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DEPARTMENT OF ENERGY
Environmental Management Los Alamos Field Office (EM-LA)
Los Alamos, New Mexico 87544

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Waste Bureau

EMLA-23-BF94-2-1

February 13, 2023

Mr. Rick Shean
Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6313

Subject: Submittal of the Investigation Report for Solid Waste Management Unit 16-017(j)-99 in Upper Water Canyon Aggregate Area

Dear Mr. Shean:

Enclosed please find two hard copies with electronic files of the "Investigation Report for Solid Waste Management Unit 16-017(j)-99 in Upper Water Canyon Aggregate Area."

If you have any questions, please contact Brenda Bowlby at (360) 930-4353 (brenda.bowlby@em-la.doe.gov) or Cheryl Rodriguez at (505) 414-0450 (cheryl.rodriguez@em.doe.gov).

Sincerely,

ARTURO DURAN

Digitally signed by ARTURO DURAN
Date: 2023.02.09 07:07:21 -07'00'

Arturo Q. Duran
Compliance and Permitting Manager
U.S. Department of Energy
Environmental Management
Los Alamos Field Office

Enclosures:

1. Two hard copies with electronic files – Investigation Report for Solid Waste Management Unit 16-017(j)-99 in Upper Water Canyon Aggregate Area (EM2023-0033)

cc (letter with CD/DVD enclosure[s]):
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February 2023
EM2023-0033

Investigation Report for Solid Waste Management Unit 16-017(j)-99 in Upper Water Canyon Aggregate Area

N3B Los Alamos

EM2023-0033

Investigation Report for Solid Waste Management Unit 16-017(j)-99 in Upper Water Canyon Aggregate Area

February 2023

Responsible program director:

Brenda Bowlby		Acting Program Director	RCRA Remediation Program	1/30/23
Printed Name	Signature	Title	Organization	Date

Responsible N3B representative:

Troy Thomson	Troy Thomson	Program Manager	N3B Environmental Remediation Program	1/26/23
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Arturo Q. Duran	ARTURO DURAN Digitally signed by ARTURO DURAN Date: 2023.02.09 07:07:46 -07'00'	Compliance and Permitting Manager	Office of Quality and Regulatory Compliance	
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EXECUTIVE SUMMARY

This investigation report presents the investigation activities at one solid waste management unit (SWMU) in the Upper Water Canyon Aggregate Area at Los Alamos National Laboratory. SWMU 16-017(j)-99 is located in Technical Area 16. The objectives of this investigation are to define the nature and extent of contamination and, if defined, to determine whether the site poses a potential unacceptable risk to human health or the environment. This report presents the results of site characterization activities conducted during the 2021 investigation, as directed by the approved investigation work plan for the Upper Water Canyon Aggregate Area.

The 2021 investigation activities included collecting soil, sediment, and rock samples from the surface to a maximum depth of 10 ft below ground surface. Based on the evaluation of investigation results, the extent of contamination has been defined at the site. Human health and ecological risk-screening assessments were performed for the site. Based on the results of data evaluations presented in this investigation report, the U.S. Department of Energy Environmental Management Los Alamos Field Office and Newport News Nuclear BWXT-Los Alamos, LLC, recommend the following:

- Corrective action complete without controls for one site for which extent is defined and which poses no potential unacceptable human health risk under the residential scenario and no unacceptable ecological risk.

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1.0 INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) is a multidisciplinary research facility owned by the U.S. Department of Energy (DOE). The Laboratory is located in north-central New Mexico, approximately 60 mi northeast of Albuquerque and 20 mi northwest of Santa Fe. The Laboratory site covers approximately 36 mi^2 of the Pajarito Plateau, which consists of a series of fingerlike mesas separated by deep canyons that contain perennial and intermittent streams running from west to east. Mesa tops range in elevation from approximately 6200 ft to 7800 ft above mean sea level (amsl).

The DOE Environmental Management Los Alamos Field Office’s (EM-LA’s) mission is to safely, efficiently, and transparently complete the cleanup of legacy contamination and waste resulting from nuclear weapons development and government-sponsored nuclear research before 1999 at the Laboratory. EM-LA’s cleanup scope under the 2016 Compliance Order on Consent (Consent Order) with the New Mexico Environment Department (NMED) includes waste, soil, and groundwater remediation. The cleanup sites are designated as either solid waste management units (SWMUs) or areas of concern (AOCs). EM-LA’s cleanup contractor, Newport News Nuclear BWXT-Los Alamos, LLC (N3B), implements the Los Alamos Legacy Cleanup Contract.

This investigation report addresses one potentially contaminated site within the Upper Water Canyon Aggregate Area at the Laboratory. This site is potentially contaminated with hazardous chemicals. Corrective actions at the Laboratory are subject to the Consent Order. The Consent Order was issued pursuant to the New Mexico Hazardous Waste Act, New Mexico Statutes Annotated (NMSA) 1978 Section 74-4-10, and the New Mexico Solid Waste Act, NMSA 1978, Section 74 9 36(D). NMED, pursuant to the New Mexico Hazardous Waste Act, regulates cleanup of hazardous wastes and hazardous constituents.

1.1 General Site Information

The Upper Water Canyon Aggregate Area, located in the southwestern corner of the Laboratory on a broad mesa, lies at elevations between 7100 and 7700 ft amsl (Plate 1). The southern boundary is south of Water Canyon at the Laboratory boundary at NM 4. The mesa slopes eastward toward branches of Water Canyon and Cañon de Valle. The Upper Water Canyon Aggregate Area includes portions of Technical Area 11 (TA-11), TA-16, and TA-37 and consists of 166 SWMUs and AOCs. The Upper Water Canyon Aggregate Area sits primarily in TA-16 and crosses through the southern half of TA-11 and TA-37.

SWMU 16-017(j)-99 was investigated in advance of the rest of the Upper Water Canyon Aggregate Area because of Laboratory plans to build a fire station on or near the footprint of SWMU 16-017(j)-99 (Plate 1).

1.2 Purpose of the Investigation Report

One SWMU within the Upper Water Canyon Aggregate Area was addressed by the 2021 investigation because this site was potentially contaminated with hazardous chemicals, and final assessments of site contamination, associated risks, and recommendations for additional corrective actions were incomplete. The objectives of the 2021 investigation for the site were to (1) establish the nature and extent of contamination, (2) determine whether current site conditions pose a potential unacceptable risk to human health or the environment, and (3) assess whether any additional sampling and/or corrective actions are required.

All analytical data collected from the 2021 investigation activities are presented and evaluated in this report, along with decision-level data from previous investigations.

1.3 Document Organization

This report is organized into nine sections, including this introduction, with multiple supporting appendices. Section 2 provides details on the aggregate area site conditions (surface and subsurface). Section 3 provides an overview of the scope of the activities performed during implementation of the work plan. Section 4 describes the regulatory criteria used to evaluate potential risk to ecological and human receptors. Section 5 describes the data review methods. Section 6 presents an overview of the operational history of the site, historical releases, summaries of previous investigations, results of the field activities performed during the 2021 investigation, site contamination, evaluation of the nature and extent of contamination, and summaries of the results of the human health and ecological risk-screening assessments for SWMU 16-017(j)-99. Section 7 presents the conclusions of the nature and extent determinations and risk-screening assessments. Section 8 discusses recommendations based on applicable data and the risk-screening assessments. Section 9 includes a list of references cited and the map data sources used in all the figures and plates.

The appendices include acronyms, a metric conversion table, and definitions of data qualifiers used in this report (Appendix A), field methods (Appendix B), analytical program descriptions and summaries of data quality (Appendix C), analytical suites and results and analytical reports (Appendix D [on DVD included with this document]), waste management (Appendix E), box plots and statistical results (Appendix F), and risk-screening assessments (Appendix G).

2.0 SITE CONDITIONS

2.1 Surface Conditions

The Upper Water Canyon Aggregate Area consists of roughly east- to southeast-trending, flat-topped mesas that drain into the Water Canyon watershed. Source waters are predominantly from local storm and snowmelt runoff and from storm and snowmelt runoff flowing from the Sierra de Los Valles Mountains (i.e., the eastern front of the Jemez Mountains) located to the west of the Laboratory (Collins et al. 2005, 092028, pp. 2-104−2-107).

The mesa top ranges in elevation from 7600 ft amsl at the western Laboratory boundary to 7200 ft amsl at the southern tip of the mesa. Water Canyon extends from the Jemez Mountains to the Rio Grande. Cañon de Valle is a tributary canyon to Water Canyon that also heads in the Jemez Mountains. Water Canyon has steep walls—as deep as 200 ft in the TA-16 area.

The surface vegetation community at TA-16 consists of species typical of the Rocky Mountain montane conifer forest, which contains several distinct habitat types (LANL 1998, 059891, pp. B-41−B-43). The most prevalent habitat type on the mesa tops is ponderosa pine/Gambel oak. Canyon bottoms may grade into ponderosa pine/Douglas fir. Dominant trees within the mesa overstory canopy are ponderosa pine and aspen; the mesa-top shrub layer is primarily Gambel oak and New Mexico locust. Dominant forbs and grasses include bluegrass, mountain muhly, blue gramma, pine dropseed, wormwood, false tarragon, tall lupine, and cinquefoil. Additional details on the vegetation communities and habitat types at TA-16 are presented in Appendix B of the Phase II Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) report for Consolidated Unit 16-021(c)-99 (LANL 1998, 059891, pp. B-32−B-43).

2.1.1 Soil

Soil on the Pajarito Plateau was initially mapped and described by Nyhan et al. (1978, 005702). The soil on the slopes between the mesa tops and canyon floors was mapped as mostly steep rock outcrops consisting of approximately 90% bedrock with patches of shallow, weakly developed colluvial soil. South-facing canyon walls generally are steep and usually have shallow soil in limited, isolated patches between rock outcrops. In contrast, the north-facing canyon walls generally have more extensive areas of shallow dark-colored soil under thicker forest vegetation. The canyon floors generally contain poorly developed, deep, well-drained soil on floodplain terraces or small alluvial fans (Nyhan et al. 1978, 005702).

2.1.2 Surface Water

The Water Canyon Watershed heads on the flanks of the Sierra de Los Valles on U.S. Forest Service land. Surface water in the Upper Water Canyon Aggregate Area consists of stormwater, snowmelt runoff, and spring flow in small drainages or by sheet flow into Water Canyon. Water Canyon contains flowing water during snowmelt and storm events. Most surface water in the Los Alamos area occurs as ephemeral, intermittent, or interrupted streams in canyons cut into the Pajarito Plateau. Springs on the flanks of the Jemez Mountains, west of the Laboratory’s western boundary, supply flow to the upper reaches of Cañon de Valle and to Guaje, Los Alamos, Pajarito, and Water canyons (Purtymun 1975, 011787; Stoker 1993, 056021). These springs discharge water perched in the Bandelier Tuff and Tschicoma Formation at rates from 2 to 135 gal./min (Abeele et al. 1981, 006273). The volume of flow from the springs maintains natural perennial reaches of varying lengths in each of the canyons.

2.1.3 Land Use

Currently, land use within the Upper Water Canyon Aggregate Area is industrial. The area is anticipated to remain industrial through continued use by the Laboratory and will not change in the foreseeable future. Public access to TA-16 is prohibited and is controlled through physical controls, including fencing, and limited access via guard stations. SWMU 16-017(j)-99 is located within a parking lot and is accessible to the public.

2.2 Subsurface Conditions

2.2.1 Stratigraphic Units

The stratigraphy of the Upper Water Canyon Aggregate Area is summarized in this section. Stratigraphic units include, in descending order, Tshirege Member of the Bandelier Tuff, volcanic rocks of the Cerros del Rio volcanic field, Puye Formation (including the Totavi Lentil), and the Chamita Formation of the Santa Fe Group. The generalized stratigraphy is shown in Figure 2.2-1. Unit descriptions rely heavily on the stratigraphy observed in wells R-25 (Broxton et al. 2002, 072640, pp. 20−30); R-48 (Kleinfelder 2004, 087845, p. 4; LANL 2010, 108778, p. 14); CdV-16-1(i) (Kleinfelder 2004, 087844, pp. 12−13); CdV-16-2(i)r (Kleinfelder 2005, 093665, p. 8); and CdV-R-15-3 (LANL 2002, 073211). More detailed descriptions of the stratigraphy, mineralogy, chemistry, and other properties of the rock units described in this section are presented in the Laboratory’s hydrogeologic studies of the Pajarito Plateau (Collins et al. 2005, 092028, pp. 2-10−2-29).

2.2.1.1 Tshirege Member of the Bandelier Tuff

Unit 4 of the Tshirege Member of the Bandelier Tuff is composed of a series of variably welded vitric to devitrified ash-flow tuff that extends to a depth of 84 ft below ground surface (bgs) at well R-25; to 56 ft bgs at well CdV-16-2(i)r; to 70 ft bgs at well R-48; to 25 ft bgs at well CdV-R-37-2; and to 534 ft bgs at well CdV-R-15-3. Unit 4 is characterized by local thin, discontinuous, crystal-rich, fine- to coarse-grained volcanic surge deposits. The lower, more indurated parts of unit 4 are also significantly fractured. These fractures and surge beds are potential groundwater pathways (LANL 2006, 091698; LANL 2010, 108778, p. 14).

Unit 3 of the Tshirege Member of the Bandelier Tuff is poorly to moderately welded and indurated to slightly indurated. It tends to be a cliff-forming unit of the Pajarito Plateau. At well R-25 and at TA-16 in general, it is typically divided into two subunits, Qbt 3t (t for transitional) and Qbt 3. Qbt 3t is a devitrified ignimbrite that grades from partially welded at the top to moderately welded at the base. Qbt 3 is a second devitrified ignimbrite that grades from moderately welded at the top to nonwelded at the base. Qbt 3t and upper Qbt 3 also contain localized thin, discontinuous, crystal-rich, fine- to coarse-grained surge deposits that may represent potential groundwater pathways. Unit 3 (including both subunits Qbt 3 and Qbt 3t) is 198 ft thick at well R-25, extending from 84 to 229 ft bgs. Unit 3 extends from 9 to 85 ft bgs at well CdV-16-1(i), from 56 to 195 ft bgs at well CdV-16-2(i)r, from 70 to 207 ft bgs in well R-48, and from 34 to 152 ft bgs in well CdV-R-15-3 (LANL 2006, 091698; LANL 2010, 108778, p. 14).

Unit 2 of the Tshirege Member of the Bandelier Tuff is a competent, resistant unit that forms cliffs where it is exposed on the sides of the mesa. It is a moderately welded, well-indurated, devitrified ignimbrite. Welding grades from moderately welded at the top of the unit to partially welded at the base. Unit 2 is 103 ft thick at well R-25, extending from 229 to 332 ft bgs. Qbt 2 extends from 85 to 195 ft bgs at well CdV-16-1(i), from 195 to 305 ft bgs at well CdV-16-2(i)r, from 207 to 310 ft bgs at well R-48, and from 152 to 236 ft bgs at well CdV-R-15-3 (LANL 2006, 091698; LANL 2010, 108778, p. 14). Unit 2 of the Tshirege Member is extensively fractured in many outcrops across the Laboratory as a result of contraction during postdepositional cooling. The cooling fractures are visible on mesa edges. In general, such fractures are vertical to subvertical and dissipate near the bottom of the unit. Near the base of unit 2 is a series of thin, discontinuous, crystal-rich, fine- to coarse-grained, surge deposits. Bedding structures are often observed in these deposits. These surge beds mark the base of unit 2 (LANL 2006, 091698).

Unit 1v of the Tshirege Member is a vapor-phase-altered cooling unit that underlies unit 2. This unit forms sloping outcrops that contrast with the near-vertical cliffs of unit 2. Qbt 1v is further subdivided into units 1 v-u (u for upper) and 1 v-c (c for colonnade) in many regions within the Laboratory boundary. Qbt 1v is 29.5 ft thick at well R-25, extending from 332 to 361.5 ft bgs; from 195 to 223 ft bgs at well CdV-16-1(i); from 305 to 348 ft bgs at well CdV-16-2(i)r; from 310 to 345 ft bgs at well R-48; and from 236 to 290 ft bgs at well CV-R-15-3 (LANL 2006, 091698; LANL 2010, 108778, p. 14).

Unit 1 v-u is the uppermost portion of unit 1v. It is devitrified and consists of vapor-phase-altered ash-fall and ash-flow tuff. Unit 1 v-u is unconsolidated at its base and becomes moderately welded near overlying unit 2. Only the most prominent cooling fractures that originate in unit 2 continue into the more welded upper section of unit 1 v-u; however, these end in the less consolidated lower section of the unit (LANL 2006, 091698).

Unit 1 v-c is named for the columnar jointing visible in cliffs formed from this unit. Unit 1 v-c is a poorly welded, devitrified ash-flow tuff at its base and top that becomes more welded in its interior.

Unit 1g of the Tshirege Member is a massive, poorly consolidated, vitric ash-flow tuff. Few fractures are observed in outcrops of this unit, and the weathered cliff faces have a distinct Swiss cheese appearance that reflects the variable hardness of the unit. The upper portion of Qbt 1g is resistant to erosion, which helps to preserve the vapor-phase notch in the outcrop. A distinctive pumice-poor surge bed forms the base of Qbt 1g. Qbt 1g is 20.3 ft thick at well R-25 and extends from 361.5 to 381.8 ft bgs. Qbt 1g extends from 223 to 240 ft bgs at well CdV-16-1 (i), from 348 to 398 ft bgs at well CdV-16-2(i)r, from 345 to 359 ft bgs at well R-48, and from 290 to 350 ft bgs at well CdV-R-15-3 (LANL 2006, 091698; LANL 2010, 108778, p. 14).

2.2.1.2 Tsankawi Pumice Bed of the Bandelier Tuff

The Tsankawi Pumice Bed is the basal Plinian, air-fall deposit of the Tshirege Member of the Bandelier Tuff. It is a thin bed of gravel-sized vitric pumice. The unit is 2.2 ft thick at well R-25 and extends from 381.8 to 384 ft bgs. The Tsankawi Pumice Bed extends from 223 to 240 ft bgs at well CdV-16-1(i) and from 350 to 362 ft bgs at well CdV-R-15-3 (LANL 2006, 091698).

2.2.1.3 Cerro Toledo Interval

The Cerro Toledo interval separates the Tshirege and Otowi Members of the Bandelier Tuff and consists of thin beds of tuffaceous sandstones, paleosols, siltstones, ash, and pumice falls. The Cerro Toledo interval also includes localized gravel- and cobble-rich fluvial deposits predominantly derived from intermediate-composition lavas eroded from the Jemez Mountains west of the Pajarito Plateau. Numerous large lithics, including native dacites, are present at well R-25. The interval is 125 ft thick in the well R-25 borehole and extends from 384 to 509 ft bgs. This large thickness indicates that well R-25 is located in a paleodrainage on the surface of the underlying Otowi Member of the Bandelier Tuff. The Cerro Toledo interval extends from 240 to 457 ft bgs at well CdV-16-1(i), from 395 to 570 ft bgs at well CdV-16-2(i)r, from 359 to 430 ft bgs at well R-48, and from 362to 582 ft bgs at well CdV-R-15-3 (LANL 2006, 091698; LANL 2010, 108778, p. 14).

2.2.1.4 Otowi Member of the Bandelier Tuff

The Otowi Member of the Bandelier Tuff is 341.5 ft thick at well R-25, extending from 509 to 843.8 ft bgs. The tuff is a massive, poorly consolidated, nonwelded, pumice-rich, and mostly vitric ash flow. The pumices are fully inflated and support tubular structures that have not collapsed as a result of welding. The matrix is an unsorted mix of glass shards, phenocrysts, perlite clasts, and broken pumice fragments. The Otowi Member extends from 457 ft bgs to below the total depth (TD) of 683 ft bgs at well CdV-16-1(i), from 570 to 802 ft bgs at well CdV-16-2(i)r, from 430 to 894 ft bgs at well R-48, and from 582 to 750 ft bgs at well CdV-R-15-3 (LANL 2006, 091698; LANL 2010, 108778, p. 14).

The Guaje Pumice Bed forms the lowermost 6.7 ft of the Otowi Member at well R-25, extending from 843.8 to 850.5 ft bgs. It is the basal air-fall deposit of the Otowi Member of the Bandelier Tuff. The occurrence of the Guaje Pumice Bed at well R-25 is thinner than occurrences farther to the east and north, indicating either that this area was south of the main dispersal axis for this fall deposit or that this deposit was partly eroded before, or during, emplacement of the main Otowi ignimbrite. Two cycles of pumice fall were noted at well R-25. The Guaje Pumice Bed extends from 802 to 818 ft bgs at well CdV 16-2(i)r, from 894 to 900 ft bgs at well R-48, and from 750 to 800 ft bgs at well CdV-R-15-3 (LANL 2006, 091698; LANL 2010, 108778, p.14).

2.2.1.5 Puye Formation

The Puye Formation at well R-25 is an alluvial fan deposit made up primarily of coarse, clastic rocks derived from the rhyodacite units of the Tschicoma Formation that crop out in the Jemez Mountains west of the Pajarito fault. Because of the proximity of these source rocks, these fanglomerate deposits consist of poorly consolidated and poorly sorted boulders, cobble, gravels, and sands. Boulders up to 2 ft in diameter were observed during the drilling of well R-25 (LANL 2006, 091698).

Based on cuttings and lithologic description, the Puye Formation exists at well R-25 from 852 ft to below the TD of 1942 ft bgs, at well CdV-16-2(i)r from 818 ft bgs to below the TD of 1063 ft bgs, and at well R-48 from 900–995 ft bgs (LANL 2006, 091698; LANL 2010, 108778, p. 14).

2.2.2 Hydrogeology

The hydrogeology of the Pajarito Plateau is separable in terms of mesas and canyons forming the plateau. Mesas are generally devoid of water, both on the surface and within the rock forming the mesa. Canyons range from wet to relatively dry; the wettest canyons contain continuous streams and contain perennial groundwater in the canyon-bottom alluvium. Dry canyons have only occasional streamflow and may lack alluvial groundwater. Intermediate perched groundwater has been found at certain locations on the plateau at depths ranging between 100 and 700 ft bgs. The regional aquifer is found at depths of 1197 and 1352 ft bgs at wells CdV-R-37-2 and R-48, respectively, in TA-16 within the Cañon de Valle Aggregate Area (LANL 2002, 073707, p. 16; LANL 2010, 108778, p. 14). No wells have penetrated the regional aquifer in the Upper Water Canyon Aggregate Area, but the depths to the aquifer are likely similar to those found in wells CdV-R-37-2 and R-48.

The hydrogeologic conceptual site model for the Laboratory (Collins et al. 2005, 092028) shows that, under natural conditions, relatively small volumes of water move beneath mesa tops because of low rainfall, high evaporation, and efficient water use by vegetation. Atmospheric evaporation may extend into mesas, further inhibiting downward flow.

In the Los Alamos area, groundwater occurs as (1) water in shallow alluvium in some of the larger canyons, (2) an intermediate-perched groundwater body, which lies above a less permeable layer and is separated from the underlying aquifer by an unsaturated zone, and (3) the regional aquifer.

Contamination of the perched water and/or regional groundwater aquifer can occur only by recharge of infiltrating precipitation from contamination at or near the surface to the underlying groundwater. The hydrogeologic conceptual site model for the Laboratory (Collins et al. 2005, 092028) shows that, under natural conditions, relatively small volumes of water move beneath mesa tops because of low rainfall, high evaporation, and efficient water use by vegetation. Atmospheric evaporation may extend into mesas, further inhibiting downward flow.

Vadose Zone

The unsaturated zone from the mesa surface to the top of the regional aquifer is referred to as the vadose zone. The source of moisture for the vadose zone is precipitation, but much of it runs off, evaporates, or is absorbed by plants. The subsurface vertical movement of water is influenced by properties and conditions of the materials that make up the vadose zone.

The Bandelier Tuff is generally dry and does not readily transmit moisture. Most of the pore spaces in the tuff are of capillary size and have a strong tendency to hold water against gravity by surface-tension forces. Vegetation is very effective at removing moisture near the surface. During the summer rainy season when rainfall is highest, near-surface moisture content is variable because of higher rates of evaporation and of transpiration by vegetation, which flourishes during this time.

The various units of the Bandelier Tuff tend to have relatively high porosities. Porosity ranges between 30% and 60% by volume, generally decreasing for more highly welded tuff. Permeability varies for each cooling unit of the Bandelier Tuff. The moisture content of tuff beneath the mesa tops is low, generally less than 5% by volume throughout the profile (Kearl et al. 1986, 015368; Purtymun and Stoker 1990, 007508).

Based on the hydrogeologic conceptual model for mesas (Collins et al. 2005, 092028), moisture movement through the vadose zone in the Upper Water Canyon Aggregate Area is expected to be very slow because of low precipitation, the lack of surface water on the mesa top (including artificial water sources such as ponds), and the drying effect of air exchange along mesa edges. Net infiltration beneath dry mesas is low, with rates generally believed to be less than tens of millimeters per year and commonly on the order of 1 mm/yr or less. Transport times to the regional aquifer beneath dry canyons are expected to exceed hundreds of years (Birdsell et al. 2005, 092048).

Alluvial Groundwater

Intermittent and ephemeral streamflows in the canyons of the Pajarito Plateau have deposited alluvium as thick as 100 ft. The alluvium in canyons that originate from the Jemez Mountains is generally composed of sands, gravels, pebbles, cobbles, and boulders derived from the Tschicoma Formation and Bandelier Tuff on the flank of the mountains. The alluvium in canyons that originate from the Pajarito Plateau is comparatively more finely grained, consisting of clays, silts, sands, and gravels derived from the Bandelier Tuff (LANL 1998, 059599, p. 2-17).

In contrast to the underlying volcanic tuff and sediment, alluvium is relatively permeable. Ephemeral runoff in some canyons infiltrates the alluvium until downward movement is impeded by the less permeable tuff and sediment, which results in the buildup of a shallow alluvial groundwater body (Collins et al. 2005, 092028, p. 2-90). Depletion by evapotranspiration and movement into the underlying rock limit the horizontal and vertical extent of the alluvial water (Purtymun et al. 1977, 011846). The limited saturated thickness and extent of the alluvial groundwater preclude its use as a viable source of water for municipal and industrial needs. Lateral flow of the alluvial perched groundwater is in an easterly, downcanyon direction (Purtymun et al. 1977, 011846).

It is not clear that alluvial groundwater is present in the Upper Water Canyon Aggregate Area, although it is likely to be present in the headwaters of Water Canyon (west of the Laboratory). Alluvial groundwater is intermittent in Martin Canyon (a small tributary to Water Canyon), and present in middle Water Canyon, east of the Upper Water Canyon Aggregate Area (Collins et al. 2005, 092028, p. 3-A-38).

Intermediate-Perched Water

Identification of perched groundwater systems beneath the Pajarito Plateau comes mostly from direct observation of saturation in boreholes, wells, or piezometers or from borehole geophysics. Perched groundwater is widely distributed across the northern and central part of the Pajarito Plateau with depth-to-water ranging from 118 to 894 ft bgs. The principal occurrences of perched groundwater occur in (1) the relatively wet Los Alamos and Pueblo Canyon watersheds, (2) the smaller watersheds of Sandia and Mortandad Canyons, which receive significant volumes of treated effluent from Laboratory operations, and (3) the Cañon de Valle area in the southwestern part of the Laboratory. Perched water is most often found in Puye fanglomerates, Cerros del Rio basalt, and units of Bandelier Tuff.

The reported occurrences of perched groundwater in the southern part of the Laboratory are based on observations from a few deep boreholes located in that area. A deep-sounding surface-based magnetotelluric survey was conducted in the Cañon de Valle/Water Canyon area. The survey results indicate that perched groundwater is discontinuous laterally, occurring instead as vertical, fingerlike groundwater bodies (Collins et al. 2005, 092028, pp. 2-96−2-97). At wells R-25 and R-25c in Cañon de Valle, intermediate perched water was found at depths of 711 ft bgs and 808 ft bgs, respectively (Collins et al. 2005, 092028, p. 1-B-21; LANL 2008, 103408, p. 15). Additional perched zones probably occur beneath the adjacent wet watersheds of Pajarito and Water Canyons (Collins et al. 2005, 092028, pp. 2-96–2-97).

Regional Aquifer

The regional aquifer of the Los Alamos area is the only aquifer capable of large-scale municipal water supply (Purtymun 1984, 006513). The surface of the regional aquifer rises westward from the Rio Grande within the Santa Fe Group into the lower part of the Puye Formation beneath the central and western part of the Pajarito Plateau. The depths to groundwater below the mesa tops range between about 1200 ft along the western margin of the plateau and about 600 ft at the eastern margin. The locations of wells and generalized water-level contours on top of the regional aquifer are described in the 2009 General Facility Information report (LANL 2009, 105632). The regional aquifer is typically separated from the alluvial groundwater and intermediate-perched zone groundwater by 350 to 620 ft of tuff, basalt, and sediments (LANL 1993, 023249).

Groundwater in the regional aquifer flows east-southeast toward the Rio Grande. The velocity of groundwater flow ranges from about 20 to 250 ft/yr (LANL 1998, 058841, p. 2-7). Details of depths to the regional aquifer, flow directions and rates, and well locations are presented in various Laboratory documents (e.g., Purtymun 1995, 045344; LANL 1997, 055622; LANL 2000, 066802). Groundwater monitoring is conducted under annual updates to the Interim Facility-Wide Groundwater Monitoring Plan (LANL 2014, 256728).

The depths to the regional aquifer at TA-16 that have been determined by drilling are 1197 ft bgs at well CdV-R-37-2 (LANL 2002, 073707, p. 16), 1286 ft bgs at well R-25 (LANL 2003, 077965, p. B-20), and 1352 ft bgs at regional well R-48 (LANL 2010, 108778). The nearest production well to TA-16 is PM-2 in Pajarito Canyon, 4–5 mi east of the operational areas at TA-16. While the hydrogeology within the Upper Water Canyon Aggregate Area may vary from the conditions encountered in the Cañon de Valle regional wells, the depth to the top of the regional aquifer is likely to be within the range of 1100–1400 ft bgs.

3.0 SCOPE OF ACTIVITIES

This section presents an overview of field activities performed during the implementation of the “Investigation Work Plan for Upper Water Canyon Aggregate Area, Revision 1” (IWP) and “Direction to Modify, Upper Water Canyon Aggregate Area Investigation Work Plan, Revision 1,” (LANL 2011, 111602; NMED 2011, 111827) for SWMU 16-017(j)-99; the field investigation results and observations are presented in detail in section 6 and in the appendices. The scope of activities for the 2021 Upper Water Canyon Aggregate Area investigation included site access and premobilization activities, geodetic surveys, surface and shallow-subsurface sampling, health and safety monitoring, and waste management activities.

3.1 Site Access and Premobilization Activities

Public access to most of TA-16 is prohibited and is controlled through physical controls, including fencing, and limited access via guard stations. SWMU 16-017(j)-99 is located within a parking lot and is accessible to the public. Before field mobilization, efforts were made to provide a secure and safe work area and to reduce impacts to workers and the environment.

Premobilization activities included completing the permit requirements identification form, completing an excavation permit, requesting sampling paperwork from the N3B Sample Management Office (SMO), and conducting the preparedness review. Additional premobilization activities included staging waste containers.

3.2 Field Activities

This section describes the field activities conducted during the 2021 investigation. Additional details regarding the field methods and procedures followed to perform these field activities are presented in Appendix B.

3.2.1 Geodetic Surveys

Geodetic surveys were conducted during the Upper Water Canyon Aggregate Area investigation to identify surface and subsurface sampling locations. The planned sampling locations for the 2021 investigation are described in the IWP (LANL 2011, 111602; NMED 2011, 111827). An initial geodetic survey was performed to establish and mark the planned sampling locations in the field.

Geodetic surveys were conducted using a differential global positioning system (GPS) unit. Horizontal accuracy of the GPS unit is within 1.0 ft.

The surveyed coordinates for all sampling locations are presented in Table 3.2-1. All coordinates are expressed as State Plane Coordinate System 83, New Mexico Central, U.S. All surveyed coordinates for sampling locations were uploaded to the Environmental Information Management (EIM) database.

3.2.2 Field Screening

All samples collected were screened for gross-alpha and -beta radioactivity by N3B radiological control technicians (RCTs). Screening was performed using an Eberline E600 portable radiation monitor with either a Thermo Scientific HP-380AB or RadEye SX probe, a Ludlum 43-93 detector, and an Eberline RO-20 dose rate meter. The probe was held less than 1 in. away from the medium. Measurements were made by conducting a quick scan to find the location with the highest initial reading and then collecting a 1-min reading at that location to determine levels of gross-alpha and -beta radioactivity.

RCTs collected background level measurements for gross-alpha and -beta radioactivity daily and recorded the measurements on field sample collection logs (SCLs) and chain of custody (COC) forms.

RCTs performed and documented a free-release survey of the exterior of the sample containers, and a U.S. Department of Transportation shipping survey was performed and documented before transportation to the SMO. Results were recorded on each SCL/COC form.

SCLs/COC forms are included in Appendix D (on DVD included with this document). The screening results are presented in Table 3.2-2.

3.2.3 Surface and Shallow-Subsurface Soil Investigation

Samples were collected according to the approved IWP (LANL 2011, 111602; NMED 2011, 111827). Soil samples were collected in accordance with N3B-SOP-ER-2001, “Soil, Tuff, and Sediment Sampling.” Before any other samples were collected from the sample material, samples were collected for volatile organic compound (VOC) analysis. Samples were collected using stainless-steel augers or spoons, placed in stainless-steel bowls for homogenization, and transferred to sterile sample collection jars or bags for transport to the SMO.

Quality assurance/quality control samples (field duplicates, field trip blanks, and rinsate blanks) were collected in accordance with N3B-SOP-SDM-1100, “Sample Containers, Preservation, and Field Quality Control.” Field duplicate samples were collected at a minimum rate of 1 per 10 investigation samples. Rinsate blanks were also collected at a minimum rate of 1 per 10 investigation samples to confirm decontamination of the sampling equipment. When VOC samples were collected, field trip blank samples were collected in conjunction with investigation samples at a minimum rate of 1 per day.

All sample collection activities were coordinated with the SMO. Upon collection, samples always remained in the controlled custody of the field team until they were delivered to the SMO. Sample custody was then relinquished to the SMO for delivery to a preapproved off-site contract analytical laboratory for the analyses specified by the approved IWP (LANL 2011, 111602; NMED 2011, 111827). The SCLs/COC forms for all samples are provided in Appendix D (on DVD included with this document).

3.2.4 Subsurface Investigation

3.2.4.1 Subsurface Sampling

All required sample depths were reached by hand augers. Samples were collected using stainless-steel hand augers in accordance with N3B-SOP-ER-2001, “Soil, Tuff, and Sediment Sampling,” at depth intervals based on criteria established in the approved IWP (LANL 2011, 111602; NMED 2011, 111827).

3.2.4.2 Borehole Abandonment

The five sample locations at SWMU 16-017(j)-99 were abandoned by filling the holes with the cuttings after sample results were received. All cuttings from those locations were managed as waste as described in Appendix E until the analytical data were received and reviewed.

3.2.4.3 Equipment Decontamination

Between collection of each sample and between sampling locations, all field equipment with the potential to contact sample material (e.g., hand augers, sampling spoons, and bowls) was decontaminated to prevent cross-contamination of samples and locations. Dry decontamination was performed in accordance with N3B-SOP-ER-2002, “Field Decontamination of Equipment.” The dry decontamination methods used are described in Appendix B. Rinsate blanks were used to check the effectiveness of decontamination.

3.2.5 Health and Safety Measures

All 2021 investigation activities were conducted in accordance with the N3B Integrated Work Control Process that details the work steps, potential hazards, hazard controls, and required training to conduct work. These health and safety measures generally included the use of modified level-D personal protective equipment (PPE).

3.2.6 Waste Management

All waste generated during the investigation for SWMU 16-017(j)-99 was managed in accordance with the waste management plan (LANL 2011, 111602, Appendix B; NMED 2011, 111827) and the N3B-approved waste characterization strategy form (WCSF) (Appendix E, Attachment E-1). These documents incorporate the requirements of all applicable U.S. Environmental Protection Agency (EPA) and NMED regulations and DOE orders. Characterization and management of waste was performed in accordance with N3B-P409-0, "N3B Waste Management."

The waste streams associated with the investigation included contact investigation-derived waste and environmental media.

Sample cuttings from surface and shallow subsurface boreholes were collected and containerized in 5-gal. buckets and placed on pallets in a waste staging area pending characterization. This waste stream was characterized in accordance with the N3B-approved WCSF (Appendix E, Attachment E-1). The sample cuttings waste stream was initially classified as nonhazardous waste pending characterization results and finally characterized as nonhazardous. The cuttings were used to backfill the boreholes and were land-applied.

Contact investigation-derived waste included PPE such as gloves, decontamination towels, and other solid waste that may have come in contact with potentially contaminated environmental media. Contact investigation-derived waste was stored in a 5-gal. bucket at the waste staging area, pending characterization. As described in the WCSF, the contact waste was characterized using samples collected during the investigation and its final characterization was nonhazardous. This waste was transported to the Los Alamos County Eco Station.

Each waste stream was containerized and managed in storage areas appropriate to the type of waste. The management of waste is described in greater detail in Appendix E. All available waste documentation, including the WCSF, is provided in Appendix E.

3.3 Sample Analyses

The SMO shipped all investigation samples to off-site contract analytical laboratories for the requested analyses. The analyses requested were specified in the approved IWP (LANL 2011, 111602; NMED 2011, 111827) and were analyzed for all or a subset of the following: target analyte list (TAL) metals, total cyanide, nitrate, perchlorate, explosive compounds, semivolatile organic compounds (SVOCs), VOCs, and pH.

Field duplicates of investigation samples were analyzed for the same analytical suites as the corresponding investigation samples. Equipment rinsate blanks were analyzed for the same inorganic suites as the related investigation samples. Field trip blanks were analyzed only for VOCs.

3.4 Deviations

Deviations from the scope of activities defined in the approved IWP (LANL 2011, 111602; NMED 2011, 111827) occurred during the implementation of the Upper Water Canyon Aggregate Area investigation of SWMU 16-017(j)-99 (see section B-7.0 of Appendix B).

4.0 REGULATORY CRITERIA

This section describes the criteria used for evaluating potential risk to ecological and human receptors. Regulatory criteria identified by sample medium in the Consent Order include cleanup standards, risk-based screening levels, and risk-based cleanup goals.

Human health risk-screening evaluations were conducted for SWMU 16-017(j)-99 using NMED guidance (NMED 2022, 702141). Ecological risk-screening assessments were performed using Laboratory guidance (LANL 2017, 602649).

4.1 Current and Future Land Use

The specific screening levels used in the risk evaluation and corrective action decision process at a site depend on the current and reasonably foreseeable future land use(s). The current and reasonably foreseeable future land use(s) for a site determine the receptors and exposure scenarios used to select screening and cleanup levels. The land use within and surrounding the Upper Water Canyon Aggregate Area is currently industrial and is expected to remain industrial for the reasonably foreseeable future. The residential scenario is evaluated for comparison purposes per the Consent Order and is the decision scenario for sites that do not require future controls. For sites to be recommended for corrective action complete without controls, both the residential scenario and construction worker scenario were evaluated in order to identify sites where the residential scenario is not protective of the construction worker.

4.2 Screening Levels

Human health and ecological risk-screening evaluations were conducted for the chemicals of potential concern (COPCs) detected in solid media at SWMU 16-017(j)-99 within the Upper Water Canyon Aggregate Area in accordance with N3B-SOP-ER-2009, “Performing Human and Ecological Risk Screening Assessments.” The human health risk-screening assessments (Appendix G) were performed on inorganic and organic COPCs using NMED soil screening levels (SSLs) for the industrial, construction worker, and residential scenarios (NMED 2022, 702141). When an NMED SSL was not available for a COPC, industrial and residential SSLs were obtained from EPA regional tables (https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables) (adjusted to a risk level of 1×10^{-5} for carcinogens) and construction worker SSLs were calculated using the equations outlined in the NMED soil screening guidance (NMED 2022, 702141), incorporating toxicity and chemical-specific parameters from EPA regional tables. Surrogate SSLs based on structural similarity or breakdown products were used for some COPCs for which no SSLs were available.

4.3 Ecological Screening Levels

The ecological risk-screening assessments (Appendix G) were conducted using ecological screening levels (ESLs) obtained from the ECORISK Database, Version 4.3 (N3B 2022, 702057) in accordance with N3B SOP-ER-2009, “Performing Human and Ecological Risk Screening Assessments.” The ESLs are based on similar species and are derived from experimentally determined no observed adverse effect levels, lowest observed adverse effect levels (LOAELs), or doses determined lethal to 50% of the test population. Information relevant to the calculation of ESLs, including equations, bioconcentration factors, transfer factors, and toxicity reference values are presented in the ECORISK Database, Version 4.3 (N3B 2022, 702057). Surrogate ESLs based on structural similarity or breakdown products were used for some COPCs for which no ESLs were available.

4.4 Cleanup Standards

As specified in the Consent Order, SSLs for inorganic and organic chemicals are used as soil cleanup levels unless they are determined to be impracticable or values do not exist for the current and reasonably foreseeable future land uses (NMED 2022, 702141). Screening assessments compare COPC concentrations for each site with industrial, construction worker, and residential SSLs.

The cleanup goals specified in Section IX of the Consent Order are a target risk of 1×10^{-5} for carcinogens or a hazard index (HI) of 1 for noncarcinogens. The SSLs used for the risk-screening assessments in Appendix G are based on these cleanup goals.

For ecological risk, remediation of contaminated sites or media requires information on concentrations of chemicals in the environment that are protective of ecological receptors. These concentrations can be considered ecological preliminary remediation goals (Eco-PRGs) and differ from ESLs. The Eco-PRGs have been developed for use as ecological cleanup levels in soil at the Los Alamos Legacy Cleanup program sites. The methodology for developing the Eco-PRGs is documented in “Development of Ecological Preliminary Remediation Goals for Los Alamos National Laboratory” (LANL 2017, 602228). Eco-PRGs for sediment are recommended to be calculated on a site-specific basis.

5.0 DATA REVIEW METHODOLOGY

The purpose of the data review is to define the nature and extent of contaminant releases for SWMU 16-017(j)-99 in the Upper Water Canyon Aggregate Area. The nature of a contaminant release refers to the specific contaminants that are present, the affected media, and associated concentrations. The nature of contamination is defined through identification of COPCs, which is discussed in section 5.1. The identification of a chemical as a COPC does not mean the constituent is related to the site as a result of site operations. A COPC is identified because it is present at a site based on the criteria discussed below, but it might be present because of adjacent and/or upgradient operations and/or infrastructure typical of industrial and metropolitan development. If such origins are evident, the constituent might be excluded from the data analyses and risk assessments. The extent of contamination refers to the spatial distribution of COPCs, with an emphasis on the distribution of COPCs potentially posing a risk or requiring corrective action. The process for determining the extent of contamination and for concluding no further sampling for extent is warranted is discussed in section 5.2.

5.1 Identification of COPCs

COPCs are chemicals that may be present as a result of releases from SWMUs. Inorganic chemicals occur naturally, and inorganic chemicals detected because of natural background are not considered COPCs. The Laboratory collected data on background concentrations of many inorganic chemicals. These data have been used to develop media-specific background values (BVs) (LANL 1998, 059730). For inorganic chemicals for which BVs exist, identification of COPCs involves background comparisons, which are described in sections 5.1.1 and 5.1.2. If no BVs are available, COPCs are identified based on detection status (i.e., if the inorganic chemical is detected, it is identified as a COPC unless there is information indicating it is not present as a result of a release from the SWMU).

Organic chemicals may also be present as a result of anthropogenic activities unrelated to the SWMU, or to a lesser extent, from natural sources. Because there are no background data for organic chemicals, background comparisons cannot be performed in the same manner as for inorganic chemicals or radionuclides. Therefore, organic COPCs are identified based on detection status (i.e., the organic chemical is detected). When the nature of contamination is assessed, the history of site operations may be evaluated to determine whether an organic COPC is present because of a release from a SWMU or is present from a non-site-related source. Organic chemicals that are clearly present from sources other than releases from a SWMU may be eliminated as COPCs and not evaluated further.

5.1.1 Inorganic Chemical Background Comparisons

The COPCs are identified for inorganic chemicals in accordance with N3B-SOP-ER-2004, "Background Comparisons for Inorganic Chemicals." Inorganic COPCs are identified by comparing site data with BVs, statistical comparisons, and other lines of evidence, as applicable (LANL 1998, 059730). The upper end of the background data set may be used for comparison if one or more of the following conditions exist:

- Statistically determined BV is significantly greater than the maximum background concentration.
- Statistical tests cannot be performed because of insufficient data (fewer than eight samples and/or five detections per medium) or a high percentage of nondetections.
- Sufficient numbers of samples have been collected to determine nature and extent, but results are predominately nondetections.
- Site history does not indicate the constituent is directly related to site activities or to a dominant waste stream.
- Spatial analyses do not show a pattern or trend indicating contamination.
- The maximum detected concentration is statistically determined to be an outlier. (Note: A sufficient number of samples must be collected to show a point is an outlier and is not indicative of a hot spot.)

Background data are generally available for inorganic chemicals in soil, sediment, and tuff (LANL 1998, 059730). However, some analytes (e.g., nitrate, perchlorate, and hexavalent chromium) have no BVs. A BV may be either a calculated value from the background data set (upper tolerance limit [UTL] or the 95% upper confidence bound on the 95th quantile) or a detection limit (DL). When a BV is based on a DL, there is no corresponding background data set for that analyte/media combination.

For inorganic chemicals, data are evaluated by sample media to facilitate the comparison with media-specific background data. To identify inorganic COPCs, the first step is to compare the sampling result with BVs. If sampling results are above the BV and sufficient data are available (eight or more sampling results and five or more detections), statistical tests are used to compare the site sample data with the background data set for the appropriate media. If statistical tests cannot be performed because of insufficient data or a high percentage of nondetections, the sampling results are compared with the BV and the upper end of background concentration for the appropriate media. If concentrations are above the BV but no results are greater than the upper end of the background data set, lines of evidence are presented to determine whether the inorganic chemical is or is not a COPC. If at least one sampling result is above the BV and the upper end of the background data set, the inorganic chemical is identified as a COPC. The same evaluation is performed using DLs when an inorganic chemical is not detected but has a DL above the BV. If no BV is available, detected inorganic chemicals are identified as COPCs.

Sample media encountered during the investigation at SWMU 16-017(j)-99 in Upper Water Canyon Aggregate Area includes fill material (media code FILL). Because no separate BVs are available for fill material, fill samples are evaluated by comparison with soil BVs (LANL 1998, 059730). In this report, the discussions of site contamination in soil include fill samples along with soil samples in sample counts and comparisons with background. Fill samples are not discussed separately from soil (LANL 1998, 059730).

5.1.2 Statistical Methods Overview

A variety of statistical methods may be applied to each of the data sets. The use of any of these methods depends on how appropriate the method is for the available data. The results of the statistical tests are presented in Table F-1 in Appendix F.

5.1.2.1 Distributional Comparisons

Comparisons between site-specific data and Laboratory background data are performed using a variety of statistical methods. These methods begin with a simple comparison of site data with a UTL estimated from the background data (the 95% upper confidence bound on the 95th quantile). The UTLs are used to represent the upper end of the concentration distribution and are referred to as BVs. The UTL comparisons are then followed, when appropriate, by statistical tests that evaluate potential differences between the distributions. These tests are used for testing hypotheses about data from two potentially different distributions (e.g., a test of the hypothesis that site concentrations are elevated above background levels). Nonparametric tests most commonly performed include the Gehan test (modification of the Wilcoxon Rank Sum test) and the quantile test (Gehan 1965, 055611; Gilbert and Simpson 1990, 055612).

The Gehan test is recommended when between 10% and 50% of the data sets are nondetections. It handles data sets with nondetections reported at multiple DLs in a statistically robust manner (Gehan 1965, 055611; Millard and Deverel 1988, 054953). The Gehan test is not recommended if either of the two data sets has more than 50% nondetections. If there are no nondetected concentrations in the data, the Gehan test is equivalent to the Wilcoxon Rank Sum test. The Gehan test is the preferred test because of its applicability to a majority of environmental data sets and its recognition and recommendation in EPA-sponsored workshops and publications.

The quantile test is better suited to assessing shifts in a subset of the data. The quantile test determines whether more of the observations in the top chosen quantile of the combined data set come from the site data set than would be expected by chance, given the relative sizes of the site and background data sets. If the relative proportion of the two populations being tested is different in the top chosen quantile of the data from that of the remainder of the data, the distributions may be partially shifted because of a subset of site data. This test is capable of detecting a statistical difference when only a small number of concentrations are elevated (Gilbert and Simpson 1992, 054952). The quantile test is the most useful distribution shift test where samples from a release represent a small fraction of the overall data collected. The quantile test is applied at a prespecified quantile or threshold, usually the 80th percentile. The test cannot be performed if more than 80% (or, in general, more than the chosen percentile) of the combined data are nondetected values. It can be used when the frequency of nondetections is approximately the same as the quantile being tested. For example, in a case with 75% nondetections in the combined background and site data set, application of a quantile test comparing 80th percentiles is appropriate. However, the test cannot be performed if nondetections occur in the top chosen quantile. The threshold percentage can be adjusted to accommodate the detection rate of an analyte or to look for differences further into the distribution tails. The quantile test is more powerful than the Gehan test for detecting differences when only a small percentage of the site concentrations are elevated.

If the differences between two distributions appear to occur far into the tails, the slippage test might be performed. This test evaluates the potential for some of the site data to be greater than the maximum concentration in the background data set if, in fact, the site data and background data came from the same distribution. This test is based on the maximum concentration in the background data set and the number (“n”) of site concentrations that exceed the maximum concentration in the background set (Gilbert and Simpson 1990, 055612, pp. 5–8). The result (p-value) of the slippage test is the probability that “n” site samples (or more) exceed the maximum background concentration by chance alone. The test accounts for the number of samples in each data set (number of samples from the site and number of samples from background) and determines the probability of “n” (or more) exceedances if the two data sets came from identical distributions. This test is like the BV comparison in that it evaluates the largest site measurements but is more useful than the BV comparison because it is based on a statistical hypothesis test, not simply on a statistic calculated from the background distribution.

Statistical tests for radionuclides are performed only in limited cases. Although there are BVs for naturally occurring radionuclides in soil or tuff based on elemental analyses and assumed isotopic distributions, there are not background data sets for specific isotopes. Therefore, statistics were not performed if there were any detections of uranium isotopes above BV in soil or tuff. Although there are background data sets for fallout radionuclides in soil, the background data are limited to the depth range of 0.0 to 1.0 ft bgs for evaluation of fallout radionuclides. Therefore, statistical tests were not performed for fallout radionuclides in soil unless there were also no detections in soil below 1.0 ft bgs and no detections in tuff. Fallout values are not applicable for tuff, so statistical tests cannot be performed. Background data sets are available for naturally occurring and fallout radionuclides in sediment, and background evaluations for sediment are not limited to the depth range of 0.0 to 1.0 ft bgs. Therefore, statistical tests can be performed for radionuclides in sediment. However, statistical tests for radionuclides in sediment were not performed for a site if there were also detections of naturally occurring radionuclides above BV in soil, detections of fallout radionuclides above FV in soil in the 0.0-to-1.0 ft bgs depth range, detections of fallout radionuclides in soil below 1.0 ft bgs, and/or detections of fallout radionuclides in tuff.

For all statistical tests, a p-value less than 0.05 was the criterion for accepting the null hypothesis that site sampling results are different from background.

5.1.2.2 Graphical Presentation

Box plots are provided in Appendix F for a visual representation of the data and to help illustrate the presence of outliers or other anomalous data that might affect statistical results and interpretations. The plots allow a visual comparison among data distributions. The differences of interest may include an overall shift in concentration (shift of central location) or, when the centers are nearly equal, a difference between the upper tails of the two distributions (elevated concentrations in a small fraction of one distribution). The plots may be used in conjunction with the statistical tests (distributional comparisons) described above. Unless otherwise noted, the nondetected concentrations are included in the plots at their reported DL.

The box plots presented in Appendix F of this report consist of a box, a line across the box, whiskers (lines extended beyond the box and terminated with a short perpendicular line), and points outside the whiskers. The box area of the plot is the region between the 25th percentile and the 75th percentile of the data, the interquartile range or middle half of the data. The horizontal line within the box represents the median (50th percentile) of the data. The whiskers extend to the most extreme point that is not considered an outlier, with a maximum whisker length of 1.5 times the interquartile range, outside of which data may be evaluated for their potential to be outliers. The concentrations are plotted as points overlying the box plot. When a data set contains both detected concentrations and nondetected concentrations reported as DLs, the detected concentrations are plotted as Xs and the nondetected concentrations are plotted as Os.

5.2 Extent of Contamination

Spatial concentration trends are initially used to determine whether the extent of contamination is defined. Evaluation of spatial concentration data considers the conceptual site model of the release and subsequent migration. Specifically, the conceptual site model should define where the highest concentrations would be expected if a release had occurred and how these concentrations should vary with distance and depth. If the results are different from the conceptual site model, it could indicate that no release has occurred or there are other sources of contamination.

In general, both laterally and vertically decreasing concentrations are used to define extent. If concentrations are increasing or not changing, other factors are considered to determine whether extent is defined or if additional extent sampling is warranted. These factors include

- the magnitude of concentrations and rate of increase compared with SSLs,
- the magnitude of concentrations of inorganic chemicals or radionuclides compared with the maximum background concentrations for the medium,
- concentrations of organic chemicals compared with estimated quantitation limits (EQLs), and
- results from nearby sampling locations.

The primary focus for defining the extent of contamination is characterizing contamination that potentially poses an unacceptable risk and might require additional corrective actions. As such, comparison with SSLs is used as an additional step following a determination of whether extent is defined by decreasing concentrations with depth and distance and whether concentrations are below EQLs or DLs. The initial SSL comparison uses the residential SSL (regardless of whether the current and reasonably foreseeable future land use is residential) because this value is typically the most protective. If the current and reasonably foreseeable future land use is not residential, and if the residential SSL is exceeded by or is similar to COPC concentrations, comparison with the relevant SSL may also be conducted. For SWMU 16-017(j)-99, the current and reasonably foreseeable future land use is industrial (section 4.1).

The SSL comparison is not necessary if all COPC concentrations are decreasing with depth and distance. If, however, concentrations increase with depth and distance or do not display any obvious trends, the SSLs are used to determine whether additional sampling for extent is warranted. If the COPC concentrations are sufficiently below the SSL (e.g., the residential and/or industrial SSL is 10 times [an order of magnitude] or more than all concentrations), the COPC does not pose a potential unacceptable risk and no further sampling for extent is warranted. The validity of the assumption that the COPC does not pose a risk is confirmed with the results of the risk-screening assessment. The calculation of risk also assists in determining whether additional sampling is warranted to define the extent of contamination needing additional corrective actions.

6.0 TA-16 BACKGROUND AND FIELD INVESTIGATION RESULTS

6.1 Background of TA-16

6.1.1 Operational History

TA-16, also known as S-Site (Plate 1), contains many of the Laboratory’s high explosives (HE) facilities, the Laboratory’s state-of-the-art tritium facility, and several administrative support buildings. Activities involve fabricating and testing HE, plastics, and adhesives; conducting research in process development for manufacturing HE, plastics, adhesives, and other materials; repackaging tritium to user-specified pressures;

chemical purification of tritium by removing contaminants; reclaiming tritium; mixing tritium with other gases; analyzing gas mixtures; and conducting applied research and development for boost systems.

In general, operations at TA-16 sites did not involve radionuclides.

6.1.2 Summary of Releases

Potential contaminants at SWMU 16-017(j)-99 may have been released into the environment through operational releases at and downgradient from the former storage magazine.

6.1.3 Current Site Usage and Status

Currently the site is located at the side of a parking lot. The Laboratory plans to build a fire station near or on the footprint of SWMU 16-0017(j)-99 (Figure 6.1-1).

6.2 SWMU 16-017(j)-99, Former Storage Magazine 16-63

6.2.1 Site Description and Operational History

SWMU 16-017(j)-99 is a former magazine (structure 16-63) at TA-16 (Figure 6.2-1). The magazine was a 24 ft wide × 26 ft long × 9 ft high wood-framed structure surrounded by an earthen berm on three sides and the top. The magazine was built in 1945 and removed in 1998 (LANL 1998, 059602). The storage magazine was built at grade, and there is no longer any evidence of the berm that once surrounded the magazine. Any remaining berm material is indistinguishable from the surrounding soil.

This SWMU was originally designated as part of SWMU 16-017, a group of 24 structures in central TA-16 (LANL 1994, 039440, pp. 6-31–6-33). In 1999, SWMU 16-017 was separated into 24 SWMUs, each consisting of a single structure.

6.2.2 Relationship to Other SWMUs and AOCs

There are no upgradient SWMUs or AOCs within 600 ft of SWMU 16-017(j)-99.

6.2.3 Summary of Previous Investigations

No previous investigation has been conducted at this site.

6.2.4 Site Contamination

6.2.4.1 Soil, Rock, and Sediment Sampling

The following activities were completed as part of the 2021 investigation.

- A total of 15 samples were collected from 5 locations within and around the footprint of the former magazine (structure 16-63). At each location, samples were collected at the surface (0.0 to 1.0 ft bgs), shallow subsurface (4.0 to 5.0 ft bgs), and from the subsurface (9.0 to 10.0 ft bgs). All samples were analyzed at off-site fixed laboratories for TAL metals, cyanide, perchlorate, nitrate, SVOCs, explosive compounds, VOCs, and pH.

Samples were not analyzed for polychlorinated biphenyls (PCBs) or radionuclides because per the IWP (LANL 2011, 111602; NMED 2011, 111827), the site was only used for storage of HE with no record or indication of PCBs or radionuclide use at the site.

The 2021 sampling locations at SWMU 16-017(j)-99 are shown in Figure 6.2-1. Table 6.2-1 presents the samples collected and analyses requested for SWMU 16-017(j)-99. The geodetic coordinates of sample locations are presented in Table 3.2-1.

6.2.4.2 Soil, Rock, and Sediment Field-Screening Results

For the radiological screening results, five samples exceeded twice the maximum site background levels for alpha-emitting radionuclides. One sample exceeded twice the maximum site background levels for beta/gamma-emitting radionuclides. No changes were made to sampling or other activities based on field-screening results. Field-screening results are presented in Table 3.2-2.

6.2.4.3 Soil, Rock, and Sediment Sampling Analytical Results

Decision-level data at SWMU 16-017(j)-99 consist of results from 15 fill samples collected from 5 locations.

Inorganic Chemicals

A total of 15 samples (all fill) were collected from 5 locations and analyzed for TAL metals, cyanide, nitrate, and perchlorate. Table 6.2-2 presents the inorganic chemicals detected above BVs and detected inorganic chemicals with no BVs. Figure 6.2-2 shows the spatial distribution of inorganic chemicals detected or detected above BVs.

Antimony was detected above the soil BV (0.83 mg/kg) in two fill samples with a maximum concentration of 1.34 mg/kg. Antimony is retained as a COPC.

Nitrate was detected in 11 samples with a maximum concentration of 15.9 mg/kg. Nitrate is retained as a COPC.

Selenium was detected above the soil BV (1.52 mg/kg) in seven fill samples with a maximum concentration of 3.23 mg/kg. The Gehan and quantile tests indicated site concentrations of selenium in soil are statistically different from background (Figure F-1 and Table F-1). Selenium is retained as a COPC.

Organic Chemicals

A total of 15 samples (all fill) were collected and analyzed for SVOCs, explosive compounds, and VOCs. Table 6.2-3 presents the detected organic chemicals. Figure 6.2-3 shows the spatial distribution of detected organic chemicals.

Organic chemicals detected at SWMU 16-017(j)-99 include benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; bis(2-ethylhexyl)phthalate; carbazole; chrysene; di-n-butylphthalate; fluoranthene; indeno(1,2,3-cd)pyrene; phenanthrene; and pyrene. The detected organic chemicals are retained as COPCs.

Radionuclides

Samples from SWMU 16-017(j)-99 were not analyzed for radionuclides.

6.2.4.4 Nature and Extent of Contamination

The nature and extent of inorganic and organic COPCs at SWMU 16-017(j)-99 are discussed below. The spatial distribution of COPCs was evaluated using the data presented in Tables 6.2-2 and 6.2-3 and Figures 6.2-2 and 6.2-3.

Inorganic Chemicals

Inorganic COPCs at SWMU 16-017(j)-99 include antimony, nitrate, and selenium.

Antimony was detected above the soil BV in two fill samples with a maximum concentration of 1.34 mg/kg. Concentrations decreased with depth at location 16-61445, increased with depth at location 16-61447, and increased laterally to the east. The residential SSL was approximately 23 times the maximum concentration. Further sampling for extent of antimony is not warranted.

Nitrate was detected in 11 samples with a maximum concentration of 15.9 mg/kg. Concentrations increased with depth at locations, 16-61447, 16-61448, and 16-61449 and increased laterally to the north. The residential SSL was approximately 7860 times the maximum concentration. Further sampling for extent of nitrate is not warranted.

Selenium was detected above the soil BV (1.52 mg/kg) in seven fill samples with a maximum concentration of 3.23 mg/kg. Concentrations did not change substantially with depth (0.04 mg/kg) at location 16-61447; decreased with depth at all other locations; and increased laterally to the north. The residential SSL was approximately 121 times the maximum concentration. Further sampling for extent of selenium is not warranted.

Organic Chemicals

Organic COPCs at SWMU 16-017(j)-99 include benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; bis(2-ethylhexyl)phthalate; carbazole; chrysene; di-n-butylphthalate; fluoranthene; indeno(1,2,3-cd)pyrene; phenanthrene; and pyrene.

Benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene were each detected in two samples with maximum concentrations of 0.168 mg/kg, 0.215 mg/kg, and 0.305 mg/kg, respectively. Concentrations increased with depth at location 16-61447 and increased laterally to the east. The residential SSLs were approximately 9.1 times, 5.2 times, and 5 times the maximum concentration, respectively. The industrial SSLs were approximately 192 times, 110 times, and 106 times the maximum concentration, respectively. Further sampling for extent of benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene is not warranted.

Benzo(g,h,i)perylene; benzo(k)fluoranthene; bis(2-ethylhexyl)phthalate; carbazole; and indeno(1,2,3-cd)pyrene were each detected in one sample at concentrations of 0.112 mg/kg, 0.115 mg/kg, 0.0132 mg/kg, 0.0234 mg/kg, and 0.119 mg/kg, respectively. Concentrations increased with depth at location 16-61447 and increased laterally to the east. The residential SSLs ranged from approximately 12.9 times to 28,790 times the maximum concentration. Further sampling for extent of benzo(g,h,i)perylene; benzo(k)fluoranthene; bis(2-ethylhexyl)phthalate; carbazole; and indeno(1,2,3-cd)pyrene is not warranted.

Chrysene, fluoranthene, and pyrene were each detected in two samples with maximum concentrations of 0.18 mg/kg, 0.16 mg/kg, and 0.153 mg/kg, respectively. Concentrations increased with depth at location 16-61447 and increased laterally to the east. The residential SSLs were approximately 850 times; 14,500 times; and 11,370 times the maximum concentration, respectively. Further sampling for extent of chrysene, fluoranthene, and pyrene is not warranted.

Di-n-butylphthalate was detected in 10 samples with a maximum concentration of 2.74 mg/kg. Concentrations increased with depth at location 16-61447, decreased at all other locations, and increased laterally to the south. The residential SSL was approximately 2250 times the maximum concentration. Further sampling for extent of di-n-butylphthalate is not warranted.

Phenanthrene was detected in two samples with maximum concentration of 0.0416 mg/kg. Concentrations increased with depth at location 16-61447, decreased with depth at all other locations, and decreased laterally. The residential SSL was approximately 41,800 times the maximum concentration. Lateral extent of phenanthrene is defined and further sampling for vertical extent is not warranted.

Radionuclides

Samples from SWMU 16-017(j)-99 were not analyzed for radionuclides.

6.2.5 Summary of Human Health Risk Screening

Industrial Scenario

No carcinogenic chemical COPCs were identified. The industrial HI is 0.0005, which is less than the NMED target HI of 1. No radionuclide samples were collected for the 0.0–1.0-ft depth interval.

Construction Worker Scenario

The total excess chemical cancer risk for the construction worker scenario is 4×10^{-8}, which is less than the NMED target risk level of 1×10^{-5}. The construction worker HI is 0.02, which is less than the NMED target HI of 1. No radionuclide samples were collected for the 0.0–10.0-ft depth interval.

Residential Scenario

The total excess chemical cancer risk for the residential scenario is 6×10^{-6}, which is less than the NMED target risk level of 1×10^{-5}. The residential HI is 0.04, which is less than the NMED target HI of 1. No radionuclide samples were collected for the 0.0–10.0-ft depth interval.

Based on the risk-screening assessment evaluation, no potential unacceptable risks exist for the industrial, construction worker, and residential scenarios at SWMU 16-017(j)-99.

6.2.6 Summary of Ecological Risk Screening

Based on evaluations of the minimum ESLs, HI analyses, LOAEL analyses, ecological scoping notes, and the relationship of detected concentrations and screening levels to background concentrations, no potential ecological risks exist for SWMU 16-017(j)-99.

7.0 CONCLUSIONS

7.1 Nature and Extent of Contamination

Based on the evaluation of the data from the 2021 investigation, the nature and extent of contamination have been defined, and/or no further sampling for extent is warranted, for SWMU 16-017(j)-99. The nature and extent of contamination for SWMU 16-017(j)-99 located in the Upper Water Canyon Aggregate Area are summarized below.

7.1.1 SWMU 16-017(j)-99

The nature and extent of contamination have been defined, and/or no further sampling for extent is warranted for SWMU 16-017(j)-99.

7.2 Summary of Risk-Screening Assessments

SWMU 16-017(j)-99 was evaluated for potential risk by human health risk-screening assessments and evaluated for potential risk by ecological risk-screening assessments.

7.2.1 Human Health Risk-Screening Assessment

Based on the comparison with SSLs, there is no carcinogenic risk to the industrial, construction worker, or residential scenarios.

7.2.2 Ecological Risk-Screening Assessment

Based on evaluations of the minimum ESLs, HI analyses, LOAEL analyses, and chemicals of potential ecological concern without ESLs, no potential ecological risks to the Mexican spotted owl, gray fox, American kestrel, American robin, mountain cottontail, montane shrew, deer mouse, earthworm, or generic plant exist at SWMU 16-017(j)-99.

8.0 RECOMMENDATIONS

The determination of site status is based on the results of the risk-screening assessments and the nature and extent evaluation. This site is recommended as corrective action complete without controls or additional corrective action. The residential scenario is the only scenario under which corrective action complete without controls is applicable; that is, the site meets cleanup objectives for human health, poses no unacceptable risk to ecological receptors, and no additional corrective actions or conditions are necessary. The current and reasonably foreseeable future land use for SWMU 16-017(j)-99 is industrial.

8.1 Recommendation for Corrective Actions Complete

8.1.1 Corrective Actions Complete without Controls

SWMU 16-017(j)-99 does not pose a potential unacceptable risk under the industrial, construction worker, and residential scenarios and has no potential ecological risks for any receptor. The nature and extent of contamination are defined for this site, and/or no further sampling for extent is warranted. This site is appropriate for corrective action complete without controls.

9 0 REFERENCES AND MAP DATA SOURCES

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9.2 Map Data Sources

Data sources for all figures are provided below, unless otherwise indicated on the figures themselves.

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Bandelier Tuff	Tshirege Member (Qbt)	Qbt 4	Ash-Flow Units
		Qbt 3	
		Qbt 2	
		Qbt 1v	
		Qbt 1g	
		Tsankawi Pumice Bed	
Cerro Toledo Interval (Qct)		Volcaniclastic Sediments and Ash-Falls	
Bandelier Tuff	Otowi Member (Qbo)	Ash-Flow Units	
		Guaje Pumice Bed (Qbog)	
Puye Formation (Tp)	Fanglomerate	Fanglomerate facies includes sand, gravel, conglomerate, and tuffaceous sediments.	
	Basalt and Andesite	Cerros del Rio basalts intercalated within the Puye Formation, includes up to four interlayered basaltic flows. Andesites of the Tschicoma Formation present in western part of plateau.	
	Fanglomerate	Fanglomerate facies includes sand, gravel, conglomerate, and tuffaceous sediments; includes “old alluvium.”	
	Axial facies deposits of the ancestral Rio Grande	Totavi Lentil	
Santa Fe Group	Coarse Sediments	Coarse-grained upper facies (formerly called the “Chaquehui Formation” by Purtymun 1995, 045344)	
	Basalt		
	Coarse Sediments		
	Basalt		
	Coarse Sediments		
	Basalt		
	Coarse Sediments		
	Arkosic clastic sedimentary deposits	Undivided Santa Fe Group (includes Chamita[?] and Tesuque Formations)	

Source: Adapted from (LANL 1999, 064617).

Figure 2.2-1 Generalized stratigraphy of bedrock geologic units of the Pajarito Plateau

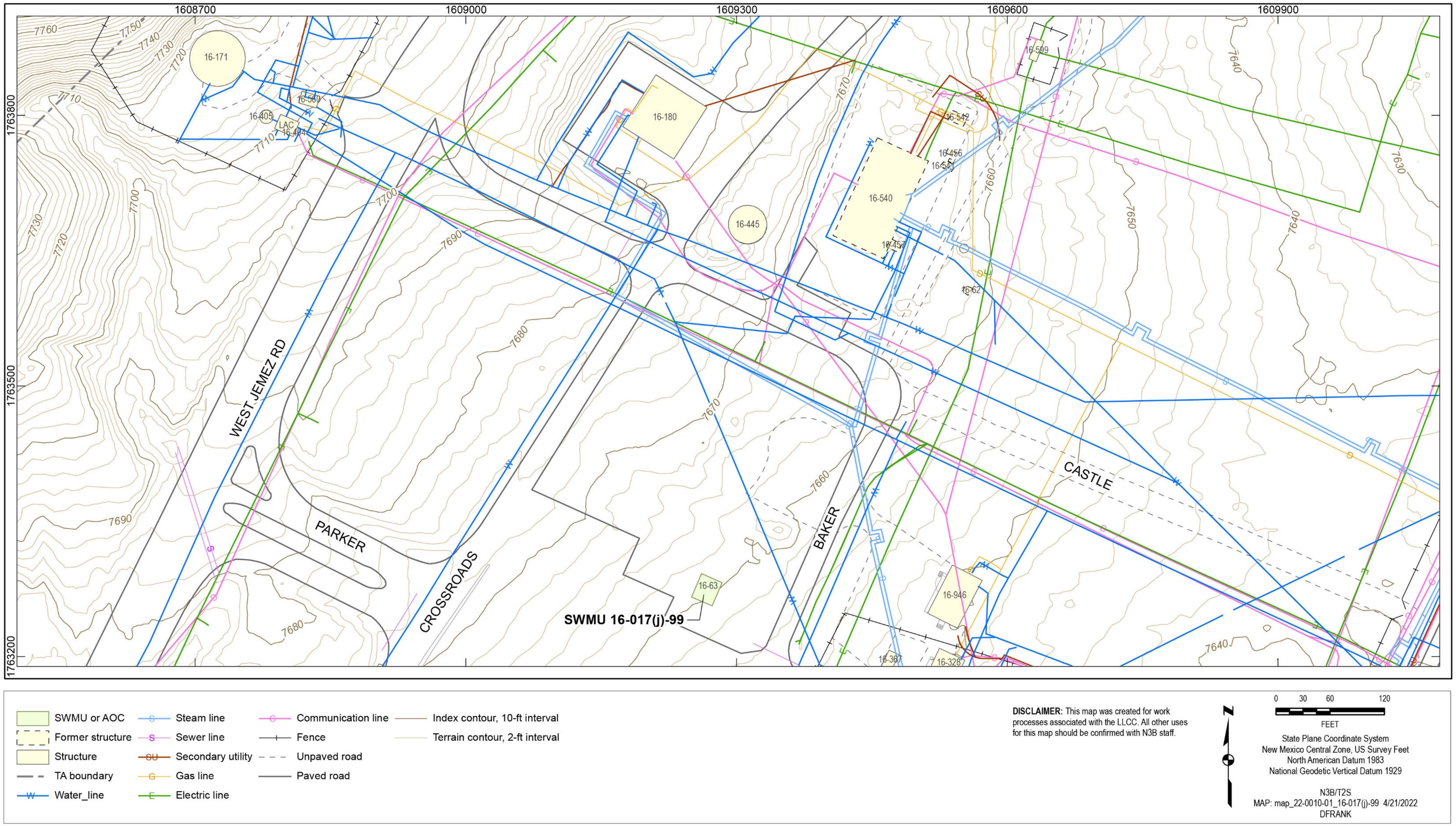

Figure 6.1-1 Location of SWMU 16-017(j)-99 in Upper Water Canyon Aggregate Area

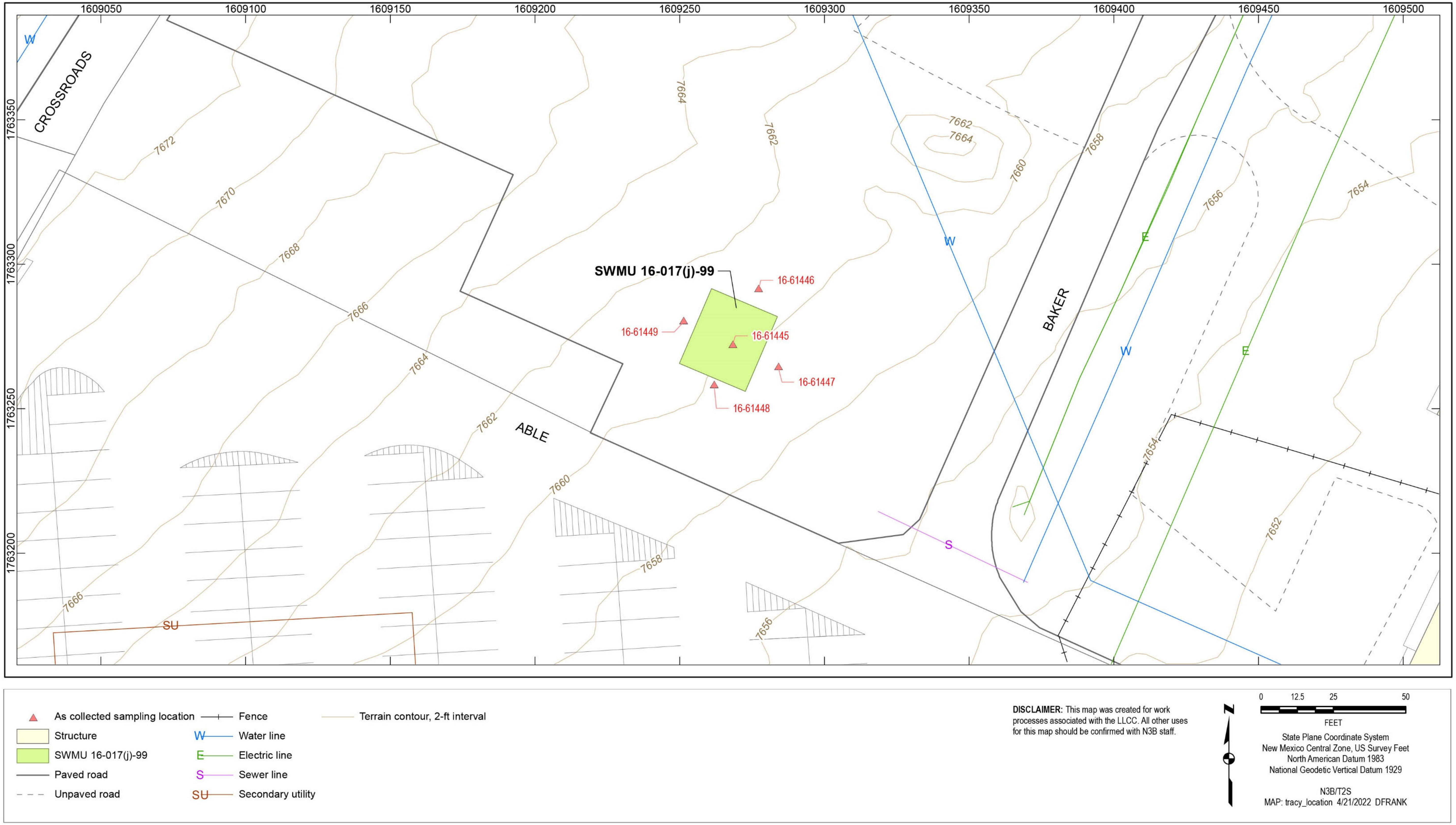

Figure 6.2-1 **SWMU 16-017(j)-99 site map and sampling locations**

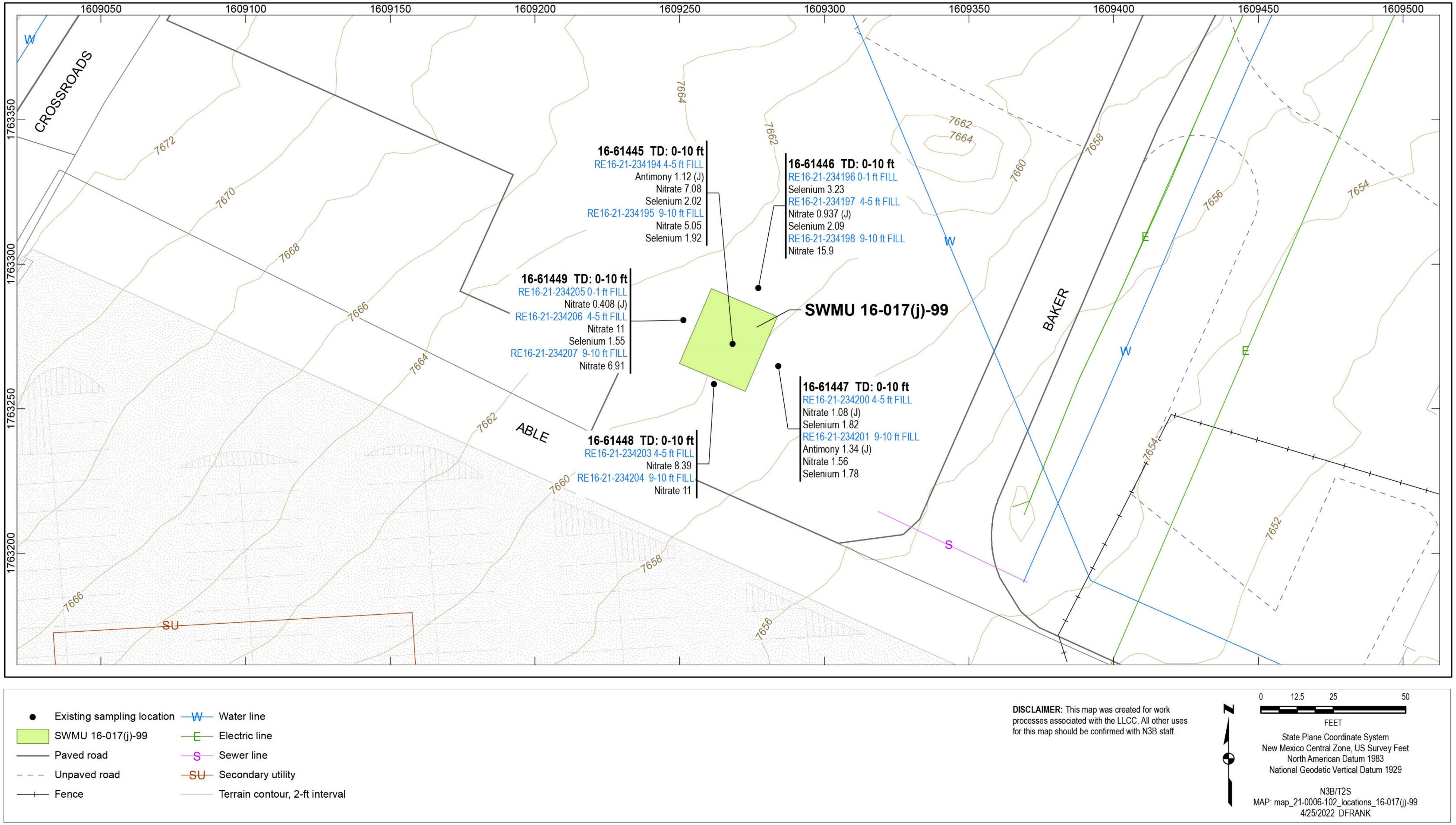

Figure 6.2-2 Inorganic chemicals detected or detected above BVs at SWMU 16-017(j)-99

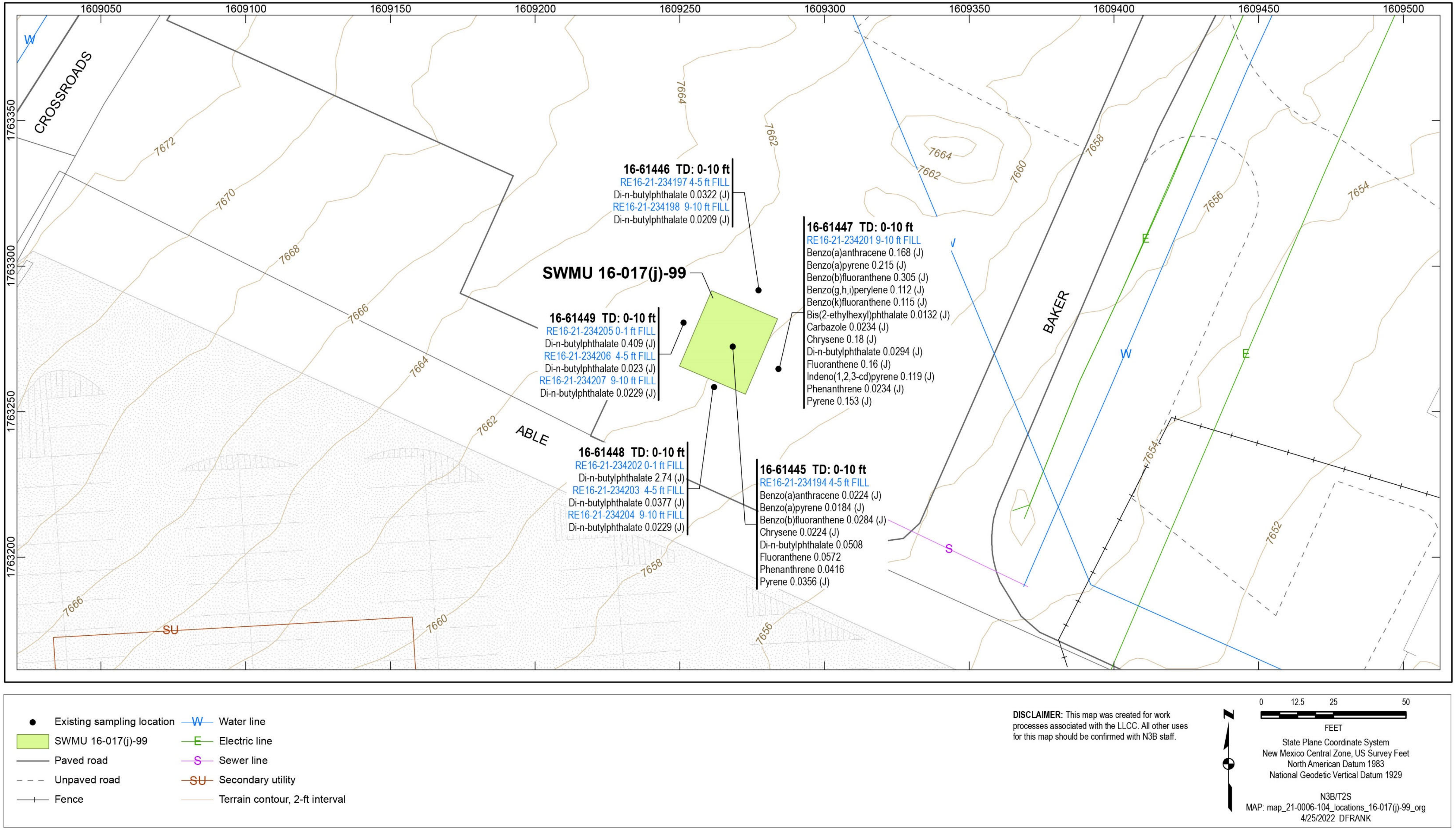

Figure 6.2-3 Organic chemicals detected at SWMU 16-017(j)-99

Table 3.2-1
Surveyed Coordinates for Locations Sampled in 2021

SWMU/AOC	Location ID	Easting (ft)	Northing (ft)
SWMU 16-017(j)-99	16-61445	1609268.358	1763272.497
	16-61446	1609277.259	1763291.843
	16-61447	1609284.098	1763264.848
	16-61448	1609261.835	1763258.541
	16-61449	1609251.319	1763280.682

Table 3.2-2
Field-Screening Results for Samples Collected at SWMU 16-017(j)-99

SWMU/AOC	Location ID	Sample ID	Start Depth (ft)	End Depth (ft)	Alpha Reading (dpm*/100 cm^2)	Beta/Gamma Reading (dpm/100 cm^2)	Background Alpha (dpm/100 cm^2)	Background Beta/Gamma (dpm/100 cm^2)
SWMU 16-017(j)-99	16-61445	RE16-21-234193	0	1	30	1980	10	1082
SWMU 16-017(j)-99	16-61445	RE16-21-234194	4	5	20	1733	10	1082
SWMU 16-017(j)-99	16-61445	RE16-21-234195	9	10	30	1530	10	1082
SWMU 16-017(j)-99	16-61446	RE16-21-234196	0	1	15	1795	10	1082
SWMU 16-017(j)-99	16-61446	RE16-21-234197	4	5	35	1908	10	1082
SWMU 16-017(j)-99	16-61446	RE16-21-234198	9	10	20	1620	15	878
SWMU 16-017(j)-99	16-61447	RE16-21-234199	0	1	20	1661	10	1082
SWMU 16-017(j)-99	16-61447	RE16-21-234200	4	5	25	1745	10	1082
SWMU 16-017(j)-99	16-61447	RE16-21-234201	9	10	35	1648	10	1082
SWMU 16-017(j)-99	16-61448	RE16-21-234202	0	1	15	1555	15	878
SWMU 16-017(j)-99	16-61448	RE16-21-234203	4	5	20	1689	15	878
SWMU 16-017(j)-99	16-61448	RE16-21-234204	9	10	20	1620	15	878
SWMU 16-017(j)-99	16-61449	RE16-21-234205	0	1	25	1886	15	878
SWMU 16-017(j)-99	16-61449	RE16-21-234206	4	5	35	1673	15	878
SWMU 16-017(j)-99	16-61449	RE16-21-234207	9	10	30	1520	15	878

* dpm = Disintegrations per minute.

Table 6.2-1
Samples Collected and Analyses Requested at SWMU 16-017(j)-99

Sample ID	Location ID	Depth (ft)	Media	TAL Metals	Perchlorate	Cyanide	VOCs	SVOCs	Explosive Compounds	Nitrate
RE16-21-234193	16-61445	0.0–1.0	FILL	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	—*	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534
RE16-21-234194	16-61445	4.0–5.0	FILL	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534
RE16-21-234195	16-61445	9.0–10.0	FILL	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534
RE16-21-234196	16-61446	0.0–1.0	FILL	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	—	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534
RE16-21-234197	16-61446	4.0–5.0	FILL	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534
RE16-21-234198	16-61446	9.0–10.0	FILL	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550
RE16-21-234199	16-61447	0.0–1.0	FILL	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	—	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534
RE16-21-234200	16-61447	4.0–5.0	FILL	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534
RE16-21-234201	16-61447	9.0–10.0	FILL	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534	N3B-2021-2534
RE16-21-234202	16-61448	0.0–1.0	FILL	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	—	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550
RE16-21-234203	16-61448	4.0–5.0	FILL	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550
RE16-21-234204	16-61448	9.0–10.0	FILL	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550
RE16-21-234205	16-61449	0.0–1.0	FILL	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	—	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550
RE16-21-234206	16-61449	4.0–5.0	FILL	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550
RE16-21-234207	16-61449	9.0–10.0	FILL	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550	N3B-2021-2550

Note: Numbers in analyte columns are request numbers.

* — = Analysis not requested.

Table 6.2-2
Inorganic Chemicals Detected above BVs at SWMU 16-017(j)-99

Sample ID	Location ID	Depth (ft)	Media	Antimony	Nitrate	Selenium
Soil Background Value[a]				**0.83**	**na[b]**	**1.52**
Construction Worker SSL[c]				**142**	**566,000**	**1750**
Industrial SSL[c]				**519**	**2,080,000**	**6490**
Residential SSL[c]				**31.3**	**125,000**	**391**
RE16-21-234193	16-61445	0.0–1.0	FILL	—[d]	—	—
RE16-21-234194	16-61445	4.0–5.0	FILL	1.12 (J)	7.08	2.02
RE16-21-234195	16-61445	9.0–10.0	FILL	—	5.05	1.92
RE16-21-234196	16-61446	0.0–1.0	FILL	—	—	3.23
RE16-21-234197	16-61446	4.0–5.0	FILL	—	0.937 (J)	2.09
RE16-21-234198	16-61446	9.0–10.0	FILL	—	15.9	—
RE16-21-234199	16-61447	0.0–1.0	FILL	—	—	—
RE16-21-234200	16-61447	4.0–5.0	FILL	—	1.08 (J)	1.82
RE16-21-234201	16-61447	9.0–10.0	FILL	1.34 (J)	1.56	1.78
RE16-21-234202	16-61448	0.0–1.0	FILL	—	—	—
RE16-21-234203	16-61448	4.0–5.0	FILL	—	8.39	—
RE16-21-234204	16-61448	9.0–10.0	FILL	—	11	—
RE16-21-234205	16-61449	0.0–1.0	FILL	—	0.408 (J)	—
RE16-21-234206	16-61449	4.0–5.0	FILL	—	11	1.55
RE16-21-234207	16-61449	9.0–10.0	FILL	—	6.91	—

Note: Results are in mg/kg. Data qualifiers are presented in Appendix A.

[a] BVs from LANL (1998, 059730).

[b] na = Not available.

[c] SSLs from NMED (2022, 702141) unless otherwise noted.

[d] — = Not detected or not detected above BV.

Table 6.2-3
Organic Chemicals Detected at SWMU 16-017(j)-99

Sample ID	Location ID	Depth (ft)	Media	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Bis(2-ethylhexyl)phthalate	Carbazole	Chrysene	Di-n-butylphthalate	Fluoranthene	Indeno(1,2,3-cd)pyrene	Phenanthrene	Pyrene
Construction Worker SSL[a]				**240**	**15**	**240**	**7530**[b]	**2310**	**5380**	**85**[c,d]	**23,100**	**26,900**	**10,000**	**240**	**8070**	**7530**
Industrial SSL[a]				**32.3**	**23.6**	**32.3**	**25,300**[b]	**323**	**1830**	**1200**[d,e]	**3230**	**91,600**	**33,700**	**32.3**	**27,500**	**25,300**
Residential SSL[a]				**1.53**	**1.12**	**1.53**	**1740**[b]	**15.3**	**380**	**78**[d,e]	**153**	**6160**	**2320**	**1.53**	**1850**	**1740**
RE16-21-234194	16-61445	4-5	FILL	0.0224 (J)	0.0184 (J)	0.0284 (J)	—[f]	—	—	—	0.0224 (J)	0.0508	0.0572	—	0.0416	0.0356 (J)
RE16-21-234197	16-61446	4-5	FILL	—	—	—	—	—	—	—	—	0.0322 (J)	—	—	—	—
RE16-21-234198	16-61446	9-10	FILL	—	—	—	—	—	—	—	—	0.0209 (J)	—	—	—	—
RE16-21-234201	16-61447	9-10	FILL	0.168 (J)	0.215 (J)	0.305 (J)	0.112 (J)	0.115 (J)	0.0132 (J)	0.0234 (J)	0.18 (J)	0.0294 (J)	0.16 (J)	0.119 (J)	0.0234 (J)	0.153 (J)
RE16-21-234202	16-61448	0-1	FILL	—	—	—	—	—	—	—	—	2.74 (J)	—	—	—	—
RE16-21-234203	16-61448	4-5	FILL	—	—	—	—	—	—	—	—	0.0377 (J)	—	—	—	—
RE16-21-234204	16-61448	9-10	FILL	—	—	—	—	—	—	—	—	0.0229 (J)	—	—	—	—
RE16-21-234205	16-61449	0-1	FILL	—	—	—	—	—	—	—	—	0.409 (J)	—	—	—	—
RE16-21-234206	16-61449	4-5	FILL	—	—	—	—	—	—	—	—	0.023 (J)	—	—	—	—
RE16-21-234207	16-61449	9-10	FILL	—	—	—	—	—	—	—	—	0.0229 (J)	—	—	—	—

Note: Results are in mg/kg. Data qualifiers are presented in Appendix A.

[a] SSLs from NMED (2022, 702141).

[b] Pyrene used as a surrogate based on structural similarity.

[c] Construction worker SSLs calculated using the equations outlined in NMED (2022, 702141), incorporating toxicity and chemical-specific parameters from EPA regional screening level (RSL) tables (https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables).

[d] Dibenzofuran used as a surrogate based on structural similarity.

[e] SSLs from EPA RSL tables (http://www.epa.gov/risk/risk-based-screening-table-generic-tables).

[f] — = Not detected.

Appendix A

Acronyms and Abbreviations, Metric Conversion Table, and Data Qualifier Definitions

A-1.0 ACRONYMS AND ABBREVIATIONS

%R	percent recovery
ADR	Automated Data Review (software module)
amsl	above mean sea level
AOC	area of concern
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	area use factor
bgs	below ground surface
BMP	best management practice
BV	background value
CCV	continuing calibration verification
COC	chain of custody
Consent Order	Compliance Order on Consent
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CSM	conceptual site model
DAF	dilution attenuation factor
DL	detection limit
DOE	Department of Energy (U.S.)
DOT	Department of Transportation (U.S.)
dpm	disintegration per minute
Eco-PRG	ecological preliminary remediation goal
EDD	electronic data deliverable
Eh	redox potential
EIM	Environmental Information Management (database)
EM-LA	Environmental Management Los Alamos Field Office (DOE)
EPA	Environmental Protection Agency (U.S.)
EPC	exposure point concentration
EQL	estimated quantitation limit
ESL	ecological screening level
FD	field duplicate
FR	field rinsate (blank)
FTB	field trip blank

GIS	Geographic Information System
GPS	Global Positioning System
HE	high explosives
HI	hazard index
HQ	hazard quotient
HR	home range
ICS	interference check sample
ICV	initial calibration verification
IDW	investigation-derived waste
IWP	investigation work plan
IS	internal standard
K_d	soil-water partition coefficient
K_{oc}	organic carbon-water partition coefficient
K_{ow}	octanol/water partition coefficient
LAL	lower acceptance limit
LANL	Los Alamos National Laboratory
LCS	laboratory control sample
LOAEL	lowest observed adverse effect level
MB	method blank
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
N3B	Newport News Nuclear BWXT-Los Alamos, LLC
NH	nonhazardous (waste)
NMED	New Mexico Environment Department
NMSA	New Mexico Statutes Annotated
NOAEL	no observed adverse effect level
NQ	not qualified (detected without data qualification)
PAUF	population area use factor
PCB	polychlorinated biphenyl
PPE	personal protective equipment
PQL	practical quantitation limit
QA	quality assurance
QC	quality control

RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
RfD	reference dose
RFI	Resource Conservation and Recovery Act Facility Investigation
RP-SVS	Radiation Protection Services Group (LANL)
RPD	relative percent difference
RRF	relative response factor
SCL	sample collection log
SF	slope factor
SMO	Sample Management Office
SOP	standard operating procedure
SOW	statement of work
SQL	Structured Query Language
SSL	soil screening level
SVOC	semivolatile organic compound
SWMU	solid waste management unit
T&E	threatened and endangered
TA	technical area
TAL	target analyte list
TD	total depth
TRV	toxicity reference value
UAL	upper acceptance limit
UCL	upper confidence limit
UTL	upper tolerance limit
VOC	volatile organic compound
WCSF	waste characterization strategy form

A-2.0 METRIC CONVERSION TABLE

Multiply SI (Metric) Unit	by	To Obtain U.S. Customary Unit
kilometers (km)	0.622	miles (mi)
kilometers (km)	3281	feet (ft)
meters (m)	3.281	feet (ft)
meters (m)	39.37	inches (in.)
centimeters (cm)	0.03281	feet (ft)
centimeters (cm)	0.394	inches (in.)
millimeters (mm)	0.0394	inches (in.)
micrometers or microns (µm)	0.0000394	inches (in.)
square kilometers (km^2)	0.3861	square miles (mi^2)
hectares (ha)	2.5	acres
square meters (m^2)	10.764	square feet (ft^2)
cubic meters (m^3)	35.31	cubic feet (ft^3)
kilograms (kg)	2.2046	pounds (lb)
grams (g)	0.0353	ounces (oz)
grams per cubic centimeter (g/cm^3)	62.422	pounds per cubic foot (lb/ft^3)
milligrams per kilogram (mg/kg)	1	parts per million (ppm)
micrograms per gram (µg/g)	1	parts per million (ppm)
liters (L)	0.26	gallons (gal.)
milligrams per liter (mg/L)	1	parts per million (ppm)
degrees Celsius (°C)	9/5 + 32	degrees Fahrenheit (°F)

A-3.0 DATA QUALIFIER DEFINITIONS

Data Qualifier	Definition
U	The analyte was analyzed for but not detected above the reported estimated quantitation limit.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
J+	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample but likely to have a high bias.
J-	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample but likely to have a low bias.
UJ	The analyte was analyzed for but not detected. The associated value is an estimate.

Appendix B

Field Methods

B-1.0 INTRODUCTION

This appendix summarizes the field methods used during the 2021 investigation of Solid Waste Management Unit (SWMU) 16-017(j)-99 in Technical Area 16 (TA-16) at Los Alamos National Laboratory (LANL or the Laboratory) within the Upper Water Canyon Aggregate Area. Table B-1.0-1 presents a summary of the field methods used, and the following sections provide more detailed descriptions of these methods. All activities were conducted in accordance with standard operating procedures (SOPs) listed in Table B-1.0-2.

B-2.0 EXPLORATORY DRILLING CHARACTERIZATION

No exploratory drilling characterization was conducted.

B-3.0 FIELD-SCREENING METHODS

This section summarizes the field-screening methods used during the investigation activities. Field screening for radioactivity was performed on each sample collected. Field-screening results are presented in Table 3.2-2 of the investigation report.

B-3.1 Field-Screening for Radioactivity

During sampling of fill each sample was screened for radioactivity shortly after it was collected, targeting alpha and beta/gamma emitters. Screening was conducted by Newport News Nuclear BWXT-Los Alamos, LLC (N3B) radiological control technicians (RCTs) using an Eberline E600 portable radiation monitor with either a Thermo Scientific HP-380AB or RadEye SX probe, a Ludlum 43-93 detector, and an Eberline RO-20 dose rate meter. Screening measurements were recorded on the sample collection logs/chain of custody (SCLs/COC) forms and are provided in Appendix D (on DVD included with this document). These screening results are presented in Table 3.2-2 of the investigation report.

Before leaving TA-16 N3B RCTs performed and documented a free-release survey of the exterior of the sample containers, and a U.S. Department of Transportation shipping survey was performed and documented before transportation to the Sample Management Office (SMO).

B-4.0 FIELD INSTRUMENT CALIBRATION

All instruments were calibrated before use. Calibration of the Eberline E600 and RadEye SX are conducted by the Laboratory’s Radiation Protection Services (RP-SVS) group according to the manufacturers’ specifications and requirements with approved operating procedures.

B-4.1 Eberline E600 and RadEye SX Calibration and Response Check

Response checks of the Eberline E600 and RadEye SX were conducted by an N3B RCT daily, before use, to measure levels for radioactivity. All response checks were performed according to approved operating procedures. Response checks were recorded in daily functional check logs. The Laboratory’s RP-SVS group calibrated the instrument using americium-241 and chloride-36 sources for alpha and beta emissions, respectively. Calibration records are maintained by RP-SVS.

B-5.0 SURFACE AND SUBSURFACE SAMPLING

This section summarizes the methods used to collect surface and subsurface samples of fill in accordance with the investigation work plan, Revision 1 (IWP) (LANL 2011, 111602; NMED 2011, 111827).

B-5.1 Surface Sampling Methods

Surface samples were collected within SWMU 16-017(j)-99 using either hand auger or spade-and-scoop methods. Surface samples were collected in accordance with N3B-SOP-ER-2001, "Soil, Tuff, and Sediment Sampling." A hand auger or stainless-steel scoop was used to collect material in approximately 6-in. increments. The sample material was placed in a stainless-steel bowl with a stainless-steel scoop, after which it was transferred to sterile sample collection jars. Samples were preserved using insulated containers with ice packs to maintain the required temperature, in accordance with N3B-SOP-SDM-1100, "Sample Containers, Preservation, and Field Quality Control."

Samples were appropriately labeled, sealed with custody seals, and documented before being transported to the SMO. Samples were managed according to N3B-SOP-SDM-1101, "Sample Control and Field Documentation."

Sample collection tools were decontaminated immediately before each sample was collected in accordance with N3B-SOP-ER-2002, "Field Decontamination of Equipment" (see section B-5.6).

B-5.2 Subsurface Sampling Methods

Subsurface samples were collected using a stainless-steel hand auger. The samples were collected in accordance with N3B-SOP-ER-2001, "Soil, Tuff, and Sediment Sampling."

Samples for volatile organic compound (VOC) analysis were collected immediately upon retrieval of the split-spoon core barrel or hand auger to minimize the loss of VOCs during the sample-collection process. Containers for VOC samples were filled as completely as possible, leaving no or minimal headspace, and sealed with a Teflon-lined cap. The remaining material was then field-screened for radioactivity, visually inspected, and logged. After the VOC samples were collected and field-screened, the remaining sample material was placed in a stainless-steel bowl, homogenized, and then placed into the sample containers.

A stainless-steel scoop and bowl were used to transfer samples to sterile sample collection jars for transport to the SMO. The sample collection tools were decontaminated immediately before each sample was collected in accordance with N3B-SOP-ER-2002, "Field Decontamination of Equipment" (see section B-5.6).

B-5.3 Quality Assurance/Quality Control Samples

Quality assurance/quality control (QA/QC) samples were collected in accordance with N3B-SOP-SDM-1100, "Sample Containers, Preservation, and Field Quality Control." The QA/QC samples included field duplicates, field equipment rinsate blanks, and field trip blanks.

Field duplicate samples were collected from the same material as the regular investigation samples and submitted for the same analyses. Field duplicate samples were collected at a frequency of at least 1 per 10 samples (10%).

Field equipment rinsate blanks were collected to evaluate field decontamination procedures. Rinsate blanks were collected by rinsing sampling equipment (i.e., auger buckets, sampling bowls, and spoons) with deionized water after decontamination. The rinsate water was collected in a sample container, preserved, and submitted to the SMO. Field rinsate blank samples were analyzed for inorganic chemicals (target analyte list metals, perchlorate, and total cyanide), and were collected from sampling equipment at a frequency of 1 per day.

Field trip blanks were collected at a frequency of 1 per day to determine contamination during storage and transport when samples were being collected for VOC analysis. Field trip blanks were containers of certified clean sand, unopened and kept with the sample containers during sampling and transport.

B-5.4 Sample Documentation and Handling

Field personnel completed an SCL/COC form for each sample. Sample containers were sealed with signed custody seals and placed in insulated containers at approximately 4°C. Samples were handled in accordance with N3B-SOP-SDM-1101, “Sample Control and Field Documentation,” and N3B-SOP-SDM-1100, “Sample Containers, Preservation, and Field Quality Control.” Samples were transported to the SMO in sealed coolers containing ice packs and shipped from the SMO to the analytical laboratories. The SMO personnel reviewed and approved the SCLs/COC forms before taking custody of the samples. The SCLs/COC forms are provided in Appendix D (on DVD included with this document).

B-5.5 Borehole Abandonment

The five sample locations at SWMU 16-017(j)-99 were abandoned by filling the holes with the cuttings after sample results were received. All cuttings from those locations were managed as waste as described in Appendix E until the analytical data were received and reviewed.

B-5.6 Decontamination of Sampling Equipment

All sampling equipment, including hand augers, was decontaminated using dry decontamination methods immediately before each sample was collected to avoid outside contamination and cross-contamination between samples. Decontamination activities were performed in accordance with N3B-SOP-ER-2002, “Field Decontamination of Equipment.” To evaluate decontamination activities, field equipment rinsate blank samples were collected in accordance with procedures N3B-SOP-SDM-1100, “Sample Containers, Preservation and Field Quality Control” and N3B-SOP-ER-2002, “Field Decontamination of Equipment.”

B-6.0 GEODETIC SURVEYING

Geodetic surveys of sampling locations were performed by a licensed State of New Mexico surveyor utilizing real-time kinematic global positioning System (GPS) surveying. The specific equipment used was Javad Navigation Systems, Inc., TRIUMPH-1 receivers coupled with a Juniper Systems, Inc., Allegro 2 controller. Horizontal accuracy of the GPS unit is within 1.0 ft. During sampling, if the planned location could not be sampled because of surface or subsurface obstruction or other unanticipated field conditions, the relocated sampling location was resurveyed. The surveyed sample location coordinates are presented in Table 3.2-1 of the investigation report.

B-7.0 DEVIATIONS FROM WORK PLAN

There were three deviations to the proposed sampling at SWMU 16-017(g)-99 in the Upper Water Canyon Aggregate Area approved IWP (LANL 2011, 111602; NMED 2011, 111827):

- The horizontal accuracy of the geodetic survey equipment was less than 1.0 ft, not less than 0.5 ft.
- The boreholes were backfilled with the excess sample material after the analytical results were received and verified as less than residential soil screening levels.
- Organic vapor screening of surface and subsurface samples was not conducted.

B-8.0 REFERENCES

The following reference list includes documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. ERIDs were assigned by the Laboratory's Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above).

LANL (Los Alamos National Laboratory), January 2011. "Investigation Work Plan for Upper Water Canyon Aggregate Area, Revision 1," Los Alamos National Laboratory document LA-UR-11-0135, Los Alamos, New Mexico. (LANL 2011, 111602)

NMED (New Mexico Environment Department), February 18, 2011. "Direction to Modify, Upper Water Canyon Aggregate Area Investigation Work Plan, Revision 1," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2011, 111827)

Table B-1.0-1
Summary of Field Investigation Methods

Method	Summary
Field-Screening and Instrument Calibration	The response check and calibration of instruments used to screen for radioactivity was conducted by a qualified representative. All response checks and calibrations were performed daily according to the manufacturers' specifications and requirements with approved operating procedures and recorded on the appropriate forms.
Spade-and-Scoop Collection of Soil Samples	This method was used to collect shallow (i.e., approximately 0−1.0 ft) soil or sediment samples. The spade-and-scoop method involved digging a hole to the desired depth, as prescribed in the approved investigation work plan, and collecting a discrete grab sample. Samples for VOC analysis were transferred immediately into sample containers. Containers for VOC analysis were filled as completely as possible and sealed with Teflon-lined caps. Remaining sample material was placed in a clean stainless-steel bowl for transfer to various sample containers.
Hand-Auger Sampling	This method is typically used for sampling soil or sediment at depths of less than 10–15 ft but in some cases may be used to collect samples of weathered or nonwelded tuff. The method involves hand-turning a stainless-steel bucket auger (typically 3–4 in. inside diameter), creating a vertical hole that can be advanced to the desired sample depth. When the desired depth was reached, the auger was decontaminated before advancing the hole through the sampling depth. Samples for VOC analysis were transferred immediately to sample containers. Containers for VOC analysis were filled as completely as possible and sealed with Teflon-lined caps. The remaining sample material was transferred from the auger bucket to a stainless-steel sampling bowl before the various required sample containers were filled.
Handling, Packaging, and Shipping of Samples	Field team members sealed and labeled samples before packing to ensure the sample and the transport containers were free of external contamination. The samples were packaged to minimize the possibility of breakage during transport. Newport News Nuclear BWXT-Los Alamos, LLC, radiological control technicians performed and documented a free-release survey of the exterior of the sample containers, and a U.S. Department of Transportation shipping survey was performed and documented before transportation to the Sample Management Office (SMO). After all environmental samples were collected, packaged, and preserved a field team member transported them to the SMO, which arranged to ship the samples to the analytical laboratories.
Sample Control and Field Documentation	The collection, screening, and transport of samples were documented on standard forms generated by the SMO. These included sample collection logs (SCLs), chain of custody (COC) forms, and sample container labels. SCLs were completed at the time of sample collection, and the logs were signed by the sampler and a reviewer who verified the logs for completeness and accuracy. Corresponding labels were initialed and applied to each sample container, and custody seals were placed around each sample container. COC forms were completed and signed to verify that the samples had not been left unattended.
Field Quality Control Samples	Field quality control samples were collected as follows: Field Duplicates – collected at a frequency of 10% at the same time as a regular sample and submitted for the same analyses. Equipment Rinsate Blank – collected at a frequency of 10% by rinsing sampling equipment with deionized water, which was then collected in a sample container and submitted for laboratory analysis. Trip Blanks – required for all field events that included the collection of samples for VOC analysis. Trip-blank containers of certified clean sand were unopened and kept with the other sample containers during the sampling process.

Table B-1.0-1 (continued)

Method	Summary
Field Decontamination of Drilling and Sampling Equipment	Dry decontamination was used to minimize the generation of liquid waste. Dry decontamination consisted of using a wire brush or other tool to remove soil or other material adhering to the sampling equipment, followed by use of a commercial cleaning agent (nonacid, waxless cleaners) and paper wipes.
Containers and Preservation of Samples	Specific requirements/processes for sample containers, preservation techniques, and holding times are based on U.S. Environmental Protection Agency guidance for environmental sampling, preservation, and quality assurance. Specific requirements for each sample were printed on the SCL provided by the SMO (size and type of container, e.g., glass, amber glass, or polyethylene). All samples were preserved by placement in insulated containers with ice to maintain a temperature of 4ºC.
Management of Environmental Remediation Program Waste, Waste Characterization	Investigation-derived waste (IDW) was managed, characterized, and stored in accordance with an approved waste characterization strategy form that documents site history, field activities, and characterization approach for each waste stream managed. During the investigation, waste characterization complied with on- or off-site waste acceptance criteria. All stored IDW was marked with appropriate signage and labels. Drummed IDW was stored on pallets to prevent deterioration of containers. A waste storage area was established before waste was generated. Waste storage areas were located in controlled areas of the Laboratory and were monitored as needed to prevent inadvertent addition to or management of wastes by unauthorized personnel. Each container of waste generated was individually labeled with waste classification, item identification number, and radioactivity (if applicable) immediately following containerization. All waste was segregated by classification and compatibility to prevent cross-contamination. Management of IDW is described in Appendix E.
Coordinating and Evaluating Geodetic Surveys	Geodetic surveys obtained survey data of acceptable quality to use during project investigations. Geodetic surveys were performed by a Licensed State of New Mexico Surveyor. All coordinates were expressed as State Plane Coordinate System 83, NM Central, U.S. feet. All elevation data were reported relative to the National Geodetic Vertical Datum of 1983.

Table B-1.0-2
Standard Operating Procedures Used for the Investigation Activities at SWMU 16-017(j)-99

N3B-AP-ER-1002	Environmental Remediation (ER) Field Work Requirements
N3B-AP-TRU-2150	Waste Characterization Strategy Form
N3B-GDE-ER-5015	Storm Water Best Management Practices Manual
N3B-SOP-ER-2001	Soil, Tuff, and Sediment Sampling
N3B-SOP-ER-2002	Field Decontamination of Equipment
N3B-SOP-SDM-1100	Sample Containers, Preservation, and Field Quality Control
N3B-SOP-SDM-1101	Sample Control and Field Documentation

Appendix C

Analytical Program

C-1.0 INTRODUCTION

This appendix discusses the analytical methods and data-quality review for samples collected during the Solid Waste Management Unit (SWMU) 16-017(j)-99 investigation at Technical Area 16 in Upper Water Canyon Aggregate Area at Los Alamos National Laboratory (LANL or the Laboratory).

Newport News Nuclear BWXT-Los Alamos, LLC (N3B) uses the Environmental Information Management (EIM) database for data management. This is a cloud-based data management platform used for managing sampling events, tracking the packaging and transportation of samples, and storing the resultant data. In addition to N3B, Triad National Security, LLC, and the U.S. Department of Energy (DOE) Oversight Bureau of the New Mexico Environment Department (NMED) share EIM for all LANL environmental analytical data. EIM interfaces with Intellus New Mexico (Intellus), a fully searchable database available to the public through the Intellus website (http://www.intellusnm.com).

The system, written and maintained by Locus Technologies, consists of a cloud-based Structured Query Language (SQL) server database platform coupled with a web-based user interface. It is a comprehensive sample and data management application, designed to manage the process from sample planning through data review and reporting. It includes modules for sample planning, sample tracking, manual and electronic field data upload, electronic data deliverables (EDDs) upload, Automated Data Review (ADR) routines, notification emails, and reporting tools.

Laboratory data packages and EDDs adhere to the requirements specified in N3B's Exhibit D: Scope of Work and Technical Specifications for Off-Site Analytical Laboratory Services.

N3B ensures that reported external analytical laboratory data are of sufficient quality to fulfill their intended purpose and that the condition of the data is documented so that future users of analytical laboratory results produced for the Los Alamos Legacy Cleanup Contract can use the data. The data collected must have sufficient quality and quantity to support defensible decision-making as described in U.S. Environmental Protection Agency (EPA) guidance (https://www.epa.gov/quality/guidance-systematic-planning-using-data-quality-objectives-process-epa-qag-4). The N3B Sample Data Management Program has data quality objectives detailing minimum quality assurance (QA)/quality control (QC) requirements.

Data examination, verification, and validation include (1) application of data qualifiers and reason codes to analytical results and (2) modification of detection status, based on outcome of specific laboratory QC sample analyses (e.g., spikes, duplicates, surrogates, method blanks [MBs], laboratory control samples [LCSs], and tracers), holding times, proper preservation, and field QC samples as applicable. The process also includes a best-selection evaluation to determine the best value for multiple analytical results of the same analyte from the same sample. Qualification of 100% of analytical data occurs during verification using the EIM ADR module, and a minimum of 10% of analytical data is also subjected to a more in-depth validation by an N3B chemist.

The entire data validation process includes a description of the reasons for any failure to meet method, procedural, or contractual requirements and an evaluation of the impact of such failure on the associated data or data set.

During this process, individual sample results are qualified as accepted or rejected. Data that are accepted per the validation criteria are classified as follows: not detected (U), estimated but not detected (UJ), estimated (J), or detected without data qualification (NQ). Accepted data can then be used as needed, assuming that no problems occurred during the sampling events. Data that are rejected per the validation criteria are unusable. In addition, the analytical results can also be further labeled with data validation reason codes that explain the reason for the qualification. See Appendix A of this document, which includes data qualifier definitions.

The analytical data, instrument printouts, and data validation reports are provided in Appendix D (on DVD included with this document). In addition to the laboratory analytical data, sample collection logs (SCLs) and chain of custody forms (COCs) are also provided in Appendix D.

N3B data validation is performed externally by the analytical laboratory and end users of the data. This data validation process applies a defined set of performance-based criteria to analytical data, which may result in qualification of that data. Data validation provides a level of assurance, based on this technical evaluation, of the data quality. N3B validation of chemistry data includes a technical review of the analytical data package that covers the evaluation of both field and laboratory QA/QC samples, the identification and quantitation of analytes, and the effect of QA/QC deficiencies on analytical data, as well as other factors affecting the data quality.

Sampling and data validation were conducted using standard operating procedures (SOPs) and other documents that are part of N3B's comprehensive QA/QC program. Procedures and other documents include the most current version of the following:

- N3B-SOP-ER-2001, “Soil, Tuff, and Sediment Sampling”
- N3B-SOP-SDM-1100, “Sample Containers, Preservation, and Field Quality Control”
- N3B-SOP-SDM-1101, “Sample Control and Field Documentation”
- N3B-SOP-SDM-1102, “Sample Receiving and Shipping by the N3B Sample Management Office”
- N3B-AP-SDM-3001, “Validation of Volatile Organic Compounds Analytical Data”
- N3B-AP-SDM-3003, “Validation of Organochlorine Pesticides and Herbicides and Polychlorinated Biphenyls Analytical Data”
- N3B-AP-SDM-3005, “Validation of Metals Analytical Data”
- N3B-AP-SDM-3006, “Validation of Radiochemical Analytical Data”
- N3B-AP-SDM-3007, “Validation of General Chemistry Analytical Data”
- N3B-AP-SDM-3008, “Validation of High Explosives Analytical Data”
- N3B-AP-SDM-3012, “Validation of Analytical Data by Liquid Chromatography and Liquid Chromatography/Tandem Mass Spectrometry”

After the sampling event is planned using the EIM Sample Request module, sample collection logs are created and printed to serve as COC documents and analytical request forms.

The sampling events included collection of field trip blank (FTB), field rinsate (FR) blank, and field duplicate (FD) QA/QC samples. Detection of analytes in FTBs may indicate contamination resulting from sample collection, transportation, or the analytical laboratory processes. Differences in analytical results between a FD and its regular sample may indicate the samples were not uniform or that significant variation in analysis occurred between the two samples. Detection of analytes in FR blanks may indicate contamination from inadequately decontaminated field equipment or from the analytical laboratory process.

The FTBs are septum amber glass containers prefilled with soil that are subjected to the same conditions as regular samples. FTBs are collected when volatile organic compound (VOC) samples are collected at a minimum rate of 1 per day. FTBs are collected from locations where the regular samples are collected.

FR blanks are collected at a minimum rate of 1 per 10 investigation samples to confirm decontamination of the sampling equipment.

FDs are collected at a minimum rate of 1 per 10 investigation samples collected. FDs are split samples collected from locations where the regular samples are collected.

Following sample collection, sampling personnel deliver the samples and the field collection log to sample management personnel at the N3B Sample Management Office (SMO). An analytical COC is then created, which includes the field sample identification number, the date and time of field sample collection, the analytical parameters group code, and the number of bottles for each analytical parameter group. The N3B SMO ships the samples to the appropriate laboratory for analysis.

The laboratory QA/QC process is defined in the appropriate analytical method and the external analytical laboratory statement of work (SOW).

The external laboratory uploads the EDD and its corresponding analytical data pdf data package to EIM. The data are then validated both manually and in the EIM autovalidation process, then reviewed by an N3B chemist at the appropriate level, and then fully transferred into EIM.

C-2.0 ANALYTICAL DATA ORGANIZATION

None of the organic chemical analytical results were rejected for the purpose of this report. All data, including qualified data, are usable for evaluation and interpretive purposes.

Summaries of the analytical methods for inorganic and organic chemicals are provided in the following sections.

C-3.0 INORGANIC CHEMICAL ANALYSES

SWMU 16-017(j)-99 samples collected during this investigation were analyzed for the following inorganic chemicals: nitrate, perchlorate, total cyanide, mercury, and target analyte list (TAL) metals. Samples were analyzed for nitrate using EPA SW-846 Method 9056; for perchlorate using SW-846 Method 6850; and for cyanide using SW-846 Method 9012B. Samples were analyzed for mercury using SW-846 Method 7471A. Samples were also analyzed for TAL metals using SW-846 Methods 6010C and 6020B. The analytical methods used for inorganic chemicals are listed in Table C-3.0-1.

A total of 15 samples (plus 2 FDs and 2 FR blanks) were submitted for analysis of nitrate, perchlorate, total cyanide, mercury, and TAL metals.

All decision-level analytical data are included in Appendix D (on DVD included with this document) and can also be found in the public Intellus database at http://www.intellusnm.com.

C-3.1 Inorganic Chemical QA/QC Analyses

The use of QA/QC samples is designed to produce quantitative measures of the reliability of specific parts of an analytical procedure. The results of the QA/QC analyses performed on a sample provide confidence about whether the analyte is present and whether the concentration reported is accurate. To assess accuracy and precision of inorganic chemical analyses, calibration verifications, LCSs, MBs, matrix spike (MS) samples, laboratory duplicate samples, interference check samples (ICSs), and serial dilution samples were analyzed as part of the SWMU 16-017(j)-99 investigation. Each of these QA/QC sample types is defined in the analytical services SOWs (N3B 2021, 701955; N3B 2022, 701957) and is described briefly below.

Calibration verification is the establishment of a quantitative relationship between the response of the analytical procedure and the concentration of the target analyte. There are two aspects of calibration verification: initial and continuing. The initial calibration verifies the accuracy of the calibration curve as well as the individual calibration standards used to perform the calibration. The continuing calibration ensures that the initial calibration is still holding and is correct as the instrument is used to process samples. The continuing calibration also serves to determine whether analyte identification criteria such as retention times and spectral matching are being met.

The LCS serves as a monitor of the overall performance of each step during the analysis, including sample digestion. For inorganic chemicals in soil/tuff, LCS percent recoveries (%R) should fall between the lower acceptance limit (LAL) and upper acceptance limit (UAL).

An MB is an analyte-free matrix to which all reagents are added in the same volumes or proportions as those used in the environmental sample processing and which is extracted and analyzed in the same manner as the corresponding environmental samples. MBs are used to assess the potential for sample contamination during extraction and analysis. All target analytes in the MB should be below the contract-required detection limit.

MS samples assess the accuracy of inorganic chemical analyses. These samples are designed to provide information about the effect of the sample matrix on the sample preparation procedures and analytical technique. The MS acceptance criterion is between the LAL and UAL, inclusive for all spiked analytes.

Laboratory duplicate samples assess the precision of inorganic chemical analyses. All relative percent differences (RPDs) between the sample and laboratory duplicate should be ±35% for soil (N3B 2018, 701957; N3B 2021, 701955).

The ICSs assess the accuracy of the analytical laboratory’s interelement and background correction factors used for inductively coupled plasma emission spectroscopy. The ICS %R should be between the LAL and UAL.

Serial dilution samples measure potential physical or chemical interferences and correspond to a sample dilution ratio of 1:5. The chemical concentration in the undiluted sample must be at least 50 times the method detection limit (MDL) and 100 times the MDL for inductively coupled plasma mass spectroscopy for valid comparison. For sufficiently high concentrations, the RPD should be within 10%.

Details regarding the quality of the inorganic chemical analytical data included in the data set are summarized in the following subsections.

C-3.2 Data Quality Results for Inorganic Chemicals

The majority of the analytical results are qualified as not detected (U) or not qualified (NQ) because the analytes were not detected by the respective analytical methods or were detected without data qualification. These data do not have any quality issues associated with the values presented.

C-3.2.1 Chain of Custody

COC forms were maintained properly for all samples analyzed for inorganic chemicals (see Appendix D [on DVD included with this document]).

C-3.2.2 Sample Documentation

All samples analyzed for inorganic chemicals were properly documented in the field in the SCLs (see Appendix D [on DVD included with this document]).

C-3.2.3 Sample Dilutions

Some samples were diluted for inorganic chemical analyses. No qualifiers were applied to any inorganic chemical analytical results because of dilutions.

C-3.2.4 Sample Preservation

Preservation criteria were met for all samples analyzed for inorganic chemicals.

C-3.2.5 Laboratory Duplicate Samples

A total of 43 TAL metal results were qualified as estimated (J) because the sample and duplicates were greater than or equal to 5 times the reporting limit and the duplicate RPD was greater than 35% (code I10a).

C-3.2.6 Method Blanks

A total of eight TAL metal results were qualified as estimated and potentially biased high (J+) because the analyte was identified in the MB but was greater than 5 times the associated sample result (code I4a).

C-3.2.7 MS Samples

A total of eight TAL metal results were qualified as estimated and potentially biased low (J-) because the associated MS recovery was below the LAL but greater than 10% (code I6a).

A total of seven TAL metal results were qualified as estimated and potentially biased high (J+) and seven were qualified as estimated (J) because the associated MS recovery was above the UAL (code I6b).

C-3.2.8 Method Detection Limits

A total of 31 TAL metal results, 3 nitrate results, and 1 total cyanide result were qualified as estimated (J) because the result was less than the practical quantitation limit (PQL) but greater than the MDL (code J_LAB).

C-3.2.9 Field Duplicates and Rinsate Blanks

The majority of the FTB and FR blank analytical results were qualified as not detected (U) or not qualified (NQ) because the analytes were not detected by the respective analytical methods or were not qualified. These data do not have any quality issues associated with the values presented.

A total of six TAL metal results were qualified as estimated (J) because the sample and duplicates were greater than or equal to 5 times the reporting limit and the duplicate RPD was greater than 35% (code I10a).

One TAL metal result was qualified as estimated and potentially biased high (J+) because the analyte was identified in the MB but was greater than 5 times the associated sample result (code I4a).

One TAL metal result was qualified as estimated and potentially biased low (J-) because the associated MS recovery was below the LAL but greater than 10% (code I6a).

One TAL metal result was qualified as estimated and potentially biased high (J+) because the associated MS recovery was above the UAL (code I6b).

One nitrate result was qualified as estimated and potentially biased low (J-) because the extraction holding time was exceeded (code I9a).

A total of eight TAL metal results and one nitrate result were qualified as estimated (J) because the result was less than the PQL but greater than the MDL (code J_LAB).

C-3.2.10 Rejected Results

All samples analyzed for inorganic chemicals were accepted.

C-4.0 ORGANIC CHEMICAL ANALYSES

Fill samples were analyzed for one or more of the following organic chemicals: explosive compounds, semivolatile organic compounds (SVOCs), and VOCs. Samples were analyzed for explosive compounds using EPA SW-846 Method 8330B; for SVOCs using SW-846 Method 8270D; and for VOCs using SW-846 Method 8260D. The analytical methods used for organic chemicals are listed in Table C-4.0-1.

A total of 15 samples (plus 2 FDs) were submitted for analysis of high explosives and SVOCs; and 10 samples (plus 1 FD and 2 FTBs) were submitted for analysis of VOCs.

All organic chemical analytical results are included in Appendix D (on DVD included with this document) and can also be found in the public Intellus database at https://www.intellusnm.com.

C-4.1 Organic Chemical QA/QC Samples

The use of QA/QC samples is designed to produce quantitative measures of the reliability of specific parts of an analytical procedure. The results of the QA/QC analyses performed on a sample provide confidence about whether the analyte is present and whether the concentration reported is accurate. Calibration verifications, LCSs, MBs, MS samples, laboratory duplicate samples, surrogates, and internal standards (ISs) were analyzed to assess the accuracy and precision of organic chemical analyses. Each of these QA/QC sample types is defined in the analytical services SOWs (N3B 2021, 701955; N3B 2022, 701957) and described briefly below.

Calibration verification is the establishment of a quantitative relationship between the response of the analytical procedure and the concentration of the target analyte. There are two aspects of calibration verification: initial and continuing. The initial calibration verifies the accuracy of the calibration curve as well as the individual calibration standards used to perform the calibration. The continuing calibration ensures that the initial calibration is still holding and is correct as the instrument is used to process samples. The continuing calibration also serves to determine whether analyte identification criteria such as retention times and spectral matching are being met.

The LCS is a sample of a known matrix that has been spiked with compounds that are representative of the target analytes, and it serves as a monitor of overall performance on a “controlled” sample. The LCS is the primary demonstration, on a daily basis, of the ability to analyze samples with good qualitative and quantitative accuracy. The LCS recoveries should fall between the LAL and UAL.

An MB is an analyte-free matrix to which all reagents are added in the same volumes or proportions as those used in the environmental sample processing; it is extracted and analyzed in the same manner as the corresponding environmental samples. MBs are used to assess the potential for sample contamination during extraction and analysis. All target analytes should be below the contract-required detection limit in the MB (N3B 2018, 701957; N3B 2021, 701955).

MS samples are used to measure the ability to recover prescribed analytes from a native sample matrix and consist of aliquots of the submitted samples spiked with a known concentration of the target analyte(s). Spiking typically occurs before sample preparation and analysis. The spike sample recoveries should be between the LAL and UAL.

Laboratory duplicate samples assess the precision of organic chemical analyses. All RPDs between the sample and laboratory duplicate should be ±35% for soil (N3B 2021, 701955; N3B 2022, 701957).

A surrogate compound (surrogate) is an organic compound used in the analyses of target analytes that is similar in composition and behavior to the target analytes but normally is not found in environmental samples. Surrogates are added to every blank, sample, and spike to evaluate the efficiency with which analytes are recovered during extraction and analysis. The recovery percentage of the surrogates must be within specified ranges or the sample may be rejected or assigned a qualifier.

ISs are chemical compounds added to every blank, sample, and standard extract at a known concentration. They are used to compensate for (1) analyte concentration changes that might occur during storage of the extract and (2) quantitation variations that can occur during analysis. ISs are used as the basis for quantitation of target analytes. The %R for ISs should be within the range of 50% to 200%.

Details regarding the quality of the organic chemical analytical data included in the data sets are summarized in the following subsections.

C-4.2 Data Quality Results for Organic Chemicals

The majority of the analytical results are qualified as not detected (U) or not qualified (NQ) because the analytes were not detected by the respective analytical methods or were detected without data qualification. These data do not have any quality issues associated with the values presented.

A total of 56 SVOC results and 30 VOC results were qualified as estimated not detected (UJ) because the N3B project chemist identified quality deficiencies in the reported data that require further qualification (codes SV7K and V7K).

C-4.2.1 Maintenance of Chain of Custody

COC forms were maintained properly for all samples analyzed for organic chemicals (see Appendix D [on DVD included with this document]).

C-4.2.2 Sample Documentation

All samples analyzed for organic chemicals were properly documented in the SCLs in the field (see Appendix D [on DVD included with this document]).

C-4.2.3 Sample Dilutions

Some samples were diluted for organic chemical analyses. No qualifiers were applied to any organic chemical sample results because of dilution.

C-4.2.4 Sample Preservation

Preservation criteria were met for all samples analyzed for organic chemicals.

C-4.2.5 Holding Times

Holding times were met for all samples analyzed for organic chemicals.

C-4.2.6 ICVs and CCVs

A total of seven explosive compound results were qualified as estimated not detected (UJ) because the initial calibration verifications (ICVs) and/or continuing calibration verifications (CCVs) were recovered outside the method-specific limits (code HE7C).

A total of 10 VOC results were qualified as estimated not detected (UJ) because the affected analytes were analyzed with a relative response factor (RRF) of less than 0.05 in the ICV and/or CCV (code V7B).

C-4.2.7 Laboratory Duplicate Samples

A total of 16 SVOC results were qualified as estimated (J) and 10 SVOC results were qualified as estimated not detected (UJ) because the sample and duplicate precision criteria were not met (code SV10c).

C-4.2.8 Laboratory Control Sample Recoveries

A total of seven SVOC results were qualified as estimated not detected (UJ) because the LCS %R was less than the LAL but greater than 10% (code SV12a).

C-4.2.9 MS Samples

A total of 21 SVOC and 30 VOC results were qualified as estimated not detected (UJ) because the MS/matrix spike duplicate (MSD) %R was below the lower limit (codes SV12e and V12e).

A total of seven SVOC results were qualified as estimated not detected (UJ) because the MS/MSD RPD acceptance limit was exceeded (code SV12g).

C-4.2.10 Method Detection Limits

A total of 10 SVOC results were qualified as estimated (J) because the result was less than the PQL but greater than the MDL (code J_LAB).

C-4.2.11 Field Trip Blanks, Field Duplicates, and Rinsate Blanks

The majority of the FTB and FR blank analytical results were qualified as not detected (U) or not qualified (NQ) because the analytes were not detected by the respective analytical methods or were not qualified. These data do not have any quality issues associated with the values presented.

One explosive compound result was qualified as estimated not detected (UJ) because the ICVs and/or CCVs were recovered outside the method-specific limits (code HE7C).

A total of five SVOC results and two VOC results were qualified as estimated (J) because the result was less than the PQL but greater than the MDL (code J_LAB).

A total of 10 SVOC results were qualified as estimated not detected (UJ) because the sample and duplicate precision criteria were not met (code SV10c).

One SVOC result was qualified as estimated not detected (UJ) because the LCS %R was less than the LAL but greater than 10% (code SV12a).

A total of three SVOC and nine VOC results were qualified as estimated not detected (UJ) because the MS/MSD %R was below the lower limit (codes SV12e and V12e).

One SVOC result was qualified as estimated not detected (UJ) because the MS/MSD RPD acceptance limit was exceeded (code SV12g).

A total of eight SVOC results and six VOC results were qualified as estimated not detected (UJ) because the N3B project chemist identified quality deficiencies in the reported data that require further qualification (codes SV7K and V7K).

Two VOC results were qualified as estimated not detected (UJ) because the affected analytes were analyzed with an RRF of less than 0.05 in the ICV and/or CCV (code V7b).

C-4.2.12 Rejected Data

All samples analyzed for organic chemicals were accepted.

C-5.0 REFERENCES

The following reference list includes documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. ERIDs were assigned by Los Alamos National Laboratory's (the Laboratory's) Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above).

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), September 1, 2021. "Newport News Nuclear BWXT-Los Alamos, LLC, Contract for Off-Site Analytical Services for Subcontract No. PO-0000346 Exhibit D Modifications for Contract through September 2021," from S. Sandborgh (N3B), Los Alamos, New Mexico. (N3B 2021, 701955)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), February 1, 2022. "N3B Contract for Off-Site Analytical Services for SubK No. PO-0000346 Exhibit D Modifications February 2022: New/Adjusted Analytes and Pay Items Requested for Subcontract No. PO-0000261," from S. Sandborgh (N3B), Los Alamos, New Mexico. (N3B 2022, 701957)

Table C-3.0-1
Inorganic Chemical Analytical Methods for Samples Collected from SWMU 16-017(j)-99

Analytical Method	Analytical Description	Analytical Suite
SW-846:6010C	Inductively coupled plasma atomic emission spectroscopy	Aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, cobalt, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, sodium, silver, thallium, vanadium, and zinc (TAL metals)
SW-846:6020/6020B	Inductively coupled plasma mass spectrometry	Aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, cobalt, chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, sodium, silver, thallium, uranium, vanadium, and zinc (TAL metals plus uranium)
SW-846:6850	Perchlorate by liquid chromatography/mass spectrometry or by liquid chromatography/mass spectrometry/mass spectrometry	Perchlorate
SW-846:7470A	Manual cold-vapor technique	Mercury
SW-846:7471A	Manual cold-vapor technique	Mercury (TAL metal)
SW-846:9012B	Automated colorimetric/off-line distillation	Cyanide (total)
EPA:335.4	Semi-automated colorimetry	Cyanide (total)
EPA:353.2	Automated colorimetry/cadmium reduction	Nitrate
SW-846:9056/9056A	Ion chromatography	Nitrate

Table C-4.0-1
Organic Chemical Analytical Methods for Samples Collected from SWMU 16-017(j)-99

Analytical Method	Analytical Description	Target Compound List
SW-846:8260D	Purge and trap, gas chromatography/mass spectrometry	VOCs
SW-846:8270D	Solvent extraction, gas chromatography/mass spectrometry	SVOCs
SW-846:8330B	High-performance liquid chromatography/mass spectrometry	Explosive compounds, nitroaromatics, and nitramines

Appendix D

Analytical Suites and Results and Analytical Reports
(on DVD included with this document)

Appendix E

Investigation-Derived Waste Management

E-1.0 INTRODUCTION

This appendix contains the waste management records for the investigation-derived waste (IDW) generated during the implementation of the investigation work plan for Solid Waste Management Unit (SWMU) 16-017(j)-99 in the Upper Water Canyon Aggregate Area (LANL 2011, 111602; NMED 2011, 111827) at Technical Area 16 of Los Alamos National Laboratory (LANL or the Laboratory).

All IDW generated during the field investigation was managed in accordance with N3B-P409-0, “N3B Waste Management.” This procedure incorporates the requirements of applicable U.S. Environmental Protection Agency and New Mexico Environment Department (NMED) regulations, U.S. Department of Energy orders, and Newport News Nuclear BWXT-Los Alamos, LLC (N3B) implementation requirements.

Consistent with N3B procedures, a waste characterization strategy form (WCSF) (N3B 2020, 701111) was prepared by N3B to address characterization approaches, on-site management, and final disposition options for wastes. Analytical data and/or acceptable knowledge was used to complete the WCSF. The WCSF is included in this appendix as Attachment E-1 (on CD included with this document).

The selection of waste containers was based on appropriate U.S. Department of Transportation requirements, waste types, and estimated volumes of IDW to be generated. Immediately following containerization, each waste container was individually labeled with a unique identification number and information regarding waste classification, contents, waste generator, and date generated.

Wastes were staged in clearly marked and appropriately constructed registered staging areas. Container and storage requirements were detailed in the WCSF and approved before waste was generated. Investigation activities were conducted in a manner that minimized the generation of waste.

E-2.0 WASTE STREAMS

The IDW streams generated and managed during the investigation of SWMU 16-017(j)-99 are described below and summarized in Table E-2.0-1.

- *WCSF Waste #1: Contact IDW.* This waste stream is composed of solid waste generated during the investigation and removal activities that has come into contact with contaminated environmental media and equipment. This includes, but is not limited to, personal protective equipment (e.g., gloves), disposable sampling supplies (e.g., plastic bags), and dry decontamination wastes (e.g., paper items). The total amount of contact IDW was 0.012 yd^3.
- *WCSF Waste #2: Environmental Media.* This waste stream consists of contaminated soil. The total amount of media generated was 0.05 yd^3.

E-3.0 REFERENCES

The following reference list includes documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. ERIDs were assigned by Los Alamos National Laboratory's (the Laboratory's) Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above).

LANL (Los Alamos National Laboratory), January 2011. "Investigation Work Plan for Upper Water Canyon Aggregate Area, Revision 1," Los Alamos National Laboratory document LA-UR-11-0135, Los Alamos, New Mexico. (LANL 2011, 111602)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), November 16, 2020. "Waste Characterization Strategy Form (WCSF) Excess Sample Media, Revision 1," Newport News Nuclear BWXT-Los Alamos, LLC, document EM2020-0610, Los Alamos, New Mexico. (N3B 2020, 701111)

NMED (New Mexico Environment Department), February 18, 2011. "Direction to Modify, Upper Water Canyon Aggregate Area Investigation Work Plan, Revision 1," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2011, 111827)

Table E-2.0-1
Summary of IWD Generation and Management

Waste Stream	Waste Type	Volume	Characterization Method	On-Site Management	Disposition
Contact waste (contact IDW)	NH*	0.012 yd^3	Analytical results of site characterization	5-gal. bucket	Los Alamos County Eco Station
Environmental media	NH	0.05 yd^3	Analytical results of site characterization	5-gal. buckets	Land-applied

* NH = Nonhazardous waste.

Attachment E-1

Waste Characterization Strategy Form
(on CD included with this document)

Appendix F

Box Plot and Statistical Results

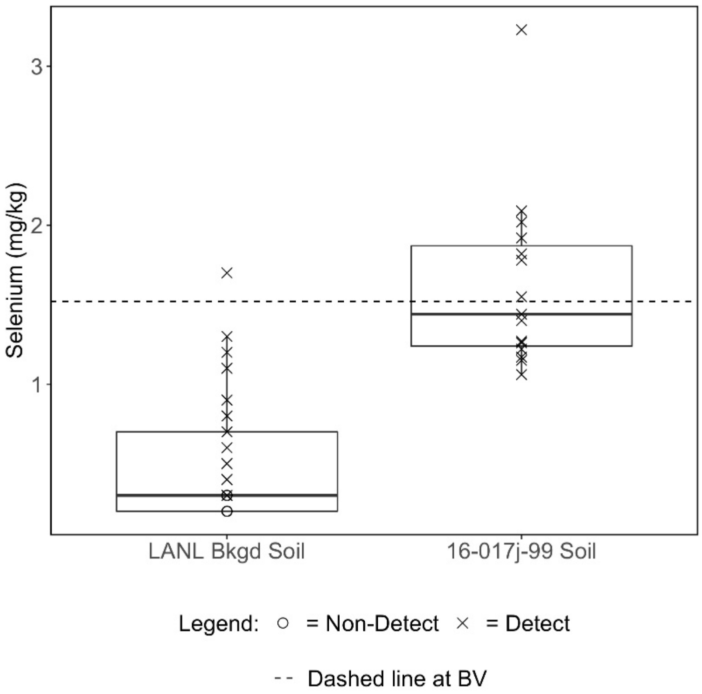

Figure F-1 Box plot for selenium in soil at Solid Waste Management Unit 16-017(j)-99

Table F-1
Results for Statistical Tests for Inorganic Chemicals in Soil at Solid Waste Management Unit 16-017(j)-99

Analyte	Gehan Test p-Value	Quantile Test p-Value	Slippage Test p-Value	COPC?*
Selenium	<0.001	<0.001	<0.001	Yes

* COPC = Chemical of potential concern.

Appendix G

Risk Assessments

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Attachments

G-1.0 INTRODUCTION

This appendix presents the results of the human health and ecological risk-screening evaluations conducted in support of the environmental characterization of solid waste management unit (SWMU) 16-017(j)-99 within the Upper Water Canyon Aggregate Area, located in the western portion of Los Alamos National Laboratory (LANL or the Laboratory). The evaluation of potential risk at one SWMU is based on decision-level data from the 2021 investigation.

G-2.0 BACKGROUND

A brief description of SWMU 16-017(j)-99, the site assessed for potential risk, is presented below.

G-2.1 Site Description and Operational History of SWMU 16-017(j)-99

SWMU 16-017(j)-99 is a former magazine (structure 16-63) at Technical Area 16 (TA-16). The magazine was a 24 ft × 26 ft × 9 ft wood-framed structure surrounded by an earthen berm on three sides and the top. The magazine was built in 1945 and removed in 1998 (LANL 1998, 059602). The storage magazine was built at grade, and there is no longer any evidence of the berm that once surrounded the magazine. Any remaining berm material is indistinguishable from the surrounding soil.

This SWMU was originally designated as part of SWMU 16-017, a group of 24 structures in central TA-16 (LANL 1994, 039440, pp. 6-31–6-33). In 1999, SWMU 16-017 was separated into 24 SWMUs, each consisting of a single structure.

G-2.2 Investigation Sampling

The final data set used to identify chemicals of potential concern (COPCs) for SWMU 16-017(j)-99 and used in this appendix to evaluate the potential risks to human health and the environment consists of the qualified analytical results from the 2021 investigation. Only those data determined to be of decision-level quality following the data quality assessment (Appendix D [on DVD included with this document]) are included in the final data set evaluated in this appendix.

G-2.3 Determination of COPCs

Section 5.0 of the investigation report summarizes the COPC selection process. Only COPCs detected above background (inorganic chemicals), with detection limits greater than background values (BVs) (inorganic chemicals), and detected (organic chemicals and inorganic chemicals with no BVs) were retained. The industrial scenario and the ecological screening used data for samples collected at 0.0–1.0 ft and 0.0–6.0 ft below ground surface (bgs), respectively. The residential and construction worker scenarios used data for samples collected at 0.0–10.0 ft bgs.

Tables G-2.3-1 to G-2.3-3 summarize the COPCs evaluated for potential risk for SWMU 16-017(j)-99. Some of the COPCs identified in this report may not be evaluated for potential risk under one or more scenarios because samples were not collected within the specified depth intervals associated with a given scenario.

G-3.0 CONCEPTUAL SITE MODEL

The primary mechanisms of release related to historical contaminant sources are described in detail in the historical investigation report (LANL 2010, 110410) and summarized in section 2.0 of the approved investigation work plan (LANL 2011, 111602; NMED 2011, 111827). Releases from sites at SWMU 16-017(j)-99 may have occurred as a result of surface releases. Previous sampling results indicated contamination from inorganic chemicals and organic chemicals (LANL 2011, 111602).

G-3.1 Receptors and Exposure Pathways

The primary exposure pathway for human receptors is surface soil and subsurface soil/tuff that may be brought to the surface through intrusive activities. Migration of contamination to groundwater through the vadose zone is unlikely, given the depth to groundwater (approximately 1000 ft at TA-16). Human receptors may be exposed through direct contact with soil or suspended particulates by ingestion, inhalation, dermal contact, and external irradiation pathways. Direct contact exposure pathways from subsurface contamination to human receptors are complete for the resident and the construction worker, where appropriate. The exposure pathways are the same as those for surface soil. Sources, exposure pathways, and receptors are shown in the conceptual site model (CSM) (Figure G-3.1-1).

NMED guidance (NMED 2022, 702141) requires that sites larger than 2 acres be evaluated to determine if beef ingestion is a plausible and complete exposure pathway. SWMU 16-017(j)-99 is smaller than 2 acres. In addition, grazing is not allowed on Laboratory property. Therefore, further evaluation of the beef ingestion pathway is not necessary.

SWMU 16-017(j)-99 is located in an industrial area on Laboratory property. Considering the unpaved site or area where potential habitat is present, exposure pathways are complete to surface soil and tuff for ecological receptors. The potential pathways are root uptake by plants, inhalation of vapors (burrowing animals only), inhalation of dust, dermal contact, incidental ingestion of soil, and food web transport. Pathways from subsurface releases may be complete for plants. Surface water exposure was not evaluated because of the lack of surface water features. Sources, exposure pathways, and receptors are presented in the CSM (Figure G-3.1-1).

G-3.2 Environmental Fate and Transport

The evaluation of environmental fate addresses the chemical processes affecting the persistence of chemicals in the environment, and the evaluation of transport addresses the physical processes affecting mobility along a migration pathway. Migration into soil and tuff depends on precipitation or snowmelt, soil moisture content, depth of soil, soil hydraulic properties, and properties of the COPCs. Migration into and through tuff also depends on the unsaturated flow properties of the tuff and the presence of joints and fractures.

The most important factor with respect to the potential for COPCs to migrate to groundwater is the presence of saturated conditions. Downward migration in the vadose zone is also limited by a lack of hydrostatic pressure as well as the lack of a source for the continued release of contamination. Without sufficient moisture and a source, little or no potential migration of materials through the vadose zone to groundwater occurs.

Contamination at depth is addressed in the discussion of nature and extent in the investigation report. Results from the deepest samples collected at the site showed either no detected concentrations of COPCs or low- to trace-level concentrations of only a few inorganic and/or organic COPCs in fill. The limited extent of contamination is related to the absence of the key factors that facilitate migration, as discussed previously. Given how long the contamination has been present in the subsurface, the physical and chemical properties of the COPCs, and the lack of saturated conditions, the potential for contaminant migration to groundwater is very low.

NMED guidance (NMED 2022, 702141) contains screening levels that consider the potential for contaminants in soil to result in groundwater contamination. These screening levels consider equilibrium partitioning of contaminants among solid, aqueous, and vapor phases and account for dilution and attenuation in groundwater through the use of dilution attenuation factors (DAFs). These DAF soil screening levels (SSLs) may be used to identify chemical concentrations in soil that have the potential to contaminate groundwater (EPA 1996, 059902). Screening contaminant concentrations in soil against these DAF SSLs does not, however, provide an indication of the potential for contaminants to migrate to groundwater. The assumptions used in the development of these DAF SSLs include an assumption of uniform contaminant concentrations from the contaminant source to the water table (i.e., it is assumed that migration to groundwater has already occurred). Furthermore, this assumption is unfounded for cases such as SWMU 16-017(j)-99, where sampling has shown that contamination is vertically bounded near the surface and the distance from the surface to the water table is considerable. For these reasons, screening of contaminant concentrations in soil against the DAF SSLs was not performed.

The relevant release and transport processes of the COPCs are a function of chemical-specific properties that include the relationship between the physical form of the constituents and the nature of the constituent transport processes in the environment. Specific properties include the degree of saturation and the potential for ion exchange (barium and other inorganic chemicals) or sorption and the potential for natural bioremediation. The transport of volatile organic compounds (VOCs) occurs primarily in the vapor phase by diffusion or advection in subsurface air.

Current potential transport mechanisms that may lead to exposure include the following:

- dissolution and/or particulate transport of surface contaminants during precipitation and runoff events
- airborne transport of contaminated surface soil
- continued dissolution and advective/dispersive transport of chemical contaminants contained in subsurface soil and tuff as a result of past operations
- disturbance of contaminants in shallow soil and subsurface tuff by Laboratory operations
- disturbance and uptake of contaminants in shallow soil by plants and animals

Contaminant distributions at the site indicate that after the initial deposition of contaminants from operational activities and historical remediation efforts, elevated levels of COPCs tend to remain concentrated in the vicinity of the original release points. The primary potential release and transport mechanisms identified for SWMU 16-017(j)-99 include direct discharge; precipitation, sorption, and mechanical transport; dissolution and advective transport in water; and volatilization, diffusion, and dispersion. Less significant transport mechanisms include wind entrainment and dispersal of surface soil and uptake of contaminants from soil and water by biota.

Gas or vapor-phase contaminants such as VOCs are likely to volatilize to the atmosphere from near-surface soil and sediment and/or migrate by diffusion through air-filled pores in the vadose zone. Migration of vapor-phase contaminants from tuff into ambient air may occur by diffusion or advection driven by barometric pressure changes.

G-3.2.1 Inorganic Chemicals

In general, and particularly in a semiarid climate, inorganic chemicals are not highly soluble or mobile in the environment, although there are exceptions. The physical and chemical factors that determine the distribution of inorganic COPCs within the soil and tuff at SWMU 16-017(j)-99 are the soil-water partition coefficient (K_d) of the inorganic chemicals, the pH of the soil, soil characteristics (such as sand or clay content), and the redox potential (Eh). The interaction of these factors is complex, but the K_d values provide a general assessment of the potential for migration through the subsurface; chemicals with higher K_d values are less likely to be mobile than those with lower ones. Chemicals with K_d values greater than 40 are very unlikely to migrate through soil towards the water table (Kincaid et al. 1998, 093270). Table G-3.2-1 presents the K_d values and water solubility for the inorganic COPCs for SWMU 16-017(j)-99. Based on this criterion, antimony has a low potential to mobilize and migrate through soil and the vadose zone. The K_d values for nitrate and selenium are less than 40 and may indicate a greater potential to mobilize and migrate through soil and the vadose zone beneath the sites.

It is important to note that other factors besides the K_d values (e.g., speciation in soil, oxidation-reduction potential, pH, and soil mineralogy) also play significant roles in the likelihood that inorganic chemicals will migrate. Nutrients necessary for life, such as calcium, magnesium, and potassium, are not discussed. The COPCs with K_d values less than 40 are discussed further below. Information about the fate and transport properties of inorganic chemicals was obtained from individual chemical profiles published by the Agency for Toxic Substances and Disease Registry (ATSDR); https://www.atsdr.cdc.gov/toxprofiledocs/index.html.

Nitrate is an inorganic water-soluble salt with the potential for rapid migration through soils to surface water and groundwater. Sorption of anions such as nitrate is insignificant in most soils. Leaching of excess soil nitrate into bodies of water is therefore an important consideration. Drainage characteristics of soils are strongly related to nitrate levels in shallow wells near agricultural areas. Other factors affecting leaching potential include the texture of the soil, pH, precipitation rates, tillage, and the types of crops or vegetation that may be planted in the soils. Nitrate has the potential to move into various environmental compartments and is subject to abiotic and biotic degradation processes. Transformation and degradation processes include denitrification to atmospheric nitrogen and plant uptake. Levels of nitrate in soil vary considerably as a function of soil properties, temperature, precipitation rates, nitrogen loadings, farming practices (tillage, crops planted), and seasonal changes. In well-drained aerobic soils, the conversion of ammonia into nitrate (nitrification) increases the soil-nitrate content. In anaerobic soils with high organic matter, such as waterlogged soils or wetlands, denitrification decreases the levels of nitrate in soils. Acidic soils tend to have lower levels of nitrate since the nitrification process ceases at pH levels below 4.5. Nitrate is expected to have moderate mobility under the environmental conditions (neutral to slightly alkaline soil pH and oxidizing near-surface conditions) present at SWMU 16-017(j)-99.

Selenium is not often found in the environment in its elemental form but is usually combined with sulfide minerals or with silver, copper, lead, and nickel minerals. In soil, pH and Eh are determining factors in the transport and partitioning of selenium. In soil with a pH of greater than 7.5, selenates, which have high solubility and a low tendency to adsorb onto soil particles, are the major selenium species and are very mobile. The soil pH at SWMU 16-017(j)-99 is neutral to slightly alkaline, indicating that selenium is not likely to migrate.

G-3.2.2 Organic Chemicals

Table G-3.2-2 presents the physical and chemical properties (organic carbon-water partition coefficient [K_{oc}], logarithm to the base 10 octanol/water partition coefficient [log K_{ow}], and solubility) of the organic COPCs identified for SWMU 16-017(j)-99. The physical and chemical properties of organic chemicals are important when evaluating their fate and transport. The following physiochemical property information illustrates some aspects of the fate and transport of COPCs at SWMU 16-017(j)-99. The information is summarized from Ney (1995, 058210).

Water solubility may be the most important chemical characteristic used to assess mobility of organic chemicals. The higher the water solubility of a chemical, the more likely it is to be mobile and the less likely it is to accumulate, bioaccumulate, volatilize, or persist in the environment. A highly soluble chemical (water solubility greater than 1000 mg/L) is prone to biodegradation and metabolism that may detoxify the parent chemical. One COPC detected at SWMU 16-017(j)-99 has a water solubility greater than 1000 mg/L, di-n-butylphthalate.

The lower the water solubility of a chemical, especially below 10 mg/L, the more likely it will be immobilized by adsorption. Chemicals with lower water solubilities are more likely to accumulate or bioaccumulate and persist in the environment, are slightly prone to biodegradation, and are metabolized in plants and animals. The COPCs identified as having water solubilities less than 10 mg/L are benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; bis(2-ethylhexyl)phthalate; carbazole; chrysene; fluoranthene; indeno(1,2,3-cd)pyrene; phenanthrene; and pyrene.

Vapor pressure is a chemical characteristic used to evaluate the tendency of organic chemicals to volatilize. Chemicals with vapor pressure greater than 0.01 mm Hg are likely to volatilize, and concentrations at the site are therefore reduced over time. Vapors of these chemicals are more likely to travel toward the atmosphere and not migrate towards groundwater. No organic chemicals detected at SWMU 16-017(j)-99 have vapor pressures greater than 0.01 mm Hg.

Chemicals with vapor pressures less than 0.000001 mm Hg are less likely to volatilize and therefore tend to remain immobile. Benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; bis(2-ethylhexyl)phthalate; carbazole; chrysene; and indeno(1,2,3-cd)pyrene have vapor pressures less than 0.000001 mm Hg.

The K_{ow} is an indicator of a chemical's potential to bioaccumulate or bioconcentrate in the fatty tissues of living organisms. The unitless K_{ow} value is an indicator of water solubility, mobility, sorption, and bioaccumulation. The higher the K_{ow} above 1000, the greater the affinity the chemical has for bioaccumulation/bioconcentration in the food chain, the greater the potential for sorption in the soil, and the lower the mobility (Ney 1995, 058210). No organic chemicals detected at SWMU 16-017(j)-99 have a K_{ow} greater than 1000.

A K_{ow} of less than 500 indicates high water solubility, mobility, little to no affinity for bioaccumulation, and degradability by microbes, plants, and animals. Benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(g,h,i)perylene; benzo(k)fluoranthene; bis(2-ethylhexyl)phthalate; carbazole; chrysene; di-n-butylphthalate; fluoranthene; indeno(1,2,3-cd)pyrene; phenanthrene; and pyrene all have a K_{ow} much less than 500.

The K_{oc} measures the tendency of a chemical to adsorb to organic carbon in soil. K_{oc} values above 500 cm^3/g indicate a strong tendency to adsorb to soil, leading to low mobility (NMED 2021, 701849). Most organic COPCs have K_{oc} values above 500 cm^3/g, indicating a very low potential to migrate toward groundwater. The organic COPC with a K_{oc} value less than 500 cm^3/g is di-n-butylphthalate.

Polycyclic aromatic hydrocarbons and phthalates are the least mobile and the most likely to bioaccumulate. Because the organic COPCs were detected at low concentrations and extent is defined, they are not likely to migrate to groundwater.

G-3.3 Exposure Point Concentration Calculations

The exposure point concentrations (EPCs) represent upper-bound concentrations of COPCs. For comparison with risk-screening levels, the upper confidence limit (UCL) of the arithmetic mean was calculated when possible and used as the EPC. The UCLs were calculated using all available decision-level data within the depth range of interest. If an appropriate UCL of the mean could not be calculated, or if the UCL exceeded the maximum concentration, the maximum detected concentration of the COPC was used as the EPC (maximum detection limits [DLs] were used as the EPCs for some inorganic COPCs). The summary statistics, including the EPC for each COPC for the human health and the ecological risk-screening assessments and the distribution used for the calculation, are presented in Tables G-2.3-1 to G-2.3-3.

The UCLs of the mean concentrations were calculated using the U.S. Environmental Protection Agency (EPA) ProUCL 5.2 software (EPA 2022, 702275), which is based on EPA guidance (EPA 2002, 085640). The ProUCL program calculates 95%, 97.5%, and 99% UCLs and recommends a distribution and UCL. The 95% UCL for the recommended calculation method was used as the EPC. The ProUCL software performs distributional tests on the data set for each COPC and calculates the most appropriate UCL based on the distribution of the data set. Environmental data may have a normal, lognormal, or gamma distribution but are often nonparametric (no definable shape to the distribution). The ProUCL documentation strongly recommends against using the maximum detected concentration for the EPC. The maximum detected concentration was used to represent the EPC for COPCs only when there were too few detections to calculate a UCL. Input and output data files for ProUCL calculations are provided on CD as Attachment G-1, included with this document.

G-4.0 HUMAN HEALTH RISK-SCREENING EVALUATIONS

Human health risk-screening assessments were conducted for SWMU 16-017(j)-99. The site was screened for construction worker and residential scenarios using data from 0.0 to 10.0 ft bgs. The site was also screened for the industrial scenario using data from 0.0 to 1.0 ft bgs. The human health risk-screening assessments compared either the 95% UCL of the mean concentration or the maximum detected concentration of each COPC with SSLs for chemicals.

G-4.1 Human Health SSLs

Human health risk-screening assessments were conducted using SSLs for the industrial and residential scenarios obtained from NMED guidance (NMED 2022, 702141). The NMED SSLs are based on a target hazard quotient (HQ) of 1 and a target cancer risk of 1×10^{-5} (NMED 2022, 702141). If SSLs were not available from NMED guidance, the EPA regional screening tables (https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables) were used. However, EPA regional screening levels do not include construction worker values, so if NMED does not have a construction worker SSL, then a construction worker SSL must be calculated using the toxicity data from the EPA regional screening table and the parameters and equations from the NMED guidance (NMED 2022, 702141). Attachment G-2 (on CD included with this document) reports the calculated construction worker values used in this report. The EPA regional screening levels for carcinogens were multiplied by 10 to adjust from a 10^{-6} cancer risk level to the NMED target cancer risk level of 10^{-5}. Surrogate chemicals based on structural similarity were also used for some COPCs without an SSL or because the COPC is a breakdown product (NMED 2003, 081172). Exposure parameters used to calculate the industrial, construction worker, and residential SSLs are presented in Table G-4.1-1.

G-4.2 Results of Human Health Screening Evaluation

The EPC of each COPC was compared with the SSLs for the industrial, construction worker, and residential scenarios, as appropriate. For carcinogenic chemicals, the EPCs were divided by the SSL and multiplied by 1×10^{-5}. The sum of the carcinogenic risks was compared with the NMED target cancer risk level of 1×10^{-5}. For noncarcinogenic chemicals, an HQ was generated for each COPC by dividing the EPC by the SSL. The HQs were summed to generate a hazard index (HI). The HI was compared with the NMED target HI of 1. The results are presented in Tables G-4.2-1 to G-4.2-5 and are described below.

G-4.2.1 SWMU 16-017(j)-99

The results of the risk-screening assessment for the industrial scenario are presented in Table G-4.2-1. No carcinogenic COPCs were identified in the 0–1 ft depth interval. The industrial HI is 0.0005, which is less than the NMED target HI of 1 (NMED 2022, 702141). No radionuclide samples were collected for the 0.0–1.0 ft depth interval.

The results of the risk-screening assessment for the construction worker scenario are presented in Tables G-4.2-2 and G-4.2-3. The total excess cancer risk for the construction worker scenario is 4×10^{-8}, which is less than the NMED target risk level of 1×10^{-5} (NMED 2022, 702141). The construction worker HI is 0.02, which is less than the NMED target HI of 1 (NMED 2022, 702141). No radionuclide samples were collected for the 0.0–10.0 ft depth interval.

The results of the risk-screening assessment for the residential scenario are presented in Tables G-4.2-4 and G-4.2-5. The total excess cancer risk for the residential scenario is 6×10^{-6}, which is less than the NMED target risk level of 1×10^{-5} (NMED 2022, 702141). The residential HI is 0.04, which is less than the NMED target HI of 1 (NMED 2022, 702141). No radionuclide samples were collected for the 0.0–10.0 ft depth interval.

G-4.3 Vapor-intrusion Pathway

NMED soil-screening guidance (NMED 2022, 702141, Section 2.5) requires an evaluation of the vapor-intrusion pathway per EPA guidance. Note that NMED guidance cites “OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)” (EPA 2002, 094114); however, EPA’s “Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air” is the most current guidance (https://www.epa.gov/vaporintrusion/technical-guide-assessing-and-mitigating-vapor-intrusion-pathway-subsurface-vapor). Residential receptors and commercial/industrial workers could be exposed to volatile compounds vaporized from subsurface media (soil gas and/or groundwater) through pore spaces in the vadose zone and building foundations (or slabs) into indoor air. This pathway must be evaluated if (1) there are compounds present in subsurface media that are sufficiently volatile and toxic and (2) there are existing or planned buildings where exposure could occur. The executive summary of the EPA guidance (https://www.epa.gov/vaporintrusion/technical-guide-assessing-and-mitigating-vapor-intrusion-pathway-subsurface-vapor) specifically states that, among other criteria, the vapor-intrusion pathway is referred to as “complete” only if buildings exist that are occupied by one or more individuals when the vapor-forming chemicals are present indoors. The guidance further states that the vapor-intrusion pathway is incomplete if these conditions are absent and reasonably expected to be absent in the future.

For the site investigated, the following designation was made for the vapor-intrusion pathway: incomplete pathway and no action required. Because only bulk soil data are available for this site, NMED vapor-intrusion screening levels are not applicable for the evaluation.

Incomplete Pathway: No Action Required

The vapor-intrusion pathway is designated as “incomplete” and will not be evaluated further if one of the following conditions is met:

- Volatile and toxic compounds are not detected, meaning all the results were 100% nondetections (NMED 2022, 702141); https://www.epa.gov/vaporintrusion/technical-guide-assessing-and-mitigating-vapor-intrusion-pathway-subsurface-vapor.
- The site has no history of containing volatile and toxic compounds and VOC sampling was not conducted during the investigation.

No source of volatile and toxic organic COPCs exists for SWMU 16-017(j)-99; therefore, the vapor-intrusion pathway is incomplete and no action is required.

G-4.4 Uncertainty Analysis

G-4.4.1 Data Evaluation and COPC Identification Process

A primary uncertainty associated with the COPC identification process is the possibility that a chemical may be inappropriately identified as a COPC when it is actually not a COPC, or that a chemical may not be identified as a COPC when it actually should be identified as a COPC. Inorganic chemicals are appropriately identified as COPCs because only the chemicals detected or that have DLs above background are retained for further analysis. There are no established BVs for organic chemicals, and all detected organic chemicals are identified as COPCs and retained for further analysis. Other uncertainties may include errors in sampling, laboratory analysis, and data analysis. However, because concentrations used in the risk-screening evaluations include those detected below the estimated quantitation limits and nondetections above BVs, data evaluation uncertainties are expected to have little effect on the risk-screening results.

G-4.4.2 Exposure Evaluation

The current and reasonably foreseeable future land use is industrial. To the degree that actual activity patterns are not represented by those activities assumed by the industrial scenario, uncertainties are introduced in the assessment, and the evaluation presented in this assessment overestimates potential risk. An individual may be subject to exposures in a different manner than the exposure assumptions used to derive the industrial SSLs. For the sites evaluated, individuals might not be on-site at present or in the future for that frequency and duration. The construction worker assumptions for the SSLs are that the potentially exposed individual is outside on-site for 8 hr/day, 250 days/yr, and 1 yr (NMED 2022, 702141). The industrial assumptions for the SSLs are that the potentially exposed individual is outside on-site for 8 hr/day, 225 days/yr, and 25 yr (NMED 2022, 702141). The residential SSLs are based on exposure of 24 hr/day, 350 days/yr, and 30 yr (NMED 2022, 702141). As a result, the construction worker, industrial, and residential scenarios evaluated at these sites likely overestimate the exposure and risk.

A number of assumptions are made relative to exposure pathways, including input parameters, completeness of a given pathway, the contaminated media to which an individual may be exposed, and intake rates for different routes of exposure. In the absence of site-specific data, the exposure assumptions used were consistent with default values (NMED 2022, 702141). When several upper-bound values (as are found in NMED guidance [NMED 2022, 702141]) are combined to estimate exposure for any one pathway, the resulting risk estimate can exceed the 99th percentile, and therefore can exceed the range of risk that may be reasonably expected. Also, the assumption that residual concentrations of chemicals in the tuff are available and result in exposure in the same manner as if they were in soil overestimates the potential exposure and risk to receptors.

Uncertainty is introduced in the concentration aggregation of data for estimating the EPCs at a site. Risk from a single location or area with relatively high COPC concentrations may be underestimated by using a representative sitewide value. The use of a UCL is intended to provide a protective upper-bound (i.e., conservative) COPC concentration and is assumed to be representative of the average exposure to a COPC across the entire site. Potential risk and exposure from a single location or area with relatively high COPC concentrations may be overestimated if a representative sitewide value is used. The use of the maximum detected concentration for the EPC overestimates the exposure to contamination because receptors are not consistently exposed to the maximum detected concentration across the site. In addition, the maximum DL was used as the EPC for some inorganic COPCs with elevated DLs above BVs.

G-4.4.3 Toxicity Evaluation

The primary uncertainty associated with the SSLs is related to the derivation of toxicity values used in their calculation. Toxicity values (reference doses [RfDs] and slope factors [SFs]) were used to derive the SSLs used in this risk-screening evaluation (NMED 2022, 702141). Uncertainties were identified in five areas with respect to the toxicity values: (1) extrapolation from other animals to humans, (2) variability among individuals in the human population, (3) the derivation of RfDs and SFs, (4) the chemical form of the COPC, and (5) the use of surrogate chemicals.

Extrapolation from Animals to Humans. The SFs and RfDs are often determined by extrapolation from animal data to humans. This may result in uncertainties in toxicity values because differences exist in chemical absorption, metabolism, excretion, and toxic responses between animals and humans. Differences in body weight, surface area, and pharmacokinetic relationships between animals and humans are taken into account to address these uncertainties in the dose-response relationship. However, conservatism is usually incorporated in each of these steps, resulting in the overestimation of potential risk.

Variability in the Human Population. For noncarcinogenic effects, the degree of variability in human physical characteristics is important both in determining the risks that can be expected at low exposures and in defining the no observed adverse effect level (NOAEL). The NOAEL uncertainty factor approach incorporates a 10-fold factor to reflect individual variability within the human population that can contribute to uncertainty in the risk evaluation. This factor of 10 is generally considered to result in a conservative estimate of risk to noncarcinogenic COPCs.

Derivation of RfDs and SFs. The RfDs and SFs for different chemicals are derived from experiments conducted by different laboratories that may have different accuracy and precision that could lead to an overestimation or underestimation of the risk. The uncertainty associated with the toxicity factors for noncarcinogens is measured by the uncertainty factor, the modifying factor, and the confidence level. For carcinogens, the weight-of-evidence classification indicates the likelihood that a contaminant is a human carcinogen. Toxicity values with high uncertainties may change as new information is evaluated.

Chemical Form of the COPC. COPCs may be bound to the environment matrix and not available for absorption into the human body. However, COPCs are assumed to be bioavailable. This assumption can lead to an overestimation of the total risk.

*Use of Surrogate Chemicals***.** The use of surrogates for chemicals that do not have EPA-approved or provisional toxicity values also contributes to uncertainty in the risk assessment. Surrogates were used to provide SSLs for benzo(g,h,i)perylene and carbazole based on structural similarity. The overall impact of surrogates on the risk assessment is minimal because these COPCs were generally detected at low concentrations (less than 1 mg/kg).

G-4.4.4 Additive Approach

For noncarcinogens, the effects of exposure to multiple chemicals are generally unknown. Possible interactions could be synergistic or antagonistic, resulting in either an overestimation or underestimation of the potential risk. In addition, RfDs used in the risk calculations typically are not based on the same endpoints with respect to severity, effects, or target organs. Therefore, the potential for noncarcinogenic effects may be overestimated for individual COPCs that act by different mechanisms or by different modes of action but are addressed additively.

G-4.5 Interpretation of Human Health Risk Screening Results

Industrial Scenario

No carcinogenic chemical COPCs were identified. The industrial HI is 0.0005, which is less than the NMED target HI of 1 (NMED 2022, 702141). No radionuclide samples were collected for the 0.0–1.0 ft depth interval.

Construction Worker Scenario

The total excess cancer risk for the construction worker scenario is 4×10^{-8}, which is less than the NMED target risk level of 1×10^{-5} (NMED 2022, 702141). The construction worker HI is 0.02, which is less than the NMED target HI of 1 (NMED 2022, 702141). No radionuclide samples were collected for the 0.0–10.0 ft depth interval.

Residential Scenario

The total excess cancer risk for the residential scenario is 6×10^{-6}, which is less than the NMED target risk level of 1×10^{-5} (NMED 2022, 702141). The residential HI is 0.04, which is less than the NMED target HI of 1 (NMED 2022, 702141). No radionuclide samples were collected for the 0.0–10.0 ft depth interval.

G-5.0 ECOLOGICAL RISK-SCREENING EVALUATIONS

The approach for conducting ecological evaluations is described in the “Screening Level Ecological Risk Assessment Methods, Revision 5.1” (LANL 2018, 602965). The evaluation consists of four parts: a scoping evaluation, a screening evaluation, an uncertainty analysis, and an interpretation of the results.

G-5.1 Scoping Evaluation

The scoping evaluation establishes the breadth and focus of the screening evaluation. The ecological scoping checklist (Attachment G-3) is a useful tool for organizing existing ecological information. The information was used to determine whether ecological receptors might be affected, identify the types of receptors that might be present, and develop the ecological conceptual site model for SWMU 16-017(j)-99. Some of the area on the mesa top is developed and provides minimal potential habitat for ecological receptors. The quality of the habitat varies and, in some cases, includes some sites that have native grasses, forbs, and trees that can be suitable habitat for ecological receptors.

The scoping evaluation indicated that terrestrial receptors were appropriate for evaluating the concentrations of COPCs in soil and tuff. Exposure is assessed across a site to a depth of 0.0–6.0 ft bgs. Aquatic receptors were not evaluated because no aquatic communities and no aquatic habitat or perennial source of water exist at this site. The depth of the regional aquifer (greater than 1000 ft bgs) and the semiarid climate limit transport to groundwater. The potential exposure pathways for terrestrial receptors in soil and tuff are root uptake, inhalation, soil ingestion, dermal contact, and food web transport (Attachment G-3). The weathering of tuff is the only viable natural process that may result in the exposure of receptors to contaminants in tuff. Because of the slow rate of weathering expected for tuff, exposure in tuff is negligible, although it is included in the assessment. Plant exposure in tuff is largely limited to fractures near the surface, which does not produce sufficient biomass to support an herbivore population. Consequently, the contaminants in tuff are unavailable to receptors.

The potential risk was evaluated in the risk-screening assessments for the following ecological receptors representing several trophic levels:

- generic plant
- soil-dwelling invertebrate (represented by the earthworm)
- the deer mouse (mammalian omnivore)
- the montane shrew (mammalian insectivore)
- mountain cottontail (mammalian herbivore)
- gray fox (mammalian carnivore)
- American robin (avian insectivore, avian omnivore, and avian herbivore)
- American kestrel (avian insectivore and avian carnivore)

The rationale for using these receptors is presented in “Screening Level Ecological Risk Assessment Methods, Revision 5.1” (LANL 2018, 602965). SWMU 16-017(j)-99 lies outside the mapped threatened and endangered (T&E) species core or buffer habitats.

G-5.2 Assessment Endpoints

An assessment endpoint is an explicit expression of the environmental value to be protected. The endpoints are ecologically relevant and help sustain the natural structure, function, and biodiversity of an ecosystem or its components (EPA 1998, 062809). In a screening-level ecological evaluation, receptors represent the populations and/or communities, and assessment endpoints are any adverse effects on the chosen ecological receptors. The purpose of the ecological evaluation is to protect populations and communities of biota rather than individual organisms, except for listed or candidate T&E species and treaty-protected species, when individuals must be protected (EPA 1999, 070086). Populations of protected species tend to be small, and the loss of an individual adversely affects the species as a whole (EPA 1997, 059370).

In accordance with this guidance, the Laboratory developed generic assessment endpoints (LANL 1999, 064137) to ensure that values at all levels of ecological organization are considered in the ecological screening process. These general assessment endpoints can be measured using impacts on reproduction, growth, and survival to represent categories of effects that may adversely impact populations. In addition, specific receptor species were chosen to represent each functional group. The receptor species were chosen because of their presence at the site, their sensitivity to the COPCs, and their potential for exposure to those COPCs. These categories of effects and the chosen receptor species were used to select the types of effects seen in toxicity studies considered in the development of the toxicity reference values (TRVs). Toxicity studies used in the development of TRVs included only studies in which the adverse effect evaluated affected reproduction, survival, and/or growth.

The selection of receptors and assessment endpoints is designed to be protective of both the representative species used as screening receptors and the other species within their feeding guilds and the overall food web for the terrestrial and aquatic ecosystems. Focusing the assessment endpoints on the general characteristics of species that affect populations (rather than the biochemical and behavioral changes that may affect only the studied species) also ensures the applicability to the ecosystem of concern.

G-5.3 Ecological Risk Screening Evaluation

The ecological screening evaluation identifies chemicals of potential ecological concern (COPECs) and is based on the comparison of EPCs (95% UCLs, maximum detected concentrations, or maximum DLs) with ecological screening levels (ESLs). The EPCs used in the assessments for the SWMU 16-017(j)-99 are presented in Table G-2.3-3.

The ESLs were obtained from the ECORISK Database, Version 4.3 (N3B 2022, 702057) and are presented in Table G-5.3-1. The ESLs are based on similar species of the test population derived from a variety of toxicity studies and converted to a NOAEL. Lowest observed adverse effect level– (LOAEL-) based-ESLs are used in the uncertainty analysis for the ecological screening. Information relevant to the calculation of NOAEL-based ESLs and LOAEL-based ESLs, including concentration equations, dose equations, bioconcentration factors, transfer factors, and TRVs, are presented in the ECORISK Database, Version 4.3 (N3B 2022, 702331).

The screening evaluation begins with calculating a HQ by dividing the EPC by the minimum ESL for a given COPC. HQs greater than 0.3 in the minimum ESL table are used to identify COPECs requiring additional evaluation (N3B 2022, 702331). Once COPECs are identified, the next step is performed to determine receptors potentially at risk by calculating the ratio of the COPEC-specific EPC to the receptor-specific NOAEL-based ESL (receptor HQ). Individual NOAEL-based HQs for a receptor are then summed to derive an HI for each ecological receptor. An HI greater than 1 indicates that further assessment is needed for that receptor. Consistent with COPEC identification, the HQ values greater than 0.3 are highlighted in the receptor HQ-HI tables. All COPECs are further evaluated for all receptors in uncertainty analysis section G-5.4.5 using population area use factor– (PAUF-) adjusted NOAEL-based ESLs. Only wildlife have population adjustments because home range (HR) information is available for these receptors. To clarify which receptors require additional evaluation, the HQs greater than 0.1 and the HIs greater than 1 are highlighted in the PAUF-adjusted HI tables. COPCs without NOAEL-based ESLs are retained as COPECs and discussed further in section G-5.4.8. The HQ and HI analysis is a conservative indication of potential adverse effects and is designed to minimize the potential of overlooking possible COPECs at the site.

G-5.3.1 SWMU 16-017(j)-99

The results of the minimum ESL comparisons are presented in Table G-5.3-2. Antimony, selenium, and di-n-butylphthalate were retained as COPECs because the HQs were greater than 0.3.

Nitrate does not have an ESL, is retained as a COPEC, and is discussed in the uncertainty section.

HQs and HIs for these COPEC and receptor combinations are presented in Table G-5.3-3. The HI analysis indicates that the American robin (all feeding guilds), mountain cottontail, montane shrew, deer mouse, and generic plant have HIs greater than 1. The COPECs and receptors are discussed in the uncertainty section.

G-5.4 Uncertainty Analysis

The uncertainty analysis describes the key sources of uncertainty related to the screening evaluations. This analysis can result in either adding or removing chemicals from the list of COPECs for sites. The following narrative contains a qualitative uncertainty analysis of the issues relevant to evaluating the potential ecological risk at SWMU 16-017(j)-99.

G-5.4.1 Chemical Form

The assumptions used in the ESL derivations were conservative and not necessarily representative of actual conditions. These assumptions include maximum chemical bioavailability, maximum receptor ingestion rates, minimum bodyweight, and additive effects of multiple COPECs. Most of these factors tend to result in conservative estimates of the ESLs, which may lead to an overestimation of the potential risk. The assumption of additive effects for multiple COPECs may result in an overestimation or underestimation of the potential risk to receptors.

The chemical form of the individual COPCs was not determined as part of the investigation, largely a limitation on analytical quantitation of individual chemical species. Toxicological data are typically based on the most toxic and bioavailable chemical species not likely found in the environment. The inorganic and organic COPECs are generally not 100% bioavailable to receptors in the natural environment because of the adsorption of chemical constituents to matrix surfaces (e.g., soil) or rapid oxidation or reduction changes that render harmful chemical forms unavailable to biotic processes. The ESLs were calculated to ensure a conservative indication of potential risk (LANL 2018, 602965) and the values were biased toward overestimating the potential risk to receptors.

G-5.4.2 Exposure Assumptions

The EPCs used in the calculations of HQs were the 95% UCL, the maximum detected concentration, or the maximum DL to a depth of 6.0 ft, thereby conservatively estimating the exposure to each COPC. As a result, the exposure of individuals within a population was evaluated using this specific concentration, which was assumed constant throughout the exposure area. The sampling also focused on areas of known contamination, and receptors were assumed to ingest 100% of their food and spend 100% of their time at the site. The assumptions made regarding exposure for terrestrial receptors result in an overestimation of the potential exposure and risk, because COPECs varied across the site and were infrequently detected.

G-5.4.3 Toxicity Values

The HQs were calculated using ESLs, which are based on NOAELs as threshold effect levels. Actual risk for a given COPEC/receptor combination occurs at a higher level, somewhere between the NOAEL-based threshold and the threshold based on the LOAEL. The use of NOAELs leads to an overestimation of potential risk to ecological receptors. ESLs are based on laboratory studies requiring extrapolation to wildlife receptors. Laboratory studies are typically based on “artificial” and maintained populations with genetically similar individuals and are limited to single chemical exposures in isolated and controlled conditions using a single exposure pathway. Wild species are concomitantly exposed to a variety of chemical and environmental stressors, potentially rendering them more susceptible to chemical stress. On the other hand, wild populations are likely more genetically diverse than laboratory populations, making wild populations, as a whole, less sensitive to chemical exposure than laboratory populations. The uncertainties associated with the ESLs may result in an underestimation or overestimation of potential risk. In addition, ESLs are based on the use of ecological receptor model parameters that produce the most conservative estimate for the ESL. In order to bound the risk with a central tendency comparison value, a comparison with LANL Ecological Preliminary Remediation Goals (Eco-PRGs) is included in the site discussions (section G-5.4.7).The Eco-PRGs are reported in the ECORISK Database Release 4.3 (N3B 2022, 702331) and the methodology for their development is outlined in “Ecological Preliminary Remediation Goals for Soils at Los Alamos National Laboratory, Revision 1,” (LANL 2017, 602647).

G-5.4.4 Area Use Factors

In addition to the direct comparison of the EPC with the ESLs, area use factors (AUFs) are used to account for the amount of time a receptor is likely to spend within the contaminated areas based on the size of the receptor’s HR. The AUF for individual organisms is calculated by dividing the size of the site by the HR for that receptor. Because T&E species must be assessed on an individual basis (EPA 1999, 070086), the AUF is used for the Mexican spotted owl. The HR for the Mexican spotted owl is 366 ha (EPA 1993, 059384). The site area and AUF for SWMU 16-017(j)-99 are presented in Table G-5.4-1. The kestrel (top carnivore) is used as the surrogate receptor for the Mexican spotted owl.

The HI for SWMU 16-017(j)-99 for the kestrel (top carnivore) was less than 1. Application of the AUF for the Mexican spotted owl to the HI for the kestrel (top carnivore) resulted in adjusted HI of 2E-05. Therefore, there are no potential adverse impacts to the Mexican spotted owl at the site.

G-5.4.5 Population Area Use Factors

Following the initial screening evaluation in section G-5.3, COPECS are further evaluated using PAUFs, which are described below, to ensure that exposure to multiple COPECs at a site will not lead to potential adverse impacts on a given receptor population. The PAUFs calculated for the NOAEL-based ESLs discussed in this section may also be used to adjust the LOAEL-based ESLs (section G-5.4.6).

EPA guidance is to manage the ecological risk to populations rather than to individuals, with the exception of T&E species (EPA 1999, 070086). One approach to address the potential effects on populations at the SWMU 16-017(j)-99 site is to estimate the spatial extent of the area inhabited by the local population that overlaps the contaminated area. The population area for a receptor is based on the individual receptor HR and its dispersal distance. Bowman et al. (2002, 073475) estimate that the median dispersal distance for mammals is 7 times the linear dimension of the HR (i.e., the square root of the HR area). If only the dispersal distances for the mammals with HRs within the range of the screening receptors are used (Bowman et al. 2002, 073475), the median dispersal distance becomes 3.6 times the square root of the HR ($R^2 = 0.91$). If it is assumed that the receptors can disperse the same distance in any direction, the population area is circular and the dispersal distance is the radius of the circle. Therefore, the population area can be derived by $\pi(3.6\sqrt{\text{HR}})^2$ or approximately 40 HR.

The PAUFs are calculated by dividing the site area by the population area of each receptor. The HQs are adjusted by multiplying by the PAUFs. HIs are recalculated using the PAUF-adjusted HQs. If the PAUF is above 1, the HQs are not adjusted for that receptor. The HQs for the generic plant and earthworm are not adjusted by PAUFs because these receptors do not have HRs. The adjusted HQs are summed for each receptor to calculate the adjusted HIs.

The HRs for the robin, deer mouse, shrew, mountain cottontail, and gray fox were determined using the data in EPA's wildlife exposure factors handbook (EPA 1993, 059384). The HRs were either for specific environments or averages of different environments presented in the respective exposure parameter/population dynamic tables (EPA 1993, 059384). "Screening-Level Ecological Risk Assessments Methods, Revision 5.1" (LANL 2017, 602649, Table 3.3.1) presents how the EPA data were used to derive the HRs for each receptor. The HRs were used to calculate the population areas for each receptor as described previously in this section.

If the PAUF-adjusted HI for any receptor is greater than 1, then those receptors and any associated COPECs with HQ greater than 0.1 are further evaluated using a LOAEL-based ESL analysis and PAUF-adjusted LOAEL-based ESL analysis described in section G-5.4.6.

The area of SWMU 16-017(j)-99 is approximately 0.0153 ha. The PAUFs are estimated by dividing the site area by the population area of each receptor population (Table G-5.4-2). The HQs and HIs are recalculated using the PAUFs. The HIs for the generic plant and earthworm are not adjusted by PAUFs because these receptors do not have HRs.

The PAUF-adjusted HI analysis using NOAEL-based ESLs yielded HIs less than 1 for all receptors (Table G-5.4-3). The generic plant had an unadjusted NOAEL-based HI of 4 (Table G-5.4-3).

G-5.4.6 LOAEL Analysis

A LOAEL-based ESL HQ-HI analysis was performed if the HQ-HI analysis using PAUF-adjusted NOAEL-based ESLs (section G-5.4.5) resulted in a receptor with an HI greater than 1 (the generic plant) and a COPEC for the respective receptor had an HQ greater than 0.1 (selenium). The LOAEL-based ESLs were used to address the HIs and reduce the associated uncertainty and conservativeness of the NOAEL ESLs used in the initial screening evaluations described in section G-5.3. The LOAEL-based ESLs were calculated based on toxicity information in the ECORISK Database, Version 4.3 (N3B 2022, 702331) and are presented in Table G-5.4-4. First, LOAEL-based ESL receptor HQ-HI calculations were completed. Any HI values greater than 1 and any HQ values greater than 0.1 are highlighted in the HI analysis using LOAEL-based ESL tables. If one or more wildlife receptors are identified in the HI analysis using LOAEL-based ESL tables, then a final step involving population-adjusted HI values is completed. The results of the PAUF-adjusted LOAEL-based ESL HQ-HI analysis are presented in the adjusted HI analysis using LOAEL-based ESL tables, and HI values greater than 1 or any HQ values greater than 0.1 are highlighted. The PAUFs used for the LOAEL analyses are the same as those described in section G-5.4.5.

G-5.4.7 Site Discussion

The HI analysis using PAUF-adjusted NOAEL-based ESLs for SWMU 16-017(j)-99 is greater than 1 for the generic plant, with selenium being the primary COPEC. The HI analysis using LOAEL-based ESLs yielded an HI of 0.7 for the generic plant (Table G-5.4-5). Therefore, the HI analysis using LOAEL-based ESLs does not indicate potential risk to the generic plant or other biota.

G-5.4.8 Chemicals without ESLs

One COPEC detected at SWMU 16-017(j)-99, nitrate, does not have an ESL for any receptor in Version 4.3 of the ECORISK Database (N3B 2022, 702331). Toxicity data are not available for nitrate and no surrogate or other toxicity information is available.

Nitrate was identified as a COPC from 0.0–6.0 ft at SWMU 16-017(j)-99, with a maximum concentration of 11 mg/kg. The NMED residential SSL for nitrate is 125,000 mg/kg, indicating that potential toxicity is very low. Because nitrate is infrequently detected at elevated concentrations and the potential toxicity is low, nitrate is eliminated as a COPEC.

G-5.5 Interpretation of Ecological Risk-Screening Results

G-5.5.1 Receptor Lines of Evidence

Based on the ecological risk-screening assessments, several COPECs (including COPECs without an ESL) were identified for SWMU 16-017(j)-99. Receptors were evaluated using several lines of evidence: minimum ESL comparisons, HI analyses, potential effects to populations (individuals for T&E species), LOAEL analyses, and the relationship of detected concentrations and DLs to background concentrations.

Generic Plant

- The HI analyses using the NOAEL-based ESLs yielded an HI greater than 1 for the generic plant at SWMU 16-017(j)-99.
- The HI analyses using the LOAEL-based ESL yielded an HI less than or equivalent to 1 at SWMU 16-017(j)-99.
- Field observations made during the site visits found no indication of adverse effects on the generic plant community from COPECs. In addition, the area in and/or around the site is developed and does not provide quality habitat for any ecological receptors.

These lines of evidence support the conclusion that no potential ecological risk to the generic plant exists at SWMU 16-017(j)-99.

Earthworm (Invertebrate)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the earthworm, were less than 0.3.
- The HI analyses using the NOAEL-based ESLs yielded HIs less than 1 for the earthworm at SWMU 16-017(j)-99.

These lines of evidence support the conclusion that no potential ecological risk to the earthworm exists at SWMU 16-017(j)-99.

Montane Shrew (Insectivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the shrew, were less than 0.3.
- The HI analyses using the PAUF-adjusted NOAEL-based ESLs yielded an HI less than 1 for the shrew at SWMU 16-017(j)-99.

These lines of evidence support the conclusion that no potential ecological risk to the montane shrew exists at SWMU 16-017(j)-99.

Deer Mouse (Omnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the deer mouse, were less than 0.3.
- The HI analyses using the PAUF-adjusted NOAEL-based ESLs yielded an HI less than 1 for the deer mouse at SWMU 16-017(j)-99.

These lines of evidence support the conclusion that no potential ecological risk to the deer mouse exists at SWMU 16-017(j)-99.

Mountain Cottontail (Herbivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the mountain cottontail, were less than 0.3.
- The HI analyses using the PAUF-adjusted NOAEL-based ESLs yielded an HI less than 1 for the mountain cottontail at SWMU 16-017(j)-99.

These lines of evidence support the conclusion that no potential ecological risk to the mountain cottontail exists at SWMU 16-017(j)-99.

Gray Fox (Carnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the gray fox, were less than 0.3.
- The HI analyses yielded an HI less than 1 for the gray fox at SWMU 16-017(j)-99.

These lines of evidence support the conclusion that no potential ecological risk to the gray fox exists at SWMU 16-017(j)-99.

American Robin (All Feeding Guilds)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the American robin, were less than 0.3.
- The HI analyses using the PAUF-adjusted NOAEL-based ESLs yielded HIs less than 1 for the American robin (all feeding guilds) at SWMU 16-017(j)-99.

These lines of evidence support the conclusion that no potential ecological risk to the American robin (all feeding guilds) exists SWMU 16-017(j)-99.

American Kestrel (All Feeding Guilds)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the American kestrel, were less than 0.3.
- The HI analyses using the NOAEL-based ESLs yielded HIs less than 1 for the American kestrel (all feeding guilds) at SWMU 16-017(j)-99.

These lines of evidence support the conclusion that no potential ecological risk to the kestrel (all feeding guilds) exists at SWMU 16-017(j)-99.

G-5.5.2 COPECs with No ESLs

The COPEC without an ESL, nitrate, was eliminated based on comparisons with human health SSLs. The analysis of the COPEC without an ESL supports the conclusion that no potential ecological risk to receptors exists at SWMU 16-017(j)-99.

G-5.5.3 Summary

Based on evaluations of the minimum ESLs, HI analyses, potential effects to populations (individuals for T&E species), LOAEL analyses, and COPECs without ESLs, no potential ecological risks to the generic plant, earthworm, montane shrew, deer mouse, mountain cottontail, gray fox, American robin, or American kestrel exist for SWMU 16-017(j)-99.

G-6.0 CONCLUSIONS

G-6.1 Human Health Risk

For the industrial scenario, SWMU 16-017(j)-99 had an HI less than the target of 1.

For the construction worker scenario, SWMU 16-017(j)-99 had a total excess cancer risk less than the NMED target risk of 1×10^{-5} and had an HI less than the target of 1.

For the residential scenario, SWMU 16-017(j)-99 had a total excess cancer risk less than the NMED target risk of 1×10^{-5} and had an HI less than the target of 1.

G-6.2 Ecological Risk

Based on evaluations of the minimum ESLs, HI analyses, LOAEL analyses, and COPECs without ESLs, no potential ecological risks to the Mexican spotted owl, generic plant, earthworm, montane shrew, deer mouse, mountain cottontail, gray fox, American robin, or American kestrel exist at SWMU 16-017(j)-99.

G-7.0 REFERENCES

The following reference list includes documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. ERIDs were assigned by Los Alamos National Laboratory's (the Laboratory's) Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above).

G-7.1 References

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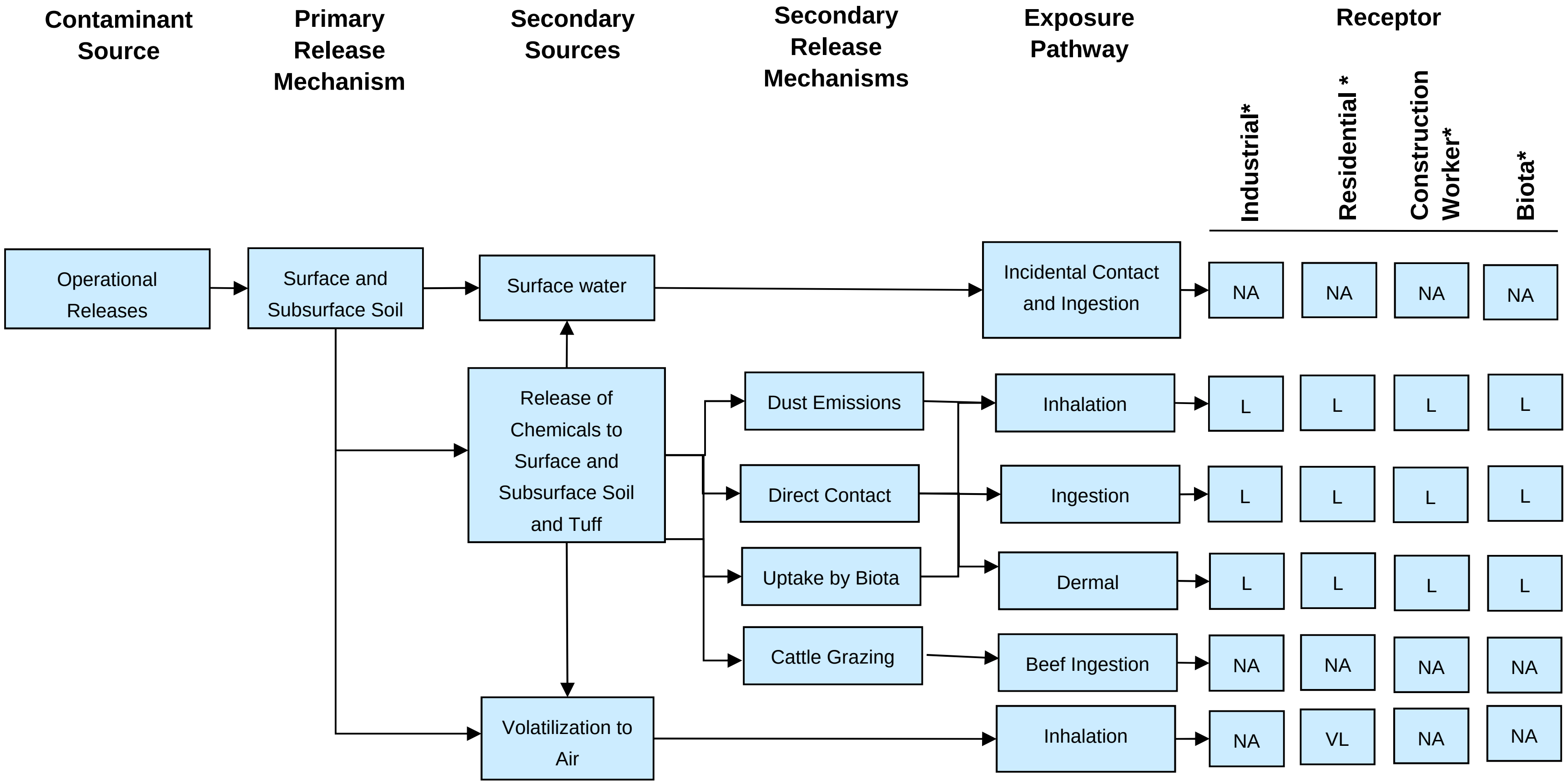


* Very Low (VL), Low (L), and Moderate (M) designations indicate the pathway is a potentially complete pathway and is evaluated in the risk assessments.
Not Applicable (NA) indicates the pathway is incomplete and is not evaluated in the risk assessments.

Figure G-3.1-1 Conceptual site model for SWMU 16-017(j)-99

Table G-2.3-1
Exposure Point Concentrations at SWMU 16-017(j)-99 for the Industrial Scenario

COPC	Number of Analyses	Number of Detections	Minimum Concentration	Maximum Concentration	Distribution	EPC[a]	EPC Method
Inorganic Chemicals (mg/kg)							
Nitrate	5	1	0.336(U)	0.408	n/a[b]	0.408	Maximum detected concentration
Selenium	5	5	1.06	3.23	n/a	3.23	Maximum detected concentration
Organic Chemicals (mg/kg)							
Di-n-butylphthalate	5	2	0.207(U)	2.74	n/a	2.74	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.

[a] EPC = Exposure point concentration.

[b] n/a = Not applicable.

Table G-2.3-2
Exposure Point Concentrations at SWMU 16-017(j)-99 for the Residential and Construction Worker Scenarios

COPC	Number of Analyses	Number of Detections	Minimum Concentration	Maximum Concentration	Distribution	EPC[a]	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	15	8	0.324(U)	1.34	Normal	0.723	95% KM (t)
Nitrate	15	11	0.336(U)	15.9	Normal	7.05	95% KM (t)
Selenium	15	15	1.06	3.23	Normal	1.879	95% Student's-t
Organic Chemicals (mg/kg)							
Benzo(a)anthracene	15	2	0.0111(U)	1.06(U)	n/a[b]	0.168	Maximum detected concentration
Benzo(a)pyrene	15	2	0.0111(U)	1.06(U)	n/a	0.215	Maximum detected concentration
Benzo(b)fluoranthene	15	2	0.0111(U)	1.06(U)	n/a	0.305	Maximum detected concentration
Benzo(g,h,i)perylene	15	1	0.0111(U)	1.06(U)	n/a	0.112	Maximum detected concentration
Benzo(k)fluoranthene	15	1	0.0111(U)	1.06(U)	n/a	0.115	Maximum detected concentration
Bis(2-ethylhexyl)phthalate	15	1	0.0111(U)	1.06(U)	n/a	0.0132	Maximum detected concentration
Carbazole	15	1	0.0111(U)	1.06(U)	n/a	0.0234	Maximum detected concentration
Chrysene	15	2	0.0111(U)	1.06(U)	n/a	0.18	Maximum detected concentration

Table G-2.3-2 (continued)

COPC	Number of Analyses	Number of Detections	Minimum Concentration	Maximum Concentration	Distribution	EPC[a]	EPC Method
Di-n-butylphthalate	15	10	0.0121(U)	2.74	Nonparametric	0.562	95% KM (t)
Fluoranthene	15	2	0.0111(U)	1.06(U)	n/a	0.16	Maximum detected concentration
Indeno(1,2,3-cd)pyrene	15	1	0.0111(U)	1.06(U)	n/a	0.119	Maximum detected concentration
Phenanthrene	15	2	0.0111(U)	1.06(U)	n/a	0.0416	Maximum detected concentration
Pyrene	15	2	0.0111(U)	1.06(U)	n/a	0.153	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.

[a] EPC = Exposure point concentration.

[b] n/a = Not applicable.

Table G-2.3-3
Exposure Point Concentrations at SWMU 16-017(j)-99 for Ecological Risk

COPC	Number of Analyses	Number of Detections	Minimum Concentration	Maximum Concentration	Distribution	EPC[a]	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	10	6	0.324(U)	1.12	Normal	0.708	95% KM (t)
Nitrate	10	6	0.336(U)	11	Normal	5.506	95% KM (t)
Selenium	10	10	1.06	3.23	Normal	2.045	95% Student's-t
Organic Chemicals (mg/kg)							
Benzo(a)anthracene	10	1	0.0111(U)	1.06(U)	n/a[b]	0.0224	Maximum detected concentration
Benzo(a)pyrene	10	1	0.0111(U)	1.06(U)	n/a	0.0184	Maximum detected concentration
Benzo(b)fluoranthene	10	1	0.0111(U)	1.06(U)	n/a	0.0284	Maximum detected concentration
Chrysene	10	1	0.0111(U)	1.06(U)	n/a	0.0224	Maximum detected concentration
Di-n-butylphthalate	10	6	0.0121(U)	2.74	Nonparametric	0.864	95% KM (t)
Fluoranthene	10	1	0.0111(U)	1.06(U)	n/a	0.0572	Maximum detected concentration
Phenanthrene	10	1	0.0111(U)	1.06(U)	n/a	0.0416	Maximum detected concentration
Pyrene	10	1	0.0111(U)	1.06(U)	n/a	0.0356	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.

[a] EPC = Exposure point concentration.

[b] n/a = Not applicable.

Table G-3.2-1
Physical and Chemical Properties of Inorganic COPCs for SWMU 16-017(j)-99

COPC	K_d[a] (cm^3/g)	Water Solubility[a,b] (g/L)
Antimony	45	Insoluble
Nitrate	na[c]	Soluble
Selenium	5	Insoluble

[a] Information from https://rais.ornl.gov/cgi-bin/tools/TOX_search.

[b] Denotes reference information from https://www.epa.gov/superfund/superfund-chemical-data-matrix-scdm.

[c] na = Not available.

Table G-3.2-2
Physical and Chemical Properties of Organic COPCs for SWMU 16-017(j)-99

COPC	Water Solubility[a] (mg/L)	Organic Carbon Coefficient K_{oc}[a] (L/kg)	Log Octanol-Water Partition Coefficient K_{ow}[a]	Vapor Pressure[a] (mm Hg at 25°C)
Benzo(a)anthracene	9.40E-03[b]	2.31E+05	5.76E+00[b]	1.90E-06[b]
Benzo(a)pyrene	1.62E-03[b]	7.87E+05	6.13E+00[b]	5.49E-09[b]
Benzo(b)fluoranthene	1.50E-03[b]	8.03E+05	5.78E+00[b]	5.00E-07[b]
Benzo(g,h,i)perylene	2.60E-04[b]	2.68E+06	6.63E+00[b]	1.00E-10[b]
Benzo(k)fluoranthene	8.00E-04[b]	7.87E+05	6.10E+00[b]	9.65E-10[b]
Bis(2-ethylhexyl)phthalate	2.70E-01[b]	1.65E+05	7.60E+00[b]	1.42E-07[b]
Carbazole	1.80E+00	9.16E+03	3.72E+00	7.50E-07
Chrysene	6.30E-03[b]	2.36E+05	5.81E+00[b]	6.23E-09[b]
Di-n-butylphthalate	1.46E+03	4.50E+00	4.70E+00[b]	2.01E-05
Fluoranthene	2.06E-01[c]	7.09E+04[c]	5.16E+00[c]	9.22E-06[c]
Indeno(1,2,3-cd)pyrene	1.90E-04	1.95E+06	6.70E+00	1.25E-12
Phenanthrene	1.15E+00[b]	2.08E+04	4.46E+00[b]	1.12E-04[b]
Pyrene	1.35E-01[b]	6.94E+04	4.88E+00[b]	4.50E-06[b]

[a] Information from https://rais.ornl.gov/cgi-bin/tools/TOX_search.

[b] Denotes reference information from https://www.epa.gov/superfund/superfund-chemical-data-matrix-scdm.

[c] Information from NMED (2022, 702141).

Table G-4.1-1
Exposure Parameters Used to Calculate Chemical SSLs for the Industrial, Construction Worker, and Residential Scenarios

Parameters	Industrial Values[a]	Construction Worker Values[a]	Residential Values[a]
Target HQ	1	1	1
Target cancer risk	10^{-5}	10^{-5}	10^{-5}
Averaging time (carcinogen/mutagen)	70 yr × 365 days	70 yr × 365 days	70 yr × 365 days
Averaging time (noncarcinogen)	Exposure duration × 365 days	Exposure duration × 365 days	Exposure duration × 365 days
Skin absorption factor	SVOC[b] = 0.1	SVOC = 0.1	SVOC = 0.1
	Chemical-specific	Chemical-specific	Chemical-specific
Adherence factor–child	n/a[c]	n/a	0.2 mg/cm^2
Body weight–child	n/a	n/a	15 kg (0–6 yr of age)
Cancer slope factor–oral (chemical-specific)	(mg/kg-day)$^{-1}$	(mg/kg-day)$^{-1}$	(mg/kg-day)$^{-1}$
Inhalation unit risk (chemical-specific)	(µg/m^3)	(µg/m^3)	(µg/m^3)
Exposure frequency	225 days/yr	225 days/yr	350 days/yr
Exposure time	8 hr/day	8 hr/day	24 hr/day
Exposure duration–child	n/a	n/a	6 yr[d]
Age-adjusted ingestion factor for carcinogens	n/a	n/a	36,750 mg/kg
Age-adjusted ingestion factor for mutagens	n/a	n/a	25,550 mg/kg
Soil ingestion rate–child	n/a	n/a	200 mg/day
Particulate emission factor	6.61×10^9 m^3/kg	2.1×10^6 m^3/kg	6.61×10^9 m^3/kg
Reference dose–oral (chemical-specific)	(mg/kg-day)	(mg/kg-day)	(mg/kg-day)
Reference dose–inhalation (chemical-specific)	(mg/kg-day)	(mg/kg-day)	(mg/kg-day)
Exposed surface area–child	n/a	n/a	2690 cm^2/day
Age-adjusted skin contact factor for carcinogens	n/a	n/a	112,266 mg/kg
Age-adjusted skin contact factor for mutagens	n/a	n/a	166,833 mg/kg
Volatilization factor for soil (chemical-specific)	(m^3/kg)	(m^3/kg)	(m^3/kg)
Body weight–adult	80 kg	80 kg	80 kg

Table G-4.1-1 (continued)

Parameters	Industrial Values[a]	Construction Worker Values[a]	Residential Values[a]
Exposure duration[e]	25 yr	1 yr	30 yr[f]
Adherence factor–adult	0.12 mg/cm^2	0.3 mg/cm^2	0.07 mg/cm^2
Soil ingestion rate–adult	100 mg/day	330 mg/day	100 mg/day
Exposed surface area–adult	3470 cm^2/day	3470 cm^2/day	6032 cm^2/day

[a] Parameter values from NMED (2022, 702141) unless otherwise noted.

[b] SVOC = Semivolatile organic compound.

[c] n/a = Not applicable.

[d] The child exposure duration for mutagens is subdivided into 0–2 yr and 2–6 yr.

[e] Exposure duration for lifetime resident is 26 yr. For carcinogens, the exposures are combined for child (6 yr) and adult (20 yr).

[f] The adult exposure duration for mutagens is subdivided into 6–16 yr and 16–30 yr.

Table G-4.2-1
Industrial Noncarcinogenic
Screening Evaluation for SWMU 16-017(j)-99

COPC	EPC (mg/kg)	Industrial SSL* (mg/kg)	HQ
Nitrate	0.408	2,080,000	1.96E-07
Selenium	3.23	6490	4.98E-04
Di-n-butylphthalate	2.74	91,600	2.99E-05
		Hazard Index	**0.0005**

* SSLs from NMED (2022, 702141).

Table G-4.2-2
Construction Worker Carcinogenic
Screening Evaluation for SWMU 16-017(j)-99

COPC	EPC (mg/kg)	Construction Worker SSL* (mg/kg)	Cancer Risk
Benzo(a)anthracene	0.168	240	7.00E-09
Benzo(a)pyrene	0.215	173	1.24E-08
Benzo(b)fluoranthene	0.305	240	1.27E-08
Benzo(k)fluoranthene	0.115	2310	4.98E-10
Bis(2-ethylhexyl)phthalate	0.0132	13,400	9.85E-12
Chrysene	0.18	23,100	7.79E-11
Indeno(1,2,3-cd)pyrene	0.119	240	4.69E-09
		Total Excess Cancer Risk	**4E-08**

* SSLs from NMED (2022, 702141).

Table G-4.2-3
Construction Worker Noncarcinogenic Screening Evaluation for SWMU 16-017(j)-99

COPC	EPC (mg/kg)	Construction Worker SSL[a] (mg/kg)	HQ
Antimony	0.723	142	5.09E-03
Nitrate	7.05	566,000	1.25E-05
Selenium	1.879	1750	1.07E-03
Benzo(a)pyrene	0.215	15	1.43E-02
Benzo(g,h,i)perylene	0.112	7530[b]	1.49E-05
Bis(2-ethylhexyl)phthalate	0.0132	5380	2.45E-06
Carbazole	0.0234	85[c]	2.75E-04
Di-n-butylphthalate	0.562	26,900	2.09E-05
Fluoranthene	0.16	10,000	1.60E-05
Phenanthrene	0.0416	8070	5.15E-06
Pyrene	0.153	7530	2.03E-05
		Hazard Index	**0.02**

[a] SSLs from NMED (2022, 702141).

[b] Pyrene used as a surrogate based on structural similarity.

[c] Construction worker SSL calculated using toxicity value from EPA regional screening tables (https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables) and equation and parameters in NMED (2022, 702141). Calculations are provided in Attachment G-3.

Table G-4.2-4
Residential Carcinogenic Screening Evaluation for SWMU 16-017(j)-99

COPC	EPC (mg/kg)	Residential SSL* (mg/kg)	Cancer Risk
Benzo(a)anthracene	0.168	1.53	1.10E-06
Benzo(a)pyrene	0.215	1.12	1.92E-06
Benzo(b)fluoranthene	0.305	1.53	1.99E-06
Benzo(k)fluoranthene	0.115	15.3	7.52E-08
Bis(2-ethylhexyl)phthalate	0.0132	380	3.47E-10
Chrysene	0.18	153	1.18E-08
Indeno(1,2,3-cd)pyrene	0.119	1.53	7.78E-07
		Total Excess Cancer Risk	**6E-06**

* SSLs from NMED (2022, 702141).

Table G-4.2-5
Residential Noncarcinogenic Screening Evaluation for SWMU 16-017(j)-99

COPC	EPC (mg/kg)	Residential SSL[a] (mg/kg)	HQ
Antimony	0.723	31.3	2.31E-02
Nitrate	7.05	125,000	5.64E-05
Selenium	1.879	391	4.81E-03
Benzo(a)pyrene	0.215	17.4	1.24E-02
Benzo(g,h,i)perylene	0.112	1740[b]	6.44E-05
Bis(2-ethylhexyl)phthalate	0.0132	1230	1.07E-05
Carbazole	0.0234	78[c,d]	3.00E-04
Di-n-butylphthalate	0.562	6160	9.12E-05
Fluoranthene	0.16	2320	6.90E-05
Phenanthrene	0.0416	1850	2.25E-05
Pyrene	0.153	1740	8.79E-05
		Hazard Index	**0.04**

[a] SSLs from NMED (2022, 702141).

[b] Pyrene used as a surrogate based on structural similarity.

[c] SSL from EPA regional screening tables (https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables).

[d] Dibenzofuran used as a surrogate based on structural similarity.

Table G-5.3-1
Ecological Screening Levels for Terrestrial Receptors

COPEC	Gray Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Mountain Cottontail (mammalian herbivore)	Montane Shrew (mammalian insectivore)	Deer Mouse (mammalian omnivore)	Earthworm (soil-dwelling invertebrate)	Generic Plant (terrestrial autotroph-producer)
Inorganic Chemicals (mg/kg)											
Antimony	46[a]	na[b]	na	na	na	na	2.7	7.9	2.3	78	11
Selenium	92	74	3.7	0.98	0.83	0.71	2.2	0.7	0.82	4.1	0.52
Organic Chemicals (mg/kg)											
Benzo(a)anthracene	110	28	6.4	0.73	0.8	0.88	6.1	4	3.4	na	18
Benzo(a)pyrene	3400	na	na	na	na	na	260	62	84	na	na
Benzo(b)fluoranthene	2400	na	na	na	na	na	130	44	51	na	18
Benzo(g,h,i)perylene	3600	na	na	na	na	na	470	25	46	na	na
Benzo(k)fluoranthene	4300	na	na	na	na	na	330	71	99	na	na
Bis(2-ethylhexyl)phthalate	500	9.3	0.096	16	0.04	0.02	1900	0.6	1.1	na	na
Carbazole	13,000	na	na	na	na	na	140	110	79	na	na
Chrysene	110	na	na	na	na	na	6.3	3.1	3.1	na	na
Di-n-butylphthalate	62,000	2	0.052	0.38	0.021	0.011	17,000	180	360	na	160
Fluoranthene	3900	na	na	na	na	na	270	22	38	10	na
Indeno(1,2,3-cd)pyrene	4600	na	na	na	na	na	510	71	110	na	na
Phenanthrene	1900	na	na	na	na	na	62	11	15	5.5	na
Pyrene	3100	3000	160	68	44	33	110	23	31	10	na

[a] ESLs are based on NOAELs and were obtained from the ECORISK Database, Version 4.3 (N3B 2022, 702331).

[b] na = Not available.

Table G-5.3-2
Minimum ESL Comparison for SWMU 16-017(j)-99

COPC	EPC	ESL	Receptor	HQ
Inorganic Chemicals (mg/kg)				
Antimony	0.708	2.3	Deer mouse	**3.08E-01**
Selenium	2.045	0.52	Generic plant	**3.93E+00**
Organic Chemicals (mg/kg)				
Benzo(a)anthracene	0.0224	0.73	American robin (herbivore)	3.07E-02
Benzo(a)pyrene	0.0184	62	Shrew	2.97E-04
Benzo(b)fluoranthene	0.0284	18	Generic plant	1.58E-03
Chrysene	0.0224	3.1	Shrew	7.23E-03
Di-n-butylphthalate	0.864	0.011	American robin (insectivore)	**7.85E+01**
Fluoranthene	0.0572	10	Earthworm	5.72E-03
Phenanthrene	0.0416	5.5	Earthworm	7.56E-03
Pyrene	0.0356	10	Earthworm	3.56E-03

Note: Bolded values indicate HQs greater than 0.3.

Table G-5.3-3
HI Analysis Using NOAEL-Based ESLs for SWMU 16-017(j)-99

COPEC	EPC (mg/kg)	Gray Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Mountain Cottontail (mammalian herbivore)	Montane Shrew (mammalian insectivore)	Deer Mouse (mammalian omnivore)	Earthworm (soil-dwelling invertebrate)	Generic Plant (terrestrial autotroph-producer)
Antimony	0.708	1.54E-02	na*	na	na	na	na	2.62E-01	8.96E-02	**3.08E-01**	9.08E-03	6.44E-02
Selenium	2.045	2.22E-02	2.76E-02	**5.53E-01**	**2.09E+00**	**2.46E+00**	**2.88E+00**	**9.30E-01**	**2.92E+00**	**2.49E+00**	**4.99E-01**	**3.93E+00**
Di-n-butylphthalate	0.864	1.39E-05	**4.32E-01**	**1.66E+01**	**2.27E+00**	**4.11E+01**	**7.85E+01**	5.08E-05	4.80E-03	2.40E-03	na	5.40E-03
HI		4E-02	5E-01	2E+01	**4E+00**	**4E+01**	**8E+01**	**1E+00**	**3E+00**	**3E+00**	5E-01	**4E+00**

Note: Bolded values indicate HQs greater than 0.3 or HIs greater than 1.

* na = Not available.

Table G-5.4-1
Mexican Spotted Owl AUFs for SWMU 16-017(j)-99

Site	Site Area (ha)	AUF*
SWMU 16-017(j)-99	0.0153	0.0000418

* AUF is calculated as the area of the site divided by the owl HR of 366 ha.

Table G-5.4-2
PAUFs for Ecological Receptors for SWMU 16-017(j)-99

Receptor	HR (ha)[a]	Population Area (ha)	PAUF[b]
American Kestrel	106	4240	3.61E-06
American Robin	0.42	16.8	9.11E-04
Deer Mouse	0.077	3	4.97E-03
Mountain Cottontail	3.1	124	1.23E-04
Montane Shrew	0.39	15.6	9.81E-04
Gray Fox	1038	41,520	3.68E-07

[a] Values from EPA (1993, 059384)

[b] PAUF is calculated as the area of the site (0.0153 ha) divided by the population area.

Table G-5.4-3
PAUF-Adjusted HI Analysis Using NOAEL-Based ESLs for SWMU 16-017(j)-99

COPEC	EPC (mg/kg)	Gray Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Mountain Cottontail (mammalian herbivore)	Montane Shrew (mammalian insectivore)	Deer Mouse (mammalian omnivore)	Earthworm (soil-dwelling invertebrate)	Generic Plant (terrestrial autotroph-producer)
Antimony	0.708	5.67E-09	na*	na	na	na	na	3.24E-05	8.79E-05	1.57E-03	9.08E-03	6.44E-02
Selenium	2.045	8.19E-09	9.97E-08	1.99E-06	1.90E-03	2.24E-03	2.62E-03	1.15E-04	2.87E-03	1.27E-02	**4.99E-01**	**3.93E+00**
Di-n-butylphthalate	0.864	5.14E-12	1.56E-06	6.00E-05	2.07E-03	3.75E-02	7.15E-02	6.27E-09	4.71E-06	1.19E-05	na	5.40E-03
HI		1E-08	2E-06	6E-05	4E-03	4E-02	7E-02	1E-04	3E-03	1E-02	5E-01	**4E+00**

Note: Bolded values indicate HQs greater than 0.1 or HIs greater than 1.

* na = Not available.

Table G-5.4-4
Summary of LOAEL-Based ESLs for Terrestrial Receptors

COPEC	Receptor	LOAEL-Based ESL* (mg/kg)
Selenium	Generic Plant	3

* LOAEL-based ESLs from ECORISK Database, Version 4.3 (N3B 2022, 702331).

Table G-5.4-5
HI Analysis Using LOAEL-Based ESLs for SWMU 16-017(j)-99

COPEC	EPC (mg/kg)	Generic Plant
Selenium	2.045	**6.82E-01**
	Hazard Index	**7E-01**

Note: Bolded values indicate HQ greater than 0.1 or HIs greater than 1.

Attachment G-1

ProUCL Files
(on CD included with this document)

Attachment G-2

Construction Worker Calculation
(on CD included with this document)

Attachment G-3

Ecological Scoping Checklist

G3-1.0 PART A—SCOPING MEETING DOCUMENTATION

Site Identification (Include Aggregate Area)	SWMU 16-017(j)-99 in Upper Water Canyon Aggregate Area
Form of Site Releases (Solid, Liquid, Vapor) **Describe known or suspected <u>mechanisms</u> of release (spills, dumping, material disposal, outfall, explosive testing, etc.) and describe potential <u>areas</u> of release. Reference map if appropriate.**	SWMU 16-017(j)-99 is a former magazine at Technical Area 16. The magazine was a 24 ft × 26 ft × 9 ft wood-framed structure surrounded by an earthen berm on three sides and the top. The magazine was built in 1945 and removed in 1998 (LANL 1998, 059602). The storage magazine was built at grade, and there is no longer any evidence of the berm that once surrounded the magazine. Any remaining berm material is indistinguishable from the surrounding soil.
Directly Impacted Media **Indicate all that apply.**	**Surface soil** – Yes **Surface water/sediment** – not applicable (n/a) **Subsurface** – n/a **Groundwater** – n/a **Other, explain** – n/a
Vegetation Class Based on Geographic Information System (GIS) Vegetation Coverage **Indicate all that apply.**	**Water** – n/a **Bare Ground/Unvegetated** – Yes **Spruce-fir-aspen-mixed conifer** – n/a **Ponderosa pine** – N/A **Piñon-juniper/juniper savannah** – n/a **Grassland-shrubland** – n/a **Developed** – Yes **Burned** – n/a
Threatened and Endangered Species Habitat **If applicable, list threatened and endangered species known or suspected of using the site for breeding or foraging.**	SWMU 16-017(j)-99 lies outside of the mapped threatened and endangered species core or buffer habitats (LANL 2017, 701039).
Neighboring/Contiguous/Upgradient Sites **Include a summary of chemicals of potential concern and the type of releases if impacting site.** **(Use this information to evaluate the need to aggregate sites for scoping and screening.)**	No contiguous or upgradient sites.
Surface Water Erosion Potential **Indicate if erosion is present and type; terminal point of surface water transport; slope; and surface water run-on sources. Indicate if best management practices (BMPs) are in place or are needed.**	The site is a relatively flat area with disturbed soil and asphalt. The potential for surface water transport is therefore low for this site.

G3-2.0 PART B—SITE VISIT DOCUMENTATION

Site ID	SWMU 16-017(j)-99
Date of Site Visit	3/23/2022
Site Visit Conducted by	Patricia Wald-Hopkins, Tracy McFarland, Nathan Canaris

Receptor Information:

Estimate cover	**Relative vegetative cover (high, medium, low, none)** = Low **Relative wetland cover (high, medium, low, none)** = None **Relative structures/asphalt, etc., cover (high, medium, low, none)** = High
Field notes on the GIS vegetation class	SWMU 16-017(j)-99 is located in a developed area. Highly disturbed soil pile with debris in an open parking lot.
Are ecological receptors present at the site? **(yes/no/uncertain)** **Describe the general types of receptors present at the site (terrestrial and aquatic), and note the quality of habitat present at the site.**	Minimal plants (grass, forbs, shrubs). No visible signs of burrowing animals or insects. Terrestrial receptors would not be expected to use site for foraging or nesting.

Contaminant Transport Information:

Surface Water Transport **Field notes on the erosion potential and BMPs, including a discussion of the terminal point of surface water transport (if applicable).**	Runoff potential at this site is low because it is situated on a mesa top and surrounded by an asphalt parking lot. The site is relatively flat with little to no potential for runoff.
Are there any off-site transport pathways (surface water, air, or groundwater)? **(yes/no/uncertain)** **Provide explanation**	Yes. Surface water run-on to the site and runoff leaving the site may enter Water Canyon. There may be some air dispersion when the area is dry, but it is a minor transport pathway. A pathway to groundwater is unlikely because regional groundwater is greater than 800 ft below ground surface to the aquifer.

Ecological Effects Information:

Physical Disturbance **(Provide list of major types of disturbances, including erosion and construction activities; review historical aerial photos where appropriate.)**	SWMU 16-017(j) is located on developed land that has been disturbed. The site is surrounded by asphalt, and a soil and debris pile is located within a portion of the footprint of the site.
Are there obvious ecological effects? **(yes/no/uncertain)** **Provide explanation and apparent cause (e.g., contamination, physical disturbance, other).**	No obvious ecological effects except that the area is highly developed and disturbed and not a rich habitat for ecological receptors.

Adequacy of Site Characterization:

Do existing or proposed data provide information on the nature and extent of contamination? **(yes/no/uncertain)** **Provide explanation**	Yes. The sampling approach in the approved work plan (LANL 2011, 111602; NMED 2011, 111827) included biased sampling to determine the nature and extent of contamination.
Do existing or proposed data for the site address potential transport pathways of site contamination? **(yes/no/uncertain)** **Provide explanation**	Yes. Existing and planned data from samples collected within SWMU 16-017(j)-99 address potential transport pathways and characterize the potential ecological risk. The results indicate that the nature and extent of contamination at the site have been defined.

No Exposure/Transport Pathways:

If there are no complete exposure pathways to ecological receptors on-site and no transport pathways to off-site receptors, do not complete Part C. Provide explanation/justification for proposing an ecological "No Further Action" recommendation. There are no compete exposure pathways in the area covered by concrete and asphalt. There is potential exposure in the exposed soil area; therefore the remainder of the checklist was completed for this bare soil portion.

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors, if appropriate. Wildlife known to access the area include deer, elk, bear, etc. Insects and worms could potentially live in the soil.

G3-3.0 PART C—ECOLOGICAL PATHWAYS CONCEPTUAL EXPOSURE MODEL

Provide answers to Questions A to V to develop the Ecological Pathways Conceptual Exposure Models (use to complete figures at end of Part C).

Answer all questions with drop-down menu choices. When finished, select the entire document using control A, and press F9. This will update all the fields in the models to reflect the questions. You can also click in individual fields in the models and press F9 to update.

Question A:

Could soil contaminants reach receptors through vapors?

- **Determine the volatility of the hazardous substance (volatile chemicals generally have Henry's law constant >1E-05 atm-m^3/mol and molecular weight <200 g/mol).**
- **In the case of burrowing animals, the contamination would have to occur in the depth interval where burrows are present (near surface to 5 ft below ground surface).**

Answer (likely/unlikely/uncertain): Unlikely.

Provide explanation: Benzo(a)anthracene was detected and is considered a volatile organic compound (VOC) based on the New Mexico Environment Department's (NMED's) definition of a chemical being considered sufficiently volatile if its Henry's law constant is approximately 1×10^{-5} atm-m^3/mole or greater and its molecular weight is approximately 200 g/mole or less. However, there was no evidence of burrows at the site.

Question B:

Could the soil contaminants reach receptors through fugitive dust carried in air?

- **Soil contamination would have to be on the actual soil surface to become available for dust.**
- **In the case of dust exposures to burrowing animals, the contamination would have to occur in the depth interval where the burrows occur.**

Answer (likely/unlikely/uncertain): Likely.

Provide explanation: Some chemicals of potential concern (COPCs) were detected in the surface soil interval.

Question C:

Can contaminated soil be transported to aquatic communities?

If erosion is an off-site transport pathway, determine the terminal point to see if aquatic receptors could be impacted by contamination from the site.

Answer (likely/unlikely/uncertain): Unlikely.

Provide explanation: No aquatic habitat near site.

Question D:

Is contaminated groundwater potentially available to biological receptors through seeps or springs or shallow groundwater?

- **The potential exists for contaminants to migrate through groundwater and discharge into habitats and/or surface waters.**
- **Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone.**
- **Terrestrial wildlife receptors generally will not come in contact with groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Unlikely.

Provide explanation: The depth to the regional groundwater is approximately 800 to 1200 ft. No springs or seeps exist at the site.

Question E:

Is infiltration/percolation from contaminated subsurface material a viable transport and exposure pathway?

- **The potential for contaminants to migrate to groundwater.**
- **The potential for contaminants to migrate to groundwater and discharge into habitats and/or surface waters.**
- **Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone.**
- **Terrestrial wildlife receptors generally will not come in contact with groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Unlikely.

Provide explanation: The depth to the regional groundwater is approximately 800 to 1200 ft. No springs or seeps exist at the site.

Question F:

Might erosion or mass-wasting events be a potential release mechanism for contaminants from subsurface materials or perched aquifers to the surface?

- **This question is applicable only to release sites located on or near the mesa edge.**
- **Consider the potential erosion of surficial material and the geologic processes of canyon/mesa edges.**

Answer (likely/unlikely/uncertain): Unlikely.

Provide explanation: The site is not located near a mesa edge, so mass wasting is not relevant.

Question G:

Could airborne contaminants interact with receptors through the respiration of vapors?

- **Contaminants must be present as volatiles in the air.**
- **Consider the importance of the inhalation of vapors for burrowing animals.**
- **Foliar uptake of vapors is typically not a significant exposure pathway.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 1 Unlikely Pathway

Terrestrial Animals: 1 Unlikely Pathway

Provide explanation: Benzo(a)anthracene was detected and is considered a VOC based on NMED's definition of a chemical being considered sufficiently volatile if its Henry's law constant is approximately 1 × 10^{-5} atm-m^3/mole or greater and its molecular weight is approximately 200 g/mole or less. However, there was no evidence of burrows at the site.

Question H:

Could airborne contaminants interact with plants through the deposition of particulates or with animals through the inhalation of fugitive dust?

- **For this exposure pathway to be complete, contaminants must be present as particulates in the air or as dust.**
- **Exposure through the inhalation of fugitive dust is particularly applicable to ground-dwelling species that would be exposed to dust disturbed by their foraging or burrowing activities or by wind movement.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 3 Major Pathway

Terrestrial Animals: 3 Major Pathway

Provide explanation: Soil can easily become fugitive dust.

Question I:

Could contaminants interact with plants through root uptake or rain splash from surficial soil?

- **Contaminants in bulk soil may partition into soil solution, making them available to roots.**
- **Exposure of terrestrial plants to contaminants may occur through particulates deposited on leaf and stem surfaces by rain striking contaminated soil (i.e., rain splash).**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 3 Major Pathway

Provide explanation: COPCs are in the root zone of plants and in the surface soil zone.

Question J:

Could contaminants interact with receptors through food web transport from surficial soil?

- **The chemicals may bioaccumulate in animals.**
- **Animals may ingest contaminated food.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 2 Minor Pathway

Provide explanation: Possible food web transport.

Question K:

Could contaminants interact with receptors through the incidental ingestion of surficial soil?

- **Incidental ingestion of contaminated soil could occur while animals grub for food resident in the soil, feed on plant matter covered with contaminated soil, or groom themselves.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 3 Major Pathway

Provide explanation: COPCs are in surface soil.

Question L:

Could contaminants interact with receptors through dermal contact with surficial soil?

- **Exposure through dermal contact would generally be limited to organic contaminants that are lipophilic and can cross epidermal barriers.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 3 Major Pathway

Provide explanation: COPCs are in surface soil.

Question M:

Could contaminants interact with plants or animals through external irradiation?

- **External irradiation is most relevant for gamma-emitting radionuclides.**
- **Burial of contamination attenuates radiological exposure.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 0 No Pathway

Terrestrial Animals: 0 No Pathway

Provide explanation: Radionuclides were not analyzed for because site history did not indicate radionuclide use.

Question N:

Could contaminants interact with plants through direct uptake from water and sediment or sediment rain splash?

- **Contaminants may be taken up by terrestrial plants whose roots are in contact with surface waters.**
- **Terrestrial plants may be exposed to particulates deposited on leaf and stem surfaces by rain striking contaminated sediment (i.e., rain splash) in an area that is only periodically inundated with water.**
- **Contaminants in sediment may partition into soil solution, making them available to roots.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 0 No Pathway

Provide explanation: No water or sediment at site.

Question O:

Could contaminants interact with receptors through food web transport from water and sediment?

- **The chemicals may bioconcentrate in food.**
- **Animals may ingest contaminated food.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 0 No Pathway

Provide explanation: No water or sediment at site.

Question P:

Could contaminants interact with receptors through the ingestion of water and suspended sediment?

- **If sediment is present in an area that is only periodically inundated with water, terrestrial receptors may incidentally ingest sediment.**
- **Terrestrial receptors may ingest water-borne contaminants if contaminated surface waters are used as a source of drinking water.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 0 No Pathway

Provide explanation: No water or sediment at site.

Question Q:

Could contaminants interact with receptors through dermal contact with water and sediment?

- **If sediment is present in an area that is only periodically inundated with water, terrestrial species may be dermally exposed during dry periods.**
- **Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 0 No Pathway

Provide explanation: No water or sediment at site.

Question R:

Could suspended or sediment-based contaminants interact with plants or animals through external irradiation?

- **External irradiation is most relevant for gamma-emitting radionuclides.**
- **Burial of contamination attenuates radiological exposure.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 0 No Pathway

Terrestrial Animals: 0 No Pathway

Provide explanation: No water or sediment at site. Radionuclides were not analyzed for because site history did not indicate radionuclide use.

Question S:

Could contaminants bioconcentrate in free-floating aquatic plants, attached aquatic plants, or emergent vegetation?

- **Aquatic plants are in direct contact with water.**
- **Contaminants in sediment may partition into pore water, making them available to submerged roots.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Aquatic Plants/Emergent Vegetation: 0 No Pathway

Provide explanation: No water or sediment at site.

Question T:

Could contaminants bioconcentrate in sedimentary or water-column organisms?

- **Aquatic receptors may actively or incidentally ingest sediment while foraging.**
- **Aquatic receptors may be directly exposed to contaminated sediment or may be exposed to contaminants through osmotic exchange, respiration, or ventilation of sediment pore waters.**
- **Aquatic receptors may be exposed through osmotic exchange, respiration, or ventilation of surface waters.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Aquatic Animals: 0 No Pathway

Provide explanation: No water or sediment at site.

Question U:

Could contaminants bioaccumulate in sedimentary or water-column organisms?

- **Lipophilic organic contaminants and some metals may concentrate in an organism's tissues.**
- **Ingestion of contaminated food may result in bioaccumulation through the food web.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Aquatic Animals: 0 No Pathway

Provide explanation: No water or sediment at site.

Question V:

Could contaminants interact with aquatic plants or animals through external irradiation?

- **External irradiation is most relevant for gamma-emitting radionuclides.**
- **The water column acts to absorb radiation; therefore, external irradiation is typically more important for sediment-dwelling organisms.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

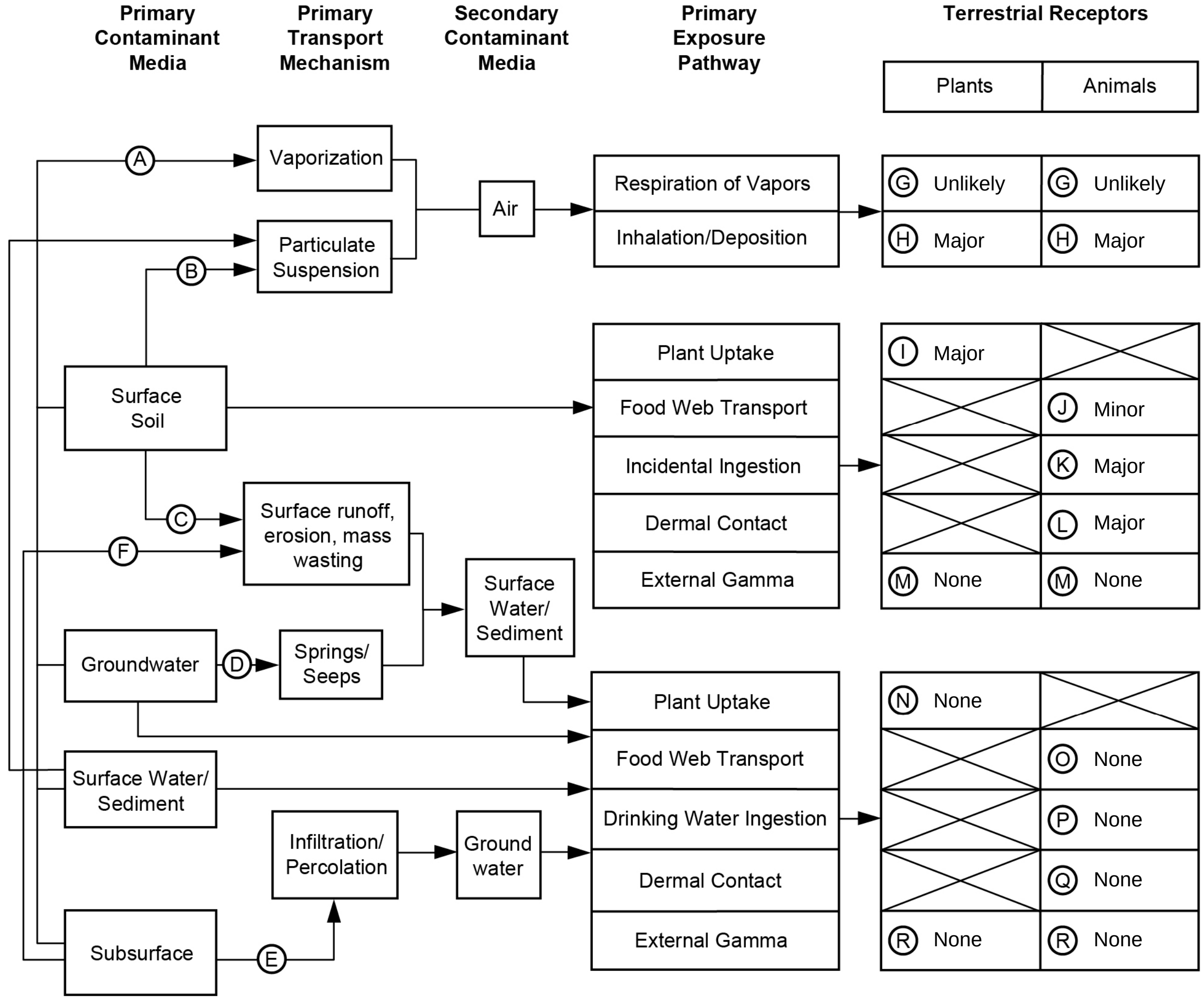
Aquatic Plants: 0 No Pathway

Aquatic Animals: 0 No Pathway

Provide explanation: No water or sediment at site. Radionuclides were not analyzed for because site history did not indicate radionuclide use.

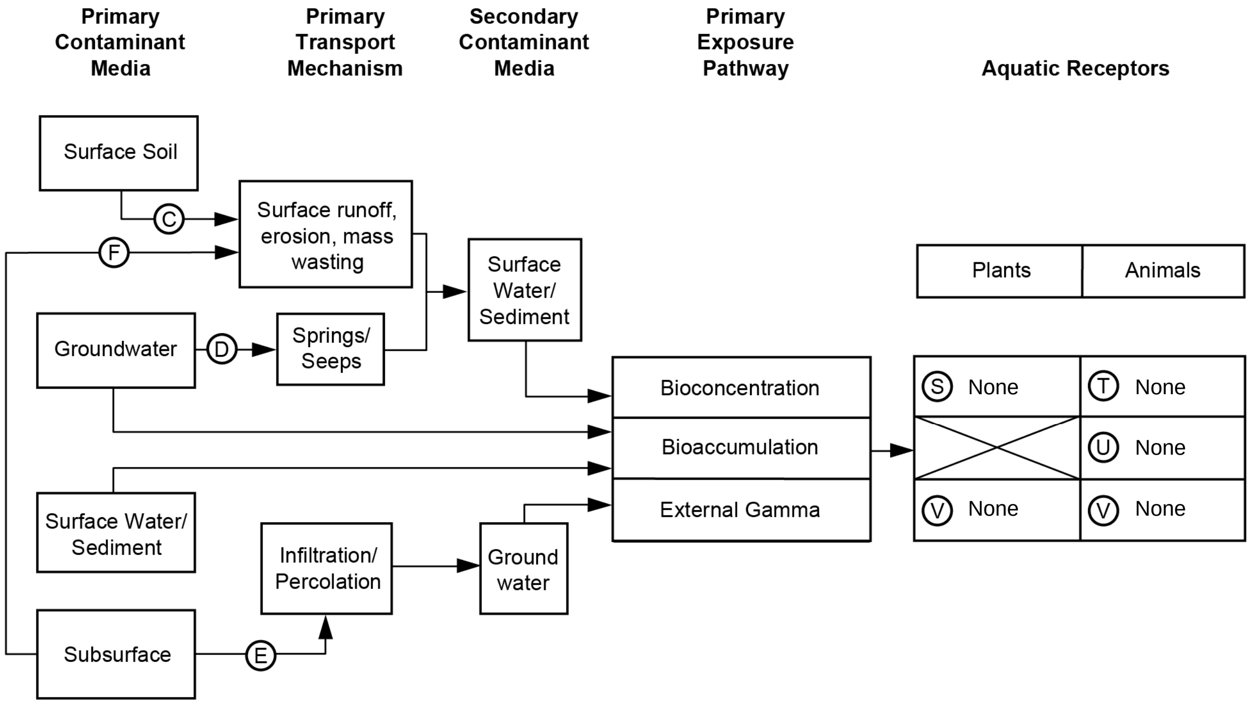
Ecological Scoping Checklist
Terrestrial Receptors
Ecological Pathways Conceptual Exposure Model

NOTE:
Letters in circles refer to questions on the scoping checklist.



Ecological Scoping Checklist
Aquatic Receptors
Ecological Pathways Conceptual Exposure Model

NOTE:
Letters in circles refer to questions on the scoping checklist.



SIGNATURES AND CERTIFICATION

Checklist completed by:

Name (printed): Patricia Wald-Hopkins

Name (signature): Patricia Wald-Hopkins Digitally signed by Patricia Wald-Hopkins
Date: 2023.01.05 10:51:23 -07'00'

Organization: N3B Los Alamos

Date completed: 3/24/2022

Checklist reviewed by:

Name (printed): Tracy McFarland

Name (signature): Tracy McFarland Digitally signed by Tracy McFarland
Date: 2023.01.04 12:08:52 -07'00'

Organization: N3B Los Alamos

Date reviewed: 11/29/2022

G2-4.0 REFERENCES

The following reference list includes documents cited in this attachment. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. ERIDs were assigned by Los Alamos National Laboratory's (the Laboratory's) Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above).

LANL (Los Alamos National Laboratory), September 1998. "Decommissioning Completion Report for High-Explosive Facilities at Technical Area 16 (Buildings 27, 10, 13 and 63)," Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 1998, 059602)

LANL (Los Alamos National Laboratory), January 2011. "Investigation Work Plan for Upper Water Canyon Aggregate Area, Revision 1," Los Alamos National Laboratory document LA-UR-11-0135, Los Alamos, New Mexico. (LANL 2011, 111602)

LANL (Los Alamos National Laboratory), October 2017. "Threatened and Endangered Species Habitat Management Plan for Los Alamos National Laboratory," Los Alamos National Laboratory document LA-UR-17-29454, Los Alamos, New Mexico. (LANL 2017, 701039)

NMED (New Mexico Environment Department), February 18, 2011. "Direction to Modify, Upper Water Canyon Aggregate Area Investigation Work Plan, Revision 1," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2011, 111827)

Plate 1 Upper Water Canyon Aggregate Area

- ▲ SWMU or AOC
- ⊕ Regional well location
- ▭ Structure
- ⬚ Former structure
- 🟩 Canyon reach
- 🟧 Upper Water Canyon Aggregate Area
- ═ Major road
- — Local Rd
- ‒ ‒ · TA Boundary
- ━ LANL Boundary
- ┼ Fence
- — Paved road
- — Terrain contour, 80-ft interval

New Mexico State Plane Coordinate System Central Zone (3002)
North American Datum, 1983 (NAD 83)

US Survey Ft

GIS: Dave Frank, david.frank@em-la.doe.gov, 551-2945
Created: 05-April-2022
Last Opened: Thursday, April 7, 2022

File: map_22-0010-14_16-017(j)-99_overall_site_plate

DISCLAIMER: This map was created for work processes associated with the LLCC. All other uses for this map should be confirmed with N3B staff.

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Feet

Document Path: Q:\22-Projects\22-0010\mxd\map_22-0010-14_16-017(j)-99_overall_site_plate.mxd