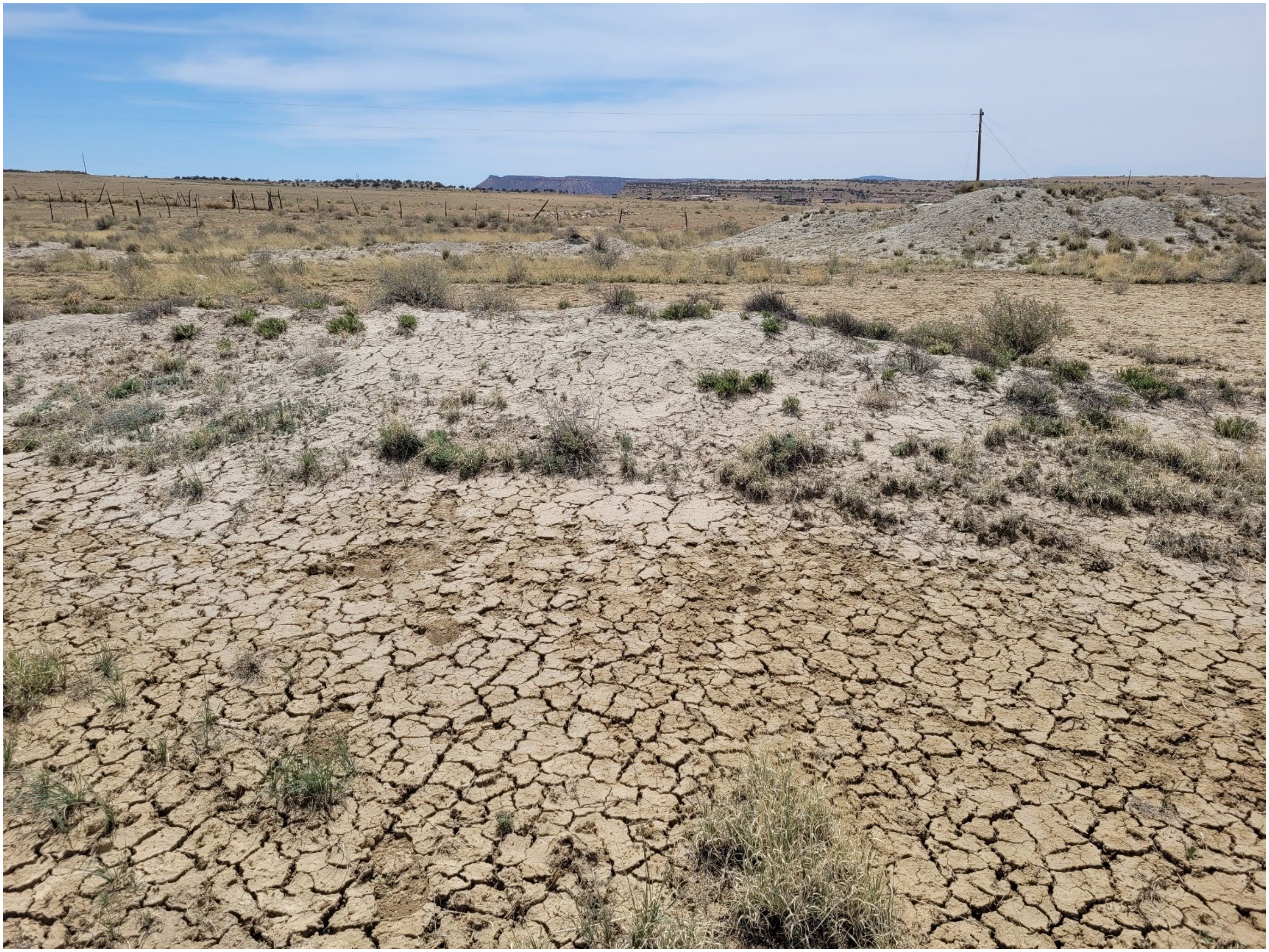


Figure B-8. Section 32 and 33 Mines Unreclaimed Waste Pile S33-02 Facing Southeast

Figure B-9. Section 32 Stockpile Facing East

Figure B-10. Reclaimed Section 32/33 Transfer Station Facing North with Disturbed Soil and No Vegetation

APPENDIX C

RISK ASSESSMENT

Section 32 and 33 Mines

Casamero Lake Chapter, Navajo Nation, New Mexico

Final

Appendix C

Risk Assessment

Response, Assessment, and Evaluation Services 2

Contract No. 68HE0923D0002

Task Order 003

March 2024

Submitted to

U.S. Environmental Protection Agency

Submitted by

Tetra Tech, Inc.

1999 Harrison Street, Suite 500

Oakland, CA 94612

TETRA TECH

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EXHIBITS

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ATTACHMENT

ACRONYMS AND ABBREVIATIONS

AUM	Abandoned uranium mine
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Contaminant of concern
COEC	Contaminant of ecological concern
COI	Constituent of interest
COPC	Contaminant of potential concern
COPEC	Contaminant of potential ecological concern
CSM	Conceptual site model
Eco-SSL	Ecological soil screening level
EE/CA	Engineering evaluation/cost analysis
EPC	Exposure point concentration
ERA	Ecological risk assessment
ERICA	Environmental Risks from Ionizing Contaminants: Assessment and Management
ESL	Ecological screening level
EU	Exposure unit
HHRA	Human health risk assessment
HQ	Hazard quotient
IUR	Inhalation unit risk
Kerr-McGee	Kerr-McGee Corporation
LANL	Los Alamos National Laboratory
LOEC	Lowest observed effect concentration
N3B	Newport News Nuclear BWXT-Los Alamos, LLC
NAUM	Navajo abandoned uranium mine
NNDFW	Navajo Nation Department of Fish and Wildlife
NNEPA	Navajo Nation Environmental Protection Agency
NOEC	No observed effect concentration
NORM	Naturally occurring radioactive material
ORNL	Oak Ridge National Laboratory
OSWER	Office of Solid Waste and Emergency Response
Ra-226	Radium-226
RfC	Reference concentration
RfD	Reference dose

ACRONYMS AND ABBREVIATIONS (CONTINUED)

RME	Reasonable maximum exposure
RSE	Removal site evaluation
RSL	Regional screening level
SE	Secular equilibrium
SF	Slope factor
SLERA	Screening-level ecological risk assessment
TENORM	Technologically enhanced naturally occurring radioactive material
Tetra Tech	Tetra Tech, Inc.
UCL95	95 percent upper confidence limit
USEPA	U.S. Environmental Protection Agency
Weston	Weston Solutions, Inc.

1.0 BACKGROUND AND ENVIRONMENTAL SETTING

The purpose of this Navajo Abandoned Uranium Mines (NAUM) program site-specific risk assessment is to estimate current and future human health risk under appropriate reasonable maximum exposure (RME) scenarios and ecological risk focused on the known ecosystems for the region. The results of the risk assessment are used to assist in removal action decisions at the Section 32 and 33 Mines. This NAUM risk assessment was performed using “Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act]” (U.S. Environmental Protection Agency [USEPA] 1993) and, thus, does not include or require all elements of a baseline risk assessment (USEPA 1989, 2001).

The human health risk assessment (HHRA) identifies candidate human health contaminants of concern (COC) for each exposure unit (EU) while the ecological risk assessment (ERA) identifies candidate contaminants of ecological concern (COEC) for each EU. The results of the risk assessments serve as lines of evidence in determining the extent of soil removal necessary at the Section 32 and 33 Mines to meet the removal action goals. See the NAUM risk assessment methodology (USEPA 2024b) for additional information for conducting risk assessments at NAUM sites.

The Navajo Nation contains areas of naturally high levels of uranium. Starting in the 1940s, large amounts of uranium were mined on the Navajo Nation. Mining has brought more uranium to the surface of the earth, making exposure to people, plants, and animals more likely. Uranium is a naturally occurring radioactive material (NORM), and the effects of mining can lead to the presence of technologically enhanced naturally occurring radioactive material (TENORM).

Examples of TENORM at the Section 32 and 33 Mines include mine shafts and unmapped underground workings, waste piles, mine debris, a transfer station, and a haul road. Reclamation of some of these mine features occurred during the 2012 removal action and are described in Section 2.2 of the main engineering evaluation/cost analysis (EE/CA) report.

1.1 MINE HISTORY AND LOCATION

The Section 32 and 33 Mines are located within the Casamero Lake Chapter of the Navajo Nation in the Eastern Abandoned Uranium Mine (AUM) Region. The site is 9 miles north of the Prewitt, New Mexico, exit on Interstate 40 at 35.490 degrees latitude and -108.017 degrees longitude in McKinley County, New Mexico. The elevation is approximately 7,000 feet above mean sea level. The Section 32 Mine is within Navajo Allotment Land, and the Section 33 Mine is privately owned. Figure C-1 shows the site location.

The Section 32 and 33 Mines are accessed from Prewitt, New Mexico, by traveling north on paved County Road 19 and then east on an unpaved access road. The unpaved access road passes by multiple residences and ends along the south boundary of the Section 32 Mine temporary stockpile. A fence borders the private property on the Section 33 Mine along the west boundary of the Section 33 Mine.

The Section 32 and 33 Mines were deep, dry underground mines accessed through near-vertical mine shafts. The mines were likely developed using underground room-and-pillar mining techniques to extract lenticular ore bodies containing uranium and vanadium (New Mexico Energy and Minerals Department 1979). Whether the pillars were salvaged and the rooms blasted closed is unknown. The Section 32/33 Transfer Station south of the main mining area was used for both mines.

Much of the waste produced at the Section 32 and 33 Mines is overburden that was piled near the mine shafts. Overburden is low-grade, native material that miners had to get through to access the ore. No surface features such as subsidence, fissures, or cracks that may indicate mine collapse were observed during the removal site evaluation (RSE) investigation (Weston Solutions, Inc. [Weston] 2019).

The Section 32 and 33 Mines were developed in the early 1960s by the Kerr-McGee Corporation (Kerr-McGee), a predecessor of Tronox. The Section 32 Mine was operated by Kerr-McGee from 1960 to 1969 and produced 20,117 tons of uranium ore (McLemore and Chenoweth 1991). The Section 33 Mine was operated by Kerr-McGee from 1960 to 1964 and produced 4,242 tons of uranium ore (McLemore and Chenoweth 1991). Both mines are reported to be last operated by the Cobb Nuclear Company. Section 32 and 33 Mines features, haul and exploratory roads, exploratory boreholes, and reclamation features are shown on Figure 3 of the main EE/CA report.

1.2 GEOLOGY, HYDROGEOLOGY, AND HYDROLOGY

The following subsections describe the geology, hydrogeology, and hydrology of the Section 32 and 33 Mines. For more information, see Section 2.1.5 of the main EE/CA report.

1.2.1 Geology

The Section 32 and 33 Mines are within the Smith Lake subdistrict of the Grants Mining District. The Grants Mining District is a belt of sandstone-hosted uranium deposits that stretches from the Pueblo of Laguna to the area of Gallup, New Mexico. Most uranium deposits in the Grants Mining District are found in sandstone members of the Jurassic-age Morrison Formation. In the Section 32 and 33 Mines area, the Morrison Formation is covered by younger Cretaceous-age sandstones and mudstones. Quaternary-aged sand, sediment, and soil deposits fill small stream valleys and cover floodplains. Figure 5 of the main EE/CA report presents the geology at the site and in the surrounding areas. The important geological units in and near the Section 32 and 33 Mines are listed in stratigraphic order (oldest to youngest) and described below:

- Morrison Formation:
  - The Recapture member is made of sandstone and claystone.
  - The Westwater Canyon member is made of sandstone and is the main host of uranium deposits in the portion of the Grants Mining District where the Section 32 and 33 Mines are located (Santos 1970). The Westwater Canyon member interfingers with both the Recapture and Brushy Basin members. One of the larger fingers of the Westwater Canyon member in the overlying Brushy Basin member is the Poison

Canyon Sandstone, which includes the ore horizon mined through the Section 32 and 33 Mines. The Poison Canyon Sandstone varies in thickness, and ore is known to be where the sandstone is 30 to 90 feet thick (Santos 1970).

  - The Brushy Basin member is made of green/gray mudstones and a minor amount of sandstone.

- Dakota Sandstone is made of sandstone with a minor amount of mudstone, coal, and conglomerate, and interfingers with the overlying Mancos Shale. The mesa to the south of the Section 32 and 33 Mines is primarily Dakota Sandstone.
- Mancos Shale is made of mudstone, claystone, and siltstone. A small amount of Mancos Shale outcrops at the surface within the Section 32 and 33 Mines area. The mesa to the east the Section 32 and 33 Mines is primarily Mancos Shale.
- Alluvium is the silt, sand, and gravel in small stream valleys and floodplains. Most of the surface geology at the Section 32 and 33 Mines is alluvium.

1.2.2 Hydrogeology

A series of drainages, formed from surface water flow from the surrounding mesas, are the main drainage pathways in the Section 32 and 33 Mines area. These drainages are dry most of the year and flood during monsoon season. The closest drainage to the Section 32 and 33 Mines is approximately 200 feet to the north and is shallow and southwest flowing.

Groundwater depth and information on nearby water wells used for drinking water were not available during the 2019 Weston RSE (Weston 2019). No drinking water wells were identified within 4 miles of the mine sites during the 2009 Weston site screening investigation (Weston 2009). Additional research into existing wells and groundwater depth will be part of the construction design at Section 32 and 33 Mines.

1.3 LAND USE

Several residences are located nearby the Section 32 and 33 Mines, and the closest residence is 2,000 feet to the west. The closest population center is the community surrounding the Casamero Lake Chapter House, which is approximately 9 miles northwest of the Section 32 and 33 Mines.

The area containing the Section 32 and 33 Mines is fenced off from active cattle grazing on the Section 33 private property. Resident use of the area near the Section 32/33 Transfer Station is evidenced by recently used access roads and a trash dump site. The flat terrain of the Section 32 and 33 Mines provides more potential locations for the siting of houses, hogans, corrals, or stock-loading ramps. Future land uses could include agricultural activities, commercial activities, and residential areas; however, for the HHRA, only the RME scenario is evaluated at each EU (USEPA 2024b). The following potential RME land uses are identified for the Section 32 and 33 Mines:

- **Kee'da'whíí tééh (full-time Navajo resident)** is defined as areas that are easily accessible and relatively flat and is the land use identified at the Section 32 Mine.

- **Residential** is the potential current and future land use identified for the private property at the Section 33 Mine.

See Section 2.3 for information on the EUs and receptors evaluated for each area of the Section 32 and 33 Mines.

1.4 ECOLOGICAL SETTING

The Section 32 and 33 Mines are in a remote area with a revegetated, previously disturbed mine area potentially providing habitat for ecological receptors. Wildlife inhabiting the site may directly ingest radionuclides and metals, which may then be transported to the organs within the wildlife receptors or other sites.

A natural resources survey was performed in November 2018 to identify protected species and general wildlife habitat and general vegetation and vegetative community types for the Section 32 and 33 Mine area (NV5, Inc. 2019). The survey found that shrub and grassland communities dominate the area around the Section 32 and 33 Mines and most closely resemble the Plains-Mesa Grassland community. The shrubby areas consisted of Great Basin Desert Shrub Saltbush communities. Arroyo Riparian vegetation is confined to the bottom of the intermittent waterways that cross through the study area, but waterways constitute less than 2 percent of the overall area.

The Section 32 and 33 Mines are within an Area 3 wildlife sensitive area, as identified by the Navajo Nation Department of Fish and Wildlife (NNDFW). Area 3 wildlife sensitive areas are classified as a less sensitive area containing a low and fragmented concentration of endangered and rare plant, animal, and game species on the Navajo Nation (NNDFW 2022). Therefore, development can proceed as recommended by NNDFW with few exceptions.

1.4.1 Climate

The Navajo Nation lies in a semi-arid climate with a high annual net pan evaporation rate of 54 inches per year. The nearby City of Gallup receives an average annual rainfall of 11 inches. Wind for 11 months of the year typically originates from the southwest, and in the month of August originates predominantly from the south. The winter average temperature is 29 degrees Fahrenheit with an average temperature in summer of 68 degrees Fahrenheit. Extreme heat in the summer (100 degrees Fahrenheit) and cold in the winter (-34 degrees Fahrenheit) can occur. Additional information on the climate at the Section 32 and 33 Mines is provided in Section 2.1.8 of the main EE/CA report.

1.4.2 Vegetation

Documented vegetative communities around the Section 32 and 33 Mines are Great Basin Desert Scrub (Saltbush, Blue Grama, Galleta, Western Wheat Grass), Great Basin Desert Scrub (Saltbush, Kochia, Gumweed, Various Weeds), and Arroyo Riparian (Rabbitbrush, Saltbush, Galleta). All of these are lowland communities that occur on mostly flat open ground. Most of the area has been heavily disturbed by mining activities in the past and is still impacted by cattle grazing. As a result, the overall vegetative cover and species diversity across much of this area is low (NV5, Inc. 2019). Vegetated areas at the site are expected to provide better habitat for terrestrial receptors because plants serve as a food source and provide areas of refuge.

1.4.3 Wildlife

Most of the habitat at the Section 32 and 33 Mines is terrestrial/upland, and the primary impacted environmental medium is soil. Several small drainages pass through the Section 32 and 33 Mines, but these do not support wetlands or a riparian corridor and appear to convey insufficient flows to justify augmentation (NV5, Inc. 2019). Stock ponds are also located near the site but are not surrounded by vegetation. Riparian and wetland habitats are particularly important for ecological health in arid ecosystems, such as that at the Section 32 and 33 Mines area.

In general, wildlife is not common across the Section 32 and 33 Mines. Fewer than 20 vertebrate species were documented at the site during the natural resources survey (NV5, Inc. 2019). Overall, birds were scarce in species diversity and numbers. Signs of large mammals were found only in the wooded areas around the periphery of the Section 32 and 33 Mines. Small mammals were also uncommon. Some of this lack of diversity and abundance is likely because of the time of year the survey was conducted (winter). However, many of the lowland Great Basin Desert Scrub communities were in poor condition with stunted shrub growth and very little herbaceous ground cover. Additionally, a substantial portion of the northern half of the Section 32 Mine is impacted by human activities and domestic predators, such as dogs. All these factors can reduce the quality of habitat for vertebrate species.

1.4.4 Special Status Species

Tetra Tech, Inc. (Tetra Tech) (2022) conducted a habitat assessment for the Section 32 and 33 Mines that reviewed the most recent species lists for the area provided by the U.S. Fish and Wildlife Service and NNDFW. All potential species in the area that are federally threatened, endangered, candidates for listing, or included on the Navajo Endangered Species List were evaluated for potential to occur at the site. The habitat assessment concluded that suitable habitat exists on the site for mountain plover (*Charadrius montanus*) and that a protocol-level biological survey will need to be completed within 2 years of any intrusive work. Proposed action for the Section 32 and 33 Mines will not likely have an adverse effect on mountain plover or on this species' designated critical habitats. A separate assessment may be required for construction activities that will occur over a longer time frame (>2 years) during any removal action. Future biological assessments will identify conservation measures for mountain plover and any other special status species identified during pre-construction surveys to protect the continued existence of these species in the Section 32 and 33 Mines area during the proposed removal action.

2.0 DATA USED IN THE RISK ASSESSMENT

Data compilation and management tasks conducted at the Section 32 and 33 Mines risk assessment included the selection of useable data and evaluation of sample depth intervals and selection of depth intervals to be evaluated. At this time, gamma data are not considered definitive data and, therefore, were not used in the risk assessment. However, gamma data were used to help delineate TENORM boundaries and will be used to define the risk-based footprint for removal decisions.

The compiled investigation data for the constituents of interest (COI) were reviewed to confirm that the appropriate data were used for the evaluation of each EU. Essential nutrients such as calcium, magnesium, potassium, and sodium are not retained as COIs. The data were separated by the depth intervals to be evaluated before calculating the exposure point concentrations (EPC) and other statistical values.

Figure C-2 presents the locations of the available soil samples used in the risk assessment for the Section 32 Mine. Figure C-3 presents the locations of the available soil samples used in the risk assessment for the Section 33 Mine.

2.1 AVAILABLE DATA

Evaluation of potential human and ecological exposure at the Section 32 and 33 Mines is limited to radionuclides and metals in soil. Table C-1 provides the summary of all sample results available for the risk assessment for the Section 32 and 33 Mines. Table C-2 provides the summary of the number of samples available for each EU at the Section 32 and 33 Mines. No speciation data are available for chromium; therefore, chromium is assumed to be 100 percent hexavalent chromium. Attachment C-1 presents the results of all available soil samples for the Section 32 and 33 Mines.

A data useability assessment is conducted to confirm that the useability of the laboratory data is consistent with USEPA guidance (1992b). Data validation of all results used in the risk assessment was performed per the guidelines for data review (USEPA 2004, 2020). Data validation reports were reviewed, and the following key data validation flags should be considered in the data reduction process:

- Estimated values (flagged with "J" qualifiers) are treated as detected concentrations.
- Rejected data (flagged with "R" qualifiers) are not included in the risk assessment datasets because of deficiencies in meeting quality control criteria. No data in the datasets were rejected.
- Results with final validation qualifiers containing a "U" or "UJ" are nondetect values included as part of the risk assessment datasets. The method reporting limit was used as the value for nondetect results. There are four selenium and five uranium results in the RSE results (Weston 2019) that are reported as nondetect, but the method reporting limit was not provided with the data. These four selenium and five uranium results were not included in the exposure evaluation of the risk assessment.

2.2 DATA REDUCTION METHODS

The metals and radiological data were queried to select the best result for each unique combination of sample media, location ID, sample date, and sample depth for which duplicate data exist. These procedures conservatively select one result for original and field duplicate pairs. For duplicate samples, the maximum detected concentration of the original and field duplicate result was selected as the result for use in the risk assessment. If both the original and field duplicate result are nondetect, the result associated with the lower reporting limit was used.

2.3 EXPOSURE UNITS

An EU is a geographic area where receptors (a person or animal) may reasonably be assumed to move at random and where contact across the EU is equally likely over the course of an exposure duration. The Section 32 and 33 Mines EUs were developed by identifying areas of contiguous TENORM contamination and anticipated future land use. Areas of NORM, such as natural mineralized outcrops and nonimpacted areas of the site, although not included in the TENORM boundary, were also included within the risk assessment boundary because a receptor would also be exposed to the NORM areas when at the site. See Section 2.3 of the main EE/CA report for descriptions of previous investigations and Section 2.4 of the main EE/CA report for the extent of contamination at the Section 32 and 33 Mines.

Based on the site evaluation and summarized in Table C-2, the following EUs were identified at the Section 32 and 33 Mines. The ERA is conducted on a site-wide basis; all HHRA EUs were combined to create the site-wide EU.

- **Section 32 Mine** – The Section 32 Mine is allotment land of the Navajo Nation. Several residences are located on the Section 32 Mine with the nearest residence located approximately 2,000 feet from the former mine site. Therefore, Kee'da'whíí tééh (full-time Navajo resident) was selected as the RME receptor for the HHRA.
- **Section 33 Mine** – The Section 33 Mine is privately-owned land that is currently used for livestock grazing. Most of the active mining took place at the Section 33 Mine, and waste piles are present on site. The property could be used for a residence in the future; therefore, the default resident (non-Navajo) was selected as the RME receptor for the HHRA.
- **Site-Wide** – A 490-acre area that encompasses all the human health EUs for evaluation of the ecological receptors at the Section 32 and 33 Mines.

The existing or anticipated future land use for an area is key in determining the potential receptors evaluated in the HHRA conducted for a site. Local chapters establish how areas within their jurisdiction can be used, and some lands have been designated as wildlife areas, which may restrict the type of future land use that is permitted. Section 32 and 33 Mines is classified as an Area 3 wildlife area; thus, development can proceed as recommended by NNDFW with few exceptions.

The RME receptor for each EU was selected based on the criteria provided in the NAUM risk assessment methodology (USEPA 2024b) and site knowledge. Figure C-2 and Figure C-3 provide the locations of samples used in the risk assessment for each EU.

2.4 EXPOSURE POINT CONCENTRATIONS

To calculate concentrations in environmental media (for example, surface soil) to which people and ecological receptors might be exposed, representative statistics are calculated from the data sets for each EU. The available soil data for the site were divided by the EUs identified in Section 2.3. Soil samples are further divided by sample depth to correspond to the surface and subsurface soil intervals evaluated in the risk assessment. Surface soil samples are those collected from 0 to 6 inches bgs while subsurface soil samples are those collected from 0 up to 72 inches bgs. As described in the NAUM risk assessment methodology (USEPA 2024b), these soil depths were selected to incorporate the use of more of the available data from the NAUM sites. A depth of 72 inches was selected for potential human health exposures because deeper soil could become exposed in the future by erosion. In addition, plants in desert settings commonly have roots to 72 inches bgs. Thus, uptake to plants from contamination at depth is a complete exposure pathway for both the HHRA and ERA. Furthermore, burrowing animals are evaluated in the ERA; 72 inches bgs is an appropriate exposure depth for evaluating these ecological receptors, which may be hunted by members of the Navajo Nation.

The process provided in Appendix D of the NAUM risk assessment methodology (USEPA 2024b) was used to calculate the EPC for each COPC. The approach and calculations for EPCs follow USEPA (1989, 1992c, 2000a, 2002) guidance. The 95 percent upper confidence limit (UCL95) of the mean values were calculated for each COPC using ProUCL 5.2 (USEPA 2022b). A minimum of 10 samples and 4 detected results are required to calculate the UCL95 of the arithmetic mean used as the EPC for a given contaminant. If the dataset was smaller than 10 samples or the number of detections was less than 4, the maximum detected concentration was used as the EPC. If a nonradioactive COPC was not detected in a sample when entering data into ProUCL, the sample reporting limit was used as the numerical value for EPC calculations.

2.5 EVALUATION OF SECULAR EQUILIBRIUM

A site-specific secular equilibrium (SE) evaluation was conducted on the Section 32 and 33 Mines dataset. A range of equilibrium conditions were observed; however, the overall conclusion is that uranium-238 is in SE with its decay products. When uranium-238 is in SE, site data for radium-226 in conjunction with uranium-238 in SE toxicity values can be used to calculate the risk for the entire uranium-238 decay chain (USEPA 2024a).

3.0 HUMAN HEALTH RISK ASSESSMENT

The HHRA evaluates whether site-related contaminants detected in soil pose unacceptable risks to potential current and future people at a site under conditions at the time of the EE/CA (unremediated conditions) (USEPA 1989). The HHRA results will serve, along with other factors (such as the ERA and the three National Oil and Hazardous Substances Pollution Contingency Plan and EE/CA criteria of feasibility, implementability, and cost), as a basis for risk management decisions. The HHRA is intended to provide input for risk management decision-making for a site while maintaining a conservative approach protective of people. The methodology for the HHRA is based on the NAUM risk assessment methodology (USEPA 2024b). Table C-1 through Table C-7 present data and analysis associated with the HHRA.

3.1 DATA EVALUATION AND IDENTIFICATION OF CONTAMINANTS OF POTENTIAL CONCERN

All samples collected between 0 and 72 inches below ground surface (bgs) and analyzed by a certified laboratory were used to screen for contaminants of potential concern (COPC) for the HHRA. Samples at Section 32 and 33 Mines were analyzed for metals and radionuclides. The maximum detected concentrations of contaminants were screened using the Kee'da'whíí tééh (full-time Navajo resident) soil screening levels using a target cancer risk of 1 in 1 million ($1{\times}10^{-6}$) and a noncancer target hazard quotient of 0.1 provided in the NAUM risk assessment methodology (USEPA 2024b). These conservative screening levels were used to ensure contaminants that could substantially contribute to cumulative risk are retained in the risk calculations and that the contaminants affecting the same target organ are accounted for in the noncancer hazard calculations. For contaminants with both cancer and noncancer health effects, the lower of the two screening levels was used for screening.

Any contaminant with a maximum detected concentration exceeding its COPC screening level is retained as a COPC for the HHRA risk calculations. Table C-1 provides the COPC screening for the available Section 32 and 33 Mines data. Based on the screening, the following contaminants were identified as COPCs and are included in the risk estimates in the HHRA: uranium-238 in SE, aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, manganese, selenium, thallium, uranium, and vanadium.

3.2 EXPOSURE ASSESSMENT

The exposure assessment is the process of measuring or estimating intensity, frequency, and duration of human exposure to a contaminant in the environment. The exposure assessment considers land use assumptions, discusses the mechanisms by which people might contact COPCs in environmental media, and characterizes exposure factors (for example, time on site). The intake assumptions are combined with the estimated concentration for each COPC at each EU, called the EPC (see Section 2.4), to quantitatively estimate the contaminant exposure for the receptors at a given EU. The EPCs used in the HHRA for each COPC for each EU and grouped by soil depth interval are presented in Table C-4. In accordance with USEPA (1989) guidance, an exposure assessment consists of three steps:

1. Characterization of the exposure setting (physical environment and potential receptors)

2. Identification of exposure pathways (constituent sources, exposure points, and exposure routes)
3. Quantification of pathway-specific exposures (receptor intake calculations using the EPC and exposure assumptions)

3.2.1 Conceptual Site Model

The risk assessment conceptual site model (CSM) describes the exposure setting and identifies potentially complete exposure pathways by which receptors (people, plants, and animals) could contact site-related contamination. The CSM is used throughout the site investigation and removal processes to (1) provide a framework for addressing potential risks, (2) evaluate the need for additional data acquisition activities, and (3) evaluate health risks and the need for corrective measures. As defined in Volume 1, Part A, of the “Risk Assessment Guidance for Superfund” (USEPA 1989), the following four elements are necessary to form a complete exposure pathway:

- A source or release from a source
- A mechanism of release and transport
- A point of contact for potential receptors
- An exposure route.

If any one of the four elements are missing, the exposure pathway is incomplete. In general, only potentially complete exposure pathways are evaluated in the HHRA.

The removal actions at NAUM sites are focused on removing soil as the source of contamination. Removal of contaminated soil should remove the source of contamination to surface water and groundwater. For the HHRA, exposure to surface water or groundwater is assumed to be minimal as water used for domestic purposes is supplied on the Navajo Nation. Water used in homes and for cattle is tested for contamination.

Soil and sediment data from 0 up to 72 inches bgs were used to evaluate potential risks to people. Drainages at the site are dry for most of the year; therefore, sediment results were evaluated as soil. See Section 1.4 of the main EE/CA report for further discussion on the sources and extent of contamination. The site-specific CSM for the Section 32 and 33 Mines is presented on Figure C-4.

3.2.2 Human Health Receptors, Exposure Pathways, and Exposure Parameters

The areas of concern for soil contamination at the Section 32 and 33 Mines are five unreclaimed waste piles, one temporary stockpile, and one former haul road. No mine waste has been removed from the Section 32 and 33 Mines. The current and future potential human receptors based on land use were identified at the Section 32 and 33 Mines as follows:

- Kee'da'whíí tééh (full-time Navajo resident) at the Section 32 Mine on the Navajo Nation
- Default resident (non-Navajo) at the Section 33 Mine on private property

Consistent with Superfund methodology, the risks and hazards related to removal activities at the site are anticipated to be managed within acceptable levels using engineering controls and personal protective equipment. Therefore, potential exposures to contaminants by removal action workers are not evaluated in the risk assessment, but worker protections should be included for removal actions at the site.

The CSM (Figure C-4) describes the exposure setting and identifies potentially complete exposure pathways by which people could contact site-related contamination.

Consistent with the NAUM risk assessment methodology (USEPA 2024b), the HHRA only evaluates the RME individual at an EU. Exhibit C-1 presents the RME receptor selected at each EU and a description of the exposure scenario.

Exhibit C-1. Receptor Evaluated at Each Exposure Unit

Exposure Unit	Receptor Name	Receptor Description
Section 32 Mine	Kee'da'whíí tééh (Full-Time Navajo Resident)	Members of the Navajo Nation (adult and child) that live full time at a site. Includes external exposure to radiation, incidental ingestion of soil, dermal exposure to soil (metals only), inhalation of soil or dust, ingestion of homegrown produce and gathered wild plants, and consumption of animal products from raised animals (meat, milk, eggs) and hunted animals (meat), as well as plant exposures (ingestion, dermal, and inhalation) from Other Diné Lifeways practices, including medicinal and ceremonial exposures.
Section 33 Mine	Default Resident (Non-Navajo)	Non-Navajo people that live full time at a site. Exposure pathways evaluated include external exposure to radiation, incidental ingestion of soil, dermal exposure to soil (metals only), and inhalation of soil or dust.

The following list provides the RME scenarios evaluated at the Section 32 and 33 Mines and the potentially complete human exposure pathways that apply to all land use types and receptors:

- Potential exposure to gamma radiation via external exposure
- Potential exposure to site-related contaminants in soil through the incidental ingestion, dermal contact, and inhalation

In addition, the RME receptor, Kee'da'whíí tééh (full-time Navajo resident), at the Section 32 Mine was evaluated for the following exposure pathways:

- Potential exposure to site-related contaminants in homegrown produce through ingestion
- Potential exposure to site-related contaminants in gathered plants via ingestion or inhalation or both and potential exposure to metals in gathered plants via dermal contact (the plant exposure pathway includes use of plants for medicinal and ceremonial purposes)
- Potential exposure to site-related contaminants in animal products (raised and hunted) via ingestion

3.2.3 Exposure Parameters

Exposure inputs for the Navajo receptors are based on the Navajo Nation Environmental Protection Agency (NNEPA) inputs for receptors evaluated at the NAUM sites. The Navajo receptor exposure parameters are provided in Table C-3, and the rationale for the exposure inputs provided by NNEPA are included as Attachment 1 of the NAUM risk assessment methodology (USEPA 2024b). Appendix B of the NAUM risk assessment methodology provides discussion of the non-standard exposure pathways evaluated in the Navajo-specific exposure scenarios, including selection of input parameters for plant and animal consumption pathways.

3.3 TOXICITY ASSESSMENT

The toxicity assessment describes the relationship between a dose of a contaminant and the potential likelihood of an adverse health effect. The purpose of the toxicity assessment is to quantitatively estimate the inherent toxicity of COPCs for use in risk characterization. Potential effects of contaminants are separated into two categories: cancer and noncancer effects. Some contaminants can cause cancer while others can cause noncancer health effects such as neurological problems, kidney disease, and thyroid disease. Some contaminants, such as arsenic, have both cancer and noncancer health effects. Potential health risks for radionuclide COPCs are evaluated only for cancer risks while metals COPCs are evaluated for both cancer risks and noncancer hazards as appropriate. No speciation data are available for chromium; therefore, chromium is assumed to be 100 percent hexavalent chromium.

3.3.1 Carcinogenic Effects

For carcinogens, such as radionuclides, USEPA assumes that no dose is low enough to not cause an adverse health effect and that the risk increases as the dose increases.

Potential carcinogenic effects resulting from human exposure to contaminants are estimated quantitatively using cancer slope factors (SF), which represent the theoretical increased risk per milligram of constituent intake per kilogram body weight per day (inverse of milligram per kilogram per day). Oral SFs are toxicity values for evaluating the probability of an individual developing cancer from oral exposure to contaminant levels over a lifetime. The oral SF is also used in the dermal exposure pathway with an absorption factor applied for the nonradioactive contaminants.

The inhalation unit risk (IUR) factor is defined as the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to a contaminant at a concentration of 1 microgram per cubic meter in air. SFs or IUR factors are used to estimate a theoretical upper-bound lifetime probability of an individual developing cancer from exposure to a potential carcinogen.

3.3.2 Noncarcinogenic Effects

Potential noncarcinogenic effects resulting from human exposure to contaminants are generally estimated quantitatively using chronic reference doses (RfD) and chronic reference concentrations (RfC). The RfD, expressed in units of daily dose (in milligrams per kilogram per day), is an estimate of the daily maximum level of exposure to human populations (including sensitive sub-populations) that is likely to be without an appreciable risk of deleterious effects

(USEPA 1989). The oral RfD is also used in the dermal exposure pathway with an absorption factor applied. USEPA has derived RfCs for inhalation exposures for some contaminants. An inhalation RfC is similar to an RfD. If the concentration of a contaminant in air to which a human is exposed is lower than the RfC, no appreciable risk for noncancer health effects results from that exposure.

3.3.3 Sources of Toxicity Values and Other Contaminant-Specific Parameters

The Superfund program hierarchy of human health toxicity values should be followed for selecting the toxicity values used in the HHRA (USEPA 2003). When developing the NAUM Risk Calculator used to generate the screening level tables, USEPA used toxicity values from the "Preliminary Remediation Goals for Radionuclides" (USEPA 2023b) and "Regional Screening Levels (RSL)" (USEPA 2023c, 2024a). USEPA established a hierarchy among the "Tier 3" sources identified in the toxicity value hierarchy memorandum (USEPA 2003) for use in the RSL tables and calculator (USEPA 2023c). This HHRA used the toxicity values used in the NAUM Risk Calculator (USEPA 2024c) and provided in Table 4 and Table 5 of the NAUM risk assessment methodology (USEPA 2024b) for radionuclides and metals, respectively.

3.4 RISK CHARACTERIZATION

In general, risk characterization proceeds by combining the results of the exposure and toxicity assessments. In standard Superfund HHRAs, exposures are calculated by use of medium-specific EPCs and a series of pathway-specific exposure parameters. These exposures are then multiplied or divided by analyte-specific toxicity factors (for example, SFs, unit risk factors, RfDs, and RfCs) to generate receptor- and exposure pathway-specific risks and hazards.

3.4.1 Estimates of Cancer Risk and Noncancer Hazard

Human health exposure factors were calculated for each applicable receptor and COPCs for all the potentially complete soil-related exposure pathways. For metal COPCs with both carcinogenic and noncarcinogenic toxicity, intake factors were calculated for both cancer and noncancer for each relevant exposure pathway. The methods, assumptions, and inputs for the calculation of the intake factors for the Navajo-specific scenario is provided in the NAUM risk assessment methodology (USEPA 2024b). Table C-5.1 and Table C-5.2 present the calculated cumulative cancer risk and noncancer hazard for each COPC for each EU by soil depth interval. That is, the risk is summed for all the exposure pathways relevant to each receptor. Table C-6 provides a summary of the cumulative risk by exposure pathway for each EU.

The intake factors used in the HHRA were calculated using the NAUM Risk Calculator (USEPA 2024c). The USEPA (2023c) RSL Calculator considers only direct soil exposures (for example, soil ingestion, dermal contact, and inhalation of fugitive dust). The NAUM Risk Calculator generates exposure pathway-specific cancer risks and noncancer hazards, including animal product and produce consumption pathways, and exposure pathways specific to the Navajo, as well as external exposure to radiation and direct exposure to radiation in soil through incidental ingestion and inhalation. The complete set of equations and inputs for calculating the exposure inputs for Navajo receptors is provided in the NAUM risk assessment methodology (USEPA 2024b).

The cumulative cancer risk for the age-adjusted adult and child receptors and noncancer hazards for the adult and child receptors for each EU and soil depth interval are provided in Table C-7 and summarized in Exhibit C-2.

Exhibit C-2. Cancer Risks and Noncancer Hazards

Exposure Unit	Soil Interval	Cancer Risk	Adult Noncancer Hazard	Child Noncancer Hazard
Section 32 Mine	Surface Soil	**1×10^{-2}**	**10**	**20**
	Subsurface Soil	**2×10^{-2}**	**10**	**20**
Section 33 Mine	Surface Soil	**2×10^{-3}**	0.5	**5**
	Subsurface Soil	**3×10^{-3}**	0.5	**5**

Note:
Bolded values exceed the target risk (1×10^{-4}) or target hazard quotient (1).

Candidate COCs are identified based on the cancer risk exceeding the target cancer risk of 1×10^{-4} or a noncancer hazard of 1 for the RME receptor at the EU. COPCs with a cancer risk within the USEPA risk range of greater than 1×10^{-6} to 1×10^{-4} are indicated on Table C-7. Target organ analyses were not performed for any scenario-media combination because no instances arose where the target organ hazard index exceeded 1 and no individual COPC had a hazard exceeding 1. Exhibit C-3 presents the candidate COCs for each EU as identified in Table C-7.

Exhibit C-3. Candidate COCs Identified Based on Cancer Risks and Noncancer Hazards

Exposure Unit	Soil Interval	Cancer Risk	Noncancer Hazard
Section 32 Mine	Surface and Subsurface Soil	Uranium-238 in SE Arsenic Chromium[1]	Arsenic Cobalt Iron Manganese Thallium Uranium
Section 33 Mine	Surface and Subsurface Soil	Uranium-238 in SE	Uranium

Notes:
1 No speciation data are available for chromium; therefore, chromium is assumed to be 100 percent hexavalent chromium.
COC Contaminant of concern
SE Secular equilibrium

3.4.2 Uncertainty Associated with the Human Health Risk Assessment

Uncertainties are inherent in the process of quantitative risk assessments based on the use of environmental sampling results, assumptions regarding exposure, and the quantitative representation of contaminant toxicity. Analysis of the critical areas of uncertainty in a risk assessment provides a better understanding of the quantitative results through the identification of the uncertainties that most significantly affect the results.

USEPA (1989) guidance stresses the importance of providing an in-depth analysis of uncertainties so that risk managers are better informed when evaluating risk assessment conclusions. Potentially significant sources of uncertainty for this risk assessment are discussed in the following subsections. The NAUM risk assessment methodology (USEPA 2024b) provides more general HHRA uncertainty discussions for topics applicable to all NAUM sites.

3.4.2.1 Uncertainty in Sample Design

The sampling collection for the site was not based on a random sampling design. Instead, sampling was biased toward known areas of contamination based on the results of gamma surveys. Thus, while some areas do not have the same level of sampling coverage as others, those areas are not likely to have high levels of contamination based on the site survey techniques employed before collection of discrete samples for laboratory analysis. The uncertainty associated with the sample collection is moderate, but the samples used in the risk assessment are likely to overestimate the actual site risk because of the biased nature of the samples collected at the site.

3.4.2.2 Uncertainty in the Conceptual Site Model

The CSM for the Section 32 and 33 Mines incorporates several assumptions regarding the completeness and reasonableness of the exposure scenarios presumed at the site. The primary assumptions seem evidently valid. Examples include:

- Potential future use of areas within the Section 32 Mine for Kee'da'whíí tééh (full-time Navajo resident) — Examples of nearby full-time residences on the Navajo Nation are available.
- Potential future use of the mine areas within the Section 33 Mine for a default (non-Navajo) resident — Examples of nearby full-time residences are available, and no restrictions are in place to prevent building a residence on the site.

The NAUM Risk Calculator (USEPA 2024c) used to calculate the risk and hazards incorporates numerous Navajo-specific exposure pathways. Therefore, any potential to underestimate total exposure by a Kee'da'whíí tééh (full-time Navajo resident) receptor is expected to be small to moderate.

The risk and hazards for the default resident (non-Navajo) were calculated using standard exposure parameters that are based on average expected exposures and are backed by peer-reviewed studies. Therefore, any potential to underestimate total exposure by a default resident receptor is expected to be minimal.

An overall cumulative site-wide risk and hazard was not calculated for the Section 32 and 33 Mines because both areas used a residential receptor and adding the receptors to each other is not appropriate.

3.4.2.3 Uncertainty in Use of Hexavalent Chromium Toxicity for Chromium

Hexavalent chromium is not expected to be present in large concentrations at former uranium mining sites because site operations did not concentrate or use hexavalent chromium. The assumption of 100 percent hexavalent chromium overestimates the cancer risk from samples analyzed for total chromium by an unknown amount.

3.4.2.4 Uncertainty in Exposure Parameters

Values assumed for most of the exposure parameters used in the calculation of intakes were based primarily on default parameters recommended by USEPA (2023b, 2023c) guidance. These assumptions might result in under- or overestimating the intakes calculated for specific receptors, depending on the accuracy of the assumptions relative to actual site conditions and land uses. The NAUM risk assessment methodology (USEPA 2024b) provides discussion of the uncertainties associated with the Navajo receptors evaluated.

A default residential receptor was selected for the private property at the Section 33 Mine. If this receptor is less conservative than the actual future land use (for example, the land is not used for residential), the HHRA would not be protective. Likewise, if the future land use is less intensive than the receptor selected (for example, agriculture), the HHRA would be overly protective.

At other NAUM sites, the risk and hazards to RME receptors from different EUs were added as possible and reasonable. However, only two EUs are identified at the Section 32 and 33 Mines and both are evaluated for residential receptors. Thus, the risk and hazards from the individual EUs are not appropriate to add together for a site-wide HHRA.

4.0 ECOLOGICAL RISK ASSESSMENT

An ERA is the process for evaluating how likely the environment will be impacted as a result of exposure to one or more environmental stressors, such as radionuclides or metals. The objective of the ERA is to evaluate whether ecological receptors may be adversely affected by exposure to contaminants. The ERA is intended to provide input for risk management decision-making at each site while maintaining a conservative approach protective of ecological populations and communities. This ERA follows the guidelines in the NAUM risk assessment methodology (USEPA 2024b).

As described in USEPA (1993) EE/CA guidance, a risk assessment is used to help justify a removal action, identify what current or potential exposures should be prevented, and focus on the specific problem that the removal action is intended to address. NAUM ERAs include a screening-level ecological risk assessment (SLERA) and SLERA refinement. The SLERA includes Steps 1 and 2 of USEPA's eight-step ERA process (USEPA 1997) and is intended to provide a conservative estimate using maximum site concentrations of potential ecological risks and compensate for uncertainty in a precautionary manner by incorporating conservative assumptions. The SLERA refinement includes a refinement of Steps 1 and 2 and is intended to provide additional information for risk managers. Candidate COECs are identified based on the results of the SLERA refinement for soil. Table C-1, Table C-2, and Table C-8 through Table C-12 present data and analysis associated with the ERA.

Consistent with standard risk assessment practice and USEPA (1992a, 1998, 2022a) guidance, the ERA is presented in three major phases:

- Problem formulation
- Analysis of exposure and effects
- Risk characterization

4.1 PROBLEM FORMULATION

The problem formulation phase is a planning and scoping process that establishes the goals, breadth, and focus of the risk assessment. The product of the problem formation is a CSM that identifies the environmental values to be protected (assessment endpoints), data needed, and analyses to be used. The components of the problem formulation include:

- Ecological habitat and biological resources
- Stressors and COI selection
- Potentially complete exposure pathways
- Assessment endpoints
- Measurement endpoints
- Ecological CSM

The SLERA includes the screening-level problem formulation (Step 1), exposure estimation, effects evaluation, and screening-level risk calculation (Step 2) of the USEPA risk assessment process. The maximum detected concentration across the site is used as the EPC in the SLERA, which is compared with the minimum no observed effect concentration (NOEC) for all ecological receptors. The product of the SLERA is a list of contaminants of potential ecological concern (COPEC) in affected media that are recommended for further ecological assessment.

The SLERA refinement provides additional information for risk managers. For plants and invertebrates, the SLERA refinement includes a point-by-point comparison of individual sample results to plant and invertebrate NOECs. For free-ranging birds and mammals, the SLERA refinement uses an estimate of the average concentration as the EPC to represent exposure to free-ranging birds and mammals and includes a comparison of the EPC with the minimum NOEC for birds and mammals.

At the conclusion of the SLERA refinement, the candidate COECs are identified. Analytes with any individual sample results exceeding the plant and invertebrate NOEC will be identified as candidate COECs for plants and invertebrates, and analytes with a refined hazard quotient (HQ) equal to or greater than 1.0 will be identified as candidate COECs for birds and mammals. These analytes are called candidate COECs (rather than COECs) because the analytes have not yet undergone a background evaluation, which will be completed in the EE/CA. The background evaluation should not be performed as part of the risk assessment.

4.1.1 Ecological Habitat and Biological Resources

The ecological habitat and biological resources at the Section 32 and 33 Mines are described in Section 1.4. The Section 32 and 33 Mines are within an Area 3 wildlife sensitive area.

4.1.2 Stressors and Constituents of Interest Selection

All detected metals and radionuclides in soil and surface water were considered COIs in this SLERA. Essential nutrients that are not priority pollutants, such as calcium, magnesium, potassium, and sodium, were not retained as COIs. No speciation data are available for chromium; therefore, chromium is assumed to be 100 percent hexavalent chromium. See Section 2.4 of the main EE/CA report for further discussion on the sources and extent of contamination.

Soil was sampled from each EU. Samples collected within soil (0 to 6 and 0 to 72 inches bgs) were used in the risk assessment as described in Section 2.0.

4.1.3 Potentially Complete Exposure Pathways

A contaminant must be able to travel from the source to the representative receptor and must be taken up by the receptor through one or more exposure routes for an exposure pathway to be considered complete. Potential exposure pathways that may result in receptor contact with contaminants in the environment include soils, sediment, surface water, groundwater, air, and food-chain transfer. Soil and sediment are the primary exposure media of concern. Potential exposure pathways are shown in the wire diagram CSM (Figure C-4). Discussion of the exposure pathways for ecological receptors at NAUM sites is provided in the NAUM risk assessment methodology (USEPA 2024b).

Soil exposures are evaluated in the SLERA for the Section 32 and 33 Mines. The removal actions at NAUM sites are focused on removing soil as the removal of contaminated soil should remove the source of contamination to surface water and groundwater. Exposure to surface water or groundwater is assumed to be minimal because the presence of surface water at the Section 32 and 33 Mines is intermittent and groundwater is too deep for ecological receptors to access.

4.1.4 Assessment Endpoints

USEPA (1997) defines assessment endpoints as explicit expressions of the actual environmental values (for example, ecological resources) that are to be protected. Assessment endpoints are environmental characteristics that, if impaired, would indicate a need for action by risk managers.

The assessment endpoints identified for evaluation in the SLERA were based on the ecological habitat, stressors and COPECs, and potentially complete exposure pathways identified in Section 4.1.3 and depicted on the CSM (Figure C-4). Each assessment endpoint is intended to protect the local populations of the identified resources. The assessment endpoints used to evaluate the potential ecological risk to receptors typical of the area at the Section 32 and 33 Mines were:

- Protection of terrestrial plants
- Protection of terrestrial invertebrates
- Protection of herbivorous birds
- Protection of insectivorous birds
- Protection of carnivorous birds
- Protection of herbivorous mammals
- Protection of insectivorous mammals
- Protection of carnivorous mammals

4.1.5 Measurement Endpoints

Measurement endpoints related to the assessment endpoints were identified because assessment endpoints are usually not amenable to direct measurement. USEPA (1997) defines a measurement endpoint as a measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint and is a measure of biological effects (such as mortality, reproduction, or growth). Measurement endpoints for soil and sediment for both radionuclides and metals are described below.

For radionuclides in soil, ecological screening levels (ESL) for the NAUM program were developed by Tetra Tech (Appendix F of the NAUM risk assessment methodology [USEPA 2024b]). An ecological radiation dose assessment was performed for radionuclides in the uranium-238 decay chain using the dose assessment model Environmental Risks from Ionizing Contaminants: Assessment and Management (ERICA). The ERICA model is scientifically robust, follows approaches recommended by the International Commission on Radiation Protection for radiation protection of the environment, and provides dose assessment for uranium-238 and all its decay progeny. Using the ERICA Tool (Brown and others 2008; Larsson 2008), ESLs were calculated for the following radionuclides or groups of radionuclides in soil for terrestrial organisms:

- Uranium-238 in SE (adjusted radium-226) adjusted to account for the entire uranium-238 decay chain
- Radium-226 in SE (adjusted radium-226) adjusted to account for radium-226 and decay products
- Individual radionuclides uranium-238, uranium-234, and thorium-230

ESLs are based on dose rates where no effects have been observed and, therefore, are NOECs. For all radionuclides, the limiting ESLs are for lichen-bryophytes and small burrowing animals at 4 and 6 picocuries per gram, respectively. The ESLs are designed for use for comparison with radium-226 site concentrations. Use of site data for radium-226 reduces the number of analytical methods needed to evaluate risks from radionuclides. Furthermore, radium-226 concentrations can be correlated to gamma survey results, which provides an efficient and reliable way to evaluate the extent of radiation contamination.

For metals for soil, USEPA (2023a) ecological soil screening levels (Eco-SSL) are used as the primary source for NOEC levels. Eco-SSLs are available for the protection of terrestrial plants, invertebrates, birds, and mammals from the three primary feeding groups (herbivores, insectivores, and carnivores). The Eco-SSLs for soil-dwelling invertebrates and plants are based on direct contact with soil by plants and soil-dwelling organisms living in impacted soil. The Eco-SSLs for upper-trophic-level wildlife are based on incidental ingestion of soil and ingestion of food sources that have bioaccumulated contaminants. The no effect Eco-SSL is based on a no-observed-adverse-effect-level-based toxicity reference value that is protective of wildlife populations and sensitive individuals because it represents an exposure that is not associated with an adverse effect. The Eco-SSLs are intended to be conservative screening values that can be used to eliminate contaminants not associated with unacceptable risks (USEPA 2005).

Where a USEPA Eco-SSL is not available for a COPEC and receptor combination (for example, total mercury, thallium, and uranium), a no-observed-adverse-effect-level-based toxicity value from the Los Alamos National Laboratory (LANL) EcoRisk database (Newport News Nuclear BWXT-Los Alamos, LLC [N3B] 2022) is selected as the screening level. The LANL EcoRisk database includes ESLs for plant, invertebrate, avian, and mammalian receptors. Soil invertebrate and plant screening levels were also taken from the Oak Ridge National Laboratory (ORNL) (Efroymson, Will, and Suter II 1997; Efroymson, Will, Suter II, and Wooten 1997) if a screening level was not available as an Eco-SSL or from the LANL EcoRisk database. No Eco-SSL or LANL values for mammals were available for molybdenum; therefore, screening values were taken from ORNL's "Preliminary Remediation Goals for Ecological Endpoints" (Efroymson, Suter II, Sample, and Jones 1997).

The screening levels selected from USEPA Eco-SSLs (USEPA 2023a), LANL ESLs (N3B 2022), and ORNL (Efroymson, Will, and Suter II 1997; Efroymson, Will, Suter II, and Wooten 1997) for metals and developed from ERICA (for radionuclides) for use in the SLERA screening are the lowest NOECs for all receptor groups (that is, the lowest of the plant, invertebrate, bird [herbivorous, insectivorous, and carnivorous], and mammal [herbivorous, insectivorous, and carnivorous] NOECs) for each COPEC. The screening levels are provided in Table C-8.

4.1.6 Conceptual Site Model

The CSM illustrates exposure pathways to be evaluated in the SLERA and provides other key information such as contaminant sources, release and transport mechanisms, and the relative importance of exposure pathways to specific receptor groups. The CSM incorporates all components of the problem formulation as discussed above and illustrated on Figure C-4.

4.2 ANALYSIS OF EXPOSURE AND EFFECTS

In the analysis phase, exposure to stressors (metals and radionuclides) and their relationship to ecological effects are evaluated. A determination is made of (1) the degree to which ecological receptors are exposed and (2) whether that level of exposure is likely to cause harmful ecological effects.

4.2.1 Exposure Estimates

For the SLERA, a single site-wide exposure area that included all data collected within the Section 32 and 33 Mines was used for the evaluation of potential risk to ecological receptors. Exposure estimates for the SLERA for soil are the maximum detected concentrations for COIs in soil compared to the minimum screening levels for all receptors (plants, invertebrates, birds [herbivorous, insectivorous, and carnivorous], and mammals [herbivorous, insectivorous, and carnivorous]). For each detected analyte, the maximum detected concentrations used in the SLERA for each COPEC are presented in Table C-8.

Following the comparison of the maximum detection to the NOEC, a SLERA refinement of exposure was completed by assessing site data within surface and subsurface soils and using the UCL95 (for analytes where sufficient data were available) instead of the maximum concentration to evaluate risk to free-ranging receptors (birds and mammals) for the assessment of wildlife. Surface and subsurface soils include depth intervals of 0 to 6 inches bgs for surface soil and 0 to 72 inches bgs for subsurface soil (see Section 2.1). The EPCs used in the SLERA refinement for birds and mammals for each COPEC were calculated per the procedure in Section 2.4 and are presented in Table C-9. For the SLERA refinement for plants and invertebrates, individual sample concentrations are used in a point-by-point comparison.

4.2.2 Ecological Effects

Ecological effects of potential concern are those that can impact populations by causing adverse effects on development, reproduction, and survival (USEPA 1997). Literature-based effects concentrations (NOECs) as described in Section 4.1.5 were used in the SLERA to characterize potential effects from direct contact and uptake through the food web to terrestrial ecological receptors, including vegetation, soil invertebrates, birds, and mammals.

For the SLERA, an HQ was calculated as the ratio of the maximum contaminant concentration to the screening level (NOEC) by COPEC and receptor. HQs equal to or greater than 1.0 indicate potential unacceptable risk to plants, invertebrates, birds, and mammals based on a conservative comparison of the maximum detected concentration to the minimum NOEC-based screening level for all receptors. HQs less than 1.0 indicate little to no potential ecological risk for a given COPEC, and the COPEC is excluded from further consideration (that is, the COPEC was not evaluated in the Refined SLERA). The SLERA HQ was calculated as follows:

$$\text{SLERA HQ} = \frac{\text{Maximum Detected Concentration}}{\text{Screening Level (NOEC or ESL)}}$$

To better understand potential risk to free-ranging receptors, the site-wide EPC (based on the lesser of the UCL95 and maximum detected concentration) will be used as a refinement in the SLERA refinement using NOECs based on birds and mammals. The refined SLERA HQ is calculated as follows:

$$\text{Refined SLERA HQ} = \frac{\text{EPC}}{\text{Screening Level (NOEC or ESL)}}$$

Because plant and soil invertebrates are not mobile, concentration data from each sample location should be compared to the plant and invertebrate NOEC-based screening levels in a separate table.

4.3 RISK CHARACTERIZATION

In the risk characterization phase, potential risk is estimated through integration of exposure and effects, potential risks are considered in the context of uncertainties associated with the SLERA, and risk descriptions are provided.

4.3.1 Screening-Level Ecological Risk Assessment for Contaminants of Potential Ecological Concern

HQs, which represent the ratio of the maximum detected concentration in the environmental medium to the screening levels, are presented in Table C-8. Contaminants in soil that have an HQ greater than or equal to 1.0 were uranium-238 in SE, antimony, arsenic, barium, chromium, lead, manganese, nickel, selenium, thallium, uranium, vanadium, and zinc.

4.3.2 Screening-Level Ecological Risk Assessment Refinement

The SLERA refinement incorporates components of Step 3 of USEPA’s eight-step ERA process to refine the soil risk estimates from the SLERA (USEPA 2000b, 2001). The SLERA refinement involves assessing plants and invertebrates on a point-by-point basis and wildlife (birds and mammals) based on a refined EPC.

4.3.2.1 Plants and Soil Invertebrates

Plants and soil invertebrates are not mobile; therefore, comparison of the UCL95 to the NOEC may not appropriately assess whether potential unacceptable risk to plants and invertebrates exists. Therefore, a comparison on a point-by-point basis using the plant and invertebrate NOECs is required. COPECs are identified as candidate COECs if at least one sample result exceeds the plant or soil invertebrate NOEC for surface soil or the plant NOEC for subsurface soil. Table C-10 presents a comparison of individual surface soil sample results to NOECs for the plant and invertebrate communities and of individual subsurface soil sample results to NOECs for the plant communities (invertebrates are not exposed to soil at depths greater than 6 inches bgs). For plants and invertebrates, analytes with any individual sample results exceeding the plant and invertebrate NOEC are identified as candidate COECs.

Candidate COECs for plants were uranium-238 in SE, barium, chromium, manganese, selenium, thallium, uranium, and vanadium (surface only). Candidate COECs for invertebrates in surface soil were arsenic, chromium, and selenium.

4.3.2.2 Birds and Mammals

For free-ranging wildlife, the EPCs are calculated on a site-wide basis for contaminants with analyte-specific HQs that are equal to or greater than 1.0 in the SLERA. SLERA refinement risk estimates are calculated by dividing EPCs by the minimum NOEC or ESL for birds and mammals for each COPEC in surface soil and by dividing EPCs by the NOEC or ESL for mammals in subsurface soil (birds and nonburrowing mammals are not exposed to soil at depths greater than 6 inches bgs).

Table C-11 and Table C-12 present HQs for birds and mammals, respectively. Candidate COECs for birds and mammals are identified for analytes with HQs greater than 1.0 based on the comparison of the EPC (UCL95) to the minimum screening level (minimum NOEC or ESL for wildlife).

Candidate COECs for birds were lead, selenium, vanadium, and zinc. Candidate COECs for mammals were uranium-238 in SE, antimony, nickel, and selenium.

4.3.3 Candidate Contaminants of Ecological Concern

Candidate COECs were identified based on available laboratory and toxicological data for the Section 32 and 33 Mines. The SLERA results indicate that risk is above a level of concern for the contaminants listed in Exhibit C-4.

Exhibit C-4. Site-Wide Candidate COECs

Exposure Unit	Soil Interval	Contaminant												
		Uranium-238 in SE	Antimony	Arsenic	Barium	Chromium[1]	Lead	Manganese	Nickel	Selenium	Thallium	Uranium	Vanadium	Zinc
Plants	Surface	X	--	--	X	X	--	X	--	X	X	X	X	--
	Subsurface	X	--	--	X	X	--	X	--	X	X	X	--	
Invertebrates	Surface	--	--	X	--	X	--	--	--	X	--	--	--	--
Birds	Surface	--	--	--	--	--	X	--	--	X	--	--	X	X
Mammals	Surface	X	X	--	--	--	--	--	X	X	--	--	--	--
	Subsurface	X	X	--	--	--	--	--	X	X	--	--	--	--

Notes:

1 No speciation data are available for chromium; therefore, chromium is assumed to be 100 percent hexavalent chromium.

-- Not a candidate COEC

X Candidate COEC

COEC Contaminant of ecological concern

SE Secular equilibrium

4.4 UNCERTAINTY ASSOCIATED WITH THE ECOLOGICAL RISK ASSESSMENT

Uncertainty plays an important role in risk-based decision-making and is, therefore, incorporated explicitly into the risk characterization process. Identifying known sources of uncertainty is a critical component of an SLERA because conservative default assumptions incorporated into the SLERA protocol are associated with substantial uncertainty. The SLERA process is based on assumptions and extrapolations to evaluate potential risk to ecological receptors. These assumptions are intentionally conservative and may result in overestimates of site-specific risk to ensure that no COPECs that pose actual risk are eliminated from the SLERA. The primary components of uncertainties include those associated with site data and exposure, the development and use of toxicity values, and interpretation of HQs to estimate potential risk to representative receptors. The NAUM risk assessment methodology (USEPA 2024b) provides more general ERA uncertainty discussions for topics applicable to all NAUM sites.

4.4.1 Exposure Estimates

Because Tetra Tech evaluated the Section 32 and 33 Mines using limited collected data, all concentrations measured are, therefore, only estimates of concentrations that may occur throughout the site (with associated error). Tetra Tech assumed in the SLERA that the maximum detected concentration detected in surface and subsurface soils at the Section 32 and 33 Mines represented the entire site to ensure protectiveness. However, this method creates bias in the data toward the more disturbed or affected environments at the site and is likely to overestimate COPEC exposure concentrations.

Similarly, in the SLERA refinement, an EPC for each COPEC for surface and subsurface soils was used to estimate exposures and ensure protectiveness. The use of the UCL95 concentration may under- or overestimate COPEC concentrations used to characterize conditions throughout the site, depending on their actual sitewide distribution. In addition, portions of the site are bare ground and do not provide habitat or foraging area for some ecological receptors. Bare ground areas are included in the evaluation; however, the nature of the bare ground areas (toxicity, lack of soil, etc.) is unknown.

Site-specific bulk chemistry concentrations were compared with toxicity benchmarks values such as USEPA Eco-SSLs and LANL ESLs as an indicator of the potential for adverse effects. Bulk chemistry results for onsite samples likely overestimate the bioavailable fraction of each COPEC as the results do not consider whether the contaminant is bound to soil particles or other compounds that could prevent uptake by plants and invertebrates, or absorption upon direct contact or ingestion by higher trophic-level receptors.

The SLERA assumes that all receptors live and forage solely at the site; however, this assumption is not necessarily true for the avian and larger mammalian receptors, which can forage over larger areas and are not likely to be consistently exposed to COPECs in soil at the estimated site concentrations. Mobile ecological receptors could be exposed to areas beyond the site boundary depending on the foraging and home range of the particular species. The use of media-based screening levels does not account for the size of the site or the foraging area. Nonmobile receptors, such as the plant and soil invertebrate communities, are assessed by sample, and small ranging receptors, such as small mammals, would likely remain within the site boundaries if sufficient food and shelter were available. However, free-ranging wildlife, such as raptors, large herbivores, and top-level predators, would travel beyond the site boundary. Furthermore, use of a site can vary seasonally. Therefore, the actual amount of soil or prey ingested from the site would likely be less than the values used in the risk calculations, resulting in an overestimate of risk. The impact of this uncertainty is species dependent but likely small given that those receptors that would travel beyond the site boundary have large home ranges.

As with any site investigation, uncertainty will be associated with the representativeness of the samples both spatially and temporally. Soil samples were collected from two events in 2019 for the RSE and in 2022 to address data gaps. Figure C-2 and Figure C-3 show the sample locations for each EU. Spatial variability is limited because soil samples used in the risk assessment were primarily collected within the disturbed area of the mine site. Temporal variability is limited because soil sampling methods were consistent among sampling events and because of the known environmental fate of the COPECs (lack of degradation).

4.4.2 Nondetected Contaminants of Potential Ecological Concern

Little uncertainty is involved with the analytical analysis for soil at the Section 32 and 33 Mines as all COPECs were detected in soil above their respective detection limits.

4.4.3 Combined Exposures Across Media

The design of the ecological screening process and use of media-based screening levels assumes isolation of exposure (for example, risk from exposure to soil is not added to the risk from exposure to surface water because data is not available to assess surface water). Because surface water is present irregularly on site, an aquatic community would be unlikely to become established; however, birds, mammals, and reptiles could ingest the water when it is available.

4.4.4 Risk to Plant and Invertebrate Communities

To address the potential risk to plant and invertebrate communities, concentration data from each sample are compared to the community-specific screening values (NOECs). Table C-11 presents this analysis so that risk managers can evaluate the potential risk to these communities by sample location.

Aluminum and iron do not have screening values for either the plant or invertebrate community. The magnitude of the impacts of aluminum and iron on nonmobile communities is unknown. Three additional COPECs at the Section 32 and 33 Mines (thallium, uranium, and vanadium) do not have soil invertebrate screening values. The magnitude of the impacts of these metals on the soil invertebrate community is unknown.

5.0 RISK ASSESSMENT RESULTS SUMMARY

The HHRA and SLERA results indicate human health and ecological risk exceed the acceptable risk levels. Candidate COCs and COECs were identified based on available laboratory and toxicological data for the Section 32 and 33 Mines and are recommended for further evaluation in the EE/CA. The HHRA and SLERA results indicate risk is above a level of concern for the contaminants listed in Exhibit C-5.

Exhibit C-5. Candidate COCs or COECs for Soil

Exposure Unit	Soil Interval	Contaminant													
		Uranium-238 in SE	Arsenic	Barium	Chromium[1]	Cobalt	Iron	Lead	Manganese	Nickel	Selenium	Thallium	Uranium	Vanadium	Zinc
Section 32 Mine	Surface and Subsurface	X	X	--	X	X	X	--	X	--	--	X	X	--	--
Section 33 Mine	Surface and Subsurface	X	--	--	--	--	--	--	--	--	--	--	X	--	--
Site-Wide (Ecological Risk)	Surface	X	X	X	X	--	--	X	X	X	X	X	X	X	X
	Subsurface	X	--	X	X	--	--	--	X	X	X	X	X	--	--

Notes:
1 No speciation data are available for chromium; therefore, chromium is assumed to be 100 percent hexavalent chromium.
-- Not a candidate COC or COEC. Not recommended for further evaluation in the EE/CA.
X Candidate COC and/or COEC. Recommended for further evaluation in the EE/CA.
COC Contaminant of concern
COEC Contaminant of ecological concern
EE/CA Engineering evaluation/cost analysis
SE Secular equilibrium

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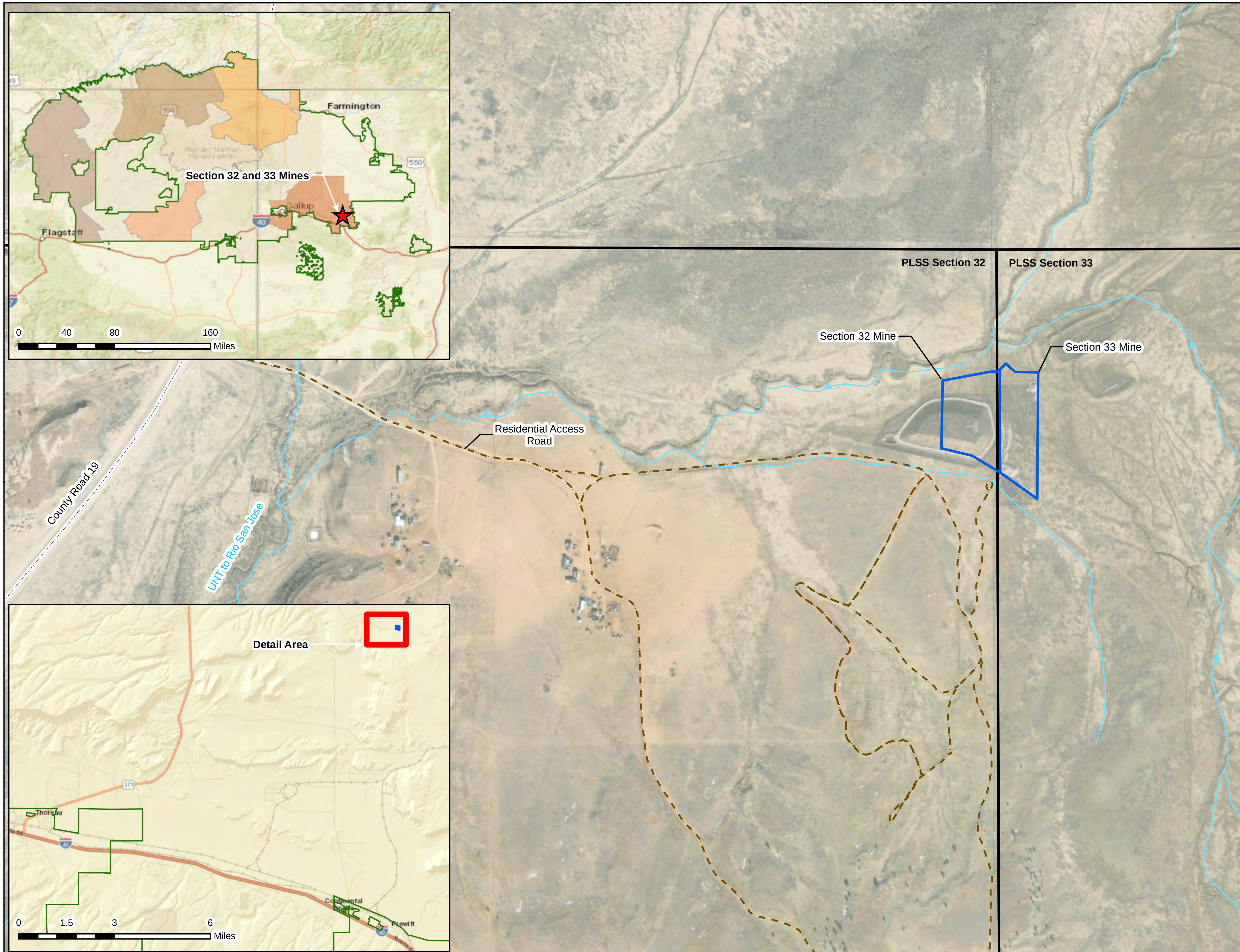
FIGURES



Tronox AUM Site[1]
PLSS Section Boundary / RSE Survey Area
County Road
Local Road
Drainage

Navajo Nation Regions

Central Region
Eastern Region
North Central Region
Northern Region
Southern Region
Western Region

Notes:
[1] Boudary is from TSG (2007).

AUM	Abandoned uranium mine
PLSS	Public Land Survey System
RSE	Removal site evaluation
TSG	TerraSpectra Geomatics
UNT	Unnamed tributary

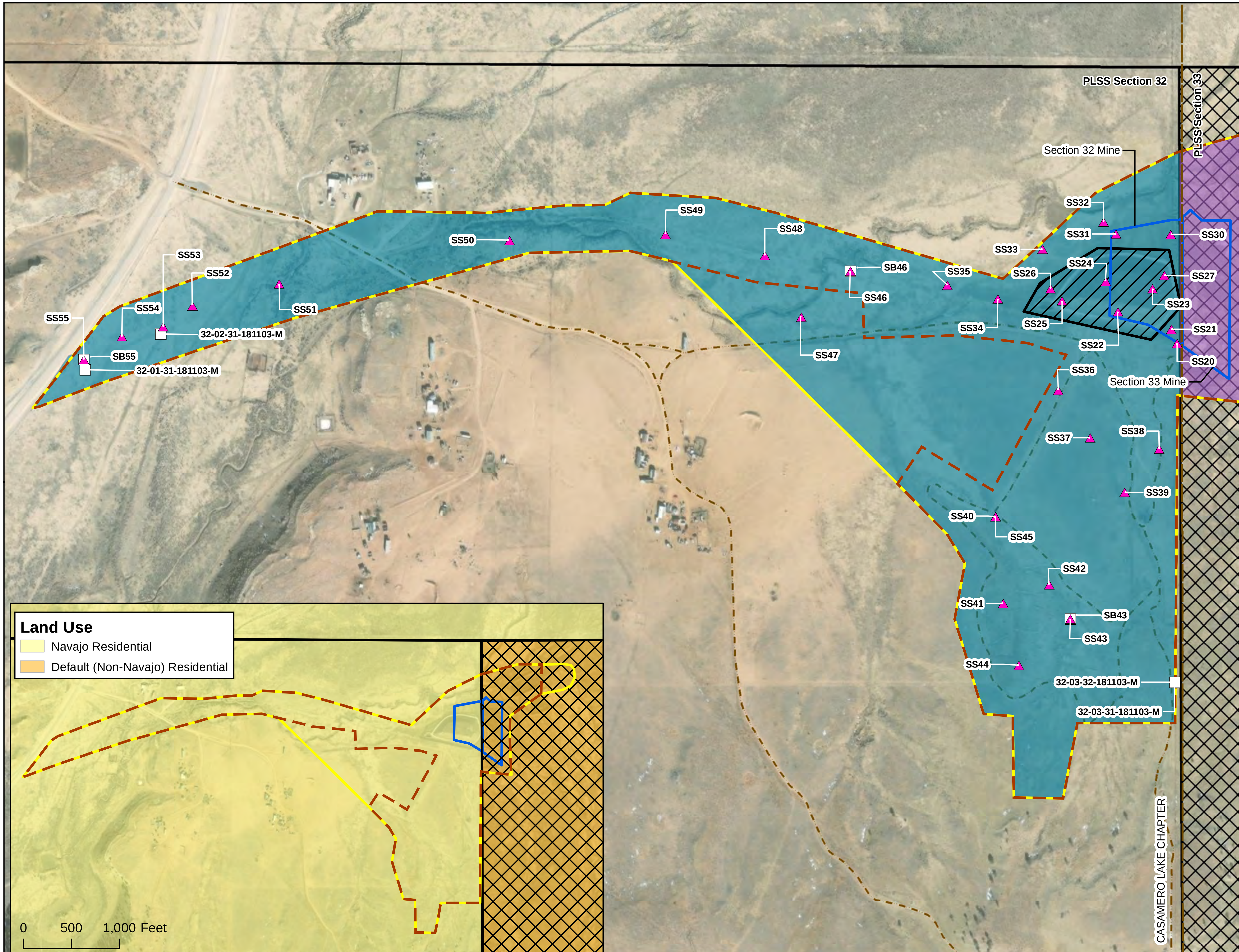
1 inch = 500 feet
1:6,000
0 250 500 1,000 Feet
N W E S

SECTION 32 AND 33 MINES LOCATION

Prepared For: U.S. EPA Region 9

Prepared By: TETRA TECH
1999 Harrison Street, Suite 500
Oakland, CA 94612

Task Order No.: 0003	Contract No.: 68HE0923D0002
Location: NAVAJO NATION	Date: 3/2/2024
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: C-1



PLSS Section Boundary / RSE Survey Area
Private Property
Tronox AUM Site[1]
Section 32 Waste Stockpile - Subsurface Only
TENORM Boundary
Local Road

Soil Sample Locations

Surface Soil
Subsurface Soil

Exposure Unit

Section 32 Mine
Section 33 Mine
Site-wide (Ecological Risk)

Notes:
[1]Boundary is from TSG (2007).

AUM	Abandoned uranium mine
PLSS	Public land survey system
RSE	Removal site evaluation
TENORM	Technologically enhanced naturally occurring radioactive material
TSG	TerraSpectra Geomatics

1 inch = 400 feet

1:4,800

0 200 400 800 Feet

N W E S

SECTION 32 EXPOSURE UNIT AND SAMPLE LOCATIONS

Prepared For: U.S. EPA Region 9

Prepared By: TETRA TECH 1999 Harrison Street, Suite 500 Oakland, CA 94612

Task Order No.: 0003

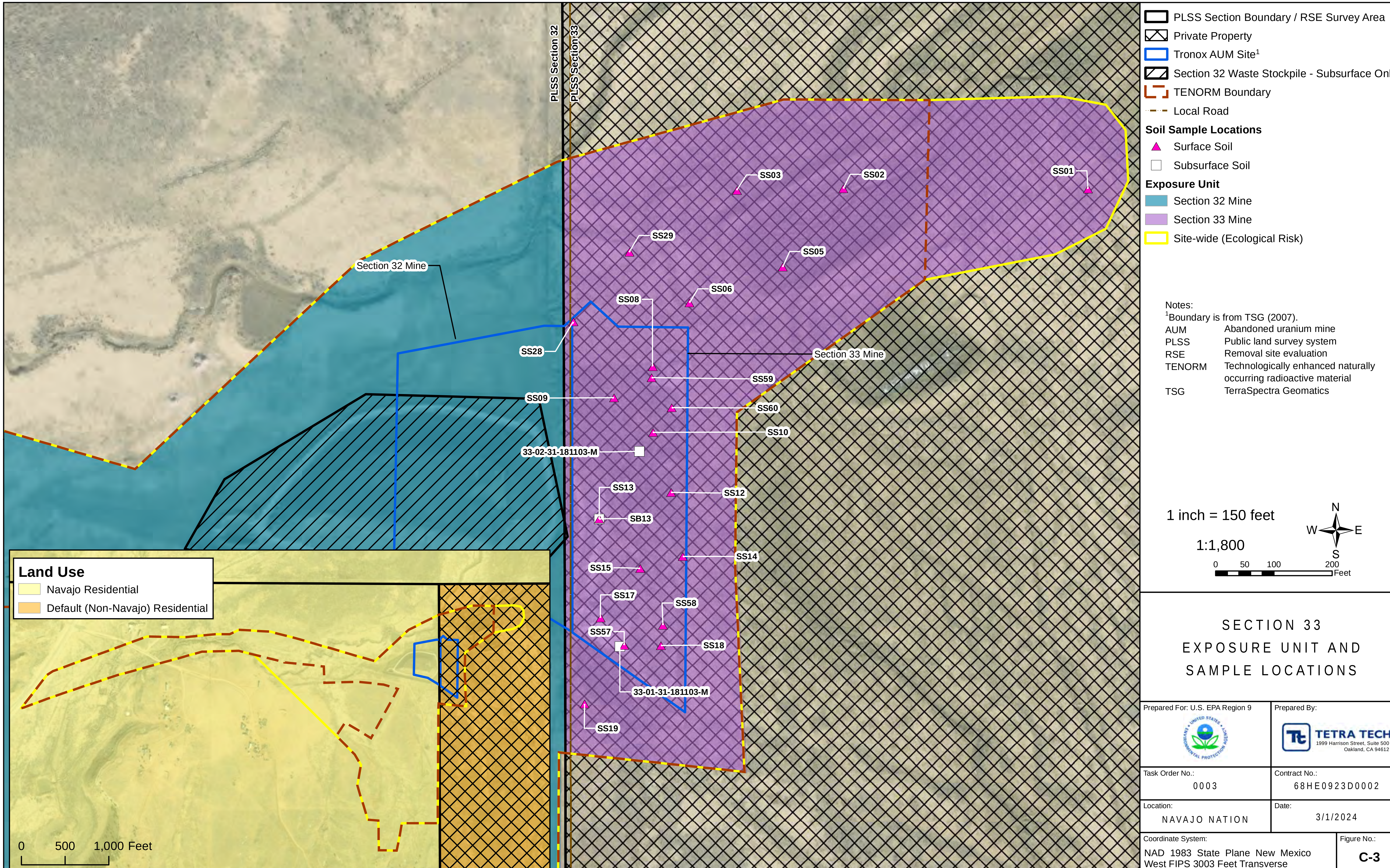
Contract No.: 68HE0923D0002

Location: NAVAJO NATION

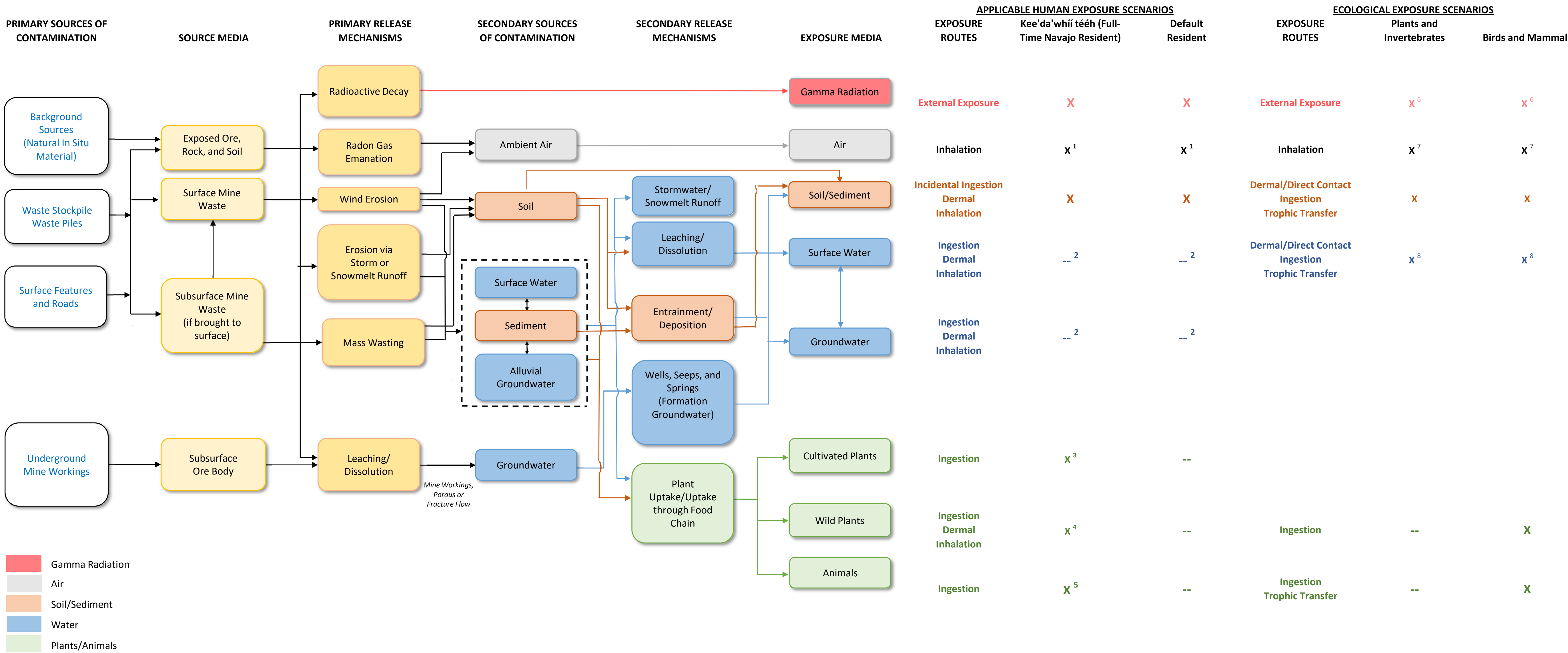
Date: 3/2/2024

Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse

Figure No.: C-2



PLSS Section 32
PLSS Section 33
Section 32 Mine
Section 33 Mine
SS01
SS02
SS03
SS05
SS06
SS08
SS09
SS10
SS12
SS13
SB13
SS14
SS15
SS17
SS18
SS19
SS28
SS29
SS57
SS58
SS59
SS60
33-02-31-181103-M
33-01-31-181103-M
Land Use
Navajo Residential
Default (Non-Navajo) Residential
0 500 1,000 Feet
PLSS Section Boundary / RSE Survey Area
Private Property
Tronox AUM Site[1]
Section 32 Waste Stockpile - Subsurface Only
TENORM Boundary
Local Road
Soil Sample Locations
Surface Soil
Subsurface Soil
Exposure Unit
Section 32 Mine
Section 33 Mine
Site-wide (Ecological Risk)
Notes:
[1]Boundary is from TSG (2007).
AUM Abandoned uranium mine
PLSS Public land survey system
RSE Removal site evaluation
TENORM Technologically enhanced naturally occurring radioactive material
TSG TerraSpectra Geomatics
1 inch = 150 feet
1:1,800
N
W
E
S
0 50 100 200 Feet
SECTION 33 EXPOSURE UNIT AND SAMPLE LOCATIONS
Prepared For: U.S. EPA Region 9
Prepared By:
TETRA TECH
Task Order No.: 0003
Contract No.: 68HE0923D0002
Location: NAVAJO NATION
Date: 3/1/2024
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse
Figure No.: C-3



Notes:

X Indicates the exposure pathway is potentially complete and is evaluated in the risk assessment except as noted.

-- Indicates the exposure pathway is not complete or *de minimis* and is not evaluated in the risk assessment

[1] The human health risk evaluation does not include inhalation of radon by humans or animals. Because radon is a gas and readily disperses in outdoor air, the risk in outdoor air is minimal. Radon in indoor air is a potential risk for future residential receptors; however, radon exposure is building-specific and the buildings are not currently present and, thus, cannot be evaluated. Furthermore, because radon is a known risk in the area, any future buildings would likely be constructed to mitigate this known risk.

[2] The human health risk evaluation does not include ingestion of surface water or groundwater by humans or animals. Safe drinking water is supplied to residents in the area. Wells used for livestock have been tested and are upgradient of the known groundwater contamination in the area.

[3] The human health risk evaluation includes ingestion of select cultivated plants (crops) by this receptor. Scenario inputs were provided by the Navajo Nation Environmental Protection Agency (NNEPA) (2021).

[4] The human health risk evaluation includes ingestion, dermal (metals only), and inhalation of select wild herbs and medicinal plants by this receptor. Scenario inputs were provided by NNEPA (2021).

[5] The human health risk evaluation includes ingestion of home-raised animals (meat, milk, and eggs) and hunted animals (meat only) for this receptor. Scenario inputs were provided by NNEPA (2021).

[6] The ecological risk evaluation includes evaluation of external radiation based on exposure to gamma-emitting radionuclides from contaminated soil and evaluation of internal radiation through plant uptake, incidental soil ingestion, and food web uptake (Los Alamos National Laboratory [LANL] 2015).

[7] Potential exposures include inhalation of ambient air and air in burrows and underground mines. The ecological risk evaluation does not include evaluation of the inhalation pathway.

[8] The ecological risk evaluation does not include evaluation of direct contact with or ingestion of surface water.

References:

Los Alamos National Laboratory (LANL). 2015. "Screening-Level Ecological Risk Assessment Methods." Revision 4. EP2015-0174. October 29.

Navajo Nation Environmental Protection Agency (NNEPA). 2021. "Navajo Tribe Provisional Reasonable Maximum Exposures RME for the Navajo Risk Assessments." Draft. September 15.

Figure C-4. Section 32 and 33 Mines Risk Assessment Conceptual Site Model

TABLES

Table C-1. Soil Results Data Summary and Contaminant of Potential Concern Screening

Constituent of Interest[a]	Detection Frequency[b]	Units	Minimum Detected Concentration (qualifier)[b]	Maximum Detected Concentration (qualifier)[b]	Location of Maximum Concentration[b]	Depth of Maximum Concentration (inches bgs)[b]	COPC Screening Level[c]	Include Constituent as a COPC?[d]
Radionuclides								
Uranium-238 in SE[e]	60 / 60	pCi/g	1.08	161	S3233-SS59-01-111822	0-6	0.00050	**Yes**
Metals								
Aluminum	65 / 65	mg/kg	4,650	25,000	32-02-31-181103-M	0-18	1,250	**Yes**
Antimony	6 / 60	mg/kg	0.343 J	0.638 J	S3233-SS14-01-111522	0-6	0.39	**Yes**
Arsenic	65 / 65	mg/kg	1.29	13.8	S3233-SS60-01-111822	0-6	0.025	**Yes**
Barium	65 / 65	mg/kg	26.8	307	S3233-SS23-01-111522	0-6	124	**Yes**
Beryllium	65 / 65	mg/kg	0.257	1.19	S3233-SS53-01-111822	0-6	2.9	No
Cadmium	57 / 60	mg/kg	0.0207 J	0.24	S3233-SS30-01-111722	0-6	0.042	**Yes**
Chromium[f]	65 / 65	mg/kg	1.25 J	18.2	S3233-SS34-01-111722	0-6	0.027	**Yes**
Cobalt	65 / 65	mg/kg	1.23	9.35	S3233-SS12-01-111522	0-6	0.26	**Yes**
Copper	65 / 65	mg/kg	2.7	18	S3233-SS09-01-111522	0-6	6.5	**Yes**
Iron	65 / 65	mg/kg	4,570	26,300	S3233-SS26-01-111522	0-6	796	**Yes**
Lead	65 / 65	mg/kg	5.67	19.9	S3233-SS09-01-111522	0-6	200	No
Manganese	65 / 65	mg/kg	73.2	419	S3233-SS20-01-111522	0-6	3.2	**Yes**
Molybdenum	58 / 60	mg/kg	0.205 J	1.18	S3233-SS30-01-111722	0-6	1.24	No
Nickel	65 / 65	mg/kg	2.43	18.7	S3233-SS30-01-111722	0-6	20	No
Selenium[g]	62 / 62	mg/kg	0.467 J	102	S3233-SS58-01-111822	0-6	1.7	**Yes**
Silver	28 / 60	mg/kg	0.123 J	0.663	S3233-SB43-0612-111822	6-12	2.0	No
Thallium	56 / 60	mg/kg	0.142 J	0.471	S3233-SS30-01-111722	0-6	0.0092	**Yes**
Uranium[g]	61 / 61	mg/kg	0.606 J	251	S3233-SS59-01-111822	0-6	0.28	**Yes**
Vanadium	65 / 65	mg/kg	8 J	92.3	S3233-SS59-01-111822	0-6	6.9	**Yes**
Zinc	65 / 65	mg/kg	9.87	95.6	S3233-SS08-01-111522	0-6	147	No

Notes:

[a] **Bolded contaminants** are selected as human health COPCs because the maximum detected concentration exceeds the COPC screening level.

[b] Includes all soil samples with analytical results from the Section 32 and 33 Mines, collected for the removal site evaluation (Weston 2019) and 2022 sampling (Tetra Tech 2023).

[c] The COPC screening levels are calculated using the USEPA (2024c) NAUM Risk Calculator for the Kee'da'whíí tééh (full-time Navajo resident) using a target risk of 1E-06 and target hazard quotient of 0.1 except for lead. The lead screening value is based on the recommended regional screening level for residential soil (USEPA 2024a).

[d] A contaminant is included as a COPC for the human health risk assessment if the maximum detected concentration exceeds the COPC screening level.

[e] When uranium-238 is in SE, site data for radium-226 in conjunction with uranium-238 in SE toxicity values can be used to calculate the risk for the entire uranium-238 decay chain.

Table C-1. Soil Results Data Summary and Contaminant of Potential Concern Screening

Notes (continued):

[f] In the absence of speciated chromium data, chromium is evaluated using the assumption that it is 100 percent hexavalent chromium (USEPA 2024b). No speciated chromium data are available.

[g] Four selenium and five uranium results in the removal site evaluation results were reported as nondetect, but the method reporting limit was not provided with the data (Weston 2019). These four selenium and five uranium results were not included in the exposure evaluation of the risk assessment.

bgs	Below ground surface
COPC	Contaminant of potential concern
J	Estimated concentration
mg/kg	Milligram per kilogram
NAUM	Navajo abandoned uranium mine
pCi/g	Picocurie per gram
SE	Secular equilibrium
Tetra Tech	Tetra Tech, Inc.
USEPA	U.S. Environmental Protection Agency
Weston	Weston Solutions, Inc.

References:

Tetra Tech, Inc. (Tetra Tech). 2023. "Section 32 and 33 Mines Eastern Abandoned Uranium Mine Region Data Gap Investigation Report." Response, Assessment, and Evaluation Services. Contract No. 68HE0923D0002. August.

U.S. Environmental Protection Agency (USEPA). 2024a. "Updated Residential Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities." Office of Land and Emergency Management. January 17.

USEPA. 2024b. “Navajo Abandoned Uranium Mines Risk Assessment Methodology.” Draft Final. March.

USEPA. 2024c. “Navajo Abandoned Uranium Mine Risk Calculator." Version 1.03. March.

Weston Solutions, Inc. (Weston). 2019. “Removal Site Evaluation Report for Tronox Navajo Area Uranium Mines Sections 32 and 33 Mines, McKinley County, New Mexico." Prepared for the U.S. Environmental Protection Agency. September.

Table C-2. Exposure Unit Summary of Land Use, Geologic Formation, Type, Area, and Available Samples

Exposure Unit	Land Use / Receptor	Geologic Formation	Type	Area (acre)	Number of Surface Soil (or Sediment) Samples (0-6 inches bgs)[a]	Number of Subsurface Soil Samples (0-72 inches bgs) [a,b]
Section 32 Mine	Kee'da'whíí tééh (Full-Time Navajo Resident)	Quaternary alluvium	TENORM	485	35 - Radiological 359 - Metals	38 - Radiological 39 - Uranium 41 - Aluminum, Arsenic, Barium, Beryllium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Nickel, Vanadium, Zinc 38 - Antimony, Cadmium, Moybdenum, Selenium, Silver, Thallium
Section 33 Mine	Default Resident (Non-Navajo)	Quaternary alluvium	TENORM	4.9	21 - Radiological 21 - Metals	22 - Radiological 24 - Aluminum, Arsenic, Barium, Beryllium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Nickel, Selenium, Vanadium, Zinc 38 - Antimony, Cadmium, Moybdenum, Silver, Thallium, Uranium
Site-Wide	Ecological	Quaternary alluvium	TENORM	490	56 - Radiological 56 - Metals	60 - Radiological 61 - Uranium 62 - Selenium 65 - Aluminum, Arsenic, Barium, Beryllium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Nickel, Vanadium, Zinc 60 - Antimony, Cadmium, Moybdenum, Silver, Thallium

Notes:

[a] Includes all soil samples with analytical results from the Section 32 and 33 Mines, collected for the removal site evaluation (Weston 2019) and 2022 data gaps sampling (Tetra Tech 2023). Soil depths were not provided in the Weston (2019) data tables, but the text indicates that samples were collected from 0 to 18 inches bgs.

[b] Four selenium and five uranium results in the removal site evaluation results were reported as nondetect, but the method reporting limit was not provided with the data (Weston 2019). These four selenium and five uranium results were not included in the exposure evaluation of the risk assessment.

bgs	Below ground surface
TENORM	Technologically enhanced naturally occurring radioactive material
Tetra Tech	Tetra Tech, Inc.
Weston	Weston Solutions, Inc.

References:

Tetra Tech, Inc. (Tetra Tech). 2023. "Section 32 and 33 Mines Eastern Abandoned Uranium Mine Region Data Gap Investigation Report." Response, Assessment, and Evaluation Services. Contract No. 68HE0923D0002. August.

Weston Solutions, Inc. (Weston). 2019. “Removal Site Evaluation Report for Tronox Navajo Area Uranium Mines Sections 32 and 33 Mines, McKinley County, New Mexico." Prepared for the U.S. Environmental Protection Agency. September.

Table C-3. Human Health Exposure Parameters

Input Parameter	Symbol	Units	Receptor	
			Kee'da'whíí téého (Navajo Resident)[a]	Default Resident[b]
Common Parameters				
Exposure Duration - Adult	ED	years	69	20
Exposure Duration - Child	EDc	years	6	6
Exposure Duration - Lifetime Total	EDa	years	75	26
Exposure Time - Lifetime Total	t	years	75	26
Averaging Time - Cancer	ATc	days	27,375	25,550
Averaging Time - Noncancer - Adult	ATnc	days	25,185	7,300
Averaging Time - Noncancer - Child	ATnc	days	2,190	2,190
Exposure Frequency - Adult	EFa	days/year	350	350
Exposure Frequency - Child	EFc	days/year	350	350
Consumption Exposure Frequency for Animal and Plant Products- Adult	CEFa	days/year	350	0
Consumption Exposure Frequency for Animal and Plant Products- Child	CEFc	days/year	350	0
Body Weight - Adult	BWa	kg	80	80
Body Weight - Child	BWc	kg	15	15
Conversion Factor 1	CF1	g/mg	1/1,000	1/1,000
Conversion Factor 2	CF2	kg/mg	1/1,000,000	1/1,000,000
Conversion Factor 3	CF3	day/hours	1/24	1/24
Conversion Factor 4	CF4	g/kg	1,000	1,000
Conversion Factor 5	CF5	year/days	1/365	1/365
Conversion Factor 6	CF6	kg/g	1/1,000	1/1,000
Conversion Factor 7	CF7	pCi/Bq	27.027027	27.027027
Decay Constant	λ	1/year	Radionuclide-specific from the PRG	
Soil Ingestion Parameters				
Onsite Soil Ingestion Rate - Adult	IRSa	mg/day	360	100
Onsite Soil Ingestion Rate - Child	IRSc	mg/day	400	200
Dust Inhalation Parameters				
Inhalation Rate when Exposed - Adult	IRAres-a	m^3/day	25	20
Inhalation Rate when Exposed - Child	IRAres-c	m^3/day	10	10
Exposure Time - Adult	ETa	hours/day	22	24
Exposure Time - Child	ETc	hours/day	22	24
City/Climatic Zone	-	-	Albuquerque, NM	Albuquerque, NM
Mean Annual Wind Speed	Um	m/s	4.02	4.02
Areal extent of site surface soil	As	acres	0.5	0.5
Fraction of Vegetative Cover	V	-	0.5	0.5
Particulate Emission Factor	PEF	m^3/kg	6,609,630,250	6,609,630,250
Radiation External Exposure Parameters				
Gamma Shielding Factor - Outdoor	GSF_o	-	1	1
Gamma Shielding Factor - Indoor	GSF_i		0.7	0.4
Exposure Time on Site Outdoors - Adult	ET_{a-o}	hours/day	12	1.752
Exposure Time on Site Indoors - Adult	ET_{a-i}		10	16.416
Exposure Time on Site Outdoors - Child	ET_{c-o}	hours/day	12	1.752
Exposure Time on Site Indoors - Child	ET_{c-i}		10	16.416
Metals Dermal Exposure Parameters				
Surface Area - Adult	SAa	cm^2/day	6,032	6,032
Surface Area - Child	SAc	cm^2/day	2,373	2,373
Adherence Factor - Adult	AFa	mg/cm^2	0.12	0.07
Adherence Factor - Child	AFc	mg/cm^2	0.2	0.2

Table C-3. Human Health Exposure Parameters

Input Parameter		Symbol	Units	Receptor	
				Kee'da'whíí tééh (Navajo Resident)[a]	Default Resident[b]
Plant Consumption Parameters					
Total Plant Ingestion Rate - Adult		IRa	g/day	834	0
Total Plant Ingestion Rate - Child		IRc	g/day	417	0
Produce Contaminated Fraction	Annual Average	CFplant	-	0.55	-
	Fall	-	-	0.75	-
	Winter	-	-	0.5	-
	Spring	-	-	0.3	-
	Summer	-	-	0.65	-
	Herbs/medicinal	CFmedicinal	-	1	-
Diet Fraction	Corn - White	DF	-	0.1	-
	Corn - Blue		-	0.1	-
	Corn - Yellow		-	0.05	-
	Corn - Red Speckled		-	0.03	-
	Corn - Sweet Corn		-	0.02	-
	Squash - Pumpkin		-	0.02	-
	Squash - Other Squash		-	0.08	-
	Melons - Watermelon		-	0.05	-
	Melons - Cantaloupe		-	0.05	-
	Tree Fruit - Apples		-	0.05	-
	Tree Fruit - Apricots		-	0.05	-
	Tree Fruit - Peaches		-	0.05	-
	Other Vegetables - Beans		-	0.1	-
	Other Vegetables - Brussels Sprouts		-	0.02	-
Plant Consumption Parameters (Continued)					
Diet Fraction (Continued)	Other Vegetables - Cucumbers	DF	-	0.02	-
	Other Vegetables - Tomatoes		-	0.02	-
	Other Vegetables - Chili		-	0.05	-
	Other Vegetables - Onions		-	0.02	-
	Other Vegetables - Potatoes		-	0.02	-
	Herbs and Medicinal		-	0.1	-
Plant-Soil Transfer Factor		Bvwet	pCi/g-fresh plant per pCi/g-dry soil	Plant-specific based on plant type[c]	-
Mass Loading Factor		MLF	g-dry soil per g-fresh plant	Plant-specific based on plant type[c]	-
Animal Consumption Parameters					
Total Animal Ingestion Rate - Adult		IRa	g/day	983	0
Total Animal Ingestion Rate - Child		IRc	g/day	491.5	0

Table C-3. Human Health Exposure Parameters

Input Parameter		Symbol	Units	Receptor	
				Kee'da'whíí téêh (Navajo Resident)[a]	Default Resident[b]
Animal Consumption Parameters (continued)					
Contaminated Fraction	Chicken	CF	-	0.05	-
	Chicken Eggs	CF	-	0.75	-
	Beef	CF	-	0.25	-
	Milk - Cow	CF	-	0.01	-
	Pig	CF	-	0.05	-
	Goat	CF	-	1	-
	Milk - Goat	CF	-	1	-
	Sheep	CF	-	0.9	-
	Milk - Sheep	CF	-	0.9	-
	Horse	CF	-	1	-
	Domesticated Turkey	CF	-	0.05	-
	Wild Turkey	CF	-	0.02	-
	Deer	CF	-	0.02	-
	Elk	CF	-	0.02	-
	Rabbit	CF	-	1	-
	Prairie Dog	CF	-	1	-
	Badger	CF	-	1	-
Diet Fraction	Chicken	DF	-	0.2	-
	Chicken Eggs	DF	-	0.07	-
	Beef	DF	-	0.25	-
	Milk - Cow	DF	-	0.06	-
	Pig	DF	-	0.07	-
	Goat	DF	-	0.05	-
	Milk - Goat	DF	-	0.01	-
	Sheep	DF	-	0.2	-
	Milk - Sheep	DF	-	0	-
	Horse	DF	-	0.005	-
	Domesticated Turkey	DF	-	0.003	-
	Wild Turkey	DF	-	0.002	-
	Deer	DF	-	0.03	-
	Elk	DF	-	0.03	-
	Rabbit	DF	-	0.005	-
	Prairie Dog	DF	-	0.01	-
	Badger	DF	-	0.005	-
Mass-Loading Factor for Pasture		MLFpasture	g-dry soil per g-dry plant	0.25	-
Density of Milk		ρm	kg/L	1.03	-
Soil Intake Rate		Qs	kg/day	Animal-specific[d]	-
Fodder Intake Rate		Qp	kg/day	Animal-specific[d]	-
Bioaccumulation Factor for Metals		Ba	days/kg	Animal-specific[d]	-
Other Diné Lifeways[e]					
Age-adjusted ingestion rate of medicinal plants	Navajo Tea	IFadj	g/day	1.0	-
	Sumac (skunkbush and other)	IFadj	g/day	6.4	-
	Soaptree Yucca	IFadj	g/day	6.4	-
	Sagebrush	IFadj	g/day	12.9	-
	Corn Pollen and Other Corn	IFadj	g/day	19.3	-
	Other Plant Types	IFadj	g/day	6.4	-

Table C-3. Human Health Exposure Parameters

Input Parameter		Symbol	Units	Receptor	
				Kee'da'whíí tééh (Navajo Resident)[a]	Default Resident[b]
Other Diné Lifeways[e] (continued)					
Adult dermal rate of medicinal plants	Navajo Tea	DCRa	g/day	2.1	-
	Sumac (skunkbush and other)	DCRa	g/day	38.6	-
	Soaptree Yucca	DCRa	g/day	38.6	-
	Sagebrush	DCRa	g/day	12.9	-
	Corn Pollen and Other Corn	DCRa	g/day	38.6	-
	Other Plant Types	DCRa	g/day	6.4	-
Mass of plant available for inhalation	Sagebrush	IMa	g/day	25.7	-
	Corn Pollen and Other Corn	IMa	g/day	12.9	-
	Other Plant Types	IMa	g/day	6.4	-
Inhalation fraction	Sagebrush	IF	-	0.1	-
	Corn Pollen and Other Corn	IF	-	0.1	-
	Other Plant Types	IF	-	0.1	-

Notes:

[a] Exposure inputs for the Navajo receptor provided by NNEPA (2021).

[b] Default values for resident receptor from the PRG Calculator (USEPA 2023b) and RSL Calculator (USEPA 2023c). Plant ingestion is included in the USEPA PRG Calculator but not in the RSL Calculator and was set to zero for the default resident.

[c] Plant-specific inputs are from Appendix B of the "Navajo Abandoned Uranium Mines Risk Assessment Methodology" (USEPA 2024b).

[d] Animal-specific inputs are from Appendix B of the "Navajo Abandoned Uranium Mines Risk Assessment Methodology" (USEPA 2024b).

[e] Input parameters for Other Diné Lifeways were only provided for adult receptors (NNEPA 2021).

-	Not applicable	m^3/kg	Cubic meter per kilogram
cm^2/day	Square centimeter per day	mg/cm^2	Milligram per square centimeter
days/kg	Days per kilogram	mg/day	Milligram per day
g	Gram	mg/kg	Milligram per kilogram
g/day	Gram per day	NM	New Mexico
g/kg	Gram per kilogram	NNEPA	Navajo Nation Environmental Protection Agency
g/mg	Gram per milligram	pCi/Bq	Picocurie per becquerel
kg	Kilogram	pCi/day	Picocurie per day
kg/day	Kilogram per day	pCi/g	Picocurie per gram
kg/g	Kilogram per gram	pCi/kg	Picocurie per kilogram
kg/L	Kilogram per liter	PRG	Preliminary remediation goal
kg/mg	Kilogram per milligram	RME	Reasonably maximum exposed
m/s	Meter per second	RSL	Regional screening level
m^3/day	Cubic meter per day	USEPA	U.S. Environmental Protection Agency

References:

Navajo Nation Environmental Protection Agency (NNEPA). 2021. "Navajo Tribe Provisional Reasonable Maximum Exposures for the Navajo Risk Assessments." Draft. September 15.

U.S. Environmental Protection Agency (USEPA). 2023b. "Preliminary Remediation Goals for Radionuclides (PRG)." September. https://epa-prgs.ornl.gov/cgi-bin/radionuclides/rprg_search.

USEPA. 2023c. "Regional Screening Levels (RSLs)." November. https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search.

USEPA. 2024b. “Navajo Abandoned Uranium Mines Risk Assessment Methodology.” Draft Final. March.

Table C-4. Exposure Point Concentrations for Human Health Risk Assessment

Section 32 Mine											
COPC[a]	Units	Detection Frequency	Number of High Nondetect Results[b]	Maximum Concentration (qualifier)	Location of Maximum Concentration	Arithmetic Mean[c]	UCL95 / Distribution[d]		Exposure Point Concentration		
									Value[e]	Statistic[e]	Method[f]
Surface Soil (0-6 inches bgs)											
Radium-226	pCi/g	35 / 35	0	27.3	S3233-SS27-01-111522	3.86	5.57	NP	5.6	UCL95	(14)
Aluminum	mg/kg	35 / 35	0	23,800	S3233-SS26-01-111522	16,605	17,799	N	17,800	UCL95	(2)
Antimony	mg/kg	1 / 35	11	0.343	S3233-SS46-01-111822	0.30	--	0.00	0.34	Maximum	(1)
Arsenic	mg/kg	35 / 35	0	8.3	S3233-SS41-01-111822	6.13	6.49	N	6.5	UCL95	(2)
Barium	mg/kg	35 / 35	0	307	S3233-SS23-01-111522	174	194	N	194	UCL95	(2)
Cadmium	mg/kg	35 / 35	0	0.24	S3233-SS30-01-111722	0.14	0.16	N	0.16	UCL95	(2)
Cobalt	mg/kg	35 / 35	0	8.72	S3233-SS30-01-111722	6.68	7.06	N	7.1	UCL95	(2)
Copper	mg/kg	35 / 35	0	17.1	S3233-SS30-01-111722	11.33	12.25	N	12	UCL95	(2)
Iron	mg/kg	35 / 35	0	26,300	S3233-SS26-01-111522	19,251	20,350	N	20,400	UCL95	(2)
Manganese	mg/kg	35 / 35	0	419	S3233-SS20-01-111522	265.3	282.1	N	282	UCL95	(2)
Selenium	mg/kg	35 / 35	0	13.3	S3233-SS27-01-111522	2.02	2.69	NP	2.7	UCL95	(14)
Thallium	mg/kg	34 / 35	0	0.471	S3233-SS30-01-111722	0.27	0.30	N	0.30	UCL95	(3)
Uranium	mg/kg	35 / 35	0	32.4	S3233-SS27-01-111522	5.09	7.22	NP	7.2	UCL95	(14)
Vanadium	mg/kg	35 / 35	0	38.7	S3233-SS53-01-111822	26.18	28.12	N	28	UCL95	(2)
Subsurface Soil (0-18 inches bgs)											
Radium-226	pCi/g	38 / 38	0	32.7	S3233-SB55-0612-111822	4.48	6.54	NP	6.5	UCL95	(14)
Aluminum	mg/kg	41 / 41	0	25,000	32-02-31-181103-M	16,280	17,443	N	17,400	UCL95	(2)
Antimony	mg/kg	1 / 38	0	0.343 J	S3233-SS46-01-111822	0.30	--	0.00	0.34	Maximum	(1)
Arsenic	mg/kg	41 / 41	0	8.3	S3233-SS41-01-111822	5.94	6.29	N	6.3	UCL95	(2)
Barium	mg/kg	41 / 41	0	307	S3233-SS23-01-111522	174	194	G	194	UCL95	(4)
Cadmium	mg/kg	38 / 38	0	0.24	S3233-SS30-01-111722	0.14	0.15	N	0.15	UCL95	(2)
Cobalt	mg/kg	41 / 41	0	8.72	S3233-SS30-01-111722	6.41	6.82	N	6.8	UCL95	(2)
Copper	mg/kg	41 / 41	0	17.1 J	S3233-SS30-01-111722	10.79	11.67	N	12	UCL95	(2)
Iron	mg/kg	41 / 41	0	26,300	S3233-SS26-01-111522	18,710	19,802	N	19,800	UCL95	(2)
Manganese	mg/kg	41 / 41	0	419	S3233-SS20-01-111522	258.4	274.5	N	274	UCL95	(2)
Selenium	mg/kg	38 / 38	0	13.3	S3233-SS27-01-111522	2.12	2.77	NP	2.8	UCL95	(14)
Thallium	mg/kg	37 / 38	0	0.471	S3233-SS30-01-111722	0.26	0.29	N	0.29	UCL95	(3)
Uranium	mg/kg	39 / 39	0	77	32-03-31-181103-M	7.24	10.86	NP	11	UCL95	(15)
Vanadium	mg/kg	41 / 41	0	38.7	S3233-SS53-01-111822	25.81	27.62	N	28	UCL95	(2)

Table C-4. Exposure Point Concentrations for Human Health Risk Assessment

COPC[a]	Units	Detection Frequency	Number of High Nondetect Results[b]	Maximum Concentration (qualifier)	Location of Maximum Concentration	Arithmetic Mean[c]	UCL95 / Distribution[d]		Exposure Point Concentration		
									Value[e]	Statistic[e]	Method[f]
Section 33 Mine											
Surface Soil (0-6 inches bgs)											
Radium-226	pCi/g	21 / 21	0	161	S3233-SS59-01-111822	16.38	30.35	NP	30	UCL95	(14)
Aluminum	mg/kg	21 / 21	0	27,000	S3233-SS03-01-111522	15,979	18,297	N	18,300	UCL95	(2)
Antimony	mg/kg	5 / 21	0	0.638 J	S3233-SS14-01-111522	0.37	0.420	N	0.42	UCL95	(3)
Arsenic	mg/kg	21 / 21	0	13.8	S3233-SS60-01-111822	6.348	7.374	N	7.4	UCL95	(2)
Barium	mg/kg	21 / 21	0	131	S3233-SS19-01-111522	83.78	95.33	NP	95	UCL95	(14)
Cadmium	mg/kg	18 / 21	0	0.333	S3233-SS03-01-111522	0.161	0.197	N	0.20	UCL95	(3)
Cobalt	mg/kg	21 / 21	0	10.4	S3233-SS03-01-111522	6.601	7.625	NP	7.6	UCL95	(14)
Copper	mg/kg	21 / 21	0	20	S3233-SS03-01-111522	12.70	14.64	NP	15	UCL95	(14)
Iron	mg/kg	21 / 21	0	31,500	S3233-SS03-01-111522	19,369	22,285	NP	22,300	UCL95	(14)
Manganese	mg/kg	21 / 21	0	301	S3233-SS03-01-111522	209	230.50	NP	231	UCL95	(14)
Selenium	mg/kg	21 / 21	0	102	S3233-SS58-01-111822	12.22	21.65	NP	22	UCL95	(14)
Thallium	mg/kg	19 / 21	0	0.65	S3233-SS03-01-111522	0.352	0.408	N	0.41	UCL95	(3)
Uranium	mg/kg	21 / 21	0	251	S3233-SS59-01-111822	22.7	44.71	NP	45	UCL95	(14)
Vanadium	mg/kg	21 / 21	0	92.3	S3233-SS59-01-111822	33.58	40.05	NP	40	UCL95	(14)
Subsurface Soil (0-18 inches bgs)											
Radium-226	pCi/g	22 / 22	0	161	S3233-SS59-01-111822	16.42	30	NP	30	UCL95	(14)
Aluminum	mg/kg	24 / 24	0	27,000	S3233-SS03-01-111522	15,470	17,729	N	17,700	UCL95	(2)
Antimony	mg/kg	5 / 22	0	0.638 J	S3233-SS14-01-111522	0.37	0.414	N	0.41	UCL95	(3)
Arsenic	mg/kg	24 / 24	0	13.8	S3233-SS60-01-111822	5.98	6.953	N	7.0	UCL95	(2)
Barium	mg/kg	24 / 24	0	131	S3233-SS19-01-111522	79.5	91.84	N	92	UCL95	(2)
Cadmium	mg/kg	19 / 22	0	0.333	S3233-SS03-01-111522	0.154	0.191	N	0.19	UCL95	(3)
Cobalt	mg/kg	24 / 24	0	10.40	S3233-SS03-01-111522	6.179	7.164	NP	7.2	UCL95	(14)
Copper	mg/kg	24 / 24	0	20.0	S3233-SS03-01-111522	11.85	13.71	NP	14	UCL95	(14)
Iron	mg/kg	24 / 24	0	31,500	S3233-SS03-01-111522	18,526	21,307	NP	21,300	UCL95	(14)
Manganese	mg/kg	24 / 24	0	301	S3233-SS03-01-111522	196	219	NP	219	UCL95	(14)
Selenium	mg/kg	24 / 24	0	102	S3233-SS58-01-111822	11.64	20.31	NP	20	UCL95	(14)
Thallium	mg/kg	19 / 22	0	0.645	S3233-SS03-01-111522	0.342	0.398	N	0.40	UCL95	(3)
Uranium	mg/kg	22 / 22	0	251	S3233-SS59-01-111822	23.8	43.5	NP	44	UCL95	(14)
Vanadium	mg/kg	24 / 24	0	92.3	S3233-SS59-01-111822	32.58	38.38	NP	38	UCL95	(14)

Table C-4. Exposure Point Concentrations for Human Health Risk Assessment

Notes:

[a] EPCs calculated if "Yes" for "Include Constituent as a COPC?" on Table C-1.

[b] Number of nondetect results that exceeded the maximum detected concentration. These results were not included in the statistical calculations.

[c] The arithmetic mean for datasets with nondetected results is calculated using the KM method.

[d] Following USEPA (2002, 2022b) guidance, this value may be estimated by a 95, 97.5, or 99 percent UCL depending on the sample size, skewness, and degree of censorship.

[e] Tested using the Shapiro-Wilk W or Lilliefors test for normal and lognormal distributions and the Anderson-Darling and Kolmogorov-Smirnov tests for gamma distributions. A 5 percent level of significance was used in all tests. Distribution tests were conducted only for samples with at least four detected results.

[f] The EPC is the lesser of the UCL95 (or UCL99) and the maximum detected concentration. The maximum detected concentration is the default when there are fewer than 10 samples or fewer than four detected results. See Appendix D of USEPA (2024b).

[g] The statistical methods for selecting the exposure point concentration are as follows (not all are used):

(1) Maximum detected concentration
(2) 95% Student's t UCL
(3) 95% KM (t) UCL
(4) 95% Adjusted Gamma UCL
(5) 95% Gamma Adjusted KM-UCL
(6) 95% Approximate Gamma UCL
(7) 95% Gamma Approximate KM-UCL
(8) 95% H-UCL
(9) 95% H-UCL (KM log)
(10) 95% Bootstrap-t UCL
(11) 95% KM Bootstrap-t UCL
(12) 95% BCA UCL
(13) 95% KM BCA UCL
(14) 95% Percentile Bootstrap UCL
(15) 95% KM Percentile Bootstrap UCL
(16) 99% Bootstrap-t UCL
(17) 99% KM Percentile Bootstrap UCL

BCA	Bias-corrected accelerated bootstrap method
bgs	Below ground surface
COPC	Contaminant of potential concern
EPC	Exposure point concentration
EU	Exposure unit
G	Gamma distribution
H-UCL	UCL based upon Land’s H-statistic
J	Estimated concentration
KM	Kaplan-Meier
LN	Lognormal distribution
mg/kg	Milligram per kilogram
N	Normal distribution
ND	Not detected
NP	Nonparametric distribution
pCi/g	Picocurie per gram
UCL	Upper confidence limit
UCL95	95 percent upper confidence limit
UCL99	99 percent upper confidence limit
USEPA	U.S. Environmental Protection Agency

References:

U.S. Environmental Protection Agency (USEPA). 2002. “Calculating Exposure Point Concentrations at Hazardous Waste Sites.” Office of Solid Waste and Emergency Response. Directive 9285.6-10. December.

USEPA. 2022b. “ProUCL Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations.” Version 5.2.0. June 14.

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Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																	
COPC[a]	EPC[b]	Units	Cancer Intake[c]	Units	Slope Factor/ Unit Risk[d]	Units	Cancer Risk[e]	Adult Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Adult	Child Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Child
Exposure Medium: Surface Soil (0-6 inches bgs)																	
Exposure Route: Incidental Soil Ingestion																	
Uranium-238 in SE	5.6E+00	pCi/g	5.3E+04	pCi/g	6.2E-09	Risk/pCi/g	3.3E-04	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	3E-04				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	7.7E-02	mg/kg-day	1.0E+00	mg/kg-day	0.077	4.6E-01	mg/kg-day	1.0E+00	mg/kg-day	0.46
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.5E-06	mg/kg-day	4.0E-04	mg/kg-day	0.0037	8.7E-06	mg/kg-day	4.0E-04	mg/kg-day	0.022
Arsenic	6.5E+00	mg/kg	2.3E-05	mg/kg-day	1.5E+00	$(mg/kg-day)^{-1}$	3.5E-05	1.7E-05	mg/kg-day	3.0E-04	mg/kg-day	0.056	1.0E-04	mg/kg-day	3.0E-04	mg/kg-day	0.33
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	8.4E-04	mg/kg-day	2.0E-01	mg/kg-day	0.0042	5.0E-03	mg/kg-day	2.0E-01	mg/kg-day	0.025
Cadmium	1.6E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	6.9E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0069	4.1E-06	mg/kg-day	1.0E-04	mg/kg-day	0.041
Chromium	1.4E+01	mg/kg	2.24E-04	mg/kg-day	5.0E-01	$(mg/kg-day)^{-1}$	1.1E-04	6.0E-05	mg/kg-day	3.0E-03	mg/kg-day	0.0201	3.6E-04	mg/kg-day	3.0E-03	mg/kg-day	0.119
Cobalt	7.1E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	3.1E-05	mg/kg-day	3.0E-04	mg/kg-day	0.10	1.8E-04	mg/kg-day	3.0E-04	mg/kg-day	0.61
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	5.2E-05	mg/kg-day	4.0E-02	mg/kg-day	0.0013	3.1E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0077
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	8.8E-02	mg/kg-day	7.0E-01	mg/kg-day	0.13	5.2E-01	mg/kg-day	7.0E-01	mg/kg-day	0.75
Manganese	2.8E+02	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.2E-03	mg/kg-day	2.4E-02	mg/kg-day	0.051	7.2E-03	mg/kg-day	2.4E-02	mg/kg-day	0.30
Selenium	2.7E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.2E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0023	6.9E-05	mg/kg-day	5.0E-03	mg/kg-day	0.014
Thallium	3.0E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.3E-06	mg/kg-day	1.0E-05	mg/kg-day	0.13	7.7E-06	mg/kg-day	1.0E-05	mg/kg-day	0.77
Uranium	7.2E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	3.1E-05	mg/kg-day	2.0E-04	mg/kg-day	0.16	1.8E-04	mg/kg-day	2.0E-04	mg/kg-day	0.92
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.2E-04	mg/kg-day	5.0E-03	mg/kg-day	0.024	7.2E-04	mg/kg-day	5.0E-03	mg/kg-day	0.14
						Metals Cancer Total	1E-04				**Metals Noncancer Total**	0.8				**Metals Noncancer Total**	4
						Exposure Route Cancer Total	5E-04				**Exposure Route Noncancer Total**	0.8				**Exposure Route Noncancer Total**	4
Exposure Medium: Surface Soil (0-6 inches bgs)																	
Exposure Route: External Exposure																	
Uranium-238 in SE	5.6E+00	pCi/g	2.9E+02	pCi/g	8.5E-06	risk/year pCi/g	2.4E-03	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	2E-03				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
						Exposure Route Cancer Total	2E-03				**Exposure Route Noncancer Total**	--				**Exposure Route Noncancer Total**	--
Exposure Route: Dermal Exposure																	
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	1.0E+00	mg/kg-day	--	--	mg/kg-day	1.0E+00	mg/kg-day	--
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	4.0E-04	mg/kg-day	--	--	mg/kg-day	4.0E-04	mg/kg-day	--
Arsenic	6.5E+00	mg/kg	1.4E-06	mg/kg-day	1.5E+00	$(mg/kg-day)^{-1}$	2.1E-06	9.9E-07	mg/kg-day	3.0E-04	mg/kg-day	0.0033	5.9E-06	mg/kg-day	3.0E-04	mg/kg-day	0.020
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	2.0E-01	mg/kg-day	--	--	mg/kg-day	2.0E-01	mg/kg-day	--
Cadmium	1.6E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	3.2E-08	mg/kg-day	1.0E-04	mg/kg-day	0.00032	1.9E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0019
Chromium	1.4E+01	mg/kg	--	mg/kg-day	5.0E-01	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	3.0E-03	mg/kg-day	--	--	mg/kg-day	3.0E-03	mg/kg-day	--
Cobalt	7.1E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	mg/kg-day	3.0E-04	mg/kg-day	--
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	4.0E-02	mg/kg-day	--	--	mg/kg-day	4.0E-02	mg/kg-day	--
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	7.0E-01	mg/kg-day	--	--	mg/kg-day	7.0E-01	mg/kg-day	--
Manganese	2.8E+02	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	2.4E-02	mg/kg-day	--	--	mg/kg-day	2.4E-02	mg/kg-day	--
Selenium	2.7E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
Thallium	3.0E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	1.0E-05	mg/kg-day	--	--	mg/kg-day	1.0E-05	mg/kg-day	--
Uranium	7.2E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	2.0E-04	mg/kg-day	--	--	mg/kg-day	2.0E-04	mg/kg-day	--
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
						Metals Cancer Total	2E-06				**Metals Noncancer Total**	0.004				**Metals Noncancer Total**	0.02
						Exposure Route Cancer Total	2E-06				**Exposure Route Noncancer Total**	0.004				**Exposure Route Noncancer Total**	0.02

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																	
COPC[a]	EPC[b]	Units	Cancer Intake[c]	Units	Slope Factor/ Unit Risk[d]	Units	Cancer Risk[e]	Adult Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Adult	Child Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Child
Exposure Medium: Surface Soil (0-6 inches bgs)																	
Exposure Route: Inhalation of Particulates																	
Uranium-238 in SE	5.6E+00	pCi/g	4.9E-01	pCi	1.5E-07	Risk/pCi	7.0E-08	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	7E-08				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
Aluminum	1.8E+04	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	2.4E-06	mg/m^3	5.0E-03	mg/m^3	0.00047	2.4E-06	mg/m^3	5.0E-03	mg/m^3	0.00047
Antimony	3.4E-01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	4.5E-11	mg/m^3	3.0E-04	mg/m^3	0.00000015	4.5E-11	mg/m^3	3.0E-04	mg/m^3	0.00000015
Arsenic	6.5E+00	mg/kg	8.6E-07	$\mu g/m^3$	4.3E-03	$(\mu g/m^3)^{-1}$	3.7E-09	8.6E-10	mg/m^3	1.5E-05	mg/m^3	0.000058	8.6E-10	mg/m^3	1.5E-05	mg/m^3	0.000058
Barium	1.9E+02	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	2.6E-08	mg/m^3	5.0E-04	mg/m^3	0.000052	2.6E-08	mg/m^3	5.0E-04	mg/m^3	0.000052
Cadmium	1.6E-01	mg/kg	2.1E-08	$\mu g/m^3$	1.8E-03	$(\mu g/m^3)^{-1}$	3.8E-11	2.1E-11	mg/m^3	1.0E-05	mg/m^3	0.0000021	2.1E-11	mg/m^3	1.0E-05	mg/m^3	0.0000021
Chromium	1.4E+01	mg/kg	3.0E-06	$\mu g/m^3$	8.4E-02	$(\mu g/m^3)^{-1}$	2.5E-07	--	mg/m^3	1.0E-04	mg/m^3	--	--	mg/m^3	1.0E-04	mg/m^3	--
Cobalt	7.1E+00	mg/kg	9.4E-07	$\mu g/m^3$	9.0E-03	$(\mu g/m^3)^{-1}$	8.5E-09	9.4E-10	mg/m^3	6.0E-06	mg/m^3	0.00016	9.4E-10	mg/m^3	6.0E-06	mg/m^3	0.00016
Copper	1.2E+01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Iron	2.0E+04	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Manganese	2.8E+02	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	3.8E-08	mg/m^3	5.0E-05	mg/m^3	0.00075	3.8E-08	mg/m^3	5.0E-05	mg/m^3	0.00075
Selenium	2.7E+00	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	3.6E-10	mg/m^3	2.0E-02	mg/m^3	0.000000018	3.6E-10	mg/m^3	2.0E-02	mg/m^3	0.000000018
Thallium	3.0E-01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Uranium	7.2E+00	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	9.6E-10	mg/m^3	4.0E-05	mg/m^3	0.000024	9.6E-10	mg/m^3	4.0E-05	mg/m^3	0.000024
Vanadium	2.8E+01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	3.7E-09	mg/m^3	1.0E-04	mg/m^3	0.000037	3.7E-09	mg/m^3	1.0E-04	mg/m^3	0.000037
						Metals Cancer Total	3E-07				**Metals Noncancer Total**	0.002				**Metals Noncancer Total**	0.002
						Exposure Route Cancer Total	3E-07				**Exposure Route Noncancer Total**	0.002				**Exposure Route Noncancer Total**	0.002
Exposure Medium: Surface Soil (0-6 inches bgs)																	
Exposure Route: Plant Consumption																	
Uranium-238 in SE	5.6E+00	pCi/g	6.2E+05	pCi/g	4.3E-09	Risk/pCi/g	2.6E-03	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	3E-03				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	2.1E-01	mg/kg-day	1.0E+00	mg/kg-day	0.21	5.5E-01	mg/kg-day	1.0E+00	mg/kg-day	0.55
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	7.7E-06	mg/kg-day	4.0E-04	mg/kg-day	0.019	2.1E-05	mg/kg-day	4.0E-04	mg/kg-day	0.052
Arsenic	6.5E+00	mg/kg	9.3E-05	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	1.4E-04	8.2E-05	mg/kg-day	3.0E-04	mg/kg-day	0.27	2.2E-04	mg/kg-day	3.0E-04	mg/kg-day	0.73
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	4.4E-03	mg/kg-day	2.0E-01	mg/kg-day	0.022	1.2E-02	mg/kg-day	2.0E-01	mg/kg-day	0.059
Cadmium	1.6E-01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	9.5E-06	mg/kg-day	1.0E-04	mg/kg-day	0.095	2.5E-05	mg/kg-day	1.0E-04	mg/kg-day	0.25
Chromium	1.4E+01	mg/kg	3.92E-04	mg/kg-day	5.0E-01	$(mg/kg\text{-}day)^{-1}$	2.0E-04	1.7E-04	mg/kg-day	3.0E-03	mg/kg-day	0.056	4.5E-04	mg/kg-day	3.0E-03	mg/kg-day	0.15
Cobalt	7.1E+00	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	1.3E-04	mg/kg-day	3.0E-04	mg/kg-day	0.43	3.4E-04	mg/kg-day	3.0E-04	mg/kg-day	1.1
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	2.0E-03	mg/kg-day	4.0E-02	mg/kg-day	0.051	5.4E-03	mg/kg-day	4.0E-02	mg/kg-day	0.13
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	2.4E-01	mg/kg-day	7.0E-01	mg/kg-day	0.34	6.3E-01	mg/kg-day	7.0E-01	mg/kg-day	0.91
Manganese	2.8E+02	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	3.1E-02	mg/kg-day	2.4E-02	mg/kg-day	1.3	8.1E-02	mg/kg-day	2.4E-02	mg/kg-day	3.4
Selenium	2.7E+00	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	4.8E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0097	1.3E-04	mg/kg-day	5.0E-03	mg/kg-day	0.026
Thallium	3.0E-01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	3.1E-06	mg/kg-day	1.0E-05	mg/kg-day	0.31	8.3E-06	mg/kg-day	1.0E-05	mg/kg-day	0.83
Uranium	7.2E+00	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	9.7E-05	mg/kg-day	2.0E-04	mg/kg-day	0.48	2.6E-04	mg/kg-day	2.0E-04	mg/kg-day	1.3
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	3.4E-04	mg/kg-day	5.0E-03	mg/kg-day	0.069	9.2E-04	mg/kg-day	5.0E-03	mg/kg-day	0.18
						Metals Cancer Total	3E-04				**Metals Noncancer Total**	4				**Metals Noncancer Total**	10
						Exposure Route Cancer Total	3E-03				**Exposure Route Noncancer Total**	4				**Exposure Route Noncancer Total**	10

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																	
COPC[a]	EPC[b]	Units	Cancer Intake[c]	Units	Slope Factor/ Unit Risk[d]	Units	Cancer Risk[e]	Adult Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Adult	Child Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Child
Exposure Medium: Surface Soil (0-6 inches bgs)																	
Exposure Route: Animal Consumption																	
Uranium-238 in SE	5.6E+00	pCi/g	1.2E+06	pCi/g	4.3E-09	Risk/pCi/g	5.0E-03	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	5E-03				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.2E-02	mg/kg-day	1.0E+00	mg/kg-day	0.012	3.3E-02	mg/kg-day	1.0E+00	mg/kg-day	0.033
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	2.3E-07	mg/kg-day	4.0E-04	mg/kg-day	0.00057	6.1E-07	mg/kg-day	4.0E-04	mg/kg-day	0.0015
Arsenic	6.5E+00	mg/kg	7.2E-06	mg/kg-day	1.5E+00	$(mg/kg-day)^{-1}$	1.1E-05	6.4E-06	mg/kg-day	3.0E-04	mg/kg-day	0.021	1.7E-05	mg/kg-day	3.0E-04	mg/kg-day	0.057
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	2.5E-05	mg/kg-day	2.0E-01	mg/kg-day	0.00013	6.7E-05	mg/kg-day	2.0E-01	mg/kg-day	0.00034
Cadmium	1.6E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	3.6E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0036	9.6E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0096
Chromium	1.4E+01	mg/kg	8.59E-05	mg/kg-day	5.0E-01	$(mg/kg-day)^{-1}$	4.3E-05	3.7E-05	mg/kg-day	3.0E-03	mg/kg-day	0.0123	9.9E-05	mg/kg-day	3.0E-03	mg/kg-day	0.0329
Cobalt	7.1E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	6.8E-05	mg/kg-day	3.0E-04	mg/kg-day	0.23	1.8E-04	mg/kg-day	3.0E-04	mg/kg-day	0.61
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.1E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0027	2.9E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0072
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.9E-01	mg/kg-day	7.0E-01	mg/kg-day	0.27	4.9E-01	mg/kg-day	7.0E-01	mg/kg-day	0.71
Manganese	2.8E+02	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	9.4E-05	mg/kg-day	2.4E-02	mg/kg-day	0.0039	2.5E-04	mg/kg-day	2.4E-02	mg/kg-day	0.010
Selenium	2.7E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	2.1E-04	mg/kg-day	5.0E-03	mg/kg-day	0.042	5.5E-04	mg/kg-day	5.0E-03	mg/kg-day	0.11
Thallium	3.0E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	5.5E-06	mg/kg-day	1.0E-05	mg/kg-day	0.55	1.5E-05	mg/kg-day	1.0E-05	mg/kg-day	1.5
Uranium	7.2E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.0E-06	mg/kg-day	2.0E-04	mg/kg-day	0.0051	2.7E-06	mg/kg-day	2.0E-04	mg/kg-day	0.014
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	3.2E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0064	8.5E-05	mg/kg-day	5.0E-03	mg/kg-day	0.017
						Metals Cancer Total	5E-05				**Metals Noncancer Total**	1				**Metals Noncancer Total**	3
						Exposure Route Cancer Total	5E-03				**Exposure Route Noncancer Total**	1				**Exposure Route Noncancer Total**	3
Exposure Medium: Surface Soil (0-6 inches bgs)																	
Exposure Route: Other Diné Lifeways Plant Ingestion																	
Uranium-238 in SE	5.6E+00	pCi/g	3.4E+05	pCi/g	4.3E-09	Risk/pCi/g	1.4E-03	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	1E-03				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.3E-01	mg/kg-day	1.0E+00	mg/kg-day	0.13	--	mg/kg-day	1.0E+00	mg/kg-day	--
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	5.0E-06	mg/kg-day	4.0E-04	mg/kg-day	0.012	--	mg/kg-day	4.0E-04	mg/kg-day	--
Arsenic	6.5E+00	mg/kg	4.6E-05	mg/kg-day	1.5E+00	$(mg/kg-day)^{-1}$	6.9E-05	5.0E-05	mg/kg-day	3.0E-04	mg/kg-day	0.17	--	mg/kg-day	3.0E-04	mg/kg-day	--
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	2.9E-03	mg/kg-day	2.0E-01	mg/kg-day	0.014	--	mg/kg-day	2.0E-01	mg/kg-day	--
Cadmium	1.6E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	6.4E-06	mg/kg-day	1.0E-04	mg/kg-day	0.064	--	mg/kg-day	1.0E-04	mg/kg-day	--
Chromium	1.4E+01	mg/kg	1.2E-04	mg/kg-day	5.0E-01	$(mg/kg-day)^{-1}$	6.1E-05	1.0E-04	mg/kg-day	3.0E-03	mg/kg-day	0.034	--	mg/kg-day	3.0E-03	mg/kg-day	--
Cobalt	7.1E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	8.1E-05	mg/kg-day	3.0E-04	mg/kg-day	0.27	--	mg/kg-day	3.0E-04	mg/kg-day	--
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.4E-03	mg/kg-day	4.0E-02	mg/kg-day	0.034	--	mg/kg-day	4.0E-02	mg/kg-day	--
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.5E-01	mg/kg-day	7.0E-01	mg/kg-day	0.21	--	mg/kg-day	7.0E-01	mg/kg-day	--
Manganese	2.8E+02	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	2.1E-02	mg/kg-day	2.4E-02	mg/kg-day	0.86	--	mg/kg-day	2.4E-02	mg/kg-day	--
Molybdenum	7.1E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	5.2E-05	mg/kg-day	5.0E-03	mg/kg-day	0.010	--	mg/kg-day	5.0E-03	mg/kg-day	--
Nickel	1.3E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.1E-04	mg/kg-day	2.0E-02	mg/kg-day	0.0056	--	mg/kg-day	2.0E-02	mg/kg-day	--
Selenium	2.7E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	3.0E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0061	--	mg/kg-day	5.0E-03	mg/kg-day	--
Thallium	3.0E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.9E-06	mg/kg-day	1.0E-05	mg/kg-day	0.19	--	mg/kg-day	1.0E-05	mg/kg-day	--
Uranium	7.2E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	6.0E-05	mg/kg-day	2.0E-04	mg/kg-day	0.30	--	mg/kg-day	2.0E-04	mg/kg-day	--
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	2.1E-04	mg/kg-day	5.0E-03	mg/kg-day	0.042	--	mg/kg-day	5.0E-03	mg/kg-day	--
						Metals Cancer Total	1E-04				**Metals Noncancer Total**	2				**Metals Noncancer Total**	--
						Exposure Route Cancer Total	2E-03				**Exposure Route Noncancer Total**	2				**Exposure Route Noncancer Total**	--

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																	
COPC[a]	EPC[b]	Units	Cancer Intake[c]	Units	Slope Factor/ Unit Risk[d]	Units	Cancer Risk[e]	Adult Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Adult	Child Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Child
Exposure Medium: Surface Soil (0-6 inches bgs)																	
Exposure Route: Other Diné Lifeways Plant Dermal																	
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	1.0E+00	mg/kg-day	--	--	mg/kg-day	1.0E+00	mg/kg-day	--
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	4.0E-04	mg/kg-day	--	--	mg/kg-day	4.0E-04	mg/kg-day	--
Arsenic	6.5E+00	mg/kg	3.9E-06	mg/kg-day	1.5E+00	$(mg/kg-day)^{-1}$	5.8E-06	4.2E-06	mg/kg-day	3.0E-04	mg/kg-day	0.014	--	mg/kg-day	3.0E-04	mg/kg-day	--
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	2.0E-01	mg/kg-day	--	--	mg/kg-day	2.0E-01	mg/kg-day	--
Cadmium	1.6E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	7.0E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0070	--	mg/kg-day	1.0E-04	mg/kg-day	--
Chromium	1.4E+01	mg/kg	--	mg/kg-day	5.0E-01	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	3.0E-03	mg/kg-day	--	--	mg/kg-day	3.0E-03	mg/kg-day	--
Cobalt	7.1E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	mg/kg-day	3.0E-04	mg/kg-day	--
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	4.0E-02	mg/kg-day	--	--	mg/kg-day	4.0E-02	mg/kg-day	--
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	7.0E-01	mg/kg-day	--	--	mg/kg-day	7.0E-01	mg/kg-day	--
Manganese	2.8E+02	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	2.4E-02	mg/kg-day	--	--	mg/kg-day	2.4E-02	mg/kg-day	--
Molybdenum	7.1E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
Nickel	1.3E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	2.0E-02	mg/kg-day	--	--	mg/kg-day	2.0E-02	mg/kg-day	--
Selenium	2.7E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
Thallium	3.0E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	1.0E-05	mg/kg-day	--	--	mg/kg-day	1.0E-05	mg/kg-day	--
Uranium	7.2E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	2.0E-04	mg/kg-day	--	--	mg/kg-day	2.0E-04	mg/kg-day	--
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
						Metals Cancer Total	6E-06				**Metals Noncancer Total**	0.02				**Metals Noncancer Total**	--
						Exposure Route Cancer Total	6E-06				**Exposure Route Noncancer Total**	0.02				**Exposure Route Noncancer Total**	--
Exposure Medium: Surface Soil (0-6 inches bgs)																	
Exposure Route: Other Diné Lifeways Plant Inhalation																	
Uranium-238 in SE	5.6E+00	pCi/g	3.5E+03	pCi	1.5E-07	risk/pCi	5.1E-04	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	5E-04				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
Aluminum	1.8E+04	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	1.3E-03	mg/m^3	5.0E-03	mg/m^3	0.26	--	mg/m^3	5.0E-03	mg/m^3	--
Antimony	3.4E-01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	5.0E-08	mg/m^3	3.0E-04	mg/m^3	0.00017	--	mg/m^3	3.0E-04	mg/m^3	--
Arsenic	6.5E+00	mg/kg	4.7E-04	$\mu g/m^3$	4.3E-03	$(\mu g/m^3)^{-1}$	2.0E-06	5.1E-07	mg/m^3	1.5E-05	mg/m^3	0.034	--	mg/m^3	1.5E-05	mg/m^3	--
Barium	1.9E+02	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	2.9E-05	mg/m^3	5.0E-04	mg/m^3	0.058	--	mg/m^3	5.0E-04	mg/m^3	--
Cadmium	1.6E-01	mg/kg	5.9E-05	$\mu g/m^3$	1.8E-03	$(\mu g/m^3)^{-1}$	1.1E-07	6.4E-08	mg/m^3	1.0E-05	mg/m^3	0.0064	--	mg/m^3	1.0E-05	mg/m^3	--
Chromium	1.4E+01	mg/kg	1.2E-03	$\mu g/m^3$	8.4E-02	$(\mu g/m^3)^{-1}$	1.0E-04	--	mg/m^3	1.0E-04	mg/m^3	--	--	mg/m^3	1.0E-04	mg/m^3	--
Cobalt	7.1E+00	mg/kg	7.5E-04	$\mu g/m^3$	9.0E-03	$(\mu g/m^3)^{-1}$	6.8E-06	8.2E-07	mg/m^3	6.0E-06	mg/m^3	0.14	--	mg/m^3	6.0E-06	mg/m^3	--
Copper	1.2E+01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Iron	2.0E+04	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Manganese	2.8E+02	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	2.1E-04	mg/m^3	5.0E-05	mg/m^3	4.1	--	mg/m^3	5.0E-05	mg/m^3	--
Molybdenum	7.1E-01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	5.2E-07	mg/m^3	2.0E-03	mg/m^3	0.00026	--	mg/m^3	2.0E-03	mg/m^3	--
Nickel	1.3E+01	mg/kg	1.0E-03	$\mu g/m^3$	2.6E-04	$(\mu g/m^3)^{-1}$	2.7E-07	1.1E-06	mg/m^3	9.0E-05	mg/m^3	0.013	--	mg/m^3	9.0E-05	mg/m^3	--
Selenium	2.7E+00	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	3.1E-07	mg/m^3	2.0E-02	mg/m^3	0.000015	--	mg/m^3	2.0E-02	mg/m^3	--
Thallium	3.0E-01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Uranium	7.2E+00	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	6.1E-07	mg/m^3	4.0E-05	mg/m^3	0.015	--	mg/m^3	4.0E-05	mg/m^3	--
Vanadium	2.8E+01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	2.1E-06	mg/m^3	1.0E-04	mg/m^3	0.021	--	mg/m^3	1.0E-04	mg/m^3	--
						Metals Cancer Total	1E-04				**Metals Noncancer Total**	5				**Metals Noncancer Total**	--
						Exposure Route Cancer Total	6E-04				**Exposure Route Noncancer Total**	5				**Exposure Route Noncancer Total**	--
						Surface Soil (0-6 inches bgs) Receptor Cancer Risk Total	**1E-02**				**Receptor/Media Noncancer Hazard Total**	**10**				**Receptor/Media Noncancer Hazard Total**	**20**

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																	
COPC[a]	EPC[b]	Units	Cancer Intake[c]	Units	Slope Factor/ Unit Risk[d]	Units	Cancer Risk[e]	Adult Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Adult	Child Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Child
Exposure Medium: Subsurface Soil (0-18 inches bgs)																	
Exposure Route: Incidental Soil Ingestion																	
Uranium-238 in SE	6.5E+00	pCi/g	6.2E+04	pCi/g	6.2E-09	Risk/pCi/g	3.8E-04	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	4E-04				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
Aluminum	1.7E+04	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	7.5E-02	mg/kg-day	1.0E+00	mg/kg-day	0.075	4.4E-01	mg/kg-day	1.0E+00	mg/kg-day	0.44
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.5E-06	mg/kg-day	4.0E-04	mg/kg-day	0.0037	8.7E-06	mg/kg-day	4.0E-04	mg/kg-day	0.022
Arsenic	6.3E+00	mg/kg	2.3E-05	mg/kg-day	1.5E+00	$(mg/kg-day)^{-1}$	3.4E-05	1.6E-05	mg/kg-day	3.0E-04	mg/kg-day	0.054	9.7E-05	mg/kg-day	3.0E-04	mg/kg-day	0.32
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	8.4E-04	mg/kg-day	2.0E-01	mg/kg-day	0.0042	5.0E-03	mg/kg-day	2.0E-01	mg/kg-day	0.025
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	6.5E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0065	3.8E-06	mg/kg-day	1.0E-04	mg/kg-day	0.038
Chromium	1.3E+01	mg/kg	2.08E-04	mg/kg-day	5.0E-01	$(mg/kg-day)^{-1}$	1.0E-04	5.6E-05	mg/kg-day	3.0E-03	mg/kg-day	0.0187	3.3E-04	mg/kg-day	3.0E-03	mg/kg-day	0.111
Cobalt	6.8E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	2.9E-05	mg/kg-day	3.0E-04	mg/kg-day	0.098	1.7E-04	mg/kg-day	3.0E-04	mg/kg-day	0.58
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	5.2E-05	mg/kg-day	4.0E-02	mg/kg-day	0.0013	3.1E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0077
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	8.5E-02	mg/kg-day	7.0E-01	mg/kg-day	0.12	5.1E-01	mg/kg-day	7.0E-01	mg/kg-day	0.72
Manganese	2.7E+02	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.2E-03	mg/kg-day	2.4E-02	mg/kg-day	0.049	7.0E-03	mg/kg-day	2.4E-02	mg/kg-day	0.29
Selenium	2.8E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.2E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0024	7.2E-05	mg/kg-day	5.0E-03	mg/kg-day	0.014
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.3E-06	mg/kg-day	1.0E-05	mg/kg-day	0.13	7.4E-06	mg/kg-day	1.0E-05	mg/kg-day	0.74
Uranium	1.1E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	4.7E-05	mg/kg-day	2.0E-04	mg/kg-day	0.24	2.8E-04	mg/kg-day	2.0E-04	mg/kg-day	1.4
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	1.2E-04	mg/kg-day	5.0E-03	mg/kg-day	0.024	7.2E-04	mg/kg-day	5.0E-03	mg/kg-day	0.14
						Metals Cancer Total	1E-04				**Metals Noncancer Total**	0.8				**Metals Noncancer Total**	5
						Exposure Route Cancer Total	5E-04				**Exposure Route Noncancer Total**	0.8				**Exposure Route Noncancer Total**	5
Exposure Medium: Subsurface Soil (0-18 inches bgs)																	
Exposure Route: External Exposure																	
Uranium-238 in SE	6.5E+00	pCi/g	3.3E+02	pCi/g	8.5E-06	risk/year pCi/g	2.8E-03	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	3E-03				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
						Exposure Route Cancer Total	3E-03				**Exposure Route Noncancer Total**	--				**Exposure Route Noncancer Total**	--
Exposure Route: Dermal Exposure																	
Aluminum	1.7E+04	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	1.0E+00	mg/kg-day	--	--	mg/kg-day	1.0E+00	mg/kg-day	--
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	4.0E-04	mg/kg-day	--	--	mg/kg-day	4.0E-04	mg/kg-day	--
Arsenic	6.3E+00	mg/kg	1.3E-06	mg/kg-day	1.5E+00	$(mg/kg-day)^{-1}$	2.0E-06	9.6E-07	mg/kg-day	3.0E-04	mg/kg-day	0.0032	5.7E-06	mg/kg-day	3.0E-04	mg/kg-day	0.019
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	2.0E-01	mg/kg-day	--	--	mg/kg-day	2.0E-01	mg/kg-day	--
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	3.0E-08	mg/kg-day	1.0E-04	mg/kg-day	0.00030	1.8E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0018
Chromium	1.3E+01	mg/kg	--	mg/kg-day	5.0E-01	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	3.0E-03	mg/kg-day	--	--	mg/kg-day	3.0E-03	mg/kg-day	--
Cobalt	6.8E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	mg/kg-day	3.0E-04	mg/kg-day	--
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	4.0E-02	mg/kg-day	--	--	mg/kg-day	4.0E-02	mg/kg-day	--
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	7.0E-01	mg/kg-day	--	--	mg/kg-day	7.0E-01	mg/kg-day	--
Manganese	2.7E+02	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	2.4E-02	mg/kg-day	--	--	mg/kg-day	2.4E-02	mg/kg-day	--
Selenium	2.8E+00	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	1.0E-05	mg/kg-day	--	--	mg/kg-day	1.0E-05	mg/kg-day	--
Uranium	1.1E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	2.0E-04	mg/kg-day	--	--	mg/kg-day	2.0E-04	mg/kg-day	--
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	$(mg/kg-day)^{-1}$	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
						Metals Cancer Total	2E-06				**Metals Noncancer Total**	0.003				**Metals Noncancer Total**	0.02
						Exposure Route Cancer Total	2E-06				**Exposure Route Noncancer Total**	0.003				**Exposure Route Noncancer Total**	0.02

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																	
COPC[a]	EPC[b]	Units	Cancer Intake[c]	Units	Slope Factor/ Unit Risk[d]	Units	Cancer Risk[e]	Adult Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Adult	Child Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Child
Exposure Medium: Subsurface Soil (0-18 inches bgs)																	
Exposure Route: Inhalation of Particulates																	
Uranium-238 in SE	6.5E+00	pCi/g	5.6E-01	pCi	1.5E-07	Risk/pCi	8.2E-08	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	8E-08				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
Aluminum	1.7E+04	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	2.3E-06	mg/m^3	5.0E-03	mg/m^3	0.00046	2.3E-06	mg/m^3	5.0E-03	mg/m^3	0.00046
Antimony	3.4E-01	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	4.5E-11	mg/m^3	3.0E-04	mg/m^3	0.00000015	4.5E-11	mg/m^3	3.0E-04	mg/m^3	0.00000015
Arsenic	6.3E+00	mg/kg	8.4E-07	μg/m^3	4.3E-03	(μg/m^3)$^{-1}$	3.6E-09	8.4E-10	mg/m^3	1.5E-05	mg/m^3	0.000056	8.4E-10	mg/m^3	1.5E-05	mg/m^3	0.000056
Barium	1.9E+02	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	2.6E-08	mg/m^3	5.0E-04	mg/m^3	0.000052	2.6E-08	mg/m^3	5.0E-04	mg/m^3	0.000052
Cadmium	1.5E-01	mg/kg	2.0E-08	μg/m^3	1.8E-03	(μg/m^3)$^{-1}$	3.6E-11	2.0E-11	mg/m^3	1.0E-05	mg/m^3	0.0000020	2.0E-11	mg/m^3	1.0E-05	mg/m^3	0.0000020
Chromium	1.3E+01	mg/kg	2.8E-06	μg/m^3	8.4E-02	(μg/m^3)$^{-1}$	2.3E-07	--	mg/m^3	1.0E-04	mg/m^3	--	--	mg/m^3	1.0E-04	mg/m^3	--
Cobalt	6.8E+00	mg/kg	9.0E-07	μg/m^3	9.0E-03	(μg/m^3)$^{-1}$	8.1E-09	9.0E-10	mg/m^3	6.0E-06	mg/m^3	0.00015	9.0E-10	mg/m^3	6.0E-06	mg/m^3	0.00015
Copper	1.2E+01	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Iron	2.0E+04	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Manganese	2.7E+02	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	3.6E-08	mg/m^3	5.0E-05	mg/m^3	0.00073	3.6E-08	mg/m^3	5.0E-05	mg/m^3	0.00073
Selenium	2.8E+00	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	3.7E-10	mg/m^3	2.0E-02	mg/m^3	0.000000019	3.7E-10	mg/m^3	2.0E-02	mg/m^3	0.000000019
Thallium	2.9E-01	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Uranium	1.1E+01	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	1.5E-09	mg/m^3	4.0E-05	mg/m^3	0.000037	1.5E-09	mg/m^3	4.0E-05	mg/m^3	0.000037
Vanadium	2.8E+01	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	3.7E-09	mg/m^3	1.0E-04	mg/m^3	0.000037	3.7E-09	mg/m^3	1.0E-04	mg/m^3	0.000037
						Metals Cancer Total	2E-07				**Metals Noncancer Total**	0.002				**Metals Noncancer Total**	0.002
						Exposure Route Cancer Total	3E-07				**Exposure Route Noncancer Total**	0.002				**Exposure Route Noncancer Total**	0.002
Exposure Medium: Subsurface Soil (0-18 inches bgs)																	
Exposure Route: Plant Consumption																	
Uranium-238 in SE	6.5E+00	pCi/g	7.2E+05	pCi/g	4.3E-09	Risk/pCi/g	3.1E-03	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	3E-03				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
Aluminum	1.7E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.0E-01	mg/kg-day	1.0E+00	mg/kg-day	0.20	5.4E-01	mg/kg-day	1.0E+00	mg/kg-day	0.54
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	7.7E-06	mg/kg-day	4.0E-04	mg/kg-day	0.019	2.1E-05	mg/kg-day	4.0E-04	mg/kg-day	0.052
Arsenic	6.3E+00	mg/kg	9.0E-05	mg/kg-day	1.5E+00	(mg/kg-day)$^{-1}$	1.4E-04	8.0E-05	mg/kg-day	3.0E-04	mg/kg-day	0.27	2.1E-04	mg/kg-day	3.0E-04	mg/kg-day	0.71
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	4.4E-03	mg/kg-day	2.0E-01	mg/kg-day	0.022	1.2E-02	mg/kg-day	2.0E-01	mg/kg-day	0.059
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	8.9E-06	mg/kg-day	1.0E-04	mg/kg-day	0.089	2.4E-05	mg/kg-day	1.0E-04	mg/kg-day	0.24
Chromium	1.3E+01	mg/kg	3.6E-04	mg/kg-day	5.0E-01	(mg/kg-day)$^{-1}$	1.8E-04	1.6E-04	mg/kg-day	3.0E-03	mg/kg-day	0.052	4.2E-04	mg/kg-day	3.0E-03	mg/kg-day	0.14
Cobalt	6.8E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	1.2E-04	mg/kg-day	3.0E-04	mg/kg-day	0.41	3.3E-04	mg/kg-day	3.0E-04	mg/kg-day	1.1
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.0E-03	mg/kg-day	4.0E-02	mg/kg-day	0.051	5.4E-03	mg/kg-day	4.0E-02	mg/kg-day	0.13
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.3E-01	mg/kg-day	7.0E-01	mg/kg-day	0.33	6.2E-01	mg/kg-day	7.0E-01	mg/kg-day	0.88
Manganese	2.7E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	3.0E-02	mg/kg-day	2.4E-02	mg/kg-day	1.2	7.9E-02	mg/kg-day	2.4E-02	mg/kg-day	3.3
Selenium	2.8E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	5.0E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0100	1.3E-04	mg/kg-day	5.0E-03	mg/kg-day	0.027
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	3.0E-06	mg/kg-day	1.0E-05	mg/kg-day	0.30	8.1E-06	mg/kg-day	1.0E-05	mg/kg-day	0.81
Uranium	1.1E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	1.5E-04	mg/kg-day	2.0E-04	mg/kg-day	0.74	3.9E-04	mg/kg-day	2.0E-04	mg/kg-day	2.0
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	3.4E-04	mg/kg-day	5.0E-03	mg/kg-day	0.069	9.2E-04	mg/kg-day	5.0E-03	mg/kg-day	0.18
						Metals Cancer Total	3E-04				**Metals Noncancer Total**	4				**Metals Noncancer Total**	10
						Exposure Route Cancer Total	3E-03				**Exposure Route Noncancer Total**	4				**Exposure Route Noncancer Total**	10

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																	
COPC[a]	EPC[b]	Units	Cancer Intake[c]	Units	Slope Factor/ Unit Risk[d]	Units	Cancer Risk[e]	Adult Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Adult	Child Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Child
Exposure Medium: Subsurface Soil (0-18 inches bgs)																	
Exposure Route: Animal Consumption																	
Uranium-238 in SE	6.5E+00	pCi/g	1.3E+06	pCi/g	4.3E-09	Risk/pCi/g	5.7E-03	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	6E-03				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
Aluminum	1.7E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	1.2E-02	mg/kg-day	1.0E+00	mg/kg-day	0.012	3.2E-02	mg/kg-day	1.0E+00	mg/kg-day	0.032
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.3E-07	mg/kg-day	4.0E-04	mg/kg-day	0.00057	6.1E-07	mg/kg-day	4.0E-04	mg/kg-day	0.0015
Arsenic	6.3E+00	mg/kg	7.0E-06	mg/kg-day	1.5E+00	(mg/kg-day)$^{-1}$	1.1E-05	6.2E-06	mg/kg-day	3.0E-04	mg/kg-day	0.021	1.6E-05	mg/kg-day	3.0E-04	mg/kg-day	0.055
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.5E-05	mg/kg-day	2.0E-01	mg/kg-day	0.00013	6.7E-05	mg/kg-day	2.0E-01	mg/kg-day	0.00034
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	3.4E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0034	9.0E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0090
Chromium	1.3E+01	mg/kg	8.0E-05	mg/kg-day	5.0E-01	(mg/kg-day)$^{-1}$	4.0E-05	3.4E-05	mg/kg-day	3.0E-03	mg/kg-day	0.0114	9.2E-05	mg/kg-day	3.0E-03	mg/kg-day	0.0305
Cobalt	6.8E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	6.5E-05	mg/kg-day	3.0E-04	mg/kg-day	0.22	1.7E-04	mg/kg-day	3.0E-04	mg/kg-day	0.58
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	1.1E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0027	2.9E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0072
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	1.8E-01	mg/kg-day	7.0E-01	mg/kg-day	0.26	4.8E-01	mg/kg-day	7.0E-01	mg/kg-day	0.69
Manganese	2.7E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	9.1E-05	mg/kg-day	2.4E-02	mg/kg-day	0.0038	2.4E-04	mg/kg-day	2.4E-02	mg/kg-day	0.010
Selenium	2.8E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.2E-04	mg/kg-day	5.0E-03	mg/kg-day	0.043	5.7E-04	mg/kg-day	5.0E-03	mg/kg-day	0.11
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	5.3E-06	mg/kg-day	1.0E-05	mg/kg-day	0.53	1.4E-05	mg/kg-day	1.0E-05	mg/kg-day	1.4
Uranium	1.1E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	1.6E-06	mg/kg-day	2.0E-04	mg/kg-day	0.0078	4.2E-06	mg/kg-day	2.0E-04	mg/kg-day	0.021
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	3.2E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0064	8.5E-05	mg/kg-day	5.0E-03	mg/kg-day	0.017
						Metals Cancer Total	5E-05				**Metals Noncancer Total**	1				**Metals Noncancer Total**	3
						Exposure Route Cancer Total	6E-03				**Exposure Route Noncancer Total**	1				**Exposure Route Noncancer Total**	3
Exposure Medium: Subsurface Soil (0-18 inches bgs)																	
Exposure Route: Other Diné Lifeways Plant Ingestion																	
Uranium-238 in SE	6.5E+00	pCi/g	3.9E+05	pCi/g	4.3E-09	Risk/pCi/g	1.7E-03	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	2E-03				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
Aluminum	1.7E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	1.2E-01	mg/kg-day	1.0E+00	mg/kg-day	0.12	--	mg/kg-day	1.0E+00	mg/kg-day	--
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	5.0E-06	mg/kg-day	4.0E-04	mg/kg-day	0.012	--	mg/kg-day	4.0E-04	mg/kg-day	--
Arsenic	6.3E+00	mg/kg	4.5E-05	mg/kg-day	1.5E+00	(mg/kg-day)$^{-1}$	6.7E-05	4.9E-05	mg/kg-day	3.0E-04	mg/kg-day	0.16	--	mg/kg-day	3.0E-04	mg/kg-day	--
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.9E-03	mg/kg-day	2.0E-01	mg/kg-day	0.014	--	mg/kg-day	2.0E-01	mg/kg-day	--
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	6.0E-06	mg/kg-day	1.0E-04	mg/kg-day	0.060	--	mg/kg-day	1.0E-04	mg/kg-day	--
Chromium	1.3E+01	mg/kg	1.1E-04	mg/kg-day	5.0E-01	(mg/kg-day)$^{-1}$	5.7E-05	9.6E-05	mg/kg-day	3.0E-03	mg/kg-day	0.032	--	mg/kg-day	3.0E-03	mg/kg-day	--
Cobalt	6.8E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	7.8E-05	mg/kg-day	3.0E-04	mg/kg-day	0.26	--	mg/kg-day	3.0E-04	mg/kg-day	--
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	1.4E-03	mg/kg-day	4.0E-02	mg/kg-day	0.034	--	mg/kg-day	4.0E-02	mg/kg-day	--
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	1.4E-01	mg/kg-day	7.0E-01	mg/kg-day	0.20	--	mg/kg-day	7.0E-01	mg/kg-day	--
Manganese	2.7E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.0E-02	mg/kg-day	2.4E-02	mg/kg-day	0.84	--	mg/kg-day	2.4E-02	mg/kg-day	--
Selenium	2.8E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	3.2E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0063	--	mg/kg-day	5.0E-03	mg/kg-day	--
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	1.8E-06	mg/kg-day	1.0E-05	mg/kg-day	0.18	--	mg/kg-day	1.0E-05	mg/kg-day	--
Uranium	1.1E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	9.2E-05	mg/kg-day	2.0E-04	mg/kg-day	0.46	--	mg/kg-day	2.0E-04	mg/kg-day	--
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.1E-04	mg/kg-day	5.0E-03	mg/kg-day	0.042	--	mg/kg-day	5.0E-03	mg/kg-day	--
						Metals Cancer Total	1E-04				**Metals Noncancer Total**	2				**Metals Noncancer Total**	--
						Exposure Route Cancer Total	2E-03				**Exposure Route Noncancer Total**	2				**Exposure Route Noncancer Total**	--

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Section 32 Mine - Kee'da'whíí téeh (Full-Time Navajo Resident)																	
COPC[a]	EPC[b]	Units	Cancer Intake[c]	Units	Slope Factor/ Unit Risk[d]	Units	Cancer Risk[e]	Adult Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Adult	Child Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Child
Exposure Medium: Subsurface Soil (0-18 inches bgs)																	
Exposure Route: Other Diné Lifeways Plant Dermal																	
Aluminum	1.7E+04	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	1.0E+00	mg/kg-day	--	--	mg/kg-day	1.0E+00	mg/kg-day	--
Antimony	3.4E-01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	4.0E-04	mg/kg-day	--	--	mg/kg-day	4.0E-04	mg/kg-day	--
Arsenic	6.3E+00	mg/kg	3.8E-06	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	5.7E-06	4.1E-06	mg/kg-day	3.0E-04	mg/kg-day	0.014	--	mg/kg-day	3.0E-04	mg/kg-day	--
Barium	1.9E+02	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	2.0E-01	mg/kg-day	--	--	mg/kg-day	2.0E-01	mg/kg-day	--
Cadmium	1.5E-01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	6.6E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0066	--	mg/kg-day	1.0E-04	mg/kg-day	--
Chromium	1.3E+01	mg/kg	--	mg/kg-day	5.0E-01	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	3.0E-03	mg/kg-day	--	--	mg/kg-day	3.0E-03	mg/kg-day	--
Cobalt	6.8E+00	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	mg/kg-day	3.0E-04	mg/kg-day	--
Copper	1.2E+01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	4.0E-02	mg/kg-day	--	--	mg/kg-day	4.0E-02	mg/kg-day	--
Iron	2.0E+04	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	7.0E-01	mg/kg-day	--	--	mg/kg-day	7.0E-01	mg/kg-day	--
Manganese	2.7E+02	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	2.4E-02	mg/kg-day	--	--	mg/kg-day	2.4E-02	mg/kg-day	--
Selenium	2.8E+00	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
Thallium	2.9E-01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	1.0E-05	mg/kg-day	--	--	mg/kg-day	1.0E-05	mg/kg-day	--
Uranium	1.1E+01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	2.0E-04	mg/kg-day	--	--	mg/kg-day	2.0E-04	mg/kg-day	--
Vanadium	2.8E+01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
						Metals Cancer Total	6E-06				**Metals Noncancer Total**	0.02				**Metals Noncancer Total**	--
						Exposure Route Cancer Total	6E-06				**Exposure Route Noncancer Total**	0.02				**Exposure Route Noncancer Total**	--
Exposure Medium: Subsurface Soil (0-18 inches bgs)																	
Exposure Route: Other Diné Lifeways Plant Inhalation																	
Uranium-238 in SE	6.5E+00	pCi/g	4.1E+03	pCi	1.5E-07	Risk/pCi	5.9E-04	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	6E-04				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
Aluminum	1.7E+04	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	1.3E-03	mg/m^3	5.0E-03	mg/m^3	0.25	--	mg/m^3	5.0E-03	mg/m^3	--
Antimony	3.4E-01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	5.0E-08	mg/m^3	3.0E-04	mg/m^3	0.00017	--	mg/m^3	3.0E-04	mg/m^3	--
Arsenic	6.3E+00	mg/kg	4.6E-04	$\mu g/m^3$	4.3E-03	$(\mu g/m^3)^{-1}$	2.0E-06	5.0E-07	mg/m^3	1.5E-05	mg/m^3	0.033	--	mg/m^3	1.5E-05	mg/m^3	--
Barium	1.9E+02	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	2.9E-05	mg/m^3	5.0E-04	mg/m^3	0.058	--	mg/m^3	5.0E-04	mg/m^3	--
Cadmium	1.5E-01	mg/kg	5.5E-05	$\mu g/m^3$	1.8E-03	$(\mu g/m^3)^{-1}$	9.9E-08	6.0E-08	mg/m^3	1.0E-05	mg/m^3	0.0060	--	mg/m^3	1.0E-05	mg/m^3	--
Chromium	1.3E+01	mg/kg	1.2E-03	$\mu g/m^3$	8.4E-02	$(\mu g/m^3)^{-1}$	9.7E-05	--	mg/m^3	1.0E-04	mg/m^3	--	--	mg/m^3	1.0E-04	mg/m^3	--
Cobalt	6.8E+00	mg/kg	7.2E-04	$\mu g/m^3$	9.0E-03	$(\mu g/m^3)^{-1}$	6.5E-06	7.9E-07	mg/m^3	6.0E-06	mg/m^3	0.13	--	mg/m^3	6.0E-06	mg/m^3	--
Copper	1.2E+01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Iron	2.0E+04	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Manganese	2.7E+02	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	2.0E-04	mg/m^3	5.0E-05	mg/m^3	4.0	--	mg/m^3	5.0E-05	mg/m^3	--
Selenium	2.8E+00	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	3.2E-07	mg/m^3	2.0E-02	mg/m^3	0.000016	--	mg/m^3	2.0E-02	mg/m^3	--
Thallium	2.9E-01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Uranium	1.1E+01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	9.3E-07	mg/m^3	4.0E-05	mg/m^3	0.023	--	mg/m^3	4.0E-05	mg/m^3	--
Vanadium	2.8E+01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	2.1E-06	mg/m^3	1.0E-04	mg/m^3	0.021	--	mg/m^3	1.0E-04	mg/m^3	--
						Metals Cancer Total	1E-04				**Metals Noncancer Total**	5				**Metals Noncancer Total**	--
						Exposure Route Cancer Total	7E-04				**Exposure Route Noncancer Total**	5				**Exposure Route Noncancer Total**	--
						Subsurface Soil (0-18 inches bgs) Receptor Cancer Risk Total	**2E-02**				**Receptor/Media Noncancer Hazard Total**	**10**				**Receptor/Media Noncancer Hazard Total**	**20**

Table C-5.1. Human Health Risk and Hazard Calculations - Section 32 Mine

Notes:

[a] COPCs are the constituents of interest with a maximum detected concentration exceeding the COPC screening level (see Table C-1).

[b] EPCs are provided on Table C-4.

[c] The intakes are the EPC multiplied by the exposure parameters and any applicable contaminant-specific inputs (see Table C-3 for exposure inputs, Table 4 of the NAUM risk assessment methodology [USEPA 2024b] for contaminant-specific inputs, and Appendix B of the NAUM risk assessment methodology [USEPA 2024b] for equations).

[d] The toxicity values are provided in Table 4 of the NAUM risk assessment methodology (USEPA 2024b).

[e] The cancer risk for each contaminant for each exposure pathway is calculated by multiplying the cancer intake value with the toxicity value as follows:

For contaminant *i* : $Risk_i = Cancer\ Intake_i \times Toxicity\ Factor_i$

[f] The noncancer hazard for each contaminant for each exposure pathway is calculated by dividing the noncancer intake value by the toxicity value as follows:

For contaminant *i* : $Hazard_i = Noncancer\ Intake_i\ /\ Toxicity\ Factor_i$

--	Not applicable
$\mu g/m^3$	Microgram per cubic meter
bgs	Below ground surface
COPC	Contaminant of potential concern
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
mg/m^3	Milligram per cubic meter
NAUM	Navajo abandoned uranium mine
pCi	Picocurie
pCi/g	Picocurie per gram
RfC	Reference concentration
RfD	Reference dose
SE	Secular equilibrium
USEPA	U.S. Environmental Protection Agency

Reference:

U.S. Environmental Protection Agency (USEPA). 2024b. “Navajo Abandoned Uranium Mines Risk Assessment Methodology.” Draft Final. March.

Table C-5.2. Human Health Risk and Hazard Calculations - Section 33 Mine

Section 33 Mine - Default Resident (Non-Navajo)																	
COPC[a]	EPC[b]	Units	Cancer Intake[c]	Units	Slope Factor/ Unit Risk[d]	Units	Cancer Risk[e]	Adult Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Adult	Child Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Child
Exposure Medium: Surface Soil (0-6 inches bgs)																	
Exposure Route: Incidental Soil Ingestion																	
Uranium-238 in SE	3.0E+01	pCi/g	3.4E+04	pCi/g	6.2E-09	Risk/pCi/g	2.1E-04	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	2E-04				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.2E-02	mg/kg-day	1.0E+00	mg/kg-day	0.022	2.3E-01	mg/kg-day	1.0E+00	mg/kg-day	0.23
Antimony	4.2E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	5.0E-07	mg/kg-day	4.0E-04	mg/kg-day	0.0013	5.4E-06	mg/kg-day	4.0E-04	mg/kg-day	0.013
Arsenic	7.4E+00	mg/kg	6.4E-06	mg/kg-day	1.5E+00	(mg/kg-day)$^{-1}$	9.6E-06	5.3E-06	mg/kg-day	3.0E-04	mg/kg-day	0.018	5.7E-05	mg/kg-day	3.0E-04	mg/kg-day	0.19
Barium	9.5E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	1.1E-04	mg/kg-day	2.0E-01	mg/kg-day	0.00057	1.2E-03	mg/kg-day	2.0E-01	mg/kg-day	0.0061
Cadmium	2.0E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.4E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0024	2.6E-06	mg/kg-day	1.0E-04	mg/kg-day	0.026
Chromium	1.4E+01	mg/kg	9.03E-05	mg/kg-day	5.0E-01	(mg/kg-day)$^{-1}$	4.5E-05	1.7E-05	mg/kg-day	3.0E-03	mg/kg-day	0.0056	1.8E-04	mg/kg-day	3.0E-03	mg/kg-day	0.060
Cobalt	7.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	9.1E-06	mg/kg-day	3.0E-04	mg/kg-day	0.030	9.7E-05	mg/kg-day	3.0E-04	mg/kg-day	0.32
Copper	1.5E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	1.8E-05	mg/kg-day	4.0E-02	mg/kg-day	0.00045	1.9E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0048
Iron	2.2E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.7E-02	mg/kg-day	7.0E-01	mg/kg-day	0.038	2.9E-01	mg/kg-day	7.0E-01	mg/kg-day	0.41
Manganese	2.3E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.8E-04	mg/kg-day	2.4E-02	mg/kg-day	0.012	3.0E-03	mg/kg-day	2.4E-02	mg/kg-day	0.12
Selenium	2.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.6E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0053	2.8E-04	mg/kg-day	5.0E-03	mg/kg-day	0.056
Thallium	4.1E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	4.9E-07	mg/kg-day	1.0E-05	mg/kg-day	0.049	5.2E-06	mg/kg-day	1.0E-05	mg/kg-day	0.52
Uranium	4.5E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	5.4E-05	mg/kg-day	2.0E-04	mg/kg-day	0.27	5.8E-04	mg/kg-day	2.0E-04	mg/kg-day	2.9
Vanadium	4.0E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	4.8E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0096	5.1E-04	mg/kg-day	5.0E-03	mg/kg-day	0.10
						Metals Cancer Total	5E-05				**Metals Noncancer Total**	0.5				**Metals Noncancer Total**	5
						Exposure Route Cancer Total	3E-04				**Exposure Route Noncancer Total**	0.5				**Exposure Route Noncancer Total**	5
Exposure Medium: Surface Soil (0-6 inches bgs)																	
Exposure Route: External Exposure																	
Uranium-238 in SE	3.0E+01	pCi/g	2.6E+02	pCi/g	8.5E-06	risk/year pCi/g	2.2E-03	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	2E-03				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
						Exposure Route Cancer Total	2E-03				**Exposure Route Noncancer Total**	--				**Exposure Route Noncancer Total**	--
Exposure Route: Dermal Exposure																	
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	--	mg/kg-day	1.0E+00	mg/kg-day	--	--	mg/kg-day	1.0E+00	mg/kg-day	--
Antimony	4.2E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	--	mg/kg-day	4.0E-04	mg/kg-day	--	--	mg/kg-day	4.0E-04	mg/kg-day	--
Arsenic	7.4E+00	mg/kg	9.0E-07	mg/kg-day	1.5E+00	(mg/kg-day)$^{-1}$	1.3E-06	1.1E-06	mg/kg-day	3.0E-04	mg/kg-day	0.0037	6.7E-06	mg/kg-day	3.0E-04	mg/kg-day	0.022
Barium	9.5E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	--	mg/kg-day	2.0E-01	mg/kg-day	--	--	mg/kg-day	2.0E-01	mg/kg-day	--
Cadmium	2.0E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	4.0E-08	mg/kg-day	1.0E-04	mg/kg-day	0.00040	2.4E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0024
Chromium	1.4E+01	mg/kg	--	mg/kg-day	5.0E-01	(mg/kg-day)$^{-1}$	--	2.8E-06	mg/kg-day	3.0E-03	mg/kg-day	0.00094	1.7E-05	mg/kg-day	3.0E-03	mg/kg-day	0.0057
Cobalt	7.6E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	mg/kg-day	3.0E-04	mg/kg-day	--
Copper	1.5E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	--	mg/kg-day	4.0E-02	mg/kg-day	--	--	mg/kg-day	4.0E-02	mg/kg-day	--
Iron	2.2E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	--	mg/kg-day	7.0E-01	mg/kg-day	--	--	mg/kg-day	7.0E-01	mg/kg-day	--
Manganese	2.3E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	--	mg/kg-day	2.4E-02	mg/kg-day	--	--	mg/kg-day	2.4E-02	mg/kg-day	--
Selenium	2.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
Thallium	4.1E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	--	mg/kg-day	1.0E-05	mg/kg-day	--	--	mg/kg-day	1.0E-05	mg/kg-day	--
Uranium	4.5E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	--	mg/kg-day	2.0E-04	mg/kg-day	--	--	mg/kg-day	2.0E-04	mg/kg-day	--
Vanadium	4.0E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
						Metals Cancer Total	1E-06				**Metals Noncancer Total**	0.005				**Metals Noncancer Total**	0.03
						Exposure Route Cancer Total	1E-06				**Exposure Route Noncancer Total**	0.005				**Exposure Route Noncancer Total**	0.03

Table C-5.2. Human Health Risk and Hazard Calculations - Section 33 Mine

Section 33 Mine - Default Resident (Non-Navajo)																	
COPC[a]	EPC[b]	Units	Cancer Intake[c]	Units	Slope Factor/ Unit Risk[d]	Units	Cancer Risk[e]	Adult Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Adult	Child Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Child
Exposure Medium: Surface Soil (0-6 inches bgs)																	
Exposure Route: Inhalation of Particulates																	
Uranium-238 in SE	3.0E+01	pCi/g	3.6E+00	pCi	1.5E-07	Risk/pCi	5.2E-07	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	5E-07				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
Aluminum	1.8E+04	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	1.3E-05	mg/m^3	5.0E-03	mg/m^3	0.0026	1.3E-05	mg/m^3	5.0E-03	mg/m^3	0.0026
Antimony	4.2E-01	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	3.0E-10	mg/m^3	3.0E-04	mg/m^3	0.00000099	3.0E-10	mg/m^3	3.0E-04	mg/m^3	0.00000099
Arsenic	7.4E+00	mg/kg	1.9E-06	μg/m^3	4.3E-03	(μg/m^3)$^{-1}$	8.3E-09	5.2E-09	mg/m^3	1.5E-05	mg/m^3	0.00035	5.2E-09	mg/m^3	1.5E-05	mg/m^3	0.00035
Barium	9.5E+01	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	6.7E-08	mg/m^3	5.0E-04	mg/m^3	0.00013	6.7E-08	mg/m^3	5.0E-04	mg/m^3	0.00013
Cadmium	2.0E-01	mg/kg	5.2E-08	μg/m^3	1.8E-03	(μg/m^3)$^{-1}$	9.4E-11	1.4E-10	mg/m^3	1.0E-05	mg/m^3	0.000014	1.4E-10	mg/m^3	1.0E-05	mg/m^3	0.000014
Chromium	1.4E+01	mg/kg	1.0E-05	μg/m^3	8.4E-02	(μg/m^3)$^{-1}$	8.8E-07	9.9E-09	mg/m^3	1.0E-04	mg/m^3	0.000099	9.9E-09	mg/m^3	1.0E-04	mg/m^3	0.000099
Cobalt	7.6E+00	mg/kg	2.0E-06	μg/m^3	9.0E-03	(μg/m^3)$^{-1}$	1.8E-08	5.4E-09	mg/m^3	6.0E-06	mg/m^3	0.00089	5.4E-09	mg/m^3	6.0E-06	mg/m^3	0.00089
Copper	1.5E+01	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Iron	2.2E+04	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Manganese	2.3E+02	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	1.6E-07	mg/m^3	5.0E-05	mg/m^3	0.0033	1.6E-07	mg/m^3	5.0E-05	mg/m^3	0.0033
Selenium	2.2E+01	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	1.6E-08	mg/m^3	2.0E-02	mg/m^3	0.00000078	1.6E-08	mg/m^3	2.0E-02	mg/m^3	0.00000078
Thallium	4.1E-01	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Uranium	4.5E+01	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	3.2E-08	mg/m^3	4.0E-05	mg/m^3	0.00079	3.2E-08	mg/m^3	4.0E-05	mg/m^3	0.00079
Vanadium	4.0E+01	mg/kg	--	μg/m^3	--	(μg/m^3)$^{-1}$	--	2.8E-08	mg/m^3	1.0E-04	mg/m^3	0.00028	2.8E-08	mg/m^3	1.0E-04	mg/m^3	0.00028
						Metals Cancer Total	9E-07				**Metals Noncancer Total**	0.008				**Metals Noncancer Total**	0.008
						Exposure Route Cancer Total	1E-06				**Exposure Route Noncancer Total**	0.008				**Exposure Route Noncancer Total**	0.008
						Surface Soil (0-6 inches bgs) Receptor Cancer Risk Total	**2E-03**				**Receptor/Media Noncancer Hazard Total**	**0.5**				**Receptor/Media Noncancer Hazard Total**	**5**
Exposure Medium: Subsurface Soil (0-18 inches bgs)																	
Exposure Route: Incidental Soil Ingestion																	
Uranium-238 in SE	3.0E+01	pCi/g	3.4E+04	pCi/g	6.2E-09	Risk/pCi/g	2.1E-04	--	--	--	--	--	--	--	--	--	--
						Radionuclide Cancer Total	2E-04				**Radionuclide Noncancer Total**	--				**Radionuclide Noncancer Total**	--
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.1E-02	mg/kg-day	1.0E+00	mg/kg-day	0.021	2.3E-01	mg/kg-day	1.0E+00	mg/kg-day	0.23
Antimony	4.1E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	4.9E-07	mg/kg-day	4.0E-04	mg/kg-day	0.0012	5.2E-06	mg/kg-day	4.0E-04	mg/kg-day	0.013
Arsenic	7.0E+00	mg/kg	6.0E-06	mg/kg-day	1.5E+00	(mg/kg-day)$^{-1}$	9.1E-06	5.0E-06	mg/kg-day	3.0E-04	mg/kg-day	0.017	5.4E-05	mg/kg-day	3.0E-04	mg/kg-day	0.18
Barium	9.2E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	1.1E-04	mg/kg-day	2.0E-01	mg/kg-day	0.00055	1.2E-03	mg/kg-day	2.0E-01	mg/kg-day	0.0059
Cadmium	1.9E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.3E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0023	2.4E-06	mg/kg-day	1.0E-04	mg/kg-day	0.024
Chromium	1.3E+01	mg/kg	8.39E-05	mg/kg-day	5.0E-01	(mg/kg-day)$^{-1}$	4.2E-05	1.6E-05	mg/kg-day	3.0E-03	mg/kg-day	0.0052	1.7E-04	mg/kg-day	3.0E-03	mg/kg-day	0.055
Cobalt	7.2E+00	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	8.6E-06	mg/kg-day	3.0E-04	mg/kg-day	0.029	9.2E-05	mg/kg-day	3.0E-04	mg/kg-day	0.31
Copper	1.4E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	1.7E-05	mg/kg-day	4.0E-02	mg/kg-day	0.00042	1.8E-04	mg/kg-day	4.0E-02	mg/kg-day	0.0045
Iron	2.1E+04	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.6E-02	mg/kg-day	7.0E-01	mg/kg-day	0.036	2.7E-01	mg/kg-day	7.0E-01	mg/kg-day	0.39
Manganese	2.2E+02	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.6E-04	mg/kg-day	2.4E-02	mg/kg-day	0.011	2.8E-03	mg/kg-day	2.4E-02	mg/kg-day	0.12
Selenium	2.0E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	2.4E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0048	2.6E-04	mg/kg-day	5.0E-03	mg/kg-day	0.051
Thallium	4.0E-01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	4.8E-07	mg/kg-day	1.0E-05	mg/kg-day	0.048	5.1E-06	mg/kg-day	1.0E-05	mg/kg-day	0.51
Uranium	4.4E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	5.3E-05	mg/kg-day	2.0E-04	mg/kg-day	0.26	5.6E-04	mg/kg-day	2.0E-04	mg/kg-day	2.8
Vanadium	3.8E+01	mg/kg	--	mg/kg-day	--	(mg/kg-day)$^{-1}$	--	4.6E-05	mg/kg-day	5.0E-03	mg/kg-day	0.0091	4.9E-04	mg/kg-day	5.0E-03	mg/kg-day	0.097
						Metals Cancer Total	5E-05				**Metals Noncancer Total**	0.4				**Metals Noncancer Total**	5
						Exposure Route Cancer Total	3E-04				**Exposure Route Noncancer Total**	0.4				**Exposure Route Noncancer Total**	5

Table C-5.2. Human Health Risk and Hazard Calculations - Section 33 Mine

Section 33 Mine - Default Resident (Non-Navajo)																	
COPC[a]	EPC[b]	Units	Cancer Intake[c]	Units	Slope Factor/ Unit Risk[d]	Units	Cancer Risk[e]	Adult Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Adult	Child Noncancer Intake[c]	Units	RfD/ RfC[d]	Units	Noncancer Hazard[f] Child
Exposure Medium: Subsurface Soil (0-18 inches bgs)																	
Exposure Route: External Exposure																	
Uranium-238 in SE	3.0E+01	pCi/g	2.6E+02	pCi/g	8.5E-06	risk/year pCi/g	2.2E-03	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							2E-03	**Radionuclide Noncancer Total**				--	**Radionuclide Noncancer Total**				--
Exposure Route Cancer Total							2E-03	**Exposure Route Noncancer Total**				--	**Exposure Route Noncancer Total**				--
Exposure Route: Dermal Exposure																	
Aluminum	1.8E+04	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	1.0E+00	mg/kg-day	--	--	mg/kg-day	1.0E+00	mg/kg-day	--
Antimony	4.1E-01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	4.0E-04	mg/kg-day	--	--	mg/kg-day	4.0E-04	mg/kg-day	--
Arsenic	7.0E+00	mg/kg	8.5E-07	mg/kg-day	1.5E+00	$(mg/kg\text{-}day)^{-1}$	1.3E-06	1.1E-06	mg/kg-day	3.0E-04	mg/kg-day	0.0035	6.4E-06	mg/kg-day	3.0E-04	mg/kg-day	0.021
Barium	9.2E+01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	2.0E-01	mg/kg-day	--	--	mg/kg-day	2.0E-01	mg/kg-day	--
Cadmium	1.9E-01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	3.8E-08	mg/kg-day	1.0E-04	mg/kg-day	0.00038	2.3E-07	mg/kg-day	1.0E-04	mg/kg-day	0.0023
Chromium	1.3E+01	mg/kg	--	mg/kg-day	5.0E-01	$(mg/kg\text{-}day)^{-1}$	--	2.6E-06	mg/kg-day	3.0E-03	mg/kg-day	0.00088	1.6E-05	mg/kg-day	3.0E-03	mg/kg-day	0.0053
Cobalt	7.2E+00	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	3.0E-04	mg/kg-day	--	--	mg/kg-day	3.0E-04	mg/kg-day	--
Copper	1.4E+01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	4.0E-02	mg/kg-day	--	--	mg/kg-day	4.0E-02	mg/kg-day	--
Iron	2.1E+04	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	7.0E-01	mg/kg-day	--	--	mg/kg-day	7.0E-01	mg/kg-day	--
Manganese	2.2E+02	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	2.4E-02	mg/kg-day	--	--	mg/kg-day	2.4E-02	mg/kg-day	--
Selenium	2.0E+01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
Thallium	4.0E-01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	1.0E-05	mg/kg-day	--	--	mg/kg-day	1.0E-05	mg/kg-day	--
Uranium	4.4E+01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	2.0E-04	mg/kg-day	--	--	mg/kg-day	2.0E-04	mg/kg-day	--
Vanadium	3.8E+01	mg/kg	--	mg/kg-day	--	$(mg/kg\text{-}day)^{-1}$	--	--	mg/kg-day	5.0E-03	mg/kg-day	--	--	mg/kg-day	5.0E-03	mg/kg-day	--
Metals Cancer Total							1E-06	**Metals Noncancer Total**				0.005	**Metals Noncancer Total**				0.03
Exposure Route Cancer Total							1E-06	**Exposure Route Noncancer Total**				0.005	**Exposure Route Noncancer Total**				0.03
Exposure Medium: Subsurface Soil (0-18 inches bgs)																	
Exposure Route: Inhalation of Particulates																	
Uranium-238 in SE	3.0E+01	pCi/g	3.2E+03	pCi	1.5E-07	Risk/pCi	4.7E-04	--	--	--	--	--	--	--	--	--	--
Radionuclide Cancer Total							5E-04	**Radionuclide Noncancer Total**				--	**Radionuclide Noncancer Total**				--
Aluminum	1.8E+04	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	1.2E-05	mg/m^3	5.0E-03	mg/m^3	0.0025	1.2E-05	mg/m^3	5.0E-03	mg/m^3	0.0025
Antimony	4.1E-01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	2.9E-10	mg/m^3	3.0E-04	mg/m^3	0.00000096	2.9E-10	mg/m^3	3.0E-04	mg/m^3	0.00000096
Arsenic	7.0E+00	mg/kg	2.1E-03	$\mu g/m^3$	4.3E-03	$(\mu g/m^3)^{-1}$	9.1E-06	4.9E-09	mg/m^3	1.5E-05	mg/m^3	0.00033	4.9E-09	mg/m^3	1.5E-05	mg/m^3	0.00033
Barium	9.2E+01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	6.5E-08	mg/m^3	5.0E-04	mg/m^3	0.00013	6.5E-08	mg/m^3	5.0E-04	mg/m^3	0.00013
Cadmium	1.9E-01	mg/kg	5.0E-08	$\mu g/m^3$	1.8E-03	$(\mu g/m^3)^{-1}$	9.0E-11	1.3E-10	mg/m^3	1.0E-05	mg/m^3	0.000013	1.3E-10	mg/m^3	1.0E-05	mg/m^3	0.000013
Chromium	1.3E+01	mg/kg	9.7E-06	$\mu g/m^3$	8.4E-02	$(\mu g/m^3)^{-1}$	8.1E-07	9.2E-09	mg/m^3	1.0E-04	mg/m^3	0.000092	9.2E-09	mg/m^3	1.0E-04	mg/m^3	0.000092
Cobalt	7.2E+00	mg/kg	1.9E-06	$\mu g/m^3$	9.0E-03	$(\mu g/m^3)^{-1}$	1.7E-08	5.1E-09	mg/m^3	6.0E-06	mg/m^3	0.00085	5.1E-09	mg/m^3	6.0E-06	mg/m^3	0.00085
Copper	1.4E+01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Iron	2.1E+04	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Manganese	2.2E+02	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	1.5E-07	mg/m^3	5.0E-05	mg/m^3	0.0031	1.5E-07	mg/m^3	5.0E-05	mg/m^3	0.0031
Selenium	2.0E+01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	1.4E-08	mg/m^3	2.0E-02	mg/m^3	0.00000071	1.4E-08	mg/m^3	2.0E-02	mg/m^3	0.00000071
Thallium	4.0E-01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	--	mg/m^3	--	mg/m^3	--	--	mg/m^3	--	mg/m^3	--
Uranium	4.4E+01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	3.1E-08	mg/m^3	4.0E-05	mg/m^3	0.00078	3.1E-08	mg/m^3	4.0E-05	mg/m^3	0.00078
Vanadium	3.8E+01	mg/kg	--	$\mu g/m^3$	--	$(\mu g/m^3)^{-1}$	--	2.7E-08	mg/m^3	1.0E-04	mg/m^3	0.00027	2.7E-08	mg/m^3	1.0E-04	mg/m^3	0.00027
Metals Cancer Total							1E-05	**Metals Noncancer Total**				0.008	**Metals Noncancer Total**				0.008
Exposure Route Cancer Total							5E-04	**Exposure Route Noncancer Total**				0.008	**Exposure Route Noncancer Total**				0.008
Subsurface Soil (0-18 inches bgs) Receptor Cancer Risk Total							**3E-03**	**Receptor/Media Noncancer Hazard Total**				0.5	**Receptor/Media Noncancer Hazard Total**				**5**

Table C-5.2. Human Health Risk and Hazard Calculations - Section 33 Mine

Notes:

[a] COPCs are the constituents of interest with a maximum detected concentration exceeding the COPC screening level (see Table C-1).

[b] EPCs are provided on Table C-4.

[c] The intakes are the EPC multiplied by the exposure parameters and any applicable contaminant-specific inputs (see Table C-3 for exposure inputs, Table 4 of the NAUM risk assessment methodology [USEPA 2024b] for contaminant-specific inputs, and Appendix B of the NAUM risk assessment methodology [USEPA 2024b] for equations).

[d] The toxicity values are provided in Table 4 of the NAUM risk assessment methodology (USEPA 2024b).

[e] The cancer risk for each contaminant for each exposure pathway is calculated by multiplying the cancer intake value with the toxicity value as follows:

For contaminant *i* : $Risk_i$ = Cancer $Intake_i$ x Toxicity $Factor_i$

[f] The noncancer hazard for each contaminant for each exposure pathway is calculated by dividing the noncancer intake value by the toxicity value as follows:

For contaminant *i* : $Hazard_i$ = Noncancer $Intake_i$ / Toxicity $Factor_i$

--	Not applicable
µg/m^3	Microgram per cubic meter
bgs	Below ground surface
COPC	Contaminant of potential concern
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
mg/kg-day	Milligram per kilogram per day
mg/m^3	Milligram per cubic meter
NAUM	Navajo abandoned uranium mine
pCi	Picocurie
pCi/g	Picocurie per gram
RfC	Reference concentration
RfD	Reference dose
SE	Secular equilibrium
USEPA	U.S. Environmental Protection Agency

Reference:

U.S. Environmental Protection Agency (USEPA). 2024b. “Navajo Abandoned Uranium Mines Risk Assessment Methodology.” Draft Final. March.

Table C-6. Human Health Risk and Hazard Summary by Exposure Pathway

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)																													
COPC	EPC	Units	Incidental Soil Ingestion			External Exposure / Dermal Contact			Inhalation of Particulates			Plant Consumption			Animal Consumption			ODL Plant Ingestion			ODL Plant Dermal			ODL Plant Inhalation			Total Risk or Hazard		
			Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard
Surface Soil (0-6 inches bgs)																													
Uranium-238 in SE	5.6E+00	pCi/g	3.3E-04	--	--	2.4E-03	--	--	7.0E-08	--	--	2.6E-03	--	--	5.0E-03	--	--	1.4E-03	--	--	--	--	--	5.1E-04	--	--	1E-02	--	--
Aluminum	1.8E+04	mg/kg	--	0.077	0.46	--	--	--	--	0.00047	0.00047	--	0.21	0.55	--	0.012	0.033	--	0.13	--	--	--	--	--	0.26	--	--	0.7	1
Antimony	3.4E-01	mg/kg	--	0.0037	0.022	--	--	--	--	0.00000015	0.00000015	--	0.019	0.052	--	0.00057	0.0015	--	0.012	--	--	--	--	--	0.00017	--	--	0.04	0.07
Arsenic	6.5E+00	mg/kg	3.5E-05	0.056	0.33	2.1E-06	0.0033	0.020	3.7E-09	0.000058	0.000058	1.4E-04	0.27	0.73	1.1E-05	0.021	0.057	6.9E-05	0.17	--	5.8E-06	0.014	--	2.0E-06	0.034	--	3E-04	0.6	1
Barium	1.9E+02	mg/kg	--	0.0042	0.025	--	--	--	--	0.000052	0.000052	--	0.022	0.059	--	0.00013	0.00034	--	0.014	--	--	--	--	--	0.058	--	--	0.1	0.08
Cadmium	1.6E-01	mg/kg	--	0.0069	0.041	--	0.00032	0.0019	3.8E-11	0.0000021	0.0000021	--	0.095	0.25	--	0.0036	0.0096	--	0.064	--	--	0.0070	--	1.1E-07	0.0064	--	1E-07	0.2	0.3
Cobalt	7.1E+00	mg/kg	--	0.10	0.61	--	--	--	8.5E-09	0.00016	0.00016	--	0.43	1.1	--	0.23	0.61	--	0.27	--	--	--	--	6.8E-06	0.14	--	7E-06	1	2
Copper	1.2E+01	mg/kg	--	0.0013	0.0077	--	--	--	--	--	--	--	0.051	0.13	--	0.0027	0.0072	--	0.034	--	--	--	--	--	--	--	--	0.09	0.1
Iron	2.0E+04	mg/kg	--	0.13	0.75	--	--	--	--	--	--	--	0.34	0.91	--	0.27	0.71	--	0.21	--	--	--	--	--	--	--	--	0.9	2
Manganese	2.8E+02	mg/kg	--	0.051	0.30	--	--	--	--	0.00075	0.00075	--	1.3	3.4	--	0.0039	0.010	--	0.86	--	--	--	--	--	4.1	--	--	6	4
Selenium	2.7E+00	mg/kg	--	0.0023	0.014	--	--	--	--	0.000000018	0.000000018	--	0.0097	0.026	--	0.042	0.11	--	0.0061	--	--	--	--	--	0.000015	--	--	0.06	0.2
Thallium	3.0E-01	mg/kg	--	0.13	0.77	--	--	--	--	--	--	--	0.31	0.83	--	0.55	1.5	--	0.19	--	--	--	--	--	--	--	--	1	3
Uranium	7.2E+00	mg/kg	--	0.16	0.92	--	--	--	--	0.000024	0.000024	--	0.48	1.3	--	0.0051	0.014	--	0.30	--	--	--	--	--	0.015	--	--	1.0	2
Vanadium	2.8E+01	mg/kg	--	0.024	0.14	--	--	--	--	0.000037	0.000037	--	0.069	0.18	--	0.0064	0.017	--	0.042	--	--	--	--	--	0.021	--	--	0.2	0.3
Exposure Pathway Risk/Hazard Total			**4E-04**	**0.7**	**4**	**2E-03**	**0.004**	**0.02**	**8E-08**	**0.002**	**0.002**	**3E-03**	**4**	**10**	**5E-03**	**1**	**3**	**2E-03**	**2**	**--**	**6E-06**	**0.02**	**--**	**5E-04**	**5**	**--**	**1E-02**	**10**	**20**
Subsurface Soil (0-18 inches bgs)																													
Uranium-238 in SE	6.5E+00	pCi/g	3.8E-04	--	--	2.8E-03	--	--	8.2E-08	--	--	3.1E-03	--	--	5.7E-03	--	--	1.7E-03	--	--	--	--	--	5.9E-04	--	--	1E-02	--	--
Aluminum	1.7E+04	mg/kg	--	0.075	0.44	--	--	--	--	0.00046	0.00046	--	0.20	0.54	--	0.012	0.032	--	0.12	--	--	--	--	--	0.25	--	--	0.7	1
Antimony	3.4E-01	mg/kg	--	0.0037	0.022	--	--	--	--	0.00000015	0.00000015	--	0.019	0.052	--	0.00057	0.0015	--	0.012	--	--	--	--	--	0.00017	--	--	0.04	0.07
Arsenic	6.3E+00	mg/kg	3.4E-05	0.054	0.32	2.0E-06	0.0032	0.019	3.6E-09	0.000056	0.000056	1.4E-04	0.27	0.71	1.1E-05	0.021	0.055	6.7E-05	0.16	--	5.7E-06	0.014	--	2.0E-06	0.033	--	3E-04	0.6	1
Barium	1.9E+02	mg/kg	--	0.0042	0.025	--	--	--	--	0.000052	0.000052	--	0.022	0.059	--	0.00013	0.00034	--	0.014	--	--	--	--	--	0.058	--	--	0.1	0.08
Cadmium	1.5E-01	mg/kg	--	0.0065	0.038	--	0.00030	0.0018	3.6E-11	0.0000020	0.0000020	--	0.089	0.24	--	0.0034	0.0090	--	0.060	--	--	0.0066	--	9.9E-08	0.0060	--	1E-07	0.2	0.3
Cobalt	6.8E+00	mg/kg	--	0.098	0.58	--	--	--	8.1E-09	0.00015	0.00015	--	0.41	1.1	--	0.22	0.58	--	0.26	--	--	--	--	6.5E-06	0.13	--	7E-06	1	2
Copper	1.2E+01	mg/kg	--	0.0013	0.0077	--	--	--	--	--	--	--	0.051	0.13	--	0.0027	0.0072	--	0.034	--	--	--	--	--	--	--	--	0.09	0.1
Iron	2.0E+04	mg/kg	--	0.12	0.72	--	--	--	--	--	--	--	0.33	0.88	--	0.26	0.69	--	0.20	--	--	--	--	--	--	--	--	0.9	2
Manganese	2.7E+02	mg/kg	--	0.049	0.29	--	--	--	--	0.00073	0.00073	--	1.2	3.3	--	0.0038	0.010	--	0.84	--	--	--	--	--	4.0	--	--	6	4
Selenium	2.8E+00	mg/kg	--	0.0024	0.014	--	--	--	--	0.000000019	0.000000019	--	0.0100	0.027	--	0.043	0.11	--	0.0063	--	--	--	--	--	0.000016	--	--	0.06	0.2
Thallium	2.9E-01	mg/kg	--	0.13	0.74	--	--	--	--	--	--	--	0.30	0.81	--	0.53	1.4	--	0.18	--	--	--	--	--	--	--	--	1	3
Uranium	1.1E+01	mg/kg	--	0.24	1.4	--	--	--	--	0.000037	0.000037	--	0.74	2.0	--	0.0078	0.021	--	0.46	--	--	--	--	--	0.023	--	--	1	3
Vanadium	2.8E+01	mg/kg	--	0.024	0.14	--	--	--	--	0.000037	0.000037	--	0.069	0.18	--	0.0064	0.017	--	0.042	--	--	--	--	--	0.021	--	--	0.2	0.3
Exposure Pathway Risk/Hazard Total			**4E-04**	**1**	**5**	**3E-03**	**0.003**	**0.02**	**9E-08**	**0.002**	**0.002**	**3E-03**	**4**	**10**	**6E-03**	**1**	**3**	**2E-03**	**2**	**--**	**6E-06**	**0.02**	**--**	**6E-04**	**5**	**--**	**1E-02**	**10**	**20**

Table C-6. Human Health Risk and Hazard Summary by Exposure Pathway

Section 33 Mine - Default Resident (Non-Navajo)																													
COPC	EPC	Units	Incidental Soil Ingestion			External Exposure / Dermal Contact			Inhalation of Particulates			Plant Consumption			Animal Consumption			ODL Plant Ingestion			ODL Plant Dermal			ODL Plant Inhalation			Total Risk or Hazard		
			Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard	Cancer Risk	Adult Hazard	Child Hazard
Surface Soil (0-6 inches bgs)																													
Uranium-238 in SE	3.0E+01	pCi/g	2.1E-04	--	--	2.2E-03	--	--	5.2E-07	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2E-03	--	--
Aluminum	1.8E+04	mg/kg	--	0.022	0.23	--	--	--	--	0.0026	0.0026	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.2
Antimony	4.2E-01	mg/kg	--	0.0013	0.013	--	--	--	--	0.00000099	0.00000099	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.001	0.01
Arsenic	7.4E+00	mg/kg	9.6E-06	0.018	0.19	1.3E-06	0.0037	0.022	8.3E-09	0.00035	0.00035	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1E-05	0.02	0.20
Barium	9.5E+01	mg/kg	--	0.00057	0.0061	--	--	--	--	0.00013	0.00013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0007	0.006
Cadmium	2.0E-01	mg/kg	--	0.0024	0.026	--	0.00040	0.0024	9.4E-11	0.000014	0.000014	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9E-11	0.003	0.03
Cobalt	7.6E+00	mg/kg	--	0.030	0.32	--	--	--	1.8E-08	0.00089	0.00089	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2E-08	0.03	0.3
Copper	1.5E+01	mg/kg	--	0.00045	0.0048	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0004	0.005
Iron	2.2E+04	mg/kg	--	0.038	0.41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	0.4
Manganese	2.3E+02	mg/kg	--	0.012	0.12	--	--	--	--	0.0033	0.0033	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.1
Selenium	2.2E+01	mg/kg	--	0.0053	0.056	--	--	--	--	0.00000078	0.00000078	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.005	0.06
Thallium	4.1E-01	mg/kg	--	0.049	0.52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.5
Uranium	4.5E+01	mg/kg	--	0.27	2.9	--	--	--	--	0.00079	0.00079	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	3
Vanadium	4.0E+01	mg/kg	--	0.0096	0.10	--	--	--	--	0.00028	0.00028	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.1
Exposure Pathway Risk/Hazard Total			**2E-04**	**0.5**	**5**	**2E-03**	**0.004**	**0.02**	**5E-07**	**0.008**	**0.008**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2E-03**	**0.5**	**5**
Subsurface Soil (0-18 inches bgs)																													
Uranium-238 in SE	3.0E+01	pCi/g	2.1E-04	--	--	2.2E-03	--	--	4.7E-04	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3E-03	--	--
Aluminum	1.8E+04	mg/kg	--	0.021	0.23	--	--	--	--	0.0025	0.0025	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.02	0.2
Antimony	4.1E-01	mg/kg	--	0.0012	0.013	--	--	--	--	0.00000096	0.00000096	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.001	0.01
Arsenic	7.0E+00	mg/kg	9.1E-06	0.017	0.18	1.3E-06	0.0035	0.021	9.1E-06	0.00033	0.00033	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2E-05	0.02	0.20
Barium	9.2E+01	mg/kg	--	0.00055	0.0059	--	--	--	--	0.00013	0.00013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0007	0.006
Cadmium	1.9E-01	mg/kg	--	0.0023	0.024	--	0.00038	0.0023	9E-11	0.000013	0.000013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9E-11	0.003	0.03
Cobalt	7.2E+00	mg/kg	--	0.029	0.31	--	--	--	2E-08	0.00085	0.00085	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2E-08	0.03	0.3
Copper	1.4E+01	mg/kg	--	0.00042	0.0045	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0004	0.004
Iron	2.1E+04	mg/kg	--	0.036	0.39	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.04	0.4
Manganese	2.2E+02	mg/kg	--	0.011	0.12	--	--	--	--	0.0031	0.0031	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01	0.1
Selenium	2.0E+01	mg/kg	--	0.0048	0.051	--	--	--	--	0.00000071	0.00000071	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.005	0.05
Thallium	4.0E-01	mg/kg	--	0.048	0.51	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.05	0.5
Uranium	4.4E+01	mg/kg	--	0.26	2.8	--	--	--	--	0.00078	0.00078	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3	3
Vanadium	3.8E+01	mg/kg	--	0.0091	0.097	--	--	--	--	0.00027	0.00027	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.009	0.1
Exposure Pathway Risk/Hazard Total			**2E-04**	**0.4**	**5**	**2E-03**	**0.004**	**0.02**	**5E-04**	**0.008**	**0.008**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**3E-03**	**0.5**	**5**

Notes:
Section 32 Mine results are from Table C-5.1, and Section 33 Mine results are from Table C-5.2.

--	Not applicable
bgs	Below ground surface
COPC	Contaminant of potential concern
EPC	Exposure point concentration
mg/kg	Milligram per kilogram
ODL	Other Diné Lifeways
pCi/g	Picocurie per gram
SE	Secular equilibrium

Table C-7. Human Health Risk and Hazard Summary and Identification of Candidate Contaminants of Concern

Section 32 Mine - Kee'da'whíí tééh (Full-Time Navajo Resident)					
COPC[a]	**Units**	**Exposure Point Concentration**	**Cancer Risk**[b,c,d]	**Noncancer Hazard**[b,d,e]	
				Adult	**Child**
Surface Soil (0-6 inches bgs)					
Radionuclides [f]					
Uranium-238 in SE	pCi/g	5.6E+00	**1.2E-02**	--	--
		Radionuclide Total	**1E-02**	--	--
Metals [h]					
Aluminum	mg/kg	1.8E+04	--	0.68	1.0
Antimony	mg/kg	3.4E-01	--	0.036	0.075
Arsenic	mg/kg	6.5E+00	**2.6E-04**	0.57	**1.1**
Barium	mg/kg	1.9E+02	--	0.10	0.084
Cadmium	mg/kg	1.6E-01	1.1E-07	0.18	0.31
Chromium	mg/kg	1.4E+01	**5.2E-04**	0.12	0.30
Cobalt	mg/kg	7.1E+00	*6.8E-06*	**1.2**	**2.3**
Copper	mg/kg	1.2E+01	--	0.089	0.15
Iron	mg/kg	2.0E+04	--	0.94	**2.4**
Manganese	mg/kg	2.8E+02	--	**6.3**	**3.7**
Selenium	mg/kg	2.7E+00	--	0.060	0.15
Thallium	mg/kg	3.0E-01	--	**1.2**	**3.1**
Uranium	mg/kg	7.2E+00	--	0.96	**2.2**
Vanadium	mg/kg	2.8E+01	--	0.16	0.34
		Metal Total	**8E-04**	**10**	**20**
		Cumulative Risk/Hazard Total	**1E-02**	**10**	**20**
Subsurface Soil (0-18 inches bgs)					
Radionuclides [f]					
Uranium-238 in SE	pCi/g	6.5E+00	**1.4E-02**	--	--
		Radionuclide Total	**1E-02**	--	--
Metals [h]					
Aluminum	mg/kg	1.7E+04	--	0.67	1.0
Antimony	mg/kg	3.4E-01	--	0.036	0.075
Arsenic	mg/kg	6.3E+00	**2.6E-04**	0.55	**1.1**
Barium	mg/kg	1.9E+02	--	0.098	0.084
Cadmium	mg/kg	1.5E-01	9.9E-08	0.17	0.29
Chromium	mg/kg	1.3E+01	**4.8E-04**	0.11	0.28
Cobalt	mg/kg	6.8E+00	*6.5E-06*	**1.1**	**2.2**
Copper	mg/kg	1.2E+01	--	0.089	0.15
Iron	mg/kg	2.0E+04	--	0.91	**2.3**
Manganese	mg/kg	2.7E+02	--	**6.2**	**3.6**
Selenium	mg/kg	2.8E+00	--	0.062	0.16
Thallium	mg/kg	2.9E-01	--	**1.1**	**3.0**
Uranium	mg/kg	1.1E+01	--	**1.5**	**3.4**
Vanadium	mg/kg	2.8E+01	--	0.16	0.34
		Metal Total	**7E-04**	**10**	**20**
		Cumulative Risk/Hazard Total	**2E-02**	**10**	**20**

Table C-7. Human Health Risk and Hazard Summary and Identification of Candidate Contaminants of Concern

Section 33 Mine - Default Resident (Non-Navajo)					
COPC[a]	Units	Exposure Point Concentration	Cancer Risk[b,c,d]	Noncancer Hazard[b,d,e]	
				Adult	Child
Surface Soil (0-6 inches bgs)					
Radionuclides [f]					
Uranium-238 in SE	pCi/g	3.0E+01	**2.4E-03**	--	--
		Radionuclide Total	**2E-03**	--	--
Metals [h]					
Aluminum	mg/kg	1.8E+04	--	0.022	0.23
Antimony	mg/kg	4.2E-01	--	0.0013	0.013
Arsenic	mg/kg	7.4E+00	*1.1E-05*	0.018	0.19
Barium	mg/kg	9.5E+01	--	0.00057	0.0061
Cadmium	mg/kg	2.0E-01	9.4E-11	0.0087	0.051
Chromium	mg/kg	1.4E+01	*4.6E-05*	0.0056	0.060
Cobalt	mg/kg	7.6E+00	1.8E-08	0.030	0.32
Copper	mg/kg	1.5E+01	--	0.0012	0.0076
Iron	mg/kg	2.2E+04	--	0.038	0.41
Manganese	mg/kg	2.3E+02	--	0.012	0.12
Selenium	mg/kg	2.2E+01	--	0.006	0.057
Thallium	mg/kg	4.1E-01	--	0.049	0.52
Uranium	mg/kg	4.5E+01	--	0.27	**2.9**
Vanadium	mg/kg	4.0E+01	--	0.013	0.11
		Metal Total	*6E-05*	0.5	**5**
		Cumulative Risk/Hazard Total	**2E-03**	0.5	**5**
Subsurface Soil (0-18 inches bgs)					
Radionuclides [f]					
Uranium-238 in SE	pCi/g	3.0E+01	**2.9E-03**	--	--
		Radionuclide Total	**3E-03**	--	--
Metals [h]					
Aluminum	mg/kg	1.8E+04	--	0.024	0.23
Antimony	mg/kg	4.1E-01	--	0.0012	0.013
Arsenic	mg/kg	7.0E+00	*1.9E-05*	0.021	0.20
Barium	mg/kg	9.2E+01	--	0.00068	0.0060
Cadmium	mg/kg	1.9E-01	9.0E-11	0.0027	0.027
Chromium	mg/kg	1.3E+01	*4.3E-05*	0.0062	0.061
Cobalt	mg/kg	7.2E+00	1.7E-08	0.030	0.31
Copper	mg/kg	1.4E+01	--	0.00042	0.0045
Iron	mg/kg	2.1E+04	--	0.036	0.39
Manganese	mg/kg	2.2E+02	--	0.014	0.12
Selenium	mg/kg	2.0E+01	--	0.0048	0.051
Thallium	mg/kg	4.0E-01	--	0.048	0.51
Uranium	mg/kg	4.4E+01	--	0.26	**2.8**
Vanadium	mg/kg	3.8E+01	--	0.0094	0.097
		Metal Total	*6E-05*	0.5	**5**
		Cumulative Risk/Hazard Total	**3E-03**	0.5	**5**

Table C-7. Human Health Risk and Hazard Summary and Identification of Candidate Contaminants of Concern

Notes:

[a] **Bolded COPCs** are selected as candidate COCs because cancer risk is greater than one in ten thousand (1E-04) or noncancer hazard is greater than 1. *Italicized COPCs* are contaminants within the USEPA's cancer risk range (cancer risk greater than 1 in 1 million [1E-06] and less than or equal to 1E-04).

[b] **Bolded values** are values greater than the target cancer risk of one in ten thousand (1E-04) or noncancer target hazard of 1. *Italicized values* are within the USEPA's acceptable cancer risk range (cancer risk greater than 1E-06 and less than or equal to 1E-04). Total risks and total hazards are reported to one significant digit; thus, values are commonly rounded. In practice, values can be slightly higher than the stated cutoff but still be considered equal to the cutoff because of rounding. Target organ analyses were performed for any scenario-media combination with a noncancer hazard greater than 1. If the target organ hazard index exceeds 1 but no individual COPC has a hazard quotient exceeding 1, the COPC contributing the highest amount of hazard was identified as a candidate COC.

[c] Cancer risks are provided on Tables C-5.1 and C-5.2.

[d] The methodology for calculating the risks and hazards and the inputs for cancer and noncancer equations are provided in the "Navajo Abandoned Uranium Mines Risk Assessment Methodology" (USEPA 2024b).

[e] Noncancer hazards are presented on Tables C-5.1 and C-5.2.

[f] For radionuclides, uranium-238 is assumed to be in SE with its decay chain; that is, all decay chain nuclides are present in equal activity concentrations. In this case, the risk from radium-226 and its decay products (that is, radium-226 in SE) will account for most of the risk from the uranium-238 decay chain.

[h] In the absence of speciated chromium data, chromium is evaluated using the assumption that it is 100 percent hexavalent chromium (USEPA 2024b). No speciated chromium data are available.

--	Not applicable
bgs	Below ground surface
COC	Contaminant of concern
COPC	Contaminant of potential concern
mg/kg	Milligram per kilogram
pCi/g	Picocurie per gram
SE	Secular equilibrium
USEPA	U.S. Environmental Protection Agency

Reference:

U.S. Environmental Protection Agency (USEPA). 2024b. “Navajo Abandoned Uranium Mines Risk Assessment Methodology.” Draft Final. March.

Table C-8. Ecological Risk Assessment Screening for Soil

Constituent of Interest[a]	Detection Frequency[b]	Maximum Detected Concentration[b]	Plant NOEC	Soil Invertebrates NOEC	Avian Herbivore NOEC	Avian Ground Insectivore NOEC	Avian Carnivore NOEC	Mammalian Herbivore NOEC	Mammalian Ground Insectivore NOEC	Mammalian Carnivore NOEC	Minimum NOEC	HQ based on Minimum NOEC[c]	Include Contaminant as COPEC in SLERA Refinement?[d]
Radionuclides (pCi/g) [e]													
Uranium-238 in SE (Adjusted Radium-226)	60 / 60	161	4.0	230	15	15	15	6.0	6.0	6.0	4.0	**40**	**Yes**
Metals (mg/kg) [f,g]													
Aluminum	65 / 65	25,000	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	No
Antimony	6 / 60	0.64	11	78	NSL	NSL	NSL	10	0.27	4.9	0.27	**2.4**	**Yes**
Arsenic	65 / 65	14	18	6.8	67	43	1,100	170	46	170	6.8	**2.0**	**Yes**
Barium	65 / 65	307	110	330	720	820	7,500	3,200	200	9,100	110	**2.8**	**Yes**
Beryllium	65 / 65	1.2	2.5	40	NSL	NSL	NSL	21	34	90	2.5	0.48	No
Cadmium	57 / 60	0.2	32	140	28	0.77	630	73	0.36	84	0.36	0.67	No
Chromium [h]	65 / 65	18	0.35	0.34	78	26	780	380	34	180	0.34	**54**	**Yes**
Cobalt	65 / 65	9	13	NSL	270	120	1,300	2,100	230	470	13	0.72	No
Copper	65 / 65	18	70	80	76	80	1,600	1,100	49	560	49	0.37	No
Iron	65 / 65	26,300	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	NSL	No
Lead	65 / 65	20	120	1,700	46	11	510	1,200	56	460	11	**1.8**	**Yes**
Manganese	65 / 65	419	220	450	4,300	4,300	650,000	5,300	4,000	6,200	220	**1.9**	**Yes**
Molybdenum [i,j]	58 / 60	1.2	**2**	NSL	18	15	90	*635*	*4.8*	*64*	2	0.59	No
Nickel	65 / 65	19	38	280	210	20	2,800	340	10	130	10	**1.9**	**Yes**
Selenium	62 / 62	102	0.52	4.1	2.2	1.2	83	2.7	0.63	2.8	0.52	**196**	**Yes**
Silver	28 / 60	0.66	560	NSL	69	4.2	930	1,500	14	990	4.2	0.16	No
Thallium	56 / 60	0.47	0.050	NSL	6.9	4.5	48	1.2	0.42	5.0	0.050	**9**	**Yes**
Uranium	61 / 61	251	25	NSL	1,500	1,100	14,000	1,000	480	4,800	25	**10**	**Yes**
Vanadium	65 / 65	92	60	NSL	13	7.8	140	1,300	280	580	7.8	**12**	**Yes**
Zinc	65 / 65	96	160	120	950	46	30,000	6,800	79	10,000	46	**2.1**	**Yes**

Notes:

Grey highlighted cells indicate the maximum concentration exceeds the NOEC for the receptor group.

[a] **Bolded contaminants** are selected as COPECs for the SLERA refinement because the HQ is greater than or equal to 1.0.

[b] Includes soil samples collected site-wide from all depths. Includes all duplicate soil samples. See Table A2-1 for the summary statistics for each contaminant.

[c] HQ is calculated by dividing the maximum concentration by the minimum NOEC. **Bolded HQ values** indicate HQs greater than 1.0.

[d] A contaminant is included as a COPEC for the SLERA refinement if the calculated HQ is greater than 1.0.

[e] Radionuclide ESLs are based on dose assessments using the ERICA Tool (Brown and others 2008) for terrestrial animals and plants (see Appendix F in USEPA 2024b). ESLs for uranium-238 in SE are based on individual radium-226 ESLs that are adjusted to include doses from all progeny of uranium-238 in secular equilibrium. Site data for radium-226 are used to evaluate uranium-238 in SE.

[f] NOECs for metals are based on the Eco-SSL (USEPA 2023a) unless underlined, **bolded,** or *italicized*.

[g] Underlined values are based on LANL no effect level ESLs (Newport News Nuclear BWXT-Los Alamos, LLC. 2022) for contaminants for which Eco-SSLs are not available.

[h] In the absence of speciated chromium data, chromium is evaluated using the assumption that it is 100 percent hexavalent chromium (USEPA 2024b). No speciated chromium data are available. LANL chromium screening values are based on Cr(VI) (hexavalent chromium) for plants and invertebrates (Newport News Nuclear BWXT-Los Alamos, LLC. 2022) and Cr(III) (trivalent chromium) for birds and mammals (USEPA 2023a). Eco-SSLs for hexavalent chromium are not available for birds, and the hexavalent chromium Eco-SSLs for mammals are higher than the trivalent chromium values (USEPA 2023a).

[i] **Bold value** for molybdenum is based on Oak Ridge National Laboratory no effect level for plants for which an Eco-SSL nor LANL ESL is available (Efroymson, Will, Suter II, and Wooten 1997).

[j] *Italicized values* for molybdenum are based on Oak Ridge National Laboratory Preliminary Remediation Goals for Ecological Receptors (Efroymson, Suter II, Sample, and Jones 1997) for mammals, for which Eco-SSLs and LANL NOECs are not available.

Table C-8. Ecological Risk Assessment Screening for Soil

Notes (Continued):

bgs	Below ground surface	mg/kg	Milligram per kilogram
COPEC	Contaminant of potential ecological concern	N3B	Newport News Nuclear BWXT-Los Alamos, LLC
Eco-SSL	Ecological soil screening level	NOEC	No observed effect concentration
ERICA	Environmental Risk from Ionizing Contaminants: Assessment and Management	NSL	No screening level
ESL	Ecological screening level	pCi/g	Picocurie per gram
HQ	Hazard quotient	SE	Secular equilibrium
LANL	Los Alamos National Laboratory	USEPA	U.S. Environmental Protection Agency

References:

Brown, J.E., B. Alfonso, R. Avila, N.A. Beresford, D. Copplestone, G. PrÖhl, and A. Ulanovsky. 2008. “The ERICA Tool.” *Journal of Environmental Radioactivity* . Volume 99, Issue 9. Pages 1371 through 1383.

Efroymson, R.A., M.E. Will, and G.W. Suter II. 1997. "Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process." ES/ER/TM-126/R2. Oak Ridge National Laboratories, Oak Ridge, TN.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997. "Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants." ES/ER/TM-85/R3. Oak Ridge National Laboratories, Oak Ridge, TN.

Newport News Nuclear BWXT-Los Alamos, LLC (N3B). 2022. “ECORISK Database." Release 4.3. 701067. Document EM2020-0575. September.

U.S. Environmental Protection Agency (USEPA). 2023a. "Interim Ecological Soil Screening Level Documents." Accessed July 20. https://www.epa.gov/chemical-research/interim-ecological-soil-screening-level-documents.

USEPA. 2024b. “Navajo Abandoned Uranium Mines Risk Assessment Methodology.” Draft Final. March.

Table C-9. Exposure Point Concentrations for Ecological Risk Assessment

Site-Wide											
Contaminant	Units	Detection Frequency	Number of High Nondetect Results[a]	Maximum Concentration (qualifier)	Location of Maximum Concentration	Arithmetic Mean[b]	UCL95 / Distribution[c]		Exposure Point Concentration		
									Value[d]	Statistic[d]	Method[e]
Surface Soil (0-6 inches bgs)											
Radium-226	pCi/g	56 / 56	0	161	S3233-SS59-01-111822	8.556	13.90	NP	14	UCL95	(14)
Antimony	mg/kg	6 / 56	0	0.638	S3233-SS14-01-111522	0.322	0.340	N	0.3	UCL95	(3)
Arsenic	mg/kg	56 / 56	0	13.8	S3233-SS60-01-111822	6.21	6.642	N	6.6	UCL95	(2)
Barium	mg/kg	56 / 56	0	307	S3233-SS23-01-111522	140	156	NP	156	UCL95	(14)
Chromium	mg/kg	56 / 56	0	21.7	S3233-SS03-01-111522	12.49	13.43	NP	13	UCL95	(14)
Lead	mg/kg	56 / 56	0	22.2	S3233-SS03-01-111522	14.41	15.2	N	15	UCL95	(2)
Manganese	mg/kg	56 / 56	0	419	S3233-SS20-01-111522	244.2	259	N	259	UCL95	(2)
Nickel	mg/kg	56 / 56	0	22.8	S3233-SS03-01-111522	12.25	13.33	N	13	UCL95	(2)
Selenium	mg/kg	56 / 56	0	102	S3233-SS58-01-111822	5.847	9.21	NP	9	UCL95	(14)
Thallium	mg/kg	53 / 56	0	0.645	S3233-SS03-01-111522	0.299	0.327	NP	0.33	UCL95	(15)
Uranium	mg/kg	56 / 56	0	251	S3233-SS59-01-111822	11.69	19.90	NP	20	UCL95	(14)
Vanadium	mg/kg	56 / 56	0	92.3	S3233-SS59-01-111822	28.95	31.7	NP	32	UCL95	(14)
Zinc	mg/kg	56 / 56	0	95.6	S3233-SS08-01-111522	51.18	55.6	N	56	UCL95	(2)
Subsurface Soil (0-18 inches bgs)											
Radium-226	pCi/g	60 / 60	0	161	S3233-SS59-01-111822	8.86	13.88	NP	14	UCL95	(14)
Antimony	mg/kg	6 / 60	0	0.638	S3233-SS14-01-111522	0.32	0.34	N	0.34	UCL95	(3)
Arsenic	mg/kg	65 / 65	0	13.8	S3233-SS60-01-111822	5.952	6.361	N	6.4	UCL95	(2)
Barium	mg/kg	65 / 65	0	307	S3233-SS23-01-111522	139.1	153.8	NP	154	UCL95	(14)
Chromium	mg/kg	65 / 65	0	21.7	S3233-SS03-01-111522	11.74	12.73	N	13	UCL95	(2)
Lead	mg/kg	65 / 65	0	22.2	S3233-SS03-01-111522	13.49	14.4	N	14	UCL95	(2)
Manganese	mg/kg	65 / 65	0	419	S3233-SS20-01-111522	235.5	250	N	250	UCL95	(2)
Nickel	mg/kg	65 / 65	0	23	S3233-SS03-01-111522	11.55	12.59	N	13	UCL95	(2)
Selenium	mg/kg	62 / 62	0	102	S3233-SS58-01-111822	5.804	9.18	NP	9	UCL95	(14)
Thallium	mg/kg	56 / 60	0	0.645	S3233-SS03-01-111522	0.29	0.317	NP	0.32	UCL95	(15)
Uranium	mg/kg	61 / 61	0	251	S3233-SS59-01-111822	13.22	21.22	NP	21	UCL95	(14)
Vanadium	mg/kg	65 / 65	0	92	S3233-SS59-01-111822	28.31	30.6	NP	31	UCL95	(14)
Zinc	mg/kg	65 / 65	0	96	S3233-SS08-01-111522	48.43	52.7	N	53	UCL95	(2)

Table C-9. Exposure Point Concentrations for Ecological Risk Assessment

Notes:

[a] Number of nondetect results that exceeded the maximum detected concentration. These results were not included in the statistical calculations.

[b] The arithmetic mean for datasets with nondetected results is calculated using the Kaplan-Meier method.

[c] Tested using the Shapiro-Wilk W or Lilliefors test for normal and lognormal distributions and the Anderson-Darling and Kolmogorov-Smirnov tests for gamma distributions. A 5 percent level of significance was used in all tests. Distribution tests were conducted only for samples with at least four detected results. Distributions not confirmed as N, LN, or G were treated as NP in all statistical calculations.

[d] The EPC is the lesser of the UCL95 (or UCL99) and the maximum detected concentration. The maximum detected concentration is the default when there are fewer than 10 samples or fewer than four detected results. See Appendix D of USEPA (2024b).

[e] The statistical methods for selecting the exposure point concentration are as follows (not all are used):

(1)	Maximum detected concentration	(7)	95% Gamma Approximate KM-UCL	(13)	95% KM BCA UCL
(2)	95% Student's t UCL	(8)	95% H-UCL	(14)	95% Percentile Bootstrap UCL
(3)	95% KM (t) UCL	(9)	95% H-UCL (KM log)	(15)	95% KM Percentile Bootstrap UCL
(4)	95% Adjusted Gamma UCL	(10)	95% Bootstrap-t UCL	(16)	99% Bootstrap-t UCL
(5)	95% Gamma Adjusted KM-UCL	(11)	95% KM Bootstrap-t UCL	(17)	99% KM Percentile Bootstrap UCL
(6)	95% Approximate Gamma UCL	(12)	95% BCA UCL		

BCA	Bias-corrected accelerated bootstrap method
bgs	Below ground surface
EPC	Exposure point concentration
G (data qualifier)	Sample density differs by more than 15% of the LCS density.
G (distribution)	Gamma distribution
H-UCL	UCL based upon Land’s H-statistic
KM	Kaplan-Meier
LN	Lognormal distribution
M3	The requested MDC was not met, but the reported activity is greater than the reported MDC
N	Normal distribution
ND	Not detected
NP	Nonparametric distribution
pCi/g	Picocurie per gram
UCL	Upper confidence limit
UCL95	95 percent upper confidence limit of the mean
UCL99	99 percent upper confidence limit of the mean
USEPA	U.S. Environmental Protection Agency

Reference:

U.S. Environmental Protection Agency (USEPA). 2024b. “Navajo Abandoned Uranium Mines Risk Assessment Methodology.” Draft Final. March.

Table C-10. Comparison of Individual Sample Results to Plant and Invertebrate Lowest Observed Effect Concentrations

Sample Identification	Sample Bottom Depth (inches bgs)[d]	COPEC:[a]	Uranium-238 in SE (Adjusted Radium-226) [b]	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium [c]	Cobalt	Copper	Iron	Lead	Manganese	Molybdenum	Nickel	Selenium	Silver	Thallium	Uranium	Vanadium	Zinc
		Plant NOEC:[d]	4.0	NSL	11	18	110	3	32	0.35	13	70	NSL	120	220	2.0	38	0.52	NSL	0.050	25	60	160
		Soil Invertebrate NOEC:[d]	230	NSL	78	7	330	40	140	0.34	NSL	80	NSL	1,700	450	NSL	280	4.1	NSL	NSL	NSL	NSL	120
		Units:	pCi/g	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Section 32 Mine																							
S3233-SS20-01-111522	0-6		--	--	--	--	--	--	--	--	7.79	--	24,200	13.5	419	0.507	--	--	--	--	--	30.6	--
S3233-SS20-02-111522	0-6		1.78	21,300	0.36 U	5.41	201	0.9	0.118	15.3	--	11.6	--	--	--	--	13.9	1.44	0.545 U	0.292	1.42	--	53.8
S3233-SS21-01-111522	0-6		1.33	21,700	0.327 U	6.53	195	0.955	0.155	16.5	8.68	13.6	23,500	15.9	309	0.642	15.9	1.6	0.495 U	0.351	1.05	29.8	62.9
S3233-SS22-01-111522	0-6		4.76	18,800	0.303 U	6.94	108	0.982	0.203	14.4	8.16	15.1	23,200	17.2	277	0.872	16.1	3.74	0.459 U	0.381	18.8	29.3	63.5
S3233-SS23-01-111522	0-6		2.33	16,700	0.312 U	8.03	307	0.87	0.0875	12.8	7.12	9.34	21,900	15.8	314	0.365	12.3	1.74	0.473 U	0.195	3.4	21.2	51.8
S3233-SS24-01-111522	0-6		2.87	13,700	0.324 U	5.29	208	0.688	0.0895	9.89	5.32	7.49	15,500	11.4	265	0.218	9.35	1.49	0.491 U	0.157	1.78	17.4	38.6
S3233-SS25-01-111522	0-6		7.24	18,700	0.352 U	5.78	156	0.853	0.132	13.6	6.56	11.5	20,100	13.8	267	0.543	12.6	3.19	0.533 U	0.276	9.41	26.8	51.8
S3233-SS26-01-111522	0-6		2.15	23,800	0.356 U	7.2	114	1.09	0.209	18.1	8.69	16.5	26,300	17.9	250	1.01	17.4	1.94	0.54 U	0.434	1.69	34.2	71.4
S3233-SS27-01-111522	0-6		27.3	14,900	0.355 U	5.84	137	0.765	0.128	10.6	5.65	10.2	16,800	13.3	219	0.665	10.5	13.3	0.537 U	0.283	32.4	34.4	42.9
S3233-SS28-01-111722	0-6		2.56	19,200	0.377 U	6.49	104	0.893	0.175	15	7.46	15	22,500	15.9	211	0.974	15.1	2.14	0.572 U	0.378	2.74	30.2	61.5
S3233-SS29-01-111722	0-6		2.04	18,700	0.379 U	6.97	84.6	0.909	0.231	14.9	7.85	16.1	23,500	17	209	1.17	16.2	1.87	0.574 U	0.433	1.76	29.7	65.2
S3233-SS30-01-111722	0-6		4.76	20,700	0.357 U	7.52	96.2	1.03	0.24	17.7	8.72	17.1	25,300	18.9	234	1.18	18.7	2.57	0.124	0.471	16	33.8	74.7
S3233-SS31-01-111722	0-6		1.68	19,300	0.329 U	7.42	90.7	0.992	0.216	16.4	8.6	16.8	24,800	18.2	237	1.07	17.7	2.03	0.0996 U	0.451	1.51	31.2	72.5
S3233-SS32-01-111722	0-6		1.35	16,300	0.365 U	6.28	110	0.826	0.17	13.4	7.14	13.3	21,200	14.4	230	0.912	13.4	1.67	0.111 U	0.33	1.37	27.5	57.1
S3233-SS33-01-111722	0-6		1.56	17,500	0.317 U	6.98	92.9	0.907	0.201	14.7	7.89	14.6	22,100	16	237	0.887	15.1	1.86	0.161	0.356	1.47	28.8	62.9
S3233-SS34-01-111722	0-6		1.84	23,100	0.358 U	7.15	118	1.05	0.214	18.2	8.1	16.1	24,800	18	238	1.05	17.2	2.07	0.125	0.447	1.86	34.7	73.5
S3233-SS35-01-111722	0-6		4.85	17,500	0.327 U	6.61	125	0.878	0.213	13.3	7.2	14.3	21,600	16.5	270	0.914	14.2	3.42	0.146	0.352	4.76	28.1	60.8
S3233-SS36-01-111722	0-6		1.08	9,310	0.342 U	3.99	148	0.496	0.136	7.7	4.54	7.27	13,400	9.99	325	0.309	7.73	1.05	0.166	0.142	0.606	15.8	31.5
S3233-SS37-01-111722	0-6		1.32	10,400	0.301 U	3.41	140	0.511	0.154	8.57	4.68	7.82	12,200	11.3	340	0.327	7.6	1.02	0.179	0.146	0.802	16.1	33.8
S3233-SS38-01-111722	0-6		1.18	18,300	0.331 U	6.37	300	0.816	0.109	13.6	6.57	9.88	18,700	11.1	277	0.411	13.4	1.38	0.1 U	0.225	2.21	31	43.4
S3233-SS39-01-111722	0-6		2.77	16,700	0.328 U	6.04	285	0.762	0.118	11.4	6.18	8.68	20,300	12.3	399	0.38	11.6	2.7	0.238	0.203	3.93	23.7	43.4
S3233-SS40-02-111722	0-6		1.55	16,600	0.326 U	7.67	289	0.833	0.115	13.1	7.22	9.48	20,300	15.7	311	0.294	12.6	1.47	0.135	0.208	1.26	19.9	52.9
S3233-SS41-01-111822	0-6		1.61	8,850	0.299 U	8.3	155	0.483	0.0484	7.9	3.72	4.87	15,900	8.14	140	0.569	5.6	1.03	0.175	0.147	2.26	15	25.7
S3233-SS42-01-111822	0-6		2.1	12,000	0.304 U	8.29	139	0.815	0.0505	10.3	6.59	9.06	19,000	13.9	191	0.341	11.1	1.3	0.151	0.182	1.87	13.9	49.3
S3233-SS43-01-111822	0-6		1.59	15,300	0.338 U	6.72	306	0.737	0.0648	11.4	6.61	7.71	19,400	13.8	313	0.264	10.9	1.44	0.231	0.194	1.36	17.7	46.2
S3233-SS44-01-111822	0-6		1.19	19,800	0.329 U	7.21	187	0.928	0.0661	14.7	6.91	7.92	20,300	13.5	337	0.512	13	1.4	0.182	0.21	1.31	24.6	49.7
S3233-SS45-01-111822	0-6		1.19	16,900	0.336 U	7.49	295	0.826	0.102	13.3	6.66	9	19,800	14.9	294	0.283	12.4	1.37	0.177	0.202	1.26	19.8	51.9
S3233-SS46-01-111822	0-6		1.64	9,520	0.343	5	99	0.616	0.133	8.77	5.43	9.43	14,800	10.7	190	0.543	9.13	1.81	0.0891 U	0.208	1.53	18.6	39
S3233-SS47-01-111822	0-6		1.48	14,800	0.326 U	4.71	112	0.683	0.144	11.6	5.61	10.8	16,000	12.8	227	0.836	10.2	0.467	0.488	0.242	1.01	24.5	43.2
S3233-SS48-01-111822	0-6		2.99	15,600	0.326 U	4.96	272	0.777	0.156	11.7	6.21	12.3	17,100	14.3	234	0.921	10.5	1.24	0.358	0.282	2.42	28.1	48.3
S3233-SS49-01-111822	0-6		1.87	14,800	0.34 U	4.41	192	0.762	0.16	10.9	5.56	11.6	15,800	13.2	222	0.813	9.37	1.36	0.354	0.243	1.42	25.8	46.2
S3233-SS50-01-111822	0-6		1.68	20,400	0.347 U	5.87	115	0.933	0.201	15.8	7.42	14.6	20,600	16.1	241	1.05	13.3	0.622	0.51	0.352	1.19	34.4	59.3
S3233-SS51-01-111822	0-6		5.75	18,100	0.366 U	5.75	118	0.923	0.152	13.7	7.6	13.4	18,800	15.2	291	0.504	10.8	1.27	0.453	0.238	7.03	32.5	55.1
S3233-SS52-01-111822	0-6		4.27	20,100	0.347 U	5.58	134	0.943	0.158	15	7.47	13.5	18,400	15.4	266	0.748	10.6	0.742	0.54	0.236	23.2	35.8	54.2
S3233-SS53-01-111822	0-6		4.84	23,600	0.339 U	6.15	165	1.15	0.148	16.8	8.11	14.5	20,300	16.9	299	0.618	11.2	1.27	0.542	0.396	12.4	38.7	58.6
S3233-SS54-01-111822	0-6		3.51	15,100	0.336 U	4.9	169	0.807	0.156	11.3	5.91	11.7	16,300	13.9	237	0.648	8.91	1.24	0.354	0.209	2.78	26.4	46.8
S3233-SS55-01-111822	0-6		24.3	8,990	0.345 U	4.15	192	0.561	0.0873	7.27	4.14	7.21	11,500	10.7	180	0.363	6.05	3.83	0.332	0.131 U	10.3	25.3	29.2
S3233-SS56-01-111822	0-6		1.43	12,000	0.329 U	4.5	209	0.649	0.121	9.1	4.87	8.29	13,600	11.3	206	0.318	7.04	0.655	0.265	0.155	0.99	20.8	35.2
Frequency of Plant NOEC Exceedance:			**9/36**	NA	0/36	0/36	**28/36**	0/36	0/36	**36/36**	0/36	0/36	NA	0/36	**28/36**	0/36	0/36	**35/36**	NA	**35/36**	**1/36**	0/36	0/36
Frequency of Soil Invertebrate NOEC Exceedance:			0/36	NA	0/36	**13/36**	0/36	0/36	0/36	**36/36**	NA	0/36	NA	0/36	0/36	NA	0/36	**1/36**	NA	NA	NA	NA	0/36
Frequency of Plant and Soil Invertebrate Exceedance:			0/36	NA	0/36	0/36	0/36	0/36	0/36	**36/36**	0/36	0/36	NA	0/36	0/36	0/36	0/36	**1/36**	NA	**35/36**	**1/36**	0/36	0/36

Table C-10. Comparison of Individual Sample Results to Plant and Invertebrate Lowest Observed Effect Concentrations

Sample Identification	Sample Bottom Depth (inches bgs)[d]	COPEC:[a]	Uranium-238 in SE (Adjusted Radium-226) [b]	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium [c]	Cobalt	Copper	Iron	Lead	Manganese	Molybdenum	Nickel	Selenium	Silver	Thallium	Uranium	Vanadium	Zinc
		Plant NOEC:[d]	4.0	NSL	11	18	110	3	32	0.35	13	70	NSL	120	220	2.0	38	0.52	NSL	0.050	25	60	160
		Soil Invertebrate NOEC:[d]	230	NSL	78	7	330	40	140	0.34	NSL	80	NSL	1,700	450	NSL	280	4.1	NSL	NSL	NSL	NSL	120
Section 33 Mine																							
S3233-SS01-01-111522	0-6		1.63	18100	0.36 U	7.86	77.6	0.945	0.295	16.1	8.72	18.2	25700	18.6	232	1.79	19.2	2.09	0.545 U	0.543	1.28	33.4	72.5
S3233-SS02-01-111522	0-6		1.61	17500	0.364 U	7.32	76.1	0.933	0.282	15.1	8.25	15.9	23600	17.1	208	1.67	17.6	1.88	0.552 U	0.512	1.19	31.2	67.2
S3233-SS03-01-111522	0-6		1.65	27000	0.324 U	8.95	106	1.19	0.333	21.7	10.4	20	31500	22.2	301	1.86	22.8	2.26	0.491 U	0.645	1.61	43.6	86.3
S3233-SS05-01-111522	0-6		2	17600	0.396 U	6.87	77.5	0.867	0.191	14.5	8.15	15.1	23900	16.9	208	1.05	16	1.85	0.599 U	0.403	1.41	26.5	64.4
S3233-SS06-01-111522	0-6		2.1	22900	0.338 U	7.4	99.1	0.991	0.236	18.1	8.84	16.9	27000	19	263	0.962	18.2	2.11	0.512 U	0.483	2.52	33.8	71.9
S3233-SS08-01-111522	0-6		15.6	19800	0.359 U	6.84	96.2	0.89	0.207	15.5	7.74	16.1	23400	17.7	234	0.952	16	4.75	0.544 U	0.418	11.6	34.5	95.6
S3233-SS09-01-111522	0-6		14.8	21100	0.324 U	7.67	116	1.01	0.223	16.7	9.18	18	26200	19.9	259	0.849	18.1	4.52	0.49 U	0.44	8.21	35.3	73.1
S3233-SS10-01-111522	0-6		1.69	19500	0.361 U	7.14	101	0.895	0.181	15.8	9.23	16.5	25100	17.3	260	0.96	17.2	1.76	0.547 U	0.395	1.33	30.5	66.1
S3233-SS12-01-111522	0-6		1.65	19200	0.356 U	6.89	99.1	0.866	0.174	15.1	9.35	15.3	25100	16.7	267	0.861	16.7	2.08	0.539 U	0.376	1.24	28.9	64.2
S3233-SS13-01-111522	0-6		34.3	9010	0.636	4.58	80.7	0.498	0.061	4.83	3.36	6.77	9060	9.68	194	0.792	5.33	16.8	0.539 U	0.2	78	29.9	20.9
S3233-SS14-01-111522	0-6		2.45	18400	0.638	6.83	99.9	0.854	0.17	15.1	8.38	15	23500	16.6	238	0.99	16.1	2.26	0.563 U	0.388	1.57	30.1	69.9
S3233-SS15-01-111522	0-6		6.98	16600	0.371 U	6.33	92.3	0.807	0.183	13.1	7.64	14.4	21900	15.7	235	0.809	14.6	10.5	0.562 U	0.364	6.31	29.8	57.8
S3233-SS17-01-111522	0-6		14.6	4650	0.51	1.29	62.8	0.273	0.0224	1.25	1.23	2.7	4570	6.92	109	0.0711 U	1.44	14.3	0.101 U	0.124 U	12.6	16.9	9.87
S3233-SS18-01-111522	0-6		10.9	19200	0.378	6.83	88.7	0.873	0.179	15.6	8.01	15.2	23500	16.9	224	1.17	16.2	9.12	0.539 U	0.419	25.1	33.9	61.8
S3233-SS19-01-111522	0-6		2.25	14300	0.53	5.29	131	0.653	0.134	10.6	5.33	9.17	17200	12.2	259	0.398	10.5	1.42	0.467 U	0.21	1.99	24.8	40.3
S3233-SS57-01-111822	0-6		22.6	5030	0.309 U	1.71	6.7	0.285	0.0188 U	1.79	2.83	2.73	6450	4.24	94.2	0.0754 U	1.99	8.22	0.158	0.132 U	11.6	22.6	6.77
S3233-SS58-01-111822	0-6		30.3	4360	0.327 U	1.4	6.08	0.231	0.0177 U	1.6	1.32	2.27	4310	5.55	110	0.139	1.46	102	0.0991 U	0.134	30.2	59.7	5.06
S3233-SS59-01-111822	0-6		161	--	--	--	131	--	--	--	--	--	--	--	215	0.439	--	57.8	0.458	--	251	92.3	--
S3233-SS59-02-111822	0-6		--	9400	0.338 U	4.84	--	0.478	0.0414	4.06	2.94	5.32	12400	13.5	--	--	4.05	--	--	0.236	--	--	15.6
S3233-SS60-01-111822	0-6		11.3	14000	0.353 U	13.8	22.9	1.08	0.0199 U	4.1	2.41	10.1	6350	11.3	61.4	0.311	3.61	6.95	0.152	0.171	23.4	7.54	9.15
Frequency of Plant NOEC Exceedance:			**10/19**	NA	0/19	0/19	**3/19**	0/19	0/19	**19/19**	0/19	0/19	NA	0/19	**11/19**	0/19	0/19	**19/19**	NA	**17/19**	**4/19**	**1/19**	0/19
Frequency of Soil Invertebrate NOEC Exceedance:			0/19	NA	0/19	**12/19**	0/19	0/19	0/19	**19/19**	NA	0/19	NA	0/19	0/19	NA	0/19	**10/19**	NA	NA	NA	NA	0/19
Frequency of Plant and Soil Invertebrate Exceedance:			0/19	NA	0/19	0/19	0/19	0/19	0/19	**19/19**	0/19	0/19	NA	0/19	0/19	0/19	0/19	**10/19**	NA	**17/19**	**4/19**	**1/19**	0/19
Subsurface Soil (6 - 72 inches bgs) [e]																							
32-01-31-181103-M	0-18		--	11,000	--	3.3	150	0.56	--	4.8	3.1	4.4	12,000	4.3	140	--	5	0 U	--	--	0 U	16	24
32-02-31-181103-M	0-18		--	25,000	--	4.9	110	1.1	--	12	6.3	10	22,000	6	220	--	9.7	0 U	--	--	0 U	34	49
32-03-31-181103-M	0-18		--	12,000	--	3.2	150	0.66	--	2.6	2.6	4.1	11,000	6.6	240	--	3.6	0 U	--	--	77	23	17
32-03-32-181103-M	0-18		--	13,000	--	4.3	250	0.72	--	2.8	2.8	5.5	11,000	6.1	240	--	4	0 U	--	--	0 U	15	14
S3233-SB43-0612-111822	6-12		1.44	16,700	0.345 U	6.89	292	0.821	0.0688	12	7.07	8.43	21,100	14	330	0.205	12	1.35	0.663	0.189	0.823	17.3	48.3
S3233-SB46-0612-111822	6-12		1.1	10,200	0.32 U	5.03	97.1	0.654	0.144	9.19	5.69	9.95	15,100	10.3	203	0.591	9.86	1.53	0.097 U	0.223	1.32	19.4	40.2
S3233-SB55-0612-111822	6-12		32.7	10,400	0.331 U	4.5	156	0.561	0.0916	7.52	4.24	7.59	12,100	12	176	0.392	6.26	6.91	0.35	0.156	25.3	32.2	31.4
33-01-31-181103-M	0-18		--	8300	--	2.5	41	0.36	--	1.7	1.8	2.7	8700	3.9	76	--	2.7	12	--	--	0 U	23	11
33-02-31-181103-M	0-18		--	22000	--	5.5	81	0.92	--	11	6.2	11	24000	7.3	170	--	13	2.8	--	--	0 U	30	50
S3233-SB13-0612-111522	6-12		17.2	5440	0.326 U	2.18	26.8	0.257	0.0207	2.49	1.67	4	5190	5.67	73.2	0.56	2.43	7.86	0.0989 U	0.128 U	47	23.8	10.6
Frequency of Plant NOEC Exceedance:			**2/4**	NA	0/4	0/10	**5/10**	0/10	0/4	**10/10**	0/10	0/10	NA	0/10	**3/10**	0/4	0/10	**6/10**	NA	**3/4**	**3/10**	0/10	0/10
Analyte Identified as Surface Soil Candidate COEC? [F]			**Yes (P)**	No	No	**Yes (I)**	**Yes (P)**	No	No	**Yes (P/I)**	No	No	No	No	**Yes (P)**	No	No	**Yes (P/I)**	No	**Yes (P)**	**Yes (P)**	**Yes (P)**	No
Analyte Identified as Subsurface Soil Candidate COEC? [F]			**Yes (P)**	No	No	No	**Yes (P)**	No	No	**Yes (P)**	No	No	No	No	**Yes (P)**	No	No	**Yes (P)**	No	**Yes (P)**	**Yes (P)**	No	No

Notes:

- (green) Exceeds the plant NOEC
- (yellow) Exceeds soil invertebrate NOEC
- (orange) Exceeds both soil invertebrate and plant NOECs

[a] A constituent is included as a COPEC if the calculated SLERA HQ is greater than or equal to 1.0 (see Table C-8).

[b] The NOECs for uranium-238 in SE are based on individual radium-226 ESLs that are adjusted to include doses from all progeny of uranium-238 in SE. Site data for radium-226 are used to evaluate uranium-238 in SE.

[c] In the absence of speciated chromium data, chromium is evaluated using the assumption that it is 100 percent hexavalent chromium (USEPA 2024b). No speciated chromium data are available. LANL chromium screening values are based on Cr(VI) (hexavalent chromium) for plants and invertebrates (Newport News Nuclear BWXT-Los Alamos, LLC. 2022).

[d] Screening levels for plants and invertebrates are NOECs (see Table C-8).

[e] Plants are exposed to surface and subsurface soil from 0 to 72 inches bgs. Soil invertebrates are exposed to surface soil (0 to 6 inches bgs) only; subsurface soil samples results are not compared to soil invertebrates NOECs.

[f] COPECs are identified as candidate COECs if at least one sample result exceeds the plant or soil invertebrate NOEC for surface soil or the plant NOEC for subsurface soil. "P" refers to plant and "I" refers to invertebrate.

--	Not analyzed	ESL	Ecological screening level	NOEC	No observed effect concentration	SE	Secular equilibrium
bgs	Below ground surface	HQ	Hazard quotient	NSL	No screening level	SLERA	Screening-level ecological risk assessment
COEC	Contaminant of ecological concern	LANL	Los Alamos National Laboratory	pCi/g	Picocurie per gram	U	Not detected
COPEC	Contaminant of potential ecological concern	mg/kg	Milligram per kilogram	Ra-226	Radium-226	USEPA	U.S. Environmental Protection Agency

References:

Newport News Nuclear BWXT-Los Alamos, LLC. 2022. “ECORISK Database.” Release 4.3. 701067. Document EM2020-0575. September.

U.S. Environmental Protection Agency (USEPA). 2024b. “Navajo Abandoned Uranium Mines Risk Assessment Methodology.” Draft Final. March.

Table C-11. Screening-Level Ecological Risk Assessment Refinement for Soil - Birds

COPEC[a]	EPC[b]	Avian Herbivore NOEC[c]	Avian Ground Insectivore NOEC[c]	Avian Carnivore NOEC[c]	Minimum Avian NOEC	Refined HQ based on Minimum Avian NOEC[d]	Include Contaminant as Candidate COEC for Birds?[e]
Site-Wide							
Surface Soil (0-6 inches bgs)							
Radionuclides (pCi/g) [f]							
Uranium-238 in SE (Adjusted Radium-226)	14	15	15	15	15	0.93	No
Metals (mg/kg)							
Antimony	0.34	NSL	NSL	NSL	NSL	NSL	No
Arsenic	6.6	67	43	1,100	43	0.15	No
Barium	156	720	820	7,500	720	0.22	No
Chromium [g]	13	78	26	780	26	0.50	No
Lead	15	46	11	510	11	**1.4**	**Yes**
Manganese	259	4,300	4,300	650,000	4300	0.06	No
Nickel	13	210	20	2,800	20	0.65	No
Selenium	9.2	2.2	1.2	83	1.2	**7.7**	**Yes**
Thallium	0.33	6.9	4.5	48	4.5	0.073	No
Uranium	20	1,500	1,100	14,000	1100	0.018	No
Vanadium	32	13	7.8	140	7.8	**4.1**	**Yes**
Zinc	56	950	46	30,000	46	**1.2**	**Yes**

Notes:

Grey highlighted cells indicate the EPC exceeds the NOEC for the receptor group.

[a] **Bolded COPECs** have a HQ greater than 1.0.

[b] EPCs are provided in Table C-9.

[c] See Table C-8 for sources of NOECs.

[d] HQ is calculated by dividing the EPC by the minimum NOEC. **Bolded HQ values** indicate HQs greater than or equal to 1.0.

[e] A contaminant is identified as a candidate COEC if the HQ (HQ based on minimum NOEC) is greater than or equal to 1.0.

[f] ESLs for uranium-238 in SE are based on individual radium-226 ESLs that are adjusted to include doses from all progeny of uranium-238 in SE. Site data for radium-226 are used to evaluate uranium-238 in SE.

[g] In the absence of speciated chromium data, chromium is evaluated using the assumption that it is 100 percent hexavalent chromium (USEPA 2024b). No speciated chromium data are available. Eco-SSLs for hexavalent chromium are not available for birds; therefore, Cr(III) (trivalent chromium) Eco-SSLs were used (USEPA 2023a).

Table C-11. Screening-Level Ecological Risk Assessment Refinement for Soil - Birds

Notes (Continued):

bgs	Below ground surface	HQ	Hazard quotient
COEC	Contaminant of ecological concern	mg/kg	Milligram per kilogram
COPEC	Contaminant of potential ecological concern	NOEC	No observed effect concentration
Eco-SSL	Ecological soil screening level	NSL	No screening level
EPC	Exposure point concentration	pCi/g	Picocurie per gram
ESL	Ecological screening level	SE	Secular equilibrium

References:

U.S. Environmental Protection Agency (USEPA). 2023a. "Interim Ecological Soil Screening Level Documents." Accessed July 20. https://www.epa.gov/chemical-research/interim-ecological-soil-screening-level-documents.

USEPA. 2024b. “Navajo Abandoned Uranium Mines Risk Assessment Methodology.” Draft Final. March.

Table C-12. Screening-Level Ecological Risk Assessment Refinement for Soil - Mammals

Site-Wide							
COPEC[a]	EPC[b]	Mammalian Herbivore NOEC[c]	Mammalian Ground Insectivore NOEC[c]	Mammalian Carnivore NOEC[c]	Minimum NOEC	Refined HQ based on Minimum Mammalian NOEC[d]	Include Contaminant as Candidate COEC for Mammals?[e]
Surface Soil (0-6 inches bgs)							
Radionuclides (pCi/g) [f]							
Uranium-238 in SE (Adjusted Radium-226)	14	6.0	6.0	6.0	6.0	**2.3**	**Yes**
Metals (mg/kg)							
Antimony	0.34	10	0.27	5	0.27	**1.3**	**Yes**
Arsenic	6.6	170	46	170	46	0.14	No
Barium	156	3,200	200	9,100	200	0.78	No
Chromium [g]	13	380	34	180	34	0.38	No
Lead	15	1,200	56	460	56	0.27	No
Manganese	259	5,300	4,000	6,200	4,000	0.065	No
Nickel	13	340	10	130	10	**1.3**	**Yes**
Selenium	9.2	2.7	0.63	2.8	0.63	**15**	**Yes**
Thallium	0.33	1.2	0.42	5.0	0.42	0.79	No
Uranium	20	1,000	480	4,800	480	0.042	No
Vanadium	32	1,300	280	580	280	0.11	No
Zinc	56	6,800	79	10,000	79	0.71	No

Table C-12. Screening-Level Ecological Risk Assessment Refinement for Soil - Mammals

Site-Wide							
COPEC[a]	EPC[b]	Mammalian Herbivore NOEC[c]	Mammalian Ground Insectivore NOEC[c]	Mammalian Carnivore NOEC[c]	Minimum NOEC	Refined HQ based on Minimum Mammalian NOEC[d]	Include Contaminant as Candidate COEC for Mammals?[e]
Subsurface Soil (0-72 inches bgs)							
Radionuclides (pCi/g) [f]							
Uranium-238 in SE (Adjusted Radium-226)	14	6.0	6.0	6.0	6.0	**2.3**	**Yes**
Metals (mg/kg)							
Antimony	0.34	10	0.27	5	0.27	**1.3**	**Yes**
Arsenic	6.4	170	46	170	46	0.14	No
Barium	154	3,200	200	9,100	200	0.77	No
Chromium [g]	13	380	34	180	34	0.38	No
Lead	14	1,200	56	460	56	0.25	No
Manganese	250	5,300	4,000	6,200	4,000	0.063	No
Molybdenum	0.79	635	4.8	64	4.8	0.17	No
Nickel	13	340	10	130	10	**1.3**	**Yes**
Selenium	9.2	2.7	0.63	2.8	0.63	**15**	**Yes**
Silver	0.28	1,500	14	990	14.0	0.020	No
Thallium	0.32	1.2	0.42	5.0	0.42	0.76	No
Uranium	21	1,000	480	4,800	480	0.044	No
Vanadium	31	1,300	280	580	280	0.11	No
Zinc	53	6,800	79	10,000	79	0.67	No

Table C-12. Screening-Level Ecological Risk Assessment Refinement for Soil - Mammals

Notes:

Grey highlighted cells indicate the EPC exceeds the NOEC for the receptor group.

[a] **Bolded COPECs** have a HQ greater than 1.0.

[b] EPCs are provided in Table C-9.

[c] See Table C-8 for sources of NOECs.

[d] HQ is calculated by dividing the EPC by the minimum NOEC. **Bolded HQ values** indicate HQs equal to or greater than 1.0.

Notes (Continued):

[e] A contaminant is identified as a candidate COEC if the HQ (HQ based on minimum NOEC) is equal to or greater than 1.0.

[f] ESLs for uranium-238 in SE are based on individual radium-226 ESLs that are adjusted to include doses from all progeny of uranium-238 in SE. Site data for radium-226 are used to evaluate uranium-238 in SE.

[g] In the absence of speciated chromium data, chromium is evaluated using the assumption that it is 100 percent hexavalent chromium (USEPA 2024b). No speciated chromium data are available. Cr(III) (trivalent chromium) Eco-SSLs were used for mammals because the hexavalent chromium Eco-SSLs for mammals are higher than the trivalent chromium values (USEPA 2023a).

bgs	Below ground surface	HQ	Hazard quotient
COEC	Contaminant of ecological concern	mg/kg	Milligram per kilogram
COPEC	Contaminant of potential ecological concern	NOEC	No observed effect concentration
Eco-SSL	Ecological soil screening level	pCi/g	Picocurie per gram
EPC	Exposure point concentration	SE	Secular equlibrium
ESL	Ecological screening level		

References:

U.S. Environmental Protection Agency (USEPA). 2023a. "Interim Ecological Soil Screening Level Documents." Accessed July 20. https://www.epa.gov/chemical-research/interim-ecological-soil-screening-level-documents.

USEPA. 2024b. “Navajo Abandoned Uranium Mines Risk Assessment Methodology.” Draft Final. March.

ATTACHMENT C-1

DATA USED IN THE RISK ASSESSMENT

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Aluminum	11,000	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Arsenic	3.3	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Barium	150	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Beryllium	0.56	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Chromium	5	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Cobalt	3	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Copper	4	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Iron	12,000	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Lead	4	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Manganese	140	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Nickel	5	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Selenium	-- U	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Uranium	-- U	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Vanadium	16	--	mg/kg
32	32-01-31-181103-M	11/3/2018	35.48968	-108.03236	0	18	--	Zinc	24	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Aluminum	25,000	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Arsenic	4.9	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Barium	110	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Beryllium	1.1	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Chromium	12	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Cobalt	6	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Copper	10	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Iron	22,000	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Lead	6	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Manganese	220	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Nickel	10	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Selenium	-- U	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Uranium	-- U	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Vanadium	34	--	mg/kg
32	32-02-31-181103-M	11/3/2018	35.49009	-108.0313	0	18	--	Zinc	49	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Aluminum	12,000	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Arsenic	3.2	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Barium	150	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Beryllium	0.66	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Chromium	3	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Cobalt	3	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Copper	4	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Iron	11,000	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Lead	7	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Manganese	240	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Nickel	4	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Selenium	-- U	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Uranium	77	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Vanadium	23	--	mg/kg
32	32-03-31-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Zinc	17	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Aluminum	13,000	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Arsenic	4.3	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Barium	250	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Beryllium	0.72	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Chromium	3	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Cobalt	3	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Copper	6	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Iron	11,000	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Lead	6	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Manganese	240	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Nickel	4	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Selenium	-- U	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Uranium	-- U	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Vanadium	15	--	mg/kg
32	32-03-32-181103-M	11/3/2018	35.48612	-108.01708	0	18	--	Zinc	14	--	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Aluminum	16,700	48.1	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Antimony	0.345 UJ	0.345	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Arsenic	6.89	0.358	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Barium	292	1.06	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Beryllium	0.821	0.0212	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Cadmium	0.0688 J	0.0212	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Chromium	12	0.212	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Cobalt	7 J	0.0635	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Copper	8 J	0.0698	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Iron	21,100	69.8	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Lead	14	0.106	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Manganese	330	2.12	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Molybdenum	0 JJ	0.0847	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Nickel	12	0.106	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	EPA 901.1M	Radium-226	1.44	0.104	pCi/g

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Selenium	1 J	0.381	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Silver	0.663	0.105	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Thallium	0.189 J	0.148	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Uranium	0.823	0.014	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Vanadium	17 J	0.317	mg/kg
32	S3233-SB43-0612-111822	11/18/2022	35.486838	-108.01853	6	12	SW6020A	Zinc	48 J	0.847	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Aluminum	10,200	42.3	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Antimony	0.32 UJ	0.32	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Arsenic	5.03	0.314	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Barium	97	0.093	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Beryllium	0.654	0.0186	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Cadmium	0.144 J	0.0186	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Chromium	9	0.186	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Cobalt	6	0.0558	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Copper	10 J	0.0614	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Iron	15,100	61.4	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Lead	10	0.093	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Manganese	203	1.86	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Molybdenum	1 J	0.0744	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Nickel	10	0.093	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	EPA 901.1M	Radium-226	1.1	0.135	pCi/g
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Selenium	2	0.335	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Silver	0.097 U	0.097	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Thallium	0.223 J	0.13	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Uranium	1.32 J	0.0123	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Vanadium	19	0.279	mg/kg
32	S3233-SB46-0612-111822	11/18/2022	35.490821	-108.02163	6	12	SW6020A	Zinc	40	0.744	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Aluminum	10,400	41.6	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Antimony	0.331 UJ	0.331	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Arsenic	4.5	0.309	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Barium	156	0.0914	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Beryllium	0.561	0.0183	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Cadmium	0.0916 J	0.0183	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Chromium	8	0.183	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Cobalt	4	0.0548	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Copper	8 J	0.0603	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Iron	12,100	60.3	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Lead	12	0.0914	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Manganese	176	0.183	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Molybdenum	0 J	0.0731	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Nickel	6	0.0914	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	EPA 901.1M	Radium-226	32.7	0.321	pCi/g
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Selenium	7	0.329	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Silver	0.35 J	0.1	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Thallium	0.156 J	0.128	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Uranium	25.3	0.0121	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Vanadium	32	0.274	mg/kg
32	S3233-SB55-0612-111822	11/18/2022	35.48979	-108.03237	6	12	SW6020A	Zinc	31	0.731	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Aluminum	19,500	44.5	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Antimony	0.336 U	0.336	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Arsenic	5.4	0.331	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Barium	187	0.0978	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Beryllium	0.832	0.0196	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Cadmium	0.114 J	0.0196	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Chromium	14 J	0.196	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Cobalt	8	0.0587	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Copper	11	0.0646	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Iron	24,200	64.6	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Lead	14	0.0978	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Manganese	419	1.96	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Molybdenum	1 J	0.0783	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Nickel	14	0.0978	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	EPA 901.1M	Radium-226	1.33	0.106	pCi/g
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Selenium	1	0.352	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Silver	0.509 UJ	0.509	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Thallium	0.29 J	0.137	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Uranium	1.22	0.0129	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Vanadium	31 J	0.293	mg/kg
32	S3233-SS20-01-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Zinc	51	0.783	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Aluminum	21,300	49.6	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Antimony	0.36 U	0.36	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Arsenic	5.41	0.369	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Barium	201	0.109	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Beryllium	0.9	0.0218	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Cadmium	0.118 J	0.0218	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Chromium	15 J	0.218	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Cobalt	8	0.0654	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Copper	12 J	0.072	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Iron	20,900	72	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Lead	13 J	0.109	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Manganese	345	2.18	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Molybdenum	0 J	0.0873	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Nickel	14 J	0.109	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	EPA 901.1M	Radium-226	1.78	0.135	pCi/g
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Selenium	1	0.393	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Silver	0.545 U	0.545	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Thallium	0.292 J	0.153	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Uranium	1.42	0.0144	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Vanadium	29	0.327	mg/kg
32	S3233-SS20-02-111522	11/15/2022	35.490003	-108.01705	0	6	SW6020A	Zinc	54	0.873	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Aluminum	21,700	46.3	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Antimony	0.327 U	0.327	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Arsenic	6.53	0.344	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Barium	195	0.102	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Beryllium	0.955	0.0204	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Cadmium	0.155 J	0.0204	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Chromium	17 J	0.204	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Cobalt	9	0.0611	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Copper	14	0.0672	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Iron	23,500	67.2	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Lead	16	0.102	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Manganese	309	2.04	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Molybdenum	1 J	0.0815	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Nickel	16	0.102	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	EPA 901.1M	Radium-226	1.33	0.105	pCi/g
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Selenium	2	0.367	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Silver	0.495 UJ	0.495	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Thallium	0.351 J	0.143	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Uranium	1.05	0.0134	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Vanadium	30 J	0.306	mg/kg
32	S3233-SS21-01-111522	11/15/2022	35.490162	-108.01713	0	6	SW6020A	Zinc	63	0.815	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Aluminum	18,800	43.8	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Antimony	0.303 U	0.303	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Arsenic	6.94	0.325	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Barium	108	0.0962	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Beryllium	0.982	0.0192	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Cadmium	0.203	0.0192	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Chromium	14 J	0.192	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Cobalt	8	0.0577	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Copper	15 J	0.0635	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Iron	23,200	63.5	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Lead	17 J	0.0962	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Manganese	277	1.92	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Molybdenum	1 J	0.077	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Nickel	16 J	0.0962	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	EPA 901.1M	Radium-226	4.76	0.167	pCi/g
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Selenium	4	0.346	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Silver	0.459 U	0.459	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Thallium	0.381 J	0.135	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Uranium	18.8	0.0127	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Vanadium	29	0.289	mg/kg
32	S3233-SS22-01-111522	11/15/2022	35.490365	-108.01788	0	6	SW6020A	Zinc	64	0.77	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Aluminum	16,700	46	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Antimony	0.312 U	0.312	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Arsenic	8.03	0.341	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Barium	307	1.01	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Beryllium	0.87	0.0202	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Cadmium	0.0875 J	0.0202	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Chromium	13 J	0.202	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Cobalt	7	0.0606	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Copper	9 J	0.0667	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Iron	21,900	66.7	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Lead	16 J	0.101	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Manganese	314	2.02	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Molybdenum	0 J	0.0808	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Nickel	12 J	0.101	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	EPA 901.1M	Radium-226	2.33	0.1	pCi/g
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Selenium	2	0.364	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Silver	0.473 U	0.473	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Thallium	0.195 J	0.141	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Uranium	3.4	0.0133	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Vanadium	21	0.303	mg/kg
32	S3233-SS23-01-111522	11/15/2022	35.490627	-108.01739	0	6	SW6020A	Zinc	52	0.808	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Aluminum	13,700	43.1	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Antimony	0.324 U	0.324	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Arsenic	5.29	0.32	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Barium	208	0.947	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Beryllium	0.688	0.0189	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Cadmium	0.0895 J	0.0189	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Chromium	10 J	0.189	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Cobalt	5	0.0568	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Copper	7 J	0.0625	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Iron	15,500	62.5	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Lead	11 J	0.0947	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Manganese	265	1.89	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Molybdenum	0 J	0.0757	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Nickel	9 J	0.0947	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	EPA 901.1M	Radium-226	2.87	0.102	pCi/g
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Selenium	1	0.341	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Silver	0.491 U	0.491	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Thallium	0.157 J	0.133	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Uranium	1.78	0.0125	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Vanadium	17	0.284	mg/kg
32	S3233-SS24-01-111522	11/15/2022	35.490713	-108.01805	0	6	SW6020A	Zinc	39	0.757	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Aluminum	18,700	44.6	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Antimony	0.352 U	0.352	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Arsenic	5.78	0.331	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Barium	156	0.098	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Beryllium	0.853	0.0196	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Cadmium	0.132 J	0.0196	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Chromium	14 J	0.196	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Cobalt	7	0.0588	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Copper	12 J	0.0647	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Iron	20,100	64.7	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Lead	14 J	0.098	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Manganese	267	1.96	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Molybdenum	1 J	0.0784	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Nickel	13 J	0.098	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	EPA 901.1M	Radium-226	7.24	0.149	pCi/g
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Selenium	3	0.353	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Silver	0.533 U	0.533	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Thallium	0.276 J	0.137	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Uranium	9.41	0.0129	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Vanadium	27	0.294	mg/kg
32	S3233-SS25-01-111522	11/15/2022	35.490489	-108.01866	0	6	SW6020A	Zinc	52	0.784	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Aluminum	23,800	49	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Antimony	0.356 U	0.356	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Arsenic	7.2	0.364	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Barium	114	0.108	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Beryllium	1.09	0.0215	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Cadmium	0.209 J	0.0215	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Chromium	18 J	0.215	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Cobalt	9	0.0646	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Copper	17 J	0.071	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Iron	26,300	71	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Lead	18 J	0.108	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Manganese	250	2.15	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Molybdenum	1 J	0.0861	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Nickel	17 J	0.108	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	EPA 901.1M	Radium-226	2.15	0.152	pCi/g
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Selenium	2	0.387	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Silver	0.54 U	0.54	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Thallium	0.434	0.151	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Uranium	1.69	0.0142	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Vanadium	34	0.323	mg/kg
32	S3233-SS26-01-111522	11/15/2022	35.490627	-108.01882	0	6	SW6020A	Zinc	71	0.861	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Aluminum	14,900	47.5	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Antimony	0.355 U	0.355	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Arsenic	5.84	0.353	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Barium	137	0.104	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Beryllium	0.765	0.0209	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Cadmium	0.128 J	0.0209	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Chromium	11 J	0.209	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Cobalt	6	0.0627	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Copper	10 J	0.069	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Iron	16,800	69	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Lead	13 J	0.104	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Manganese	219	2.09	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Molybdenum	1 J	0.0836	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Nickel	11 J	0.104	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	EPA 901.1M	Radium-226	27.3	0.221	pCi/g
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Selenium	13	0.376	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Silver	0.537 U	0.537	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Thallium	0.283 J	0.146	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Uranium	32.4	0.0138	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Vanadium	34	0.313	mg/kg
32	S3233-SS27-01-111522	11/15/2022	35.490783	-108.01723	0	6	SW6020A	Zinc	43	0.836	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Aluminum	20,700	51.7	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Antimony	0.357 UJ	0.357	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Arsenic	7.52	0.384	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Barium	96	0.114	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Beryllium	1.03	0.0227	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Cadmium	0.24	0.0227	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Chromium	18	0.227	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Cobalt	9	0.0681	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Copper	17 J	0.0749	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Iron	25,300	74.9	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Lead	19	0.114	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Manganese	234	2.27	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Molybdenum	1 J	0.0908	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Nickel	19	0.114	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	EPA 901.1M	Radium-226	4.76	0.16	pCi/g
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Selenium	3	0.409	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Silver	0.124 J	0.108	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Thallium	0.471	0.159	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Uranium	16 J	0.015	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Vanadium	34	0.341	mg/kg
32	S3233-SS30-01-111722	11/17/2022	35.49125	-108.01714	0	6	SW6020A	Zinc	75	0.908	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Aluminum	19,300	48.2	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Antimony	0.329 UJ	0.329	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Arsenic	7.42	0.358	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Barium	91	0.106	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Beryllium	0.992	0.0212	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Cadmium	0.216	0.0212	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Chromium	16	0.212	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Cobalt	9	0.0636	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Copper	17 J	0.0699	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Iron	24,800	69.9	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Lead	18	0.106	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Manganese	237	2.12	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Molybdenum	1 J	0.0848	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Nickel	18	0.106	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	EPA 901.1M	Radium-226	1.68	0.13	pCi/g
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Selenium	2	0.382	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Silver	0.0996 U	0.0996	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Thallium	0.451	0.148	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Uranium	1.51 J	0.014	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Vanadium	31	0.318	mg/kg
32	S3233-SS31-01-111722	11/17/2022	35.491254	-108.0179	0	6	SW6020A	Zinc	73	0.848	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Aluminum	16,300	42.9	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Antimony	0.365 UJ	0.365	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Arsenic	6.28	0.319	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Barium	110	0.0943	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Beryllium	0.826	0.0189	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Cadmium	0.17 J	0.0189	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Chromium	13	0.189	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Cobalt	7	0.0566	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Copper	13 J	0.0622	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Iron	21,200	62.2	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Lead	14	0.0943	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Manganese	230	1.89	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Molybdenum	1 J	0.0754	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Nickel	13	0.0943	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	EPA 901.1M	Radium-226	1.35	0.101	pCi/g
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Selenium	2	0.339	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Silver	0.111 U	0.111	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Thallium	0.33 J	0.132	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Uranium	1.37 J	0.0124	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Vanadium	28	0.283	mg/kg
32	S3233-SS32-01-111722	11/17/2022	35.491394	-108.01808	0	6	SW6020A	Zinc	57	0.754	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Aluminum	17,500	43.4	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Antimony	0.317 UJ	0.317	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Arsenic	6.98	0.323	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Barium	93	0.0954	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Beryllium	0.907	0.0191	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Cadmium	0.201	0.0191	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Chromium	15	0.191	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Cobalt	8	0.0573	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Copper	15 J	0.063	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Iron	22,100	63	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Lead	16	0.0954	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Manganese	237	1.91	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Molybdenum	1 J	0.0763	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Nickel	15	0.0954	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	EPA 901.1M	Radium-226	1.56	0.127	pCi/g
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Selenium	2	0.344	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Silver	0.161 J	0.0961	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Thallium	0.356 J	0.134	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Uranium	1.47 J	0.0126	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Vanadium	29	0.286	mg/kg
32	S3233-SS33-01-111722	11/17/2022	35.491078	-108.01893	0	6	SW6020A	Zinc	63	0.763	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Aluminum	23,100	50.1	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Antimony	0.358 UJ	0.358	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Arsenic	7.15	0.372	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Barium	118	0.11	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Beryllium	1.05	0.022	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Cadmium	0.214 J	0.022	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Chromium	18	0.22	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Cobalt	8	0.066	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Copper	16 J	0.0726	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Iron	24,800	72.6	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Lead	18	0.11	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Manganese	238	2.2	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Molybdenum	1 J	0.088	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Nickel	17	0.11	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	EPA 901.1M	Radium-226	1.84	0.134	pCi/g
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Selenium	2	0.396	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Silver	0.125 J	0.108	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Thallium	0.447	0.154	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Uranium	1.86 J	0.0145	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Vanadium	35	0.33	mg/kg
32	S3233-SS34-01-111722	11/17/2022	35.490506	-108.01956	0	6	SW6020A	Zinc	74	0.88	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Aluminum	17,500	43.2	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Antimony	0.327 UJ	0.327	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Arsenic	6.61	0.321	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Barium	125	0.0949	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Beryllium	0.878	0.019	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Cadmium	0.213	0.019	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Chromium	13	0.19	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Cobalt	7	0.0569	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Copper	14 J	0.0626	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Iron	21,600	62.6	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Lead	17	0.0949	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Manganese	270	1.9	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Molybdenum	1 J	0.0759	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Nickel	14	0.0949	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	EPA 901.1M	Radium-226	4.85	0.11	pCi/g
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Selenium	3	0.342	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Silver	0.146 J	0.0992	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Thallium	0.352 J	0.133	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Uranium	4.76 J	0.0125	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Vanadium	28	0.285	mg/kg
32	S3233-SS35-01-111722	11/17/2022	35.490665	-108.02027	0	6	SW6020A	Zinc	61	0.759	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Aluminum	9,310	4.47	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Antimony	0.342 UJ	0.342	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Arsenic	3.99	0.332	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Barium	148	0.0982	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Beryllium	0.496	0.0196	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Cadmium	0.136 J	0.0196	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Chromium	8	0.196	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Cobalt	5	0.0589	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Copper	7 J	0.0648	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Iron	13,400	64.8	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Lead	10	0.0982	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Manganese	325	1.96	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Molybdenum	0 J	0.0785	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Nickel	8	0.0982	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	EPA 901.1M	Radium-226	1.08	0.0871	pCi/g
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Selenium	1	0.353	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Silver	0.166 J	0.104	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Thallium	0.142 J	0.137	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Uranium	0.606 J	0.013	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Vanadium	16	0.294	mg/kg
32	S3233-SS36-01-111722	11/17/2022	35.489462	-108.01871	0	6	SW6020A	Zinc	32	0.785	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Aluminum	10,400	4.74	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Antimony	0.301 UJ	0.301	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Arsenic	3.41	0.352	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Barium	140	0.104	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Beryllium	0.511	0.0208	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Cadmium	0.154 J	0.0208	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Chromium	9	0.208	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Cobalt	5	0.0625	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Copper	8 J	0.0687	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Iron	12,200	68.7	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Lead	11	0.104	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Manganese	340	2.08	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Molybdenum	0 J	0.0833	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Nickel	8	0.104	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	EPA 901.1M	Radium-226	1.32	0.0863	pCi/g
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Selenium	1 J	0.375	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Silver	0.179 J	0.0912	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Thallium	0.146 J	0.146	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Uranium	0.802 J	0.0137	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Vanadium	16	0.312	mg/kg
32	S3233-SS37-01-111722	11/17/2022	35.488917	-108.01826	0	6	SW6020A	Zinc	34	0.833	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Aluminum	18,300	48.7	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Antimony	0.331 UJ	0.331	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Arsenic	6.37	0.361	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Barium	300	1.07	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Beryllium	0.816	0.0214	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Cadmium	0.109 J	0.0214	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Chromium	14	0.214	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Cobalt	7	0.0642	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Copper	10 J	0.0706	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Iron	18,700	70.6	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Lead	11	0.107	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Manganese	277	2.14	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Molybdenum	0 J	0.0855	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Nickel	13	0.107	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	EPA 901.1M	Radium-226	1.18	0.0897	pCi/g
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Selenium	1	0.385	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Silver	0.1 U	0.1	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Thallium	0.225 J	0.15	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Uranium	2.21 J	0.0141	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Vanadium	31	0.321	mg/kg
32	S3233-SS38-01-111722	11/17/2022	35.48879	-108.0173	0	6	SW6020A	Zinc	43	0.855	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Aluminum	16,700	45.1	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Antimony	0.328 UJ	0.328	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Arsenic	6.04	0.335	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Barium	285	0.99	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Beryllium	0.762	0.0198	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Cadmium	0.118 J	0.0198	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Chromium	11	0.198	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Cobalt	6	0.0594	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Copper	9 J	0.0654	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Iron	20,300	65.4	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Lead	12	0.099	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Manganese	399	1.98	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Molybdenum	0 J	0.0792	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Nickel	12	0.099	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	EPA 901.1M	Radium-226	2.77	0.156	pCi/g
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Selenium	3	0.356	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Silver	0.238 J	0.0994	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Thallium	0.203 J	0.139	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Uranium	3.93 J	0.0131	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Vanadium	24	0.297	mg/kg
32	S3233-SS39-01-111722	11/17/2022	35.488292	-108.01777	0	6	SW6020A	Zinc	43	0.792	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Aluminum	15,200	47.3	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Antimony	0.311 UJ	0.311	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Arsenic	6.9	0.351	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Barium	283	1.04	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Beryllium	0.772	0.0208	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Cadmium	0.101 J	0.0208	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Chromium	12	0.208	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Cobalt	6	0.0624	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Copper	8 J	0.0686	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Iron	18,200	68.6	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Lead	14	0.104	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Manganese	280	2.08	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Molybdenum	0 J	0.0832	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Nickel	11	0.104	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	EPA 901.1M	Radium-226	1.52	0.1	pCi/g
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Selenium	1	0.374	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Silver	0.123 J	0.0943	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Thallium	0.185 J	0.146	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Uranium	1.11 J	0.0137	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Vanadium	19	0.312	mg/kg
32	S3233-SS40-01-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Zinc	48	0.832	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Aluminum	16,600	46.5	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Antimony	0.326 UJ	0.326	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Arsenic	7.67	0.345	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Barium	289	1.02	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Beryllium	0.833	0.0204	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Cadmium	0.115 J	0.0204	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Chromium	13	0.204	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Cobalt	7	0.0613	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Copper	9 J	0.0674	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Iron	20,300	67.4	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Lead	16	0.102	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Manganese	311	2.04	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Molybdenum	0 J	0.0818	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Nickel	13	0.102	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	EPA 901.1M	Radium-226	1.55	0.112	pCi/g
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Selenium	1	0.368	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Silver	0.135 J	0.0987	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Thallium	0.208 J	0.143	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Uranium	1.26 J	0.0135	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Vanadium	20	0.307	mg/kg
32	S3233-SS40-02-111722	11/17/2022	35.488009	-108.01958	0	6	SW6020A	Zinc	53	0.818	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Aluminum	8,850	4.37	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Antimony	0.299 UJ	0.299	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Arsenic	8.3	0.325	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Barium	155	0.0961	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Beryllium	0.483	0.0192	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Cadmium	0.0484 J	0.0192	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Chromium	8	0.192	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Cobalt	4	0.0577	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Copper	5 J	0.0634	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Iron	15,900	63.4	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Lead	8	0.0961	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Manganese	140	0.192	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Molybdenum	1 J	0.0769	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Nickel	6	0.0961	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	EPA 901.1M	Radium-226	1.61	0.103	pCi/g
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Selenium	1	0.346	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Silver	0.175 J	0.0905	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Thallium	0.147 J	0.135	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Uranium	2.26 J	0.0127	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Vanadium	15	0.288	mg/kg
32	S3233-SS41-01-111822	11/18/2022	35.487015	-108.01948	0	6	SW6020A	Zinc	26	0.769	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Aluminum	12,000	48.1	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Antimony	0.304 UJ	0.304	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Arsenic	8.29	0.357	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Barium	139	0.106	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Beryllium	0.815	0.0211	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Cadmium	0.0505 J	0.0211	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Chromium	10	0.211	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Cobalt	7	0.0634	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Copper	9 J	0.0697	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Iron	19,000	69.7	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Lead	14	0.106	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Manganese	191	0.211	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Molybdenum	0 J	0.0845	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Nickel	11	0.106	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	EPA 901.1M	Radium-226	2.1	0.108	pCi/g

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Selenium	1	0.38	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Silver	0.151 J	0.0921	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Thallium	0.182 J	0.148	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Uranium	1.87 J	0.0139	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Vanadium	14	0.317	mg/kg
32	S3233-SS42-01-111822	11/18/2022	35.487231	-108.01883	0	6	SW6020A	Zinc	49	0.845	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Aluminum	15,300	48	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Antimony	0.338 UJ	0.338	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Arsenic	6.72	0.357	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Barium	306	1.06	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Beryllium	0.737	0.0211	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Cadmium	0.0648 J	0.0211	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Chromium	11	0.211	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Cobalt	7	0.0634	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Copper	8 J	0.0697	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Iron	19,400	69.7	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Lead	14	0.106	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Manganese	313	2.11	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Molybdenum	0 J	0.0845	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Nickel	11	0.106	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	EPA 901.1M	Radium-226	1.59	0.115	pCi/g
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Selenium	1	0.38	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Silver	0.231 J	0.102	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Thallium	0.194 J	0.148	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Uranium	1.36 J	0.0139	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Vanadium	18	0.317	mg/kg
32	S3233-SS43-01-111822	11/18/2022	35.486838	-108.01853	0	6	SW6020A	Zinc	46	0.845	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Aluminum	19,800	43.5	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Antimony	0.329 UJ	0.329	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Arsenic	7.21	0.323	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Barium	187	0.0956	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Beryllium	0.928	0.0191	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Cadmium	0.0661 J	0.0191	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Chromium	15	0.191	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Cobalt	7	0.0573	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Copper	8 J	0.0631	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Iron	20,300	63.1	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Lead	14	0.0956	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Manganese	337	1.91	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Molybdenum	1 J	0.0765	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Nickel	13	0.0956	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	EPA 901.1M	Radium-226	1.19	0.115	pCi/g
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Selenium	1	0.344	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Silver	0.182 J	0.0996	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Thallium	0.21 J	0.134	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Uranium	1.31 J	0.0126	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Vanadium	25	0.287	mg/kg
32	S3233-SS44-01-111822	11/18/2022	35.486306	-108.01925	0	6	SW6020A	Zinc	50	0.765	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Aluminum	16,900	47.6	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Antimony	0.336 UJ	0.336	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Arsenic	7.49	0.354	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Barium	295	1.05	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Beryllium	0.826	0.0209	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Cadmium	0.102 J	0.0209	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Chromium	13	0.209	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Cobalt	7	0.0628	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Copper	9 J	0.0691	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Iron	19,800	69.1	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Lead	15	0.105	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Manganese	294	2.09	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Molybdenum	0 J	0.0837	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Nickel	12	0.105	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	EPA 901.1M	Radium-226	1.19	0.0815	pCi/g
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Selenium	1	0.377	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Silver	0.177 J	0.102	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Thallium	0.202 J	0.146	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Uranium	1.26 J	0.0138	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Vanadium	20	0.314	mg/kg
32	S3233-SS45-01-111822	11/18/2022	35.488014	-108.01959	0	6	SW6020A	Zinc	52	0.837	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Aluminum	9,520	4.39	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Antimony	0.343 JJ	0.294	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Arsenic	5	0.326	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Barium	99	0.0965	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Beryllium	0.616	0.0193	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Cadmium	0.133 J	0.0193	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Chromium	9	0.193	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Cobalt	5	0.0579	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Copper	9 J	0.0637	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Iron	14,800	63.7	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Lead	11	0.0965	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Manganese	190	0.193	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Molybdenum	1 J	0.0772	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Nickel	9	0.0965	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	EPA 901.1M	Radium-226	1.64	0.114	pCi/g
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Selenium	2	0.348	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Silver	0.0891 U	0.0891	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Thallium	0.208 J	0.135	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Uranium	1.53 J	0.0127	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Vanadium	19	0.29	mg/kg
32	S3233-SS46-01-111822	11/18/2022	35.490821	-108.02163	0	6	SW6020A	Zinc	39	0.772	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Aluminum	14,800	42.1	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Antimony	0.326 UJ	0.326	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Arsenic	4.71	0.313	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Barium	112	0.0926	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Beryllium	0.683	0.0185	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Cadmium	0.144 J	0.0185	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Chromium	12	0.185	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Cobalt	6	0.0556	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Copper	11 J	0.0611	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Iron	16,000	61.1	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Lead	13	0.0926	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Manganese	227	1.85	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Molybdenum	1 J	0.0741	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Nickel	10	0.0926	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	EPA 901.1M	Radium-226	1.48	0.144	pCi/g
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Selenium	0.467 J	0.333	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Silver	0.488 J	0.0987	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Thallium	0.242 J	0.13	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Uranium	1.01	0.0122	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Vanadium	25	0.278	mg/kg
32	S3233-SS47-01-111822	11/18/2022	35.490294	-108.02232	0	6	SW6020A	Zinc	43	0.741	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Aluminum	15,600	44	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Antimony	0.326 UJ	0.326	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Arsenic	4.96	0.327	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Barium	272	0.967	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Beryllium	0.777	0.0193	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Cadmium	0.156 J	0.0193	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Chromium	12	0.193	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Cobalt	6	0.058	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Copper	12 J	0.0638	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Iron	17,100	63.8	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Lead	14	0.0967	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Manganese	234	1.93	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Molybdenum	1 J	0.0774	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Nickel	11	0.0967	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	EPA 901.1M	Radium-226	2.99	0.114	pCi/g
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Selenium	1	0.348	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Silver	0.358 J	0.0987	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Thallium	0.282 J	0.135	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Uranium	2.42	0.0128	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Vanadium	28	0.29	mg/kg
32	S3233-SS48-01-111822	11/18/2022	35.491	-108.02283	0	6	SW6020A	Zinc	48	0.774	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Aluminum	14,800	45.9	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Antimony	0.34 UJ	0.34	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Arsenic	4.41	0.341	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Barium	192	1.01	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Beryllium	0.762	0.0202	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Cadmium	0.16 J	0.0202	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Chromium	11	0.202	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Cobalt	6	0.0606	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Copper	12 J	0.0666	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Iron	15,800	66.6	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Lead	13	0.101	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Manganese	222	2.02	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Molybdenum	1 J	0.0808	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Nickel	9	0.101	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	EPA 901.1M	Radium-226	1.87	0.114	pCi/g
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Selenium	1	0.363	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Silver	0.354 J	0.103	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Thallium	0.243 J	0.141	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Uranium	1.42	0.0133	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Vanadium	26	0.303	mg/kg
32	S3233-SS49-01-111822	11/18/2022	35.49124	-108.02422	0	6	SW6020A	Zinc	46	0.808	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Aluminum	20,400	47.7	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Antimony	0.347 UJ	0.347	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Arsenic	5.87	0.354	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Barium	115	0.105	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Beryllium	0.933	0.021	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Cadmium	0.201 J	0.021	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Chromium	16	0.21	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Cobalt	7	0.0629	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Copper	15 J	0.0692	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Iron	20,600	69.2	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Lead	16	0.105	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Manganese	241	2.1	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Molybdenum	1 J	0.0838	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Nickel	13	0.105	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	EPA 901.1M	Radium-226	1.68	0.145	pCi/g
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Selenium	1 J	0.377	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Silver	0.51 J	0.105	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Thallium	0.352 J	0.147	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Uranium	1.19	0.0138	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Vanadium	34	0.314	mg/kg
32	S3233-SS50-01-111822	11/18/2022	35.491166	-108.02641	0	6	SW6020A	Zinc	59	0.838	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Aluminum	18,100	50.1	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Antimony	0.366 UJ	0.366	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Arsenic	5.75	0.372	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Barium	118	0.11	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Beryllium	0.923	0.022	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Cadmium	0.152 J	0.022	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Chromium	14	0.22	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Cobalt	8	0.0661	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Copper	13 J	0.0727	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Iron	18,800	72.7	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Lead	15	0.11	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Manganese	291	2.2	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Molybdenum	1 J	0.0882	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Nickel	11	0.11	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	EPA 901.1M	Radium-226	5.75	0.177	pCi/g
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Selenium	1	0.397	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Silver	0.453 J	0.111	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Thallium	0.238 J	0.154	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Uranium	7.03	0.0145	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Vanadium	33	0.331	mg/kg
32	S3233-SS51-01-111822	11/18/2022	35.490662	-108.02963	0	6	SW6020A	Zinc	55	0.882	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Aluminum	20,100	46.9	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Antimony	0.347 UJ	0.347	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Arsenic	5.58	0.348	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Barium	134	0.103	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Beryllium	0.943	0.0206	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Cadmium	0.158 J	0.0206	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Chromium	15	0.206	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Cobalt	7	0.0619	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Copper	14 J	0.068	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Iron	18,400	68	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Lead	15	0.103	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Manganese	266	2.06	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Molybdenum	1 J	0.0825	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Nickel	11	0.103	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	EPA 901.1M	Radium-226	4.27	0.19	pCi/g
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Selenium	1 J	0.371	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Silver	0.54	0.105	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Thallium	0.236 J	0.144	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Uranium	23.2	0.0136	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Vanadium	36	0.309	mg/kg
32	S3233-SS52-01-111822	11/18/2022	35.490407	-108.03085	0	6	SW6020A	Zinc	54	0.825	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Aluminum	23,600	48.1	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Antimony	0.339 UJ	0.339	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Arsenic	6.15	0.357	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Barium	165	0.106	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Beryllium	1.15	0.0211	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Cadmium	0.148 J	0.0211	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Chromium	17	0.211	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Cobalt	8	0.0634	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Copper	15 J	0.0697	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Iron	20,300	69.7	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Lead	17	0.106	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Manganese	299	2.11	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Molybdenum	1 J	0.0845	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Nickel	11	0.106	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	EPA 901.1M	Radium-226	4.84	0.203	pCi/g
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Selenium	1	0.38	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Silver	0.542	0.103	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Thallium	0.396 J	0.148	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Uranium	12.4	0.0139	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Vanadium	39	0.317	mg/kg
32	S3233-SS53-01-111822	11/18/2022	35.49017	-108.03126	0	6	SW6020A	Zinc	59	0.845	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Aluminum	15,100	47.4	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Antimony	0.336 UJ	0.336	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Arsenic	4.9	0.352	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Barium	169	0.104	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Beryllium	0.807	0.0208	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Cadmium	0.156 J	0.0208	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Chromium	11	0.208	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Cobalt	6	0.0625	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Copper	12 J	0.0687	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Iron	16,300	68.7	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Lead	14	0.104	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Manganese	237	2.08	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Molybdenum	1 J	0.0833	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Nickel	9	0.104	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	EPA 901.1M	Radium-226	3.51	0.149	pCi/g
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Selenium	1	0.375	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Silver	0.354 J	0.102	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Thallium	0.209 J	0.146	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Uranium	2.78	0.0137	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Vanadium	26	0.312	mg/kg
32	S3233-SS54-01-111822	11/18/2022	35.490054	-108.03183	0	6	SW6020A	Zinc	47	0.833	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Aluminum	8,990	4.24	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Antimony	0.345 UJ	0.345	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Arsenic	4.15	0.315	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Barium	192	0.932	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Beryllium	0.561	0.0186	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Cadmium	0.0873 J	0.0186	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Chromium	7	0.186	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Cobalt	4	0.0559	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Copper	7 J	0.0615	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Iron	11,500	61.5	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Lead	11	0.0932	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Manganese	180	0.186	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Molybdenum	0 J	0.0746	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Nickel	6	0.0932	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	EPA 901.1M	Radium-226	24.3	0.368	pCi/g
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Selenium	4	0.336	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Silver	0.332 J	0.105	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Thallium	0.131 U	0.131	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Uranium	10.3	0.0123	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Vanadium	25	0.28	mg/kg
32	S3233-SS55-01-111822	11/18/2022	35.48979	-108.03237	0	6	SW6020A	Zinc	29	0.746	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Aluminum	12,000	45.3	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Antimony	0.329 UJ	0.329	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Arsenic	4.5	0.337	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Barium	209	0.996	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Beryllium	0.649	0.0199	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Cadmium	0.121 J	0.0199	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Chromium	9	0.199	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Cobalt	5	0.0598	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Copper	8 J	0.0657	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Iron	13,600	65.7	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Lead	11	0.0996	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Manganese	206	1.99	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Molybdenum	0 J	0.0797	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Nickel	7	0.0996	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	EPA 901.1M	Radium-226	1.43	0.108	pCi/g
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Selenium	1 J	0.359	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Silver	0.265 J	0.0996	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Thallium	0.155 J	0.139	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Uranium	0.99	0.0131	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Vanadium	21	0.299	mg/kg
32	S3233-SS56-01-111822	11/18/2022	35.489415	-108.03284	0	6	SW6020A	Zinc	35	0.797	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Aluminum	8,300	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Arsenic	2.5	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Barium	41	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Beryllium	0.36	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Chromium	2	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Cobalt	2	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Copper	3	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Iron	8,700	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Lead	4	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Manganese	76	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Nickel	3	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Selenium	12	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Uranium	-- U	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Vanadium	23	--	mg/kg
33	33-01-31-181103-M	11/3/2018	35.48991	-108.0167	0	18	--	Zinc	11	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Aluminum	22,000	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Arsenic	5.5	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Barium	81	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Beryllium	0.92	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Chromium	11	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Cobalt	6	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Copper	11	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Iron	24,000	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Lead	7	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Manganese	170	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Nickel	13	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Selenium	3	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Uranium	-- U	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Vanadium	30	--	mg/kg
33	33-02-31-181103-M	11/3/2018	35.49083	-108.01659	0	18	--	Zinc	50	--	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Aluminum	5,440	4.16	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Antimony	0.326 U	0.326	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Arsenic	2.18	0.309	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Barium	27	0.0914	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Beryllium	0.257	0.0183	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Cadmium	0.0207 J	0.0183	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Chromium	2 J	0.183	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Cobalt	2	0.0549	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Copper	4	0.0603	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Iron	5,190	6.03	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Lead	6	0.0914	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Manganese	73	0.183	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Molybdenum	1 J	0.0731	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Nickel	2	0.0914	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	EPA 901.1M	Radium-226	17.2	0.158	pCi/g
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Selenium	8	0.329	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Silver	0.0989 UJ	0.0989	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Thallium	0.128 U	0.128	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Uranium	47	0.0121	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Vanadium	24 J	0.274	mg/kg
33	S3233-SB13-0612-111522	11/15/2022	35.490506	-108.01681	6	12	SW6020A	Zinc	11	0.731	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Aluminum	18,100	51	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Antimony	0.36 U	0.36	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Arsenic	7.86	0.379	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Barium	78	0.112	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Beryllium	0.945	0.0224	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Cadmium	0.295	0.0224	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Chromium	16 J	0.224	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Cobalt	9	0.0672	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Copper	18	0.0739	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Iron	25,700	73.9	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Lead	19	0.112	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Manganese	232	2.24	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Molybdenum	2 J	0.0896	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Nickel	19	0.112	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	EPA 901.1M	Radium-226	1.63	0.0969	pCi/g
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Selenium	2	0.403	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Silver	0.545 UJ	0.545	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Thallium	0.543	0.157	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Uranium	1.28	0.0148	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Vanadium	33 J	0.336	mg/kg
33	S3233-SS01-01-111522	11/15/2022	35.492066	-108.014	0	6	SW6020A	Zinc	73	0.896	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Aluminum	17,500	45.3	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Antimony	0.364 U	0.364	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Arsenic	7.32	0.337	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Barium	76	0.0997	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Beryllium	0.933	0.0199	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Cadmium	0.282	0.0199	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Chromium	15 J	0.199	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Cobalt	8	0.0598	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Copper	16	0.0658	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Iron	23,600	65.8	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Lead	17	0.0997	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Manganese	208	1.99	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Molybdenum	2 J	0.0797	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Nickel	18	0.0997	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	EPA 901.1M	Radium-226	1.61	0.165	pCi/g
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Selenium	2	0.359	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Silver	0.552 UJ	0.552	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Thallium	0.512	0.14	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Uranium	1.19	0.0132	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Vanadium	31 J	0.299	mg/kg
33	S3233-SS02-01-111522	11/15/2022	35.492066	-108.01541	0	6	SW6020A	Zinc	67	0.797	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Aluminum	27,000	51.9	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Antimony	0.324 U	0.324	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Arsenic	8.95	0.386	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Barium	106	0.114	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Beryllium	1.19	0.0228	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Cadmium	0.333	0.0228	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Chromium	21.7 J	0.228	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Cobalt	10.4	0.0684	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Copper	20	0.0753	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Iron	31,500	75.3	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Lead	22.2	0.114	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Manganese	301	2.28	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Molybdenum	1.86 J	0.0913	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Nickel	22.8	0.114	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	EPA 901.1M	Radium-226	1.65	0.124	pCi/g
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Selenium	2	0.411	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Silver	0.491 UJ	0.491	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Thallium	0.645	0.16	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Uranium	1.61	0.0151	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Vanadium	44 J	0.342	mg/kg
33	S3233-SS03-01-111522	11/15/2022	35.492057	-108.01602	0	6	SW6020A	Zinc	86	0.913	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Aluminum	17,600	51.8	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Antimony	0.396 U	0.396	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Arsenic	6.87	0.385	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Barium	78	0.114	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Beryllium	0.867	0.0228	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Cadmium	0.191 J	0.0228	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Chromium	15 J	0.228	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Cobalt	8	0.0683	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Copper	15	0.0751	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Iron	23,900	75.1	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Lead	17	0.114	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Manganese	208	0.228	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Molybdenum	1 J	0.091	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Nickel	16	0.114	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	EPA 901.1M	Radium-226	2	0.114	pCi/g
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Selenium	2	0.41	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Silver	0.599 UJ	0.599	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Thallium	0.403 J	0.159	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Uranium	1.41	0.015	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Vanadium	27 J	0.341	mg/kg
33	S3233-SS05-01-111522	11/15/2022	35.491696	-108.01576	0	6	SW6020A	Zinc	64	0.91	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Aluminum	22,900	48.9	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Antimony	0.338 U	0.338	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Arsenic	7.4	0.363	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Barium	99	0.107	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Beryllium	0.991	0.0215	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Cadmium	0.236	0.0215	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Chromium	18 J	0.215	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Cobalt	9	0.0645	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Copper	17	0.0709	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Iron	27,000	70.9	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Lead	19	0.107	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Manganese	263	2.15	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Molybdenum	1 J	0.0859	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Nickel	18	0.107	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	EPA 901.1M	Radium-226	2.1	0.133	pCi/g

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Selenium	2	0.387	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Silver	0.512 UJ	0.512	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Thallium	0.483	0.15	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Uranium	2.52	0.0142	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Vanadium	34 J	0.322	mg/kg
33	S3233-SS06-01-111522	11/15/2022	35.491526	-108.01629	0	6	SW6020A	Zinc	72	0.859	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Aluminum	19,800	46.7	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Antimony	0.359 U	0.359	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Arsenic	6.84	0.347	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Barium	96	0.103	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Beryllium	0.89	0.0205	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Cadmium	0.207	0.0205	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Chromium	16 J	0.205	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Cobalt	8	0.0616	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Copper	16	0.0678	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Iron	23,400	67.8	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Lead	18	0.103	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Manganese	234	2.05	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Molybdenum	1 J	0.0821	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Nickel	16	0.103	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	EPA 901.1M	Radium-226	15.6	0.208	pCi/g
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Selenium	5	0.37	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Silver	0.544 UJ	0.544	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Thallium	0.418	0.144	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Uranium	11.6	0.0136	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Vanadium	35 J	0.308	mg/kg
33	S3233-SS08-01-111522	11/15/2022	35.491225	-108.0165	0	6	SW6020A	Zinc	95.6	0.821	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Aluminum	21,100	49.3	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Antimony	0.324 U	0.324	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Arsenic	7.67	0.366	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Barium	116	0.108	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Beryllium	1.01	0.0217	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Cadmium	0.223	0.0217	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Chromium	17 J	0.217	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Cobalt	9	0.065	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Copper	18	0.0715	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Iron	26,200	71.5	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Lead	20	0.108	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Manganese	259	2.17	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Molybdenum	1 J	0.0867	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Nickel	18	0.108	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	EPA 901.1M	Radium-226	14.8	0.144	pCi/g
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Selenium	5	0.39	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Silver	0.49 UJ	0.49	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Thallium	0.44	0.152	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Uranium	8.21	0.0143	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Vanadium	35 J	0.325	mg/kg
33	S3233-SS09-01-111522	11/15/2022	35.491077	-108.01673	0	6	SW6020A	Zinc	73	0.867	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Aluminum	19,500	50	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Antimony	0.361 U	0.361	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Arsenic	7.14	0.371	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Barium	101	0.11	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Beryllium	0.895	0.022	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Cadmium	0.181 J	0.022	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Chromium	16 J	0.22	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Cobalt	9	0.0659	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Copper	17	0.0725	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Iron	25,100	72.5	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Lead	17	0.11	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Manganese	260	2.2	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Molybdenum	1 J	0.0879	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Nickel	17	0.11	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	EPA 901.1M	Radium-226	1.69	0.136	pCi/g
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Selenium	2	0.396	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Silver	0.547 UJ	0.547	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Thallium	0.395 J	0.154	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Uranium	1.33	0.0145	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Vanadium	31 J	0.33	mg/kg
33	S3233-SS10-01-111522	11/15/2022	35.490915	-108.0165	0	6	SW6020A	Zinc	66	0.879	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Aluminum	19,200	50	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Antimony	0.356 U	0.356	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Arsenic	6.89	0.371	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Barium	99	0.11	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Beryllium	0.866	0.022	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Cadmium	0.174 J	0.022	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Chromium	15 J	0.22	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Cobalt	9	0.0659	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Copper	15	0.0725	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Iron	25,100	72.5	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Lead	17	0.11	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Manganese	267	2.2	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Molybdenum	1 J	0.0879	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Nickel	17	0.11	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	EPA 901.1M	Radium-226	1.65	0.101	pCi/g
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Selenium	2	0.396	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Silver	0.539 UJ	0.539	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Thallium	0.376 J	0.154	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Uranium	1.24	0.0145	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Vanadium	29 J	0.33	mg/kg
33	S3233-SS12-01-111522	11/15/2022	35.490632	-108.0164	0	6	SW6020A	Zinc	64	0.879	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Aluminum	9,010	4.39	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Antimony	0.636 J	0.356	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Arsenic	4.58	0.326	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Barium	81	0.0965	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Beryllium	0.498	0.0193	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Cadmium	0.061 J	0.0193	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Chromium	5 J	0.193	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Cobalt	3	0.0579	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Copper	7	0.0637	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Iron	9,060	6.37	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Lead	10	0.0965	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Manganese	194	1.93	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Molybdenum	1 J	0.0772	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Nickel	5	0.0965	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	EPA 901.1M	Radium-226	34.3	0.215	pCi/g
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Selenium	17	0.347	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Silver	0.539 UJ	0.539	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Thallium	0.2 J	0.135	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Uranium	78	0.0127	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Vanadium	30 J	0.289	mg/kg
33	S3233-SS13-01-111522	11/15/2022	35.490506	-108.01681	0	6	SW6020A	Zinc	21	0.772	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Aluminum	18,400	51.5	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Antimony	0.638 J	0.372	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Arsenic	6.83	0.382	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Barium	100	0.113	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Beryllium	0.854	0.0226	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Cadmium	0.17 J	0.0226	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Chromium	15 J	0.226	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Cobalt	8	0.0679	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Copper	15	0.0746	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Iron	23,500	74.6	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Lead	17	0.113	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Manganese	238	2.26	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Molybdenum	1 J	0.0905	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Nickel	16	0.113	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	EPA 901.1M	Radium-226	2.45	0.144	pCi/g
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Selenium	2	0.407	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Silver	0.563 UJ	0.563	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Thallium	0.388 J	0.158	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Uranium	1.57	0.0149	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Vanadium	30 J	0.339	mg/kg
33	S3233-SS14-01-111522	11/15/2022	35.49033	-108.01633	0	6	SW6020A	Zinc	70	0.905	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Aluminum	16,600	49.4	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Antimony	0.371 U	0.371	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Arsenic	6.33	0.367	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Barium	92	0.109	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Beryllium	0.807	0.0217	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Cadmium	0.183 J	0.0217	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Chromium	13 J	0.217	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Cobalt	8	0.0651	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Copper	14	0.0716	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Iron	21,900	71.6	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Lead	16	0.109	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Manganese	235	2.17	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Molybdenum	1 J	0.0868	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Nickel	15	0.109	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	EPA 901.1M	Radium-226	6.98	0.155	pCi/g
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Selenium	11	0.391	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Silver	0.562 UJ	0.562	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Thallium	0.364 J	0.152	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Uranium	6.31	0.0143	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Vanadium	30 J	0.326	mg/kg
33	S3233-SS15-01-111522	11/15/2022	35.490273	-108.01657	0	6	SW6020A	Zinc	58	0.868	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Aluminum	4,650	4.04	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Antimony	0.51 J	0.332	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Arsenic	1.29	0.3	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Barium	63	0.0889	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Beryllium	0.273	0.0178	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Cadmium	0.0224 J	0.0178	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Chromium	1 J	0.178	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Cobalt	1	0.0533	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Copper	3	0.0587	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Iron	4,570	5.87	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Lead	7	0.0889	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Manganese	109	0.178	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Molybdenum	0 UJ	0.0711	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Nickel	1	0.0889	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	EPA 901.1M	Radium-226	14.6	0.148	pCi/g
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Selenium	14	0.32	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Silver	0.101 UJ	0.101	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Thallium	0.124 U	0.124	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Uranium	12.6	0.0117	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Vanadium	17 J	0.267	mg/kg
33	S3233-SS17-01-111522	11/15/2022	35.490039	-108.0168	0	6	SW6020A	Zinc	10	0.711	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Aluminum	19,200	48.5	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Antimony	0.378 J	0.356	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Arsenic	6.83	0.36	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Barium	89	0.107	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Beryllium	0.873	0.0213	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Cadmium	0.179 J	0.0213	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Chromium	16 J	0.213	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Cobalt	8	0.064	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Copper	15	0.0704	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Iron	23,500	70.4	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Lead	17	0.107	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Manganese	224	2.13	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Molybdenum	1 J	0.0853	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Nickel	16	0.107	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	EPA 901.1M	Radium-226	10.9	0.165	pCi/g
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Selenium	9	0.384	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Silver	0.539 UJ	0.539	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Thallium	0.419 J	0.149	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Uranium	25.1	0.0141	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Vanadium	34 J	0.32	mg/kg
33	S3233-SS18-01-111522	11/15/2022	35.489909	-108.01645	0	6	SW6020A	Zinc	62	0.853	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Aluminum	14,300	44.3	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Antimony	0.53 J	0.308	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Arsenic	5.29	0.329	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Barium	131	0.0974	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Beryllium	0.653	0.0195	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Cadmium	0.134 J	0.0195	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Chromium	11 J	0.195	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Cobalt	5	0.0585	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Copper	9	0.0643	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Iron	17,200	64.3	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Lead	12	0.0974	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Manganese	259	1.95	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Molybdenum	0 J	0.078	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Nickel	11	0.0974	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	EPA 901.1M	Radium-226	2.25	0.0847	pCi/g
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Selenium	1	0.351	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Silver	0.467 UJ	0.467	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Thallium	0.21 J	0.136	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Uranium	1.99	0.0129	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Vanadium	25 J	0.292	mg/kg
33	S3233-SS19-01-111522	11/15/2022	35.489633	-108.01689	0	6	SW6020A	Zinc	40	0.78	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Aluminum	19,200	48.4	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Antimony	0.377 U	0.377	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Arsenic	6.49	0.359	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Barium	104	0.106	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Beryllium	0.893	0.0213	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Cadmium	0.175 J	0.0213	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Chromium	15 J	0.213	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Cobalt	7	0.0638	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Copper	15 J	0.0702	mg/kg

Attachment C-1. Data Used in the Risk Assessment

Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Iron	22,500	70.2	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Lead	16 J	0.106	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Manganese	211	0.213	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Molybdenum	1 J	0.0851	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Nickel	15 J	0.106	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	EPA 901.1M	Radium-226	2.56	0.137	pCi/g
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Selenium	2	0.383	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Silver	0.572 U	0.572	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Thallium	0.378 J	0.149	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Uranium	2.74	0.014	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Vanadium	30	0.319	mg/kg
33	S3233-SS28-01-111722	11/17/2022	35.491435	-108.01696	0	6	SW6020A	Zinc	62	0.851	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Aluminum	18,700	48.3	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Antimony	0.379 U	0.379	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Arsenic	6.97	0.359	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Barium	85	0.106	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Beryllium	0.909	0.0212	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Cadmium	0.231	0.0212	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Chromium	15 J	0.212	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Cobalt	8	0.0637	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Copper	16 J	0.0701	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Iron	23,500	70.1	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Lead	17 J	0.106	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Manganese	209	0.212	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Molybdenum	1 J	0.085	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Nickel	16 J	0.106	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	EPA 901.1M	Radium-226	2.04	0.183	pCi/g
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Selenium	2	0.382	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Silver	0.574 U	0.574	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Thallium	0.433	0.149	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Uranium	1.76	0.014	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Vanadium	30	0.319	mg/kg
33	S3233-SS29-01-111722	11/17/2022	35.491764	-108.01664	0	6	SW6020A	Zinc	65	0.85	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Aluminum	5,030	4.29	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Antimony	0.309 UJ	0.309	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Arsenic	1.71	0.319	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Barium	7	0.0942	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Beryllium	0.285	0.0188	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Cadmium	0.0188 U	0.0188	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Chromium	2	0.188	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Cobalt	3	0.0565	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Copper	3 J	0.0622	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Iron	6,450	6.22	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Lead	4	0.0942	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Manganese	94	0.188	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Molybdenum	0 UJ	0.0754	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Nickel	2	0.0942	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	EPA 901.1M	Radium-226	22.6	0.262	pCi/g
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Selenium	8	0.339	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Silver	0.158 J	0.0936	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Thallium	0.132 U	0.132	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Uranium	11.6	0.0124	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Vanadium	23	0.283	mg/kg
33	S3233-SS57-01-111822	11/18/2022	35.48991	-108.01666	0	6	SW6020A	Zinc	7	0.754	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Aluminum	4,360	4.02	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Antimony	0.327 UJ	0.327	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Arsenic	1.4	0.299	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Barium	6	0.0883	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Beryllium	0.231	0.0177	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Cadmium	0.0177 U	0.0177	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Chromium	2	0.177	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Cobalt	1	0.053	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Copper	2 J	0.0583	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Iron	4,310	5.83	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Lead	6	0.0883	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Manganese	110	0.177	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Molybdenum	0 JJ	0.0707	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Nickel	1	0.0883	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	EPA 901.1M	Radium-226	30.3	0.363	pCi/g
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Selenium	102	3.18	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Silver	0.0991 U	0.0991	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Thallium	0.134 J	0.124	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Uranium	30.2	0.0117	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Vanadium	60	0.265	mg/kg
33	S3233-SS58-01-111822	11/18/2022	35.490005	-108.01644	0	6	SW6020A	Zinc	5	0.707	mg/kg

Attachment C-1. Data Used in the Risk Assessment

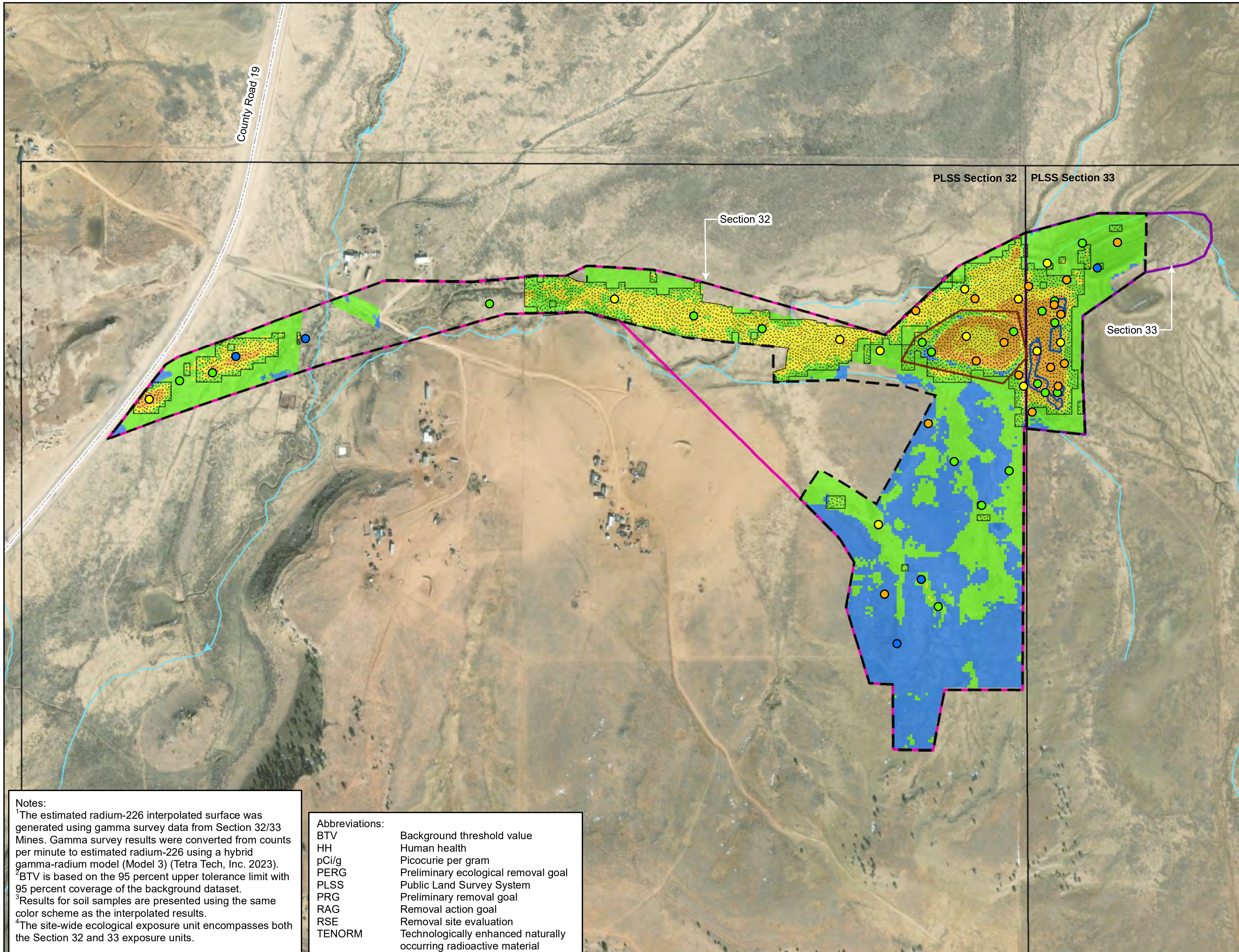
Exposure Unit	Sample Number	Sample Date	Latitude	Longitude	Sample Top Depth (inches bgs)	Sample Bottom Depth (inches bgs)	Analytical Method	Analyte	Result and Qualifier	MDL/ MDC	Units
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Aluminum	9,130	4.54	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Antimony	0.329 UJ	0.329	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Arsenic	4.44	0.337	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Barium	131	0.0998	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Beryllium	0.463	0.02	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Cadmium	0.0301 J	0.02	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Chromium	4	0.2	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Cobalt	3	0.0599	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Copper	5 J	0.0658	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Iron	11,200	65.8	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Lead	13	0.0998	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Manganese	215	2	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Molybdenum	0 J	0.0798	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Nickel	4	0.0998	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	EPA 901.1M	Radium-226	161	0.548	pCi/g
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Selenium	58	0.359	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Silver	0.458 J	0.0998	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Thallium	0.216 J	0.14	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Uranium	251	0.0132	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Vanadium	92	0.299	mg/kg
33	S3233-SS59-01-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Zinc	14	0.798	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Aluminum	9,400	4.48	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Antimony	0.338 UJ	0.338	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Arsenic	4.84	0.333	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Barium	84	0.0985	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Beryllium	0.478	0.0197	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Cadmium	0.0414 J	0.0197	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Chromium	4	0.197	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Cobalt	3 J	0.0591	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Copper	5 J	0.065	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Iron	12,400	65	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Lead	14	0.0985	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Manganese	211	1.97	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Molybdenum	0 J	0.0788	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Nickel	4	0.0985	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	EPA 901.1M	Radium-226	148	0.806	pCi/g
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Selenium	57 J	0.355	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Silver	0.293 J	0.102	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Thallium	0.236 J	0.138	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Uranium	225	0.013	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Vanadium	86 J	0.296	mg/kg
33	S3233-SS59-02-111822	11/18/2022	35.491172	-108.01651	0	6	SW6020A	Zinc	16 J	0.788	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Aluminum	14,000	45.3	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Antimony	0.353 UJ	0.353	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Arsenic	13.8	0.337	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Barium	23	0.0996	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Beryllium	1.08	0.0199	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Cadmium	0.0199 U	0.0199	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Chromium	4	0.199	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Cobalt	2 J	0.0598	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Copper	10 J	0.0657	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Iron	6,350	6.57	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Lead	11	0.0996	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Manganese	61	0.199	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Molybdenum	0 J	0.0797	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Nickel	4	0.0996	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	EPA 901.1M	Radium-226	11.3	0.173	pCi/g
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Selenium	7 J	0.359	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Silver	0.152 J	0.107	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Thallium	0.171 J	0.139	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Uranium	23.4	0.0131	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Vanadium	8 J	0.299	mg/kg
33	S3233-SS60-01-111822	11/18/2022	35.491031	-108.01639	0	6	SW6020A	Zinc	9 J	0.797	mg/kg

Notes:

--	Not reported
bgs	Below ground surface
J	Estimated concentration
JJ	Estimated concentration
MDC	Minimum detectable concentration
MDL	Method detection limit
mg/kg	Milligram per kilogram
pCi/g	Picocurie per gram
U	Not detected
UJ	Not detected; detection limit is estimated

APPENDIX D

CONTAMINANT DISTRIBUTION



Interpolated Estimated Radium-226 (pCi/g)[1]

≤ 0.050	≤ HH PRG (Navajo Resident)
0.050 - 1.20	HH PRG (Navajo Resident) - HH PRG (Private Resident)
1.20 - 1.90	HH PRG (Private Resident) - RAG (BTV)[2]
1.90 - 3.80	RAG (BTV) - 2 x RAG (BTV)
3.80 - 40.0	2 x RAG (BTV) - PERG
> 40.0	> PERG

Soil Sample Locations[3]

- Surface Soil
- TENORM Boundary
- Radium-226 Removal Action Extent

Exposure Unit[4]

- Section 32
- Section 33

Site Features

- Waste Pile
- Waste Stockpile Footprint
- PLSS Section Boundary / RSE Survey Area
- Drainage

1 inch = 500 feet

1:6,000

500 250 0 500 Feet

N W E S

Notes:

[1]The estimated radium-226 interpolated surface was generated using gamma survey data from Section 32/33 Mines. Gamma survey results were converted from counts per minute to estimated radium-226 using a hybrid gamma-radium model (Model 3) (Tetra Tech, Inc. 2023).

[2]BTV is based on the 95 percent upper tolerance limit with 95 percent coverage of the background dataset.

[3]Results for soil samples are presented using the same color scheme as the interpolated results.

[4]The site-wide ecological exposure unit encompasses both the Section 32 and 33 exposure units.

Abbreviations:

BTV	Background threshold value
HH	Human health
pCi/g	Picocurie per gram
PERG	Preliminary ecological removal goal
PLSS	Public Land Survey System
PRG	Preliminary removal goal
RAG	Removal action goal
RSE	Removal site evaluation
TENORM	Technologically enhanced naturally occurring radioactive material

ESTIMATED RADIUM-226 AND RADIUM-226 RESULTS WITHIN THE TENORM BOUNDARY

Prepared For: U.S. EPA Region 9

Prepared By: TETRA TECH, 1999 Harrison Street, Suite 500, Oakland, CA 94612

Task Order No.: 0003

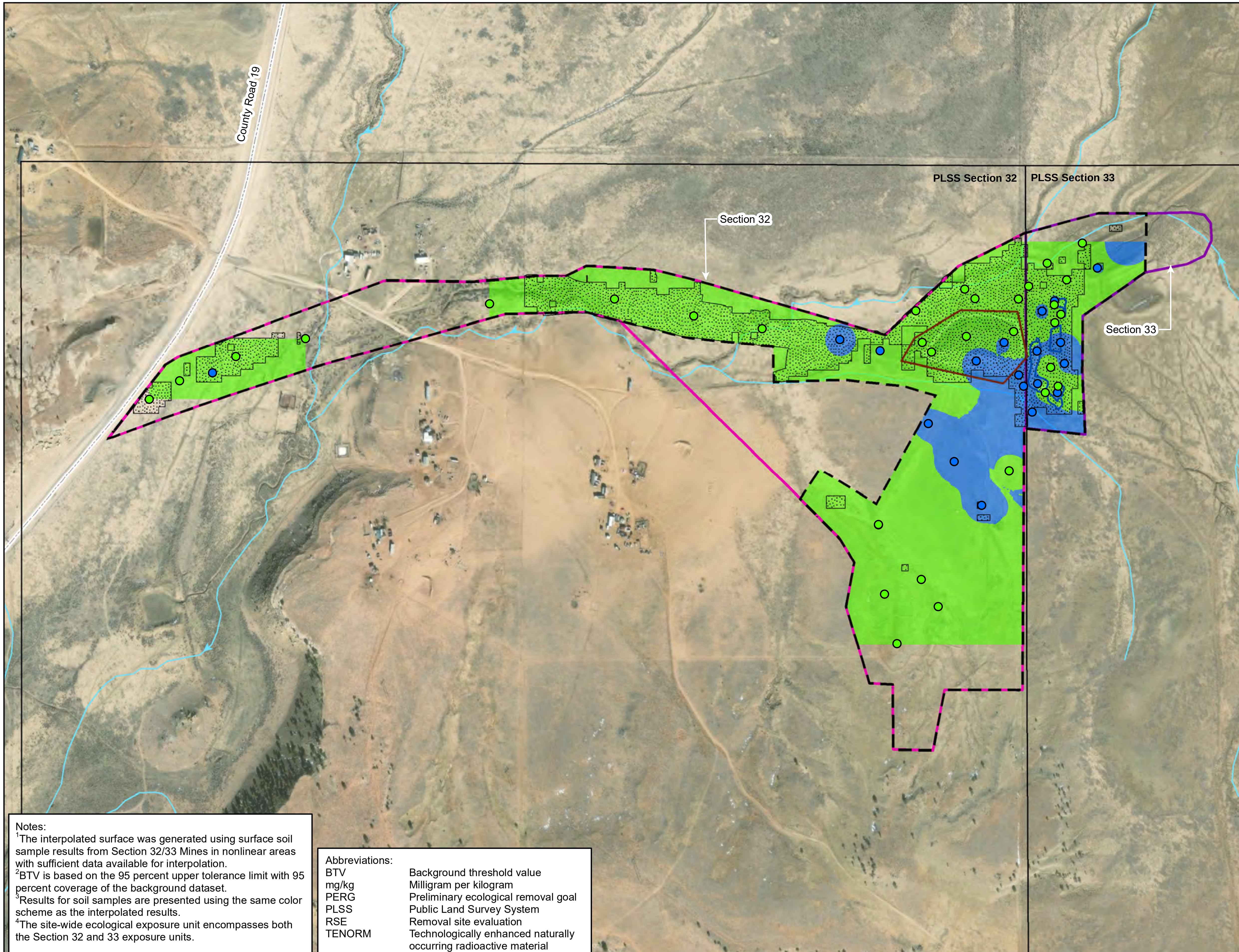
Contract No.: 68HE0923D0002

Location: NAVAJO NATION

Date: 3/4/2024

Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse

Figure No.: D-1



Interpolated Barium (mg/kg)[1]

- ≤ 104 — ≤ BTV[2]
- 104 - 1,400 — BTV - PERG
- >1,400 — > PERG

Soil Sample Locations[3]

- Surface Soil
- TENORM Boundary
- Radium-226 Removal Action Extent

Exposure Unit[4]

- Section 32
- Section 33

Site Features

- Waste Pile
- Waste Stockpile Footprint
- PLSS Section Boundary / RSE Survey Area
- Drainage

1 inch = 500 feet

1:6,000

N W E S

500 250 0 500 Feet

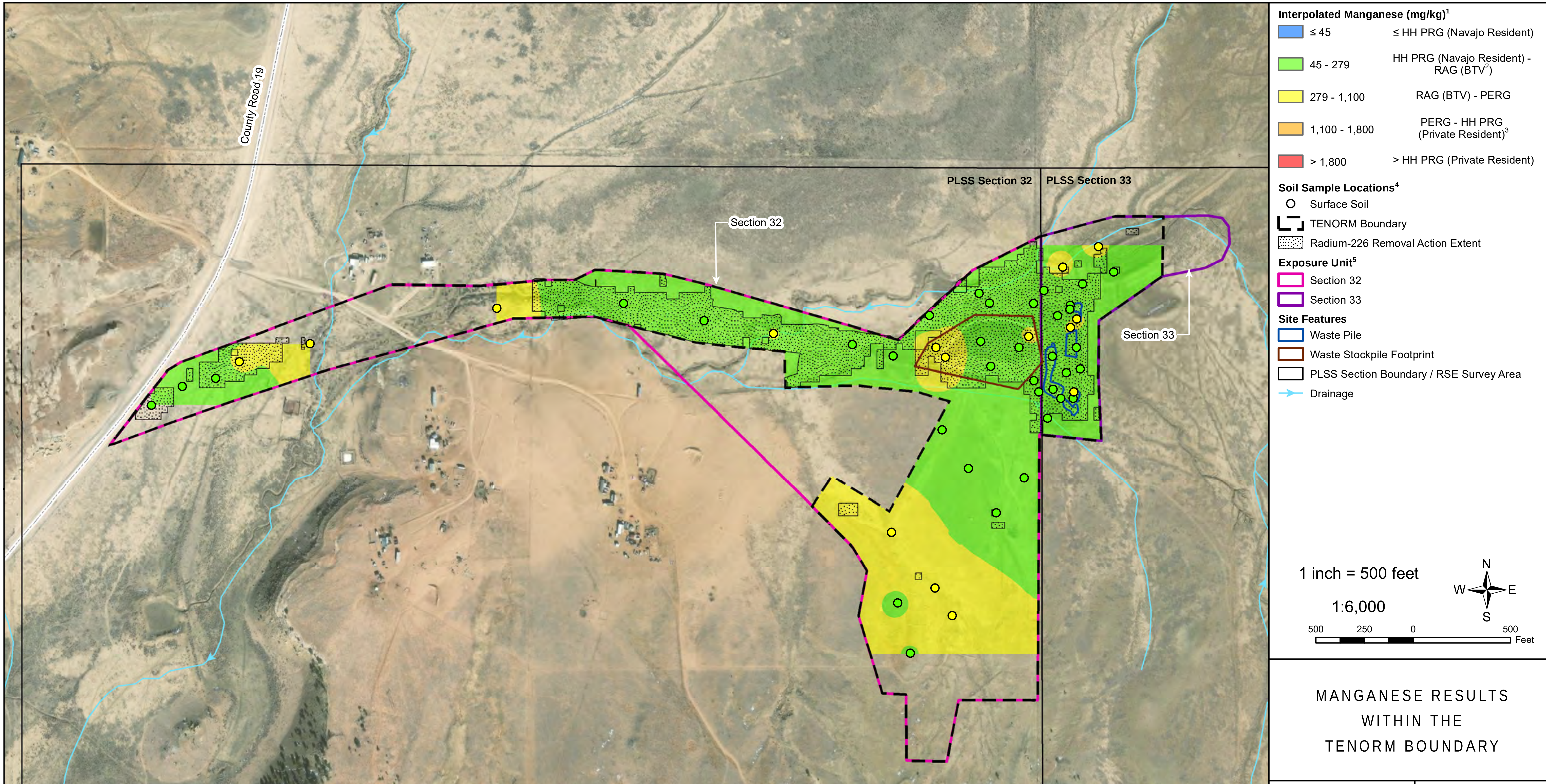
Notes:
[1]The interpolated surface was generated using surface soil sample results from Section 32/33 Mines in nonlinear areas with sufficient data available for interpolation.
[2]BTV is based on the 95 percent upper tolerance limit with 95 percent coverage of the background dataset.
[3]Results for soil samples are presented using the same color scheme as the interpolated results.
[4]The site-wide ecological exposure unit encompasses both the Section 32 and 33 exposure units.

Abbreviations:

BTV	Background threshold value
mg/kg	Milligram per kilogram
PERG	Preliminary ecological removal goal
PLSS	Public Land Survey System
RSE	Removal site evaluation
TENORM	Technologically enhanced naturally occurring radioactive material

BARIUM RESULTS WITHIN THE TENORM BOUNDARY

Prepared For: U.S. EPA Region 9	Prepared By: TETRA TECH, 1999 Harrison Street, Suite 500, Oakland, CA 94612
Task Order No.: 0003	Contract No.: 68HE0923D0002
Location: NAVAJO NATION	Date: 3/4/2024
Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse	Figure No.: D-2



Notes:
[1]The interpolated surface was generated using surface soil sample results from Section 32/33 Mines in nonlinear areas with sufficient data available for interpolation.
[2]BTV is based on the 95 percent upper tolerance limit with 95 percent coverage of the background dataset.
[3]Manganese was not identified as a candidate COC for the Section 33 Private Resident exposure scenario. The PRG for the private resident is provided for context.
[4]Results for soil samples are presented using the same color scheme as the interpolated results.
[5]The site-wide ecological exposure unit encompasses both the Section 32 and 33 exposure units.

Abbreviations:

BTV	Background threshold value
COC	Contaminant of concern
HH	Human health
mg/kg	Milligram per kilogram
PERG	Preliminary ecological removal goal
PLSS	Public Land Survey System
PRG	Preliminary removal goal
RAG	Removal action goal
RSE	Removal site evaluation
TENORM	Technologically enhanced naturally occurring radioactive material

MANGANESE RESULTS WITHIN THE TENORM BOUNDARY

Prepared For: U.S. EPA Region 9

Prepared By: TETRA TECH, 1999 Harrison Street, Suite 500, Oakland, CA 94612

Task Order No.: 0003

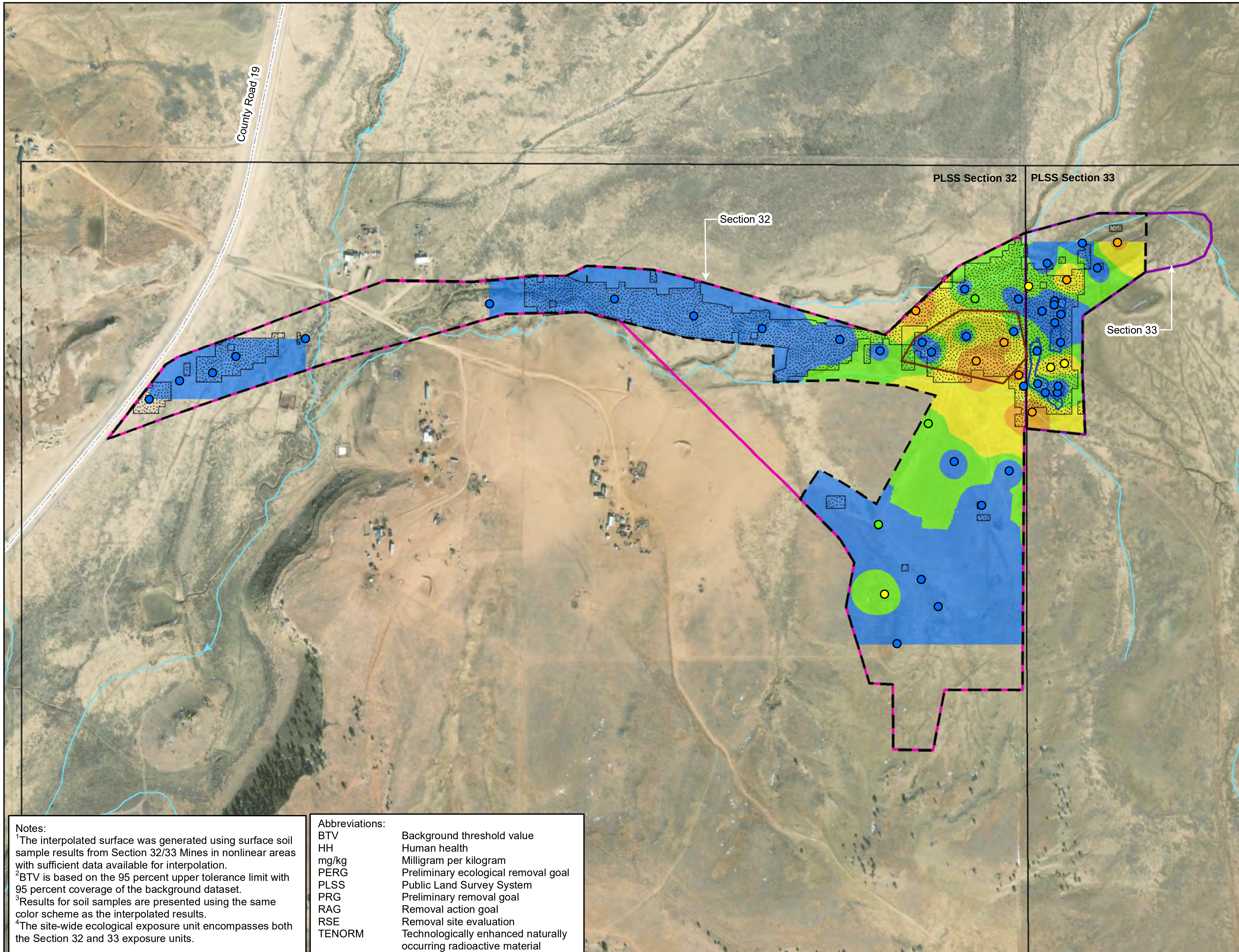
Contract No.: 68HE0923D0002

Location: NAVAJO NATION

Date: 3/4/2024

Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse

Figure No.: D-3



Notes:
[1]The interpolated surface was generated using surface soil sample results from Section 32/33 Mines in nonlinear areas with sufficient data available for interpolation.
[2]BTV is based on the 95 percent upper tolerance limit with 95 percent coverage of the background dataset.
[3]Results for soil samples are presented using the same color scheme as the interpolated results.
[4]The site-wide ecological exposure unit encompasses both the Section 32 and 33 exposure units.

Abbreviations:

BTV	Background threshold value
HH	Human health
mg/kg	Milligram per kilogram
PERG	Preliminary ecological removal goal
PLSS	Public Land Survey System
PRG	Preliminary removal goal
RAG	Removal action goal
RSE	Removal site evaluation
TENORM	Technologically enhanced naturally occurring radioactive material

SELENIUM RESULTS WITHIN THE TENORM BOUNDARY

Prepared For: U.S. EPA Region 9

Prepared By: TETRA TECH, 1999 Harrison Street, Suite 500, Oakland, CA 94612

Task Order No.: 0003

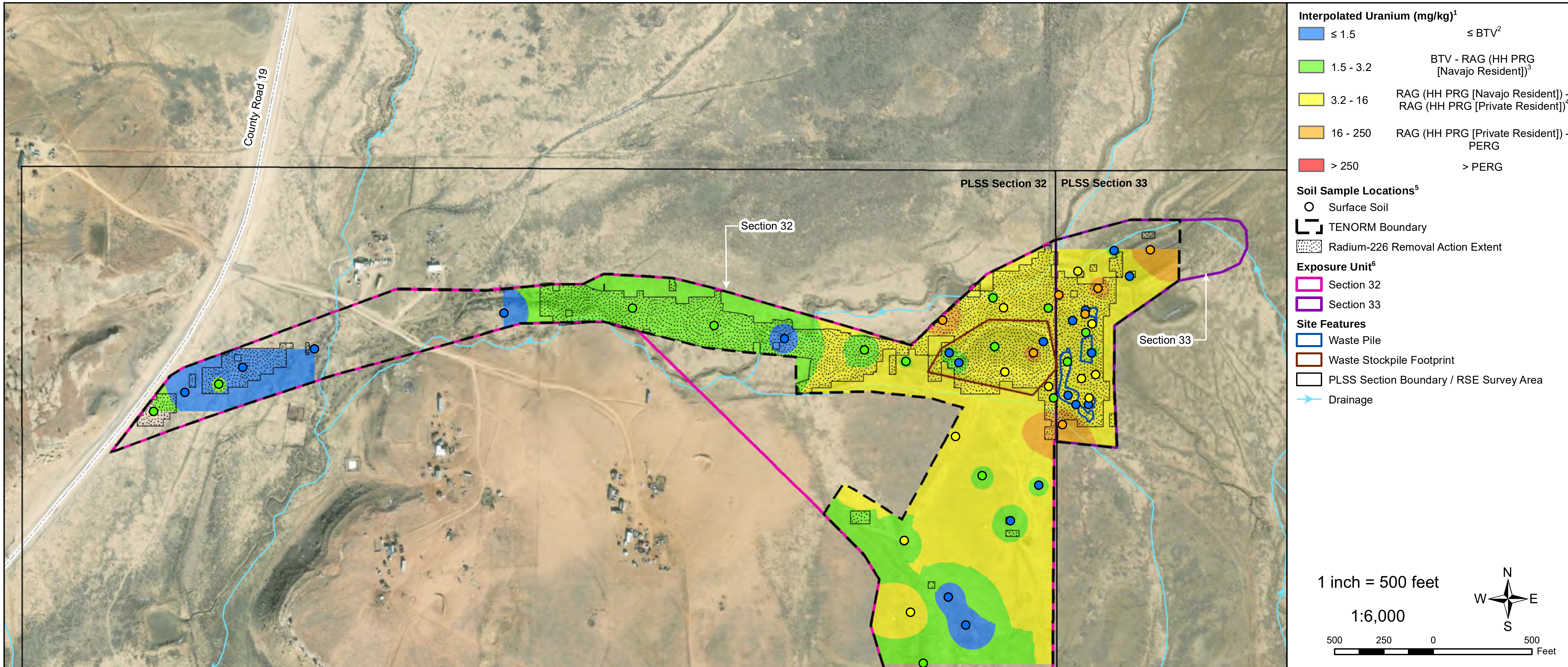
Contract No.: 68HE0923D0002

Location: NAVAJO NATION

Date: 3/4/2024

Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse

Figure No.: D-4



Notes:
[1]The interpolated surface was generated using surface soil sample results from Section 32/33 Mines in nonlinear areas with sufficient data available for interpolation.
[2]BTV is based on the 95 percent upper tolerance limit with 95 percent coverage of the background dataset.
[3]The RAG applies to Section 32 on the Navajo Nation.
[4]The RAG applies to Section 33 on private property.
[5]Results for soil samples are presented using the same color scheme as the interpolated results.
[6]The site-wide ecological exposure unit encompasses both the Section 32 and 33 exposure units.

Abbreviations:

BTV	Background threshold value
HH	Human health
mg/kg	Milligram per kilogram
PERG	Preliminary ecological removal goal
PLSS	Public Land Survey System
PRG	Preliminary removal goal
RAG	Removal action goal
RSE	Removal site evaluation
TENORM	Technologically enhanced naturally occurring radioactive material

URANIUM RESULTS WITHIN THE TENORM BOUNDARY

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Task Order No.: 0003

Contract No.: 68HE0923D0002

Location: NAVAJO NATION

Date: 3/4/2024

Coordinate System: NAD 1983 State Plane New Mexico West FIPS 3003 Feet Transverse

Figure No.: D-5

APPENDIX E

ENVIRONMENTAL METRICS

Table E-1. Environmental Metrics Assessment Summary

Alternative	Energy Use[1]	Air Pollutants[2]	Water Use[3]	Water Quality Impacts[4]	Ecosystem Impact[5]	Materials[6]	Overall Greenness Score[7]
Alternative 1: No Action	8	8	8	8	8	8	**48**
Alternative 2: Consolidate and Cap All Waste at Onsite Repository	5	5	4	4	5	5	**28**
Alternative 3: Dispose of All Mine Waste Off Site at Red Rocks Disposal Facility	3	3	2	3	4	6	**21**
Alternative 4: Dispose of All Mine Waste Off Site at a RCRA C or LLRW Facility	1	1	1	1	1	6	**11**

Notes:

A rating system of 1 through 8 is used where 8 is best and 1 is worst.

[1] Total energy use and percentage of renewable energy

[2] Air pollutants and greenhouse gas emissions

[3] Water use

[4] Impacts on water resources

[5] Protecting ecosystem services

[6] Materials management and waste reduction

[7] Overall greenneess score was calculated by summing the score in each of the six core elements.

LLRW Low-level radioactive waste

RCRA Resource Conservation and Recovery Act

Table E-2. Estimated Risk of Injuries and Fatalities and Greenhouse Gas Emissions from Onsite and Offsite Trucking

Alternative	Truckloads of Waste	Miles Round Trip to Transport Waste	Truckloads of Offsite Fill	Miles Round Trip to Import Fill and Cover	Water Truck Mileage	Total Miles	Estimated Injuries from Offsite Trucking[1]	Estimated Fatalities from Offsite Trucking[1]	Estimated Greenhouse Gas Emissions from Offsite Trucking[2] (metric tons CO_2e)
1: No Action	0	0	0	0	0	0	0	0	0
2: Consolidate and Cap All Mine Waste at Onsite Repository	3,855	2	450	15	945	15,405	0.0050	0.0002	0.0
3: Dispose of All Mine Waste Off Site at Red Rocks Disposal Facility	5,140	26	0	0	1,020	134,660	0.0436	0.0020	200
4: Dispose of All Mine Waste Off Site at a RCRA C or LLRW Facility	5,140	1,134	0	0	3,420	5,832,180	1.8896	0.0881	10,400

Notes:

1 A rate of 32.4 injuries and 1.51 fatalities per 100 million large truck miles traveled was calculated as shown below using data (2011 - 2020) from the National Center for Statistics and Analysis (2022).

Year	People Killed in Crashes Involving Large Trucks	Number of Large Trucks Involved in Injuries	Large-Truck Miles Traveled (millions)	Injury Rate per 100 Million Large-Truck-Miles Traveled	Fatality Rate per 100 Million Large-Truck-Miles Traveled
2011	3,633	62,534	267,594	23.37	1.36
2012	3,825	76,621	269,207	28.46	1.42
2013	3,921	73,089	275,017	26.58	1.43
2014	3,749	88,473	279,132	31.70	1.34
2015	4,075	87,307	279,844	31.20	1.46
2016	4,562	102,080	287,895	35.46	1.58
2017	4,805	106,733	297,593	35.87	1.61
2018	4,909	112,253	304,864	36.82	1.61
2019	5,033	118,527	300,050	39.50	1.68
2020	4,842	106,902	302,141	35.38	1.60

32.43 injuries per 100 million miles traveled

Average from 2011 - 2020 1.51 fatalities per 100 million miles traveled

2 Metric tons of CO_2e per large truck mile traveled was calculated as shown below using data and methods from the U.S. Environmental Protection Agency (2022) Greenhouse Gases Equivalencies Calculator. Carbon dioxide emissions per gallon of diesel fuel was obtained from the U.S. Energy Information Administration (2022). Mileage for combination trucks (Classification Types 8-13) was obtained from Federal Highway Administration (2018) highway statistics based on 2012 and 2013 data.

$$\frac{22.38 \text{ lb } CO_2/\text{gallon diesel fuel}}{2{,}205 \text{ lb } CO_2/\text{metric ton } CO_2} \times \frac{1\ CO_2e}{0.986\ CO_2} \times \frac{1}{5.8 \text{ miles/gallon}} = 0.001775 \ \frac{\text{metric tons } CO_2e}{\text{miles traveled}}$$

CO_2e Carbon dioxide equivalent

LLRW Low-level radioactive waste

RCRA Resource Conservation and Recovery Act

References:

Federal Highway Administration. 2018. "Annual Vehicle Distance Traveled in Miles and Related Data - 2013 by Highway Category and Vehicle Type: Table M-1." Revised May. https://www.fhwa.dot.gov/policyinformation/statistics/2013/vm1.cfm.

National Center for Statistics and Analysis. 2022. "Large Trucks: 2020 Data." Traffic Safety Facts. Report No. DOT HS 813 286. National Highway Traffic Safety Administration. April. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813286.

U.S. Energy Information Administration. 2022. "Frequently Asked Questions: How Much Carbon Dioxide Is Produced from U.S. Gasoline and Diesel Fuel Consumption?" Last updated May 10. https://www.eia.gov/tools/faqs/faq.php?id=307&t=11.

U.S. Environmental Protection Agency. 2022. "Greenhouse Gases Equivalencies Calculator - Calculations and References." Last updated June 23. https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references.

APPENDIX F

COST ESTIMATE

Table F-1. Alternative 2: Consolidate and Cap All Waste at Onsite Repository

Cost Estimate Summary

Site: Section 32/33 Mines
Location: Navajo Nation, New Mexico
Phase: Feasibility Study (-30% to +50%)
Base Year: 2023
Date: June 2023

Description: Alternative 2: Consolidate and Cap All Waste at Onsite Repository

Direct Capital Costs				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Field Overhead and Oversight Costs:				
Field Overhead and Oversight	4	MO	34,740	$139,000
Mobilization/Demobilization	2	EA	28,258	$56,500
Travel, Lodging and Per Diem	20	Ea Person per MO	5,505	$110,100
SUBTOTAL				**$306,000**
General Site Work Costs:				
Fence Construction/Repair - Equipment Storage Area	1,000	LF	$28.24	$28,200
Clearing and Grubbing	23	AC	$1,332	$31,100
Land Surveying	23	AC	$697	$16,300
New Access and Haul Road	1	Lump Sum	$112,270	$112,300
SUBTOTAL				**$187,900**
Earthwork Costs:				
Excavation of Mine Waste (excavate and load onto trucks)	67,854	BCY	$2.16	$146,700
Excavation of Mine Waste - Dozer (Assuming 25% of total volume)	16,963	BCY	$2.68	$45,500
Site Restoration	23	AC	$23,807	$556,000
Erosion and Sediment Control	23	AC-YR	$735	$17,200
Dust Control	59	Day	$5,931	$352,600
Soil Cap	8,745	CCY	$34.10	$298,200
Mirafi 160N/O Orange Nonwoven Fabric	8,745	SY	$1.81	$15,800
SUBTOTAL				**$1,432,000**
Transportation and Disposal Costs:				
Off-Site Disposal of Contaminated Soil	0	Ton	$0.00	$0
SUBTOTAL				**$0**
Total Direct Capital Costs (Rounded to Nearest $1,000)				**$1,926,000**

Indirect Capital Costs		
Description	**% of Direct Capital Costs**	**Total Cost**
Permitting/Planning/Institutional Controls	4%	$77,040
Professional/Techician - Project Management	5%	$96,300
Professional/Techician - Remedial Design	6%	$115,560
Professional/Techician - Construction Management	6%	$115,560
Total Indirect Capital Costs (Rounded to Nearest $1,000)		**$404,000**

Total Capital Costs		
Description	**% of Total Capital Costs**	**Total Cost**
Subtotal Capital Costs		$2,330,000
Contingency Allowance	15%	$349,500
Total Capital Cost (Rounded to Nearest $1,000)		**$2,680,000**

Maintenance Costs		
Description		**Total Cost**
Present Worth of 10, 30, and 100 Years of Maintenance Costs Depending on Activity (Rounded to the Nearest $1,000)	**7.0%**	$1,342,000
Contingency Allowance	**25%**	$335,500
Total Present Worth Maintenance Cost (Rounded to Nearest $1,000)		**$1,677,500**
Total Cost (Rounded to Nearest $1,000)		**$4,358,000**

Notes:
x1.25 Expansion Factor Used for all LCY quantities
x0.9 Compaction Factor Used for all CCY quantities

AC	Acre	LCY	Loose cubic yard
BCY	Bank cubic yard	LF	Linear foot
CCY	Compacted cubic yard	MO	Month
CF	Cubic foot	SY	Square yard
EA	Each	YR	Year

Table F-2. Alternative 3: Disposal of All Mine Waste Off Site at Red Rocks Disposal Facility

Cost Estimate Summary

Site: Section 32/33 Mines
Location: Navajo Nation, New Mexico
Phase: Feasibility Study (-30% to +50%)
Base Year: 2023
Date: June 2023

Description: Alternative 3: Dispose of All Mine Waste Off Site at Red Rocks Disposal Facility

Direct Capital Costs				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Field Overhead and Oversight Costs:				
Field Overhead and Oversight	4	MO	34,740	$139,000
Mobilization/Demobilization	2	EA	28,258	$56,500
Travel, Lodging and Per Diem	20	Ea Person per MO	5,505	$110,100
SUBTOTAL				**$306,000**
General Site Work Costs:				
Fence Construction/Repair - Equipment Storage Area	1,000	LF	$28.24	$28,200
Clearing and Grubbing	23	AC	$1,332	$31,100
Land Surveying	23	AC	$697	$16,300
New Access and Haul Road	1	Lump Sum	$211,218	$211,200
SUBTOTAL				**$286,800**
Earthwork Costs:				
Excavation of Mine Waste (excavate and load onto trucks)	67,854	BCY	$2.16	$146,700
Site Restoration	23	AC	$23,807	$556,000
Erosion and Sediment Control	23	AC-YR	$735	$17,200
Dust Control	11	Day	$5,931	$62,600
SUBTOTAL				**$783,000**
Transportation and Disposal Costs:				
Hauling to Red Rock Disposal Facility	84,817	LCY	$3.90	$330,800
Disposal Contaminated Soil - Red Rock Disposal Facility	84,817	LCY	$58.00	$4,919,400
Dust Control	54	Day	$5,931	$317,600
SUBTOTAL				**$5,567,800**
Total Direct Capital Costs (Rounded to Nearest $1,000)				**$6,944,000**
Indirect Capital Costs				
Description	**% of Direct Capital Costs**			**Total Cost**
Permitting/Planning/Institutional Controls	4%			$80,984
Professional/Technician - Project Management	5%			$101,230
Professional/Technician - Remedial Design	5%			$101,230
Professional/Technician - Construction Management.	6%			$121,476
Total Indirect Capital Costs (Rounded to Nearest $1,000)				**$405,000**
Total Capital Costs				
Description	**% of Total Capital Costs**			**Total Cost**
Subtotal Capital Costs				$7,349,000
Contingency Allowance	15%			$1,102,350
Total Capital Cost (Rounded to Nearest $1,000)				**$8,451,000**
Maintenance Costs				
Description				**Total Cost**
Present Worth of 10 and 30 Years of Maintenance Costs Depending on Activity (Rounded to the Nearest $1,000)	3.5%			$1,091,000
Contingency Allowance	25%			$272,800
Total Present Worth Maintenance Cost (Rounded to Nearest $1,000)				**$1,364,000**
Total Cost (Rounded to Nearest $1,000)				**$9,815,000**

Notes:
x1.25 Expansion Factor Used for all LCY quantities
x0.9 Compaction Factor Used for all CCY quantities

AC	Acre	LCY	Loose cubic yard
BCY	Bank cubic yard	LF	Linear foot
CCY	Compacted cubic yard	MO	Month
CF	Cubic foot	SY	Square yard
EA	Each	YR	Year

Table F-3. Alternative 4: Dispose of All Mine Waste Off Site at a Resource Conservation and Recovery Act C or Low-Level Radioactive Waste Facility

Cost Estimate Summary

Site: Section 32/33 Mines
Location: Navajo Nation, New Mexico
Phase: Feasibility Study (-30% to +50%)
Base Year: 2023
Date: June 2023

Description: Alternative 4: Dispose of All Mine Waste Off Site at a Resource Conservation and Recovery Act C or Low-Level Radioactive Waste Facility

Direct Capital Costs

Description	Quantity	Unit	Unit Cost	Total Cost
Field Overhead and Oversight Costs:				
Field Overhead and Oversight	12	MO	34,740	$416,900
Mobilization/Demobilization	4	EA	28,258	$113,000
Travel, Lodging and Per Diem	7	Ea Person per MO	5,505	$38,500
SUBTOTAL				**$568,000**
General Site Work Costs:				
Fence Construction/Repair - Equipment Storage Area	1,000	LF	$28.24	$28,200
Clearing and Grubbing	23	AC	$1,332	$31,100
Land Surveying	23	AC	$697	$16,300
New Access and Haul Road	1	Lump Sum	$211,218	$211,200
SUBTOTAL				**$76,000**
Earthwork Costs:				
Excavation of Mine Waste (excavate and load onto trucks)	67,854	BCY	$2.16	$146,700
Site Restoration	23	AC	$23,807	$556,000
Erosion and Sediment Control	47	AC-YR	$735	$34,300
Dust Control	11	Day	$5,931	$62,600
SUBTOTAL				**$800,000**
Transportation and Disposal Costs:				
Hauling to Deer Trail, CO	84,817	LCY	$180	$15,267,100
Disposal Contaminated Soil - Deer Trail, CO	84,817	LCY	$105	$8,905,800
Dust Control	214	Day	$5,931	$1,270,300
SUBTOTAL				**$25,443,200**
Total Direct Capital Costs (Rounded to Nearest $1,000)				**$26,887,000**

Indirect Capital Costs

Description	% of Direct Capital Costs	Total Cost
Permitting/Planning/Institutional Controls	4%	$719,248
Professional/Technician - Project Management	5%	$899,060
Professional/Technician - Remedial Design	5%	$899,060
Professional/Technician - Construction Management	6%	$1,078,872
Total Indirect Capital Costs (Rounded to Nearest $1,000)		**$3,596,000**

Total Capital Costs

Description	% of Total Capital Costs	Total Cost
Subtotal Capital Costs		$30,483,000
Contingency Allowance	15%	$4,572,450
Total Capital Cost (Rounded to Nearest $1,000)		**$35,055,000**

Maintenance Costs

Description		Total Cost
Present Worth of 10 and 30 Years of Maintenance Costs Depending on Activity (Rounded to the Nearest $1,000)	7.0%	$1,091,000
Contingency Allowance	25%	$272,800
Total Present Worth Maintenance Cost (Rounded to Nearest $1,000)		**$1,364,000**
Total Cost (Rounded to Nearest $1,000)		**$36,419,000**

Notes:
x1.25 Expansion Factor Used for all LCY quantities
x0.9 Compaction Factor Used for all CCY quantities

AC	Acre	LCY	Loose cubic yard
BCY	Bank cubic yard	LF	Linear foot
CCY	Compacted cubic yard	MO	Month
CF	Cubic foot	SY	Square yard
EA	Each	YR	Year