TA-16

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Refer to: ER2003-0729

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SUBJECT: SUBMITTAL OF VOLUNTARY CORRECTIVE ACTION (VCA) COMPLETION REPORT FOR SOLID WASTE MANAGEMENT UNIT (SWMU) 16-016(c)-99 AT TECHNICAL AREA (TA) -16

Dear Mr. Young:

Enclosed are two copies of the Los Alamos National Laboratory (LANL) Risk Reduction Environmental Stewardship-Remediation Services (RRES-RS) VCA Completion Report for SWMU 16-016(c)-99 at TA-16. The original report, Material Disposal Area (MDA) Closure Certification Report (MDA P, 387 Flash Pad, and Solid Waste Management Unit [SWMU] 16-016(c)-99), Annex I, was submitted to your office on January 31, 2003 (ER2003-0095). To meet corrective action reporting requirements, as per your letters dated April 30, 2003 and August 29, 2003, a stand-alone VCA Completion Report for SWMU 16-016(c)-99 is now being provided.

If you have any questions, please contact William Criswell at (505) 665-5886 or Lance Woodworth at (505) 665-5820.

Sincerely,

David McInroy, Deputy Project Director
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Sincerely,

David Gregory, Project Manager
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Enclosures: Certification
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CERTIFICATION

CERTIFICATION BY THE RISK REDUCTION AND ENVIRONMENTAL STEWARDSHIP-REMEDIATION SERVICES (RRES-RS) PROJECT TECHNICAL REPRESENTATIVES

Document Title: **SUBMITTAL OF VOLUNTARY CORRECTIVE ACTION (VCA) COMPLETION REPORT FOR SOLID WASTE MANAGEMENT UNIT (SWMU) 16-016(c)-99 AT TECHNICAL AREA (TA) -16**

I certify under penalty of law that these documents and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violation.

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LA-UR-03-8482
November 2003
ER2003-0711

Voluntary Corrective Action Completion Report for Solid Waste Management Unit 16-016(c)-99 at Technical Area 16

CD included with this document

Los Alamos
NATIONAL LABORATORY
Los Alamos NM 87545

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Prepared by Risk Reduction and Environmental Stewardship–Remediation Services

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LA-UR-03-8482
ER2003-0711

Voluntary Corrective Action Completion Report for Solid Waste Management Unit 16-016(c)-99 at Technical Area 16

November 2003

Responsible project leader:

Printed Name	Signature	Title	Organization	Date
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David Gregory		Project Manager	DOE-LASO	11/25/03

EXECUTIVE SUMMARY

This voluntary corrective action (VCA) completion report addresses the characterization and remediation of Solid Waste Management Unit (SWMU) 16-016(c)-99 in Technical Area 16 at Los Alamos National Laboratory (the Laboratory). SWMU 16-016(c)-99 is a consolidated unit consisting of the following three SWMUs: 16-010(a), the TA-16-386 Flash Pad (Flash Pad 386); 16-016(c), a former barium nitrate pile; and 16-006(e), a septic tank system. The SWMUs that comprise SWMU 16-016(c)-99 are listed in Module VIII of the Laboratory's Hazardous Waste Facility Permit.

VCA activities were integrated with clean closure of two regulated waste management sites, Material Disposal Area (MDA) P (SWMU 16-018) and Flash Pad 387 [SWMU 16-010(b)]. The VCA for SWMU 16-016(c)-99 involved removing contaminated soil and the septic tank (including piping associated with the tank), collecting confirmation samples, assessing potential risks to human health and the environment, and interim stabilization and revegetation. VCA sampling results, which are combined with the confirmation sample results for MDA P and Flash Pad 387, confirmed that the extent of contamination for the entire area was defined and residual contaminant concentrations at the site pose no unacceptable risk to human or ecological receptors under current and projected future land use.

Based on the results of the VCA, SWMU 16-016(c)-99 is proposed for no further action (NFA) under Criterion 5 (Table ES-1). This criterion states that the SWMU has been characterized or remediated in accordance with applicable state or federal regulations and that available data indicate that chemicals of concern either are not present or are present at concentrations that pose no potential unacceptable risk to human or ecological receptors under projected future land use.

Table ES-1
Summary of Proposed Actions

SWMU Number	SWMU Description	HSWA[a]	Radionuclide Component[b]	Proposed Action	Rationale for Recommendation
16-016(c)-99	Burning ground	Yes	Yes	NFA, Criterion 5[c]	The site has been characterized and the available data indicate that contaminants pose no potential unacceptable risk to human and ecological receptors.

[a] Indicates whether the site is listed in the Hazardous and Solid Waste Amendments (HSWA) Module VIII of the Laboratory's Hazardous Waste Facility Permit.

[b] Indicates whether the site has a radionuclide component.

[c] NFA criteria are listed in section II.B.4.a.(4).(b) of NMED's Resource Conservation and Recovery Act permits management program documents requirement guide.

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1.0 INTRODUCTION

Los Alamos National Laboratory (the Laboratory) is a multidisciplinary research facility owned by the US Department of Energy (DOE) and managed by the University of California. 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 43 mi^2 of the Pajarito Plateau, which consists of a series of finger-like mesas separated by deep canyons. These canyons contain ephemeral and intermittent streams that run from west to east. Mesa tops range in elevation between approximately 6200 ft and 7800 ft.

The Laboratory's Risk Reduction and Environmental Stewardship–Remediation Services (RRES-RS) project, formerly known as the Environmental Restoration (ER) Project, is involved in a national DOE effort to clean up facilities that had been involved in weapons production. The goal of the RRES-RS project is to ensure that DOE's past operations do not threaten human or environmental health and safety in and around Los Alamos County. To achieve that goal, RRES-RS is investigating sites that potentially are contaminated by past Laboratory operations.

This voluntary corrective action (VCA) completion report addresses the characterization and remediation of Solid Waste Management Unit (SWMU) 16-016(c)-99 (Figure 1.0-1), a consolidation of three SWMUs:

- the TA-16-386 Flash Pad (Flash Pad 386), SWMU 16-010(a);
- former barium nitrate pile, SWMU 16-016(c); and
- septic system, SWMU 16-006(e).

SWMU 16-016(c)-99 is located in Technical Area (TA) 16 at the Laboratory. The SWMUs that comprise SWMU 16-016(c)-99 are listed in Module VIII of the Laboratory's Hazardous Waste Facility Permit ID# NM0890010515-1, issued to the Laboratory by the US Environmental Protection Agency (EPA) on May 23, 1990, and modified on May 19, 1994 (EPA 1990, 01585; EPA 1994, 44146).

SWMU 16-016(c)-99 is contiguous with two regulated waste management units: Material Disposal Area (MDA) P (SWMU 16-018) and Flash Pad 387 [SWMU 16-010(b)]. Collectively, SWMU 16-016(c)-99, SWMU 16-018, and SWMU 16-010(b) are referred to as the "MDA P Site." VCA activities for SWMU 16-016(c)-99 were conducted simultaneously with the closure activities of MDA P and Flash Pad 387 to enhance the efficiency of field operations and because a risk-based approach for demonstrating successful cleanup is appropriate for demonstrating completion of both clean closure and corrective action. The decision process leading to combining the sites is described below.

The approved closure plan for MDA P (LANL 1995, 58713) established that MDA P would undergo closure by removal and decontamination in order to meet clean closure requirements. In the approved closure plan, a strategy was proposed for comparing confirmation sampling data with baseline levels of environmental contamination attributable to sources adjacent to MDA P. This strategy was intended to distinguish between MDA P-related contamination and that which was attributable to nearby sites.

After the MDA P closure plan was approved by the New Mexico Environment Department (NMED) in 1997 and closure activities began, the Laboratory recognized that the MDA P closure activities were likely to affect the schedule of closure activities at Flash Pad 387 and remediation activities at SWMU 16-016(c)-99, which would be proceeding simultaneously (LANL 1999, 63546). Because of the sites' proximity to one another and their similar characteristics, the Laboratory determined that combining the three activities would allow for more efficient use of resources, such as mobilization of field equipment. The Laboratory also concluded that confirmation sampling and assessment of human health and ecological impacts of the three sites together following the closure/remediation activities would be

appropriate. Therefore, in February 1999, the Laboratory and NMED agreed that the sites adjacent to MDA P would be closed or remediated concurrently with MDA P; any residual contamination would be assessed concurrently; and the sites would be closed or remediated to a common cleanup standard (LANL 21999, 63546). This decision was made for two reasons: (1) the hazardous wastes and hazardous constituents within the sites were similar, and (2) the boundaries of the sites overlap. During discussions between the Laboratory and NMED concerning the MDA P sampling and analysis plan (SAP), it was further agreed that

- two additional plans would be developed in conjunction with the MDA P SAP: a VCA plan for SWMU 16-016(c)-99 and a closure plan for Flash Pad 387;
- Equipment from the ongoing closure operations at MDA P would remain mobilized at MDA P to cleanup these additional sites;
- One set of operational preliminary remediation goals (PRGs) would be developed for field screening during cleanup activities at all three sites;
- The scope of the MDA P SAP would be expanded to include a confirmation sampling plan for verifying that operational PRGs had been achieved for all three sites and for demonstrating that post-cleanup residual contamination levels pose no unacceptable risk to human health or the environment (LANL 1999, 63546).

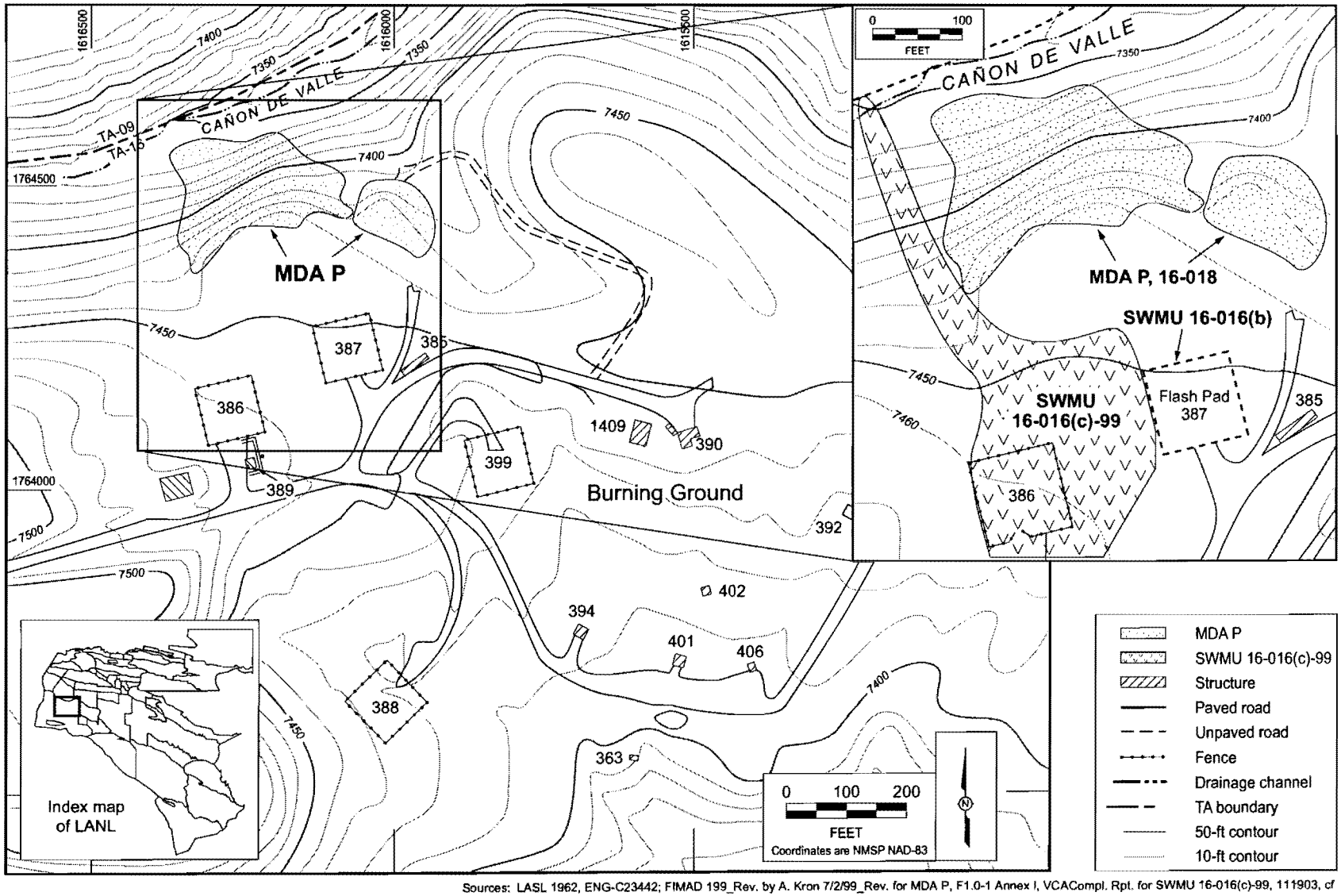
Thus, the footprint of MDA P was expanded to include Flash Pad 387 and SWMU 16-016(c)-99, referred to collectively in this report as the MDA P Site.

The VCA plan for SWMU 16-016(c)-99 was submitted as an appendix to the MDA P SAP (LANL 1999, 63546) and approved by NMED on July 7, 2001. The VCA for SWMU 16-016(c)-99 was conducted in accordance with the requirements of the Resource Conservation and Recovery Act (RCRA) and the New Mexico Hazardous Waste Act and adhered to the VCA plan for remediation of consolidated SWMU 16-016(c)-99 (LANL 1999, 63546). The objectives of this VCA were to

- determine the nature and extent of soil contamination;
- perform remedial actions; and
- collect postremedial confirmation samples.

Section 2 of this report discusses the site description and operational history, remedial activities, analytical results for soil samples, and human health and ecological risk assessments. Section 3 describes site waste management activities. References are listed in section 4. Appendix A contains a list of acronyms, a glossary of terms, and a metric-to-English units conversion table. Appendix B presents the surface water assessment erosion matrix for SWMU 16-016(c)-99. Appendix C contains information related to the risk assessments. A compact disc (CD) containing VCA confirmation sample data is attached at the front of this report. Other relevant information regarding cleanup and confirmation activities at the MDA P Site is included in the following documents:

- "Material Disposal Area P Site: Phase I Closure Implementation Report," June 2003, LA-UR-02-7002 (LANL 2003, 76054)
- "Bedrock Fracture Characterization at Material Disposal Area P Site: Phase II Closure Investigation Report," July 2003, LA-UR-02-7200 (LANL 2003, 77423)
- "Material Disposal Area P Site Closure Certification Report," October 2003, LA-UR-03-8046 (LANL 2003, 79563).



Sources: LASL 1962, ENG-C23442; FIMAD 199_Rev. by A. Kron 7/2/99_Rev. for MDA P, F1.0-1 Annex I, VCACompl. Rpt. for SWMU 16-016(c)-99, 111903, cf

Figure 1.0-1. Location of SWMU 16-016(c)-99, MDA P, and Flash Pad 387 within TA-16 Burning Ground

2.0 SWMU 16-016(c)-99

2.1 Site Description and Operational History

TA-16 is a high-explosives (HE) research, development, and testing capabilities facility. SWMU 16-016(c)-99 is located at the TA-16 Burning Ground within the TA-16 HE exclusion area (Figure 1.0-1). SWMU 16-016(c)-99 is regulated under the corrective action portion (Module VIII) of the Laboratory's Hazardous Waste Facility Permit and is the consolidation of three SWMUs (Figure 1.0-1):

- SWMU 16-010(a), TA-16-386 Flash Pad (Flash Pad 386);
- SWMU 16-016(c), the former barium nitrate pile; and
- SWMU 16-006(e), a septic tank system.

SWMU 16-010(a), Flash Pad 386, was constructed in 1951 and is located approximately 150 ft southwest of Flash Pad 387. Flash Pad 386 was built for operations similar to those conducted at Flash Pad 387; however, no evidence could be found to indicate that Flash Pad 386 was ever used for the treatment of HE-contaminated materials. Flash Pad 386 was originally constructed in a manner identical to Flash Pad 387. The base of the pad was soil, and the pad was situated within a 100 x 100-ft area enclosed by an 8-ft-high chainlink fence. In 1998, a metal building was installed in the southeast corner of the area. In 1999, as part of the MDA P closure activities, the area was halved and the northern section of fence was relocated 50 ft to the south, resulting in an enclosed area of 50 x 100 ft. This allowed heavy truck access through the area to support waste shipments from MDA P Site excavation and removal activities.

The barium nitrate pile [SWMU 16-016(c)] was located in the west-central area of Flash Pad 386. The VCA plan states that the barium nitrate pile probably was located within the confines of Flash Pad 386 in the late 1960s, but had been removed by the early 1970s (LANL 1999, 63546). Photographic evidence shows that Flash Pad 386 was used to store barium nitrate sometime during the 1950s, prior to which the barium nitrate pile was located to the north of Flash Pad 386. The SWMU boundary extends around the suspected former location of the barium nitrate pile and northward, where surface runoff may have transported contamination down the drainage. Barium nitrate was used in the production of baratol from the 1950s through the 1960s. The approximately 0.85-ac footprint for the barium nitrate pile was removed in the early 1970s. The former SWMU was located on a steep, north-facing slope at the head of a small drainage channel into Cañon de Valle.

SWMU 16-006(e) was an approximately 100-gal. steel septic tank that was part of a sanitary facility constructed in 1963 (LANL 1995, 58713). It was located east of structure 16-389, a control shelter at a burning ground. The historical description of the septic system included the tank, a leach field, an outfall, and associated drainline; the septic system served the control shelter at the burning ground. The water closet, lavatory, and floor drain in the control shelter discharged to the septic tank. Structure 16-389 generally was occupied only during burning ground operations, which occurred one to two days a week from the 1950s to 1984. In 1987, the Laboratory obtained a sanitary waste permit for the septic tank from Los Alamos County; however, the tank outfall was plugged in 1988. A 4-in.-diameter vitrified clay pipe (VCP) was plugged and left in place at the tank end. During excavation in 2000 and 2001, no evidence was found of an outfall or leach field associated with the septic system.

2.2 Previous Activities

2.2.1 Previous Investigations

The results of the previous investigations summarized in this section can be found in the VCA plan (LANL 1999, 63546).

In March 1995, initial sampling was conducted at the former barium nitrate pile [SWMU 16-016(c)]. A field-randomized, 20-ft grid, which also extended over the area of SWMU 16-010(a), was used to collect barium, HE, and radiation field-screening data. Surface-soil samples were collected from the five areas with the highest barium readings and submitted for laboratory analysis. The drainage channel also was field-screened for barium, HE, and radiation at groups of 3 points every 30 ft downgradient for a distance of 210 ft; beyond 210 ft, surface samples were collected at 30-ft intervals from the center of the drainage to Cañon de Valle (a distance of 150 ft). A total of 18 samples collected from the grid and drainage transect were submitted for laboratory analysis, which showed several inorganic chemicals, particularly barium and lead, at elevated concentrations. Results also showed elevated concentrations of polycyclic aromatic hydrocarbons (PAHs), HE, and total uranium. In 1998, potential contaminant migration from SWMU 16-016(c) was minimized by the installation of best management practice (BMP) erosion-control features, such as run-on diversion, a vegetative buffer strip, regrading, and straw-bale barriers.

In September 1995, the septic tank [SWMU 16-006(e)] was sampled as part of a survey for radioactivity in Laboratory septic tanks (LANL 1997, 63133). Liquid and sludge samples were collected and analyzed for gross alpha, gross beta, gross gamma, and tritium. No elevated radioactivity was found in the tank. In addition, the ER Project drilled two boreholes at the proximal and distal ends of the septic system: one borehole near the septic system (location 16-1335) was drilled to 9 ft; the second borehole, approximately 75 ft down the drainline from the septic tank (location 16-1339), was drilled to 4.5 ft. The two boreholes were field-screened for HE, and three samples indicated elevated HE (the 1- to 2-ft interval in both boreholes and the 3.5- to 4.5-ft interval at location 16-1339). As a result of the field screening, four samples were submitted for laboratory analysis for HE, semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), metals, and gamma-emitting radionuclides. No elevated chemical concentrations or activities were detected by the laboratory analyses. In 1998, the contents of the tank were analyzed and determined to meet the waste acceptance criteria (WAC) of the Sanitary Wastewater Systems Consolidation (SWSC) plant. The contents of the tank were removed and disposed of at the Laboratory's SWSC plant. Analytical results of the tank's contents and the exterior of the tank support the conclusion that the tank received only sanitary wastewater during its operational life (LANL 1999, 63132).

The ER Project conducted a RCRA facility investigation (RFI) at SWMU 16-010(a), Flash Pad 386, in 1995. Thirty samples from thirty locations were field-screened for HE and inorganic chemicals. Based on the field screening, four samples were collected from areas with the highest barium concentrations and were submitted for laboratory analysis. Barium concentrations were highest in surface samples collected near the former barium nitrate pile [SWMU 16-016(c)]. The RFI report recommended no further action (NFA) at SWMU 16-010(a) and recommended that the barium should be investigated and remediated as part of SWMU 16-016(c) (LANL 1997, 62539).

2.2.2 Preliminary Conceptual Model

The VCA plan for SWMU 16-016(c)-99 included a preliminary conceptual model of the transport and exposure pathways for the SWMU (LANL 1999, 63546). Most of SWMU 16-016(c)-99 was located in an area of steep drainages. Potential contamination was expected to be in shallow surface soils, which may have been transported by surface water runoff in the downgradient direction of the drainage. The assumptions of transport were based on data collected during RFI sampling of SWMU 16-016(c)-99 in

March 1995 and on the surface water site assessment that determined an erosion matrix score of 72 for SWMU 16-016(c) (LANL 1999, 63546).

The primary mechanisms available for off-site transport of contaminants from surface soils and tuff within the SWMU were determined to be (1) occasional dissolution and transport via surface water runoff from snowmelt and rainfall (potentially reaching the Cañon de Valle stream channel), (2) soil erosion, and (3) wind dispersion (LANL 1999, 63546).

Potentially complete exposure pathways for both human and ecological receptors included in the VCA plan are incidental soil ingestion, dermal contact, and inhalation of particulates and dust. Additionally, food-web uptake and transfer and plant uptake were listed in the VCA plan preliminary conceptual model as mechanisms for exposure to ecological receptors.

2.3 Remedial Activities

2.3.1 VCA Investigative and Remediation Activities

PRGs were established to serve as operational guidelines during excavation. Barium was established as the primary index for removal activities for inorganic chemicals for the following reasons: barium contamination was ubiquitous across the MDA P Site; barium was assumed to be collocated with other inorganic chemicals; barium was likely to be at higher concentrations and may have been more mobile in the environment than other metals; and barium concentrations could be readily measured with a field x-ray fluorescence (XRF) instrument. It was determined that the human health risk-based barium PRG of 5600 mg/kg presented in the MDA P closure plan would not meet the removal criterion for hazardous waste soils, i.e., soils for which a sample extract could fail the toxicity characteristic leaching procedure (TCLP) limit of 100 milligrams per liter (mg/L) for barium. Thus, a total concentration of 20 times the regulatory limit of 100 mg/L for barium, which is a guideline for predicting TCLP results, was used to establish the operational PRG of 2000 mg/kg for field-screening determinations of suspected hazardous waste for staging purposes and for making determinations of whether sufficient materials had been excavated to reduce human health and ecological risks related to residual contamination at the MDA P Site.

Other contaminants known to be ubiquitous across the MDA P Site were the HE compounds 1,3,5-trinitro-1,3,5-triazacyclohexane (RDX) and 2,4,6-trinitrotoluene (TNT). As with barium, RDX and TNT were measured in the excavated materials for assessing health and safety concerns during waste segregation operations and to determine whether sufficient material had been excavated and removed. RDX and TNT measurements were not as efficient or as timely as the XRF results, as soil samples had to be collected and processed for analysis by EPA Solid Waste 846 (SW-846) Methods 8510 and 8515. RDX was established as the operational index for removal activities for HE for the following reasons: RDX was found to be more prevalent than TNT; RDX has a higher toxicity than TNT (thus, removal based on RDX is based on a more restrictive standard and is more protective of human health than TNT); RDX was assumed to be collocated with other HE contamination; and RDX was likely to be at higher concentrations, and is more mobile in the environment, than other HE compounds. An operational PRG of 16 mg/kg was used for RDX to determine if sufficient materials had been excavated and removed to address human health and ecological risk concerns. This value is consistent with the EPA Region 6 industrial human health medium-specific screening level (EPA 1999, 64637).

The VCA plan described how SWMUs 16-010(a) and 16-016(c) would be remediated and field-screened to direct the removal of contaminated soils (LANL 1999, 63546). The VCA plan also included collecting two samples from within the tank of the former septic system [SWMU 16-006(e)] to confirm that it had received only sanitary waste and to further support the previous recommendation to remove SWMU

16-006(e) from Module VIII of the Laboratory's Hazardous Waste Facility Permit (EPA 1990, 01585; EPA 1994, 44146).

Most of the SWMU 16-016(c)-99 excavation was performed after the removal of MDA P and Flash Pad 387 was complete, from approximately August 2000 to March 2001.

Excavation within the boundary of the barium nitrate pile included both remote and conventional means. Because part of the boundary of the barium nitrate pile extended down the western margin of MDA P, contaminated materials in this area were excavated during the excavation of MDA P. No attempt was made to segregate or identify materials that were related specifically to migration of barium nitrate from the pile area.

Soils within Flash Pad 386 were excavated and staged with soils from adjacent areas of the MDA P excavation. Field screening for barium was used to identify the extent of excavation. Surface soils and some bedrock materials were removed from within the flash pad area. Discontinuous areas downgradient of the flash pad were removed. Barium contamination has not penetrated the bedrock beneath the flash pad. Some residual bedrock contamination was identified in the drainage along the western margin of MDA P, but it was below the barium operational PRG of 2000 mg/kg. The remaining areas of exposed soil within the Flash Pad 386 fence were screened for barium contamination. After excavation, a layer of soil and gravel was placed in the excavation within the current fence. Gravel was placed on the north side of the current fenceline as an erosion-control measure.

The septic tank and drainline were remediated in two stages (March 2001 and March 2002). In March 2001, the drainline (4-in. diameter VCP) was located and excavated from the tank to its endpoint. The pipe was empty and the connection with the tank had been plugged. The tank outlet was plugged and the drainline was taken out of service. Field screening of the pipe interior indicated that no HE or barium contamination was present. The distal 10 ft of the drainline was crushed pipe with no defined outfall. The metal top and riser of the tank were excavated to expose the tank itself, estimated to be a 100-gal. metal tank. A representative of NMED Field Operations Division inspected the tank, and the tank was backfilled with clean soil to grade and left in place. A copy of the NMED inspector's form is included in the Phase I report (LANL 2003, 76054). The pipe inlet was plugged with a polyvinyl chloride pipe fitting, and the water was turned off inside the building at the toilet to decommission the source. Soil surrounding the tank and the edges and interior portions of the tank were field-tested for HE and barium and found to be below operational PRGs for both. In March 2002, the tank and pipe were excavated, sampled, and removed completely.

Confirmation sampling (Phase II) activities were conducted as part of the MDA P Site investigation. Postexcavation activities for the MDA P Site resulted in two distinct zones: an "exposed tuff" zone and a "biological" zone; therefore, confirmation samples collected from the biological zone have both soil and tuff matrices, while the exposed tuff zone has only a tuff component. Table 2.3-1 lists the total number of confirmation samples (by analyte and by zone) obtained during Phase II activities. Samples were collected from 26 locations for SWMU 16-016(c)-99, but are not specified in Table 2.3-1 because the risk assessments supporting closure were performed for the entire MDA P Site. Figure 2.3-1 shows confirmation sample locations, including the matrix type of each sample and the boundaries of the biological and exposed tuff zones. The data are provided on the CD attached to this report, and Appendix B of the MDA P Site closure certification report (LANL 2003, 79563) contains the data quality analyses and a description of data qualifiers pertinent to the confirmation samples used in the risk assessment analyses.

Table 2.3-1
MDA P Site Phase II Confirmation Samples

Analyte Group	Number of Samples	
	Biological Zone	Exposed Tuff Zone
Inorganic Chemicals		
TAL metals	144	146
Chromium (VI)	144	146
Mercury	144	146
Perchlorate	28	33
Organic Chemicals		
VOCs	5	4
SVOCs	139	137
PCBs	3	4
HE	145	143
Dioxins/furans	3	4
Pesticides	3	4
Herbicides	3	4
Radionuclides		
Gamma spectroscopy	3	4
Uranium isotopes	3	4
Other		
pH	3	4

2.3.2 Data Review for VCA Samples

This section compares confirmation samples from the MDA P Site with Laboratory background values (BVs) for inorganic chemicals and radionuclides (LANL 1998, 59730). The samples collected within SWMU 16-016(c)-99 are not evaluated separately from the entire confirmation data set collected within the MDA P Site. For the biological zone, background comparisons are divided into samples collected from soil and those collected from tuff because the BVs are matrix-specific. No such division was necessary for the background comparisons of samples collected from the exposed tuff zone because all samples are designated as tuff. This section also presents the organic chemicals detected in confirmation samples at the MDA P Site.

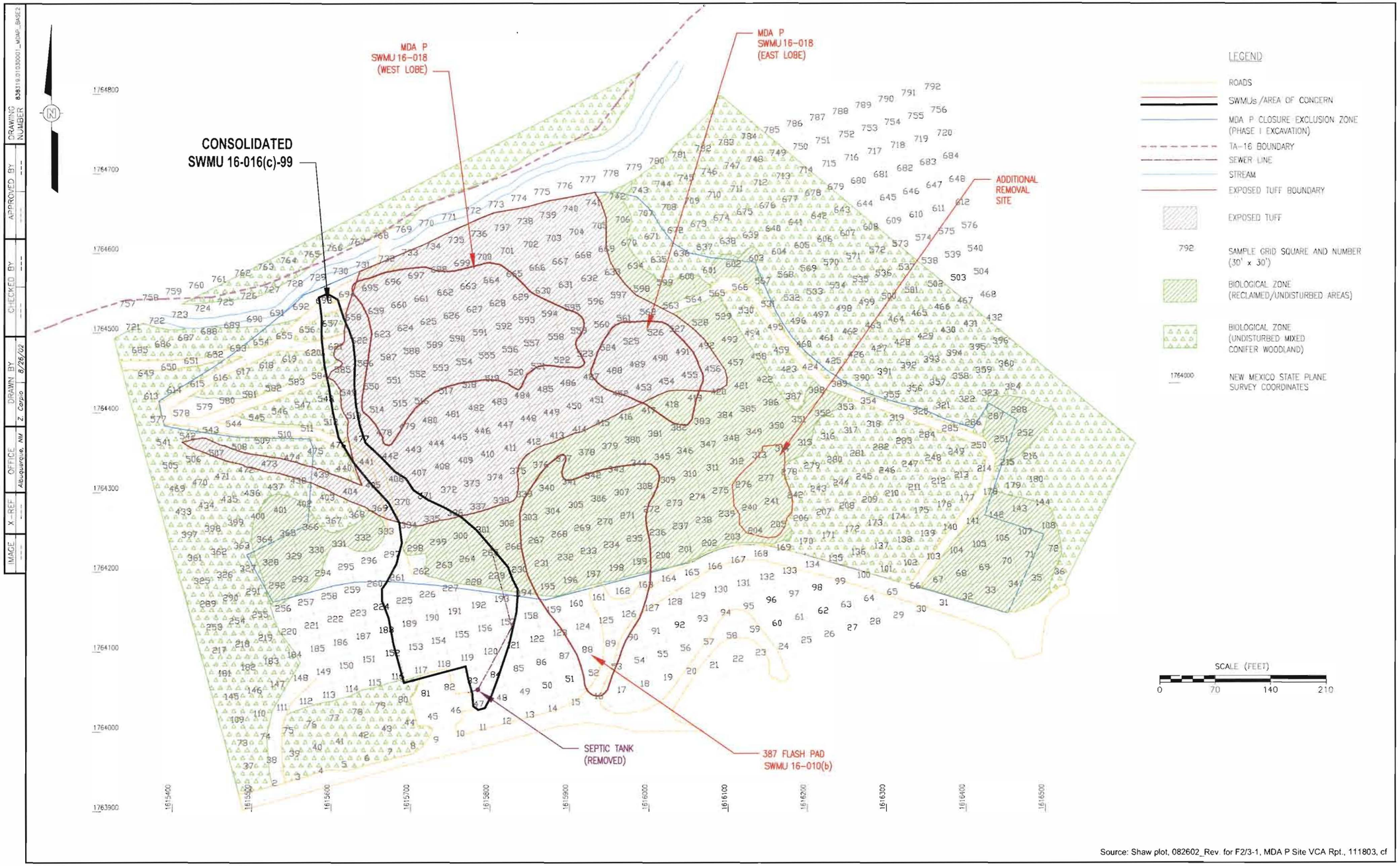


Figure 2.3-1. MDA P site Phase II confirmation sample locations

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In addition to the comparison of inorganic chemicals with their respective BVs, two statistical tests (Wilcoxon Rank Sum [WRS] and quantile tests) were used to determine whether the inorganic chemicals were statistically different from the background data sets (LANL 1998, 59596). The WRS test is a nonparametric distribution test of the hypothesis that samples within two data sets were taken from distributions with the same medians; it tests whether background data and confirmation data are similar. The quantile analysis is a nonparametric distribution evaluation of differences in the upper tails of the distributions; it tests whether the upper end of the confirmation data set is similar to the upper end of the background data set, which would indicate that significant residual contamination above background does not exist for a given analyte and that analyte can be considered similar to background concentrations. Inorganic chemicals were eliminated as chemicals of potential concern (COPCs) for the following reasons:

- the maximum concentration in the confirmation samples was less than the corresponding BV;
- the distribution comparison passed both the WRS and quantile test;
- the analyte failed the WRS test because the site median was statistically different from background but was at a lower concentration and the distribution passed the quantile test;
- the analyte failed the WRS test because of the very limited number of detections greater than BV and the distribution passed the quantile test; and
- the analyte passed the WRS test but failed the quantile test because of the very limited number of detections greater than BV.

Details of these statistical tests, including assumptions, methodology, test result values, box plots, and concentration-by-depth plots are provided in Appendix A, Attachment 2, of the MDA P Site closure certification report (LANL 2003, 79563).

2.3.2.1 Inorganic Chemical Comparison with Background

2.3.2.1.1 Biological Zone

For the soil matrix of the biological zone, 10 of 21 inorganic chemicals were detected above their respective BVs: antimony, barium, cadmium, chromium, cobalt, copper, lead, manganese, silver, and zinc (Table 2.3-2); hexavalent chromium and perchlorate were not detected in any samples and are not presented in Table 2.3-2. For the tuff matrix of the biological zone, 16 of 20 inorganic chemicals were detected above their respective BVs: aluminum, antimony, arsenic, barium, beryllium, chromium, cobalt, copper, iron, lead, nickel, selenium, silver, thallium, vanadium, and zinc (Table 2.3-2); hexavalent chromium was not detected in any samples and perchlorate was not sampled for in tuff, so neither is presented in Table 2.3-2.

Table 2.3-3 lists the results of the WRS and quantile statistical comparisons. For soil, two inorganic chemicals (barium and copper) detected above the soil BVs were statistically different from (greater than) background. Silver was retained as a COPC in soil because no background data set is available and it was detected above the BV. In addition, cobalt, lead, and zinc were retained as COPCs in the biological zone because they had concentrations in one or more samples that exceeded soil or tuff background concentrations by several factors or more. For tuff, 11 of 16 inorganic chemicals detected above the tuff BVs were statistically different from (greater than) background: aluminum, antimony, barium, chromium, cobalt, copper, iron, lead, nickel, selenium, and vanadium.

Table 2.3-2
Frequency of Detected Inorganic Chemicals above the Background Value—Biological Zone

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range[a] (mg/kg)	BV (mg/kg)	Frequency of Detects above BV	Frequency of Nondetects above BV
Aluminum	Soil	71	71	2,630 to 19,900	29,900	0/71	0/71
Aluminum	Tuff	73	73	766 to 32,700	7,340	6/73	0/73
Antimony	Soil	71	17	[0.09] to 2.90	0.83	1/71	23/71
Antimony	Tuff	73	3	[0.14] to 1.20	0.5	1/73	41/73
Arsenic	Soil	71	66	[0.12] to 4.80	8.17	0/71	0/71
Arsenic	Tuff	73	61	[0.12] to 3.80	2.79	4/73	0/73
Barium	Soil	71	71	18.7 to 6,630	295	28/71	0/71
Barium	Tuff	73	73	9.30 to 2,920	46	45/73	0/73
Beryllium	Soil	71	71	0.27 to 1.80	1.83	0/71	0/71
Beryllium	Tuff	73	73	0.23 to 1.90	1.21	7/73	0/73
Cadmium	Soil	71	24	[0.01] to 1.40	0.4	1/71	4/71
Cadmium	Tuff	73	33	[0.02] to 0.80	1.63	0/73	0/73
Chromium	Soil	71	70	1.6 to 39.4	19.3	1/71	0/71
Chromium	Tuff	73	69	0.51 to 15.6	7.14	8/73	0/73
Cobalt	Soil	71	71	0.690 to 44.7	8.64	4/71	0/71
Cobalt	Tuff	73	70	0.41 to 41.3	3.14	9/73	0/73
Copper	Soil	71	71	0.68 to 36.8	14.7	6/71	0/71
Copper	Tuff	73	73	0.004 to 32.4	4.66	19/73	0/73
Iron	Soil	71	71	4,580 to 19,900	21,500	0/71	0/71
Iron	Tuff	73	73	6.47 to 22,500	14,500	4/73	0/73
Lead	Soil	71	71	3.80 to 61.5	22.3	5/71	0/71
Lead	Tuff	73	73	1.25 to 24.20	11.2	8/73	0/73
Manganese	Soil	71	71	30.90 to 1,290	671	1/71	0/71
Manganese	Tuff	73	73	44.7 to 456	482	0/73	0/73
Mercury	Soil	71	36	[0.2] to 0.07	0.1	0/71	0/71
Mercury	Tuff	73	14	[0.0028] to 0.0610	0.1	0/73	0/73
Nickel	Soil	71	69	[1.3] to 10.5	15.4	0/71	0/71
Nickel	Tuff	73	62	0.79 to 12.6	6.58	8/73	0/73
Selenium	Soil	71	33	[0.10] to 0.480	1.52	0/71	0/71
Selenium	Tuff	73	48	0.13 to 0.74	0.3	21/73	2/73
Silver	Soil	71	16	[0.019] to 15.8	1	7/71	3/71
Silver	Tuff	73	15	[0.035] to 4.60	1	2/73	1/73
Thallium	Soil	71	30	[0.0130] to [1.2]	0.73	0/71	3/71
Thallium	Tuff	73	25	[0.012] to 1.2	1.1	1/73	1/73
Vanadium	Soil	71	70	[0.380] to 29.3	36.6	0/71	0/71
Vanadium	Tuff	73	70	[0.380] to 26.4	17	2/73	0/73
Zinc	Soil	71	67	[9.4] to 912	48.8	7/71	0/71
Zinc	Tuff	73	73	0.027 to 150	63.5	2/73	0/73

[a] [ ] = Not detected.

Table 2.3-3
Background Test Matrix—Biological Zone

Analyte	Media	Above/Below BV	WRS Test Pass/Fail	Quantile Pass/Fail	COPC?
Aluminum	Soil	Below	—[a]	—	No
Aluminum	Tuff	Above	Fail	Fail	Yes
Antimony	Soil	Above	Fail	Pass	No[b]
Antimony	Tuff	Above	Fail	Fail	Yes
Arsenic	Soil	Below	—	—	No
Arsenic	Tuff	Above	Pass	Pass	No
Barium	Soil	Above	Fail	Fail	Yes
Barium	Tuff	Above	Fail	Fail	Yes
Beryllium	Soil	Below	—	—	No
Beryllium	Tuff	Above	Pass	Pass	No
Cadmium	Soil	Above	Fail	Pass	No[b]
Cadmium	Tuff	Below	—	—	No
Chromium	Soil	Above	Fail	Pass	No[b]
Chromium	Tuff	Above	Fail	Pass	Yes
Cobalt	Soil	Above	Fail	Pass	No[b]
Cobalt	Tuff	Above	Fail	Pass	Yes
Copper	Soil	Above	Pass	Fail	Yes
Copper	Tuff	Above	Fail	Fail	Yes
Iron	Soil	Below	—	—	No
Iron	Tuff	Above	Fail	Pass	Yes
Lead	Soil	Above	Fail	Pass	No[b]
Lead	Tuff	Above	Pass	Fail	Yes
Manganese	Soil	Above	Fail	Pass	No[b]
Manganese	Tuff	Below	—	—	No
Nickel	Soil	Below	—	—	No
Nickel	Tuff	Above	Fail	Fail	Yes
Selenium	Soil	Below	—	—	No
Selenium	Tuff	Above	Fail	Fail	Yes
Silver	Soil	Above	na[c]	na	Yes[d]
Silver	Tuff	Above	Fail	Pass	No[e]
Thallium	Soil	Above	Fail	Pass	No[b]
Thallium	Tuff	Above	Fail	Pass	No[b]
Vanadium	Soil	Below	—	—	No
Vanadium	Tuff	Above	Fail	Pass	Yes
Zinc	Soil	Above	Pass	Pass	No
Zinc	Tuff	Above	Pass	Pass	No

[a] Statistical analysis not required because BV was not exceeded.
[b] WRS failed because the site median was statistically less than the background median.
[c] na = Background data set or BV not available.
[d] Detected chemical, but no background data set is available for statistical comparison tests.
[e] One hit greater than maximum background.

Table C-1 in Appendix C lists all MDA P Site biological zone samples that show inorganic chemical concentrations above BVs; samples collected from SWMU 16-016(c)-99 are highlighted. Seven inorganic chemicals had samples with concentrations above BV within the boundary of SWMU 16-016(c)-99 (number of samples greater than the BV in parentheses): antimony (3), barium (12), chromium (1), cobalt (1), copper (2), selenium (2), and silver (1). Several inorganic chemicals also had detection limits above one or both BVs: antimony, cadmium, selenium, silver, and thallium. Of these, only antimony and silver had detection limits greater than the associated BV within SWMU 16-016(c)-99. With the exception of barium, cobalt, copper, and selenium, the concentrations of inorganic chemicals detected above BVs within SWMU 16-016(c)-99 were within the range of the background data sets (LANL 1998, 59730).

2.3.2.1.2 Exposed Tuff Zone

For the exposed tuff zone, 19 of the 21 inorganic chemicals sampled for were detected above their respective BVs: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc (Table 2.3-4); hexavalent chromium was not detected in any samples and is not presented in Table 2.3-4. Additionally, perchlorate, for which analyses were conducted for 33 samples from the exposed tuff zone and which does not have an associated BV, was detected in 7 samples.

Table 2.3-4
Frequency of Detected Inorganic Chemicals above the Background Value—Exposed Tuff Zone

Analyte	Number of Analyses	Number of Detects	Concentration Range[a] (mg/kg)	BV (mg/kg)	Frequency of Detects above BV[b]	Frequency of Nondetects above BV
Aluminum	146	146	656 to 28,100	7,340	26/146	0/146
Antimony	146	22	[0.02] to 2.70	0.5	3/146	97/146
Arsenic	146	120	[0.11] to 7.20	2.79	16/146	0/146
Barium	146	145	5.20 to 6,980	46	79/146	0/146
Beryllium	146	146	0.25 to 3.30	1.21	26/146	0/146
Cadmium	146	65	[0.015] to 5.70	1.63	2/146	0/146
Chromium	146	145	0.32 to 18.70	7.14	23/146	0/146
Cobalt	146	144	0.35 to 151.00	3.14	53/146	0/146
Copper	146	144	[0.94] to 34.00	4.66	57/146	0/146
Iron	146	146	4,130 to 20,600	14,500	12/146	0/146
Lead	146	146	1.20 to 144.00	11.2	23/146	0/146
Manganese	146	145	103.00 to 842.00	482	11/146	0/146
Mercury	146	30	[0.0028] to 0.22	0.1	1/146	1/146
Nickel	146	132	0.78 to 13.20	6.58	18/146	0/146
Perchlorate	33	7	[0.007] to [0.73]	—[c]	7/33	0/146
Selenium	146	88	0.12 to 1.40	0.3	45/146	1/146
Silver	146	22	[0.04] to 1.80	1	5/146	6/146
Thallium	146	46	[0.012] to 1.40	1.1	3/146	4/146
Vanadium	146	140	[0.38] to 36.70	17	15/146	0/146
Zinc	146	146	23.10 to 118.0	63.5	8/146	0/146

[a] [ ] = Not detected.
[b] For analytes with no BV, all detects are counted as above BV.
[c] — = No BV available.

The WRS and quantile statistical comparisons found that 15 of 19 inorganic chemicals detected above the tuff BVs were statistically different from (greater than) background: aluminum, antimony, barium, beryllium, chromium, cobalt, copper, iron, lead, mercury, nickel, perchlorate, selenium, vanadium, and zinc (Table 2.3-5).

Table 2.3-5
Background Test Matrix—Exposed Tuff Zone

Analyte	Above/Below BV	WRS Test Pass/Fail	Quantile Pass/Fail	COPC?
Aluminum	Above	Fail	Fail	Yes
Antimony	Above	Fail	Fail	Yes
Arsenic	Above	Pass	Pass	No
Barium	Above	Fail	Fail	Yes
Beryllium	Above	Fail	Fail	Yes
Cadmium	Above	Fail	Pass	No[a]
Chromium	Above	Fail	Fail	Yes
Cobalt	Above	Fail	Fail	Yes
Copper	Above	Fail	Fail	Yes
Iron	Above	Fail	Fail	Yes
Lead	Above	Pass	Fail	Yes
Manganese	Above	Fail	Pass	No[b]
Mercury	Above	NA[c]	NA	Yes[d]
Nickel	Above	Fail	Fail	Yes
Perchlorate	NA	NA	NA	Yes[d]
Selenium	Above	Fail	Fail	Yes
Silver	Above	Fail	Pass	No[a]
Thallium	Above	Fail	Pass	No[a]
Vanadium	Above	Fail	Fail	Yes
Zinc	Above	Fail	Pass	Yes[e]

[a] WRS failed because site median was statistically less than background median.
[b] One hit greater than maximum background.
[c] NA = Background data set or BV not available.
[d] Detected chemical, but no background data set, is available for statistical comparison tests.
[e] Zinc carried forward as a COPC because WRS failed because site median exceeded that for background.

Table C-2 in Appendix C lists all MDA P Site exposed tuff zone samples with inorganic chemical concentrations above BVs; samples from SWMU 16-016(c)-99 are highlighted. Twelve inorganic chemicals had samples with concentrations above BV within SWMU 16-016(c)-99 (number of samples greater than the BV in parentheses): aluminum (5), antimony (7), barium (10), beryllium (2), chromium (5), cobalt (7), copper (9), iron (1), lead (2), nickel (3), selenium (4), and vanadium (1). Antimony had detection limits greater than the associated BV but was not detected at SWMU 16-016(c)-99. Except for

chromium and iron, all inorganic chemicals that failed the background screen were detected within SWMU 16-016(c)-99 at concentrations greater than the range of the background data sets.

2.3.2.2 Radionuclide Comparison with Background or Fallout Values

Four radionuclide chemicals attributable to historical operations at MDA P were detected in the soil samples from the biological zone and three were detected in the exposed tuff zone. However, none of these radionuclide chemicals exceeded its respective background or fallout values (Table 2.3-6).

Table 2.3-6
Frequency of Detected Radionuclides above Background/Fallout Values—Biological and Exposed Tuff Zones

Analyte	Zone	Medium	Number of Analyses	Number of Detects	Concentration Range[a] (pCi/g)	BV or Fallout Value (pCi/g)	Frequency of Detects above BV or Fallout Value
Cesium-137[b]	B[c]	Soil	3	1	[-0.020] to 0.550	1.65	0/3
Uranium-234	B	Soil	3	3	0.480 to 0.730	2.59	0/3
Uranium-234	ET[d]	Tuff	4	4	0.45 to 0.71	1.98	0/4
Uranium-235	B	Soil	5	2	[-0.630] to [0.310]	0.20	0/5
Uranium-235	ET	Tuff	8	2	[-0.27] to 0.068	0.09	0/8
Uranium-238	B	Soil	3	3	0.510 to 0.850	2.29	0/3
Uranium-238	ET	Tuff	4	4	0.374 to 0.51	1.93	0/4

[a] [ ] = Not detected.
[b] Not detected in the exposed tuff zone.
[c] Biological zone
[d] Exposed tuff zone.

The tuff matrix of the biological zone was not sampled for radionuclides.

2.3.2.3 Evaluation of Organic Chemicals

Nineteen organic chemicals were detected in the biological zone. However, nine organic chemicals were detected in less than 5% of the samples and were eliminated from further consideration as COPCs: benzoic acid, dichlorobenzene[1,4-], dinitrobenzene[1,3-], dinitrotoluene[2,4-], dinitrotoluene[2,6-], methylnaphthalene[2-], nitrotoluene[3-], nitrotoluene[4-], and tetryl (EPA 1989, 08021). The remaining 10 detected organic chemicals were retained as COPCs: acetone, amino-2,6-dinitrotoluene[4-], amino-4,6-dinitrotoluene[2-], Aroclor-1260, bis(2-ethylhexyl)phthalate, DDT[4,4'-] (dichlorodiphenyltrichloroethane), 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane (HMX), RDX, toluene, and TNT (Table 2.3-7).

All biological zone samples with detected organic chemicals are provided in Table C-3 in Appendix C; samples from SWMU 16-016(c)-99 are highlighted. Five organic chemicals were detected within SWMU 16-016(c)-99 (number of detections in parentheses): amino-2,6-dinitrotoluene[4-] (2); amino-4,6-dinitrotoluene[2-] (2); bis(2-ethylhexyl)phthalate (2); HMX (9); and RDX (11).

Table 2.3-7
Frequency of Detected Organic Chemicals—Biological Zone

Analyte	Number of Analyses	Number of Detects	Concentration Range[a] (mg/kg)	Frequency of Detection (%)	EQL[b] (mg/kg)
Acetone	5	1	0.014 to [0.026]	20.0	0.03
Amino-2,6-dinitrotoluene[4-]	145	18	0.063 to 0.980	11.8	0.77
Amino-4,6-dinitrotoluene[2-]	145	20	0.044 to 1.10	13.2	0.36
Aroclor-1260	3	1	[0.039] to 0.061	33.3	0.04
Benzoic acid[c]	139	3	0.1 to [2.3]	2.2	2.30
Bis(2-ethylhexyl)phthalate	139	8	0.110 to [0.470]	5.8	0.47
DDT[4,4'-]	3	1	[0.002] to 0.0079	33.3	0.002
Dichlorobenzene[1,4-][c]	144	1	0.001 to [0.470]	0.7	0.47
Dinitrobenzene[1,3-][c]	145	3	0.046 to [1.40]	2.1	1.40
Dinitrotoluene[2,4-][c]	282[d]	1	[0.08] to [1.40]	0.4	1.40
Dinitrotoluene[2,6-][c]	282[d]	2	[0.08] to [1.40]	0.7	1.40
HMX	145	57	[0.08] to 16.0	38.9	0.36
Methylnaphthalene[2-][c]	139	1	0.040 to [0.470]	0.7	0.47
Nitrotoluene[3-][c]	145	1	[0.080] to [1.40]	0.7	1.40
Nitrotoluene[4-][c]	145	1	[0.080] to [1.40]	0.7	1.40
RDX	145	76	0.069 to 37.00	52.8	0.36
Tetryl[c]	144	1	[0.080] to [1.40]	0.7	1.40
Toluene	5	1	0.001 to [0.007]	20.0	0.01
TNT	145	12	0.034 to 1.20	8.3	0.77

[a] [ ] = Not detected.
[b] EQL = Estimated quantitation limit.
[c] Detected in less than 5% of the samples and eliminated as a COPC.
[d] Dinitrotoluenes were analyzed as part of the HE suite and in some samples as part of the SVOC suite.

Sixteen organic chemicals were detected in the exposed tuff zone. However, seven organic chemicals were detected in less than 5% of the samples and were eliminated from further consideration as COPCs: di-n-butylphthalate; dinitrobenzene[1,3-]; dinitrotoluene[2,4-]; dinitrotoluene[2,6-]; methylnaphthalene[2-]; nitrotoluene[4-]; and tetryl (EPA 1989, 08021). The remaining nine organic chemicals were retained as COPCs: amino-2,6-dinitrotoluene[4-]; amino-4,6-dinitrotoluene[2-]; bis(2-ethylhexyl)phthalate; carbon disulfide; HMX; RDX; toluene; trinitrobenzene [1,3,5-]; and TNT (Table 2.3-8).

Table C-4 in Appendix C lists all exposed tuff zone samples with detected organic chemicals; samples from SWMU 16-016(c)-99 are highlighted. Three organic chemicals were detected within SWMU 16-016(c)-99 (number of detections in parentheses): bis(2-ethylhexyl)phthalate (2), HMX (2), and RDX (6).

Table 2.3-8
Frequency of Detected Organic Chemicals—Exposed Tuff Zone

Analyte	Number of Analyses	Number of Detects	Concentration Range[a] (mg/kg)	Frequency of Detection (%)	EQL[b] (mg/kg)
Amino-2,6-dinitrotoluene[4-]	143	20	0.049 to 0.550	14.0	0.330
Amino-4,6-dinitrotoluene[2-]	143	23	[2.5E-07] to 0.882	16.1	0.330
Bis(2-ethylhexyl)phthalate	137	7	0.08 to 0.620	5.1	0.430
Carbon disulfide	5	1	[0.005] to 0.010	20.0	0.006
Di-n-butylphthalate[c]	137	1	0.130 to [0.430]	0.7	0.430
Dinitrobenzene[1,3-][c]	143	1	0.044 to [0.330]	0.7	0.330
Dinitrotoluene[2,4-][c]	280[d]	2	0.036 to [0.430]	0.7	0.430
Dinitrotoluene[2,6-][c]	280[d]	1	[0.080] to [0.430]	0.4	0.430
HMX	143	76	[0.080] to 5.740	53.1	0.330
Methylnaphthalene[2-][c]	137	1	0.058 to [0.430]	0.7	0.430
Nitrotoluene[4-][c]	143	1	[0.080] to [0.330]	0.7	0.330
RDX	143	107	0.054 to 10.80	74.8	0.320
Tetryl[c]	143	1	[0.08] to [0.330]	0.7	0.330
Toluene	5	2	0.001 to [0.026]	40.0	0.026
Trinitrobenzene[1,3,5-]	143	8	0.047 to 0.360	5.6	0.330
TNT	143	10	0.029 to 0.480	7.0	0.330

[a] [ ] = Not detected.
[b] EQL = Estimated quantitation limit.
[c] Detected in less than 5% of the samples and eliminated as a COPC.
[d] Dinitrotoluenes were analyzed as part of the HE suite and in some samples as part of the SVOC suite.

2.3.2.4 Summary of COPCs

Table 2.3-9 lists the COPCs identified for the MDA P Site, for both the biological zone and the exposed tuff zone. Inorganic chemicals are presented by matrix type for the biological zone because the screen against BVs that was used to determine COPCs is matrix-specific.

Table 2.3-9
Results of Data Review

Analyte	Biological Zone		Exposed Tuff Zone	Result	Rationale
	Soil	Tuff			
Inorganic Chemicals					
Aluminum	—[a]	X[b]	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed statistical tests.
Antimony	—	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed statistical tests.
Arsenic	—	—	—	Eliminated	Eliminated from both zones because detected concentrations did not exceed established BVs or were not statistically different from background.
Barium	X	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed statistical tests
Beryllium	—	—	X	Retained	Retained for exposed tuff zone because detected concentrations exceeded established BVs and failed statistical tests.
Cadmium	—	—	—	Eliminated	Eliminated from both zones because detected concentrations did not exceed established BVs or were not statistically different from background.
Chromium	—	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed statistical tests.
Cobalt	X	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed statistical tests or had samples greater than maximum BV by several factors.
Copper	X	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed statistical tests.
Iron	—	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed statistical tests.
Lead	X	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed statistical tests or had samples greater than maximum BV by several factors.

Table 2.3-9 (continued)

Analyte	Biological Zone		Exposed Tuff Zone	Result	Rationale
	Soil	Tuff			
Manganese	—	—	—	Eliminated	Eliminated from both zones because detected concentrations did not exceed established BVs or were not statistically different from background.
Mercury	—	—	X	Retained	Retained for exposed tuff zone because detected concentrations exceeded established BVs and because there is no background data set for comparison.
Nickel	—	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed statistical tests.
Perchlorate	ND[c]	ND	X	Retained	Retained for exposed tuff zone because it was detected in seven samples and does not have an associated BV.
Selenium	—	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed statistical tests.
Silver	X	—	—	Retained	Retained for biological zone because detected concentrations exceeded established BVs and because there is no background data set for comparison.
Thallium	—	—	—	Eliminated	Eliminated from both zones because detected concentrations did not exceed established BVs or were not statistically different from background.
Vanadium	—	X	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed statistical tests.
Zinc	X	—	X	Retained	Retained for both zones because detected concentrations exceeded established BVs and failed statistical tests or had samples greater than the maximum background value by several factors.
Radionuclides					
Cesium-137	—		ND	Eliminated	Eliminated from both zones because detected concentrations did not exceed established BVs or were not detected.
Uranium-234	—		—	Eliminated	Eliminated from both zones because detected concentrations did not exceed established BVs.
Uranium-235	—		—	Eliminated	Eliminated from both zones because detected concentrations did not exceed established BVs.

Table 2.3-9 (continued)

Analyte	Biological Zone		Exposed Tuff Zone	Result	Rationale
	Soil	Tuff			
Uranium-238	—		—	Eliminated	Eliminated from both zones because detected concentrations did not exceed established BVs.
Organic Chemicals					
Acetone	X		ND	Retained	Retained for biological zone because concentrations were detected in more than 5% of samples.
Amino-2,6-dinitrotoluene[4-]	X		X	Retained	Retained for both zones because concentrations were detected in more than 5% of samples.
Amino-4,6-dinitrotoluene[2-]	X		X	Retained	Retained for both zones because concentrations were detected in more than 5% of the samples
Aroclor-1260	X		ND	Retained	Retained for biological zone because concentrations were detected in more than 5% of samples.
Benzoic acid	—		ND	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of samples or were not detected.
Bis(2-ethylhexyl)phthalate	X		X	Retained	Retained for both zones because concentrations were detected in more than 5% of the samples.
Carbon disulfide	ND		X	Retained	Retained for exposed tuff zone because concentrations were detected in more than 5% of samples.
Di-n-butylphthalate	ND		—	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of samples or were not detected.
DDT[4,4]	X		ND	Retained	Retained for biological zone because concentrations were detected in more than 5% of the samples
Dichlorobenzene[1,4-]	—		ND	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of samples or were not detected.
Dinitrobenzene[1,3-]	—		—	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of samples.
Dinitrotoluene[2,4-]	—		—	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of samples.

Table 2.3-9 (continued)

Analyte	Biological Zone		Exposed Tuff Zone	Result	Rationale
	Soil	Tuff			
Dinitrotoluene[2,6-]	—		—	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of samples.
HMX	X		X	Retained	Retained for both zones because concentrations were detected in more than 5% of the samples.
Methylnaphthalene[2-]	—		—	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of the samples.
Nitrotoluene[3-]	—		ND	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of samples or were not detected.
Nitrotoluene[4-]	—		—	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of samples.
RDX	X		X	Retained	Retained for both zones because concentrations were detected in more than 5% of samples.
Tetryl	—		—	Eliminated	Eliminated from both zones because concentrations were detected in less than 5% of samples.
Toluene	X		X	Retained	Retained for both zones because concentrations were detected in more than 5% of the samples.
Trinitrobenzene[1,3,5-]	ND		X	Retained	Retained for exposed tuff zone because concentrations were detected in more than 5% of samples.
Trinitrotoluene[2,4,6-]	X		X	Retained	Retained for both zones because concentrations were detected in more than 5% of the samples.

[a] — = Eliminated as a COPC.
[b] X = Retained as a COPC.
[c] ND = 100% not detected within a given zone.

A total of 16 inorganic chemicals were retained as COPCs. Six inorganic chemicals were identified as COPCs for the biological zone soil (barium, cobalt, copper, lead, silver, and zinc). Eleven inorganic chemicals were identified as COPCs for the biological zone tuff (aluminum, antimony, barium, chromium, cobalt, copper, lead, iron, nickel, selenium, and vanadium). Fifteen inorganic chemicals were identified as COPCs for the exposed tuff zone (aluminum, antimony, barium, beryllium, chromium, cobalt, copper, iron, lead, mercury, nickel, perchlorate, selenium, vanadium, and zinc).

A total of 12 organic chemicals were retained as COPCs for further evaluation. Ten organic chemicals were identified as COPCs for the biological zone (acetone; amino-2,6-dinitrotoluene[4-]; amino-4,6-dinitrotoluene[2-]; Aroclor-1260; bis(2-ethylhexyl)phthalate; DDT[4,4-]; HMX; RDX; toluene; and TNT). Nine organic chemicals were identified as COPCs for the exposed tuff zone (amino-2,6-dinitrotoluene[4-]; amino-4,6-dinitrotoluene[2-]; bis(2-ethylhexyl)phthalate; carbon disulfide; HMX; RDX; toluene; trinitrobenzene[1,3,5-]; and TNT).

No radionuclides were identified as COPCs for the MDA P Site.

2.3.3 Revised Site Conceptual Model

The current, postexcavation MDA P Site is composed of two distinct zones: an exposed tuff zone and a biological zone. Photograph 2.3-1 shows the MDA P Site as excavation activities were being completed: the middle area of the site is the flat portion of the exposed tuff zone, in front of which is the unconsolidated tuff area that slopes steeply towards the Cañon de Valle. The uppermost portion of the site is the now-restored and reseeded biological zone. The biological zone consists of undisturbed or reclaimed areas (approximately 5.0 ac of the nearly 9.25-ac site), which border the main excavation area to the south, east, and west. The reclaimed areas within the former MDA P Site footprint have approximately 2 ft of topsoil, though the soils in some locations near the east and west perimeters of the site can be as deep as approximately 5 ft. The reclaimed areas have thriving plant communities that are composed primarily of grasses and ruderal species representative of successional or transitional areas. Undisturbed areas outside the MDA P Site footprint contain deeper soils (up to 5 ft on average, with deeper soils possible) that support mature vegetation (including deeper-rooted shrubs and trees typical of the Rocky Mountain montane mixed-conifer vegetation type). Evidence of animal activity (tracks and scat of small and large mammals) was observed in the biological zone during an August 2002 site visit.

Photograph 2.3-1. Condition of MDA P Site after Phase I activities

The exposed tuff zone consists of a single large and continuous area of exposed tuff (approximately 4.25 ac of consolidated tuff or unconsolidated tuff with large boulders) from which the topsoil was removed during Phase I excavation activities. In contrast to the biological zone, the exposed tuff zone is largely bereft of plants and supports little to no animal activity.

SWMU 16-016(c)-99 exists within both the exposed tuff and biological zones. The boundaries of the biological and exposed tuff zones and the boundaries of all SWMUs within the MDA P Site are shown on Figure 2.3-2. The transport and exposure models used for the MDA P Site apply to SWMU 16-016(c)-99.

2.3.3.1 Contaminated Media—Current Conditions

Contaminated media within the boundaries of the MDA P Site [including SWMU 16-016(c)-99] are soil and tuff, for which residual contamination largely is limited to depths less than 5 ft. Neither surface water in the vicinity of the MDA P Site nor groundwater beneath the MDA P Site is impacted by residual contamination in the soil and tuff under current conditions. Currently, run-on is directed away from the site into two adjacent drainages, using natural and engineered landscape features. Precipitation runoff that falls within the boundaries of the MDA P Site generally is diverted west and east of the site, into channels that ultimately terminate in Cañon de Valle. Runoff from large precipitation events may breach the diversion channels and result in sheet flow across the surface of the site, terminating also in Cañon de Valle.

Potential transport from the exposed tuff zone differs from that of the biological zone. Surface soils have been removed from the exposed tuff zone, which also has been denuded of all mature, native vegetation. Because there are no areas for ponding or near-saturated conditions within the exposed tuff zone, current conditions promote runoff and inhibit infiltration. Also, because the residual contamination is limited to tuff, transport from the site is primarily controlled by the tuff's slow weathering process. Thus, while movement of contaminants by runoff is the most important transport mechanism from the exposed tuff zone, the actual rate of transport is directly proportional to the rate of the tuff's weathering, which is best described in the context of geologic time (thousands of years). Off-site migration of residual contamination in the exposed tuff zone in the near-term future, defined as 30 yr, is negligible for receptor exposure in Cañon de Valle (LANL 1999, 63546).

Outside and surrounding the exposed tuff zone is the biological zone, which includes undisturbed locations or previously disturbed locations that have been reseeded/reclaimed. Soils in the biological zone are approximately 2 to 5 ft deep (though in some locations, soils may exceed 5 ft) and are largely inhabited by grasses and plants typical of successional or transitional areas that have been subjected to some kind of disturbance. Erosion of topsoil that remains within the biological zone largely has been mitigated by the implementation of Laboratory BMPs, including slope stabilization and erosion-control measures. Transport of residual contamination from the biological zone to Cañon de Valle is still possible through surface water runoff, though the presence of topsoil, plant cover, and BMP features tend to promote water infiltration within the surface soil rather than runoff, making runoff a minor transport pathway for the biological zone.

Natural, physiographic boundaries (terrain constraints) limit the lateral extent of both past and future transport. As described above, off-site contaminant transport is constrained by drainage channels east and west of the site and the upgradient road to the south, such that all run-on and runoff is directed downgradient to Cañon de Valle. Potential ecological impacts caused by the transport of COPCs to the canyon were evaluated in a risk assessment for Cañon de Valle (section 2.4.1.2).

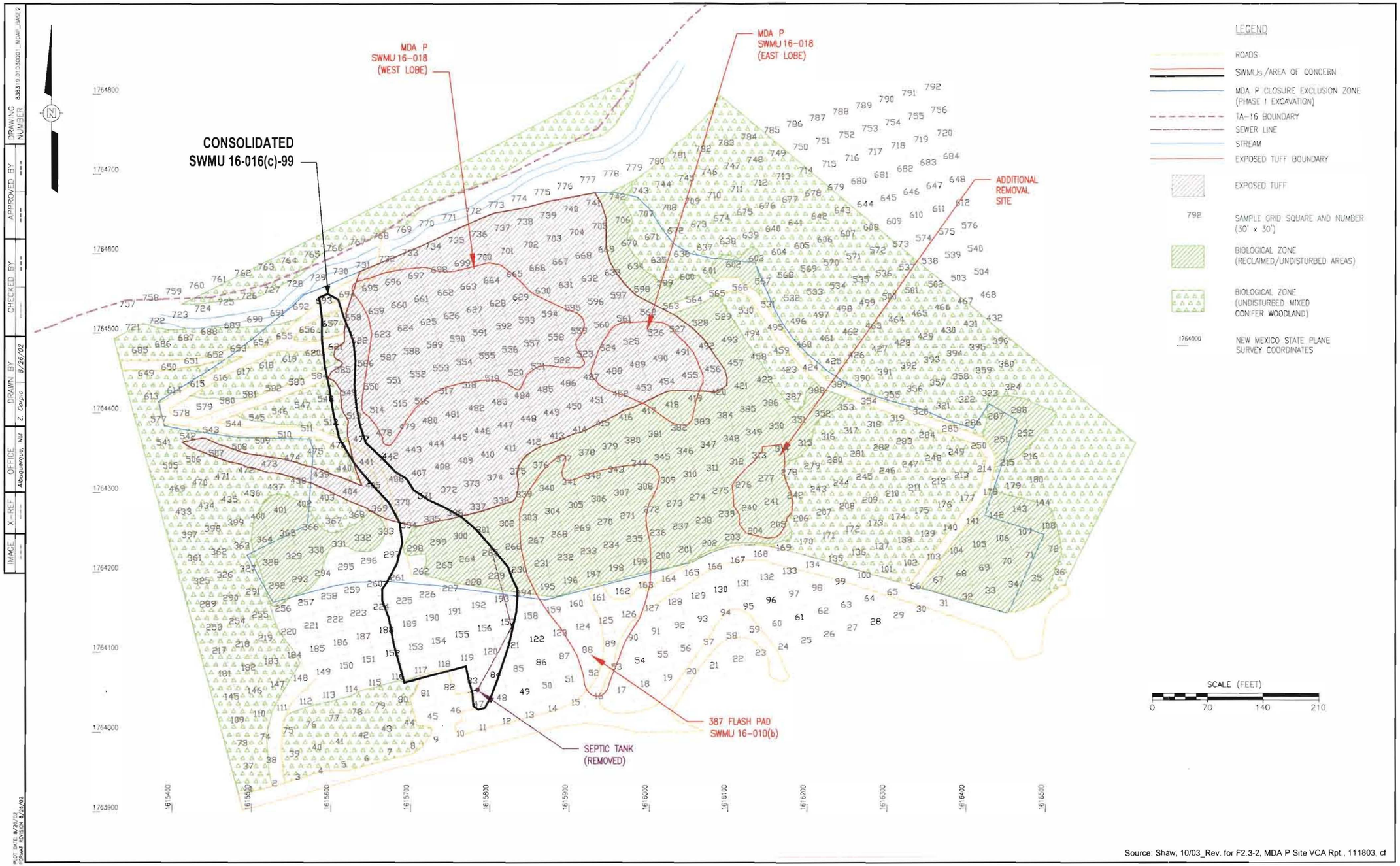

Figure 2.3-2. Boundaries of the biological and exposed tuff zones and SWMUs at the MDA P Site

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2.3.3.2 Exposure Pathways—Human Receptors

Potential, complete exposure pathways due to COPCs in surface soil and tuff include inhalation of fugitive dust and direct exposure to soil and tuff by dermal contact or incidental ingestion. Potential exposure pathways due to COPCs in subsurface soil and tuff would be complete only if contaminated soil or tuff were excavated and brought to the surface, in which case the potential exposure pathways would be similar to surface soil exposures. Tuff weathering is the only viable natural process that may result in the exposure of receptors to COPCs in tuff; due to the slow rate of weathering expected for tuff, exposure to COPCs in this medium is considered negligible. However, this assessment conservatively assumes that a reasonable depth of exposure is 0 to 5 ft in soil; 5 ft also is assumed to be the depth of exposure in the exposed tuff zone. This is conservative because (1) COPCs in tuff will cause exposure only as weathering occurs; and (2) the highest COPC concentrations are in samples within the top few feet of soil. Also, this is reasonable because the assumed 5-ft depth of exposure captures the average depth of soil and, thus, exposure to COPCs in soil at the site. Potential risk to human receptors typically is based on exposure to COPCs in the top 10 ft of soil. For the MDA P Site, most samples were collected from the top 5 ft, and the few collected below 5 ft show lower concentrations. The assessment is more conservative because the representative site concentrations are not "diluted" by the deeper samples.

Because no surface water currently exists at the site and excavation activities eliminated all potential near-saturated and ponded water sources at the surface, potential human health exposure pathways due to surface water (dermal and ingestion) are incomplete and are not evaluated. Likewise, groundwater is eliminated as a potentially contaminated medium underneath the MDA P Site because no surface-to-groundwater pathway exists; thus, pathways to the regional aquifer, which is located approximately 1200 ft below the site, are incomplete for human receptors at the MDA P Site.

2.3.3.3 Exposure Pathways—MDA P Site Ecological Receptors

The exposed tuff zone currently contains surface anomalies (e.g., depressions or cracks in the tuff) that provide isolated and discontinuous microsites that tend to accrete fine materials/deposits that can become microhabitats for plants. Thus, some isolated plants can be found growing within the exposed tuff zone. Use of the exposed tuff zone for foraging or other activities is not expected from the animal receptors that potentially may inhabit areas near the MDA P Site.

As agreed to by the Laboratory with the NMED and EPA Region 6 (LANL 2002, 73791), the exposed tuff area of the site does not require a quantitative ecological risk assessment, including generation and review of hazard quotients (HQs). The "preferred approach is a qualitative ecological risk assessment" consisting of a written discussion documenting that the various exposure pathways are not complete in this area of the site (LANL 2002, 73791). COPCs in the tuff generally are immobilized and become available to receptors only as a function of the slow tuff weathering process. Vegetation, though present in some microsites, is sparse and does not make contact with COPCs to the degree that population-level effects occur. Also, vegetation is not present in sufficient quantities to result in significant uptake through the food chain, and it is unlikely that use or foraging by ecological receptors occurs because of the unsuitable habitat. Therefore, the contact that wildlife receptors might have with COPCs in the exposed tuff zone does not drive population-level effects in the wildlife receptors. There are no complete pathways in the exposed tuff zone, and the exposure of receptors to COPCs in this zone is not evaluated quantitatively.

The remaining area of the MDA P Site footprint, which is not undisturbed or has been reseeded/reclaimed, currently supports grasses and plants that may be used as forage by ecological receptors. The relatively shallow depth of the soil in the reclaimed footprint area (an average depth of 2 ft, though as deep as 5 ft in some locations near the east and west perimeters of the site) precludes deep-

rooted plants and all but investigative burrowing activities by fossorial mammals (see Ecological Scoping Checklist, Appendix A, Attachment 1, in the MDA P closure certification report (LANL 2003, 79563). Complete exposure pathways for ecological receptors to COPCs in the surface soil and tuff in the biological zone include uptake by plants; ingestion pathways for animal receptors; and potential food-web transfer due to ingestion uptake by animal receptors. This assessment conservatively assumes that a reasonable depth of exposure is 0 to 5 ft, regardless of media type (soil or tuff). Note that the near-term exposure (30 yr) of ecological receptors to COPCs in tuff is low because of the tuff's slow weathering process.

Undisturbed areas outside the MDA P Site footprint contain deeper soils (up to 5 ft and deeper) that support mature vegetation (including deeper-rooted shrubs and trees that are typical of the Rocky Mountain montane mixed-conifer, forest vegetation type). Habitat use by ecological receptors occurs in these outlying areas, including foraging, nesting, and the development of established burrow systems by fossorial mammals (compared with investigative burrows within the reclaimed portions of the MDA P footprint). Complete exposure pathways for ecological receptors to COPCs in the surface soil and tuff that are in the biologically viable areas outside the MDA P footprint include uptake by plants and ingestion pathways for animal receptors and potential food-web transfer due to ingestion uptake by animal receptors. This assessment conservatively assumes that a reasonable depth of exposure is 0 to 5 ft, regardless of the media type (soil or tuff), and the exposure to COPCs in tuff is low because of the slow rate of tuff weathering. The assessment of potential ecological risk to receptors in the outlying, undisturbed areas was combined with that for the biological zone within the MDA P footprint because of the similarity of COPCs and the exposure pathways for ecological receptors.

As with the exposure pathways for human receptors, pathways related to the exposure of ecological receptors to COPCs in surface water at the site are incomplete because no surface water currently exists there and excavation activities eliminated all potential near-saturated and ponded water sources at the surface. Additionally, groundwater is eliminated as a potentially contaminated medium underneath the MDA P Site because no surface-to-groundwater pathway exists; thus, pathways to the regional aquifer, which is located approximately 1200 ft below the site, are incomplete for ecological receptors at the MDA P Site.

2.3.3.4 Exposure Pathways—Cañon de Valle Ecological Receptors

Cañon de Valle receptors may be exposed to MDA P Site COPCs by the historical release and transport of contaminants to the canyon. Historical releases to Cañon de Valle from the MDA P Site include the off-site transport of COPCs by surface erosion and the potential leaching of water through the landfill contents to surface water and sediments. To the extent that contaminants were transported to the canyon from the MDA P Site before source removal, historical contaminant signatures in the canyon from the MDA P Site may not correspond with residual COPC concentrations identified in confirmation samples. In fact, contaminants common to Cañon de Valle and the MDA P Site are found at higher maximum concentrations in the canyon than at the MDA P Site.

The MDA P Site is one of several historical contaminant sources for Cañon de Valle but is not the dominant source. The 260 outfall [SWMU 16-021(c)-99] is identified as the dominant contaminant source for the canyon (LANL 1998, 59891). Additionally, MDA R (SWMU 16-019) and the Silver Outfall (SWMU 16-020), up-canyon from the MDA P Site, also contributed contaminants. The focused evaluation of potential ecological risk to aquatic and terrestrial receptors in Cañon de Valle integrates the potential effects of multiple contaminant sources to canyon receptors, in addition to the effects from MDA P Site COPCs. The ecological risk assessment is summarized in section 2.4.1.2, and Appendix A of the MDA P Site closure certification report (LANL 2003, 79563) contains the complete risk assessment analyses.

2.3.3.5 Nature and Extent of Contamination

The only contaminated media currently within the boundaries of the MDA P Site are soil and tuff, for which residual contamination is largely limited to depths of less than 5 ft. Neither surface water in the vicinity of MDA P Site boundaries nor groundwater beneath the MDA P Site is impacted by the residual contamination in the soil and tuff under current conditions.

Confirmation samples were collected at surface (defined here as 0 to 1 ft), subsurface (defined here as 2 to 3 ft), and deep subsurface (defined here as greater than 3 ft) depths. A total of 200 grid cells were sampled from depths of 0.5 to 78 ft. A total of 332 unique location and depth combinations are included in the confirmation sample database because samples were collected from more than one depth in many of the 200 grid cells identified for confirmation sampling. Figure 2.3-1 shows Phase II confirmation sample locations. Sampling was conducted to provide sufficient data for demonstrating that clean closure and corrective action have been completed. Twenty-six locations were sampled within the boundary of SWMU 16-016(c)-99.

Confirmation data adequately determined the lateral extent of residual COPC concentrations at the site, as the sampling extended beyond the excavation boundaries and beyond the natural hydrologic barriers that limit potential lateral transport to the area between the east and west drainages. Thus, the lateral extent of contamination is bounded by the drainages. Generally, the residual COPC concentrations are near and within MDA P Site boundaries (the area of the excavation and removal activities), which results in generally decreasing lateral trends. Note that the observed trends in the lateral extent of residual contamination may be more an artifact of extensive excavation activities at the site than historical contaminant transport from the SWMUs to the soil and tuff.

The investigation of residual contamination at depth was accomplished by drilling four boreholes, one each in grid cells 516, 526, 554, and 557. The original commitment was to drill four boreholes to approximately 30 ft in grid cells determined to have the highest potential for residual contamination at depth. Subsequent discussions between the Laboratory and NMED determined that two boreholes would be drilled in locations where local drainage may have concentrated contaminants (grid cells 526 and 557) to a target depth of 10 ft below the level of the Cañon de Valle stream. An error in the elevational survey resulted in the two boreholes not reaching target depth, and the final depths of boreholes 526 and 557 reached the approximate elevation of the Cañon de Valle stream. The remaining two boreholes were drilled in grid cells 516 and 554 to depths of 32 and 100 ft, respectively. Although boreholes 526 and 557 did not reach their target depths, the risk analysis concluded that the four boreholes, as a group, met the objectives of defining the extent of residual contamination at depth (see the MDA P closure certification report [LANL 2003, 79563] for the data summary and the attached CD for the confirmation data, including the borehole data). Because the depth of confirmation sampling in the boreholes extended well below residual contamination in the MDA P Site soil and tuff, the vertical extent of contamination has been defined. A fifth borehole located in grid cell 273 was drilled to 170 ft, primarily for geologic logging; analytical data derived from sampling borehole 273 (0- to 5-ft samples only) were included in the risk analysis.

Confirmation data determined the vertical extent of COPC concentrations in subsurface soils and tuff at the site. All COPC concentrations decreased with depth across the site. Most sample results at depth were not detected or were detected at concentrations within the range of background or estimated quantitation limits (EQLs). Therefore, there is strong evidence that residual contamination is not present at depth (greater than 5 ft) (see concentration-by-depth plots in Appendix A, Attachment 2, of the MDA P closure certification report).

2.3.3.6 Environmental Fate

Environmental fate and transport of the residual contamination in the soils and tuff at the MDA P Site are discussed in sections 2.3.3.1 through 2.3.3.4.

2.4 Site Assessments

The human health and ecological risk assessment analyses summarized in this section were performed to support closure certification and corrective action activities at MDA P Site SWMUs. Just as excavation and cleanup activities for the MDA P Site SWMUs were conducted simultaneously, the risk assessments for the SWMUs within the MDA P Site were conducted collectively. This approach was delineated in the NMED-approved SAP for the MDA P Site (LANL 1999, 63546). This section summarizes the analysis of the Phase II confirmation sample data in the context of potential human health and ecological risk associated with residual contamination identified in samples from the MDA P Site. The complete ecological risk assessment is provided in Appendix A of the MDA P Site closure certification report (LANL 2003, 79563).

Potential risk to both human and ecological receptors was evaluated for residual contamination at the MDA P Site. Each screening assessment conducted for human and ecological receptors has four components: scoping, screening evaluation, uncertainty analysis and/or problem formulation, and interpretation of results. The human health screening assessment was conducted using the approach outlined in the NMED-approved installation work plan (IWP) (LANL 1998, 62060) and the human health risk-based screening methodology (LANL 2002, 72639). The ecological screening assessment was performed using the methodology outlined in "Screening Level Ecological Risk Assessment Methods" (LANL 1999, 64783). Additional analysis and evaluation were conducted for all inorganic and organic COPCs that did not pass the initial human health and ecological screening assessments.

2.4.1 Screening Assessments

Screening assessments were conducted for all inorganic chemicals that were determined to be greater than background concentrations in the confirmation sample data sets for the biological and exposed tuff zones (LANL 1998, 59730). Organic chemicals detected in more than 5% of the confirmation samples were designated as COPCs, for which potential risk to human and ecological receptors was evaluated. No radionuclides were identified as COPCs for the MDA P Site. Table 2.3-9 lists the COPCs retained in the biological and exposed tuff zones.

The current postexcavation MDA P Site is composed of two distinct zones: an exposed tuff zone and a biological zone. SWMU 16-016(c)-99 contains both the exposed tuff and biological zones within its boundaries (Figure 2.3-2). The exposed tuff zone was denuded of all mature, native vegetation during Phase I excavation activities, and all surface soils were removed. The exposed tuff zone, largely bereft of plants and uninhabitable by wildlife receptors, was evaluated qualitatively in the ecological screening assessment, per agreement with the NMED and EPA Region 6 (LANL 2002, 73791). The biological zone includes undisturbed or previously disturbed locations that have been reseeded/reclaimed and was evaluated quantitatively in the ecological screening assessment, using COPC concentrations measured in soil and tuff from 0 to 5 ft. The human health screening assessment quantitatively evaluated residual contamination in both zones, also using COPC concentrations measured in soil and tuff from 0 to 5 ft.

2.4.1.1 Human Health

(a) Scoping

As discussed in section 1.0, SWMU 16-016(c)-99 exists within the boundaries of the MDA P Site and within the active, operational area of TA-16. The site lies entirely on DOE land and is isolated from public

access by a security fence and security checkpoints. Based on current and proposed future land use, the site will remain under Laboratory control and continue to be used for industrial purposes, with potential on-site receptors being Laboratory workers. However, for this screening assessment, residential land use was assumed in order to support closure certification and corrective action decisions.

Potential human exposure pathways include inhalation of airborne particles or vapors, incidental ingestion of surface soil or tuff, and dermal contact with surface soil or tuff. Because no surface water currently exists at the site and excavation activities eliminated all potential near-saturated and ponded water sources at the surface, potential exposure pathways due to surface water (dermal and ingestion) are incomplete and are not evaluated. Additionally, perched groundwater has not been encountered beneath the site, and pathways to the regional aquifer, which is located approximately 1200 ft below the site, are incomplete. Therefore, potential pathways to groundwater are incomplete and are not evaluated.

(b) Screening Evaluation

The screening assessment compared COPC concentrations with screening action levels (SALs). The comparison was based on the 95% upper confidence limit (UCL) of the mean concentration of each COPC at the MDA P Site, as measured in samples collected from 0 to 5 ft (see Appendix A, Attachment 2, of the MDA P closure certification report for a description of the 95% UCL calculations). When a chemical was a COPC for either zone (biological or exposed tuff), it was assumed to be a COPC for the entire MDA P Site. Thus, the data sets defining the 95% UCL concentrations for comparison with SALs include all sample locations and both soil and tuff matrices, regardless of whether the samples were from the biological or exposed tuff zone.

SALs were calculated based on the methodology provided in Appendix C of the approved IWP (LANL 1998, 62060) and the human health risk-based screening methodology (LANL 2002, 72639). The methodology is based on guidance from EPA Region 6 and NMED (EPA 2001, 71466; NMED 2000, 68554). SALs used in the screening evaluation reflect a residential exposure scenario, assuming exposure for 24 hr/day for 350 days/yr. The SAL comparison is presented separately for noncarcinogenic chemicals and carcinogenic chemicals. SALs for noncarcinogens are based on an HQ of 1.0; SALs for carcinogens are based on a target cancer risk of 10^{-6}. Table 2.4-1 compares noncarcinogenic COPCS with SALs and Table 2.4-2 compares carcinogenic COPCS with SALs.

Barium and iron were the only noncarcinogens for which 95% UCL concentrations exceed the 0.1 SAL but were less than SALs (Table 2.4-1). The sum of the ratio of each COPC (calculated as the 95% UCL concentration divided by the respective SAL, i.e., the hazard index [HI]) was less than unity (0.8). This indicates that a human health hazard is not expected from exposure to collocated noncarcinogenic COPCs at the MDA P Site.

None of the carcinogenic COPCs had a 95% UCL concentration above their respective SALs (Table 2.4-2), and were less than the NMED target risk level of 10^{-5} (NMED 2000, 68554). The cumulative cancer risk was 6×10^{-7}. Thus, exposure in the MDA P Site does not result in an unacceptable risk to human receptors.

An additional human health risk analysis was conducted to account for potential exposure to a limited area of high COPC concentrations. A residential lot of 5400 ft^2 was assumed to represent the potential exposure area. A residential lot was selected for both the biological and exposed tuff zones to be consistent with the locations of high barium concentrations (the risk driver for the site; see Figure 2.4-1). Inorganic chemical concentrations were compared with the corresponding BV for each residential lot. Inorganic chemicals greater than BVs were evaluated for each lot. Organic chemicals that were not detected within a lot were not evaluated for that lot.

Table 2.4-1
Comparison of Noncarcinogenic COPCs with SALs, 0- to 5-ft Depth

Analyte	95% UCL (mg/kg)	0.1 SAL (mg/kg)	SAL (mg/kg)
Aluminum	6,060	7,400	74,000
Antimony	0.41	3	30
Barium	**534**[a]	520	5,200
Beryllium	0.83	15	150
Cobalt	5.35	450	4,500
Copper	6.71	280	2,800
Iron	**10,335**	2,300	23,000
Lead	9.67	40	400
Mercury	0.02	2.3	23
Nickel	4.50	150	1,500
Perchlorate	0.03	0.78	7.8
Selenium	0.25	38	380
Silver	0.54	38	380
Vanadium	9.52	53	530
Zinc	49.0	2,300	23,000
Acetone	0.10	160	1,600
Amino-2,6-dinitrotoluene[4-][b]	0.15	6.1	61
Amino-4,6-dinitrotoluene[2-][b]	0.16	6.1	61
Aroclor-1260	0.034[c]	0.11	1.1
Carbon disulfide	0.01	36	360
HMX	0.95	310	3,100
Toluene	0.005	18	180
Trinitrobenzene[1,3,5-]	0.14	180	1,800

[a] Values in bold indicate SAL or 0.1 SAL exceeded by 95% UCL.

[b] 2,6-dinitrotoluene SAL was used as a surrogate (EPA 2001, 71466).

[c] Data set had less than 10 samples; 95% UCL could not be calculated; maximum value used.

Table 2.4-2
Comparison of Carcinogenic COPCs with SALs, 0- to 5-ft Depth

Analyte	95% UCL (mg/kg)	SAL (mg/kg)
Aroclor-1260	0.034[a]	0.22
Bis(2-ethylhexyl)phthalate	0.20	35
Chromium	5.28	210
DDT[4,4]	0.0035[a]	1.7
RDX	1.89	4.4
TNT	0.14	16

[a] Data set had less than 10 samples; 95% UCL could not be calculated; maximum value used.

Figure 2.4-1. Residential lots (5400 ft^2) in the biological and exposed tuff zones

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Among the noncarcinogenic COPCs in the biological zone lot, only barium had a 95% UCL concentration greater than one-tenth the respective SAL, but less than the SAL (Table 2.4-3), similar to the initial screening results. The sum of the ratio of each COPC calculated as the 95% UCL concentration divided by the respective SAL was less than unity (0.4), indicating that a human health hazard is not expected from exposure to collocated noncarcinogenic COPCs in the biological zone residential lot.

Table 2.4-3
SAL Comparison with 95% UCL Noncarcinogen Concentrations—
Biological Zone: 5400-ft^2 Residential Lot, 0- to 5-ft Depth

Analyte	95% UCL (mg/kg)	0.1 SAL (mg/kg)	SAL (mg/kg)
Barium	**1,584**[a]	520	5,200
Copper	12.73	280	2,800
Lead	21.8	40	400
Selenium	0.31	38	380
Silver	0.68	38	380
Zinc	58.6	2,300	23,000
Amino-2,6-dinitrotoluene[4-][b]	0.51	6.1	61
Amino-4,6-dinitrotoluene[2-][b]	0.55	6.1	61
HMX	8.03	310	3,100

[a] Value in bold indicates SAL or 0.1 SAL exceeded by 95% UCL.
[b] 2,6-dinitrotoluene SAL was used as a surrogate (EPA 2001, 71466).

One carcinogenic COPC (RDX) had a 95% UCL concentration above its SAL (Table 2.4-4). The cumulative cancer risk from exposure to carcinogenic COPCs in the biological zone residential lot was approximately 4 x 10^{-6}, which is less than NMED's target risk level of 10^{-5} (NMED 2000, 68554). Therefore, the residential lot for the biological zone does not pose an unacceptable risk to human health.

Table 2.4-4
SAL Comparison with 95% UCL Carcinogen Concentrations—
Biological Zone: 5400-ft^2 Residential Lot, 0- to 5-ft Depth

Analyte	95% UCL (mg/kg)	SAL (mg/kg)
Bis(2-ethylhexyl)phthalate	0.26	35
RDX	**17.7**[a]	4.4
TNT	0.27	16

[a] Value in bold indicates SAL exceeded by 95% UCL.

Among the noncarcinogenic COPCs in the exposed tuff zone residential lot, aluminum, barium, and iron showed 95% UCL concentrations greater than one-tenth their respective SALs (Table 2.4-5). The sum of the ratio of each COPC exposure calculated as the 95% UCL concentration divided by the respective SAL slightly exceeded unity (1.7). However, approximately one-half of this is due to iron, which is an

essential nutrient. The iron 95% UCL concentration (16,404 mg/kg) was less than the maximum tuff background concentration (19,500 mg/kg) and slightly above the tuff BV (14,500 mg/kg) (LANL 1998, 59730). None of the noncarcinogenic COPCs exceeds the SAL at the 95% UCL concentration.

Table 2.4-5
SAL Comparison with 95% UCL Noncarcinogen Concentrations—
Exposed Tuff Zone: 5400-ft^2 Residential Lot, 0- to 5-ft Depth

Analyte	95% UCL (mg/kg)	0.1 SAL (mg/kg)	SAL (mg/kg)
Aluminum	**10,415**[a]	7,400	74,000
Antimony	0.50	3	30
Barium	**3,834**	520	5,200
Beryllium	1.75	15	150
Cobalt	45.6	450	4,500
Copper	6.9	280	2,800
Iron	**16,404**	2,300	23,000
Nickel	5.68	150	1,500
Selenium	0.49	38	380
Vanadium	14.4	53	530
Zinc	50.7	2,300	23,000
Amino-2,6-dinitrotoluene[4-][b]	0.27	6.1	61
Amino-4,6-dinitrotoluene[2-][b]	0.34	6.1	61
HMX	1.6	310	3,100
Trinitrobenzene[1,3,5-]	0.1	180	1,800

[a]Values in bold indicate SAL or 0.1 SAL exceeded by 95% UCL.
[b]2,6-Dinitrotoluene SAL was used as a surrogate (EPA 2001, 71466).

RDX was the only carcinogenic COPC with a 95% UCL concentration above its respective SAL (Table 2.4-6). The cumulative cancer risk from exposure to carcinogenic COPCs in the exposed tuff zone residential lot was 1.2×10^{-6}, which is less than NMED's target risk level of 10^{-5} (NMED 2000, 68554). Therefore, the residential lot for the exposed tuff zone does not pose a potential unacceptable risk to human receptors.

Table 2.4-6
SAL Comparison with 95% UCL Carcinogenic Concentrations—
Exposed Tuff Zone: 5400-ft^2 Residential Lot, 0- to 5-ft Depth

Analyte	95% UCL (mg/kg)	SAL (mg/kg)
Chromium	7.8	210
RDX	**5.63**[a]	4.4
TNT	0.15	16

[a]Value in bold indicates SAL or 0.1 SAL exceeded by 95% UCL.

(c) Uncertainty Analysis

The analysis presented in this human health screening assessment is subject to varying degrees and kinds of uncertainty. Aspects of data evaluation and COPC identification, exposure assessment, toxicity assessment, and the additive approach all contribute to uncertainties in the risk assessment process.

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. It is unlikely that inorganic chemicals were inappropriately excluded as COPCs, because the only detected inorganic chemicals excluded were those determined to be below the associated BV or those with data sets not significantly different than background. Aluminum and iron in the exposed tuff zone residential lot and iron in the sitewide comparison had 95% UCL concentrations greater that 0.1 the respective SAL, but less than the SAL. Concentrations measured in soil and tuff at the MDA P Site for these two metals are not considered a concern for human health for two reasons: (1) the high values for these metals are in the tuff and therefore are unavailable for exposure and (2) the 95% UCL concentrations of aluminum and iron across the site and within the residential lots are within the range of soil and tuff background concentrations (LANL 1998, 59730), indicating that exposure to sitewide or residential lot concentrations is similar to background. Additionally, iron is an essential nutrient; concentrations in soil would need to be substantially higher than background before iron became a concern to human health. The HI for the residential lot in the exposed tuff zone, without aluminum and iron, is 0.9. Thus, the HI values calculated for the entire area and the residential lots are due primarily to barium and are less than 1.0.

It is unlikely that organic chemicals were inappropriately excluded as COPCs because the only detected organic chemicals not retained for analysis were those that were detected in less than 5% of the confirmation samples.

Uncertainties associated with inorganic and organic chemical data include sampling errors, laboratory analysis errors, and data analysis errors. For the MDA P Site, these uncertainties are expected to have little effect on results even though many detected concentrations of organic COPCs were qualified J, indicating that the values were less than EQLs and could only be estimated.

Exposure Assessment

Three main uncertainties were identified in the exposure assessment process.

1. *Identification of Receptors*. The human health screening evaluation is a conservative comparison of the 95% UCL concentration with SALs based upon a residential land-use scenario. To the degree that activity patterns are not represented by activities assumed by the residential land-use scenario, uncertainties are introduced in the assessment. If a potentially exposed individual is an industrial worker, a screening assessment based on a residential scenario overestimates exposure and, therefore, potential hazard and risk to human receptors. The same is true if the receptor is a recreational user (e.g., hiker, jogger, etc.). If, however, future land use becomes residential, this assessment appropriately addresses potential human health risks.

2. *Exposure Pathway Assumptions*. Several assumptions are made relative to exposure pathways, including input parameters, whether or not a given pathway is complete, the contaminated media to which an individual may be exposed, and intake rates for different exposure routes. In the absence of site-specific data, the exposure assumptions used were consistent with EPA-approved parameters and default values (EPA 2001, 71466). When several upper-bound values

(as in EPA 2001, 71466) are combined to estimate exposure for any one pathway, the resulting risk can exceed the 99th percentile of "expected risk" and therefore exceed (overestimate) the range of risk that may be reasonably expected. Also, the assumption that residual concentrations of COPCs in the tuff are available and cause exposure in the same manner as if they were in soil overestimates the potential risk to receptors. Therefore, the HI of 1.7 is an overestimation of potential hazard at the site within the exposed tuff zone.

3. *Derivation of Exposure Point Concentrations.* Some uncertainty is introduced in the aggregation of data for estimating representative COPC concentrations (95% UCL) at a site. Risk from a single location or area with relatively high COPC concentrations may be "diluted" by using a representative, sitewide value. This is considered the single, largest uncertainty that may result in the underestimation of potential risk to human receptors. Thus, an additional analysis based on locations with high concentrations of barium (the only COPC to exceed 0.1 SAL in both zones) was performed to address this uncertainty. The use of the 95% UCL is intended to provide a protective, upper bound (i.e., conservative) on the average COPC concentration at the site, which likely will lead to an overestimation of the concentration representative of average exposure to a COPC across the entire site. The maximum barium concentration of 6630 mg/kg from within the boundary of SWMU 16-016(c)-99 results in an HQ of 1.3. This barium concentration is within the range of barium concentrations measured in the residential lots and results in an HQ approximately twice the maximum residential lot HQ (0.7) for barium based on the 95% UCL. The resulting HI for SWMU 16-016(c)-99, using the maximum COPC concentrations (2.2) within the SWMU boundary, is only slightly greater than the maximum HI for the residential lots (1.7). Therefore, the 95% UCLs for the entire area and for the residential lots provides a reasonable estimate of exposure and only slightly underestimates the risk from local, elevated concentrations of COPCs.

Toxicity Assessment

The primary uncertainty associated with the SALs is related to the derivation of toxicity values used in their calculation. EPA toxicity values (reference doses [RfDs] and slope factors [SFs]) were used to derive the SALs used in this risk screening assessment (EPA 2001, 70109; EPA 1997, 58968). Uncertainties were identified in three areas with respect to toxicity values: (1) extrapolation from animals to humans, (2) extrapolation from one route of exposure to another route of exposure, and (3) individual variability in the human population.

1. *Extrapolation from Animals to Humans.* SFs and RfDs often are based on extrapolation from animal data to humans, which may result in uncertainties in toxicity values because differences exist in chemical absorption, metabolism, excretion, and toxic responses between animals and humans. The EPA takes into account differences in body weight, surface area, and pharmacokinetic relationships between animals and humans 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.

2. *Extrapolation from One Route of Exposure to Another Route of Exposure.* The SFs and RfDs often contain extrapolations from one route of exposure to another that result in additional conservatisms in the risk calculations. For example, an extrapolation from the oral route to the inhalation and/or the dermal route was used in this assessment (EPA 2001, 71466), and differences between the two exposure pathways contribute uncertainty in the estimation of potential risk at this site.

3. *Individual Variability in the Human Population.* For noncarcinogenic effects, the degree of variability in human physical characteristics is important both in determining 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 assessment; this factor of 10 generally results in a conservative estimate of risk to noncarcinogenic COPCs.

Additive Approach

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

Interpretation of Results

Overall, the uncertainties associated with the evaluation of human health risks from residual concentrations of COPCs in the soil and tuff of the MDA P Site overestimate potential risk to human receptors. A detailed analysis of risk from exposure at locations with high concentrations of barium (the main risk driver at the site) indicates that no potential risk to human health exists in either the biological or exposed tuff zone.

Noncarcinogenic HI values ranged from 0.8 (sitewide) to 1.7 (exposed tuff zone) based on 95% UCL concentrations; none of the individual COPCs exceeded an HQ of 1.0. Approximately half the HI of 1.7 (0.7) is due to iron, which is an essential nutrient and has a 95% UCL within the range of background concentrations. The aluminum 95% UCL is also within the range of background concentration. In addition, COPCs in this lot are in the tuff, making exposure unlikely; the HI for the exposed tuff zone residential lot overestimates the potential hazard to receptors. The HI without iron and aluminum is 0.9, which is similar to the sitewide HI. Given the uncertainties and the overestimation of hazard, the HIs for the site and for the residential lots do not exceed NMED's target HI of 1.0 (NMED 2000, 68554) and do not pose a potential hazard to human health.

Concentrations of carcinogenic COPCs were less than their respective SALs. The incremental excess cancer risk ranged from 6×10^{-7} (sitewide risk) to 4×10^{-6} (residential lot risk). These risk levels are below the NMED target cancer risk level of 10^{-5} (NMED 2000, 68554). Therefore, the site as a whole and the residential lots within each zone do not pose a potential unacceptable risk to human health.

2.4.1.2 Ecological

(a) Scoping

A scoping evaluation is the framework for an initial screening assessment and establishes the breadth and focus of the ecological screening process. Scoping and screening analyses are based on the ecological scoping checklist (see Appendix A, Attachment 1, of the MDA P closure certification report [LANL 2003, 79563]) and the conceptual site model presented in section 2.3.3 of this report. The ecological scoping checklist was completed prior to the start of the assessment of potential risk to ecological receptors at the MDA P Site. An August 28, 2002, site visit was conducted in conjunction with the completion of the ecological scoping checklist. One objective of the site visit was to confirm that the

risk assessment approach, which was defined before Phase I excavation, was appropriate for postexcavation conditions (LANL 1999, 63546).

As described in section 2.3.3, the MDA P Site is composed of two distinct zones: (1) an exposed tuff zone that is largely bereft of plants and for which little evidence of animal activity was observed during the site visit, and (2) a biological zone that has topsoil and is populated by either successional/transitional plant species (grasses and herbaceous plants and forbs) in the areas disturbed during the Phase I excavation or mature, native vegetation typical of the Rocky Mountain mixed-conifer vegetative type in the undisturbed parts of the MDA P Site. Evidence that the biological zone of the MDA P Site is used by both small mammals (e.g., soil mounding by burrowing mammals) and large mammals (e.g., tracks and scat) was noted during the site visit.

As agreed to by the Laboratory with NMED and EPA Region 6 (LANL 2002, 73791), the "exposed tuff area of the site doesn't need a quantitative ecological risk assessment including generation and review of hazard quotients" and the "preferred approach is a qualitative ecological risk assessment" consisting of a written discussion documenting that the various exposure pathways are not complete in this area of the site. This discussion is provided in section 2.3.3 (Revised Site Conceptual Model). In summary, COPCs in the tuff generally are immobilized and become available to receptors only as a function of the slow rate of the tuff weathering process. Though present in some microsites, vegetation is sparse and does not make contact with COPCs to the degree that population-level effects would be driven by this limited exposure to COPCs in the exposed tuff zone. Also, because the vegetation is not present in quantities sufficient to result in substantial uptake through the food chain and use by ecological receptors is unlikely, the contact that wildlife receptors might have with COPCs in the exposed tuff zone does not drive population-level effects in the wildlife receptors. Thus, receptor exposure to COPCs in the exposed tuff zone is not evaluated quantitatively in this assessment.

Because potentially complete exposure pathways exist for COPCs in the biological zone, the following terrestrial receptors were evaluated quantitatively in the ecological screening assessment for the biological zone. These receptors represent several feeding guilds and trophic levels:

- plants,
- soil-dwelling invertebrates (represented by the earthworm),
- deer mouse (mammalian omnivore),
- vagrant shrew (mammalian insectivore),
- desert cottontail (mammalian herbivore),
- fox (mammalian carnivore),
- American robin (avian insectivore, omnivore, and herbivore), and
- American kestrel (avian insectivore and carnivore), which is a surrogate for avian threatened and endangered (T&E) species.

Of the terrestrial receptors evaluated, only the vagrant shrew is not expected to be of concern for the MDA P Site, because it requires free water for survival—a medium that does not exist at the site and that has been eliminated from consideration as a potential exposure medium for the MDA P Site footprint. However, because the shrew represents the insectivorous feeding guild for mammals, which is not specifically represented by any other terrestrial receptor, the shrew was retained for the MDA P Site screening assessment.

(b) Screening Evaluation

The ecological screening assessment is designed to identify chemicals of potential ecological concern (COPECs) by comparing the 95% UCL concentration for each chemical with ecological screening levels (ESLs). The higher the contaminant levels relative to the ESLs, the higher the potential risk to receptors; conversely, the higher the ESLs relative to the contaminant levels, the lower the potential risk to receptors. The discussion of the 95% UCL concentration calculations is in Appendix A, Attachment 2, of the MDA P closure certification report (LANL 2003, 79563); the ESLs were obtained from the Laboratory's ECORISK database, version 1.4 (LANL 2002, 72802) and are provided in Appendix C, Table C-5, of this report. The comparison of 95% UCLs and ESLs is summarized in the calculation of HQs for all COPCs and all appropriate screening receptors. The HQ is defined as the ratio of the ESL to the representative contaminant concentration in the exposure medium being investigated. Chemicals with HQs greater than 0.3 are identified as COPECs that require additional evaluation (LANL 1999, 64783). The HI is the sum of HQs. An HI greater than 1.0 is considered an indication of potential adverse impacts to a given receptor from exposure to multiple chemicals at a site. The HQ/HI analysis is a conservative indication of potential adverse effects and is designed to minimize the potential for overlooking possible COPECs at the site.

In this assessment, representative soil concentrations (95% UCL of the mean) of COPCs identified in the biological zone (as measured in soil and tuff samples taken from 0 to 5 ft) and ESLs were used to calculate an HQ for each COPC (Table 2.4-7). Based on this comparison, nickel and lead were eliminated as COPECs because all receptors had an associated ESL and all HQs were less than 0.3. All other chemicals are discussed in detail in the remainder of this section.

HI values for the terrestrial receptors range from 1.75 for the top carnivore American kestrel to 464 for the plant (see Table 2.4-7). Aluminum is eliminated as a COPEC because it is not expected to be bioavailable within the soil or tuff of the biological zone. EPA guidance states that aluminum "is identified as a COPC only at sites where the soil pH is less than 5.5" (EPA 2000, 73306). The pH levels measured in confirmation samples from the MDA P Site range from 5.8 to 7.4 in tuff and 6.8 to 7.6 in soil, indicating that aluminum at the MDA P Site is unavailable to ecological receptors. With aluminum eliminated, barium and cobalt are the primary contributors to the HI values for each receptor, while vanadium and DDT[4,4'-] also contribute to the HI for some receptors.

Several HQs calculated for inorganic chemicals are not ecologically meaningful estimations of potential risk because the ESLs are below the associated soil and tuff BVs. Therefore, another HQ/HI analysis was performed after ESLs that were below the associated soil BV were removed from the analysis (Table 2.4-8, see "NC" entries). All inorganic COPCs except barium showed 7 or fewer than 7 detected soil concentrations above the soil BV, indicating that residual concentrations of inorganic chemicals in the biological zone are in the tuff and therefore are unavailable to receptors. In addition, the 95% UCL concentrations determined for all inorganic COPCs except barium, cobalt, and copper are within the range of background concentrations for soil and tuff. This indicates that exposure to representative site concentrations for inorganic COPCs is similar to background. As a result, most inorganic COPCs (except barium) are not retained as COPECs.

Table 2.4-7 shows that DDT[4,4'-] was the only organic chemical that failed the initial screen because of HQs greater than 0.3 (for the insectivorous and omnivorous robin and both kestrels). However, DDT[4,4'-] was detected in only one soil sample and had HQs of 3.0 or less, which are not expected to result in adverse population-level effects to the robin or kestrel. Therefore, DDT[4,4'-] is not retained as a COPEC for the biological zone.

Table 2.4-7
HQ/HI Summary for COPCs in Biological Zone

Analyte	95% UCL, 0–5 ft (mg/kg)	Plant	Invertebrate	Robin (Insectivore)	Robin (Omnivore)	Robin (Herbivore)	Kestrel (100% Carnivore)	Kestrel (Intermediate Carnivore)	Desert Cottontail	Deer Mouse	Vagrant Shrew	Red Fox
Inorganic Chemicals												
Antimony	4.10E-01	**8.20E+00**	—[a]	—	—	—	—	—	6.61E-02	**4.14E-01**	**7.19E-01**	4.20E-03
Barium	6.56E+02	**6.56E+00**	—	**2.50E+00**	**1.73E+00**	**6.56E-01**	1.43E-02	**3.86E-01**	**1.93E+01**	**1.46E+02**	**2.73E+02**	**1.56E+00**
Chromium	5.95E+00	**2.48E+00**	**4.25E+00**	1.29E-02	1.08E-02	8.80E-03	5.00E-04	1.10E-03	7.00E-04	2.80E-03	8.50E-03	3.00E-04
Cobalt	4.18E+00	**1.67E+01**	—	**8.20E+01**	**4.50E+01**	**9.09E+00**	**6.97E-01**	**1.10E+01**	**8.36E-01**	**2.20E+01**	**4.59E+01**	**4.18E-01**
Copper	7.60E+00	**7.60E-01**	**5.85E-01**	1.96E-02	2.45E-02	2.92E-02	3.00E-04	2.30E-03	2.53E-02	4.47E-02	4.47E-02	9.00E-04
Iron	1.02E+04	—	—	—	—	—	—	—	—	—	—	—
Lead	1.04E+01	2.31E-02	5.20E-03	1.89E-01	1.44E-01	1.04E-01	3.90E-03	2.08E-02	1.12E-02	4.73E-02	1.04E-01	2.30E-03
Nickel	4.65E+00	2.33E-01	4.65E-02	4.70E-03	3.90E-03	2.90E-03	1.00E-04	4.90E-04	5.91E-04	2.20E-03	5.19E-03	2.00E-04
Selenium	2.40E-01	**2.40E+00**	3.12E-02	2.18E-01	1.20E-01	2.40E-02	1.70E-03	2.86E-02	4.40E-03	1.26E-01	2.64E-01	2.20E-03
Silver	7.00E-01	**1.40E+01**	—	5.00E-02	3.68E-02	2.33E-02	2.93E-04	7.03E-03	**1.35E+00**	**5.00E+00**	**7.69E+00**	5.00E-02
Vanadium	1.02E+01	**4.08E+02**	—	**3.64E+00**	**2.00E+00**	**3.64E-01**	2.00E-02	**4.86E-01**	1.29E-02	**5.10E-01**	**1.06E+00**	6.78E-03
Zinc	5.37E+01	**5.37E+00**	1.54E-01	**5.54E-01**	**4.13E-01**	2.56E-01	1.10E-02	8.14E-02	4.89E-02	6.40E-05	7.57E-05	2.99E-05
Organic Chemicals												
Acetone	1.40E-02	—	—	3.33E-07	3.33E-06	6.36E-06	2.50E-09	4.52E-08	3.26E-03	3.68E-03	3.78E-04	—
Amino-2,6-dinitrotoluene[4-]	1.80E-01	2.25E-03	—	—	—	—	—	—	3.10E-02	5.00E-02	3.16E-02	1.94E-04
Amino-4,6-dinitrotoluene[2-]	1.82E-01	2.28E-03	—	—	—	—	—	—	2.17E-02	3.43E-02	2.19E-02	1.40E-04
Aroclor-1260	6.1E-02[b]	—	—	1.39E-01	7.09E-02	4.07E-03	2.77E-02	3.39E-02	9.24E-05	6.10E-03	1.22E-02	1.91E-03
Bis(2-ethylhexyl)phthalate	2.00E-01	—	—	2.00E-01	1.05E-01	8.70E-03	1.18E-01	8.70E-02	5.56E-05	3.28E-03	6.67E-03	3.13E-03
DDT[4,4'-]	7.9E-03[b]	2.14E-03	—	**3.04E+00**	**1.52E+00**	6.58E-02	**8.59E-01**	**8.49E-01**	3.95E-05	3.76E-03	7.90E-03	1.72E-03
HMX	1.33E+00	—	2.66E-03	—	—	—	—	—	2.61E-02	3.09E-02	5.12E-03	3.59E-05
RDX	2.37E+00	2.37E-02	4.74E-03	—	—	—	—	—	2.16E-01	2.58E-01	7.18E-02	4.82E-04
Toluene	3.30E-03	1.65E-05	—	—	—	—	—	—	2.06E-05	4.52E-05	4.71E-05	2.75E-07
TNT	1.80E-01	2.57E-01	2.57E-01	—	—	—	—	—	2.34E-03	3.40E-03	1.80E-03	1.13E-05
HI		**4.64E+02**	**5.34E+00**	**9.29E+01**	**5.11E+01**	**1.06E+01**	**1.75E+00**	**1.30E+01**	**2.19E+01**	**1.74E+02**	**3.29E+02**	**2.05E+00**

Note: Values in bold indicate HQ > 0.3 or an HI > 1.0.
[a] ESL not available.
[b] 95% UCL could not be calculated; maximum detection was used.

Table 2.4-8
HQ/HI Summary of COPCs with Elimination of ESLs Less than Background Values—Biological Zone

Analyte	95% UCL, 0–5 ft (mg/kg)	Plant	Invertebrate	Robin (Insectivore)	Robin (Omnivore)	Robin (Herbivore)	Kestrel (100% Carnivore)	Kestrel (Intermediate Carnivore)	Desert Cottontail	Deer Mouse	Vagrant Shrew	Red Fox
Inorganic Chemicals												
Antimony	4.10E-01	NC[a]	—[b]	—	—	—	—	—	6.61E-02	**4.14E-01**	NC	4.27E-03
Barium	6.56E+02	NC	—	NC	**1.72E+00**	**6.56E-01**	1.43E-02	**3.86E-01**	NC	NC	NC	**1.56E+00**
Chromium	5.95E+00	NC	NC	1.29E-02	1.08E-02	8.75E-03	4.58E-04	1.12E-03	7.44E-04	2.83E-03	8.50E-03	3.31E-04
Cobalt	4.18E+00	NC	—	NC	NC	NC	NC	NC	NC	NC	NC	**4.18E-01**
Copper	7.60E+00	NC	NC	1.95E-02	2.45E-02	2.92E-02	3.45E-04	2.30E-03	2.53E-02	4.47E-02	4.47E-02	8.54E-04
Iron	1.02E+04	—	—	—	—	—	—	—	—	—	—	—
Selenium	2.40E-01	NC	3.12E-02	NC	1.20E-01	2.40E-02	1.74E-03	2.86E-02	4.36E-03	1.26E-01	2.64E-01	2.18E-03
Silver	7.00E-01	NC	—	5.00E-02	3.68E-02	2.33E-02	2.92E-04	7.00E-03	NC	NC	NC	5.00E-02
Vanadium	1.02E+01	NC	—	NC	NC	NC	2.00E-02	NC	1.29E-02	NC	NC	6.80E-03
Zinc	5.37E+01	NC	1.54E-01	**5.54E-01**	**4.13E-01**	2.56E-01	1.10E-02	8.14E-02	4.89E-02	6.40E-05	7.57E-05	2.99E-05
Organic Chemicals												
Acetone	1.40E-02	—	—	3.33E-07	3.33E-06	6.36E-06	2.50E-09	4.52E-08	3.26E-03	3.68E-03	3.78E-04	—
Amino-2,6-dinitrotoluene[4-]	1.80E-01	2.25E-03	—	—	—	—	—	—	3.10E-02	5.00E-02	3.16E-02	1.94E-04
Amino-4,6-dinitrotoluene[2-]	1.82E-01	2.28E-03	—	—	—	—	—	—	2.17E-02	3.43E-02	2.19E-02	1.40E-04
Aroclor-1260[c]	6.1E-02[c]	—	—	1.39E-01	7.09E-02	4.07E-03	2.77E-02	3.39E-02	9.24E-05	6.10E-03	1.22E-02	1.91E-03
Bis(2-ethylhexyl)phthalate	2.00E-01	—	—	2.00E-01	1.05E-01	8.70E-03	1.18E-01	8.70E-02	5.56E-05	3.28E-03	6.67E-03	3.13E-03
DDT[4,4'-][c]	7.9E-03[a]	2.14E-03	—	**3.04E+00**	**1.52E+00**	6.58E-02	**8.59E-01**	**8.49E-01**	3.95E-05	3.76E-03	7.90E-03	1.72E-03
HMX	1.33E+00	—	2.66E-03	—	—	—	—	—	2.61E-02	3.09E-02	5.12E-03	3.59E-05
RDX	2.37E+00	2.37E-02	4.74E-03	—	—	—	—	—	2.15E-01	2.38E-01	7.18E-02	4.84E-04
Toluene	3.30E-03	1.65E-05	—	—	—	—	—	—	2.06E-05	4.52E-05	4.71E-05	2.75E-07
TNT	1.80E-01	2.57E-01	2.57E-01	—	—	—	—	—	2.34E-03	3.40E-03	1.80E-03	1.13E-05
HI		2.88E-01	4.49E-01	**4.01E+00**	**4.03E+00**	**1.08E+00**	**1.05E+00**	**1.48E+00**	4.58E-01	9.77E-01	4.76E-01	**2.05E+00**

Notes: 1. Values in bold indicate HQ > 0.3 or an HI > 1.0.
2. 95% UCL = 95% upper confidence limit of the mean.

[a] NC = HQ not calculated because the ESL is < the BV.

[b] ESL not available.

[c] 95% UCL could not be calculated; maximum detection was used.

Three organic chemicals (acetone, Aroclor-1260, and bis[2-ethylhexyl]phthalate) had ESLs for most or all wildlife receptors, and all HQs were less than 0.3. Furthermore, these COPCs were detected in only one sample (acetone and Aroclor-1260) or eight samples (bis[2-ethylhexyl]phthalate). Due to the low number of detected concentrations, these COPCs are not expected to drive adverse population-level effects. All detected concentrations for these COPCs were at or below the maximum EQLs, indicating that only trace concentrations are present at the site. Although there are no plant and invertebrate ESLs for these COPCs, the plants at the site are healthy. Because these organic chemicals are detected infrequently at low concentrations and the HQs for receptors with ESLs are less than 0.3, acetone, Aroclor-1260, and bis[2-ethylhexyl]phthalate are not retained as COPECs.

The remaining organic chemicals (amino-2,6-dinitrotoluene[4-], amino-4,6-dinitrotoluene[2-], HMX, RDX, toluene, and TNT) have mammalian ESLs. However, these organic chemicals lack ESLs for the avian receptors and also may lack an ESL for either the plant or invertebrate. All HQs for the mammalian receptors are less than 0.3, and in many cases are at least an order of magnitude lower than 0.3; thus, no further evaluation is warranted for mammalian receptors. Plants observed at the site during an August 28, 2002, site visit appeared healthy, and no observable adverse effects to the flora were noted, indicating that plants are not adversely affected by residual concentrations of COPCs in the biological zone and that no additional evaluations are required for the plants. If a 10-fold uncertainty factor were applied to the available mammalian ESLs and used to estimate avian HQs (depending on the surrogate ESL used for a given receptor/COPC combination), the resulting HQs would be less than 1.0 for all avian receptors. The exception is potential exposure to RDX, where the resulting HQs are greater than 1.0 but less than 5.0. Lastly, except for RDX that was detected across the site in both soil and tuff, there are a limited number of detections of organic chemicals in soil, indicating that the residual concentrations of these organic chemicals in the biological zone are in the tuff. Due to the small number of detected samples in soil and given the time required for the weathering tuff to become an exposure medium for receptors, these organic chemicals in tuff are not expected to cause adverse population-level effects.

The COPECs barium and RDX warrant further site-specific evaluation in an ecological risk assessment. All other inorganic and organic chemicals are eliminated as COPECs. The COPECs in the tuff are not of concern for the receptors at the MDA P Site or in Cañon de Valle because exposure pathways are incomplete. Future exposures to COPECs in the tuff are directly related to the rate of weathering, which is slow and not likely to result in ecological impacts.

Barium is retained for additional assessment because HQs indicate potential risk to all ecological receptors, except the kestrel top carnivore (the surrogate for avian T&E receptors). RDX is also recommended for additional analysis because the avian receptors lack ESLs and estimated HQs based on assumptions related to available mammalian ESLs indicate that the potential risk to avian receptors could not be definitively eliminated.

(c) Cañon de Valle Ecological Risk Assessment

Because the MDA P Site has been disturbed by the removal of contaminated waste, soil, and tuff, the site either does not have any suitable habitat for ecological receptors or is in the process of being reestablished. Cañon de Valle has comparable COPECs at similar or higher concentrations than detected at the MDA P Site and is used to illustrate whether residual contaminant concentrations may pose potential adverse ecological effects at the MDA P Site.

The contaminant signatures and inventories in Cañon de Valle are expected to be the worst-case condition because the MDA P Site has been excavated and other sources of contaminant discharges to

the canyon have been eliminated/remediated. Because of source removal/remediation activities, contaminant concentrations will decline and inventories will dissipate with the continued influence of hydrologic processes in the canyon, thereby further decreasing potential ecological impacts from residual contamination at the MDA P Site. The complete ecological risk assessment is provided in Appendix A of the MDA P closure certification report (LANL 1993, 79563).

The ecological risk assessment considers terrestrial effects for the MDA P Site and aquatic and terrestrial effects in the canyon. The data used to support this assessment include

- postexcavation Phase II confirmation sample data for the MDA P Site;
- sediment profile data collected in 1996 for the active channel in Cañon de Valle;
- overbank samples collected for the fluvial geomorphology characterization in 1999;
- water samples collected from April 1994 to March 1999;
- small-mammal population and contaminant body-burden data collected in 2001;
- sediment toxicity test results collected in 2001; and
- synoptic benthic macro-invertebrate community data collected in 1996 and 1997.

Data sources were subset to assess the MDA P Site impacts where these data extend substantially beyond the area of influence for the MDA P Site or where the data show concentration trends in the canyon that are not relevant to the MDA P Site.

The MDA P Site is one of several historical contaminant sources to Cañon de Valle but is not the dominant source. The 260 outfall [SWMU 16-021(c)-99] is identified as the dominant source of contaminants for the canyon. Additionally, MDA R (SWMU 16-019) and the Silver Outfall (SWMU 16-020), up-canyon from the MDA P Site, also contributed contaminants. Figures 2.4-2 and 2.4-3 show the down-canyon profile of barium concentrations for overbank soils and active channel sediments, including the location of the MDA P Site, downgradient of the 260 outfall. The zero distance is the location of the 260 outfall. The overbank plot shows five locations with elevated barium concentrations between the 260 outfall and the MDA P Site. All other overbank data show a lack of trend with location in the canyon. The active channel sediment plot includes a locally smoothed line fit to approximate an average barium concentration with location in the canyon. The active channel shows a barium concentration decline below the MDA P Site. Both plots show higher barium concentrations upgradient of the MDA P Site reach. These plots indicate the MDA P Site has not been, nor currently is, a major contributor of barium to the canyon. Other COPCs have similar patterns.

The COPC concentration patterns, as represented by the barium plots, indicate that ecological investigations for adverse effects in Cañon de Valle that include the reach below the MDA P Site are also useful for evaluating historical effects from the MDA P Site.

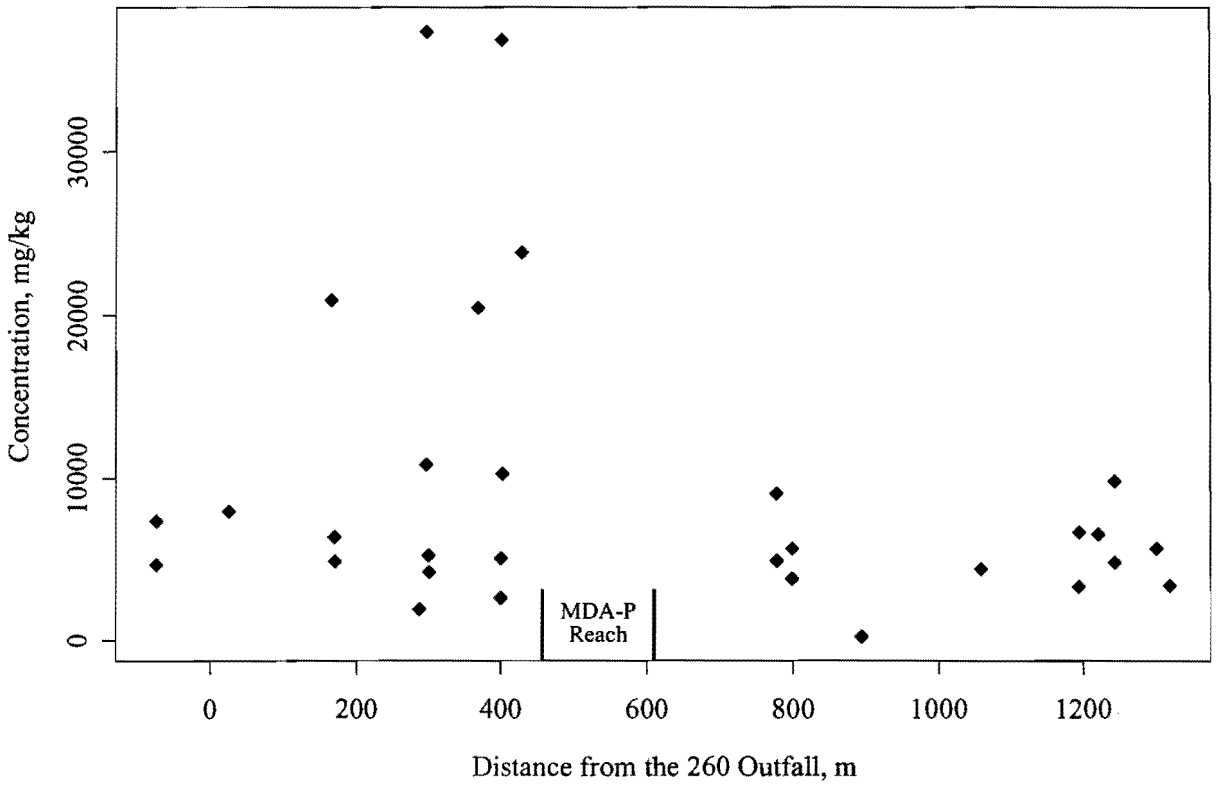


Figure 2.4-2. Down-canyon profile of barium concentrations for the overbank soils

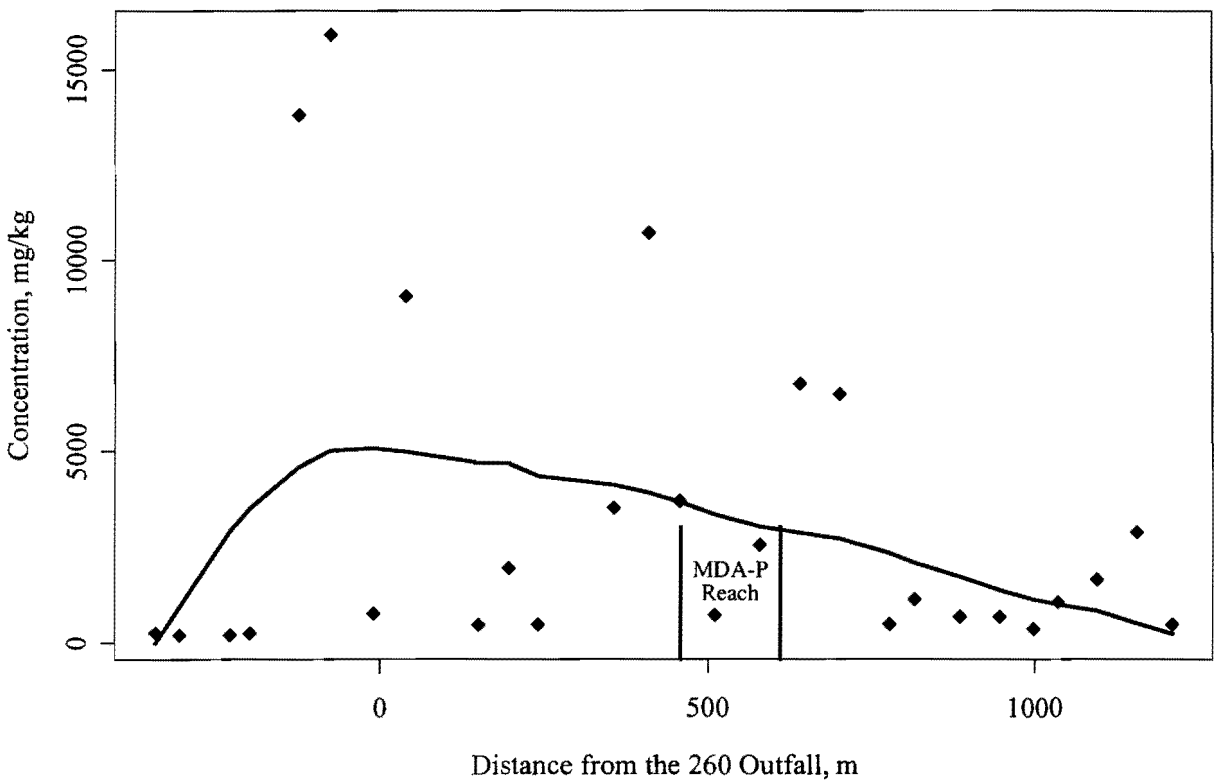


Figure 2.4-3. Down-canyon profile of barium concentrations for the active channel sediments

Cañon de Valle COPECs

The identification of Cañon de Valle COPECs for terrestrial and aquatic receptors is described by Tardiff (2002, 73764; 2003, 73730, respectively). In summary,

- six COPECs were identified in overbank soils that exceed ESLs for terrestrial receptors: barium, silver, lead, copper, HMX, and RDX;
- six COPECs were identified in water that exceeded ESLs for aquatic receptors: aluminum, barium, cadmium, cobalt, manganese, and silver; and
- ten COPECs were identified in active channel sediments that exceeded ESLs for aquatic receptors: barium, cobalt, copper, lead, silver, thallium, vanadium, di-n-butylphthalate, HMX, and RDX.

Cañon de Valle Field Studies—Introduction

The environmental values, or assessment endpoints, to be protected for Cañon de Valle consist of features of the canyon relative to the surrounding landscape and the resident threatened species. Cañon de Valle is one of many canyons incised into the Pajarito Plateau. This canyon has a perennial spring and an alluvial seep in the vicinity of the TA-16 facilities. The presence of water in the canyon is ecologically important to the viability of many species in this semiarid environment. Additionally, the canyon supports a multileveled overstory of mixed conifer, aspen, and oak with grasses and forbs on overbanks and terraces. The combination of perennial water and diverse vegetation makes the canyon a relatively attractive location for endemic fauna. The Mexican spotted owl, a threatened species, has a nesting site down-canyon from the MDA P Site and is likely to hunt in the canyon.

Assessment endpoints addressed in the focused Cañon de Valle assessment are

- community viability of small mammals as an indication of contaminant impacts upon maximally exposed taxa across trophic levels and foraging guilds in the terrestrial environment;
- contaminant concentrations in the food web as an indication of potential impacts to carnivores, including the Mexican spotted owl, a resident threatened species in the canyon; and
- the capacity of the perennial reach of the canyon to support an aquatic community as an indication of the extent to which contaminants have impaired sediment and water quality.

Specific measures of effects used to assess terrestrial small-mammal community viability and food web contaminant concentrations are

- number of small-mammal species,
- population density estimates of small mammals,
- reproductive status classes for each small-mammal species,
- small-mammal body weights, and
- small-mammal contaminant body burdens.

Specific measures of effects used to assess the capacity of the canyon's aquatic system to support an aquatic community are

- number of benthic macro-invertebrate species,
- presence of sensitive species,
- benthic macro-invertebrate community metrics,

- *Chironomus tentans* toxicity test survival, and
- *C. tentans* toxicity test growth.

Cañon de Valle Field Studies—Terrestrial Assessment

The small-mammal community is a practical choice for biota sampling for adverse terrestrial effects in Cañon de Valle. Small mammals reside in the canyon year-round and the populations are sufficiently abundant to provide multiple individuals for population estimates and to determine the amounts of contaminants taken up and stored by individuals in their body tissues, i.e., contaminant body burden. Additionally, small mammals are a dominant prey species for the carnivores active in the canyon, including the Mexican spotted owl. Contaminant body-burden data from small mammals provide the information necessary to make direct estimates of contaminant intake by carnivores, obviating most assumptions in contaminant transfer models. Small mammals were collected from Cañon de Valle and Pajarito Canyon, the latter being a reference (i.e., uncontaminated) location. Pajarito Canyon was selected as the reference canyon based on its similarity to Cañon de Valle with respect to topography, elevation, water presence and quantity, vegetation, and burn severity from the Cerro Grande fire in 2000. Trapping was conducted during May 2001 and again from September to October 2001. The lines of evidence evaluated are number of species, body weight, reproductive status classes for each species, population density estimates, and contaminant body burden.

The trophic level of a small-mammal species generally influences the accumulation rate of contaminants relative to soil concentrations. Sample et al. (1998, 72726) found that bioaccumulation is highest in insectivores and lowest in herbivores. Three endpoint species under consideration are the mountain cottontail (a herbivore), the deer mouse (an omnivore), and the dusky shrew (an insectivore). Based upon home range, the potential for bioaccumulation, and prey size preferences of the Mexican spotted owl, the dusky shrew and deer mouse populations are best suited for assessing contaminant transfers to top carnivores. Given the propensity for higher body burdens, these species also are likely to elicit population responses to COPECs if such responses are occurring. If necessary, the differences in diet between the two small mammals can be used to differentiate body burdens associated with trophic levels. Finally, the reproductive rate of these species is such that individuals removed for analysis will be replaced quickly within the populations, and negative consequences to the food chain from sampling are very unlikely. The body burden data are used to compare COPEC concentrations between Cañon de Valle and the reference canyon and to estimate the dose of COPECs to the Mexican spotted owl. Individuals were sacrificed for body-burden analysis, and samples were submitted to the analytical laboratory for analysis of HE and TAL metals. The details of the calculated minimum detection limits for estimating risk-relevant doses to the Mexican spotted owl are provided in "Cañon de Valle Terrestrial Ecological Risk Assessment Pilot Steps Four and Five: Study Design and Implementation Plan" (Tardiff 2002, 73764).

The terrestrial study data indicate that both the number of species (Table 2.4-9) and the population densities (Table 2.4-10) of small mammals are greater in Cañon de Valle than in the reference (i.e., uncontaminated) site, Pajarito Canyon. The dusky shrew, selected as a study species, was not trapped on any of the field collection/trapping dates. Additionally, Cañon de Valle consistently had more reproductive status classes than Pajarito Canyon (Table 2.4-9). These results indicate that the contaminant inventories in Cañon de Valle do not adversely affect the small-mammal community.

A comparison of body weights, by species, shows no differences between the canyons except for brush mice when the sexes are combined. However, this difference in weights is associated with a relatively large number of nonreproductive individuals in Cañon de Valle and indicates that the brush mouse population in Cañon de Valle is more active with regard to reproduction because Cañon de Valle has more individuals transitioning from juvenile to reproductive status.

Table 2.4-9
Cañon de Valle Small-Mammal Trapping Results for Spring and Fall 2001
Number of Individuals by Species and Reproductive Status

	Juvenile Female	Juvenile Male	Pregnant Female	Lactating Female	Non-Reproductive Female	Non-Scrotal Male	Scrotal Male	Totals
Spring 2001								
Cañon de Valle								
Deer mouse[a]	2		1	2	3	5	8	**21**
Montane vole[b]				1		3		**4**
Totals	**2**		**1**	**3**	**3**	**8**	**8**	**25**
Pajarito Canyon								
Deer mouse					2	2	4	**8**
Montane vole							1	**1**
Totals					**2**	**2**	**5**	**9**
Fall 2001								
Cañon de Valle								
Deer mouse	6	3		3	6	5	2	**25**
Brush mouse[c]			1	1	7	8		**17**
Pinyon mouse[d]					1			**1**
Western Harvest mouse[e]	2	2	2	1	2	3		**12**
Wood rat[f]						4		**4**
Totals	**8**	**5**	**3**	**5**	**16**	**20**	**2**	**59**
Pajarito Canyon								
Deer mouse		2	2	1	5	6	1	**17**
Brush mouse			1	1	3	2	1	**8**
Wood rat				1		1	1	**3**
Totals		**2**	**3**	**3**	**8**	**9**	**3**	**28**

[a]*Peromyscus maniculatus.*
[b]*Microtus montanus.*
[c]*Peromyscus boylii.*
[d]*Peromyscus truei.i*
[e]*Reithrodontomys megalotis.*
[f]*Neotoma mexicana.*

Table 2.4-10
Deer Mouse Population Density Estimates by Trapping Grid and Season

Location	Spring 2001 individuals/ha (±95% CI[a])	Fall 2001 individuals/ha (±95% CI)
Cañon de Valle, upper grid	10.5 (4)	na[b]
Cañon de Valle, lower grid	24 (9)	144 (66)
Pajarito Canyon, upper grid	7.1 (3.8)	11.3 (7.5)
Pajarito Canyon, lower grid	9.1 (4.1)	18.7 (8)

[a] CI = Confidence level.
[b] na = Not applicable—population density not calculated because new capture data are nonlinear (5,4,8,6).

Figure 2.4-4 shows box plots of deer mouse body burden data, with a cursor line representing the Mexican spotted owl ESL. The analysis of contaminant body burdens for small mammals show that the whole-mouse concentrations (of barium, copper, lead, silver, HMX, and RDX) are well below ESLs for the Mexican spotted owl. These data indicate that contaminant inventories in Cañon de Valle are not posing a potential risk to the owl through the food chain.

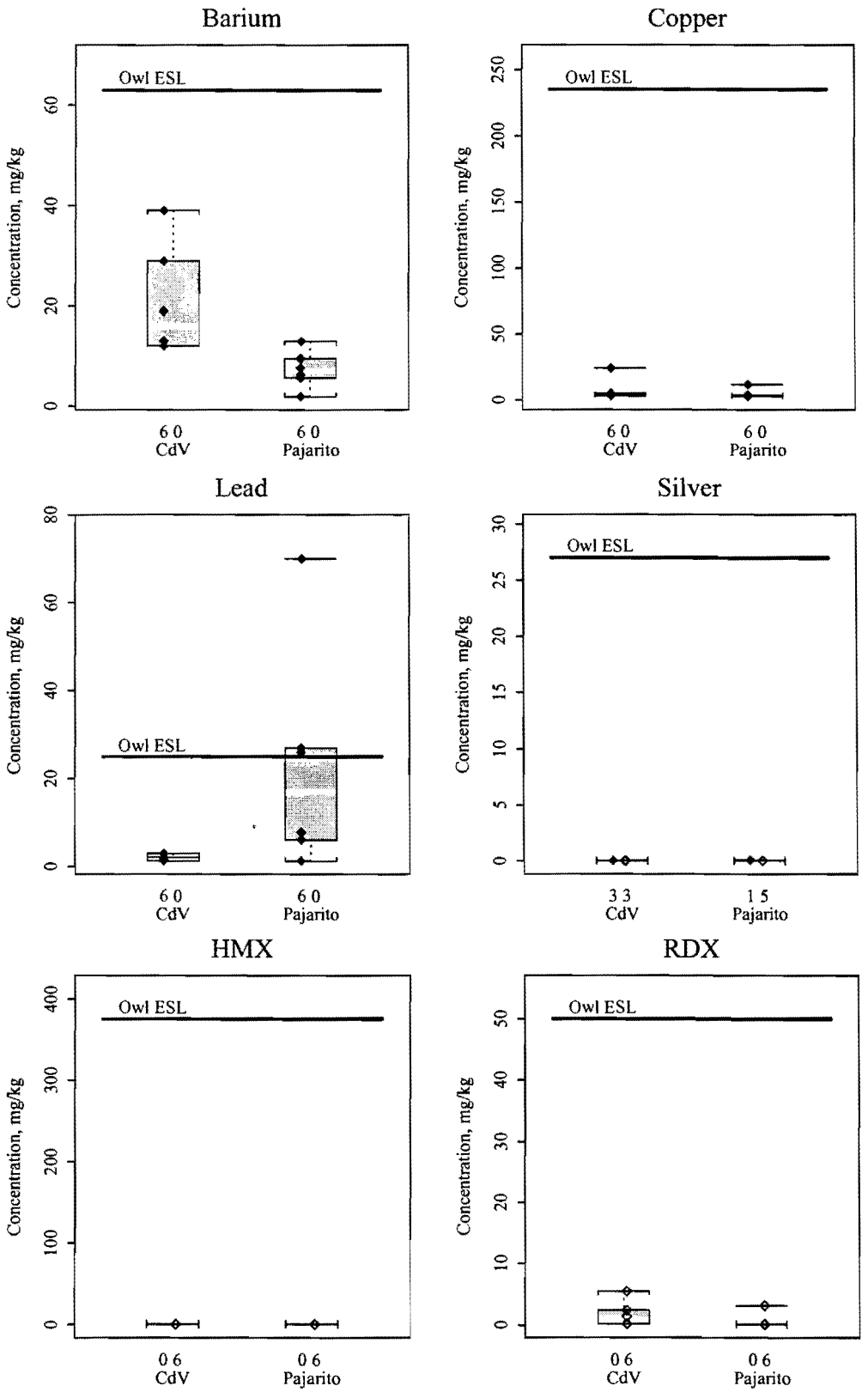
Cañon de Valle Field Studies—Aquatic Assessment

Synoptic benthic macro-invertebrate surveys and toxicity testing with *C. tentans* were selected for assessing adverse effects in the Cañon de Valle aquatic system. The study design is summarized below and fully described by Tardiff (2003, 73730).

Biotic Survey

Cañon de Valle is somewhat limited in survey options for aquatic resources because it is a very small stream that does not support fish. The lack of fish is due to the perennial reach's being disconnected from any larger body of water, its small dimensions (average width 50 cm, average depth 7 cm), and lack of sufficient pool cover to protect fish populations from freezing and drought.

The benthic macro-invertebrate community is an appropriate option for a synoptic survey. The species in this community reside in or on sediments, are continually exposed to contaminants in the water column, and feed on detritus and microorganisms. The consumption of microorganisms incorporates food-chain effects into the macro-invertebrate exposures. This community was surveyed in 1996 and 1997 and was shown to be well developed in Cañon de Valle (NMED 1999, 73769). These data are used to assess community effects in Cañon de Valle relative to the reference stream reaches on the Pajarito Plateau.



Numbers above data groups are detects (solid symbol) and nondetects (open symbol)

Figure 2.4-4. Deer mouse contaminant body burdens

A synoptic survey of benthic macro-invertebrates was conducted for riffle habitat in Cañon de Valle, Pajarito Canyon, Los Alamos Canyon, and Guaje Canyon. The latter three canyon reaches are reference streams. The lines of evidence evaluated are number of species, presence of sensitive species, and comparisons of community metrics between the two canyons. Three taxa in the orders *Ephemeroptera, Plecoptera, and Trichoptera (EPT)*, generally considered sensitive to pollutants, were measured in the canyons. Their presence at a site indicates that if pollution is present, it is most likely at low levels. The second metric consists of the ratio of EPT to EPT plus the Chironomids. Chironomidae is a taxonomic family of true flies. They typically tolerate pollution-impacted conditions. If they dominate the assemblage of taxa for a site, then the site may warrant evaluation for pollution impacts. The third metric is the community tolerance dominance quotient (CTDq) from the biotic community index of Winget and Mangum (1979, 75926). For the first two metrics, larger values indicate better site quality. For the CTDq, lower values indicated better site quality.

The benthic macro-invertebrate study results show that the total number of benthic macro-invertebrate taxa in Cañon de Valle (33) is within the range of values for the three reference reaches (25 to 42): Pajarito, Guaje, and upper Los Alamos Canyons. Sensitive species are present in Cañon de Valle, with the total number of sensitive species (EPT = 6) being lower than in the reference reaches (EPT=10, 16, and 18) (Table 2.4-11). This result corresponds to the comparisons of community metrics. The EPA Rapid Bioassessment Protocol (EPA 1999, 73728) characterizes a community metric reference comparison of greater than 79% as "full support" and a reference comparison of 70 to 79% as "full support, impacts observed." The Cañon de Valle community metric score of 81% is slightly above the cut-off for impacted streams (79%) when compared with Pajarito Canyon, the most similar reference stream. There are two possible sources of these differences. First, the scraper community is substantially reduced in Cañon de Valle primarily due to lack of habitat to support that feeding strategy (i.e., not related to contaminant impacts). When the community metrics are summed without the scraper community metric, Cañon de Valle has a community metric score of 90% relative to Pajarito Canyon. The second source of differences between Cañon de Valle and the reference reaches is stream size. Cañon de Valle is the smallest of the streams and smaller streams commonly have fewer taxa. Thus, the difference in the community metric scores of Cañon de Valle and Pajarito Canyon is not due to contaminants in Cañon de Valle, but is attributed to the lack of habitat in Cañon de Valle to support a scraper community and the smaller size of the stream.

Table 2.4-11
Sensitive Species Metrics for Cañon de Valle Relative to Three Reference Sites

	Cañon de Valle (2.6)[a]	Los Alamos Canyon (13.0)	Pajarito Canyon (9.0)	Guaje Canyon (10.0)
EPT[b]	6	18	10	16
EPT/EPT + Chironomids	0.66	0.25	0.84	0.90
CDTq[c]	91.0	71.4	80.0	62.0

[a] Miles upstream from mouth of canyon.

[b] EPT = *Ephemeroptera, plecoptera, and trichoptera.*

[c] CDTq = Community tolerance dominance quotient.

Toxicity Test

Two general approaches are available for conducting toxicity tests: the use of water column test organisms or sediment-dwelling test organisms. Given the nature of the aquatic system in Cañon de Valle, organisms that live in sediments are more representative of contaminant exposures to endemic biota than are water column organisms.

The midge, *C. tentans*, is a toxicity test organism that is well documented for its toxic responses to contaminants, is widely used in toxicity testing, and is reared from laboratory populations. Additionally, the genus *Chironomus* is present in Cañon de Valle. A cursory literature review provided in ASTM (1995, 73729) indicates that the test species, *C. tentans*, was among the most sensitive of 24 species evaluated with Great Lakes sediments. In various studies, the midge tended to be less sensitive than *Hyalella azteca* for some metals and equivalent to or more sensitive than *H. azteca* for pesticides. A study by DeFoe and Ankley (1998, 73783) showed that the sensitivity of the *C. tentans* 10-day test is greatly increased by measuring growth in addition to survival. While a single species cannot represent the toxic responses for all the members of the community, *C. tentans* is related to the Cañon de Valle aquatic community and appears to have contaminant sensitivities that can indicate the presence of adverse effects.

Sediment samples were collected in Cañon de Valle and Starmer's Gulch for toxicity testing with *C. tentans* using the EPA 10-day survival and growth protocol (EPA 2000, 73776) with daily static renewal using site water. The lines of evidence evaluated are survival and growth of the test organisms (Pacific Ecorisk 2001, 73775).

The sediment toxicity test results show that the Cañon de Valle reach above the MDA P Site is impacted relative to the reference site in Starmer's Gulch, but that the reach potentially influenced by the MDA P Site is not impacted (Table 2.4-12). Survival of the test organisms was higher below the MDA P Site (86.25% survival) than above it (68.75% survival) relative to Starmer's Gulch (82.5% survival). Similarly, the comparisons of larval growth showed impacts above the MDA P Site reach (mean ash-free dry weight of 0.38 mg/individual) but not below (mean ash-free dry weight of 0.4 mg/individual) relative to Starmer's Gulch (mean ash-free dry weight of 0.44 mg/individual).

Table 2.4-12
Data Summaries of Sediment and Water Toxicity Testing with *Chironomus tentans*

Group	Minimum	1st Quarter	Median	Mean	3rd Quarter	Maximum
Percent Survival Data Summaries Starting number is 10 individuals per replicate, with 8 replicates per site						
Starmer's Gulch	60	77.5	90	82.5	90	90
Above MDA P	30	60.0	75	68.75	80	90
Below MDA P	70	80.0	90	86.25	90	100
Growth Data Summaries Ash-free dry weight, mg/individual, based upon surviving individuals						
Starmer's Gulch	0.34	0.43	0.44	0.4356	0.46	0.52
Above MDA P	0.34	0.35	0.37	0.3756	0.38	0.44
Below MDA P	0.35	0.37	0.39	0.3956	0.40	0.50

MDA P Site and Cañon de Valle COPC Concentration Comparisons

Two COPECs in the MDA P Site biological zone soil were carried forward for ecological risk assessment: barium and RDX, both of which are present at elevated concentrations in the Cañon de Valle soils and sediments. The ecological risk assessment approach for these contaminants in MDA P Site soils is to compare their concentrations with the Cañon de Valle concentrations. The result of the ecological risk assessment for Cañon de Valle presented above is a determination of no adverse effects in the vicinity of the MDA P Site. If the COPEC concentrations for the MDA P Site footprint soils are less than, or not different from, the Cañon de Valle soils, a determination of no adverse effects is supported for the MDA P Site soils.

Contaminant concentration data for the MDA P Site soils were compared with Cañon de Valle overbank soils and are presented in Table 2.4-13 and Table 2.4-14. All statistical comparisons between Cañon de Valle and the MDA P Site are not significant ($p>0.05$), except for aluminum and cadmium. Where the tests are not significant, the concentrations in the MDA P Site soils are equivalent to or less than the concentrations in Cañon de Valle. Aluminum in MDA P Site soils is higher than in canyon soil. Per EPA guidance (EPA 2000, 73306), aluminum is a COPEC only for sites with a soil pH of less than 5.5. The pH range of the MDA P soils is 6.8 to 7.6. Based upon this criterion, aluminum is not a COPEC. Cadmium concentrations also are higher for the MDA P Site soils than for Cañon de Valle. Cadmium is eliminated as a COPEC because 22 of the 23 detected values are less than the soil BV of 0.4 mg/kg (LANL 1998, 59730). The single value that exceeds the BV is 1.4 mg/kg, which is within the range of soil background data, 0.2 mg/kg to 2.6 mg/kg, indicating that cadmium is unlikely to pose adverse population-level effects to ecological receptors (LANL 1998, 59730).

(d) Uncertainty Analysis

The major uncertainty in the Cañon de Valle risk assessment is that terrestrial and sediment toxicity evaluations were conducted during a multiyear drought and within a year of the Cerro Grande fire. Drought is one stressor and is likely to increase the potential of detecting an adverse effect that could be associated with contaminants. Fire effects often result in increased small-mammal populations associated with increased ground vegetation. If contaminant uptake and food chain transfers were a source of population effects, postfire environments should increase the likelihood of detecting these effects.

The use of laboratory toxicology studies to develop no-effects contaminant concentrations introduces uncertainties in the risk assessment. Laboratory studies use chemical forms of contaminants and exposure mechanisms that often are not representative when compared with environmental conditions. Additionally, laboratory studies often are conducted with single contaminants. The result of combinations of contaminants is largely unknown. The results presented for Cañon de Valle are based on field studies and laboratory toxicity studies with field-collected media from the canyon containing multiple contaminants. This approach obviates the usual difficulties of extrapolating laboratory data to field settings.

Another major uncertainty associated with this assessment is the adequacy of sample coverage to support characterization of the contaminant signatures at the site. In this assessment, MDA P Site soils in the biological zone were characterized with 71 samples collected in a grid pattern and often were biased towards locations where contaminant concentrations were suspected of being elevated (e.g., locations that receive focused infiltration or runoff). The overbank soils sampled in Cañon de Valle were collected as part of the geomorphic characterization of contaminants in the canyon and were biased towards areas likely to have high contaminant concentrations. The combination of these two data sets for this analysis provides an abundant basis for the conclusion of no adverse effects to the Cañon de Valle or MDA P Site ecological receptors from residual COPC concentrations at the MDA P Site.

Table 2.4-13
Detected Values for MDA P Site Soils and Cañon de Valle Overbank Soils

	Minimum (mg/kg)	1st Quarter (mg/kg)	Median (mg/kg)	Mean (mg/kg)	3rd Quarter (mg/kg)	Maximum (mg/kg)	Detects
MDA P Site Soils							
Barium	18.7	120	200.5	538.7	503	6630	70
RDX	0.069	0.2625	0.73	3.176	2.125	37	36
Aluminum	2630	5542	7305	7926	9750	19900	70
Cadmium	0.04	0.0665	0.087	0.1545	0.12	1.4	23
Cobalt	0.69	2.125	3.35	3.954	4.075	44.7	70
Copper	0.68	3.9	5.1	7.373	8.275	36.8	70
HMX	0.118	0.5725	1.05	2.828	2.425	16	32
Lead	3.8	8.325	10.45	12.18	13.87	61.5	70
Manganese	30.9	179	225	257.6	298.8	1290	70
Silver	0.099	0.165	0.73	2.146	1.5	15.8	15
Vanadium	2.9	8.3	12.2	12.89	15.3	29.3	69
Cañon de Valle Overbank Soils							
Barium	184	4430	5620	9264	9575	37300	30
RDX	0.16	0.32	0.49	0.8833	0.72	5.5	21
Aluminum	3030	4312	5370	5316	6332	8880	30
Cadmium	0.06	0.085	0.22	0.309	0.4075	1.1	10
Cobalt	1.50	4.175	5.30	6.703	7.3	17.5	30
Copper	3.30	14.3	24.55	26.53	29.4	139	30
HMX	0.19	0.8	1.60	16.47	12	290	27
Lead	7.60	28.18	36.30	35.59	44.50	65.9	30
Manganese	75.2	278.8	341	341	378.50	980	30
Silver	0.63	2.675	3.60	5.478	8.050	14.9	28
Vanadium	8.90	11.98	14.3	14.35	15.7	21.2	30

Table 2.4-14
Statistical Comparisons of Cañon de Valle COPECs with MDA P Site Soils

COPEC	Gehan Test p-value	Quantile Test p-value
Aluminum	0.00005	0.0021
Barium	1.0	1.0
Cadmium	—[a]	0.033
Cobalt	1.0	1.0
Copper	1.0	1.0
HMX	—	1.0
Lead	1.0	1.0
Manganese	1.0	1.0
RDX	—	1.0
Silver	—	1.0
Vanadium	1.0	0.99

[a] — = Insufficient number of detects for the statistical test.

(e) Interpretation

The ecological risk assessment for the terrestrial and aquatic systems in Cañon de Valle found that there is no empirical evidence of adverse effects associated with the MDA P Site. Both the terrestrial and aquatic studies indicate that ecological receptors in the canyon are not adversely affected by contaminants in the soils and sediments in the canyon. Comparisons of the MDA P Site soil COPEC concentrations to Cañon de Valle contaminant concentrations show that barium and RDX are not statistically different between the two locations. The lack of adverse ecological effects in Cañon de Valle from these contaminants is strong evidence that there are no effects due to these contaminants in the biological zone soils at the MDA P Site. The concentrations of other Cañon de Valle COPECs in the MDA P Site soils do not pose a threat of adverse effects because they do not differ from (or are lower than) the overbank soil concentrations for the canyon. This conclusion is valid for MDA P Site soils in their present location and also if they are transported into the canyon in the future because current contaminant concentrations in the canyon exceed those that may be transported from the MDA P Site in the future. These lines of evidence indicate that residual contamination from the MDA P Site does not pose a threat to the environment.

2.4.2 Other Applicable Assessments

2.4.2.1 Surface Water Assessments

The RRES-RS project has developed a procedure to assess sediment transport and erosion concerns at individual SWMUs. It provides a basis for prioritizing and scheduling actions to control the erosion of potentially contaminated soils at specific SWMUs. The procedure is a two-part evaluation. Part A is a compilation of existing analytical data for the SWMU, site maps, and knowledge-of-process information. Part B is an assessment of the erosion/sediment transport potential at a SWMU. Erosion potential is rated numerically from 1 to 100 using a matrix system. SWMUs that score below 40 have low erosion potential; those that score from 40 to 60 have medium erosion potential; and those that score above 60 have high erosion potential. Surface water assessments were conducted individually for SWMUs 16-006(e), 16-010(a), and 16-016(c) (Appendix B).

The assessment for 16-006(e), completed on March 26, 2001, resulted in an erosion matrix score of 8.8. The assessment found no debris in any nearby watercourse. There are no wetlands or springs in the vicinity of SWMU 16-006(e). The nearest spring is Burning Ground Spring, located approximately 1500 ft upgradient of SWMU 16-006(e). There are no man-made or natural hydraulic structures or features that might affect the hydrology of the site. Therefore, the results of the surface water assessment indicated little potential for contaminant transport by means of surface water or sediment.

The surface water assessment for 16-010(a), completed on July 25, 1997, resulted in an erosion matrix score of 38.4. The assessment found no debris in any nearby watercourse. There are no wetlands or springs in the vicinity of SWMU 16-010(a). The nearest spring is Burning Ground Spring, located approximately 1500 ft upgradient of SWMU 16-010(a). However, some natural hydraulic structures or features are indicative of and conducive to runoff at the site. Therefore, the results of the surface water assessment indicated a low potential for contaminant transport by means of surface water or sediment.

The surface water assessment for 16-016(c), completed on January 12, 1998, resulted in an erosion matrix score of 72. The assessment found no debris in any nearby watercourse. There are no wetlands or springs in the vicinity of SWMU 16-016(c). The nearest spring is Burning Ground Spring, located approximately 1500 ft upgradient of SWMU 16-016(c). However, some natural hydraulic structures or features are indicative of and conducive to runoff at the site. Therefore, the results of the surface water assessment indicated a high potential for contaminant transport by means of surface water or sediment.

As part of the VCA, SWMU 16-016(c)-99 was regraded and reseeded. A BMP in the form of biodegradable jute matting was put in place to prevent runoff from the site until vegetation from reseeding is established. The BMP has been and will continue to be monitored and maintained until final restoration activities at the MDA P Site are complete.

After completion of the Phase I activities, the MDA P Site was stabilized for erosion and sediment control. The MDA P landfill footprint consisted of scraped bedrock surfaces with locally thin veneer of unconsolidated deposits of soil and rock debris. The area south of the landfill had a relatively thick veneer (2 to 5 ft) of soil and fill materials. Some of these residual unconsolidated deposits were left in place, and the slopes were reduced to minimize the erosion hazard. Slopes on the western, eastern, and southern parts of the project area were reseeded with a mixture containing both fast-germinating grasses and annuals for longer-term stabilization. The steeper slopes on the margins of the east drainage were seeded and covered with coconut straw.

Boulders and rocks were used for riprap in areas that required slope and sediment control. Along the western and eastern margins of the former MDA P footprint, the drainages were lined with boulders. The lower, western drainage especially received a riprap-lined drainage for water from the adjacent watershed that impinged on the former MDA P footprint. The West Access Road was vulnerable to erosion from this source. Along the middle and lower reaches of the east drainage, riprap was installed to collect sediment from the unconsolidated deposits near the former decontamination pad. The east runoff trench was left, unlined, to also collect sediment from this area. The remnant of the former run-on trench just north of former Flash Pad 387 was left to collect runoff water and to distribute it to the lower east drainage.

2.4.2.2 Groundwater Assessment

A groundwater assessment was prepared to meet certain closure requirements for MDA P and is presented in section 3.0 of the MDA P Site closure certification report (LANL 2003, 79563). Aspects of the groundwater assessment for MDA P are relevant to the VCA activities for SWMU 16-016(c)-99. The analytical and geochemical data used in the MDA P groundwater assessment demonstrate that the potential for transport of residual hazardous constituents from MDA P, and thus from SWMU 16-016(c)-99, to groundwater is mitigated because

- the Laboratory successfully completed closure by removal and as a result, the residual hazardous constituent concentrations at the MDA P Site are below levels that pose a potential unacceptable risk to human and ecological receptors;
- the residual hazardous constituent concentrations at the MDA P Site are confined primarily to the upper 5 ft of the soil and tuff;
- the vadose zone properties beneath the MDA P Site limit the potential subsurface transport of contaminants to a depth no greater than the accumulation zone (30 to 90 ft bgs) due to evapotranspiration;
- the transport of residual hazardous constituents from the MDA P Site in the surface soils and tuff to alluvial and perched systems outside the site boundaries (e.g., in Cañon de Valle) is limited by the lack of viable surface and subsurface water transport mechanisms; and
- the thickness of the vadose zone (i.e., approximately 1200 ft to the regional aquifer) and the low hydraulic conductivities of the vadose zone strongly limit potential transport to the deep groundwater.

2.5 Conclusions and Recommendations

The VCA for SWMU 16-016(c)-99 consisted of removing contaminated soil, collecting confirmation samples, and performing interim stabilization and revegetation. This VCA completion report

- documents all cleanup activities and sampling results;
- demonstrates that the nature and extent of contamination for SWMU 16-016(c)-99 has been defined; and
- confirms that residual concentrations of COPCs pose no potential unacceptable risk to human and ecological receptors under current and projected future land use.

Therefore, the Laboratory RRES-RS project recommends NFA for SWMU 16-016(c)-99 based on Criterion 5. This criterion states that the SWMU has been characterized or remediated in accordance with applicable state and/or federal regulations and that available data indicate that chemicals of concern either are not present or are present at concentrations that pose no potential unacceptable human health or ecological risk under projected future land use (NMED 1998, 57897).

3.0 WASTE MANAGEMENT

Waste generated during soil excavation from the former barium nitrate pile and septic tank includes soils and debris. Soils from the excavation of contaminated areas were staged in 100-yd^3 lots for waste sampling. No effort was made to segregate soils from the SWMU 16-016(c)-99 sites from other MDA P Site support areas being excavated (e.g., soil staging pads and road cover). Soils mixed with the contents of the septic tank were containerized when the tank was removed, and staged at the excavation. The debris generated includes pipe materials and debris from the tank removal.

Soils generated from excavating SWMU 16-016(c)-99 sites were subjected to the same sampling regime as all soils generated during the MDA P closure. Generated soils were incorporated into those generated from the MDA P activities and were not sampled independently. No sampling was conducted on the debris other than field-screening tests for residual levels of HE and barium. The contents of the septic tank, as well as soils at the tank inlet and outlet, were sampled at the time of the tank's removal.

Soil generated from excavating SWMU 16-016(c)-99 sites were disposed of through the system developed for the MDA P closure. No attempt was made to distinguish soils from the SWMU 16-016(c)-99 areas from those of MDA P. Soils mixed with the tank contents and under the tank were found to be nonhazardous and nonregulated (i.e., environmental media), respectively, and were returned to the excavation.

The debris generated was found to be nonhazardous by the HE spot tests and barium XRF analyses. The fragments of the 4-in.-diameter VCP and tank remnants were disposed of as industrial waste. The materials were included in soil shipments to the receiving facility in Rio Rancho, New Mexico, operated by Waste Management, Inc., and are included in the soil shipment documentation. The remnants of the metal tank were transferred to the Laboratory's Engineering Sciences and Applications Division for recycling.

4.0 REFERENCES

The following list includes all references cited in this document. The parenthetical information that follows each reference provides the author, publication date, and the Environmental Restoration Record

Identification (ER ID) Number. This information also is included in the citations in the text and can be used to locate the documents.

ER ID numbers are assigned by the Laboratory's RRES-RS project to track records associated with the Program. These numbers can be used to locate copies of the actual documents at the RRES-RS Records Processing Facility and, where applicable, within the RRES-RS reference library titled Reference Set for Operable Unit 1082.

Copies of the reference library are maintained at the NMED Hazardous Waste Bureau; the DOE Los Alamos Site Office/National Nuclear Security Administration; EPA Region 6; and RRES-RS. This library is a living document that was developed to ensure that the administrative authority has all the material needed to review the decisions and actions proposed in this document. However, documents submitted to the administrative authority are not included in the reference library.

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Appendix A

Acronyms, Glossary, and Metric Conversion Table

APPENDIX A ACRONYMS, GLOSSARY, AND METRIC CONVERSION TABLE

A-1.0 Acronyms

ASTM	American Society for Testing and Materials
bgs	below ground surface
BMP	best management practice
BV	background value
CD	compact disc
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CTDq	community tolerance dominance quotient
DOE	US Department of Energy
EPA	US Environmental Protection Agency
EPT	*Ephemeroptera, Plecoptera, and Trichoptera*
EQL	estimated quantitation limit
ER	Environmental Restoration
ESL	ecological screening level
HE	high explosive
HI	hazard index
HMX	1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane
HQ	hazard quotient
HSWA	Hazardous and Solid Waste Amendments of 1984
IWP	Installation Work Plan
Laboratory	Los Alamos National Laboratory
MDA	material disposal area
NFA	no further action
NMED	New Mexico Environment Department
NOAEL	no-observed-adverse-effect level
PAH	polycyclic aromatic hydrocarbon
PRG	preliminary remediation goal
PRS	potential release site
RCRA	Resource Conservation and Recovery Act
RDX	1,3,5-trinitro-1,3,5-triazacyclohexane
RfD	reference dose
RFI	RCRA facility investigation

RRES-RS	Risk Reduction and Environmental Stewardship Division-Remediation Services
SAL	screening action level
SAP	sampling and analysis plan
SF	slope factor
SVOC	semivolatile organic compound
SWMU	solid waste management unit
SWSC	Sanitary Wastewater Systems Consolidation (Plant)
T&E	threatened and endangered
TA	technical area
TAL	target analyte list
TCLP	toxicity characteristic leaching procedure
TNT	2,4,6-trinitrotoluene
UCL	upper confidence limit
VCA	voluntary corrective action
VCP	vitrified clay pipe
VOC	volatile organic compound
WAC	waste acceptance criteria
WRS	Wilcoxon Rank Sum
XRF	x-ray fluorescence

A-2.0 Glossary

abandonment — The plugging of a well or borehole in such a manner as to preclude migration of surface runoff or ground water along the length of the well.

aquifer — Body of permeable geologic material whose saturated portion is capable of readily yielding groundwater to wells.

area of contamination — Discrete areas of generally dispersed contamination.

background level — Naturally occurring concentrations (levels) of an inorganic chemical and naturally occurring radionuclides in soil, sediment, and tuff.

best management practices (BMPs) — For facilities that manufacture, use, store, or discharge toxic or hazardous pollutants as defined by the 1977 Clean Water Act, a required program to control the potential spill or release of those materials to surface waters. (The Facts on File Dictionary of Environmental Science, edited by L. Harold Stevenson and Bruce Wyman)

chemical of concern — Chemical identified as a potential risk during a site-specific human-health or ecological risk assessment.

chemical of potential concern (COPC) — A chemical, detected at a site, that has the potential to adversely affect human receptors due to its concentration, distribution, and mechanism of toxicity. A COPC remains a concern until exposure pathways and receptors are evaluated in a site-specific human health risk assessment.

chemical of potential ecological concern (COPEC) — A chemical, detected at a site, that has the potential to adversely affect ecological receptors due to its concentration, distribution, and mechanism of toxicity.

ecological screening level (ESL) — An organism's exposure-response threshold for a given chemical constituent. The concentration of a substance in a particular medium corresponds to a hazard quotient (HQ) of 1.0 for a given organism below which no risk is indicated.

Hazardous and Solid Waste Amendments (HSWA) — The Hazardous and Solid Waste Amendments of 1984 (Public Law No. 98-616, 98 Stat. 3221), which amended the Resource Conservation and Recovery Act of 1976, 42 U.S.C. § 6901 et seq.

hazardous waste — Any solid waste is generally a hazardous waste if it
is not excluded from regulation as a hazardous waste,
is listed in the regulations as a hazardous waste,
exhibits any of the defined characteristics of hazardous waste (ignitability, corrosivity, reactivity, or toxicity), or
is a mixture of solid waste and hazardous waste.

See 40 CFR 261.3 for a complete definition of hazardous waste.

industrial-use scenario — Industrial use is the scenario in which current Laboratory operations continue. Any necessary remediation involves cleanup to standards designed to ensure a safe and healthy work environment for Laboratory workers.

no further action (NFA) — A recommendation that not further investigation or remediation is warranted based on specific criteria.

preliminary remediation goal (PRG) — Acceptable exposure levels, protective of human health and the environment, that are used as a risk-based tool for evaluating remedial alternatives.

release — Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of hazardous waste or hazardous constituents into the environment (including the abandonment or discarding of barrels, containers, and other closed receptacles that contain any hazardous wastes or hazardous constituents).

request number — An identifying number assigned by the ER Project to a group of samples that are submitted for analysis.

residential-use scenario — The standards for residential use are the most stringent of the three current- and future-use scenarios being considered by the ER Project and is the level of cleanup the EPA is currently specifying for SWMUs located off the Laboratory site and for those released for non-Laboratory use.

runoff — The portion of the precipitation on a drainage area that is discharged from the area either by sheet flow or adjacent stream channels.

screening action level (SAL) — Medium-specific concentration level for a chemical derived using conservative criteria below for which it is generally assumed that there is no potential for unacceptable risk to human health. The derivation of a SAL is based on conservative exposure and land-use assumptions. However, if an applicable regulatory standard exists that is less than the value derived by risk-based computations, it will be used for the SAL.

sediment — (1) A mass of fragmented inorganic solid that comes from the weathering of rock and is carried or dropped by air, water, gravity, or ice; or a mass that is accumulated by any other natural agent and that forms in layers on the earth's surface such as sand, gravel, silt, mud, fill, or loess. (2) A solid material that is not in solution and either is distributed through the liquid or has settled out of the liquid.

technical area (TA) — The Laboratory established technical areas as administrative units for all its operations. There are currently 49 active TAs spread over 43 square miles.

tuff — A compacted deposit of volcanic ash and dust that contains rock and mineral fragments accumulated during an eruption.

A-3.0 Metric to US Customary Units

Multiply SI (Metric) Unit	by	To Obtain US 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)

Appendix B

Surface Water Assessment Erosion Matrix for 16-016(c)-99

Los Alamos National Laboratory

Environment, Safety & Health Division
ESH-18 Water Quality & Hydrology Group

Surface Water Assessment
Erosion Matrix for PRS 16-006(e)

CRITERIA EVALUATED	Value	Erosion/Sediment Transport Potential Low 0.1	Medium 0.5	High 1.0	Calculated Score
Site Setting (43)					
On mesa top	1	Defined based on topographic setting			1.0
Within bench of canyon	4				
Within the canyon floodplain but not watercourse	13				
Within bottom of canyon channel in watercourse	17				
Estimated % ground and canopy cover	13	>75%	25-75%	<25%	6.5
Slope	13	0-10%	10-30%	>30%	1.3
Surface Water Factors-Run-off (46)					
Visible evidence of runoff discharging? (Yes/No)	5	If no, score of 0 for runoff section.			0.0
		If yes, score 5 and proceed with section.			
Where does runoff terminate?	19	Other	Bench Setting	Drainage/Wetland	0.0
Has runoff caused visible erosion? (Yes/No)	22	Sheet	Rill	Gully	0.0
		If no, score as 0. If yes, calculate as appropriate.			
Surface Water Factors-Run-on (11)					
Structures adversely affecting run-on (Yes/No)	7*	If yes, score as 7. If no, score as 0.			0.0
Current operations adversely impacting (Yes/No)	4	If yes, score as 4. If no, score as 0.			0.0
Natural drainages onto site (Yes/No)	7*	If yes, score as 7. If no, score as 0.			0.0
**Select either structures or natural drainages.*					
MAX. POSSIBLE EROSION MATRIX SCORE:	**100**			**Total Score**	8.8

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Los Alamos National Laboratory
SURFACE WATER
SITE ASSESSMENT

SITE INFORMATION

1a) PRS Number 16-006(e) **1b) Structure Number** 16-389 **1c) FMU Number** 70

2. Date/Time (M/D/Y H:M am/pm) 4/26/2001

SITE SETTING (check all that apply)

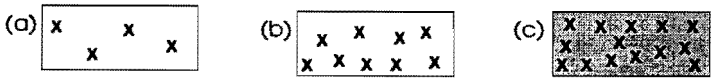
3. ◉ **On mesa top (a).** ○ **In the canyon floor, but not in an established channel (c)**

○ **Within a bench of a canyon (b).** ○ **Within established channel in the canyon floor (d).**

Explanation: Behind (east side of) retention wall for bldg. TA-16-389

4. Estimated ground and/or canopy cover at site: (deciduous leaves, pine needles, rocks, vegetation, trees,

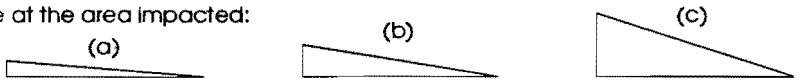
(illustration)



Estimated % of ground/canopy cov ○ 0% to 25% ◉ 25% to 75% ○ 75% to 100%

Explanation: Mullein, wildflowers, weeds.

5. Steepest slope at the area impacted:



◉ Less than 10% ○ 10% to 30% ○ 30% and greater

Explanation: Slight grade towards the east.

RUNOFF FACTORS

Y / N

☐ ☑ **6. Is there visible evidence of runoff discharging from site? If yes, answer a) - c) below:**

☐ ☑ 6a) Is runoff channelized? If yes, describ ○ Man-made channel. ○ Natural channel.

Explanation:

RUNOFF FACTORS, CONT'D

6b) Where does evidence of runoff terminate?

- ○ **Drainage or wetland (name)** Canon de Valle
- ○ **Within bench of canyon setting (name)**
- ○ **Other (i.e., retention pond, meadow, mesa top)**

Explanation:

Y / N

☐ ☑ 6c) Has runoff caused visible erosion at the site? If yes, explain below: ○ Sheet ○ Rill ○ Gully

Explanation:

RUN-ON FACTORS

Please rate the potential for storm water to run on to this site: (Check EITHER #7 or #9)

☐ ☑ **7.** Are structures (i.e., buildings, roof drains, parking lots, storm drains) creating run-on to the site?

Explanation:

☐ ☑ **8.** Are current operations (i.e., fire hydrants, NPDES outfalls) adversely impacting run-on to the site?

Explanation:

☐ ☑ **9.** Are natural drainage patterns directing stormwater onto site?

Explanation:

ASSESSMENT FINDING:

☐ ☑ **10. Based on the above criteria and the assessment of this site, does soil erosion potential exist? (REFER TO EROSION POTENTIAL MATRIX.)**

Beguin, Kristi

11. Signature of Water Quality/Hydrology Representative

_____ Initials of independent reviewer.

Check here when information is entered in database: ☑

This page is for ESH-18 notes, recommendations, and photos.

	Y	N	
12. a)	○	◉	Is there visible trash/debris on the site?
b)	○	◉	Is there visible trash/debris in a watercourse?

Description of existing BMPs:

○	○	Are BMPs being properly maintained? If no, describe in "Other Internal Notes."
○	○	Are BMPs effectively keeping sediment in place and reducing erosion potential?

OTHER INTERNAL NOTES:

Los Alamos National Laboratory

Environment, Safety & Health Division
ESH-18 Water Quality & Hydrology Group

Surface Water Assessment
Erosion Matrix for PRS 16-010(a)

CRITERIA EVALUATED	Value	Erosion/Sediment Transport Potential Low 0.1	Medium 0.5	High 1.0	Calculated Score
Site Setting (43)					
On mesa top	1	Defined based on topographic setting			1.0
Within bench of canyon	4				
Within the canyon floodplain but not watercourse	13				
Within bottom of canyon channel in watercourse	17				
Estimated % ground and canopy cover	13	>75%	25-75%	<25%	13.0
Slope	13	0-10%	10-30%	>30%	6.5
Surface Water Factors-Run-off (46)					
Visible evidence of runoff discharging? (Yes/No)	5	If no, score of 0 for runoff section.			5.0
		If yes, score 5 and proceed with section.			
Where does runoff terminate?	19	Other	Bench Setting	Drainage/Wetland	1.9
Has runoff caused visible erosion? (Yes/No)	22	Sheet	Rill	Gully	11.0
		If no, score as 0. If yes, calculate as appropriate.			
Surface Water Factors-Run-on (11)					
Structures adversely affecting run-on (Yes/No)	7*	If yes, score as 7. If no, score as 0.			0.0
Current operations adversely impacting (Yes/No)	4	If yes, score as 4. If no, score as 0.			0.0
Natural drainages onto site (Yes/No)	7*	If yes, score as 7. If no, score as 0.			0.0
**Select either structures or natural drainages.*					
MAX. POSSIBLE EROSION MATRIX SCORE:	**100**			**Total Score**	38.4

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Los Alamos National Laboratory
SURFACE WATER
SITE ASSESSMENT

SITE INFORMATION

1a) PRS Number 16-010(a) **1b) Structure Number** **1c) FMU Number** 70

2. Date/Time (M/D/Y H:M am/pm) 7/25/1997 11:58:00 AM

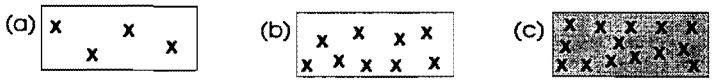
SITE SETTING (check all that apply)

3.
- (●) **On mesa top (a).**
- ( ) **Within a bench of a canyon (b).**
- ( ) **In the canyon floor, but not in an established channel (c)**
- ( ) **Within established channel in the canyon floor (d).**

Explanation: South of MDA-P-

4. Estimated ground and/or canopy cover at site: (deciduous leaves, pine needles, rocks, vegetation, trees,

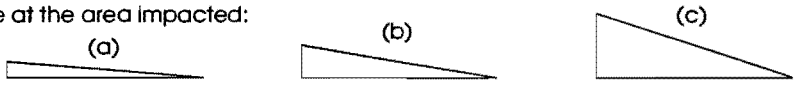
(illustration)



Estimated % of ground/canopy cov
- (●) 0% to 25%
- ( ) 25% to 75%
- ( ) 75% to 100%

Explanation: Sparse vegetative cover.

5. Steepest slope at the area impacted:



- ( ) Less than 10%
- (●) 10% to 30%
- ( ) 30% and greater

Explanation:

RUNOFF FACTORS

Y / N

☑ ☐ **6. Is there visible evidence of runoff discharging from site? If yes, answer a) - c) below:**

☑ ☐ 6a) Is runoff channelized? If yes, describ ( ) Man-made channel. (●) Natural channel.

Explanation: Erosion particularly noticeable along the fence line west of 16-010(a).

RUNOFF FACTORS, CONT'D

6b) Where does evidence of runoff terminate?

- ○ **Drainage or wetland (name)** Canon de Valle
- ○ **Within bench of canyon setting (name)**
- ◉ **Other (i.e., retention pond, meadow, mesa top)** Asphalt swale and road bed

Explanation: Majority of run-off from this site follows road bed down to Canyon de Valle.

Y / N

☑ ☐ 6c) Has runoff caused visible erosion at the site? If yes, explain below: ○ Sheet ◉ Rill ○ Gully

Explanation: Eroding down to tuff rock.

RUN-ON FACTORS

Please rate the potential for storm water to run on to this site: (Check EITHER #7 or #9)

☐ ☑ **7.** Are structures (i.e., buildings, roof drains, parking lots, storm drains) creating run-on to the site?

Explanation:

☐ ☑ **8.** Are current operations (i.e., fire hydrants, NPDES outfalls) adversely impacting run-on to the site?

Explanation:

☐ ☑ **9.** Are natural drainage patterns directing stormwater onto site?

Explanation:

ASSESSMENT FINDING:

☑ ☐ **10. Based on the above criteria and the assessment of this site, does soil erosion potential exist? (REFER TO EROSION POTENTIAL MATRIX.)**

R. Reynolds

11. Signature of Water Quality/Hydrology Representative

_____ Initials of independent reviewer.

Check here when information is entered in database: ☑

This page is for ESH-18 notes, recommendations, and photos.

	Y / N	
12. a)	○ ◉	Is there visible trash/debris on the site?
b)	○ ◉	Is there visible trash/debris in a watercourse?

Description of existing BMPs:

○	○	Are BMPs being properly maintained? If no, describe in "Other Internal Notes."
○	○	Are BMPs effectively keeping sediment in place and reducing erosion potential?

OTHER INTERNAL NOTES:

Los Alamos National Laboratory

Environment, Safety & Health Division
ESH-18 Water Quality & Hydrology Group

Surface Water Assessment
Erosion Matrix for PRS 16-016(c)

CRITERIA EVALUATED	Value	Erosion/Sediment Transport Potential Low 0.1	Medium 0.5	High 1.0	Calculated Score
Site Setting (43)					
On mesa top	1	Defined based on topographic setting			
Within bench of canyon	4				4.0
Within the canyon floodplain but not watercourse	13				
Within bottom of canyon channel in watercourse	17				
Estimated % ground and canopy cover	13	>75%	25-75%	<25%	13.0
Slope	13	0-10%	10-30%	>30%	13.0
Surface Water Factors-Run-off (46)					
Visible evidence of runoff discharging? (Yes/No)	5	If no, score of 0 for runoff section.			5.0
		If yes, score 5 and proceed with section.			
Where does runoff terminate?	19	Other	Bench Setting	Drainage/Wetland	19.0
Has runoff caused visible erosion? (Yes/No)	22	Sheet	Rill	Gully	11.0
		If no, score as 0. If yes, calculate as appropriate.			
Surface Water Factors-Run-on (11)					
Structures adversely affecting run-on (Yes/No)	7*	If yes, score as 7. If no, score as 0.			0.0
Current operations adversely impacting (Yes/No)	4	If yes, score as 4. If no, score as 0.			0.0
Natural drainages onto site (Yes/No)	7*	If yes, score as 7. If no, score as 0.			7.0
**Select either structures or natural drainages.*					
MAX. POSSIBLE EROSION MATRIX SCORE:	**100**			**Total Score**	72**

** Indicates BMPs in place. Erosion potential without BMPs may be greater.

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Los Alamos National Laboratory
SURFACE WATER
SITE ASSESSMENT

SITE INFORMATION

1a) PRS Number: 16-016(c) 1b) Structure Number: 1c) FMU Number: ER

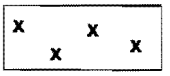
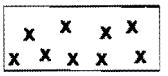
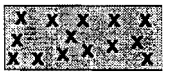
2. Date/Time (M/D/Y H:M am/pm): 1/12/1998

SITE SETTING (check all that apply)

3. (●) On mesa top (a). ( ) In the canyon floor, but not in an established channel (c)
   (●) Within a bench of a canyon (b). ( ) Within established channel in the canyon floor (d).

Explanation: PRS below flash pad area and west of MDA P. MDA P western access road passes through site towards Canon de Valle

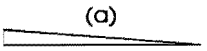
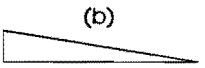
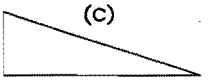
4. Estimated ground and/or canopy cover at site: (deciduous leaves, pine needles, rocks, vegetation, trees,

(illustration) (a)  (b)  (c) 

Estimated % of ground/canopy cov (●) 0% to 25% ( ) 25% to 75% ( ) 75% to 100%

Explanation: Loose tuff sediment

5. Steepest slope at the area impacted:

(a)  (b)  (c) 

( ) Less than 10% ( ) 10% to 30% (●) 30% and greater

Explanation: Road bed descends into canyon side.

RUNOFF FACTORS

Y / N

☑ ☐ **6. Is there visible evidence of runoff discharging from site? If yes, answer a) - c) below:**

☑ ☐ 6a) Is runoff channelized? If yes, describ (●) Man-made channel. ( ) Natural channel.

Explanation: Road is starting to wash out at switchback.

RUNOFF FACTORS, CONT'D

6b) Where does evidence of runoff terminate?

- (●) **Drainage or wetland (name)** Canon de Valle
- ( ) **Within bench of canyon setting (name)**
- ( ) **Other (i.e., retention pond, meadow, mesa top)**

Explanation: Wash outs along road discharge into the canyon bottom.

Y / N

☑ ☐ 6c) Has runoff caused visible erosion at the site? If yes, explain below: ( ) Sheet (●) Rill ( ) Gully

Explanation: Left hand side of road starting to wash out. Sheet flow at midway point.

RUN-ON FACTORS

Please rate the potential for storm water to run on to this site: (Check EITHER #7 or #9)

☐ ☑ **7.** Are structures (i.e., buildings, roof drains, parking lots, storm drains) creating run-on to the site?

Explanation:

☐ ☑ **8.** Are current operations (i.e., fire hydrants, NPDES outfalls) adversely impacting run-on to the site?

Explanation:

☑ ☐ **9.** Are natural drainage patterns directing stormwater onto site?

Explanation: Natural conveyance of SW run-off directed down middle of site.

ASSESSMENT FINDING:

☑ ☐ **10. Based on the above criteria and the assessment of this site, does soil erosion potential exist? (REFER TO EROSION POTENTIAL MATRIX.)**

R. Reynolds

11. Signature of Water Quality/Hydrology Representative

_____ Initials of independent reviewer.

Check here when information is entered in database: ☑

This page is for ESH-18 notes, recommendations, and photos.

	Y	N	
12. a)	○	◉	Is there visible trash/debris on the site?
b)	○	◉	Is there visible trash/debris in a watercourse?

Description of existing BMPs:

Site regrading has been performed to direct flow away from landfill. Outlet protection is provided at all upslope culverts, run-on diversion extends across the upper portion of site to direct flows always from landfill, straw bale barriers and vegetative buffers exist along the western access road.

○ ○ Are BMPs being properly maintained? If no, describe in "Other Internal Notes."

○ ○ Are BMPs effectively keeping sediment in place and reducing erosion potential?

OTHER INTERNAL NOTES:

Appendix C

Risk Assessment Information

Table C-1
Inorganic COPCs: Samples Greater than Background—Biological Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Aluminum	16-20195	0816-01-0206	8,540	Tuff	2–3
Aluminum	16-20323	0816-01-0039	10,200	Tuff	2–3
Aluminum	16-20295	0816-01-0072	13,300	Tuff	0–1
Aluminum	16-20105	0816-01-0027	14,400	Tuff	0–1
Aluminum	16-20223	0816-01-0083	17,400	Tuff	2–3
Aluminum	16-20223	0816-01-0082	32,700	Tuff	0–0.5
Antimony	16-20323	0816-01-0040	0.80 (UJ)	Tuff	0–0.5
Antimony	16-20376	0816-01-0232	0.82 (U)	Tuff	0–1
Antimony	16-20598	0816-01-0265	0.85 (UJ)	Tuff	0–1
Antimony	16-20706	0816-01-0323	0.86 (U)	Tuff	0–1
Antimony	16-20306	0816-01-0033	0.86 (U)	Tuff	0–1
Antimony	16-20511	0816-01-0100	0.87 (UJ)	Tuff	0–1
Antimony	16-20307	0816-01-0034	0.87 (U)	Tuff	0–1
Antimony	16-20598	0816-01-0266	0.88 (UJ)	Tuff	2–3
Antimony	16-20237	0816-01-0037	0.88 (U)	Tuff	0–1
Antimony	16-20323	0816-01-0039	0.89 (UJ)	Tuff	2–3
Antimony	16-20457	0816-01-0226	0.90 (UJ)	Tuff	0–1
Antimony	16-20334	0816-01-0235	0.91 (UJ)	Tuff	0–1
Antimony	16-20195	0816-01-0206	0.92 (U)	Tuff	2–3
Antimony	16-20223	0816-01-0083	0.93 (UJ)	Tuff	2–3
Antimony	16-20305	0816-01-0035	0.94 (U)	Tuff	0–1
Antimony	16-20457	0816-01-0227	0.95 (U)	Tuff	24–36
Antimony	16-20274	0816-01-0029	0.96 (U)	Tuff	0–1
Antimony	16-20223	0816-01-0082	0.97 (UJ)	Tuff	0–0.5
Antimony	16-20295	0816-01-0072	0.97 (UJ)	Tuff	0–1
Antimony	16-20419	0816-01-0244	0.98 (UJ)	Tuff	0–1
Antimony	16-20528	0816-01-0190	0.98 (U)	Tuff	0–1
Antimony	16-20273	0816-01-0032	0.99 (U)	Tuff	2–3
Antimony	16-20189	0816-01-0247	1.00 (UJ)	Tuff	2–3
Antimony	16-20198	0816-01-0114	1.00 (UJ)	Tuff	0–1
Antimony	16-20234	0816-01-0115	1.00 (UJ)	Tuff	0–1
Antimony	16-20269	0816-01-0061	1.00 (U)	Tuff	0–1
Antimony	16-20269	0816-01-0062	1.00 (U)	Tuff	2–3
Antimony	16-20273	0816-01-0031	1.00 (U)	Tuff	0–1
Antimony	16-20287	0816-01-0028	1.00 (U)	Tuff	0–1
Antimony	16-20330	0816-01-0110	1.00 (UJ)	Tuff	0–1
Antimony	16-20330	0816-01-0111	1.00 (UJ)	Tuff	2–3

Table C-1 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Antimony	16-20333	0816-01-0091	1.00 (UJ)	Tuff	0–1
Antimony	16-20333	0816-01-0093	1.00 (UJ)	Tuff	2–3
Antimony	16-20415	0816-01-0245	1.00 (UJ)	Tuff	0–1
Antimony	16-20416	0816-01-0246	1.00 (UJ)	Tuff	0–1
Antimony	16-20418	0816-01-0242	1.00 (UJ)	Tuff	0–1
Antimony	16-20418	0816-01-0243	1.00 (UJ)	Tuff	2–3
Antimony	16-20105	0816-01-0027	1.1 (U)	Tuff	0–1
Antimony	16-20121	0816-01-0097	1.1 (U)	Tuff	0–1
Antimony	16-20389	0816-01-0030	1.1 (U)	Tuff	0–1
Antimony	16-20193	0816-01-0059	1.10 (U)	Tuff	0–1
Antimony	16-20421	0816-01-0217	1.2 (J)	Tuff	0–1
Barium	16-20330	0816-01-0110	52	Tuff	0–1
Barium	16-20105	0816-01-0027	52.6	Tuff	0–1
Barium	16-20295	0816-01-0072	54.6 (J-)	Tuff	0–1
Barium	16-20195	0816-01-0206	69.8	Tuff	2–3
Barium	16-20270	0816-01-0138	71.1	Tuff	2–3
Barium	16-20242	RE16-02-44951	81.2	Tuff	0–1
Barium	16-20528	0816-01-0190	84	Tuff	0–1
Barium	16-20274	0816-01-0029	85.7	Tuff	0–1
Barium	16-20277	RE16-02-44953	105	Tuff	0–1
Barium	16-20278	RE16-02-44944	113	Tuff	0–1
Barium	16-20598	0816-01-0265	116	Tuff	0–1
Barium	16-20269	0816-01-0061	123	Tuff	0–1
Barium	16-20205	RE16-02-44945	136	Tuff	0–1
Barium	16-20205	RE16-02-44946	136	Tuff	0–1
Barium	16-20323	0816-01-0039	158	Tuff	2–3
Barium	16-20223	0816-01-0083	161 (J-)	Tuff	2–3
Barium	16-20386	0816-01-0360	196	Tuff	0–1
Barium	16-20323	0816-01-0040	201 (J)	Tuff	0–0.5
Barium	16-20234	0816-01-0115	263	Tuff	0–1
Barium	16-20197	0816-01-0120	264	Tuff	0–1
Barium	16-20692	0816-01-0086	266 (J-)	Tuff	0–1
Barium	16-20271	0816-01-0140	274	Tuff	0–1
Barium	16-20223	0816-01-0082	280 (J-)	Tuff	0–0.5
Barium	16-20198	0816-01-0114	326	Tuff	0–1
Barium	16-20334	0816-01-0235	335	Tuff	0–1
Barium	16-20278	0816-01-0359	342	Tuff	0–1
Barium	16-20270	0816-01-0136	376	Tuff	0–1

Table C-1 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Barium	16-20706	0816-01-0323	384	Tuff	0–1
Barium	16-20307	0816-01-0034	428	Tuff	0–1
Barium	16-20276	RE16-02-44952	439	Tuff	0–1
Barium	16-20206	RE16-02-44950	463	Tuff	0–1
Barium	16-20305	0816-01-0035	606	Tuff	0–1
Barium	16-20233	0816-01-0122	640	Tuff	2–3
Barium	16-20457	0816-01-0226	652	Tuff	0–1
Barium	16-20233	0816-01-0121	674	Tuff	0–1
Barium	16-20419	0816-01-0244	686 (J)	Tuff	0–1
Barium	16-20418	0816-01-0243	840 (J)	Tuff	2–3
Barium	16-20418	0816-01-0242	996 (J)	Tuff	0–1
Barium	16-20241	0816-01-0357	1,030	Tuff	0–1
Barium	16-20189	0816-01-0147	1,040	Tuff	0–1
Barium	16-20189	0816-01-0148	1,160	Tuff	2–3
Barium	16-20599	RE16-02-45443	1,170 (J-)	Tuff	0–1
Barium	16-20196	0816-01-0130	1,250	Tuff	0–1
Barium	16-20306	0816-01-0033	1,310	Tuff	0–1
Barium	16-20189	0816-01-0247	1,400 (J)	Tuff	2–3
Barium	16-20670	RE16-02-45436	2,920 (J-)	Tuff	0–1
Barium	16-20002	0816-01-0294	310	Soil	0–0.5
Barium	16-20694	0816-01-0253	323	Soil	2–3
Barium	16-20195	0816-01-0205	335 (J)	Soil	0–1
Barium	16-20262	0816-01-0105	354	Soil	0–1
Barium	16-20268	RE16-02-45437	358 (J-)	Soil	0–1
Barium	16-20191	0816-01-0046	394	Soil	0–1
Barium	16-20300	0816-01-0187	398 (J+)	Soil	2–3
Barium	16-20174	0816-01-0047	473	Soil	0–1
Barium	16-20694	0816-01-0058	473	Soil	0–1
Barium	16-20376	0816-01-0164	513 (J+)	Soil	0–1
Barium	16-20238	RE16-02-44948	527	Soil	0–1
Barium	16-20004	0816-01-0293	558	Soil	0–0.5
Barium	16-20348	0816-01-0214	588	Soil	0–1
Barium	16-20314	0816-01-0354	651	Soil	0–1
Barium	16-20304	0816-01-0036	696	Soil	0–1
Barium	16-20153	0816-01-0262	789 (J+)	Soil	0–1
Barium	16-20265	0816-01-0107	921	Soil	0–1
Barium	16-20342	0816-01-0180	983	Soil	0–1
Barium	16-20340	0816-01-0176	1,060	Soil	2–3

Table C-1 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Barium	16-20549	0816-01-0215	1,320	Soil	0–1
Barium	16-20742	RE16-02-45441	1,440	Soil	2–3
Barium	16-20742	RE16-02-45442	1,540 (J-)	Soil	2–3
Barium	16-20351	0816-01-0050	1,540	Soil	0–1
Barium	16-20387	0816-01-0161	1,730	Soil	0–1
Barium	16-20240	0816-01-0352	1,700	Soil	0–1
Barium	16-20742	RE16-02-45439	2,750 (J-)	Soil	0–1
Barium	16-20232	RE16-02-45438	3,850 (J-)	Soil	0–1
Barium	16-20006	0816-01-0289	6,630	Soil	0–0.5
Chromium	16-20457	0816-01-0226	7.3 (J)	Tuff	0–1
Chromium	16-20670	RE16-02-45436	7.5	Tuff	0–1
Chromium	16-20105	0816-01-0027	7.9	Tuff	0–1
Chromium	16-20121	0816-01-0097	8.2	Tuff	0–1
Chromium	16-20223	0816-01-0083	10	Tuff	2–3
Chromium	16-20376	0816-01-0232	10.1 (J)	Tuff	0–1
Chromium	16-20295	0816-01-0072	12.1	Tuff	0–1
Chromium	16-20223	0816-01-0082	15.6	Tuff	0–0.5
Cobalt	16-20189	0816-01-0247	3.3 (J)	Tuff	2–3
Cobalt	16-20599	RE16-02-45443	3.7	Tuff	0–1
Cobalt	16-20457	0816-01-0226	3.7 (J)	Tuff	0–1
Cobalt	16-20223	0816-01-0082	4.1 (J)	Tuff	0–0.5
Cobalt	16-20105	0816-01-0027	4.4 (J)	Tuff	0–1
Cobalt	16-20205	RE16-02-44945	5.6 (J-)	Tuff	0–1
Cobalt	16-20205	RE16-02-44946	5.9 (J-)	Tuff	0–1
Cobalt	16-20204	RE16-02-44943	21.7 (J-)	Tuff	0–1
Cobalt	16-20242	RE16-02-44951	41.3 (J-)	Tuff	0–1
Cobalt	16-20742	RE16-02-45441	25.0	Soil	2–3
Copper	16-20273	RE16-02-46406	5.0 (J)	Tuff	42.4–42.9
Copper	16-20189	0816-01-0148	5.2	Tuff	2–3
Copper	16-20323	0816-01-0039	5.4	Tuff	2–3
Copper	16-20242	RE16-02-44951	5.5	Tuff	0–1
Copper	16-20233	0816-01-0122	5.7	Tuff	2–3
Copper	16-20223	0816-01-0083	6.7	Tuff	2–3
Copper	16-20295	0816-01-0072	7.4	Tuff	0–1
Copper	16-20599	RE16-02-45443	8.5	Tuff	0–1
Copper	16-20305	0816-01-0035	10.4	Tuff	0–1
Copper	16-20223	0816-01-0082	10.5	Tuff	0–0.5
Copper	16-20196	0816-01-0130	11.2	Tuff	0–1

Table C-1 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Copper	16-20274	0816-01-0029	16.2	Tuff	0–1
Copper	16-20306	0816-01-0033	19.4	Tuff	0–1
Copper	16-20376	0816-01-0232	22.2	Tuff	0–1
Copper	16-20105	0816-01-0027	22.8	Tuff	0–1
Copper	16-20670	RE16-02-45436	23.4	Tuff	0–1
Copper	16-20307	0816-01-0034	25.5	Tuff	0–1
Copper	16-20334	0816-01-0235	25.6	Tuff	0–1
Copper	16-20237	0816-01-0037	32.4	Tuff	0–1
Copper	16-20694	0816-01-0253	18.8	Soil	2–3
Copper	16-20387	0816-01-0161	20.70	Soil	0–1
Copper	16-20340	0816-01-0176	21.8 (J)	Soil	2–3
Copper	16-20232	RE16-02-45438	28.9	Soil	0–1
Copper	16-20124	0816-01-0063	29.40	Soil	0–1
Copper	16-20304	0816-01-0036	36.80	Soil	0–1
Iron	16-20105	0816-01-0027	15,300	Tuff	0–1
Iron	16-20223	0816-01-0083	16,900	Tuff	2–3
Iron	16-20295	0816-01-0072	17,200	Tuff	0–1
Iron	16-20223	0816-01-0082	22,500	Tuff	0–0.5
Lead	16-20273	0816-01-0032	13.20	Tuff	2–3
Lead	16-20196	0816-01-0130	13.50	Tuff	0–1
Lead	16-20274	0816-01-0029	19.40	Tuff	0–1
Lead	16-20223	0816-01-0082	19.70	Tuff	0–0.5
Lead	16-20306	0816-01-0033	22.20	Tuff	0–1
Lead	16-20237	0816-01-0037	23.50	Tuff	0–1
Lead	16-20670	RE16-02-45436	24.10	Tuff	0–1
Lead	16-20105	0816-01-0027	24.20	Tuff	0–1
Nickel	16-20274	0816-01-0029	7.2	Tuff	0–1
Nickel	16-20307	0816-01-0034	7.3	Tuff	0–1
Nickel	16-20223	0816-01-0083	8.3	Tuff	2–3
Nickel	16-20376	0816-01-0232	8.8	Tuff	0–1
Nickel	16-20237	0816-01-0037	8.9	Tuff	0–1
Nickel	16-20105	0816-01-0027	10.3	Tuff	0–1
Nickel	16-20295	0816-01-0072	11.3	Tuff	0–1
Nickel	16-20223	0816-01-0082	12.6	Tuff	0–0.5
Selenium	16-20323	0816-01-0039	0.32 (U)	Tuff	2–3
Selenium	16-20273	RE16-02-45791	0.33	Tuff	0.9–1.7
Selenium	16-20277	RE16-02-44953	0.33	Tuff	0–1
Selenium	16-20278	RE16-02-44944	0.33	Tuff	0–1

Table C-1 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Selenium	16-20269	0816-01-0061	0.33 (U)	Tuff	0–1
Selenium	16-20306	0816-01-0033	0.34 (J)	Tuff	0–1
Selenium	16-20241	0816-01-0357	0.35	Tuff	0–1
Selenium	16-20189	0816-01-0247	0.35 (J-)	Tuff	2–3
Selenium	16-20457	0816-01-0227	0.35 (J-)	Tuff	24–36
Selenium	16-20237	0816-01-0037	0.37 (J)	Tuff	0–1
Selenium	16-20389	0816-01-0030	0.37 (J)	Tuff	0–1
Selenium	16-20334	0816-01-0235	0.41 (J-)	Tuff	0–1
Selenium	16-20121	0816-01-0097	0.44 (J)	Tuff	0–1
Selenium	16-20274	0816-01-0029	0.44 (J)	Tuff	0–1
Selenium	16-20287	0816-01-0028	0.46 (J)	Tuff	0–1
Selenium	16-20376	0816-01-0232	0.47 (J-)	Tuff	0–1
Selenium	16-20598	0816-01-0265	0.48 (J-)	Tuff	0–1
Selenium	16-20528	0816-01-0190	0.50 (J-)	Tuff	0–1
Selenium	16-20457	0816-01-0226	0.53 (J-)	Tuff	0–1
Selenium	16-20305	0816-01-0035	0.54 (J)	Tuff	0–1
Selenium	16-20233	0816-01-0121	0.64 (J)	Tuff	0–1
Selenium	16-20273	0816-01-0032	0.74	Tuff	2–3
Selenium	16-20307	0816-01-0034	0.74	Tuff	0–1
Silver	16-20348	0816-01-0214	1.1 (U)	Soil	0–1
Silver	16-20549	0816-01-0215	1.1 (U)	Soil	0–1
Silver	16-20240	0816-01-0352	1.10	Soil	0–1
Silver	16-20232	RE16-02-45438	1.60	Soil	0–1
Silver	16-20742	RE16-02-45439	7.80	Soil	0–1
Silver	16-20566	0816-01-0213	1.2 (U)	Soil	0–1
Silver	16-20351	0816-01-0050	1.5	Soil	0–1
Silver	16-20387	0816-01-0161	1.5	Soil	0–1
Silver	16-20742	RE16-02-45442	15.8	Soil	2–3
Silver	16-20742	RE16-02-45441	9.7	Soil	2–3
Vanadium	16-20223	0816-01-0083	18.2	Tuff	2–3
Vanadium	16-20223	0816-01-0082	26.4	Tuff	0–0.5

Note: Shaded cells indicate samples from SWMU 16-016(c)-99.

Table C-2
Inorganic COPCs: Samples Greater than Background—Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Aluminum	16-20490	0816-01-0198	7,560	0–1
Aluminum	16-20667	0816-01-0197	7,610	0–1
Aluminum	16-20695	0816-01-0048	7,870	0–1
Aluminum	16-20513	0816-01-0096	8,350	0–1
Aluminum	16-20628	0816-01-0332	8,370	0–1
Aluminum	16-20698	0816-01-0071	8,450	0–1
Aluminum	16-20702	0816-01-0074	9,020	0–1
Aluminum	16-20658	0816-01-0209	9,190	0–1
Aluminum	16-20441	0816-01-0129	9,740	0–1
Aluminum	16-20702	0816-01-0076	9,780	2–3
Aluminum	16-20660	0816-01-0193	9,910	0–1
Aluminum	16-20622	0816-01-0211	10,400	0–1
Aluminum	16-20474	0816-01-0069	10,400	2–3
Aluminum	16-20404	0816-01-0128	10,400	0–1
Aluminum	16-20454	0816-01-0307	10,600	0–1
Aluminum	16-20375	0816-01-0178	11,000	7–8
Aluminum	16-20337	0816-01-0170	11,800	0–1
Aluminum	16-20474	0816-01-0067	12,100	0–0.5
Aluminum	16-20444	0816-01-0231	12,700	0–1
Aluminum	16-20373	0816-01-0304	13,400	0–1
Aluminum	16-20337	0816-01-0171	13,500	4–5
Aluminum	16-20491	0816-01-0194	13,500	0–1
Aluminum	16-20375	0816-01-0177	15,200	5–6
Aluminum	16-20592	0816-01-0248	16,800	0–1
Aluminum	16-20370	0816-01-0237	17,400	0–1
Aluminum	16-20337	0816-01-0172	28,100	5–6
Antimony	16-20491	0816-01-0194	0.52 (J)	0–1
Antimony	16-20526	0816-01-0324	0.79 (U)	37.3–38.3
Antimony	16-20526	0816-01-0325	0.79 (U)	27.3–28.3
Antimony	16-20526	0816-01-0326	0.79 (U)	53.5–54.5
Antimony	16-20557	0816-01-0327	0.79 (U)	18.7–19.6
Antimony	16-20557	0816-01-0329	0.79 (U)	52.6–53.6
Antimony	16-20557	0816-01-0334	0.79 (U)	11.7–12.6
Antimony	16-20557	0816-01-0333	0.79 (U)	36.7–37.4
Antimony	16-20557	0816-01-0328	0.80 (U)	66–67
Antimony	16-20557	0816-01-0299	0.83 (U)	2–3
Antimony	16-20595	0816-01-0263	0.83 (UJ)	0–1

Table C-2 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Antimony	16-20596	0816-01-0259	0.83 (UJ)	0–1
Antimony	16-20373	0816-01-0234	0.83 (U)	0–1
Antimony	16-20374	0816-01-0233	0.83 (U)	0–1
Antimony	16-20513	0816-01-0096	0.83 (UJ)	0–1
Antimony	16-20553	0816-01-0300	0.85 (U)	0–1
Antimony	16-20557	0816-01-0298	0.85 (U)	0–1
Antimony	16-20557	0816-01-0302	0.85 (U)	0–1
Antimony	16-20557	0816-01-0303	0.85 (U)	2–3
Antimony	16-20664	0816-01-0309	0.85 (U)	0–1
Antimony	16-20335	0816-01-0236	0.85 (UJ)	0–1
Antimony	16-20630	0816-01-0330	0.85 (U)	0–1
Antimony	16-20661	0816-01-0251	0.85 (UJ)	2–3
Antimony	16-20665	0816-01-0261	0.85 (U)	0–1
Antimony	16-20562	0816-01-0088	0.86 (UJ)	2–3
Antimony	16-20662	0816-01-0313	0.86 (U)	0–1
Antimony	16-20444	0816-01-0231	0.86 (U)	0–1
Antimony	16-20700	0816-01-0049	0.87 (UJ)	0–1
Antimony	16-20514	0816-01-0103	0.87 (UJ)	0–1
Antimony	16-20561	0816-01-0098	0.87 (UJ)	0–1
Antimony	16-20562	0816-01-0087	0.87 (UJ)	0–1
Antimony	16-20591	0816-01-0318	0.87 (U)	0–1
Antimony	16-20372	0816-01-0230	0.87 (U)	0–1
Antimony	16-20667	0816-01-0197	0.87 (U)	0–1
Antimony	16-20699	0816-01-0057	0.88 (UJ)	0–1
Antimony	16-20558	0816-01-0102	0.88 (UJ)	0–1
Antimony	16-20663	0816-01-0311	0.88 (U)	0–1
Antimony	16-20736	0816-01-0090	0.88 (UJ)	0–1
Antimony	16-20527	0816-01-0191	0.88 (U)	0–1
Antimony	16-20592	0816-01-0248	0.88 (UJ)	0–1
Antimony	16-20632	0816-01-0308	0.88 (U)	0–1
Antimony	16-20702	0816-01-0255	0.88 (UJ)	0–1
Antimony	16-20702	0816-01-0257	0.88 (UJ)	4–5
Antimony	16-20590	0816-01-0316	0.89 (U)	0–1
Antimony	16-20626	0816-01-0312	0.89 (U)	0–1
Antimony	16-20662	0816-01-0314	0.89 (U)	2–3
Antimony	16-20370	0816-01-0237	0.89 (UJ)	0–1
Antimony	16-20696	0816-01-0066	0.90 (U)	0–1
Antimony	16-20551	0816-01-0306	0.90 (U)	0–1
Antimony	16-20590	0816-01-0317	0.90 (U)	2–3

Table C-2 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Antimony	16-20624	0816-01-0322	0.90 (U)	0–1
Antimony	16-20625	0816-01-0321	0.90 (U)	2–3
Antimony	16-20669	0816-01-0315	0.90 (U)	0–1
Antimony	16-20702	0816-01-0076	0.90 (UJ)	2–3
Antimony	16-20442	0816-01-0228	0.90 (U)	0–1
Antimony	16-20477	0816-01-0095	0.90 (UJ)	0–1
Antimony	16-20555	0816-01-0101	0.91 (UJ)	0–1
Antimony	16-20629	0816-01-0319	0.91 (U)	0–1
Antimony	16-20698	0816-01-0071	0.91 (UJ)	0–1
Antimony	16-20702	0816-01-0074	0.91 (UJ)	0–1
Antimony	16-20741	0816-01-0250	0.91 (U)	2–3
Antimony	16-20695	0816-01-0048	0.92 (UJ)	0–1
Antimony	16-20697	0816-01-0051	0.92 (UJ)	0–1
Antimony	16-20515	0816-01-0104	0.92 (UJ)	0–1
Antimony	16-20517	0816-01-0099	0.92 (UJ)	0–1
Antimony	16-20661	0816-01-0252	0.92 (UJ)	6–7
Antimony	16-20474	0816-01-0069	0.93 (U)	2–3
Antimony	16-20516	0816-01-0295	0.93 (U)	0–1
Antimony	16-20516	0816-01-0112	0.93 (UJ)	0–1
Antimony	16-20371	0816-01-0229	0.93 (U)	0–1
Antimony	16-20474	0816-01-0067	0.94 (U)	0–0.5
Antimony	16-20446	0816-01-0203	0.94 (U)	0–1
Antimony	16-20489	0816-01-0200	0.94 (U)	2–3
Antimony	16-20525	0816-01-0189	0.94 (U)	0–1
Antimony	16-20484	0816-01-0201	0.95 (U)	0–1
Antimony	16-20625	0816-01-0320	0.96 (U)	0–1
Antimony	16-20453	0816-01-0223	0.96 (U)	0–1
Antimony	16-20446	0816-01-0204	0.97 (U)	2–3
Antimony	16-20454	0816-01-0307	0.97 (U)	0–1
Antimony	16-20455	0816-01-0207	0.97 (U)	0–1
Antimony	16-20408	0816-01-0238	0.98 (UJ)	0–1
Antimony	16-20449	0816-01-0219	0.98 (U)	0–1
Antimony	16-20485	0816-01-0202	0.98 (U)	0–1
Antimony	16-20489	0816-01-0199	0.98 (U)	0–1
Antimony	16-20490	0816-01-0192	0.98 (U)	0–1
Antimony	16-20490	0816-01-0198	0.98 (U)	0–1
Antimony	16-20414	0816-01-0221	0.99 (U)	0–1
Antimony	16-20447	0816-01-0220	0.99 (U)	0–1
Antimony	16-20479	0816-01-0113	0.99 (UJ)	0–1

Table C-2 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Antimony	16-20413	0816-01-0305	1.00 (U)	0–1
Antimony	16-20373	0816-01-0304	1.00 (U)	0–1
Antimony	16-20409	0816-01-0239	1.00 (UJ)	0–1
Antimony	16-20411	0816-01-0241	1.00 (UJ)	0–1
Antimony	16-20451	0816-01-0224	1.00 (U)	0–1
Antimony	16-20452	0816-01-0222	1.00 (U)	0–1
Antimony	16-20586	0816-01-0208	1.10 (U)	0–1
Antimony	16-20658	0816-01-0209	1.20 (U)	0–1
Antimony	16-20413	0816-01-0216	1.30 (U)	0–1
Antimony	16-20628	0816-01-0332	1.4	0–1
Antimony	16-20741	0816-01-0249	2.7 (J-)	5–6
Barium	16-20661	0816-01-0252	47.6	6–7
Barium	16-20478	0816-01-0152	50.3	2–3
Barium	16-20486	0816-01-0212	57.2	0–1
Barium	16-20700	0816-01-0049	59.1	0–1
Barium	16-20527	0816-01-0191	60.5	0–1
Barium	16-20585	0816-01-0132	68.9	0–1
Barium	16-20444	0816-01-0231	71.3	0–1
Barium	16-20595	0816-01-0263	74.7	0–1
Barium	16-20373	0816-01-0304	76.1	0–1
Barium	16-20375	0816-01-0178	94.3	7–8
Barium	16-20562	0816-01-0087	106 (J-)	0–1
Barium	16-20487	0816-01-0154	112	0–1
Barium	16-20699	0816-01-0057	124	0–1
Barium	16-20337	0816-01-0170	131	0–1
Barium	16-20660	0816-01-0193	140	0–1
Barium	16-20474	0816-01-0069	152	2–3
Barium	16-20337	0816-01-0172	155	5–6
Barium	16-20622	0816-01-0211	159	0–1
Barium	16-20515	0816-01-0104	163	0–1
Barium	16-20661	0816-01-0251	171	2–3
Barium	16-20370	0816-01-0237	179 (J)	0–1
Barium	16-20696	0816-01-0066	191	0–1
Barium	16-20695	0816-01-0048	192	0–1
Barium	16-20474	0816-01-0067	200	0–0.5
Barium	16-20702	0816-01-0076	212 (J-)	2–3
Barium	16-20658	0816-01-0209	231	0–1
Barium	16-20702	0816-01-0257	261	4–5
Barium	16-20557	0816-01-0299	277 (J+)	2–3

Table C-2 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Barium	16-20375	0816-01-0177	280	5–6
Barium	16-20523	0816-01-0165	285	0–1
Barium	16-20557	0816-01-0303	295	2–3
Barium	16-20404	0816-01-0128	297	0–1
Barium	16-20559	0816-01-0118	315	0–1
Barium	16-20586	0816-01-0208	336	0–1
Barium	16-20667	0816-01-0197	374 (J+)	0–1
Barium	16-20479	0816-01-0113	387	0–1
Barium	16-20557	0816-01-0333	406	36.7–37.4
Barium	16-20629	0816-01-0319	408 (J+)	0–1
Barium	16-20526	0816-01-0326	413	53.5–54.5
Barium	16-20337	0816-01-0171	413	4–5
Barium	16-20441	0816-01-0129	415	0–1
Barium	16-20697	0816-01-0051	441	0–1
Barium	16-20478	0816-01-0151	445	0–1
Barium	16-20698	0816-01-0071	446 (J-)	0–1
Barium	16-20557	0816-01-0298	487 (J+)	0–1
Barium	16-20558	0816-01-0102	489	0–1
Barium	16-20736	0816-01-0090	493	0–1
Barium	16-20488	0816-01-0157	544	0–1
Barium	16-20557	0816-01-0302	552	0–1
Barium	16-20560	0816-01-0141	571	0–1
Barium	16-20741	0816-01-0250	582	2–3
Barium	16-20524	0816-01-0159	587	0–1
Barium	16-20561	0816-01-0098	646	0–1
Barium	16-20702	0816-01-0074	682 (J-)	0–1
Barium	16-20557	0816-01-0327	715	18.7–19.6
Barium	16-20557	0816-01-0334	773	11.7–12.6
Barium	16-20335	0816-01-0236	860 (J)	0–1
Barium	16-20489	0816-01-0199	865	0–1
Barium	16-20489	0816-01-0200	880	2–3
Barium	16-20455	0816-01-0207	1,100	0–1
Barium	16-20741	0816-01-0249	1,110	5–6
Barium	16-20477	0816-01-0095	1,200	0–1
Barium	16-20454	0816-01-0218	1,240	0–1
Barium	16-20453	0816-01-0223	1,240	0–1
Barium	16-20513	0816-01-0096	1,390	0–1
Barium	16-20628	0816-01-0332	1,430 (J+)	0–1
Barium	16-20522	0816-01-0160	1,480	0–1

Table C-2 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Barium	16-20702	0816-01-0255	1,590	0–1
Barium	16-20490	0816-01-0192	1,720	0–1
Barium	16-20525	0816-01-0189	1,790	0–1
Barium	16-20526	0816-01-0195	1,800	0–1
Barium	16-20442	0816-01-0228	1,900	0–1
Barium	16-20490	0816-01-0198	1,980	0–1
Barium	16-20371	0816-01-0229	2,060	0–1
Barium	16-20551	0816-01-0306	2,110	0–1
Barium	16-20630	0816-01-0330	2,120 (J+)	0–1
Barium	16-20592	0816-01-0248	2,430	0–1
Barium	16-20491	0816-01-0194	2,980	0–1
Barium	16-20454	0816-01-0307	6,980	0–1
Beryllium	16-20526	0816-01-0325	1.3	27.3–28.3
Beryllium	16-20702	0816-01-0076	1.3	2–3
Beryllium	16-20446	0816-01-0203	1.3	0–1
Beryllium	16-20592	0816-01-0248	1.3	0–1
Beryllium	16-20337	0816-01-0172	1.4	5–6
Beryllium	16-20454	0816-01-0307	1.4	0–1
Beryllium	16-20490	0816-01-0198	1.4	0–1
Beryllium	16-20518	0816-01-0126	1.4	0–1
Beryllium	16-20520	0816-01-0123	1.4	0–1
Beryllium	16-20526	0816-01-0195	1.4	0–1
Beryllium	16-20526	0816-01-0196	1.4	2–3
Beryllium	16-20371	0816-01-0229	1.6	0–1
Beryllium	16-20478	0816-01-0151	1.6	0–1
Beryllium	16-20490	0816-01-0192	1.7	0–1
Beryllium	16-20521	0816-01-0124	1.7	0–1
Beryllium	16-20516	0816-01-0295	1.8	0–1
Beryllium	16-20486	0816-01-0212	1.9	0–1
Beryllium	16-20516	0816-01-0112	1.9	0–1
Beryllium	16-20491	0816-01-0194	2.0	0–1
Beryllium	16-20519	0816-01-0158	2.0	0–1
Beryllium	16-20560	0816-01-0141	2.2	0–1
Beryllium	16-20370	0816-01-0237	2.4	0–1
Beryllium	16-20482	0816-01-0155	2.4	0–1
Beryllium	16-20444	0816-01-0231	3.1	0–1
Beryllium	16-20481	0816-01-0149	3.1	0–1
Beryllium	16-20373	0816-01-0304	3.3	0–1
Chromium	16-20375	0816-01-0178	7.3 (J)	7–8

Table C-2 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Chromium	16-20371	0816-01-0229	7.5 (J)	0–1
Chromium	16-20658	0816-01-0209	7.6	0–1
Chromium	16-20441	0816-01-0129	7.9	0–1
Chromium	16-20444	0816-01-0231	8.0 (J)	0–1
Chromium	16-20698	0816-01-0071	8.0	0–1
Chromium	16-20474	0816-01-0069	8.1	2–3
Chromium	16-20628	0816-01-0332	8.1	0–1
Chromium	16-20622	0816-01-0211	8.2	0–1
Chromium	16-20337	0816-01-0170	8.5 (J)	0–1
Chromium	16-20700	0816-01-0049	8.9	0–1
Chromium	16-20491	0816-01-0194	9.1	0–1
Chromium	16-20370	0816-01-0237	9.2	0–1
Chromium	16-20474	0816-01-0067	9.3	0–0.5
Chromium	16-20490	0816-01-0198	9.3	0–1
Chromium	16-20486	0816-01-0212	9.5	0–1
Chromium	16-20375	0816-01-0177	10.1 (J)	5–6
Chromium	16-20337	0816-01-0171	10.4 (J)	4–5
Chromium	16-20592	0816-01-0248	10.8	0–1
Chromium	16-20413	0816-01-0305	11.9	0–1
Chromium	16-20373	0816-01-0304	14.4	0–1
Chromium	16-20736	0816-01-0090	17.4	0–1
Chromium	16-20337	0816-01-0172	18.7 (J)	5–6
Cobalt	16-20478	0816-01-0152	3.2 (J)	2–3
Cobalt	16-20474	0816-01-0069	3.5 (J)	2–3
Cobalt	16-20557	0816-01-0302	3.5 (J)	0–1
Cobalt	16-20453	0816-01-0223	3.5 (J)	0–1
Cobalt	16-20526	0816-01-0195	3.5 (J)	0–1
Cobalt	16-20700	0816-01-0049	3.6 (J)	0–1
Cobalt	16-20525	0816-01-0189	3.6 (J)	0–1
Cobalt	16-20665	0816-01-0261	3.6 (J)	0–1
Cobalt	16-20441	0816-01-0129	3.7 (J)	0–1
Cobalt	16-20697	0816-01-0051	3.7 (J)	0–1
Cobalt	16-20669	0816-01-0315	3.7 (J)	0–1
Cobalt	16-20477	0816-01-0095	3.7 (J)	0–1
Cobalt	16-20699	0816-01-0057	3.8 (J)	0–1
Cobalt	16-20702	0816-01-0257	3.8 (J)	4–5
Cobalt	16-20736	0816-01-0090	3.9 (J)	0–1
Cobalt	16-20413	0816-01-0305	4.0 (J)	0–1
Cobalt	16-20490	0816-01-0192	4.0 (J)	0–1

Table C-2 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Cobalt	16-20741	0816-01-0249	4.0 (J)	5–6
Cobalt	16-20658	0816-01-0209	4.1 (J)	0–1
Cobalt	16-20696	0816-01-0066	4.1 (J)	0–1
Cobalt	16-20375	0816-01-0177	4.1 (J)	5–6
Cobalt	16-20695	0816-01-0048	4.2 (J)	0–1
Cobalt	16-20661	0816-01-0252	4.2 (J)	6–7
Cobalt	16-20741	0816-01-0250	4.2 (J)	2–3
Cobalt	16-20486	0816-01-0212	4.5 (J)	0–1
Cobalt	16-20660	0816-01-0193	4.7 (J)	0–1
Cobalt	16-20375	0816-01-0178	4.7 (J)	7–8
Cobalt	16-20698	0816-01-0071	4.8 (J)	0–1
Cobalt	16-20513	0816-01-0096	4.9 (J)	0–1
Cobalt	16-20442	0816-01-0228	5.0 (J)	0–1
Cobalt	16-20661	0816-01-0251	5.1 (J)	2–3
Cobalt	16-20702	0816-01-0074	5.1 (J)	0–1
Cobalt	16-20371	0816-01-0229	5.3 (J)	0–1
Cobalt	16-20491	0816-01-0194	5.3 (J)	0–1
Cobalt	16-20337	0816-01-0172	5.4 (J)	5–6
Cobalt	16-20702	0816-01-0255	5.5 (J)	0–1
Cobalt	16-20474	0816-01-0067	5.8 (J)	0–0.5
Cobalt	16-20551	0816-01-0306	5.8	0–1
Cobalt	16-20337	0816-01-0170	5.9 (J)	0–1
Cobalt	16-20490	0816-01-0198	5.9 (J)	0–1
Cobalt	16-20702	0816-01-0076	6.1	2–3
Cobalt	16-20622	0816-01-0211	6.4	0–1
Cobalt	16-20628	0816-01-0332	6.5	0–1
Cobalt	16-20630	0816-01-0330	6.6	0–1
Cobalt	16-20337	0816-01-0171	7.2 (J)	4–5
Cobalt	16-20373	0816-01-0304	8.1	0–1
Cobalt	16-20592	0816-01-0248	8.2	0–1
Cobalt	16-20664	0816-01-0309	8.5	0–1
Cobalt	16-20629	0816-01-0319	10.5	0–1
Cobalt	16-20404	0816-01-0128	11.0	0–1
Cobalt	16-20625	0816-01-0320	30.2	0–1
Cobalt	16-20662	0816-01-0314	66.8	2–3
Cobalt	16-20454	0816-01-0307	151	0–1
Copper	16-20524	0816-01-0159	4.8	0–1
Copper	16-20696	0816-01-0066	4.9	0–1
Copper	16-20560	0816-01-0141	4.9	0–1

Table C-2 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Copper	16-20490	0816-01-0192	4.9	0–1
Copper	16-20441	0816-01-0129	5.0	0–1
Copper	16-20454	0816-01-0307	5.0	0–1
Copper	16-20586	0816-01-0208	5.1	0–1
Copper	16-20516	0816-01-0112	5.2 (J)	0–1
Copper	16-20695	0816-01-0048	5.2	0–1
Copper	16-20702	0816-01-0257	5.2	4–5
Copper	16-20518	0816-01-0126	5.5	0–1
Copper	16-20481	0816-01-0149	5.6	0–1
Copper	16-20667	0816-01-0197	5.6	0–1
Copper	16-20622	0816-01-0211	5.8	0–1
Copper	16-20702	0816-01-0076	5.9	2–3
Copper	16-20404	0816-01-0128	5.9	0–1
Copper	16-20482	0816-01-0155	5.9	0–1
Copper	16-20490	0816-01-0198	5.9	0–1
Copper	16-20486	0816-01-0212	6.0	0–1
Copper	16-20516	0816-01-0295	6.0	0–1
Copper	16-20371	0816-01-0229	6.0	0–1
Copper	16-20658	0816-01-0209	6.1	0–1
Copper	16-20736	0816-01-0090	6.1	0–1
Copper	16-20373	0816-01-0304	6.1	0–1
Copper	16-20474	0816-01-0069	6.4	2–3
Copper	16-20660	0816-01-0193	6.4	0–1
Copper	16-20520	0816-01-0123	6.5	0–1
Copper	16-20702	0816-01-0255	6.5	0–1
Copper	16-20408	0816-01-0238	6.6	0–1
Copper	16-20477	0816-01-0095	6.8	0–1
Copper	16-20372	0816-01-0230	7.0	0–1
Copper	16-20491	0816-01-0194	7.1	0–1
Copper	16-20474	0816-01-0067	7.2	0–0.5
Copper	16-20698	0816-01-0071	7.2	0–1
Copper	16-20702	0816-01-0074	7.2	0–1
Copper	16-20454	0816-01-0218	7.4	0–1
Copper	16-20526	0816-01-0326	7.8	53.5–54.5
Copper	16-20526	0816-01-0324	7.9	37.3–38.3
Copper	16-20375	0816-01-0177	8.0 (J)	5–6
Copper	16-20526	0816-01-0325	8.1	27.3–28.3
Copper	16-20741	0816-01-0249	8.1	5–6
Copper	16-20697	0816-01-0051	8.5	0–1

Table C-2 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Copper	16-20513	0816-01-0096	8.6	0–1
Copper	16-20526	0816-01-0195	8.7	0–1
Copper	16-20337	0816-01-0171	9.0 (J)	4–5
Copper	16-20337	0816-01-0172	10.8 (J)	5–6
Copper	16-20551	0816-01-0306	12.0	0–1
Copper	16-20444	0816-01-0231	12.2	0–1
Copper	16-20557	0816-01-0327	13.0	18.7–19.6
Copper	16-20630	0816-01-0330	15.2	0–1
Copper	16-20592	0816-01-0248	17.4	0–1
Copper	16-20374	0816-01-0233	20.5	0–1
Copper	16-20373	0816-01-0234	24.2	0–1
Copper	16-20335	0816-01-0236	24.4	0–1
Copper	16-20370	0816-01-0237	29.5	0–1
Copper	16-20442	0816-01-0228	32.3	0–1
Copper	16-20628	0816-01-0332	34.0	0–1
Iron	16-20486	0816-01-0212	14,600	0–1
Iron	16-20592	0816-01-0248	14,800	0–1
Iron	16-20413	0816-01-0305	14,900	0–1
Iron	16-20375	0816-01-0177	15,300 (J)	5–6
Iron	16-20370	0816-01-0237	15,800	0–1
Iron	16-20337	0816-01-0172	16,100 (J)	5–6
Iron	16-20337	0816-01-0170	16,300 (J)	0–1
Iron	16-20373	0816-01-0304	17,900	0–1
Iron	16-20491	0816-01-0194	17,900	0–1
Iron	16-20490	0816-01-0192	18,100	0–1
Iron	16-20454	0816-01-0307	19,000	0–1
Iron	16-20490	0816-01-0198	20,600	0–1
Lead	16-20702	0816-01-0255	11.6	0–1
Lead	16-20702	0816-01-0076	11.6	2–3
Lead	16-20661	0816-01-0251	12.0	2–3
Lead	16-20488	0816-01-0157	12.4	0–1
Lead	16-20702	0816-01-0074	12.5	0–1
Lead	16-20551	0816-01-0306	12.6	0–1
Lead	16-20697	0816-01-0051	12.8	0–1
Lead	16-20474	0816-01-0067	13.5	0–0.5
Lead	16-20337	0816-01-0172	13.7	5–6
Lead	16-20404	0816-01-0128	13.8	0–1
Lead	16-20337	0816-01-0170	16.9	0–1
Lead	16-20477	0816-01-0095	18.3	0–1

Table C-2 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Lead	16-20486	0816-01-0212	19.0	0–1
Lead	16-20662	0816-01-0314	20.4	2–3
Lead	16-20741	0816-01-0249	20.6	5–6
Lead	16-20630	0816-01-0330	21.3	0–1
Lead	16-20662	0816-01-0313	22.4	0–1
Lead	16-20337	0816-01-0171	22.9	4–5
Lead	16-20736	0816-01-0090	25.4	0–1
Lead	16-20592	0816-01-0248	26.5	0–1
Lead	16-20513	0816-01-0096	33.3	0–1
Lead	16-20628	0816-01-0332	38.9	0–1
Lead	16-20474	0816-01-0069	144	2–3
Mercury	16-20665	0816-01-0261	0.18 (U)	0–1
Mercury	16-20628	0816-01-0332	0.22	0–1
Nickel	16-20454	0816-01-0307	6.6	0–1
Nickel	16-20491	0816-01-0194	6.6	0–1
Nickel	16-20404	0816-01-0128	7.2	0–1
Nickel	16-20337	0816-01-0171	7.3	4–5
Nickel	16-20622	0816-01-0211	7.4	0–1
Nickel	16-20698	0816-01-0071	7.5	0–1
Nickel	16-20486	0816-01-0212	8.2	0–1
Nickel	16-20474	0816-01-0069	8.4	2–3
Nickel	16-20474	0816-01-0067	8.5	0–0.5
Nickel	16-20490	0816-01-0198	8.7	0–1
Nickel	16-20375	0816-01-0177	8.8	5–6
Nickel	16-20335	0816-01-0236	8.8	0–1
Nickel	16-20373	0816-01-0304	9.1	0–1
Nickel	16-20592	0816-01-0248	9.3	0–1
Nickel	16-20702	0816-01-0076	10.5	2–3
Nickel	16-20370	0816-01-0237	11.2	0–1
Nickel	16-20628	0816-01-0332	12.5	0–1
Nickel	16-20337	0816-01-0172	13.2	5–6
Perchlorate	16-20478	0816-01-0151	0.04 (J)	0–1
Perchlorate	16-20557	0816-01-0333	0.06 (J)	36.7–37.4
Perchlorate	16-20557	0816-01-0327	0.06 (J)	18.7–19.6
Perchlorate	16-20526	0816-01-0324	0.06 (J)	37.3–38.3
Perchlorate	16-20557	0816-01-0329	0.08 (J)	52.6–53.6
Perchlorate	16-20373	0816-01-0304	0.23 (J-)	0–1
Perchlorate	16-20413	0816-01-0305	0.24 (J-)	0–1
Selenium	16-20526	0816-01-0324	0.31 (J-)	37.3–38.3

Table C-2 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Selenium	16-20562	0816-01-0087	0.31 (J-)	0–1
Selenium	16-20662	0816-01-0314	0.31 (J)	2–3
Selenium	16-20516	0816-01-0335	0.32 (J)	29.2–29.9
Selenium	16-20413	0816-01-0216	0.32 (J)	0–1
Selenium	16-20372	0816-01-0230	0.32 (J-)	0–1
Selenium	16-20491	0816-01-0194	0.33 (J)	0–1
Selenium	16-20441	0816-01-0129	0.34 (J)	0–1
Selenium	16-20526	0816-01-0325	0.34 (J-)	27.3–28.3
Selenium	16-20551	0816-01-0306	0.34 (J-)	0–1
Selenium	16-20554	0816-01-0338	0.35 (J)	76.1–76.8
Selenium	16-20371	0816-01-0229	0.35 (J-)	0–1
Selenium	16-20408	0816-01-0238	0.35 (J-)	0–1
Selenium	16-20695	0816-01-0048	0.36 (J-)	0–1
Selenium	16-20520	0816-01-0123	0.36 (J)	0–1
Selenium	16-20404	0816-01-0128	0.37 (J)	0–1
Selenium	16-20484	0816-01-0201	0.37 (J-)	0–1
Selenium	16-20741	0816-01-0249	0.37 (J-)	5–6
Selenium	16-20554	0816-01-0351	0.38 (J)	19.7–20.3
Selenium	16-20337	0816-01-0170	0.39 (J)	0–1
Selenium	16-20553	0816-01-0300	0.39 (J-)	0–1
Selenium	16-20451	0816-01-0224	0.39 (J-)	0–1
Selenium	16-20452	0816-01-0222	0.39 (J-)	0–1
Selenium	16-20455	0816-01-0207	0.39 (J-)	0–1
Selenium	16-20373	0816-01-0234	0.40 (J-)	0–1
Selenium	16-20561	0816-01-0098	0.41 (J-)	0–1
Selenium	16-20595	0816-01-0263	0.42 (J-)	0–1
Selenium	16-20449	0816-01-0219	0.43 (J-)	0–1
Selenium	16-20337	0816-01-0172	0.44 (J-)	5–6
Selenium	16-20453	0816-01-0223	0.44 (J-)	0–1
Selenium	16-20702	0816-01-0257	0.45 (J-)	4–5
Selenium	16-20335	0816-01-0236	0.46 (J-)	0–1
Selenium	16-20413	0816-01-0305	0.47 (J-)	0–1
Selenium	16-20557	0816-01-0303	0.52 (J-)	2–3
Selenium	16-20414	0816-01-0221	0.53 (J-)	0–1
Selenium	16-20558	0816-01-0102	0.54 (J-)	0–1
Selenium	16-20562	0816-01-0088	0.54 (J-)	2–3
Selenium	16-20442	0816-01-0228	0.54 (J-)	0–1
Selenium	16-20454	0816-01-0307	0.54 (J-)	0–1
Selenium	16-20586	0816-01-0208	0.55 (U)	0–1

Table C-2 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Selenium	16-20444	0816-01-0231	0.58 (J-)	0–1
Selenium	16-20515	0816-01-0104	0.59	0–1
Selenium	16-20447	0816-01-0220	0.67 (J-)	0–1
Selenium	16-20516	0816-01-0112	0.70	0–1
Selenium	16-20409	0816-01-0239	0.75 (J-)	0–1
Selenium	16-20373	0816-01-0304	1.40 (J-)	0–1
Vanadium	16-20661	0816-01-0251	17.2	2–3
Vanadium	16-20375	0816-01-0178	17.7 (J-)	7–8
Vanadium	16-20491	0816-01-0194	18.0	0–1
Vanadium	16-20702	0816-01-0074	18.1	0–1
Vanadium	16-20474	0816-01-0067	19.4	0–0.5
Vanadium	16-20702	0816-01-0076	20.2	2–3
Vanadium	16-20628	0816-01-0332	20.3	0–1
Vanadium	16-20404	0816-01-0128	20.4	0–1
Vanadium	16-20375	0816-01-0177	20.9 (J-)	5–6
Vanadium	16-20373	0816-01-0304	21.9	0–1
Vanadium	16-20622	0816-01-0211	22.2	0–1
Vanadium	16-20337	0816-01-0171	23.2 (J-)	4–5
Vanadium	16-20337	0816-01-0170	24.7 (J-)	0–1
Vanadium	16-20592	0816-01-0248	24.7	0–1
Vanadium	16-20337	0816-01-0172	36.7	5–6
Zinc	16-20736	0816-01-0090	65.00	0–1
Zinc	16-20519	0816-01-0158	65.10	0–1
Zinc	16-20413	0816-01-0305	65.60	0–1
Zinc	16-20491	0816-01-0194	66.10	0–1
Zinc	16-20453	0816-01-0223	70.70	0–1
Zinc	16-20478	0816-01-0152	85.10	2–3
Zinc	16-20490	0816-01-0198	89.00	0–1
Zinc	16-20628	0816-01-0332	118.00	0–1

Note: Shaded cells indicate samples from SWMU 16-016(c)-99.

Table C-3
Organic COPCs: Samples with Detections-Biological Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Acetone	16-20004	0816-01-0293	0.014 (J)	Soil	0–0.5
Amino-2,6-dinitrotoluene[4-]	16-20376	0816-01-0164	0.063 (J)	Soil	0–1
Amino-2,6-dinitrotoluene[4-]	16-20300	0816-01-0187	0.069 (J)	Soil	2–3
Amino-2,6-dinitrotoluene[4-]	16-20348	0816-01-0214	0.110 (J)	Soil	0–1
Amino-2,6-dinitrotoluene[4-]	16-20304	0816-01-0036	0.160 (J)	Soil	0–1
Amino-2,6-dinitrotoluene[4-]	16-20694	0816-01-0058	0.230 (J)	Soil	0–1
Amino-2,6-dinitrotoluene[4-]	16-20342	0816-01-0180	0.290	Soil	0–1
Amino-2,6-dinitrotoluene[4-]	16-20387	0816-01-0161	0.420	Soil	0–1
Amino-2,6-dinitrotoluene[4-]	16-20268	RE16-02-45437	0.088 (J)	Soil	0–1
Amino-2,6-dinitrotoluene[4-]	16-20742	RE16-02-45442	0.150 (J)	Soil	2–3
Amino-2,6-dinitrotoluene[4-]	16-20742	RE16-02-45441	0.21	Soil	2–3
Amino-2,6-dinitrotoluene[4-]	16-20148	0816-01-0073	0.150 (J)	Tuff	0–0.5
Amino-2,6-dinitrotoluene[4-]	16-20195	0816-01-0205	0.150 (J)	Tuff	0–1
Amino-2,6-dinitrotoluene[4-]	16-20196	0816-01-0130	0.300	Tuff	0–1
Amino-2,6-dinitrotoluene[4-]	16-20306	0816-01-0033	0.620	Tuff	0–1
Amino-2,6-dinitrotoluene[4-]	16-20232	RE16-02-45438	0.840 (J)	Tuff	0–1
Amino-2,6-dinitrotoluene[4-]	16-20232	RE16-02-45438	0.980	Tuff	0–1
Amino-2,6-dinitrotoluene[4-]	16-20340	0816-01-0176	0.071 (J)	Tuff	2–3
Amino-2,6-dinitrotoluene[4-]	16-20599	RE16-02-45443	0.110 (J)	Tuff	0–1
Amino-4,6-dinitrotoluene[2-]	16-20268	RE16-02-45437	0.074 (J)	Soil	0–1
Amino-4,6-dinitrotoluene[2-]	16-20742	RE16-02-45442	0.100 (J)	Soil	2–3
Amino-4,6-dinitrotoluene[2-]	16-20742	RE16-02-45441	0.14	Soil	2–3
Amino-4,6-dinitrotoluene[2-]	16-20301	0816-01-0188	0.044 (J)	Soil	0–1
Amino-4,6-dinitrotoluene[2-]	16-20239	0816-01-0168	0.066 (J)	Soil	0–1
Amino-4,6-dinitrotoluene[2-]	16-20304	0816-01-0036	0.120 (J)	Soil	0–1
Amino-4,6-dinitrotoluene[2-]	16-20348	0816-01-0214	0.130 (J)	Soil	0–1
Amino-4,6-dinitrotoluene[2-]	16-20694	0816-01-0058	0.210 (J)	Soil	0–1
Amino-4,6-dinitrotoluene[2-]	16-20387	0816-01-0161	0.320	Soil	0–1
Amino-4,6-dinitrotoluene[2-]	16-20376	0816-01-0164	0.700	Soil	0–1
Amino-4,6-dinitrotoluene[2-]	16-20599	RE16-02-45443	0.087 (J)	Tuff	0–1
Amino-4,6-dinitrotoluene[2-]	16-20148	0816-01-0073	0.110 (J)	Tuff	0–0.5
Amino-4,6-dinitrotoluene[2-]	16-20670	RE16-02-45436	0.190 (J)	Tuff	0–1
Amino-4,6-dinitrotoluene[2-]	16-20340	0816-01-0174	0.190 (J)	Tuff	0–1
Amino-4,6-dinitrotoluene[2-]	16-20670	RE16-02-45436	0.200 (J)	Tuff	0–1
Amino-4,6-dinitrotoluene[2-]	16-20742	RE16-02-45439	0.290	Tuff	0–1
Amino-4,6-dinitrotoluene[2-]	16-20196	0816-01-0130	0.300	Tuff	0–1
Amino-4,6-dinitrotoluene[2-]	16-20306	0816-01-0033	0.820	Tuff	0–1

Table C-3 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Amino-4,6-dinitrotoluene[2-]	16-20232	RE16-02-45438	0.920 (J)	Tuff	0–1
Amino-4,6-dinitrotoluene[2-]	16-20232	RE16-02-45438	1.100	Tuff	0–1
Aroclor-1260	16-20004	0816-01-0293	0.061	Soil	0–0.5
Bis(2-ethylhexyl)phthalate	16-20300	0816-01-0187	0.170 (J)	Soil	2–3
Bis(2-ethylhexyl)phthalate	16-20549	0816-01-0215	0.210 (J)	Soil	0–1
Bis(2-ethylhexyl)phthalate	16-20314	0816-01-0354	0.160 (J)	Tuff	0–1
Bis(2-ethylhexyl)phthalate	16-20670	RE16-02-45436	0.110 (J)	Tuff	0–1
Bis(2-ethylhexyl)phthalate	16-20742	RE16-02-45439	0.120 (J)	Tuff	0–1
Bis(2-ethylhexyl)phthalate	16-20196	0816-01-0130	0.160 (J)	Tuff	0–1
Bis(2-ethylhexyl)phthalate	16-20233	0816-01-0121	0.210 (J)	Tuff	0–1
Bis(2-ethylhexyl)phthalate	16-20232	RE16-02-45438	0.280 (J)	Tuff	0–1
DDT[4,4'-]	16-20004	0816-01-0293	0.008	Soil	0–0.5
HMX	16-20742	RE16-02-45442	0.610	Soil	2–3
HMX	16-20268	RE16-02-45437	1.400	Soil	0–1
HMX	16-20153	0816-01-0262	0.118	Soil	0–1
HMX	16-20265	0816-01-0107	0.190 (J)	Soil	0–1
HMX	16-20193	0816-01-0059	0.290 (J)	Soil	0–1
HMX	16-20566	0816-01-0213	0.290 (J)	Soil	0–1
HMX	16-20006	0816-01-0289	0.340	Soil	0–0.5
HMX	16-20342	0816-01-0182	0.420	Soil	2–3
HMX	16-20301	0816-01-0188	0.550	Soil	0–1
HMX	16-20742	RE16-02-45441	0.56	Soil	2–4
HMX	16-20344	0816-01-0184	0.580	Soil	0–1
HMX	16-20344	0816-01-0185	0.620	Soil	3–4
HMX	16-20694	0816-01-0058	0.650	Soil	0–1
HMX	16-20263	0816-01-0106	0.860	Soil	0–1
HMX	16-20262	0816-01-0105	1.000	Soil	0–1
HMX	16-20239	0816-01-0168	1.100	Soil	0–1
HMX	16-20304	0816-01-0036	1.600 (J-)	Soil	0–1
HMX	16-20348	0816-01-0214	1.700	Soil	0–1
HMX	16-20342	0816-01-0180	4.600	Soil	0–1
HMX	16-20004	0816-01-0293	5.700	Soil	0–0.5
HMX	16-20351	0816-01-0050	5.700	Soil	0–1
HMX	16-20124	0816-01-0063	7.700 (J)	Soil	0–1
HMX	16-20387	0816-01-0161	10.000	Soil	0–1
HMX	16-20376	0816-01-0164	2.000	Soil	0–1
HMX	16-20240	0816-01-0352	0.180 (J)	Tuff	0–1
HMX	16-20706	0816-01-0323	0.260	Tuff	0–1
HMX	16-20599	RE16-02-45443	0.310	Tuff	0–1

Table C-3 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
HMX	16-20598	0816-01-0266	0.390	Tuff	2–3
HMX	16-20598	0816-01-0265	0.448	Tuff	0–1
HMX	16-20205	RE16-02-44945	0.620	Tuff	0–1
HMX	16-20205	RE16-02-44946	0.660	Tuff	0–1
HMX	16-20692	0816-01-0086	0.710	Tuff	0–1
HMX	16-20314	0816-01-0354	2.400	Tuff	0–1
HMX	16-20694	0816-01-0253	0.120	Tuff	2–3
HMX	16-20476	0816-01-0134	0.150 (J)	Tuff	0–1
HMX	16-20271	0816-01-0140	0.190 (J)	Tuff	0–1
HMX	16-20270	0816-01-0138	0.200 (J)	Tuff	2–3
HMX	16-20334	0816-01-0235	0.200 (J)	Tuff	0–1
HMX	16-20197	0816-01-0120	0.280 (J)	Tuff	0–1
HMX	16-20333	0816-01-0091	0.320 (J)	Tuff	0–1
HMX	16-20305	0816-01-0035	0.350 (J-)	Tuff	0–1
HMX	16-20233	0816-01-0121	0.410	Tuff	0–1
HMX	16-20419	0816-01-0244	0.450	Tuff	0–1
HMX	16-20269	0816-01-0061	0.510	Tuff	0–1
HMX	16-20270	0816-01-0136	0.610	Tuff	0–1
HMX	16-20418	0816-01-0243	0.670	Tuff	2–3
HMX	16-20418	0816-01-0242	0.790	Tuff	0–1
HMX	16-20340	0816-01-0174	0.860	Tuff	0–1
HMX	16-20195	0816-01-0205	1.800	Tuff	0–1
HMX	16-20742	RE16-02-45439	2.200	Tuff	0–1
HMX	16-20148	0816-01-0073	2.500	Tuff	0–0.5
HMX	16-20670	RE16-02-45436	5.000	Tuff	0–1
HMX	16-20670	RE16-02-45436	5.100	Tuff	0–1
HMX	16-20196	0816-01-0130	5.800	Tuff	0–1
HMX	16-20306	0816-01-0033	10.000 (J-)	Tuff	0–1
HMX	16-20232	RE16-02-45438	16.000	Tuff	0–1
HMX	16-20232	RE16-02-45438	16.000	Tuff	0–1
RDX	16-20742	RE16-02-45442	0.110 (J)	Soil	2–3
RDX	16-20268	RE16-02-45437	2.900	Soil	0–1
RDX	16-20549	0816-01-0215	0.069 (J)	Soil	0–1
RDX	16-20566	0816-01-0213	0.100 (J)	Soil	0–1
RDX	16-20191	0816-01-0046	0.120 (J)	Soil	0–1
RDX	16-20300	0816-01-0186	0.180 (J)	Soil	0–1
RDX	16-20006	0816-01-0289	0.280	Soil	0–0.5
RDX	16-20579	0816-01-0065	0.300	Soil	0–1
RDX	16-20694	0816-01-0058	0.490	Soil	0–1

Table C-3 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
RDX	16-20342	0816-01-0182	0.530	Soil	2–3
RDX	16-20344	0816-01-0185	0.570	Soil	3–4
RDX	16-20344	0816-01-0184	0.720	Soil	0–1
RDX	16-20316	0816-01-0293	0.740	Soil	0–0.5
RDX	16-20239	0816-01-0168	0.860	Soil	0–1
RDX	16-20193	0816-01-0059	0.970 (J)	Soil	0–1
RDX	16-20263	0816-01-0106	1.300	Soil	0–1
RDX	16-20351	0816-01-0050	1.600	Soil	0–1
RDX	16-20262	0816-01-0105	1.800	Soil	0–1
RDX	16-20304	0816-01-0036	1.900	Soil	0–1
RDX	16-20301	0816-01-0188	2.200	Soil	0–1
RDX	16-20387	0816-01-0161	2.200	Soil	0–1
RDX	16-20348	0816-01-0214	2.600	Soil	0–1
RDX	16-20342	0816-01-0180	5.900	Soil	0–1
RDX	16-20376	0816-01-0164	2.100	Soil	0–1
RDX	16-20340	0816-01-0176	0.094 (J)	Tuff	2–3
RDX	16-20314	0816-01-0361	0.140 (J)	Tuff	0–1
RDX	16-20599	RE16-02-45443	0.210 (J)	Tuff	0–1
RDX	16-20654	0816-01-0085	0.210 (J)	Tuff	2–3
RDX	16-20386	0816-01-0360	0.330	Tuff	0–1
RDX	16-20240	0816-01-0352	0.490	Tuff	0–1
RDX	16-20238	RE16-02-44948	0.560	Tuff	0–1
RDX	16-20706	0816-01-0323	0.768	Tuff	0–1
RDX	16-20278	0816-01-0359	0.950	Tuff	0–1
RDX	16-20598	0816-01-0266	1.250	Tuff	2–3
RDX	16-20598	0816-01-0265	1.800	Tuff	0–1
RDX	16-20241	0816-01-0357	2.300	Tuff	0–1
RDX	16-20205	RE16-02-44945	3.000	Tuff	0–1
RDX	16-20205	RE16-02-44946	3.200	Tuff	0–1
RDX	16-20314	0816-01-0354	3.600	Tuff	0–1
RDX	16-20547	0816-01-0133	0.084 (J)	Tuff	0–1
RDX	16-20274	0816-01-0029	0.100 (J)	Tuff	0–1
RDX	16-20189	0816-01-0247	0.120 (J)	Tuff	2–3
RDX	16-20233	0816-01-0122	0.140 (J)	Tuff	2–3
RDX	16-20476	0816-01-0134	0.140 (J)	Tuff	0–1
RDX	16-20307	0816-01-0034	0.150 (J)	Tuff	0–1
RDX	16-20195	0816-01-0206	0.160 (J)	Tuff	2–3
RDX	16-20270	0816-01-0138	0.160 (J)	Tuff	2–3
RDX	16-20416	0816-01-0246	0.170 (J)	Tuff	0–1

Table C-3 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
RDX	16-20694	0816-01-0253	0.205	Tuff	2–3
RDX	16-20389	0816-01-0030	0.310 (J)	Tuff	0–1
RDX	16-20333	0816-01-0091	0.320	Tuff	0–1
RDX	16-20340	0816-01-0174	0.370	Tuff	0–1
RDX	16-20415	0816-01-0245	0.460	Tuff	0–1
RDX	16-20270	0816-01-0136	0.490	Tuff	0–1
RDX	16-20233	0816-01-0121	0.530	Tuff	0–1
RDX	16-20234	0816-01-0115	0.540	Tuff	0–1
RDX	16-20269	0816-01-0062	0.570 (J)	Tuff	2–3
RDX	16-20334	0816-01-0235	0.810	Tuff	0–1
RDX	16-20419	0816-01-0244	1.100	Tuff	0–1
RDX	16-20148	0816-01-0073	1.300	Tuff	0–0.5
RDX	16-20305	0816-01-0035	1.300	Tuff	0–1
RDX	16-20198	0816-01-0114	1.400	Tuff	0–1
RDX	16-20197	0816-01-0120	1.600	Tuff	0–1
RDX	16-20269	0816-01-0061	1.800 (J)	Tuff	0–1
RDX	16-20271	0816-01-0140	1.800	Tuff	0–1
RDX	16-20195	0816-01-0205	2.100	Tuff	0–1
RDX	16-20295	0816-01-0072	2.300	Tuff	0–1
RDX	16-20742	RE16-02-45439	2.700	Tuff	0–1
RDX	16-20418	0816-01-0243	3.900	Tuff	2–3
RDX	16-20418	0816-01-0242	4.600	Tuff	0–1
RDX	16-20196	0816-01-0130	7.400	Tuff	0–1
RDX	16-20670	RE16-02-45436	18.000	Tuff	0–1
RDX	16-20670	RE16-02-45436	19.000	Tuff	0–1
RDX	16-20306	0816-01-0033	22.000	Tuff	0–1
RDX	16-20232	RE16-02-45438	36.000	Tuff	0–1
RDX	16-20232	RE16-02-45438	37.000	Tuff	0–1
Toluene	16-20004	0816-01-0293	0.001 (J)	Soil	0–0.5
Trinitrotoluene[2,4,6-]	16-20348	0816-01-0214	0.034 (J)	Soil	0–1
Trinitrotoluene[2,4,6-]	16-20304	0816-01-0036	0.086 (J)	Soil	0–1
Trinitrotoluene[2,4,6-]	16-20204	0816-01-0168	0.140	Soil	0–1
Trinitrotoluene[2,4,6-]	16-20387	0816-01-0161	0.270	Soil	0–1
Trinitrotoluene[2,4,6-]	16-20004	0816-01-0293	0.300	Soil	0–0.5
Trinitrotoluene[2,4,6-]	16-20198	0816-01-0114	0.067 (J)	Tuff	0–1
Trinitrotoluene[2,4,6-]	16-20195	0816-01-0205	0.087 (J)	Tuff	0–1
Trinitrotoluene[2,4,6-]	16-20232	RE16-02-45438	0.380 (J)	Tuff	0–1
Trinitrotoluene[2,4,6-]	16-20232	RE16-02-45438	0.450	Tuff	0–1
Trinitrotoluene[2,4,6-]	16-20670	RE16-02-45436	0.550	Tuff	0–1

Table C-3 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Trinitrotoluene[2,4,6-]	16-20742	RE16-02-45439	1.200	Tuff	0–1
Trinitrotoluene[2,4,6-]	16-20306	0816-01-0033	1.200	Tuff	0–1

Note: Shaded cells indicate samples from SWMU 16-016(c)-99.

Table C-4
Organic COPCs: Samples with Detections—Exposed Tuff Zone

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Amino-2,6-dinitrotoluene[4-]	16-20696	0816-01-0066	0.049 (J)	0–1
Amino-2,6-dinitrotoluene[4-]	16-20526	0816-01-0196	0.054 (J)	2–3
Amino-2,6-dinitrotoluene[4-]	16-20337	0816-01-0172	0.055 (J)	5–6
Amino-2,6-dinitrotoluene[4-]	16-20695	0816-01-0048	0.078 (J)	0–1
Amino-2,6-dinitrotoluene[4-]	16-20524	0816-01-0159	0.094 (J)	0–1
Amino-2,6-dinitrotoluene[4-]	16-20586	0816-01-0208	0.096 (J)	0–1
Amino-2,6-dinitrotoluene[4-]	16-20491	0816-01-0194	0.099 (J)	0–1
Amino-2,6-dinitrotoluene[4-]	16-20375	0816-01-0178	0.11 (J)	7–8
Amino-2,6-dinitrotoluene[4-]	16-20490	0816-01-0192	0.14 (J)	0–1
Amino-2,6-dinitrotoluene[4-]	16-20526	0816-01-0195	0.16 (J)	0–1
Amino-2,6-dinitrotoluene[4-]	16-20454	0816-01-0218	0.23 (J)	0–1
Amino-2,6-dinitrotoluene[4-]	16-20661	0816-01-0251	0.09	2–3
Amino-2,6-dinitrotoluene[4-]	16-20628	0816-01-0332	0.09	0–1
Amino-2,6-dinitrotoluene[4-]	16-20741	0816-01-0250	0.11	2–3
Amino-2,6-dinitrotoluene[4-]	16-20551	0816-01-0306	0.12	0–1
Amino-2,6-dinitrotoluene[4-]	16-20630	0816-01-0330	0.16	0–1
Amino-2,6-dinitrotoluene[4-]	16-20741	0816-01-0249	0.20	5–6
Amino-2,6-dinitrotoluene[4-]	16-20702	0816-01-0255	0.31	0–1
Amino-2,6-dinitrotoluene[4-]	16-20592	0816-01-0248	0.44	0–1
Amino-2,6-dinitrotoluene[4-]	16-20454	0816-01-0307	0.55	0–1
Amino-4,6-dinitrotoluene[2-]	16-20526	0816-01-0196	0.042 (J)	2–3
Amino-4,6-dinitrotoluene[2-]	16-20337	0816-01-0171	0.048 (J)	4–5
Amino-4,6-dinitrotoluene[2-]	16-20526	0816-01-0325	0.048 (J)	27.3–28.3
Amino-4,6-dinitrotoluene[2-]	16-20337	0816-01-0172	0.054 (J)	5–6
Amino-4,6-dinitrotoluene[2-]	16-20489	0816-01-0199	0.056 (J)	0–1
Amino-4,6-dinitrotoluene[2-]	16-20695	0816-01-0048	0.057 (J)	0–1
Amino-4,6-dinitrotoluene[2-]	16-20526	0816-01-0324	0.061 (J)	37.3–38.3
Amino-4,6-dinitrotoluene[2-]	16-20404	0816-01-0128	0.062 (J)	0–1
Amino-4,6-dinitrotoluene[2-]	16-20524	0816-01-0159	0.071 (J)	0–1
Amino-4,6-dinitrotoluene[2-]	16-20586	0816-01-0208	0.080 (J)	0–1

Table C-4 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
Amino-4,6-dinitrotoluene[2-]	16-20490	0816-01-0192	0.082 (J)	0–1
Amino-4,6-dinitrotoluene[2-]	16-20491	0816-01-0194	0.087 (J)	0–1
Amino-4,6-dinitrotoluene[2-]	16-20526	0816-01-0195	0.17 (J)	0–1
Amino-4,6-dinitrotoluene[2-]	16-20454	0816-01-0218	0.18 (J)	0–1
Amino-4,6-dinitrotoluene[2-]	16-20628	0816-01-0332	0.08	0–1
Amino-4,6-dinitrotoluene[2-]	16-20551	0816-01-0306	0.09	0–1
Amino-4,6-dinitrotoluene[2-]	16-20741	0816-01-0250	0.11	2–3
Amino-4,6-dinitrotoluene[2-]	16-20630	0816-01-0330	0.18	0–1
Amino-4,6-dinitrotoluene[2-]	16-20741	0816-01-0249	0.20	5–6
Amino-4,6-dinitrotoluene[2-]	16-20702	0816-01-0255	0.36	0–1
Amino-4,6-dinitrotoluene[2-]	16-20592	0816-01-0248	0.52	0–1
Amino-4,6-dinitrotoluene[2-]	16-20337	0816-01-0170	0.81	0–1
Amino-4,6-dinitrotoluene[2-]	16-20454	0816-01-0307	0.88	0–1
Bis(2-ethylhexyl)phthalate	16-20477	0816-01-0095	0.080 (J)	0–1
Bis(2-ethylhexyl)phthalate	16-20404	0816-01-0128	0.099 (J)	0–1
Bis(2-ethylhexyl)phthalate	16-20630	0816-01-0330	0.100 (J)	0–1
Bis(2-ethylhexyl)phthalate	16-20558	0816-01-0102	0.110 (J)	0–1
Bis(2-ethylhexyl)phthalate	16-20551	0816-01-0306	0.120 (J)	0–1
Bis(2-ethylhexyl)phthalate	16-20702	0816-01-0255	0.53	0–1
Bis(2-ethylhexyl)phthalate	16-20513	0816-01-0096	0.62	0–1
Carbon Disulfide	16-20557	0816-01-0299	0.0098 (J)	2–3
HMX	16-20526	0816-01-0326	0.24 (J-)	53.5–54.5
HMX	16-20526	0816-01-0324	0.5 (J-)	37.3–38.3
HMX	16-20526	0816-01-0325	0.55 (J-)	27.3–28.3
HMX	16-20441	0816-01-0129	0.100 (J)	0–1
HMX	16-20408	0816-01-0238	0.19 (J)	0–1
HMX	16-20557	0816-01-0299	0.20 (J)	2–3
HMX	16-20560	0816-01-0142	0.21 (J)	2–3
HMX	16-20559	0816-01-0119	0.24 (J)	2–3
HMX	16-20486	0816-01-0212	0.24 (J)	0–1
HMX	16-20375	0816-01-0177	0.26 (J)	5–6
HMX	16-20490	0816-01-0192	0.27 (J)	0–1
HMX	16-20663	0816-01-0311	0.09	0–1
HMX	16-20625	0816-01-0320	0.13	0–1
HMX	16-20669	0816-01-0315	0.14	0–1
HMX	16-20662	0816-01-0314	0.22	2–3
HMX	16-20625	0816-01-0321	0.24	2–3
HMX	16-20591	0816-01-0318	0.24	0–1

Table C-4 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
HMX	16-20665	0816-01-0261	0.25	0–1
HMX	16-20596	0816-01-0259	0.27	0–1
HMX	16-20557	0816-01-0302	0.28	0–1
HMX	16-20374	0816-01-0233	0.28	0–1
HMX	16-20557	0816-01-0298	0.29	0–1
HMX	16-20624	0816-01-0322	0.29	0–1
HMX	16-20517	0816-01-0099	0.30	0–1
HMX	16-20557	0816-01-0303	0.30	2–3
HMX	16-20661	0816-01-0251	0.30	2–3
HMX	16-20590	0816-01-0317	0.33	2–3
HMX	16-20478	0816-01-0151	0.33	0–1
HMX	16-20487	0816-01-0154	0.33	0–1
HMX	16-20523	0816-01-0165	0.33	0–1
HMX	16-20558	0816-01-0102	0.33	0–1
HMX	16-20490	0816-01-0198	0.36	0–1
HMX	16-20559	0816-01-0118	0.36	0–1
HMX	16-20702	0816-01-0257	0.36	4–5
HMX	16-20527	0816-01-0191	0.39	0–1
HMX	16-20595	0816-01-0263	0.39	0–1
HMX	16-20560	0816-01-0141	0.40	0–1
HMX	16-20662	0816-01-0313	0.43	0–1
HMX	16-20489	0816-01-0199	0.46	0–1
HMX	16-20586	0816-01-0208	0.46	0–1
HMX	16-20590	0816-01-0316	0.48	0–1
HMX	16-20477	0816-01-0095	0.48	0–1
HMX	16-20524	0816-01-0159	0.49	0–1
HMX	16-20561	0816-01-0098	0.50	0–1
HMX	16-20632	0816-01-0308	0.51	0–1
HMX	16-20452	0816-01-0222	0.54	0–1
HMX	16-20455	0816-01-0207	0.54	0–1
HMX	16-20489	0816-01-0200	0.54	2–3
HMX	16-20526	0816-01-0196	0.54	2–3
HMX	16-20372	0816-01-0230	0.60	0–1
HMX	16-20525	0816-01-0189	0.61	0–1
HMX	16-20453	0816-01-0223	0.65	0–1
HMX	16-20697	0816-01-0051	0.66	0–1
HMX	16-20695	0816-01-0048	0.68	0–1
HMX	16-20626	0816-01-0312	0.69	0–1

Table C-4 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
HMX	16-20404	0816-01-0128	0.74	0–1
HMX	16-20702	0816-01-0076	0.79	2–3
HMX	16-20736	0816-01-0090	0.79	0–1
HMX	16-20698	0816-01-0071	0.81	0–1
HMX	16-20629	0816-01-0319	0.84	0–1
HMX	16-20337	0816-01-0170	0.92	0–1
HMX	16-20522	0816-01-0160	0.98	0–1
HMX	16-20667	0816-01-0197	1.15	0–1
HMX	16-20337	0816-01-0172	1.20	5–6
HMX	16-20454	0816-01-0218	1.20	0–1
HMX	16-20491	0816-01-0194	1.30	0–1
HMX	16-20337	0816-01-0171	1.60	4–5
HMX	16-20630	0816-01-0330	1.63	0–1
HMX	16-20526	0816-01-0195	1.70	0–1
HMX	16-20454	0816-01-0307	2.23	0–1
HMX	16-20592	0816-01-0248	2.30	0–1
HMX	16-20628	0816-01-0332	2.98	0–1
HMX	16-20702	0816-01-0255	3.14	0–1
HMX	16-20741	0816-01-0250	3.28	2–3
HMX	16-20741	0816-01-0249	3.71	5–6
HMX	16-20551	0816-01-0306	5.74	0–1
RDX	16-20519	0816-01-0158	0.054 (J)	0–1
RDX	16-20516	0816-01-0112	0.061 (J)	0–1
RDX	16-20413	0816-01-0216	0.066 (J)	0–1
RDX	16-20698	0816-01-0071	0.075 (J)	0–1
RDX	16-20520	0816-01-0123	0.085 (J)	0–1
RDX	16-20484	0816-01-0201	0.087 (J)	0–1
RDX	16-20518	0816-01-0126	0.091 (J)	0–1
RDX	16-20658	0816-01-0209	0.091 (J)	0–1
RDX	16-20554	0816-01-0145	0.093 (J)	2–3
RDX	16-20441	0816-01-0129	0.099 (J)	0–1
RDX	16-20337	0816-01-0170	0.10 (J)	0–1
RDX	16-20479	0816-01-0113	0.11 (J)	0–1
RDX	16-20586	0816-01-0208	0.11 (J)	0–1
RDX	16-20660	0816-01-0193	0.11 (J)	0–1
RDX	16-20700	0816-01-0049	0.11 (J)	0–1
RDX	16-20444	0816-01-0231	0.12 (J)	0–1
RDX	16-20696	0816-01-0066	0.12 (J)	0–1

Table C-4 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
RDX	16-20449	0816-01-0219	0.13 (J)	0–1
RDX	16-20451	0816-01-0224	0.13 (J)	0–1
RDX	16-20375	0816-01-0179	0.14 (J)	9–10
RDX	16-20486	0816-01-0212	0.14 (J)	0–1
RDX	16-20554	0816-01-0143	0.24 (J)	0–1
RDX	16-20624	0816-01-0322	0.14	0–1
RDX	16-20665	0816-01-0261	0.14	0–1
RDX	16-20669	0816-01-0315	0.16	0–1
RDX	16-20413	0816-01-0305	0.27	0–1
RDX	16-20662	0816-01-0314	0.31	2–3
RDX	16-20662	0816-01-0313	0.36	0–1
RDX	16-20697	0816-01-0051	0.36	0–1
RDX	16-20442	0816-01-0228	0.42	0–1
RDX	16-20375	0816-01-0177	0.43	5–6
RDX	16-20478	0816-01-0151	0.44	0–1
RDX	16-20625	0816-01-0320	0.44	0–1
RDX	16-20513	0816-01-0096	0.46	0–1
RDX	16-20514	0816-01-0103	0.46	0–1
RDX	16-20517	0816-01-0099	0.46	0–1
RDX	16-20474	0816-01-0067	0.50	0–0.5
RDX	16-20626	0816-01-0312	0.57	0–1
RDX	16-20562	0816-01-0087	0.60	0–1
RDX	16-20562	0816-01-0088	0.60	2–3
RDX	16-20524	0816-01-0159	0.61	0–1
RDX	16-20447	0816-01-0220	0.66	0–1
RDX	16-20555	0816-01-0101	0.70	0–1
RDX	16-20404	0816-01-0128	0.75	0–1
RDX	16-20560	0816-01-0142	0.78	2–3
RDX	16-20373	0816-01-0234	0.80	0–1
RDX	16-20477	0816-01-0095	0.83	0–1
RDX	16-20515	0816-01-0104	0.87	0–1
RDX	16-20595	0816-01-0263	0.88	0–1
RDX	16-20490	0816-01-0192	0.92	0–1
RDX	16-20561	0816-01-0098	0.96	0–1
RDX	16-20625	0816-01-0321	1.03	2–3
RDX	16-20702	0816-01-0076	1.10	2–3
RDX	16-20695	0816-01-0048	1.10	0–1
RDX	16-20596	0816-01-0259	1.14	0–1

Table C-4 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
RDX	16-20741	0816-01-0250	1.15	2–3
RDX	16-20371	0816-01-0229	1.20	0–1
RDX	16-20455	0816-01-0207	1.20	0–1
RDX	16-20527	0816-01-0191	1.20	0–1
RDX	16-20661	0816-01-0251	1.24	2–3
RDX	16-20337	0816-01-0171	1.30	4–5
RDX	16-20337	0816-01-0172	1.30	5–6
RDX	16-20372	0816-01-0230	1.40	0–1
RDX	16-20523	0816-01-0165	1.40	0–1
RDX	16-20741	0816-01-0249	1.44	5–6
RDX	16-20629	0816-01-0319	1.56	0–1
RDX	16-20490	0816-01-0198	1.60	0–1
RDX	16-20559	0816-01-0119	1.60	2–3
RDX	16-20667	0816-01-0197	1.62	0–1
RDX	16-20521	0816-01-0124	1.70	0–1
RDX	16-20408	0816-01-0238	1.80	0–1
RDX	16-20487	0816-01-0154	1.80	0–1
RDX	16-20560	0816-01-0141	1.80	0–1
RDX	16-20632	0816-01-0308	1.80	0–1
RDX	16-20525	0816-01-0189	1.90	0–1
RDX	16-20558	0816-01-0102	1.90	0–1
RDX	16-20628	0816-01-0332	1.99	0–1
RDX	16-20557	0816-01-0299	2.00	2–3
RDX	16-20489	0816-01-0199	2.10	0–1
RDX	16-20591	0816-01-0318	2.12	0–1
RDX	16-20590	0816-01-0316	2.13	0–1
RDX	16-20590	0816-01-0317	2.26	2–3
RDX	16-20488	0816-01-0157	2.30	0–1
RDX	16-20702	0816-01-0257	2.47	4–5
RDX	16-20557	0816-01-0334	2.50	11.7–12.6
RDX	16-20452	0816-01-0222	2.60	0–1
RDX	16-20559	0816-01-0118	2.70	0–1
RDX	16-20374	0816-01-0233	2.80	0–1
RDX	16-20526	0816-01-0326	2.80	53.5–54.5
RDX	16-20702	0816-01-0255	2.92	0–1
RDX	16-20491	0816-01-0194	3.00	0–1
RDX	16-20489	0816-01-0200	3.30	2–3
RDX	16-20630	0816-01-0330	3.46	0–1

Table C-4 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Depth (ft)
RDX	16-20557	0816-01-0303	3.51	2–3
RDX	16-20526	0816-01-0196	3.90	2–3
RDX	16-20557	0816-01-0327	3.90	18.7–19.6
RDX	16-20453	0816-01-0223	4.00	0–1
RDX	16-20454	0816-01-0218	4.00	0–1
RDX	16-20526	0816-01-0325	4.30	27.3–28.3
RDX	16-20557	0816-01-0298	4.50	0–1
RDX	16-20557	0816-01-0302	4.68	0–1
RDX	16-20526	0816-01-0324	4.80	37.3–38.3
RDX	16-20522	0816-01-0160	6.20	0–1
RDX	16-20454	0816-01-0307	7.06	0–1
RDX	16-20551	0816-01-0306	7.37	0–1
RDX	16-20526	0816-01-0195	8.30	0–1
RDX	16-20592	0816-01-0248	10.80	0–1
Toluene	16-20557	0816-01-0299	0.00059 (J)	2–3
Toluene	16-20557	0816-01-0298	0.00072 (J)	0–1
Trinitrobenzene[1,3,5-]	16-20557	0816-01-0328	0.047 (J)	66–67
Trinitrobenzene[1,3,5-]	16-20522	0816-01-0160	0.052 (J)	0–1
Trinitrobenzene[1,3,5-]	16-20557	0816-01-0334	0.088 (J)	11.7–12.6
Trinitrobenzene[1,3,5-]	16-20557	0816-01-0329	0.12 (J)	52.6–53.6
Trinitrobenzene[1,3,5-]	16-20557	0816-01-0327	0.13 (J)	18.7–19.6
Trinitrobenzene[1,3,5-]	16-20557	0816-01-0333	0.14 (J)	36.7–37.4
Trinitrobenzene[1,3,5-]	16-20337	0816-01-0170	0.17 (J)	0–1
Trinitrobenzene[1,3,5-]	16-20526	0816-01-0195	0.36	0–1
Trinitrotoluene[2,4,6-]	16-20526	0816-01-0196	0.029 (J)	2–3
Trinitrotoluene[2,4,6-]	16-20491	0816-01-0194	0.031 (J)	0–1
Trinitrotoluene[2,4,6-]	16-20557	0816-01-0334	0.041 (J)	11.7–12.6
Trinitrotoluene[2,4,6-]	16-20337	0816-01-0172	0.043 (J)	5–6
Trinitrotoluene[2,4,6-]	16-20586	0816-01-0208	0.078 (J)	0–1
Trinitrotoluene[2,4,6-]	16-20454	0816-01-0218	0.079 (J)	0–1
Trinitrotoluene[2,4,6-]	16-20551	0816-01-0306	0.12	0–1
Trinitrotoluene[2,4,6-]	16-20592	0816-01-0248	0.13	0–1
Trinitrotoluene[2,4,6-]	16-20702	0816-01-0255	0.16	0–1
Trinitrotoluene[2,4,6-]	16-20526	0816-01-0195	0.48	0–1

Note: Shaded cells indicate samples from SWMU 16-016(c)-99.

Table C-5
ESLs for MDA P Site Receptors for COPCs in the Biological Zone

Analyte	Plant	Invertebrate	Robin (Insectivore)	Robin (Omnivore)	Robin (Herbivore)	Kestrel (100% Carnivore)	Kestrel (Intermediate Carnivore)	Desert Cottontail	Deer Mouse	Vagrant Shrew	Red Fox
Inorganic Chemicals											
Antimony	0.05	—[a]	—	—	—	—	—	6.2	1	0.57	97
Barium	100	—	230	380	1,000	46,000	1,700	34	4.5	2.4	420
Chromium	2.4	1.4	460	550	680	13,000	5,300	8,000	2,100	700	18,000
Cobalt	0.25	—	0.051	0.093	0.46	6	0.38	5	0.19	0.091	10
Copper	10	13	390	310	260	22,000	3,300	300	170	170	8,900
Iron	—	—	—	—	—	—	—	—	—	—	—
Lead	450	2000	55	72	100	2,700	500	930	220	100	4,600
Nickel	20	100	980	1,200	1,600	38,000	9,700	7,900	2,100	900	31,000
Selenium	0.1	7.7	1.1	2	10	140	8.4	55	1.9	0.91	110
Silver	0.05	—	14	19	30	2,400	100	0.52	0.14	0.091	14
Vanadium	0.025	—	2.8	5.1	28	510	21	790	20	9.6	1,500
Zinc	10	350	97	130	210	4,900	660	1,100	840,000	710,000	1,800,000
Organic Chemicals											
Acetone	—	—	42,000	4,200	2,200	5,600,000	310,000	4.3	3.8	37	—
Amino-2,6-dinitrotoluene[4-]	80	—	—	—	—	—	—	5.8	3.6	5.7	930
Amino-4,6-dinitrotoluene[2-]	80	—	—	—	—	—	—	8.4	5.3	8.3	1,300
Aroclor-1260	—	—	0.44	0.86	15	2.2	1.8	660	10	5	32
Bis(2-ethylhexyl)phthalate	—	—	1	1.9	23	1.7	2.3	3,600	61	30	64
DDT[4,4'-]	3.7	—	0.0026	0.0052	0.12	0.0092	0.0093	200	2.1	1	4.6
HMX	—	500	—	—	—	—	—	51	43	260	37,000
RDX	100	500	—	—	—	—	—	11	9.2	33	4,900
Toluene	200	—	—	—	—	—	—	160	73	70	12,000
Trinitrotoluene[2,4,6-]	0.7	0.7	—	—	—	—	—	77	53	100	16,000

Note: Results reported in milligrams per kilogram.
[a] — = No ESL established.

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