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Investigation Work Plan for the TA-16-340 Complex, Solid Waste Management Units 13-003(a)-99, 16-003(n)-99, 16-003(o), 16-026(j2), and 16-029(f) at Technical Area 16

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Prepared by
Risk Reduction and Environmental Stewardship–Remediation Services

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March 2004

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EXECUTIVE SUMMARY

This investigation work plan presents recommendations for the investigation activities required to complete the next phase of the Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) for the TA-16-340 Complex at Los Alamos National Laboratory. The TA-16-340 Complex includes Solid Waste Management Units (SWMUs) 13-003(a)-99, 16-003(n)-99, 16-003(o), 16-026(j2), and 16-029(f) at Technical Area 16 (TA-16). SWMUs 13-003(a)-99, 16-003(n)-99, 16-026(j2), and 16-029(f) have been included as part of this investigation work plan because they are geographically close to the primary SWMU 16-003(o) and will be affected by decommissioning and decontamination (D&D) activities at the TA-16-340 Complex. D&D activities will include removal of buildings, utilities, and sumps associated with the TA-16-340 Complex up to 5 ft from structures. Risk Reduction & Environmental Stewardship–Remediation Services personnel will remove fixtures such as drainlines at a distance greater than 5 ft from structures.

The investigation activities described in this plan have been designed to continue determining the nature and extent of contamination that was identified during past investigations such as the Phase I RFI fieldwork conducted at the TA-16-340 Complex. In addition, interim action activities will accompany the D&D of the TA-16-340 Complex. This plan outlines the soil removal and the verification sampling needed to ensure that the interim action is effective. The verification sampling associated with soil removal will also help define nature and extent of contamination at the TA-16-340 Complex.

Evaluating the environmental data generated during the Phase I RFI resulted in the identification of the following primary contaminants associated with the TA-16-340 Complex: high explosives (HE), semivolatile organic compounds, metals, and volatile organic compounds (VOCs).

Phase I investigations indicate that nature and extent of contamination at the site is not fully defined at the SWMUs associated with the TA-16-340 Complex. The Phase I RFI data were also used to determine that soil removal is appropriate, as part of an interim action. Soil removal is recommended for those locations with contaminant levels above industrial outdoor worker soil screening levels (based on existing data). In addition, soil removal may be required after the sumps and drainlines have been removed; this determination will be based on screening data associated with D&D excavations. Screening parameters will include HE, VOCs, gross radioactivity, and metals.

Additional characterization activities will include collecting and analyzing samples within and beyond the existing SWMU boundaries associated with the TA-16-340 Complex. Such samples will help delineate the lateral nature and extent of contamination. To address the possibility of contamination along the sides of the main drainage, as a result of splashing from the air stripper, samples will be collected adjacent to the air stripper structure associated with the Building 16-340 outfall. Two deep boreholes will be drilled, one at the Building 16-340 outfall and one at the downslope end of the air stripper structure, to bound the vertical nature and extent of contamination. The minimum number of screening samples and analytical samples that are anticipated are 295 and 65, respectively.

Contamination derived from the TA-16-340 Complex has been found in surface waters at Fishladder Seep and at the confluence of Fishladder Canyon and Cañon de Valle. Therefore, further characterization of the subsurface alluvial system in Fishladder Canyon is required. A high-resolution resistivity survey will be conducted to determine moist zones in the canyon. Alluvial wells will be sited based on this information.

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1.0 INTRODUCTION

In this section we provide general site information, regulatory background, and objectives for this work plan.

1.1 Regulatory Background and General Site Information

Los Alamos National Laboratory (LANL or 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 covers 40 mi^2 of the Pajarito Plateau, which consists of a series of finger-like mesas separated by deep canyons containing perennial and intermittent streams running from west to east. Mesa tops range in elevation between 6200 and 7800 ft.

The Laboratory's Risk Reduction and Environmental Stewardship–Remediation Services (RRES-RS) Project, formerly the Environmental Restoration (ER) Project, is part of a national effort by the DOE to clean up sites and facilities formerly involved in weapons research and production. The goal of the RRES-RS Project is to ensure that past operations under the DOE do not threaten human or environmental health and safety in and around Los Alamos County, New Mexico. To achieve this goal, RRES-RS personnel are currently investigating sites that potentially have been contaminated by past Laboratory operations. The sites under investigation are either solid waste management units (SWMUs) or areas of concern (AOCs).

This investigation work plan (IWP) addresses SWMUs 16-003(n)-99, 16-003(o), 16-026(j2), 16-029(f), and 13-003(a)-99, which contain hazardous and radioactive components and are hence undergoing the RCRA corrective action process. Collectively, these SWMUs are hereinafter referred to as the Technical Area 16-340 (TA-16-340) Complex SWMUs. SWMUs 13-003(a)-99, 16-003(n)-99, 16-026(j2), and 16-029(f) are included as part of this IWP because they are geographically near the primary SWMU 16-003(o) and will be affected by decommissioning and decontamination (D&D) activities at the TA-16-340 Complex.

Administrative authority over work performed under the RRES-RS Project at a site depends upon the site's history and the type of contaminant(s) present or potentially present at the site. The New Mexico Environment Department (NMED) has authority under the New Mexico Hazardous Waste Act (NMHWA) over cleanup of sites with hazardous wastes or certain hazardous constituents. The DOE has authority over cleanup of sites with radioactive contamination. Radionuclides are regulated under DOE Order 5400.5, "Radiation Protection of the Public and the Environment," and DOE Order 435.1, "Radioactive Waste Management."

This document contains data on radioactive contaminants. The management of these materials is regulated under the Atomic Energy Act and is specifically excluded from regulation under the Resource Conservation and Recovery Act (RCRA) and the NMHWA. These data are provided to the NMED for informational purposes only.

Technical Area 16 (TA-16) is located in the southwest corner of the Laboratory (Figure 1). The TA covers 2410 acres or 3.8 mi^2 and is on a portion of land that was acquired by the Department of the Army for the Manhattan Project in 1943. TA-16 is bordered by Bandelier National Monument along State Highway 4 to the south and by the Santa Fe National Forest along State Highway 501 to the west. To the north and east it is bordered by TAs 8, 9, 11, 14, 15, 37, and 49 (Figure 1). TA-16 is fenced and posted along State Highway 4. Water Canyon, a 200-ft-deep ravine with steep walls, separates State Highway 4 from active

sites at TA-16. Cañon de Valle forms the northern boundary of TA-16. Security fences surround the production facilities.

The TA-16-340 Complex is located near the eastern end of the TA-16 mesa near the head of a small canyon known as Fishladder Canyon (Figure 2). Within the TA-16-340 Complex, SWMU 16-003(o) is the sumps and drainlines for Building 16-340, SWMU 16-003(n)-99 is the sumps and drainlines for Building 16-342, SWMUs 16-029(f) and 16-026(j2) are the sumps and drainlines for Building 16-345, and SWMU 13-003(a)-99 is the septic system that was associated with the western area of the P-Site Firing Site (Figures 2, 3, and 4). The TA-16-340 Complex has been inactive since 1999.

Historically, the TA-16-340 Complex was used for the production of plastic-bonded explosive powders (LANL 1993, 20948, pp. 5-35–5-38). It consisted of high explosives (HE) processing facilities (Buildings 16-340 and 16-342) and rest houses (Buildings 16-341, 16-343, and 16-345) (Figure 3). The rest houses were used to store raw HE and HE parts between HE operations in processing buildings.

This work plan presents the results of historical investigations, including the Phase I RCRA Facility Investigation (RFI),of SWMUs at the TA-16-340 Complex, describes a strategy for interim soil removal associated with D&D activities at the TA-16-340 Complex, and presents recommendations for additional sampling activities required to continue the investigation of the TA-16-340 Complex SWMUs. It contains descriptions of site background, site conditions, the scope of soil and fixture removal activities, the scope of investigation activities to continue the RFI investigations, investigation methods, and an anticipated schedule for completing the field activities. Appendix A includes a list of acronyms and presents a table with metric-to US customary unit conversions. Appendix B describes the historical investigations of the TA-16-340 Complex, including pre-RFI and Phase I RFI activities and analytical results. Appendix C, on a CD included with this plan, provides the Phase I RFI data. Appendix D is a plan for the management of investigation-derived waste (IDW).

1.2 Investigation Objectives

The objectives of this work plan for the TA-16-340 Complex are as follows:

- to present the current knowledge of the nature and extent of hazardous waste or hazardous constituent and/or radionuclide releases to the environment based on existing data, particularly those collected during the Phase I RFI
- to describe the interim action removal of contaminated soil and potentially contaminated fixtures that will be completed in coordination with the upcoming D&D of the TA-16-340 Complex
- to establish the rationale for additional data collection and analysis at the TA-16-340 Complex
- to identify appropriate methods and protocols for collecting, analyzing, and evaluating data to complete the next phase of characterization at the TA-16-340 Complex

D&D activities include the removal of buildings and fixtures during fiscal year 2004. The TA-16-340 Complex is slated for D&D because it is no longer used.

2.0 BACKGROUND

2.1 Operational History and SWMU Descriptions

TA-16 was established for the purposes of developing explosive formulations, casting and machining explosive charges, and assembling and testing explosive components for the US nuclear weapons program. Almost all of the work has been conducted in support of the development, testing, and

production of explosive charges for the implosion method. Present-day use of this TA is essentially the same, although facilities have been upgraded and expanded as explosive and manufacturing technologies have advanced.

The TA-16-340 Complex (Figure 5) operated from 1952 to 1999 and processed large quantities of HE for the production of plastic-bonded explosives. Plastic-bonded explosives are produced by using a slurry that consists of HE and solvents together with inert binders. HE- and solvent-contaminated wash waters were routed as waste to the six sumps associated with Building 16-340 (Figure 6a) and the single sump and outfall associated with Building 16-342 (Figure 6d). Historically, discharge from the Building 16-340 sumps was routed to the Building 16-340 outfall, which became known as the fishladder because an air stripper installed at the outfall in the late 1980s resembled a fishladder (Figures 5 and 6b). During a mid-1990s evaluation of flow volumes for outfalls at TA-16 that operated under National Pollutant Discharge Elimination System (NPDES) permits, discharge to the Building 16-340 outfall was measured at over 3.5 million gal./yr and discharge to the Building 16-342 outfall was measured at 4600 gal./yr (LANL 1994, 76858).

During the late 1970s, the US Environmental Protection Agency (EPA) issued NPDES permits for the operation of the Building 16-340 outfall as EPA Outfall 05A054 and the Building 16-342 outfall as EPA Outfall 05A062 (EPA 1990, 12454.2). The Building 16-345 sump (Figure 6c) and outfall were never issued permits under NPDES. The latest NPDES permitting effort for the Building 16-340 outfall occurred in 1994. The Building 16-340 outfall was deactivated on July 20, 1998, and the Building 16-342 outfall was deactivated on July 31, 1996.

This work plan describes sampling at five TA-16-340 Complex SWMUs that have not been identified as administratively complete and that will be disturbed by the D&D activities at the TA-16-340 Complex. D&D activities at the TA-16-340 Complex will also affect five administratively complete SWMUs: 16-029(i),16-012(o), 16-012(p), 16-012(q), and 16-012(r). With the exception of SWMU 16-029(i), which was identified as a sump but is a duplicate (see section 2.1.1), these SWMUs were container storage and 90-day accumulation areas associated with the TA-16-340 Complex rest houses. This section provides descriptions of the five SWMUs at the TA-16-340 Complex that have not been identified as administratively complete.

2.1.1 SWMU 16-003(n)-99

SWMU 16-003(n)-99 is the HE sump and drainline associated with Building 16-342 (Figures 2, 3, and 6d). It also includes the soil within the discharge area for the outfall. It was consolidated from SWMUs 16-003(n) and 16-029(i), both of which were identified as the Building 16-342 sump. SWMU 16-029(i) was recommended for no further action as it was a duplicate of SWMU 16-003(n) (LANL 1995, 58077.1, p. 6-3). SWMU 16-029(i) is administratively complete.

Building 16-342 was used for HE processes in which the constituents of plastic-bonded explosive formulations were mixed and blended (LANL 1993, 20948, pp. 5-35–5-36). The sump is a rectangular tank with outside dimensions approximately 8 ft long by 4 ft wide by 5 ft high. The sump walls and bottom are constructed of 8-in.-thick, steel-reinforced concrete. The sump had a removable 0.25-in. aluminum lid. The sump operated to remove suspended solids from process water before it was discharged to the outfall. HE fines collected in a cloth filter bag secured inside a metal filter basket. The baskets and filter bags were periodically removed and taken to the TA-16 basket-washing facility for cleaning. HE fines that were too small to collect in the filter bags settled to the bottom of the sump. To help separate the suspended solids, the water flowed under an aluminum baffle and over a concrete weir before it discharged to the outfall. HE in the bottom of the sump was periodically removed and burned. The sump

is connected to a 6-in. vitrified clay pipe that discharged to the outfall located to the northeast of the sump. This outfall daylighted in a small tributary to Fishladder Canyon. Fishladder Canyon ultimately connects to Cañon de Valle.

Wastes consisted primarily of HE and solvents (LANL 1993, 20948 pp. 5-35–5-36) that were transported in the washdown that resulted from cleaning activities. The principal HE used at TA-16 were trinitrotoluene (TNT), cyclotrimethylenetrinitramine (RDX), and cyclotetramethylenetetranitramine (HMX) with barium nitrate. Barium nitrate was used to process baratol, an explosive that was formerly produced in great quantity, therefore barium is another key HE-related contaminant. During the early 1970s, two evaluations of contaminant use in Building 16-342 were completed. Wilder (1970, 34564.0) classified the use of HE in Building 16-342 as high but intermittent and the probability of HE in the sump as low. Panowski and Salgado (1971, 70968.13) stated that effluents from the building were negligible and did not identify any solvents that were used in the building. Voelz (1979, 01808.2) noted that natural uranium had been used in the building. By the 1990s, solvents were containerized for disposal, but historically solvents were discharged to the sump. Thus, the potential contaminants at SWMU 16-003(n)-99 are HE, volatile organic compounds (VOCs), and inorganic chemicals including uranium.

2.1.2 SWMU 16-003(o)

SWMU 16-003(o) consists of the six inactive HE sumps and the drainline associated with Building 16-340 (Figures 2, 3, and 6a). The sump and drainline received effluent from sink drains, floor drains, equipment drains, and roof drains (LANL 1993, 20948, p. 5-37). This SWMU also includes the air stripper (“Fishladder”) and the soils downgradient from the discharge point of the outfall.

Building 16-340 was used for HE processes in which constituents of plastic-bonded explosive formulations were mixed and blended (LANL 1993, 20948, pp. 5-37–5-38). The sumps are all rectangular tanks with outside dimensions approximately 10 ft long by 4 ft wide by 5 ft high. The walls and bottom of each are constructed of 8-in.-thick, steel-reinforced concrete. Each sump had a removable 0.25-in. aluminum lid. Sump operations are described in section 2.1.1. The sumps are connected to a 10-in. vitrified clay pipe that discharged to the outfall east of Building 16-340. This outfall daylighted in Fishladder Canyon. Fishladder Canyon ultimately connects to Cañon de Valle. In the 1980s, the outfall was plumbed to an air stripper (the “fishladder”) that was designed to eliminate VOCs from the outfall. The air stripper discharged approximately 250 ft east of the sumps into Fishladder Canyon. Splashing caused by the air stripper may have resulted in the dispersal of outfall liquids over a larger area.

Wastes discharged from Building 16-340 to SWMU 16-003(o) consisted primarily of HE and solvents (LANL 1993, 20948 pp. 5-37–5-38) that were transported in the washdown that resulted from cleaning activities. Two evaluations of contaminant use in the building were completed during the early 1970s. Wilder (1970, 34564.0) classified the use of HE in Building 16-340 as moderate and the probability of HE in the sump as low. Panowski and Salgado (1971, 70968.13) inventoried chemicals used in the facility and stated that the use of solvents at TA-16 was greatest in Building 16-340. They noted that during a six month period that began in 1970 and ended in 1971, 700 lbs of acetone, 500 lbs of ammonium sulfate, 330 lbs of n-butyl-acetate, 3 lbs of chloroform, 55 lbs of 1,2-dichloroethane, 11 lbs of ethyl acetate, 72 lbs of isopropyl alcohol, 110 lbs of methanol, 72 lbs of methylene chloride, 750 lbs of butanone[2-], and 110 lbs of toluene had been used within Building 16-340. They determined that the building had released large quantities of explosives, solvents, gases, and other materials. Voelz (1979, 01808.2) noted that natural uranium had been used in the building. By the 1990s, solvents were containerized for disposal, but historically the solvents were discharged to the sump. Thus, potential contaminants at SWMU 16-003(o) are HE, VOCs, and inorganic chemicals including uranium.

2.1.3 SWMUs 16-029(f) and 16-026(j2)

SWMUs 16-029(f) and 16-026(j2) are associated with Building 16-345. SWMU 16-029(f) is the inactive HE sump and SWMU 16-026(j2) is the drainline and outfall (Figures 2, 3, and 6c). SWMU 16-026(j2) also includes the soil within the outfall.

Building 16-345 was an HE rest house that served as a storage facility for Building 16-340 (LANL 1993, 20948, p. 5-38). The sump is a rectangular tank with outside dimensions approximately 8 ft long by 4 ft wide by 5 ft high. The walls and bottom are constructed of 8-in.-thick, steel-reinforced concrete. The sump had a removable 0.25-in. aluminum lid. A description of sump operations is given in section 2.1.1 for SWMU 16-003(n)-99. The sump is connected to a 1.5 in. steel pipe that discharged to the outfall. This outfall is believed to have discharged southeast of Building 16-345, but it does not daylight and has not been located.

Wastes that were discharged from Building 16-345 consisted primarily of HE (LANL 1993, 20948, p. 5-38) transported by washdown that resulted from cleaning activities. Two evaluations of contaminant use in the building were completed during the early 1970s. Wilder (1970, 34564.0) noted that HE in Building 16-345 was stored in containers and that the probability of HE in the sump was “nil.” Panowski and Salgado (1971, 70968.13) stated that effluents from the building were negligible. Potential contaminants at SWMUs 16-029(f) and 16-026(j2) are HE, VOCs, and inorganic chemicals.

2.1.4 SWMU 13-003(a)-99

Consolidated SWMU 13-003(a)-99 consists of SWMU 13-003(a) and AOC 13-003(b), both of which are components of an inactive septic system associated with activities at former TA-13 (Figures 2, 3, and 4) (LANL 1993, 20948, pp. 5-98–5-99). Former TA-13, originally called P-Site, was located at the eastern end of the current TA-16 explosives manufacturing area. Former TA-13 was built in 1944 to support the HE Project of the Manhattan Project. It was principally designed as a site for counter x-ray diagnostics of HE lens configurations. Activities that supported the diagnostics included the operation of counter x-ray equipment, the assembly of HE test devices, and research for the magnetic method program. Buildings in the western half of former TA-13, including those associated with the septic system, were demolished in the early 1950s to make way for the construction of the TA-16-340 Complex.

SWMU 13-003(a) is the location of a decommissioned and removed septic tank (former Structure 13-12) that received liquid wastes from an office and shop building (Building P-1, later renumbered as Building 16-475) associated with implosion and initiator testing conducted during the early years of Laboratory operations. The building had a toilet, lavatory, and small darkroom adjacent to the sewer hookup. The tank served Building 16-475 from the 1940s until 1951. The tank was decommissioned and removed in 1951, when the entire area was leveled to make room for construction of Building 16-340. Parts of Building 16-340 were built on top of the original location of the septic tank. Types of liquid wastes discharged to the septic tank are unknown.

AOC 13-003(b) is the drain field associated with the septic tank. The drain field is located about 100 ft northeast of the former location of the decommissioned and removed septic tank. There are no records documenting that the drain field was removed.

An early report (Buckland 1948, 04925.2) states that either HE or radionuclide contamination may be present at P-Site. Potential contaminants at SWMU 13-003(a)-99 are HE, VOCs, inorganic chemicals, including uranium, and radionuclides (the building supported the P-Site Firing Site).

2.2 Land Use

The land adjacent to the TA-16-340 Complex is dedicated to ongoing Laboratory operations, i.e., to industrial land use (LANL 2000, 76100). The Laboratory does not anticipate that the land use at TA-16 and surrounding TAs will change in the future. Public access to the site is restricted by security fences, guards, HE access control, and other site controls. Entrance to the site requires a security clearance. The TA-16-340 Complex is no longer operational and will be removed by the D&D program during 2004. Future programmatic development at the site is possible. NMED had previously approved industrial (site-specific) scenarios for sites near the TA-16-340 Complex such as the 260 outfall (LANL 1998, 59173) and V-Site (LANL 1997, 55512).

2.3 Relationship to other SWMUs and AOCs

Several groups of SWMUs and AOCs near the TA-16-340 Complex have the potential to influence aspects of the TA-16-340 Complex RFI investigations (Figures 2 and 3). These groups are associated with World War II-era facilities, the TA-16 Burning Ground and Material Disposal Area P(MDA P), the P-Site (TA-13) Firing Site, and the TA-16 Sanitary Wastewater Treatment Plant.

2.3.1 SWMUs 16-024(u) and 16-025(d2) and AOCs C-16-049, C-16-050, and C-16-060

These SWMUs and AOCs are located near the TA-16-340 Complex and are building footprints associated with World War II-era facilities that were part of P-Site west. D&D activities are not expected to disrupt these sites. Sampling of the SWMUs will be conducted during future investigation activities at TA-16.

2.3.2 SWMUs 16-010(b, c, d, e, f), 16-010(h)-99, 16-016(c)-99, 16-018, and 16-028(a)

These SWMUs are located on the mesa in the northeast corner of TA-16 (Figures 2 and 3) and are associated with the TA-16 Burning Ground and MDA P. Runoff from several of these SWMUs is southward to Fishladder Canyon, so the possibility exists for contaminants from these sites to have commingled in Fishladder Canyon with contaminants derived from the TA-16-340 Complex. The burning ground was constructed in 1951 for HE waste treatment and disposal. Over the years, hundreds of thousands of pounds of HE and HE-contaminated waste materials have been burned at this location. Noncombustible material that remained after burning was subsequently either placed in MDA P, north of the burning ground (through 1984), or taken to TA-54 for storage pending off-site disposal (1984 to present). MDA P contained the wastes from the synthesis, processing, and testing of HE; residues from the burning of HE-contaminated equipment; and construction debris. A barium nitrate pile was located at the TA-16 Burning Ground for many years. Site investigations were conducted at several of these SWMUs in 1995 (LANL 2003, 76876). MDA P (SWMU 16-018), the flash pad [SWMU 16-010(b)] associated with Structure 16-387, and the barium nitrate pile area recently underwent RCRA closure including soil removal and decontamination. A voluntary corrective action (VCA) was conducted simultaneously at SWMU 16-016(c)-99. Altogether, approximately 55000 yd^3 of soil and debris were removed during the combined RCRA closure and the VCA (LANL 2003, 76876).

2.3.3 SWMUs 13-001-99, 16-029(h)-99, and 16-031(h)

These SWMUs are located on the mesa southeast of the TA-16-340 Complex and are associated with the P-Site (TA-13) Firing Site. TA-13 (P-Site) has been used for a variety of Laboratory activities, some dating back to World War II (LANL 1993, 20948, pp. 5-226–5-228; LANL 1995, 58077.1, pp. 5.291–5-294). P-Site was constructed in 1944 as a firing site to support implosion method development for the

Manhattan Project. Key diagnostic methods at the firing site included the x-ray method and the magnetic method. Later, the site was used for initiator testing and experimental HE machining operations. No sampling has been completed at TA-13.

2.3.4 SWMU 16-004(a)-99

SWMU 16-004(a)-99 is the TA-16 Sanitary Wastewater Treatment Plant and is located southeast of the TA-16-340 Complex (Figures 2 and 3). The inactive TA-16 Sanitary Wastewater Treatment Plant received waste from the TA-16 sewer system, which consisted of thousands of feet of piping as well as numerous lift stations and manholes (LANL 1993, 20948 pp. 5-133–5-135). The wastewater treatment plant was built during 1953 and was disconnected in 1992, after which it was connected to the Laboratory-wide sewage system during the sanitary waste system consolidation (SWSC) project. The SWSC has received only sanitary waste.

2.4 Contaminant Transport

The types of wastes potentially disposed of at the TA-16-340 Complex include HE, inorganic chemicals (including uranium), VOCs, and semivolatile organic compounds (SVOCs), including polyaromatic hydrocarbons (PAHs) (see Appendix B section B-2.2). The relevant release and transport processes associated with these waste types are a function of chemical-specific properties that include the relationship between the physical form of the constituents and the nature of the transport processes for the constituents in the environment. Specific properties include the degree of saturation and the potential for ion exchange (barium, other metals) or sorption (TNT, HMX, and RDX on natural organic carbon) and the potential for natural bioremediation. The transport of VOCs occurs primarily in the vapor phase and by diffusion or advection in subsurface air. Relatively water-soluble, low-vapor pressure constituents, such as HE and metals, are susceptible to release and transport by infiltration of water through the vadose zone or by alluvial water pathways. Contaminants with low water solubility, including some organic contaminants such as PAH, metals, and some HE, are likely to be transported by physical processes such as sediment transport.

The primary potential release and transport mechanisms for contaminants at the TA-16-340 Complex include direct discharge; precipitation, sorption, and mechanical transport; dissolution and advective transport in water; and volatization, diffusion, and dispersion.

2.4.1 Direct Discharge of Fine Particulates and Dissolved Contaminants as Operational Releases

Studies of contaminant distributions at other TA-16 sites such at the 260 outfall (LANL 1998, 59891), the 90s Line Pond (LANL 1996, 62537), and V-Site (LANL 1999, 63973) indicate that the initial deposition of contaminants at outfall discharge points or sump and drainline leakpoints tends to concentrate contaminants near their deposition points. The high specific gravity of RDX and HMX tends to cause particulates of these compounds discharged from sumps and drainlines to be initially deposited at water settling areas (e.g., outfall discharge areas).

2.4.2 Precipitation, Sorption, and Mechanical Transport

Barium and many other inorganic chemicals have a high affinity for adsorption on clays, oxides, and hydrous oxides, with literature values for sorption coefficients in soil ranging from 66 to 2800 mg/g (Myers 2003, 76188). These contaminants tend to bind to fine particulates and are transported by physical processes such as sediment transport and redeposition. For Cañon de Valle, the fine particle-sized

fraction appears to contain the highest inventories of highly sorbing contaminants such as barium (LANL 2003, 77965, p. 5-16).

2.4.3 Dissolution and Advective Transport in Water

HE such as RDX and HMX do not tend to sorb on particulates in the environment and tend to be transported in the suspended and dissolved phase (LANL 2003, 77965, p. 5-17). Rain, vadose zone water, or melting snow interacts with contaminants in macropores in sediments and tuffs, dissolves the contaminants, and transports them through surface water, the vadose zone, or alluvial systems. At TA-16, transport through the vadose zone is known to be primarily along fast pathways such as fracture zones and surge beds (LANL 1998, 59891; LANL 2003, 77965) that are intermittently saturated. RDX is moderately soluble in water (approximately 60 mg/L at 25°C). RDX and the other HE (e.g., HMX) tend to be transported primarily by either infiltration through saturated pathways through the vadose zone or through an alluvial or surface water pathway. The relative sorption potentials of barium and RDX are reflected in their respective contaminant distributions at other sites at TA-16. In the deep perched zone of R-25, although barium has not been detected at high levels, RDX has been detected at a maximum concentration of 84 µg/L.

2.4.4 Volatilization, Diffusion, and Dispersion

Gas or vapor-phase contaminants such as VOCs are likely to volatilize to the atmosphere from near-surface soils and sediments and to migrate by diffusion through air-filled pores in the vadose zone. Migration of gas- or vapor-phase contaminants from tuff into ambient air may occur by diffusion or advection driven by barometric pressure changes and could be followed by subsequent dispersion.

2.4.5 Other Release and Transport Mechanisms

Other release and transport mechanisms that are less likely to be important at the TA-16-340 Complex include wind entrainment and dispersal of surface soils and uptake of contaminants by animals or plants.

All of these transport mechanisms have evolved in their magnitude and importance during the 11 years since the “RFI Work Plan for Operable Unit [OU] 1082” (LANL 1993, 20948) was completed in 1993 and since Phase I RFI investigations at the TA-16-340 Complex were completed in 1995. Active operational releases ceased in 1999, so concentrations of released constituents are likely attenuating due to natural dilution processes. Water discharges at the TA-16-340 Complex outfalls also ceased in 1998, removing hydrologic head as a driving force for contaminant migration either vertically into the vadose zone or through the alluvial system in Fishladder Canyon. The ongoing drought has further reduced the amount of water available in the Fishladder Canyon system for either sediment transport processes or advective transport of waterborne constituents. Finally, the Cerro Grande fire (May 2000) burned lightly to moderately in Fishladder Canyon, potentially perturbing the hydrologic regime in this alluvial system.

2.5 Potential Receptors

Receptors potentially exposed to contamination at the TA-16-340 Complex include the following: on-site environmental workers, trail users, and construction (or D&D) workers. These are the receptors that were identified and approved by NMED for use in the TA-16-260 outfall corrective measures study (CMS) (NMED 1998, 62327.1; LANL 2003, 77965, p. 6-3). In this report, however, the industrial outdoor worker scenario is used for establishing interim soil cleanup levels. Use of this scenario is protective of all of the above workers because an industrial outdoor worker would spend the most time at the site.

Following the conceptual site model for the TA-16-260 outfall (LANL 2003, 77965, p. 6-3) the complete exposure pathways identified for receptor exposure include

inhalation of contaminated dust particles released from soils or tuff,

incidental ingestion of soil/tuff,

external irradiation,

dermal contact with soil/tuff, and

inhalation of gas-phase contaminants such as VOCs.

These are the most likely pathways for receptors given the activities that take place at the TA-16-340 Complex (see also LANL 1998, 59891; LANL 2000, 64355.4; LANL 2003, 77965, p. 6-3). The on-site environmental worker scenario represents individuals involved in environmental monitoring such as field sampling. The trail user scenario is for a worker who uses the area for recreational/exercise purposes such as walking or jogging (these activities are extremely unlikely to take place at the site given that controls for the TA-16 HE exclusion area currently prohibit jogging and walking). The construction worker represents individuals involved in more intrusive activities such as excavation or D&D. To be protective, however, we assume the industrial outdoor worker scenario for future possible activities at the site.

Ecological receptors may be exposed by the likely exposure pathways for workers as well as by root uptake and the food web; in addition, these receptors may be exposed to contaminants in subsurface burrows. No bodies of surface water exist at the TA-16-340 Complex itself. However, if Fishladder Canyon is included in this evaluation, there is intermittent surface water in Fishladder Seep (the seep was wet enough to sample in only five quarters between 1997 and 2003). Fishladder Seep is downgradient from the Building 16-340 outfall and the chemicals found in the seep are assumed to be primarily from operations at the TA-16-340 Complex. Exposure pathways for the seep therefore are direct contact (by ingestion and dermally) with sediment (particularly when the seep is dry) and, to a lesser extent, with surface water (when the seep is wet and during stormwater runoff events). For surface water, direct contact is minimal. Human receptors are not in direct contact with surface water (e.g., by wading) under normal circumstances, nor do they use Fishladder Seep as a drinking water source. No groundwater from the site is available for drinking water, and potential exposures to regional groundwater at TA-16 will be evaluated in the context of the deep groundwater TA-16-260 CMS.

The hydrologic system at TA-16 is complex and heterogeneous (LANL 1998, 59891, p. 5-1–5-8; LANL 2003, 77965, pp. 5-1–5-14,). Perched water has been detected at a depth of less than 200 ft in the vadose zone at boreholes located near the 90s Line Pond (3000 ft west of the TA-16-340 Complex) and near the head of Martin Spring Canyon (650 ft south of the TA-16-340 Complex); however, in both cases perched water is sporadically present, most often during initial drilling and during high recharge periods (LANL 2003, 77965, Section 4). This shallow, heterogeneous perched water is also manifest at SWSC, Martin, and Burning Ground Springs (Figure 2), As a result of the long-term drought that is affecting the region, only Burning Ground Spring is currently flowing. The nearest borehole to the TA-16-340 Complex, CDV-16-3(i) (Figure 2), which was drilled during December 2003, did not contain shallow (i.e., detected at a depth of less than 200 ft) perched water.

Deeper perched water (although determining whether this water is, in fact, perched or is connected to the regional aquifer is difficult) has been found at depths ranging from 550 to 750 ft in borehole SHB-3, well R-25, and borehole CDV-16-1(i) but not in boreholes CDV-16-3(i) or CDV-R-37-2 (Figures 2, 7a, and 7b). The status of perched water in CDV-16-2(i) is equivocal; deep perched water was present during initial drilling but persisted for less than 1 mo. Waters in R-25 and CDV-16-1(i) contain RDX and other HE, so

travel times to the deep perched aquifer and regional aquifer at TA-16 are rapid (<50 yr) (Broxton et al. 2002, 72640).

The potential for exposure of receptors by a deep regional groundwater pathway is possible (e.g., after groundwater flows reach downgradient regional supply wells) but difficult to constrain. Evaluation of this pathway will be completed in the context of the deep groundwater CMS for the TA-16-260 outfall. The results of this evaluation will apply to the TA-16-340 Complex.

2.6 Waste Inventory

No formal waste inventory exists for the TA-16-340 Complex. Wastes that have been discharged to the environment at the TA-16-340 Complex have been determined from a combination of fragmentary historical records, pre-RFI sampling data, and the 1995 RFI sampling data. A description of likely wastes disposed of at the TA-16-340 Complex is provided in the approved “RFI Work Plan for OU 1082” (LANL 1993, 20948) and this information is provided in section 2.1. Additional information on released constituents is provided in the historical investigation report in Appendix B (section B-2.0) of this document.

2.7 Historical Releases

Results of historical investigations demonstrate that contaminants have been released to environmental media at the SWMUs evaluated in this work plan. The “RFI Work Plan for OU 1082” (LANL 1993, 20948) describes historical information concerning chemical use at the TA-16-340 Complex (see section 2.1) and presents pre-RFI data concerning chemicals detected in the environment associated with releases at Building 16-340 (see section 2.1). The 1995 RFI provided additional information on released chemicals (see section 2.8 and Appendix B, section B-2.2). To summarize, historical information indicates the release of substantial amounts of VOCs (e.g., acetone, n-butyl acetate, toluene, butanone[2-]), inorganic chemicals (e.g., barium), and HE (e.g., RDX, HMX, and TNT) in sump water from Building 16-340 with releases of smaller amounts of similar chemicals at Building 16-342 and Building 16-345. Information on chemicals used at the P-Site and potentially released into the septic system is less well known, but these likely include a range of firing-site–related chemicals including VOCs, inorganic chemicals (including uranium), HE, and, potentially, radionuclides.

Pre-RFI sampling data confirmed the presence of HE in soils (e.g., RDX, HMX, and TNT) at the Building 16-340 and Building 16-342 outfalls and of solvents (e.g., butanone[2-]), inorganic chemicals (e.g., chromium and uranium), and HE (e.g., RDX) in sump waters (Baytos 1972, 4953.2, and LANL 1989, 68686.1, as summarized in LANL 1993, 20948, pp. 5-43–5-48).

RFI data collected in 1995 further demonstrated that a number of HE compounds (e.g., RDX, dinitrobenzene [1,3-], dinitrotoluene [2,4-], and TNT), inorganic chemicals (e.g., arsenic, chromium, barium, aluminum, copper, cobalt, vanadium, and lead), and organic chemicals (e.g., PAHs, acetone, butanone[2-], and diethylphthalate) had been released to soils in the vicinity of the Building 16-340 outfall, the Building 16-342 outfall, and the Building 16-345 outfall.

Water sampling of Fishladder Seep, which was conducted as a component of the Phase I RFI and the CMS for the 260 outfall, indicates that contaminants from the TA-16-340 Complex are being transported in alluvial water downgradient from the SWMUs. Aluminum, barium, iron, and manganese concentrations in seep water exceed NMED groundwater standards for human health, domestic water supply, or irrigation. Acetone, dichloroethene[cis-1,2-], HMX, RDX, tetrachloroethene, and trichloroethene have been detected in Fishladder Seep. RDX concentrations exceed the EPA Region 6 tap water screening

level and tetrachloroethene and trichloroethene are present at levels greater than EPA drinking water maximum concentration levels (EPA, 2003; 81724). See section 2.8 and Appendix B, section B-2.3 for more details on these investigations.

2.8 Summary of Historical Investigations

2.8.1 Pre-RFI Field Investigations

Information on pre-RFI field investigations is given in Appendix B, section B-1.2.

Sampling and analysis to ascertain the presence and scale of potential environmental contamination at the TA-16-340 Complex began in 1970. Baytos (as summarized in the “RFI Work Plan for OU 1082” [LANL 1993, 20948, p. 5-43]) analyzed soils samples from the Building 16-340, Building 16-342 and Building 16-345 outfalls for HE. He found a maximum of 0.6 wt % at the Building 16-340 outfall in 1970, with levels of 0.2 wt % in 1984 and 1985. The Building 16-342 outfall contained a maximum of 0.2 wt % HE in 1984 with lower levels detected in 1971, 1973, 1976, and 1985. The Building 16-345 outfall was sampled in 1970, and no HE was detected.

Sump water at Building 16-340 was sampled for HE and a limited suite of solvents in 1988 over a period of ten days. HMX was detected at levels up to 0.41 ppm and solvents were not detected (LANL 1993, 20948, p. 5-45).

Three sediment samples and six water samples were collected at the Building 16-340 outfall by a DOE subcontractor in the late 1980s (LANL 1989, 68686.1), as reported in the “RFI Work Plan for OU 1082” (LANL 1993, 20948, p. 5-46). Acetone and butanone[2-] (methylethylketone) were detected in all water samples at levels up to 390 ppm for butanone[2-]. Beryllium, chromium, uranium, and RDX were detected in one to two water samples each. Barium, cadmium, chromium, RDX, uranium, and cesium-137 were detected in sediments. Four sediment samples were collected downgradient from the Building 16-342 outfall by a DOE subcontractor in the late 1980s (LANL 1989, 68686.1) as reported in the OU 1082 work plan (LANL 1993, 20948, p. 5-48). Barium, chromium, cesium-137, trichlorethane[1,1,1-], HMX, and dinitrotoluene[2,4-] were detected. Barium and HMX were both detected at levels greater than 1993-vintage screening action levels.

2.8.2 Phase I RFI Field Investigations

Phase I RFI activities included screening (HE spot tests, photoionization detector [PID], radioactivity) of surface and subsurface soil, sediment, and tuff samples associated with the outfall drainages of Buildings 16-340, 16-342, and 16-345. Samples were collected in these drainages as part of the initial characterization of contaminant nature and extent. A borehole (13-00001) associated with SWMU 13-003(a)-99 was also drilled and sampled to characterize contamination associated with the P-Site septic system. Full details of these activities can be found in the historical investigation report (HIR) (Appendix B, section B-2.0).

2.8.3 Phase I RFI Results

Phase I RFI results are provided in the HIR (Appendix B; sections B-2.2 and B-2.3) and are briefly summarized here. Primary chemicals of potential concern (COPCs) are HE (primarily RDX), PAHs, phthalates, acetone, and metals such as arsenic, barium, chromium, copper, and lead. PAHs, arsenic, and RDX were detected above EPA Region 6 industrial outdoor worker soil screening levels (SSLs) (EPA 2003, 81724). Contamination is concentrated near the outfall areas for SWMUs 16-003(n)-99, 16-003(o),

and 16-026(j2) and is detected sporadically at mostly lower concentrations along the drainages downslope from these outfalls. The lateral nature and extent of contamination are not fully defined for these drainages or SWMU 13-003(a)-99. The vertical extent of contamination is also not fully defined, particularly for areas near the outfalls.

3.0 SITE CONDITIONS

This section discusses aspects of the environmental setting at the TA-16-340 Complex that are important in assessing the potential impacts posed by contaminated surface and subsurface media, including the following:

Climate. The climate is semiarid with low precipitation and a high evapotranspiration rate. These characteristics limit the amount of moisture percolating through surface and near-surface media and thereby limit the amount of moisture available to leach hazardous constituents or to transport contaminated sediments in the Fishladder Canyon alluvial system.

Vadose zone. The vadose zone in the area is thick and intermittently saturated. These characteristics, which may restrict matrix transport of subsurface contaminants, may also facilitate contaminant transport by “saturated ribbons” to perched and regional water bodies.

Terrain. The canyon-mesa terrain affects both atmospheric conditions and ecological habitats.

3.1 Surface Conditions

The TA-16-340 Complex is located on the TA-16 mesa, a 200-ft high mesa that trends east to west (Figures 1 and 5). The mesa is bounded on the north by Cañon de Valle (approximately 1200 ft north of the TA-16-340 Complex) and on the south by Water Canyon (approximately 3500 ft south of the TA-16-340 Complex) (Figure 1). The elevation of the mesa ranges from 7700 ft to 7500 ft with the elevation at the TA-16-340 Complex ranging from approximately 7530 ft (on the mesa top) to approximately 7350 ft (in Fishladder Canyon near Fishladder Seep). The topography at the TA-16-340 Complex itself is relatively level, with a gentle slope from west to east. Approximately 200 ft east of the complex, Fishladder Canyon and associated tributary canyons drop steeply (more than 50 ft vertically over 200 ft laterally) into a west to east trending drainage (Figure 2). Because Fishladder Canyon heads just east of the TA-16-340 complex and not in the Sierra de los Valles, the severity of flooding events in this canyon is substantially less than in the larger canyons that head in the Sierra de los Valles.

Given that the area adjacent to the TA-16-340 Complex and Fishladder Canyon burned at a low- to moderate-level in the Cerro Grande fire, the increase in erosion that is caused by fire effects has been minimal to moderate in the area, particularly now that vegetation in the area has recovered.

The surface vegetation community at TA-16 as a whole consists of species typical of the Rocky Mountain Montane Conifer forest, which contains several distinct habitat types (LANL 1998, 59891, pp. B-41–B-43). The most prevalent habitat type on the mesa top and in the area around the TA-16-340 Complex is ponderosa pine/Gamble oak. Canyon bottoms, such as Fishladder Canyon, may grade into ponderosa pine/Douglas fir. Dominant trees within the mesa overstory canopy are ponderosa pine and aspen; the mesa top shrub layer is primarily Gamble oak and New Mexico locust; and dominant forbs and grasses include bluegrass, mountain muhly, blue gramma, pine dropseed, wormwood, false tarragon, tall lupine, and cinquefoil. Additional details on the vegetation communities and habitat types at TA-16 are presented in Appendix B of the Phase II RFI Report for SWMU 16-021(c)-99 (LANL 1998, 59891).

3.1.1 Current Site Conditions

The area around the TA-16-340 Complex is a light-use, high-security industrial area typical of TA-16 areas on the mesa top. Future development of the area is possible following the D&D of the TA-16-340 Complex. The soils of the TA-16 mesa are derived from the weathering of the Tshirege Member of the Bandelier Tuff and from the El Cajete pumice (including contributions from phenocrysts and phenocryst fragments, devitrified glasses, and minor lithic fragments) and from wind-blown sources. Native soils in the vicinity of the TA-16-340 Complex have been disturbed by the construction of that facility.

A detailed discussion of soils at TA-16 is provided in Appendix B of the Phase II RFI Report for SWMU 16-021(c)-99 (LANL 1998, 59891, pp. B-12–B-15).

3.1.2 Surface Water

Surface water runoff and associated infiltration into soil are probably the most important hydrologic transport pathways at TA-16. Both HE and barium, the principal contaminants at TA-16, are moderately to strongly soluble and are transported in surface water. Six aspects of the surface hydrology at TA-16 may be relevant to contaminant transport (LANL 1998, 59891, p.B-16–17):

1. The location of pathways of surface water runoff and associated sediment deposition
2. Rates of soil erosion, transport, and sedimentation
3. The effects of operational or fire disturbances on surface hydrology
4. The relative importance of surface runoff versus infiltration as transport pathways in different soil types
5. The solubility and sorption behavior of the contaminants of concern
6. The ultimate fate of surface waters at TA-16

Surface water in the vicinity of the TA-16-340 Complex consists of storm and snowmelt runoff that may flow by small drainages or sheet flow into Fishladder Canyon and Martin Spring Canyon (the watershed divide between the Cañon de Valle and Martin Spring watersheds runs through the southern third of the TA-16-340 Complex area). Fishladder Canyon also contains flowing water during snowmelt and storm events. Alluvial groundwater occasionally discharges at Fishladder Seep, approximately 2000 ft east of the outfall discharge area for Building 16-340. The prevalence of surface flow in Fishladder Canyon has decreased significantly during the past six years. The millions of gallons per year of process discharge during the operational period for the Building 16-340 outfall helped sustain surface flow in Fishladder Canyon. Before to the drought and the shut off of the Building 16-340 NPDES outfall in the mid-1990s, surface water runoff in Fishladder Canyon yielded flowing water at the confluence of Fishladder Canyon and Cañon de Valle. Such flows are not currently seen.

Alluvial groundwater is also present in Fishladder Canyon. This is manifest during wet seasons as discharge at Fishladder Seep. It is not known whether the alluvial groundwater is present only during high-flow seasons, or whether such flow is perennial. No alluvial wells are currently present in Fishladder Canyon. Alluvial groundwater has decreased in flow since the cessation of discharge from the NPDES outfall at Building 16-340 in 1998.

Surface water runoff, alluvial water flow, and associated sediment transport represent key potential migration pathways by which contaminants may be transported to off-site receptors. Surface waters at Fishladder Seep and at the confluence of Fishladder Canyon and Cañon de Valle have contained

contaminants that likely originated from the TA-16-340 Complex; thus these transport pathways are important for TA-16-340 Complex contaminants.

RRES-RS conducted surface water assessments for the SWMUs associated with the TA-16-340 Complex during the late 1990s. SWMU 16-003(n)-99 received a score of 25, SWMU 16-003(o) received a score of 27.3, SWMUs 16-029(f) and 16-026(j2) received a score of 15.8, and SWMU 13-003(a)-99 received a score of 8.8. Higher scores indicate higher erosion potential. Best management practices (BMPs) consisting of straw wattles have been installed at SWMUs 16-003(n)-99 and 16-003(o).

3.2 Subsurface Conditions

3.2.1 Stratigraphy

The former ER Project (now RRES-RS) and the Laboratory Groundwater Protection Program drilled, cored, and sampled several intermediate and deep boreholes relevant to interpretation of the subsurface stratigraphy in the vicinity of the TA-16-340 Complex (Figures 7a, 7b, and 8). These include the R-25 well (total depth of 1942 ft), located approximately 1000 ft north of the TA-16-340 Complex; well CdV-R-37-2 (total depth of 1664 ft), located approximately 5500 ft southeast of the TA-16-340 Complex; intermediate depth well CdV-16-1(i) (total depth of 683 ft), located approximately 1300 ft north of the TA-16-340 Complex; borehole CdV-16-2(i) (total depth of 1063 ft), located approximately 3000 ft northeast of the TA-16-340 Complex; and borehole CdV-16-3(i) (total depth of ~1400 ft), located approximately 1000 ft southeast of the TA-16-340 Complex. Locations and depths of the boreholes used to infer the stratigraphy beneath the TA-16-340 Complex are shown in Figures 2, 7a, and 7b. Figures 7a and 7b also show geologic cross sections in the vicinity of the TA-16-340 Complex. The stratigraphy in the vicinity of the TA-16-340 Complex includes Bandelier Tuff, Cerro Toledo Formation, Puye Formation, and Tschicoma Lavas (Figures 7a, 7b, and 8).

Descriptions of the stratigraphic units in the vicinity of the TA-16-340 Complex are provided in this section. These descriptions rely most heavily on the stratigraphy observed in the R-25 well, which lies at approximately the same distance from the Valles Caldera as the TA-16-340 Complex. More detailed descriptions of the stratigraphy, mineralogy, chemistry, and other properties of the rock units described in this section are available in the R-25 well completion report (Broxton et al. 2002, 72640).

Bandelier Tuff

The Bandelier Tuff is a chemically zoned ignimbrite that exhibits complex zones of welding and crystallization subdivided into four major cooling units. The term welding is used to distinguish between tuffs that are noncompacted and porous (nonwelded) from tuffs that are more compacted and dense (welded). In the field or in borehole cuttings, the degree of welding is quantified by the degree of flattening of pumice fragments (a higher degree of flattening and elongation equals a higher degree of welding). Petrographically, welded tuffs show adhesion (welding) of grains and nonwelded tuffs do not. The term “devitrified” is applied to tuffs whose volcanic glass has crystallized.

Tshirege Member

The Pleistocene Tshirege Member of the Bandelier Tuff is a compound cooling unit that resulted from several successive ash flow depositions separated by periods of inactivity that allowed partial cooling of each unit. Properties related to water flow and contaminant migration (e.g., density, porosity, degree of welding, fracture content, and mineralogy) vary both vertically and laterally as a result of localized

variations in emplacement temperature, cooling history, thickness, gas content, and chemical composition. The Tshirege Member of the Bandelier Tuff was 383 ft thick in the R-25 well.

Tshirege Member Unit 4 (Qbt 4)

Unit 4 of the Tshirege Member of the Bandelier Tuff is made up of a series of variably welded vitric to devitrified ash flow tuffs that extend to a depth of 84 ft in the R-25 well. Unit 4 is characterized by local thin, discontinuous, crystal-rich, fine- to coarse-grained volcanic surge deposits. The lower, more indurated parts of Unit 4 are also significantly fractured. These fractures and surge beds are potential groundwater pathways. Unit 4 comprises the mesa-top unit at the TA-16-340 Complex and outcrops on the slopes extending into Fishladder Canyon.

Tshirege Member Unit 3 (Qbt 3 and Qbt 3t)

Unit 3 of the Tshirege Member of the Bandelier Tuff is poorly to moderately welded and indurated to slightly indurated. It tends to be a cliff-forming unit of the Pajarito Plateau. In the R-25 well, and at TA-16 in general, it is typically divided into two subunits, Qbt 3t (*t* for transitional) and Qbt 3. Qbt 3t is a devitrified ignimbrite that grades from partially welded at the top to moderately welded at the base. Qbt 3 is a second devitrified ignimbrite that grades from moderately welded at the top to nonwelded at the base. Qbt 3t and upper Qbt 3 also contain localized thin, discontinuous, crystal-rich, fine- to coarse-grained surge deposits that may represent potential groundwater pathways. Unit 3 (including both subunits Qbt 3 and Qbt 3t) is 198 ft thick in the R-25 well.

Tshirege Member Unit 2 (Qbt 2)

Unit 2 of the Tshirege Member of the Bandelier Tuff is a competent, resistant unit that forms cliffs where it is exposed on the sides of the mesa. It is a moderately welded, well indurated, devitrified ignimbrite. Welding grades from moderately welded at the top of the unit to partially welded at the base. Unit 2 is 103 ft thick in the R-25 well.

Tshirege Member unit 2 is extensively fractured in many outcrops across the Laboratory as a consequence of contraction during post-depositional cooling. The cooling fractures are visible on mesa edges. In general, such fractures are vertical to subvertical and dissipate near the bottom of the unit.

Near the base of unit 2 is a series of thin, discontinuous, crystal-rich, fine- to coarse-grained surge deposits. Bedding structures are often observed in these deposits. These surge beds mark the base of unit 2.

Tshirege Member Unit 1v (Qbt 1v)

Tshirege Member unit 1v is a vapor-phase-altered cooling unit that underlies unit 2. This unit forms sloping outcrops that contrast with the near-vertical cliffs of unit 2. Unit 1v is further subdivided into units 1vu and 1vc in many parts of the Laboratory. Unit 1v is 29.5 ft thick in the R-25 well but was not broken out into subunits based on the cuttings from that borehole.

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

Unit 1vc. Beneath unit 1vu is unit 1vc (*c* stands for colonnade), named for the columnar jointing visible in cliffs formed from this unit. Unit 1vc is a poorly welded, devitrified ash-flow tuff at its base and top, becoming more welded in its interior.

Tshirege Member Unit 1g (Qbt 1g)

The basal contact of unit 1vc is characterized by an abrupt change (within 0.7 ft vertically) from devitrified (crystallized) matrix in unit 1vc to vitric (glassy) matrix in the underlying unit 1g (*g* stands for glassy). Vitric pumices in unit 1g stand out in relief against the weathered outcrops, whereas devitrified pumices above this interval are weathered out. In outcrop, this devitrification interval forms a prominent erosional recess termed the “vapor-phase notch.” There is no depositional or compositional break associated with the vapor-phase notch; the abrupt transition indicates that this feature is the base of the devitrification front that occurred in the hot interior of the cooling ash-flow sheets after emplacement.

Unit 1g is a massive, poorly consolidated, vitric ash-flow tuff. Few fractures are observed in outcrops of this unit, and the weathered cliff faces have a distinct Swiss-cheese appearance that reflects the variable hardness of the unit. The upper portion of unit 1g is resistant to erosion, which helps to preserve the vapor-phase notch in outcrop. A distinctive pumice-poor surge bed forms the base of unit 1g. Unit 1g is 20.3 ft thick in the R-25 well.

Tsankawi Pumice Bed (Qbt 1g)

The Tsankawi Pumice Bed is the basal Plinian air-fall deposit of the Tshirege member of the Bandelier Tuff. It is a thin bed of gravel-sized vitric pumice. The unit thickness in the R-25 well is 2.2 ft.

Cerro Toledo Interval (Qct)

The Cerro Toledo Interval separates the Tshirege and Otowi Members of the Bandelier Tuff and consists of thin beds of tuffaceous sandstones, paleosols, siltstones, ash, and pumice falls. The Cerro Toledo interval also includes localized gravel- and cobble-rich fluvial deposits predominantly derived from intermediate-composition lavas eroded from the Jemez Mountains west of the Pajarito Plateau. Numerous large lithics, including dacite lava derived from Sawyer Dome, were present in the R-25 well. The interval is 125 ft thick in the R-25 borehole. This anomalously large thickness indicates that the R-25 well was located in a paleodrainage on the surface of the underlying Otowi Member of the Bandelier Tuff.

Otowi Member and Guaje Pumice Bed (Qbo)

The Otowi Member tuffs are 341.5 ft thick in the R-25 well. The tuffs are a massive, poorly consolidated, nonwelded, pumice-rich, and mostly vitric ash flow. The pumices are fully inflated and support tubular structures that have not collapsed as a result of welding. The matrix is an unsorted mix of glass shards, phenocrysts, perlite clasts, and broken pumice fragments.

The Guaje Pumice Bed forms the lowermost 6.7 ft of the Otowi Member in R-25. It is the basal air-fall deposit of the Otowi Member of the Bandelier Tuff. The occurrence of the Guaje Pumic Bed at R-25 is thinner than occurrences farther to the east and north, indicating either that this area was either south of the main dispersal axis for this fall deposit or that this deposit was partly eroded before or during emplacement of the main Otowi ignimbrite. Two cycles of pumice fall were noted in the R-25 well.

Puye Formation Fanglomerates (Tpf)

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

The Puye Formation is more than 1090 ft thick in R-25, extending from a depth of 852 ft to below the total depth of 1942 ft. It is overlain by a 1.5-ft-thick late-Miocene paleosol deposit characterized by brown, massive, generally fine-grained sediment with highly scattered pebbles. Two subunits of the Puye Formation are recognized in R-25 according to the provenance of their dominant clasts: (1) the upper Pajarito Mountain unit at depths from 852 to 1657 ft, and (2) the Rendija Canyon unit at depths from 1657 to 1942 ft. The upper Pajarito Mountain unit is the eastern part of a fan that was contemporaneous with eruption of the upper dacite of Pajarito Mountain. The Rendija Canyon unit represents the southern part of a fan that was contemporaneous with eruption of the rhyodacite of Rendija Canyon. Lithification at both units is poor and as such likely to sustain open fractures.

Tschicoma Formation Dacite Lavas

Lava flows of the Tschicoma Formation occur in CdV-R-37-2, to the southeast of R-25 but were not found in the R-25 well. In addition, they were intercepted in the recently drilled CdV-16-3(i) borehole located southeast of the TA-16-340 Complex. Thus, the transition between subsurface deposits including dacite lavas probably occurs in the vicinity of the TA-16-340 Complex. The dacite lavas are massive, apparently homogeneous, locally rubbly intermediate lavas. Minor siltstones are present in the upper 142 ft at the CdV-R-37-2 borehole. The Tschicoma dacite lavas extend from a depth of 1072 ft to total depth (1664 ft) in CdV-R-37-2 and from 900 ft to total depth (approximately 1400 ft) in CdV-16-3(i).

3.2.2 Hydrology

The hydrogeologic conceptual model for TA-16 is presented in Figure 9 (LANL 2003, 77965, p. 5-2). The model postulates infiltration of water into the subsurface and subsequent transport of water, natural solutes, and contaminants at multiple recharge zones at TA-16. Shallow transport pathways are heterogeneous, with water transport primarily along fast pathways such as surge beds and fracture zones. Perched and regional groundwater flow directions are generally from west to east, but there are significant complexities in flow in the deep aquifers at TA-16.

Infiltration

Surface water infiltration is a potential mechanism for surface contaminant migration into subsurface soil and tuff and eventually into perched or regional aquifers. Surface water infiltration is recharging perched aquifers at TA-16 (LANL 1998, 59891, p. B-18; LANL 2003, 77965, p. B-16). The presence of HE compounds in R-25 indicates that transport from surface waters to deep perched and possibly the regional aquifer at TA-16 is rapid (less than 50 yr). The surface and alluvial groundwaters present in Cañon de Valle are hypothesized to be the major source of these contaminated waters. Geophysical surveys and other lines of evidence presented in the Phase III RFI report for SWMU 16-021(c)-99 (LANL 2003, 77965) indicate that a key area of infiltration is a zone of Cañon de Valle west of MDA P. Surface water infiltration is an important contaminant transport pathway at TA-16 in Cañon de Valle.

Other recharge infiltration zones that have been identified or hypothesized at TA-16 include the Pajarito fault zone; the steam plant drainage; localized ponding areas, such as the 90s Line Pond, on the TA-16 mesa top; diffuse infiltration from the TA-16 mesa top; and other intermittent zones of natural and anthropogenic surface water runoff (Figure 9) (LANL 2003, 77965, p. 5-2). The alluvial system that is intermittently present in Fishladder Canyon downgradient from the TA-16-340 Complex likely is or has been part of a zone of infiltration, inasmuch as the process waters that discharged to Fishladder Canyon only rarely were observed to reach Cañon de Valle.

Groundwater

Groundwater beneath the Laboratory occurs in the regional aquifer at depths ranging from 1300 to 600 ft (Figure 10) and in perched aquifers at both shallow (less than 200 ft) and deep (up to ~1000 ft) depths (LANL 2000, 66802; Nylander et al. 2003, 76059). Canyon and mesa topography and the internal structures (surge beds, fracture zones, permeable units) of the Bandelier Tuff and other subsurface units control the hydrogeology of TA-16. The hydrology (occurrence and movement of water in the surface and subsurface environments) of individual SWMUs or sites such as the TA-16-340 Complex is controlled by the physiographic location (e.g., in canyon bottoms, on canyon edges, or on mesa tops) of each SWMU or site. The TA-16-340 Complex itself is located on the mesa top, but its outfalls are located on the mesa edge and discharge into the small, intermittently saturated Fishladder Canyon.

Perched Intermediate Waters

Perched water may occur in the Bandelier Tuff, in epiclastic sediments, and in basalts of the Pajarito Plateau (LANL 2000, 66802). These frequently form at horizons where medium properties change dramatically, such as at paleosol horizons, surge beds, or zones containing clays or caliche. TA-16 is characterized by an abundance of perched waters, although distinguishing true perched waters from waters hydrologically connected to the regional aquifer is difficult. In this document, waters are referred to as perched if a distinct zone of dry rock exists beneath a zone of saturation or if the depth of the waters is consistent with water depths for perched zones in nearby wells. These zones may be hydrologically connected to the regional aquifer.

Several springs and seeps have been identified at TA-16 during the past several years (Figure 2). These represent discharge points of shallow (less than 200 ft depth) perched waters in the vadose zone. The Phase II RFI report for TA-16-260 (LANL 1998, 59891, Chapter 4) and the Phase III RFI report for that site (LANL 2003, 77965, Chapter 4) provide details on these springs and the perched zones. The investigations for the TA-16-260 outfall have shown that (1) connectivity between the mesa top and springs is rapid (less than six months) based on a tracer study; (2) the springs are manifestations of zones of saturated ribbons in the vadose zone (most boreholes drilled on the mesa top have not intersected perched waters; two intersected water but dried up soon after drilling and only occasionally rewet during high-recharge time periods); (3) the perched zones appear to be concentrated within the transition zone between Tshirege units 3 and 4, which is characterized by several localized base surge units; and (4) there are multiple recharge zones for these shallow perched zones, including outfalls from buildings used for processing, mesa-top ponding areas (such as the 90s Line Pond), and diffuse recharge from east of the Pajarito fault zone.

Waters identified as perennial perched intermediate waters have been found in wells SHB-3, R-25, R-26, and borehole CdV-16-1(i). SHB-3 had a static water level of 664 ft in 1992, which is consistent with its containing a perennial perched zone. Perched water was encountered in the R-25 well at a depth of 747 ft within the Otowi Member of the Bandelier Tuff and extending intermittently to a depth of 1132 ft within the Puye Formation (Broxton et al. 2002, 72640). Hydraulic head measurements in this zone

decrease with depth, indicating that there is a downward vertical gradient and that this well is located in a recharge area. R-26 encountered what is probably a perched zone at 604 ft. CdV-16-1(i) encountered water at a depth of 563 ft, which is consistent with the depth to the perched zone in the R-25.

Borehole video logs and drilling observations for boreholes CdV-15-3, CdV-37-2, and CdV-16-2(i) record small quantities of what may be perched water. However, the screens installed to capture water from these zones have never produced enough for sampling. Small, ephemeral perched water zones apparently existed in these boreholes, but they are not of the scale of the perched zones in R-25. Neither perched water nor the regional aquifer were encountered to a depth of ~1400 ft in CdV-16-3(i), located southeast of the TA-16-340 Complex.

The groundwater from the perched zone in R-25 contains concentrations of RDX greater than EPA health advisory (HA) limits (maximum value of 84 µg/L compared to EPA lifetime HA limit of 2 µg/L) (Broxton et al., 2002, 72640, p. 59; EPA 2002, 85203), nitrate concentrations greater than those observed in the Water Canyon Gallery, VOCs, elevated metal concentrations, and tritium at levels indicating travel times to the upper saturated zone of 10 to 50 yr (Broxton et al. 2002, 72640). Preliminary data from recently drilled boreholes CdV-16-1(i) and the ephemeral zone at CdV-16-2(i) also indicate levels of RDX greater than EPA HA limits; although these levels are lower than those observed in R-25 (Broxton et al. 2002, 72640).

The TA-16-340 Complex lies in a transitional region between R-25, which contains a thick perched zone, and CdV-16-3(i), which does not. The presence, location, and depth of a perched zone directly beneath the TA-16-340 Complex remain unknown.

Regional Aquifer

The regional aquifer of the Pajarito Plateau is the only aquifer capable of supporting a large-scale municipal water supply (Purtymun 1984, 6513) The regional aquifer extends throughout the Española Basin (an area of roughly 6000 km^2) and reaches its maximum thickness beneath the Pajarito Plateau (over 9800 ft thick; Cordell 1979, 76049). The regional aquifer is located primarily in the Santa Fe Group and the Puye Formation.

Depths to the regional aquifer range between about 1300 ft (along the western edge of the plateau) to about 600 ft (to the east). The depths to the regional aquifer at TA-16 that have been determined by drilling are 1245 ft (at CdV-R15-3 east of Cañon de Valle), 1197 ft (at CdV-R-37-2 southeast of TA-16), and 1286 ft (at R-25 due north of the TA-16-340 Complex) (LANL 2003, 77965, p. B-20). The regional aquifer was not penetrated at a depth of 1400 ft in the CdV-16-3(i) borehole just east of the TA-16-340 Complex. The nearest production well to TA-16 is PM-2 in Pajarito Canyon 4 to 5 mi east of the operational areas at TA-16. Figure 10 depicts water table elevations in the regional aquifer across the Pajarito Plateau; this figure does not include results for wells drilled during 2003.

The regional aquifer at R-25 also exhibits a downward head gradient, indicating that this is a zone of recharge (Broxton et al. 2002, 72640, p. 46). Lateral gradients in the regional aquifer are typically on the order of 0.02 to 0.03. These estimates do not take into account the results of drilling during 2003.

Estimates of groundwater transport velocity will be evaluated more accurately using the existing aquifer model (Nylander et al. 2003, 76059) and using site-specific modeling in support of the deep groundwater CMS for SWMU 16-021(c)-99, the 260 outfall. These calculations will take into account the three-dimensionality of the groundwater flow paths, the spatial distribution of recharge along the canyons, media heterogeneity, and the time variation of pumping in water supply wells.

Vadose Zone

The region beneath the ground surface and above the regional aquifer is called the vadose (unsaturated) zone. This discussion focuses on the vadose zone beneath the TA-16 mesa top. The principal sources of moisture in the vadose zone are precipitation, much of which is removed as runoff, evaporation and transpiration, and infiltration from canyon bottoms. Characteristics of infiltration in the vadose zone are described in the preceding sections for infiltration and perched intermediate waters. Subsurface movement of moisture is predominantly vertical in direction and is influenced by the properties and conditions of the vadose zone. Lateral flow can also occur when there are significant contrasts in hydrologic properties between adjacent units. Surge beds may be a particularly favorable zone of lateral mobility due to their high porosity.

The geologic properties of the Bandelier Tuff that most influence fluid flow in the vadose zone are the degree of welding and hydraulic conductivity. There are significant heterogeneities in both of these properties within the TA-16 vadose zone. Welded tuffs tend to have less matrix porosity and more fractures than nonwelded tuffs. Fractures in welded tuffs may include relatively closely spaced cooling joints as well as tectonic fractures. Nonwelded tuffs also have fractures but generally fewer than welded tuffs. Saturated hydraulic conductivities in the Bandelier Tuff beneath the TA-16 mesa top range by over five orders of magnitude between subunits in Tshirege units 4 and 3t (LANL 2003, 77965, p. 4-58). In boreholes drilled at TA-16, saturated hydraulic conductivity ranges from 3.8×10^{-3} cm/sec in a surge unit to 9.8×10^{-9} cm/sec in a densely welded subunit.

Several competing effects determine moisture content, degree of saturation, and resultant likelihood of flow and contaminant transport. Whereas water moves slowly through unsaturated tuff matrix, it can move rapidly through fractures and surge beds if saturated conditions exist (LANL 1997, 63131). Because of the higher precipitation levels at TA-16, volumetric moisture levels at TA-16 tend to be higher than at TAs east of TA-16. Several zones in boreholes at TA-16 were at or near saturation, in particular the intermittent saturated zones in boreholes located near the 90s Line Pond and near the head of Martin Spring Canyon (LANL 2003, 77965, p. 4-55). Such pathways are indicated as the saturated ribbons on the conceptual model diagram (Figure 9).

4.0 SCOPE OF ACTIVITIES

This section identifies the specific activities that will be performed as part of the remediation and characterization of the TA-16-340 Complex. These activities will be performed concurrently with and after D&D program activities at the site. Methods that will be used during the performance of these activities are provided in section 5.

Specific goals include

- delineation of areas likely to require remediation based on screening and RFI Phase I results;
- removal and disposal of contaminated soils; and
- defining the nature and extent of contamination.

4.1 TA-16-340 Complex Investigation Activities

The following activities are anticipated for the investigation of the TA-16-340 Complex:

mobilization and site preparation

removing fixtures (sumps, drainlines, etc.) and associated soils with elevated COPC concentrations as indicated by screening associated with D&D activities

removing soils from drainage locations with elevated COPCs as indicated by Phase I RFI results

characterization of the nature and extent of contamination, including

- pre-sampling geodetic and utilities survey
- surface and subsurface sampling
- field screening
- fixed analytical laboratory analysis

site restoration and demobilization

post-sampling geodetic survey

disposal of IDW (see Appendix D)

Health and safety activities will be controlled by a site-specific health and safety plan. The Laboratory does not anticipate that health and safety concerns will impact this work.

4.2 General Investigation Strategies for Remediation and Characterization

The investigation strategies for remediation and characterization described in this section apply to SWMUs 16-003(n)-99, 16-003(o), 16-029(f) and 16-026(j2). The strategy for SWMU 13-003(a)-99 is described in section 4.2.2.

The investigation strategy for remediation is ultimately one of interim soil removal that will ensure that most areas of contamination are remediated. Cleanup will be based on achieving a hazard index of 1.0 and a 10^{-5} cancer risk. COPC-specific cleanup levels will be adjusted based on the number of COPCs detected at a particular site (e.g., cleanup will be to 25% of industrial outdoor worker SSLs if four COPCs are present) and analytical data will be used to determine residual risk levels. The strategy uses industrial outdoor worker SSLs for operational interim soil cleanup levels. These interim cleanup levels are protective of other worker scenarios (see section 2.5). The strategy for remediation proposes a field screening criterion of removal of soils with contamination that is 50% or more of the interim soil clean-up levels (i.e., industrial outdoor worker SSLs) for each COPC. These field screening criteria are referred to in the text as interim action levels. The target of 50% of the interim cleanup level was chosen to compensate for the potential uncertainty associated with some of the field analytical methods and to ensure that cleanup levels would be achieved. The measurement error associated with these screening methods is larger than that associated with laboratory analytical methods on which final cleanup (i.e., confirmation) decisions will be based. The objective of this field screening criterion is to meet the target risk levels mentioned above.

Table 1 shows the industrial outdoor worker SSLs for the principal site COPCs and the 50% SSLs. The SSLs for most of the contaminants are from EPA Region 6 (EPA 2003, 81724), with the exceptions of the SSL for uranium, which is from EPA Region 9 (EPA 2002, 85203) and the SSL for tetryl, which is from EPA Region 3 (EPA 1999, 85202). SSLs for specific COPCs are 17 ppm for RDX, 1.8 ppm for arsenic,

and 0.23 ppm for benzo(a)pyrene (Table 1). During the Phase I RFI, benzo(a)pyrene was detected above industrial outdoor worker SSLs in all samples in which other PAHs were also detected above SSLs (see Appendix B, Table B-8).

The investigation strategy for characterization includes surface and subsurface sampling, field and quantitative screening, and laboratory analysis of confirmatory samples. In addition to sampling for characterization of nature and extent, sampling will also be conducted in association with soil removal during and after D&D removal of fixtures and soil removal associated with contaminated zones identified during Phase I RFI investigations (see sections 4.2.1 and 4.2.2). Data obtained from these activities will be used to further define the nature and extent of contamination at the TA-16-340 Complex and to confirm that removal activities have removed soils with contamination greater than the interim action levels.

Table 2 shows the proposed number and type of sampling locations to be collected at each SWMU subarea. The numbers of sample locations shown are minimums. Additional screening locations and samples will be collected based on field observations and initial screening results.

The term “samples” will hereafter refer to analytical samples sent to off-site laboratories. Screening samples will be specifically identified as such.

The selection of samples for quantitative screening and confirmatory laboratory analysis and the locations from which to collect these samples will be biased by the field screening results. All screening samples will be screened for gross radioactivity and spot-tested for HE. Field screening will also include PID screening for VOCs and x-ray fluorescence spectroscopy (XRF) screening for target analyte list (TAL) metals (e.g., barium, lead, chromium, and copper). Field screening will be carried out either in situ or in a field trailer located near the site. Field screening will not be conducted for arsenic or for PAHs because the detection limits of the field screening tools (XRF for arsenic and PAH kits for PAHs) are above the interim action levels (the XRF detection limit for arsenic is 35 ppm; the PAH test kit detection limit for PAHs is 1 ppm).

Sample sets from each location will consist of a sample from the surface to 6 in. below the surface (either a pre-existing surface or a surface exposed by excavation) and a sample from 2 ft into tuff. This will ensure that vertical extent has been determined 2 ft below each excavated area. If the results of the field screening indicate contamination above interim action levels, then the location will be excavated until field screening results obtained at least 2 ft vertically and 2 ft laterally from the excavation are no longer above 50% of the cleanup level. When possible, screening and confirmatory samples will be collected at the soil–tuff interface so that they will contain both soil from above the interface as well as tuff from below the interface. Data from these samples will be used to characterize conditions of potential interflow and contaminant mobility.

Confirmatory samples will be collected from the bottom of each excavation and sent to a fixed analytical laboratory to verify that excavation has removed soil contaminated above interim action levels and that remaining contamination is below interim action levels.

Approximately half of the samples spot-tested for HE will be quantitatively screened using the D-Tech HE screening kit (see section 5.1.2) and the results compared to interim action levels. The D-Tech HE screening will include screening for RDX but not TNT because TNT was not commonly found in TA-16-340 Complex soils, sediment, or tuff during the Phase I RFI (see Appendix B). If the D-Tech results for RDX are above the detection limit (1 ppm) and less than the interim action level, the sample will be selected for laboratory analysis. If D-Tech results are greater than the interim action level, soils will be excavated, sampled for waste characterization, and disposed of off-site. In addition, and to determine the

applicability of US Department of Transportation regulations to the transport of HE samples to off-site laboratories, D-Tech results will be obtained for all samples that spot-test positive for HE (the detection limit for HE by spot test is 100 ppm).

For samples containing detectable concentrations of TAL metals, the ratio of XRF measurements to SSLs will be used to bias samples for off-site laboratory analysis.

In the absence of other positive field screening values, PID and beta-gamma field screening will be used to bias laboratory sample locations. Positive PID readings were observed during Phase I RFI sampling at the TA-16-340 Complex, whereas above background radiation detects were absent (see Appendix B).

BMPs such as placing straw bales in drainages and plastic coverings over excavations will be implemented throughout the soil removal and the sampling effort in order to minimize potential migration of contamination off-site.

To fully characterize the vertical and lateral nature and extent of contamination may require reoccupying sample locations to sample farther into tuff and the collection of additional surface samples within or outside of SWMU boundaries. Additional sampling, if necessary, will be conducted after initial evaluation of nature and extent data for these sites.

4.2.1 Soil Removal

Historical investigations and Phase I RFI results at the TA-16-340 Complex structures show that HE, metals, and other COPCs are present in surface and subsurface soils at concentrations above interim cleanup levels (i.e., industrial outdoor worker SSLs). The soil removal proposed as an interim action involves the removal of contaminated soil (greater than 50% of interim cleanup levels for each COPC) and thereby the removal of a potential sources of future contaminant migration from the site. The interim action will be conducted in two stages to coordinate with D&D activities at the site.

The first stage will be conducted immediately after the D&D contractor or RRES-RS workers conduct D&D of the underground and aboveground structures and fixtures. During this stage, field personnel will conduct screening in the areas affected by the D&D and in locations in drainages identified for soil removal.

Field screening methods that quantitatively detect contaminants at the proposed interim cleanup levels (Table 1) are available for several of the COPCs (e.g., RDX, barium, and chromium) at the TA-16-340 Complex and will be used to determine if soil containing these and other contaminants is to be removed by field personnel. Although barium and chromium were not found at concentrations above industrial SSLs during the Phase I RFI investigations (see Appendix B), the frequency of detects during that investigation suggests that values greater than industrial outdoor worker SSLs may be found during Phase II investigations. Because field screening methods are not available for the quantitative detection of arsenic and PAHs at the interim clean up levels, excavation to remove these COPCs will be guided by data from samples analyzed at off-site fixed laboratories. Using the screening and laboratory analysis results to determine if soil is to be removed will conservatively ensure that all soil contaminated above the interim action levels is removed during this stage of the cleanup. Contaminated soil will be segregated by waste types. Waste management samples will be collected from the segregated wastes (see Appendix D).

During the second stage, confirmation sampling will be conducted in the soil remaining at the SWMUs to confirm that interim action levels have been achieved. The following sections describe investigation activities and strategies for cleanup and characterization for specific locations and types of structures

within the TA-16-340 Complex, including SWMUs 16-003(n)-99, 16-003(o), 16-029(f), and 16-026(j2). The strategy for SWMU 13-003(a)-99 is treated separately in section 4.2.2.

Sumps

Visual inspection of sumps will occur during D&D. Screening will be biased towards areas of staining or obvious leak points. At each sump, in the area exposed by removal of the sump, eight locations will be screened for HE by spot test, VOCs by PID, metals by XRF, and radioactivity by NaI detector. Four of these locations will be additionally screened by D-Tech HE test kits. A backhoe (or equivalent type of earth-moving equipment) may be used to excavate trenches at each sump location to depths below the tuff interface.

Screening results will be used to bias the location of the two sets of samples per sump, unless the screening results are high enough to warrant excavation in that area (Figure 11a). If the screening results exceed interim action levels, excavation will be conducted, with field-screening results being used to guide soil removal. If excavation is conducted, confirmation samples will be collected in the excavation and sent for laboratory analysis. Sample sets will consist of one sample of soil collected from 0 to 6- in. below the surface and one sample collected from 2 ft into tuff from the bottom of the D&D excavation, near the area of greatest contamination. Confirmation samples will replace any samples that might have been removed by excavation. In the absence of further RRES-RS-related excavation, each set of samples will consist of one sample collected from the D&D excavated surface and a sample from 2 ft into tuff to bound the vertical extent of contamination.

Drainlines

Screening samples (HE, PID, radioactivity, XRF) will be collected at 20-foot intervals along the length of the drainlines to their respective outfall locations (Table 2). Screening samples will also be collected from any visible leakage areas in the drainlines. Half of the HE screening samples will also be screened by D-Tech. Samples will be collected with a hand auger, backhoe, or equivalent earth-moving device. Samples will be collected from 0 to 6 in below the exposed surface and 2 ft into tuff. The locations for sample collection will be biased based on the screening results, as outlined in section 4.2, and based on the historical presence of joints and field observations of staining and leakage. The minimum number of locations from which laboratory sample sets will be collected is based on the lengths of the drainlines. The minimum numbers of sampling locations for the drainlines are two for SWMU 16-003(n)-99, four for SWMU 16-003(o), and two for SWMUs 16-029(f)/16-026(j2). The selection of these sampling locations will be biased by the field screening results. If the drainage ditch containing the drainline is found to have contaminants at levels above the interim action level, soil will be excavated from the contaminated area and another sample set will be collected for confirmation. Data for confirmation sample sets will also be used for characterization.

Drainages

Soil removal and characterization will occur in drainages downslope of the outfalls located at each SWMU. The locations for soil removal and confirmation sampling will initially be based on existing Phase I RFI data and are indicated on Figure 11a. Soil removal will occur to tuff and to a length and width determined by field screening. Historical splashing of discharge from the area of the fishladder air stripper may have spread contamination laterally away from the structure. D-Tech screening will be used to bound lateral contamination, as HE is the contaminant that can be screened most precisely. Screening locations will be sampled every 10 ft down the length of the air stripper, and the screening results will guide the lateral soil removal process. Based on these screening results, additional soil removal, relative to that

shown in Figure 11a, may be required along portions of the fishladder structure. D-Tech screening will occur every 2 ft laterally out from either side of the structure until the screening results obtained are less than the interim action levels. Soil removal for SWMU 16-026(j2) will be based primarily on the occurrence of benzo(a)pyrene and other PAHs as determined in the Phase I RFI investigations (see Appendix B). Screening will also guide the depth of excavation, with numbers of samples dependent upon the size of the excavation. A minimum of eight screening samples will be collected at the bottom of each excavation, with a minimum of four samples analyzed by D-tech. Confirmation samples will be taken at the base of the excavations (from 0 to 6 in. below the surface) and at 2 ft into tuff. The minimum number of confirmation sample locations will be two for SWMU 16-003(n)-99, two to three for SWMU 16-026(j2), and one every 20 ft laterally within soil removal areas of SWMU 16-003(o). The proposed locations from which sample sets will be collected are shown schematically on Figure 11a.

4.2.2 Further Site Characterization

Further characterization sampling will occur in the drainages to bound lateral nature and extent of contamination (deep boreholes and soil removal and confirmation sampling will help bound vertical nature and extent). Uncertainty in vertical nature and extent is most prevalent near outfall discharge points. These areas will be characterized as part of soil removal activities at these locations.

Characterization activities will include mobilization and site preparation, a presampling geodetic survey, the collection of analytical samples, characterization activities at SWMU 13-003(a)-99, a high-resolution resistivity (HRR) survey, the construction and monitoring of alluvial wells, and the drilling and sampling of deep boreholes. These activities are described in the following subsections.

Mobilization and Site Preparation

Mobilization and site preparation activities include the following tasks:

- mobilizing equipment and preparing the sites (including any necessary BMPs)
- ensuring control of the site, including waste management and support areas, by using fences, signs, and any other appropriate measures to prevent unauthorized entry by workers
- utilities surveys

Pre-Sampling Geodetic Survey

Land surveys will be conducted to properly identify and stake proposed sampling locations.

Analytical Samples

At SWMU 16-003(n)-99, two laboratory surface samples will be collected from locations in the downslope area within the SWMU boundary (see Figure 11b) and the results will be used to evaluate migration of contaminants and to confirm nature and extent (see Appendix B). An additional laboratory surface sample will be collected from a location in the downslope area outside the SWMU boundary (see Figure 11b). At SWMU 16-003(o), five surface samples will be collected from the locations shown in Figure 11b. Three will be collected from locations within the SWMU boundary and two will be collected from locations outside of the SWMU boundary and farther down the drainage. At least 12 additional surface samples will be collected from locations on the edges of the excavation area associated with the former air stripper (Figure 11a). The samples collected from these locations will serve as confirmation samples related to soil removal; however, the analytical results will also be used to characterize the lateral nature and extent

of contamination in the area of the air stripper. Two samples will be taken at SWMU 16-026(j2) from the locations shown in Figure 11b, and the analytical results will again be used to define lateral nature and extent of contamination. Areas where vertical nature and extent are unbounded are co-located with areas proposed for soil removal, so confirmation data obtained for soil removal will also provide data necessary for vertical bounding.

SWMU 13-003(a)-99 Characterization Activities

D&D activities at this SWMU will determine whether a septic system is present or was removed during installation of utilities during construction of the TA-16-340 Complex. The contaminant most likely associated with the septic system is HE. Following D&D removal of utilities, 10 screening samples will be collected from locations spaced at approximately equal intervals along the length of the SWMU. Screening parameters will include HE (by spot test), gross radioactivity, and VOCs (by PID). The selection of screening locations will be biased toward areas of staining or other features that indicate the possibility of contamination. Five D-tech samples will be selected randomly from among the ten HE spot tests, if those tests prove negative. Two locations for sample sets will be selected based on the highest D-Tech results (see Figure 11a). If all HE tests are negative, then two locations will be selected at either end of the SWMU. Samples from the surface of the excavation (related to D&D removal of utilities) and 2 ft into tuff will be collected. The existing borehole (13-00001) will be drilled 2 ft deeper and sampled to define vertical nature and extent of contamination. If any anomalously high PID readings are found in samples from locations not co-located with HE, then additional samples will be collected at these locations. Soil removal is not anticipated at this SWMU.

HRR Survey

Because alluvial water contamination is intermittently present at Fishladder Seep (expressed as surface water) and at the confluence of Fishladder Canyon and Cañon de Valle (expressed as surface water) characterization of alluvial moisture down the drainage from the Building 16-340 outfall will occur. HRR geophysical surveys have proven useful in this regard in Cañon de Valle (LANL 2003, 77965, Appendix D). An HRR survey will be conducted from the Building 16-342 outfall past the end of the fishladder structure to 0.25 mi downstream of Fishladder Seep (Figure 11b).

Alluvial Wells Installation and Monitoring

Alluvial wells will allow for sampling and characterization of alluvial waters upstream and downstream of Fishladder Seep. Wells will be sited based on the results of the HRR survey. One well will be placed upslope of the seep and one downslope of the seep (Figure 11b). It is anticipated that wells will be placed approximately 5 ft into tuff. These wells will be monitored and sampled quarterly when wet.

Drilling and Characterization of Deep (200 ft) Boreholes

Two deep boreholes will be drilled to bound vertical nature and extent of contamination associated with the Building 16-340 outfall. One borehole will be located at the outfall and one borehole will be located at the bottom of the fishladder air stripping structure (see Figure 11b). These are locations that were found to have high levels of contamination during the Phase I RFI (see Appendix B). Boreholes will be drilled to a total depth of 200 ft and would be expected to penetrate unit 3 of the Bandelier Tuff (see Figure 12). If perched water is encountered, drilling will be stopped and a well will be completed following submission of a well design to NMED and NMED approval of the design. Screening (D-Tech, PID, radioactivity, and XRF) will be conducted at 20-ft intervals and samples will be collected every 40 ft and at total depth, with

the exception of pore gas samples which will be collected at 50 ft, 100 ft, and total depth. Additional screening will be conducted at any fractures and/or surge beds encountered. Additional samples will be collected at locations that are not on the 40-ft intervals for which screening results are positive. It is unknown if VOCs at this site are associated with the matrix or are present only as pore gas. For this reason, pore gas analytical sampling will be part of the sampling scheme (Figure 12). A second round of pore gas sampling will occur post-drilling after enough time has passed to allow pore gas conditions, which may be affected by drilling, to stabilize. The borehole will be left open until results from these pore gas samples are obtained, at which point a well with appropriate pore gas monitoring points will be completed if appropriate.

4.2.3 Site Restoration, Decontamination, and Demobilization

Site restoration will include backfilling of all sampling locations to the surrounding grade of the ground surface. Extensive revegetation upon completion of RRES-RS activities will not likely be required since the site is currently sparsely vegetated; however, native seed mix will be hand-dispersed over areas of significant disturbance. In addition, BMPs to control storm water run-on and run-off will be installed and maintained as needed.

Disturbances from intrusive activities such as hand-auger sampling will be minimal; however, any subsurface soil and tuff excavated from all sampling locations will be used to backfill the respective borings.

Stainless steel sampling equipment will be decontaminated between sampling locations using an alconox/water solution decontamination technique.

Wastewater derived from the daily decontamination of sampling equipment will be sampled and stored in a 5-gal. (19-L) plastic bucket and may be disposed of on-site, based on the exemption for wastewater volumes of less than 6 gal. (23 L) per day (see Appendix D).

All sampling and decontamination equipment, materials, and IDW will be removed from the site (Appendix D).

A final site inspection will be conducted to assure that site restoration, decontamination, and demobilization activities are completed.

All site preparation, site field work (excavation, sampling, etc.), and site restoration activities will be documented, along with photographs with descriptive annotations taken during this phase of the work.

4.2.4 Post-Sampling Geodetic Survey

A post-investigation geodetic survey will be conducted at all sampling locations to confirm the exact locations of sample collection and to ensure that any deviations from the proposed sample design are documented.

5.0 INVESTIGATION METHODS

The most current versions of the following RRES-RS standard operating procedures (SOPs) and quality procedures (QPs) and the RRES-RS quality management plan are applicable to the investigation activities proposed in this plan. The SOPs referred to in this or other sections are the latest version of the SOP. They are available at http://erproject.lanl.gov/documents/procedures.html.

SOP-01.01, “General Instruction for Field Investigations”

SOP-01.02, “Sample Container and Preservation”

SOP-01.03, “Handling, Packaging, and Shipping of Samples”

SOP-01.04, “Sample Control and Field Documentation”

SOP-01.05, “Field Quality Control Samples”

SOP-01.06, “Management of ER Project Wastes”

SOP-01.07, “Operational Guidelines for Taking Soil and Water Samples in Explosive Areas”

SOP-01.08, “Field Decontamination of Drilling and Sampling Equipment”

SOP-01.10, “Waste Characterization”

SOP-01.12, “Field Site Closeout Checklist”

SOP-03.11, “Geodetic Surveys”

SOP-04.01, “Drilling Methods and Drill-Site Management”

SOP-05.03, “Monitoring Well and RFI Borehole Abandonment”

SOP-05.07, “Operation of LANL-Owned Borehole Logging Trailer”

SOP-06.01, “Purging and Sampling Methods for Single Completion Wells”

SOP-06.02, “Field Analytical Methods of Groundwater”

SOP-06.03, “Sampling for Volatile Organic Compounds in Groundwater”

SOP-06.09, “Spade and Scoop Method for Collection of Soil Samples”

SOP-06.10, “Hand Auger and Thin-Wall Tube Sampler”

SOP-06.26, “Core Barrel Sampling for Subsurface Earth Materials”

SOP-06.31, “Sampling of Sub-Atmospheric Air”

SOP-10.08, “Operation of the Spectrace 9000 Field-Portable X-Ray Fluorescence Instrument”

SOP-12.01, “Field Logging, Handling, and Documentation of Borehole Materials”

QP-2.2, “Personnel Orientation and Training”

QP-3.2, “Lessons Learned”

QP-3.4, “Managing Nonconformance, Deficiency, and Corrective Actions”

QP-4.4, “Record Transmittal to the Records Processing Facility”

QP-4.12, “Documenting Oral Communications”

QP-5.2,“Control of Measuring and Test Equipment”

QP-5.3,“Readiness Planning and Reviews”

QP-5.7,“Notebook Documentation for Environmental Restoration Technical Activities”

QP-7.2,“Supplier Evaluation and the RRES-RS Quality Management Plan”

QP-10.3,“Stop Work and Restart”

Additional procedures may be used as necessary to guide the IWP activities.

There are no health and safety issues or practices that will affect the completion of the tasks specified in this IWP.

5.1 Sampling for Site Characterization and Nature and Extent

The lateral and vertical extent of COPCs at the TA-16-340 Complex will be determined by performing surface and subsurface soil and tuff sample collection and analysis as outlined in section 4. The data will be evaluated to determine the nature and extent of contamination, whether residual COPC concentrations at the site pose potential human health or ecological risks, and whether additional soil removal is warranted.

5.1.1 Surface and Subsurface Sampling

Surface and subsurface soil and tuff samples will be collected as outlined in section 4. Surface soil and subsurface soil or tuff samples will be collected from the specified sample depths at each sample location in accordance with SOP-06.09, “Spade and Scoop Method for Collection of Soil Samples,” SOP-06.10, “Hand Auger and Thin-Wall Tube Sampler,” and SOP-06.26, “Core Barrel Sampling for Subsurface Earth Materials.” Samples will be packaged, preserved, and shipped according to SOP-01.02, “Sample Container and Preservation,” and SOP-01.03, “Handling, Packaging, and Shipping of Samples.” To minimize the loss of VOCs, samples for VOC analysis will be collected immediately upon recovery using disposable En Core samplers (see SOP-06.31, “Sampling of Sub-Atmospheric Air”).

5.1.2 Field Analytical Methods

Each sample will be screened using qualitative screening both for health and safety purposes and to identify areas of contamination that require immediate soil removal. These qualitative methods include screening for radionuclides by using a NaI detector, screening for HE by using the HE spot test, and screening for headspace organic vapors by using a PID with a 10.6 or higher electron volt lamp.

Quantitative field screening will be completed for TAL metals and HE. This quantitative field screening will be used to define areas that require soil removal and to bias locations for further sampling and analysis. Strategic Diagnostics, Inc., D-Tech RDX immunoassay test kits will be used to field screen both soil and tuff samples for RDX. A Spectrace 9000 field-portable XRF instrument will used to field screen for metals such as barium, lead, chromium, and copper. Immunoassay and XRF field screening results will be recorded on the field boring logs. A field duplicate sample will be screened with every set (typically 10) of characterization samples analyzed (see SOP-10.08, “Operation of the Spectrace 9000 Field-Portable X-Ray Fluorescence Instrument”). Field calibration standards for quantitative field screening methods will be run daily or as prescribed in the manufacturer’s instructions.

The quantitative field analytical method for RDX is EPA SW-846 Method 4051 (EPA 1997, 57589). The detection limit for RDX in soils is approximately 1 ppm.

Metals will be quantitatively screened in accordance with SOP 10.08, “Operation of the Spectrace 9000 Field-Portable X-Ray Fluorescence Instrument”. The Spectrace 9000 XRF has detection limits of 35 mg/kg for arsenic and 10 mg/kg for barium, based on the manufacturer’s specifications. Other field screening methods will follow the manufacturer’s instructions. The PID will be calibrated according to the manufacturer’s instructions. A principal limitation of PID screening is that it does not discriminate VOCs and is susceptible to false positives in response to naturally occurring compounds. Typical PID detection limits are 1 ppm.

5.1.3 Fixed Laboratory Analytical Methods

Fixed laboratory analytical samples will be submitted as outlined in section 4. Confirmation sample collection and analysis will be coordinated with the RRES-RS Sample Management Office (SMO). The SMO will ship samples to an analytical laboratory qualified according to QP-7.2, “Supplier Evaluation,” and on the RRES-RS-approved list of suppliers.

Surface soil and subsurface soil or tuff confirmation samples will be submitted to the SMO for off-site contract laboratory analysis for the following analytes using the analytical protocols indicated in parentheses: HE (EPA SW-846 Method 8321); perchlorate (EPA SW-846 Method 8321); anions, including nitrate (EPA SW-846 Method 300); VOCs (EPA SW-846 Method 8260B); SVOCs (EPA SW-846 Method 8270C); and TAL metals (EPA SW-846 Methods 6010B, 6020, and 7470A/7471A) plus cyanide (EPA SW-846 Method 9012) and uranium (EPA SW-846 Method 6020) (EPA 1997, 57589). Samples from SWMU 13-003(a) will also be analyzed by gamma spectrometry. Waste samples will be analyzed for metals by the toxicity characteristic leaching procedure rather than a total metals method. Quality assurance/quality control (QA/QC) samples will include field duplicates (at a rate of 1 in 10 samples) to evaluate the reproducibility of the sampling techniques, equipment rinsate blanks to evaluate decontamination procedures (if decontaminated equipment is being re-used for sampling), and field blanks (for VOCs and SVOCs) to evaluate possible laboratory cross-contamination (see SOP-01.05, “Field Quality Control Samples”). These samples will be collected at a frequency consistent with SOP-01.05.

5.2 Surface Geophysical Methods

An HRR geophysical study will be performed by Hydrogeophysics, Inc. along the axis of Fishladder Canyon for a distance of 0.25 miles beyond Fishladder Seep as outlined in section 4.2.2 to identify zones of increased moisture in the subsurface. These results will be used to site two alluvial boreholes, one upgradient and one downgradient from Fishladder Seep. This geophysical survey will be completed using the same protocols as the HRR geophysical surveys that were completed in Cañon de Valle (LANL 2004, 77965, Appendix D). The survey in Cañon de Valle was completed with a commercial pole-pole array system. This system uses a commercial four-pole system of electrodes in which two remote electrodes are placed a minimum of 2000 ft away from the survey lines and two roving electrodes are placed along each survey line. Hydrogeophysics, Inc. processes these data using proprietary software (see LANL 2004, 77965, Appendix D). Hydrogeophysics, Inc. will provide a report on this data to be included in the TA-16-340 Complex investigation report.

5.3 Methods for Drilling and Sampling Boreholes and Alluvial Wells

5.3.1 Drilling Protocols

Two vertical boreholes and two alluvial wells are proposed. Vertical boreholes, as outlined in Section 4.2.2, will be drilled using the hollow-stem auger method. Alluvial wells, as outlined in Section 4.2.2, will

be completed using direct-push methods or hollow-stem auger methods. A brief description of these methods is provided below. More information can be found in SOP-04.01, “Drilling Methods and Drill Site Management.”

Hollow-Stem Auger

The hollow-stem auger consists of a hollow steel shaft with a continuous, spiraled steel flight welded onto the exterior site of the stem. The stem is connected to an auger bit and, when rotated, transports cuttings to the surface. The hollow stem of the auger allows drill rods, split-spoon core barrels, Shelby tubes, and other samplers to be inserted through the center of the auger so that samples may be retrieved during the drilling operations. The hollow stem also acts to case the borehole temporarily, so that the casing (riser) may be inserted down through the center of the auger once the desired depth is reached, thus minimizing the risk of possible collapse of the borehole. A bottom plug or pilot bit can be fastened onto the bottom of the auger to mostly keep out soils and/or water, which have a tendency to clog the bottom of the auger during drilling. Drilling without a center plug is acceptable provided that the soil plug formed in the bottom of the auger is removed before sampling or installing well casings. The soil plug can be removed by washing out the plug using a side-discharge rotary bit or augering out the plug with a solid-stem auger bit sized to fit inside the hollow-stem auger.

Two 200 ft boreholes will be drilled in the approximate locations shown on Figure 11b. Each borehole will be continuously cored using a split-barrel sampler following SOP-04.01, “Drilling Methods and Drill-Site Management,” to total depth. Core will be screened for radioactivity, HE, VOCs, and metals; visually inspected; and geologically logged. If contamination is detected using field screening methods at the proposed total depth, the boring will be advanced at least 25 ft until nature and extent are defined or to the drilling-depth limit of the rig.

Direct Push

Direct push is a subsurface sampling method that pushes a tool string into the ground using the weight of a truck combined with a hydraulic ram or hammer. Various tool strings can be used to obtain discrete and/or continuous geologic and shallow groundwater samples. The inside of the continuous sampler is exposed to the subsurface environment while it is advanced to the sample interval. A dual-tube sampler, so named because it uses two sets of rods to collect soil cores, is used. The outer rods receive the driving force from the hydraulic pushing method and provide a sealed hole from which soil samples may be recovered without possible cross-contamination or cave-in. The inner set of rods is placed within the outer rods and holds a sampler in place while the outer rods are driven to the sample interval. The inner rods are then retracted to retrieve the soil core.

Water samples are collected using a grab-sample tool. The grab-sample tool is installed temporarily to collect groundwater samples and is then removed from the subsurface. Groundwater grab samplers include profilers, which are capable of collecting multiple, discrete samples during one downhole push, and standard samplers, which can be driven to a desired depth where the screen is exposed to collect samples with a check-valve apparatus or pump. The direct-push methods will follow the guidelines of the American Society of Testing and Materials Subcommittee on Direct-Push Sampling (D18.21).

5.3.2 Collection of Tuff Samples

Subsurface tuff samples will be collected from the split-spoon core barrel into sealed sleeves or core-protect bags to preserve core moisture by using the methods described in SOP-06.26, “Core Barrel Sampling for Subsurface Earth Materials.” Tuff samples will be collected according to protocols presented

in section 4.2.2. Samples will be collected from intervals where contamination is suspected because field screening results are elevated and/or visual inspection identifies fractures or staining; otherwise, samples will be collected at the 40-ft default intervals presented in section 4.2.2.

Field documentation of samples collected from fractures will include a detailed physical description of the fracture fill material and rock matrix sampled and will be conducted according to SOP-12.01, “Field Logging, Handling, and Documentation of Borehole Materials.” The volumes of fracture fill and rock matrix material included in the sample will be estimated from field measurements.

Tuff samples from the two 200 ft boreholes will be analyzed for the following analytes using the analytical protocols indicated in parentheses: HE (EPA SW-846 Method 8321); perchlorate (EPA SW-846 Method 8321); anions, including nitrate (EPA SW-846 Method 300); VOCs (EPA SW-846 Method 8260B); SVOCs (EPA SW-846 Method 8270C); and TAL metals (EPA SW-846 Methods 6010B, 6020, and 7470A/7471A), plus cyanide (EPA SW-846 Method 9012) and uranium (EPA SW-846 Method 6020) (EPA 1997, 57589). QA/QC samples will include field duplicate samples to evaluate the reproducibility of the sampling technique, rinsate blanks to evaluate decontamination procedures, and trip blanks (for VOCs and SVOCs) to evaluate contamination during transport or at the analytical laboratories. These samples will be collected by using the procedures and at the frequency described in SOP-01.05, “Field Quality Control Samples.”

5.3.3 Collection of Pore-Gas Samples

Subsurface pore-gas samples will be collected from the two 200 ft boreholes by using the procedures described in SOP-06.31, “Sampling of Sub-Atmospheric Air.” In each borehole, samples will be at minimum collected at 50 ft and 100 ft below the surface and a final sample will be collected at total depth (Figure 12). Pore-gas samples will be collected using a straddle packer to isolate discrete depths within the borehole. Each interval will be purged before sampling until measurements of carbon dioxide and oxygen are stable and representative of subsurface conditions. Subsurface pore-gas samples will be collected in SUMMA canisters and submitted for analysis of VOCs using EPA Method TO-14. QA/QC samples for VOCs in pore gas will consist of an equipment blank and field duplicate for each sampling round. After sampling and purge decontamination, the equipment blank will be collected by pulling zero gas (99.9% ultrahigh-purity nitrogen) through the packer sampling apparatus. This sample will be used to evaluate decontamination procedures. The field duplicate sample will be used to evaluate the reproducibility of the sampling technique. QA/QC samples will be collected in accordance with SOP-01.05, “Field Quality Control Samples.”

5.3.4 Collection of Perched and Alluvial Water Samples

Water samples will be collected from each borehole whenever water is encountered during drilling and from each completed alluvial or perched water well when water is present (see SOPs 6.01, 6.02, and 6.03). The sampling procedures for sampling water during drilling are different from the procedures for sampling from a completed well. Both methods are described in this section.

Collection of Water Samples during Drilling

If saturation is encountered as a borehole advances, drilling will stop and the water level will be measured to determine whether sufficient water volume is available for sample collection and water quality screening analysis. Screening analyses typically are for metals, HE, anions, perchlorate, alkalinity, and total dissolved solids, and the total volume required for analysis is usually 0.5 to 1 L. Of this volume, 100 mL is unfiltered and unpreserved and another 100 mL is filtered and preserved with nitric acid. If a

sufficient volume of groundwater cannot be collected for screening analysis, then the borehole will continue to be advanced to the planned total depth or until saturation is encountered again, in which case the water collection process will be repeated. A porous-cup lysimeter or absorbent membrane will be installed at the depth of saturation to monitor the zone if the borehole is completed for pore-gas monitoring. Insufficient water sample volumes from discreet depths will not be commingled to obtain the required volume for screening analysis.

If a sufficient volume of groundwater is collected, the sample will be delivered to a Laboratory geochemistry laboratory for water quality screening on a rapid turnaround basis. Typically, for example for the R-well drilling program, analysis results for groundwater screening samples will be available within 48 hr. After the sample is collected, the borehole will be advanced to the base of saturation or the perching horizon. The objective is to identify, but not penetrate, the perching horizon and thereby determine the thickness of the zone of saturation and the characteristics of the perching horizon. Borehole drilling will be halted at the base of saturation or the perching horizon, a monitoring well will be designed, and the well design will be submitted to NMED for approval. Following approval of the design, the well will be installed.

Collection of Water Samples from a Perched Zone Well or Alluvial Well

Following well development, wells will be completed with single-screen systems. Alluvial wells will be prepacked RCRA-compliant wells suitable for deployment in the shallow alluvial system. The procedures that will be used for collecting groundwater samples are those described in SOP-06.01, “Purging and Sampling of Single Completion Wells,” and SOP-06.03, “Sampling for Volatile Organic Compounds in Groundwater.”

The first step in collecting a groundwater sample at a single-completion well will be to measure the static water level. This measurement will be used with measurements for the total depth and diameter of the well to calculate the volume of water that must be purged before collecting a sample. The water will be purged either with a submersible pump or a bailer. The total volume of water purged will be noted on the sample collection log and measurements of discharge rate and water level will be made periodically.

During and after purging, multiple 1.0 L stainless steel sampling bottles will be filled with water from the screen and hoisted to the surface. Subsamples will be collected from the sampling bottles for laboratory analyses. A 0.45-µm filter will be used to filter samples that are to be analyzed for dissolved constituents. Field parameters (i.e., temperature, conductivity, pH, alkalinity, dissolved oxygen, and turbidity) will be measured at the start of purging and several times thereafter. The samples will be collected when either three casing volumes have been removed or field parameters have been stabilized. Field parameters are considered stabilized when pH varies by less than 0.2 units or the variation in the other parameters over a series of four readings is within 10%. If the field parameters do not stabilize, a sample will be collected and the field parameters recorded. Field parameters will be measured for each sample by using the procedures described in SOP 6.02, “Field Analytical Measurements of Groundwater.”

Groundwater samples that have been collected and processed will be placed in appropriate containers and preserved according to SOP-01.02, “Sample Container and Preservation.” Groundwater samples for chemical analyses will be placed in appropriate secondary containers and transported to the SMO for shipment to off-site analytical laboratories or to LANL laboratories for more rapid analyses. The procedures for sample packaging and delivery that will be used are described in SOP-01.0, “Handling, Packaging, and Shipping of Samples.”

Analytical suites and methods (in parentheses) for all water samples associated with the TA-16-340 Complex are HE (EPA SW-846 Method 8321); perchlorate (EPA SW-846 Method 8321); anions,

including nitrate (EPA SW-846 Method 300); VOCs (EPA SW-846 Method 8260B); SVOCs (EPA SW-846 Method 8270C); and TAL metals (EPA SW-846 Methods 6010B, 6020, and 7470A/7471A) plus cyanide (EPA SW-846 Method 9010) and uranium (EPA SW-846 Method 6020) (EPA 1997, 57589). Filtered and unfiltered water samples will be analyzed for TAL metals, cyanide, and uranium. Analysis of all other suites will be conducted only for unfiltered water samples. Water samples will be collected following initial completion of each well and as required by the monitoring and sampling program described in section 6. QA/QC samples will be collected in accordance with SOP-01.05, “Field Quality Control Samples.”

6.0 MONITORING AND SAMPLING PROGRAM

Monitoring of waters and pore gases associated with the TA-16-340 Complex may be necessary. However, the information required for monitoring plan design is insufficient at this time.

Monitoring and sampling of waters at Fishladder Seep and at the confluence of Fishladder Canyon and Cañon de Valle is ongoing as part of the 260 outfall CMS. The sampling locations at these sites are checked quarterly. If water is present, unfiltered samples are collected and analyzed for HE, VOCs, and anions (including perchlorate) and filtered and unfiltered samples are collected and analyzed for TAL metals. Analysis of unfiltered samples for SVOCs and uranium is performed annually.

Two intermediate depth boreholes and two alluvial wells are proposed to be drilled as part of this investigation. If evidence for perched water is found during drilling of the intermediate depth boreholes, then these will be completed as RCRA-compliant monitoring wells. Because of the known ephemeral nature of alluvial water flow in Fishladder Canyon, the two alluvial wells will be outfitted with sampling ports, whether or not water is detected during drilling. The screened intervals of the completed wells will be checked for the presence of water on a quarterly basis. If water is present in any of these wells, unfiltered samples will be collected and analyzed for the following chemicals by the methods indicated in parentheses: HE (EPA SW-846 Method 8321); perchlorate (EPA SW-846 Method 8321); anions including nitrate (EPA SW-846 Method 300); VOCs (EPA SW-846 Method 8260B); and SVOCs (EPA SW-846 Method 8270C) (EPA 1997, 57589). Filtered and unfiltered samples will be collected if water is present and analyzed for TAL metals (EPA SW-846 Methods 6010B, 6020 and 7470A/7471A) plus cyanide (EPA SW-846 Method 9010) and uranium (EPA SW-846 Method 6020) (EPA 1997, 57589). Sampling will continue at these locations for a minimum of eight quarters, after which the data will be evaluated and the usefulness of future monitoring determined. QA/QC samples will be collected in accordance with SOP-01.05, “Field Quality Control Samples.”

7.0 SCHEDULE

This IWP for the TA-16-340 Complex will be submitted to NMED on March 31, 2004. Assuming a 60-day NMED review period and 30 days to resolve comments between NMED and the Laboratory, the work plan will be approved in late June 2004.

The D&D program will likely begin fieldwork on the exterior of the TA-16-340 Complex in late June 2004. The Laboratory may begin fieldwork “at risk” (with DOE approval) on those portions of the TA-16-340 Complex where D&D is operating, such as the sumps and associated drainlines. Laboratory representatives will consult with representatives from NMED on this decision. These D&D-support field activities will likely extend through the duration of the D&D program.

The rest of the field activities, including drainline removal, sampling of excavated areas, subsurface sampling, and drilling will take approximately 8 wks to complete (barring inclement weather or other

unforeseen delays). Sampling results are anticipated to be received and validated within 45 days. Second rounds of sampling may be required to bound the nature and extent of contamination (e.g., if a sample needs to be taken at depth beneath a positive analytical result). These sampling rounds will likely be conducted within 30 days of receipt of results from the first sampling round. If second rounds of sampling are conducted, the results will be received and validated within an additional 45 days.

The final report for this TA-16-340 Complex sampling investigation and interim action will be finalized by January 31, 2006. Additional drilling may be proposed in the final report, if the nature and extent of contamination are not adequately defined as a result of this investigation.

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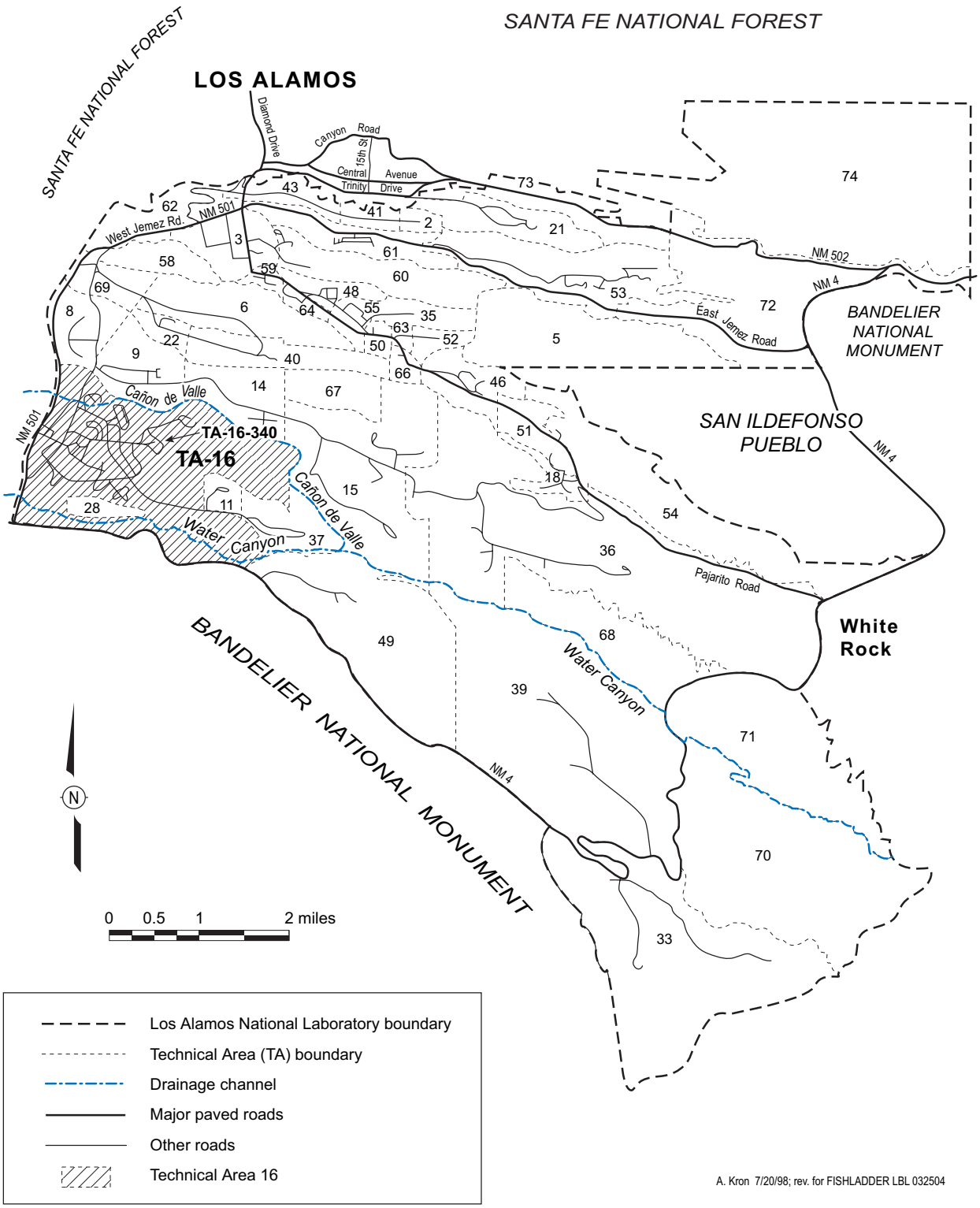


Figure 1. Location of the TA-16-340 Complex with respect to Laboratory technical areas

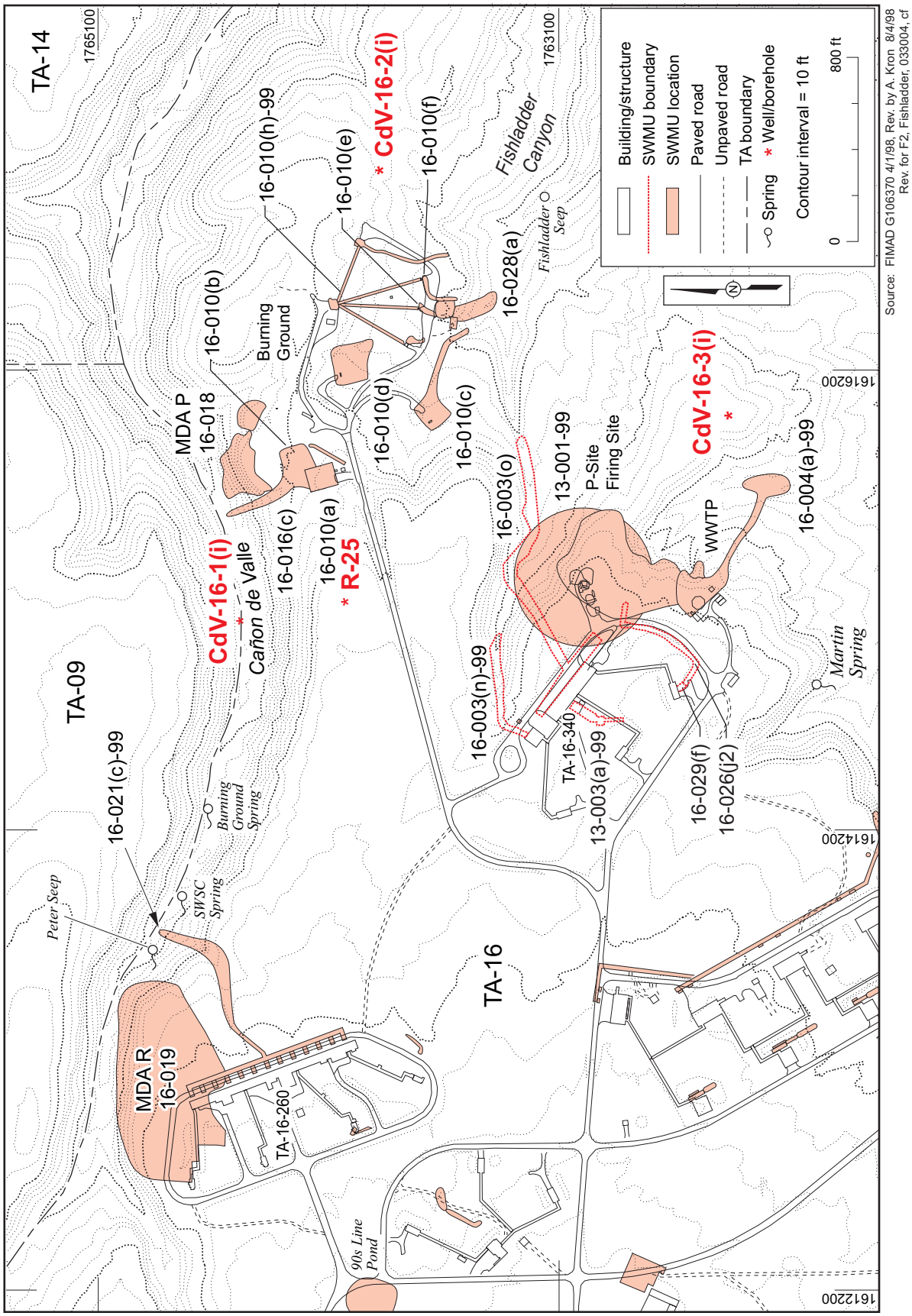


Figure 2. Regional map of the TA-16-340 Complex with adjacent wells

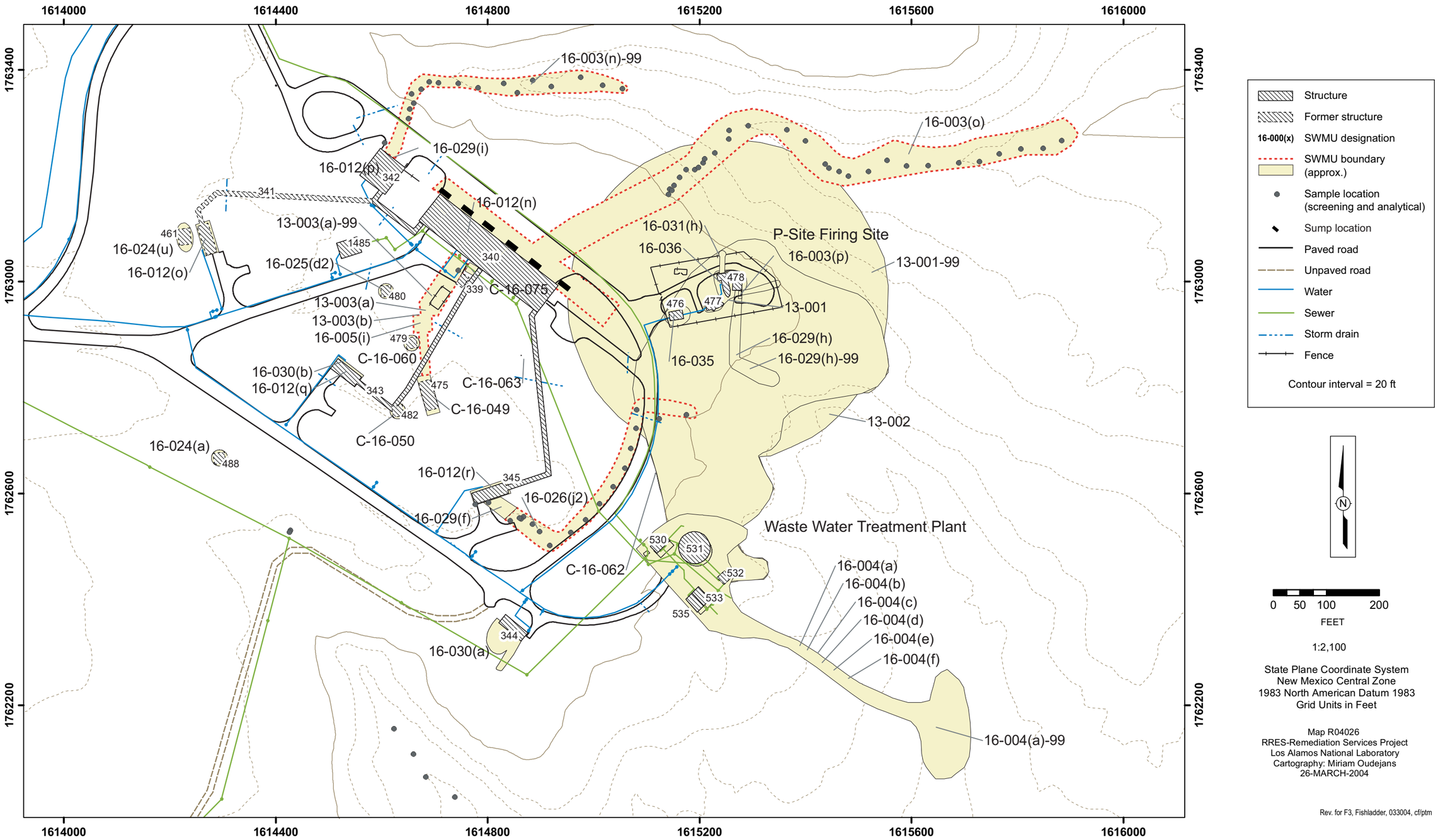


Figure 3. SWMUs in the vicinity of the TA-16-340 Complex

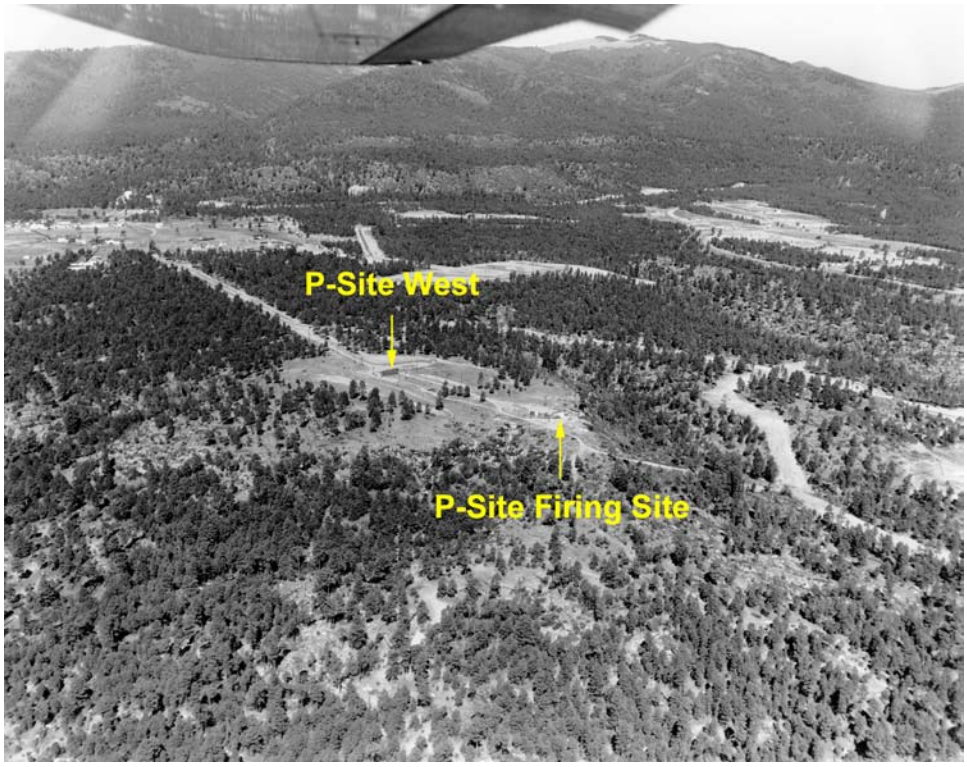


Figure 4. **1940s aerial photograph of P-Site before construction of the TA-16-340 Complex (view is to the northwest)**

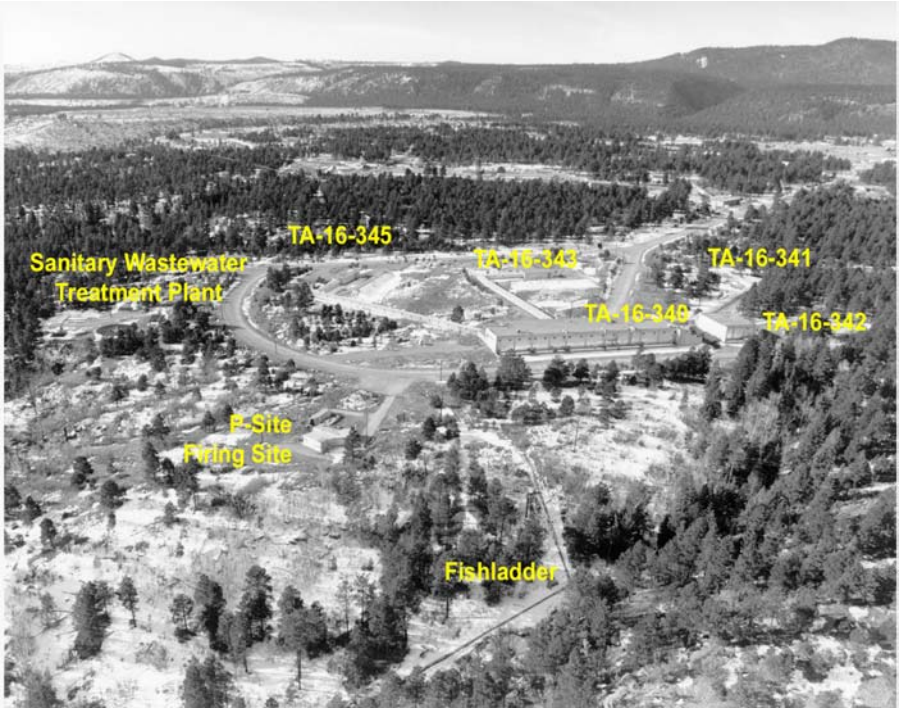


Figure 5. **Aerial view of the TA-16-340 Complex including the fishladder air-stripping structure in the foreground (view is to the northwest)**

Figure 6. **Photographs of (a) sumps associated with Building 16-340, (b) end of the fishladder air stripper structure, (c) sump associated with Building 16-345, and (d) outfall for Building 16-342**

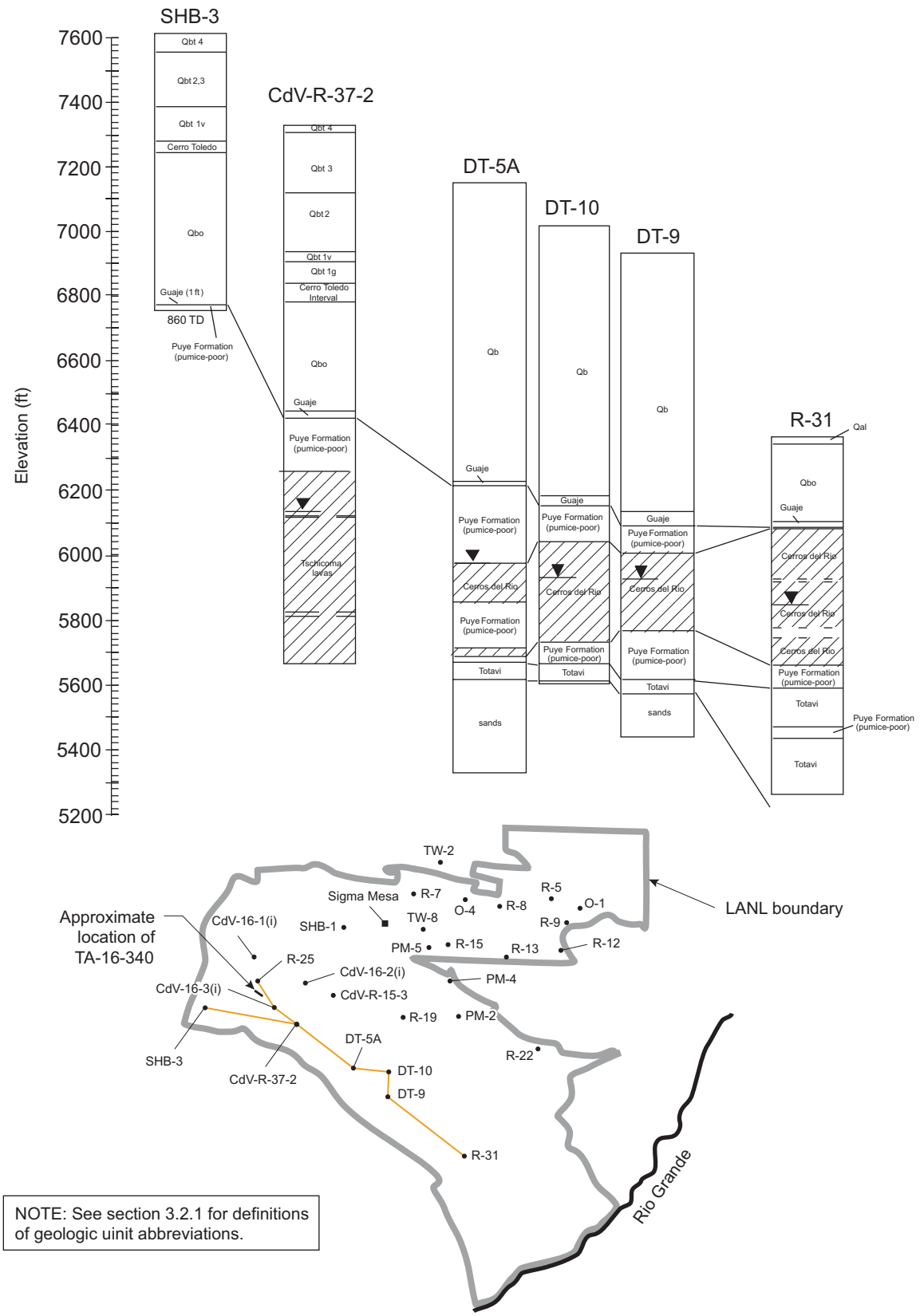
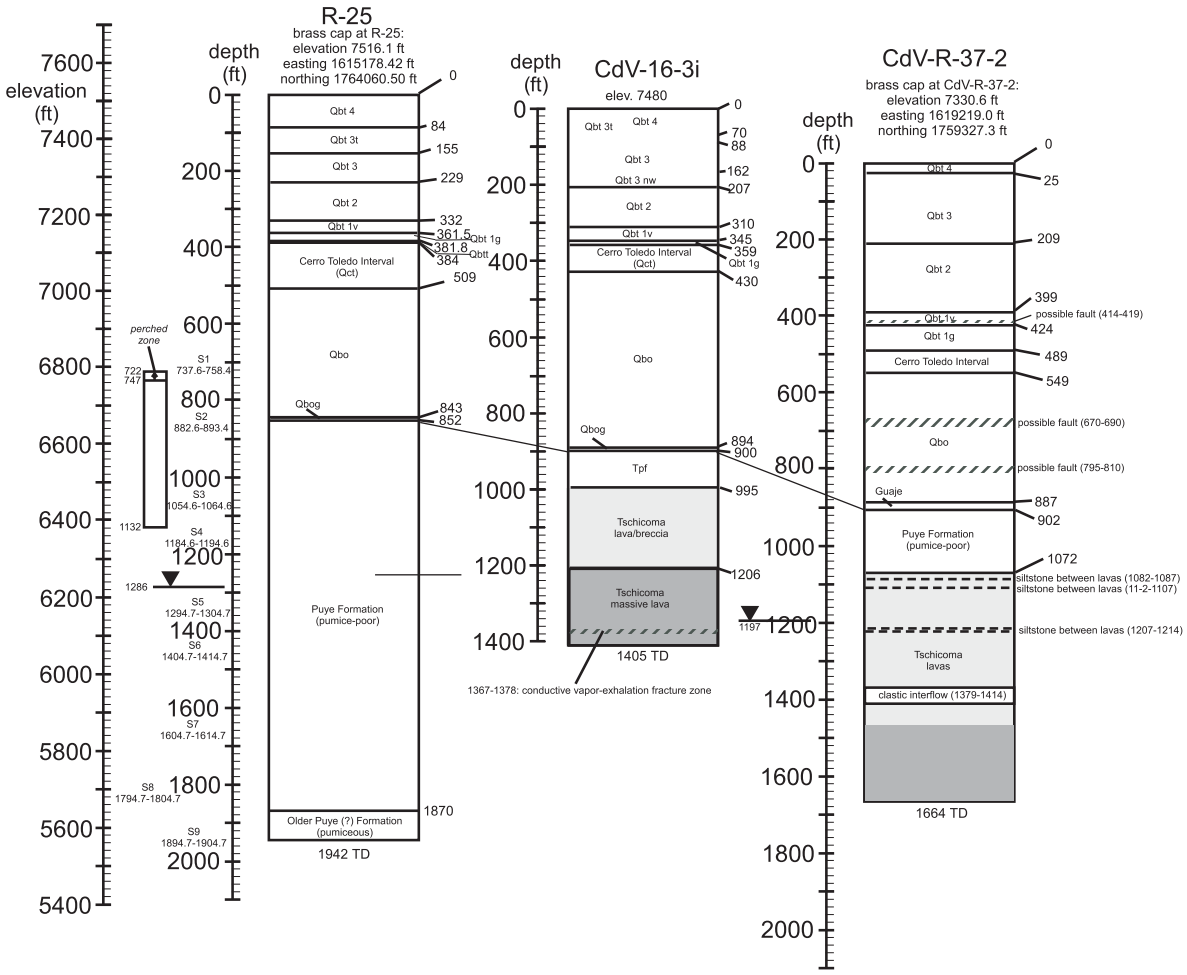
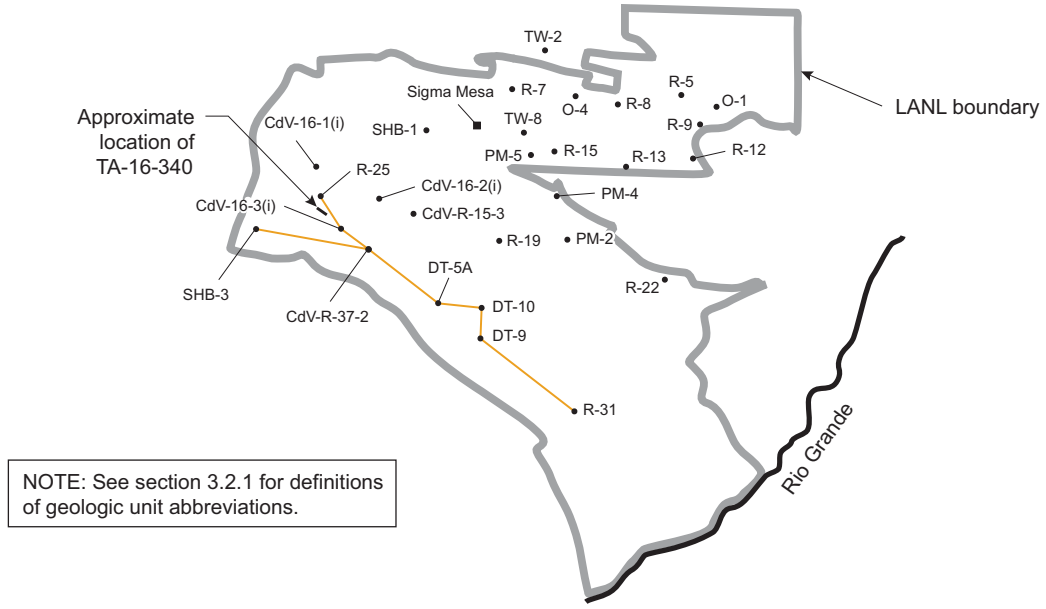


Figure 7a. West-northwest to east-southeast drill hole correlations





NOTE: See section 3.2.1 for definitions of geologic unit abbreviations.

Figure 7b. South to north drill hole correlations

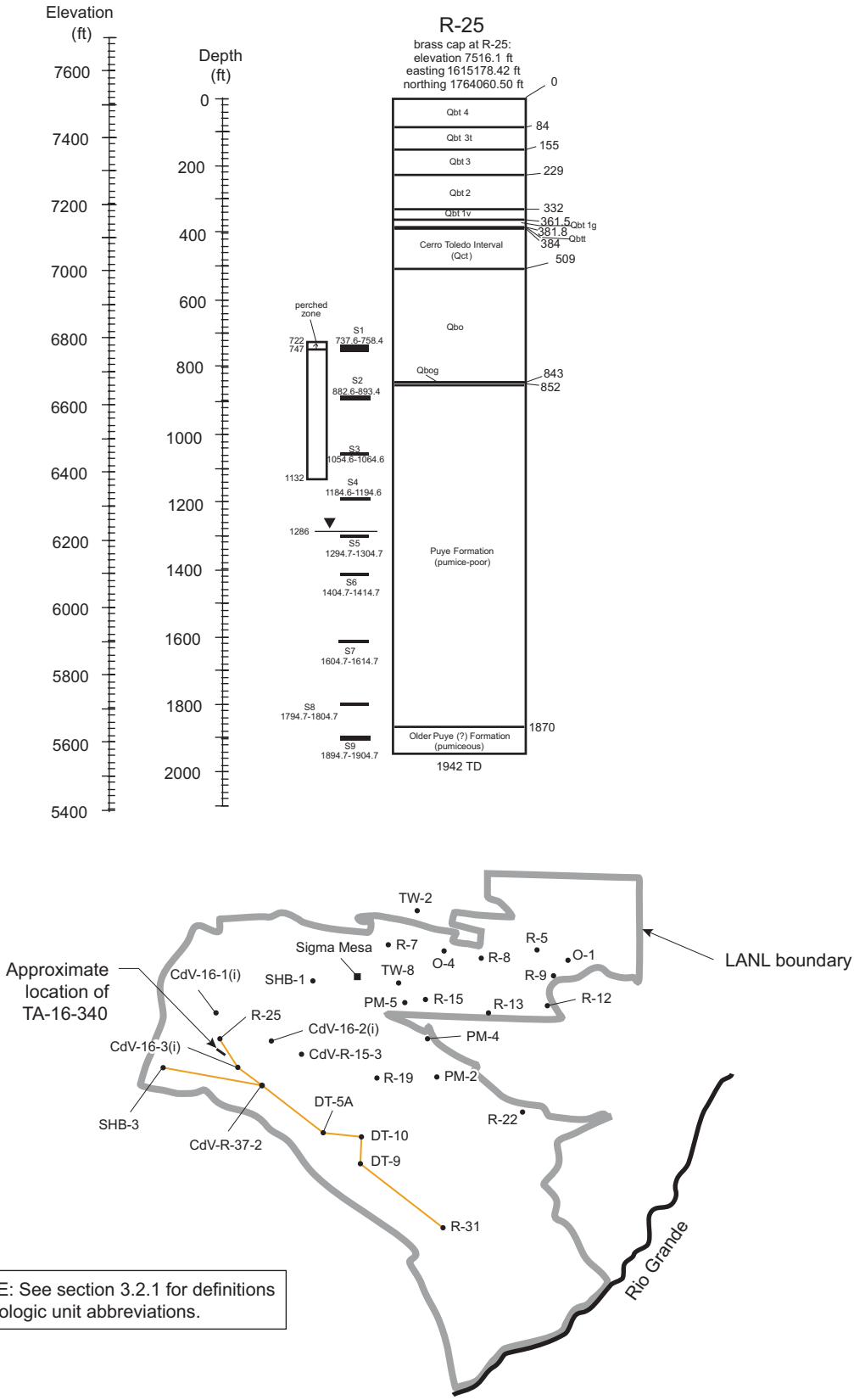


Figure 8. Stratigraphy at the TA-16-340 Complex, based on the stratigraphy from Well R-25

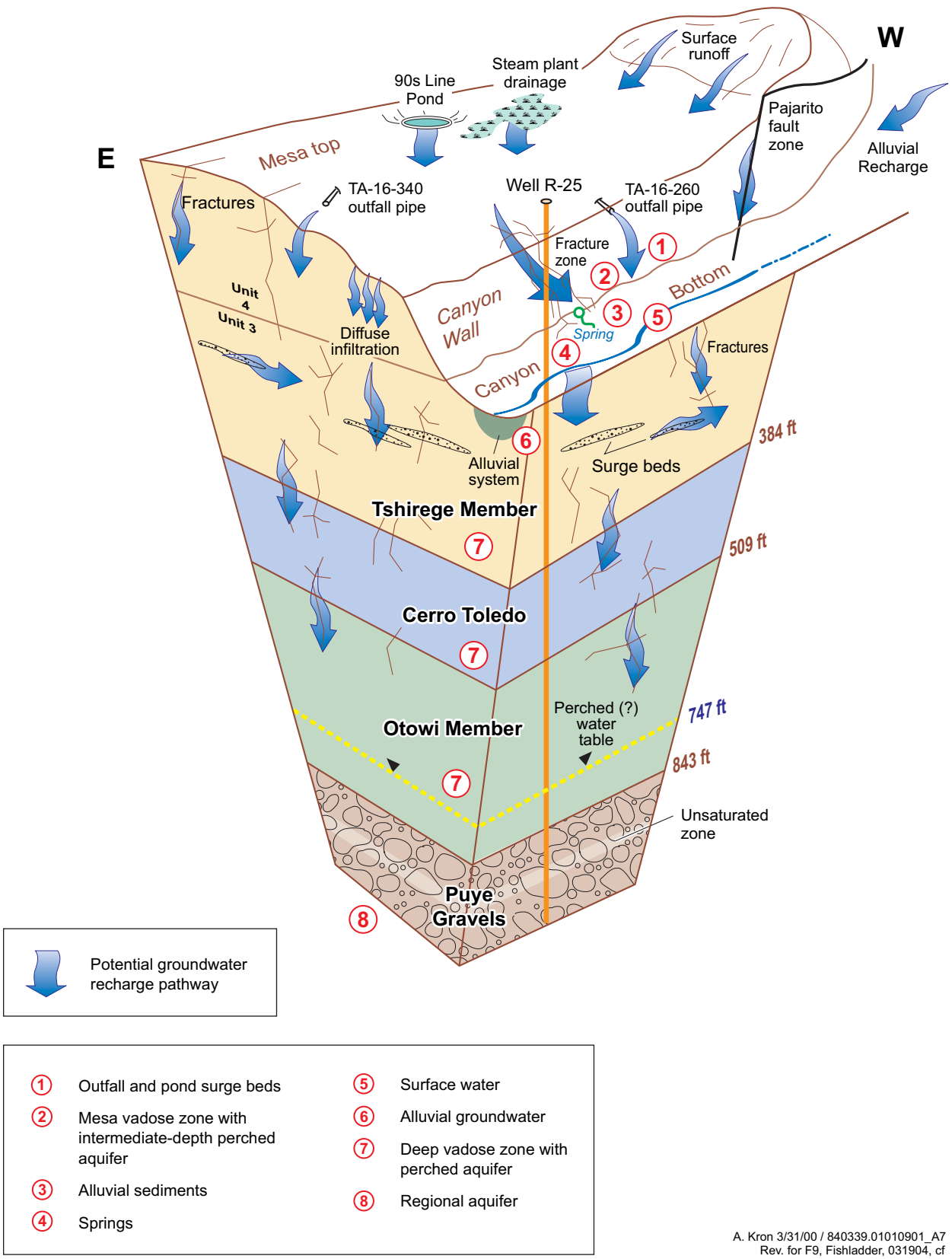


Figure 9. Hydrogeologic conceptual model for TA-16

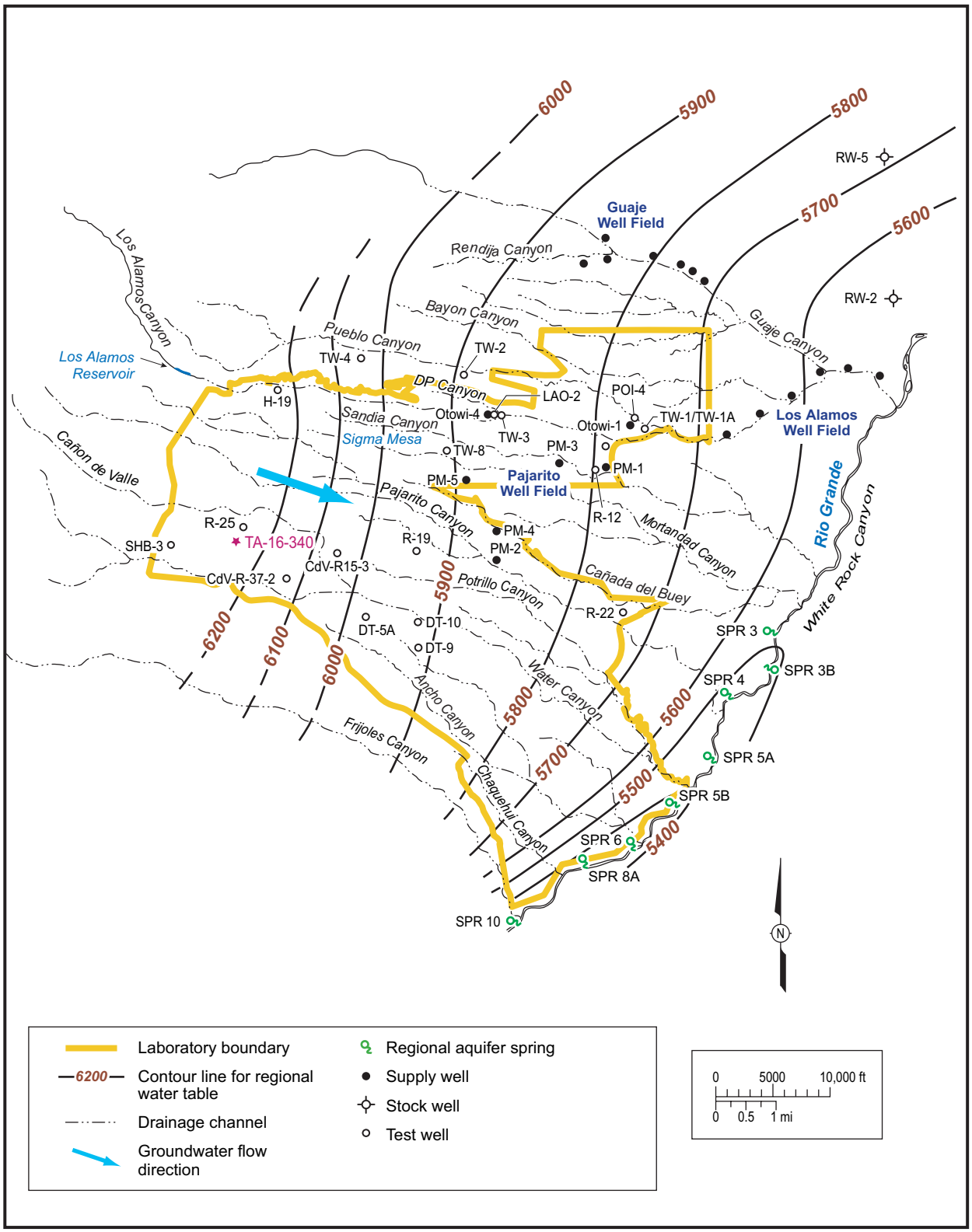


Figure 10. Water table elevations across the Pajarito Plateau

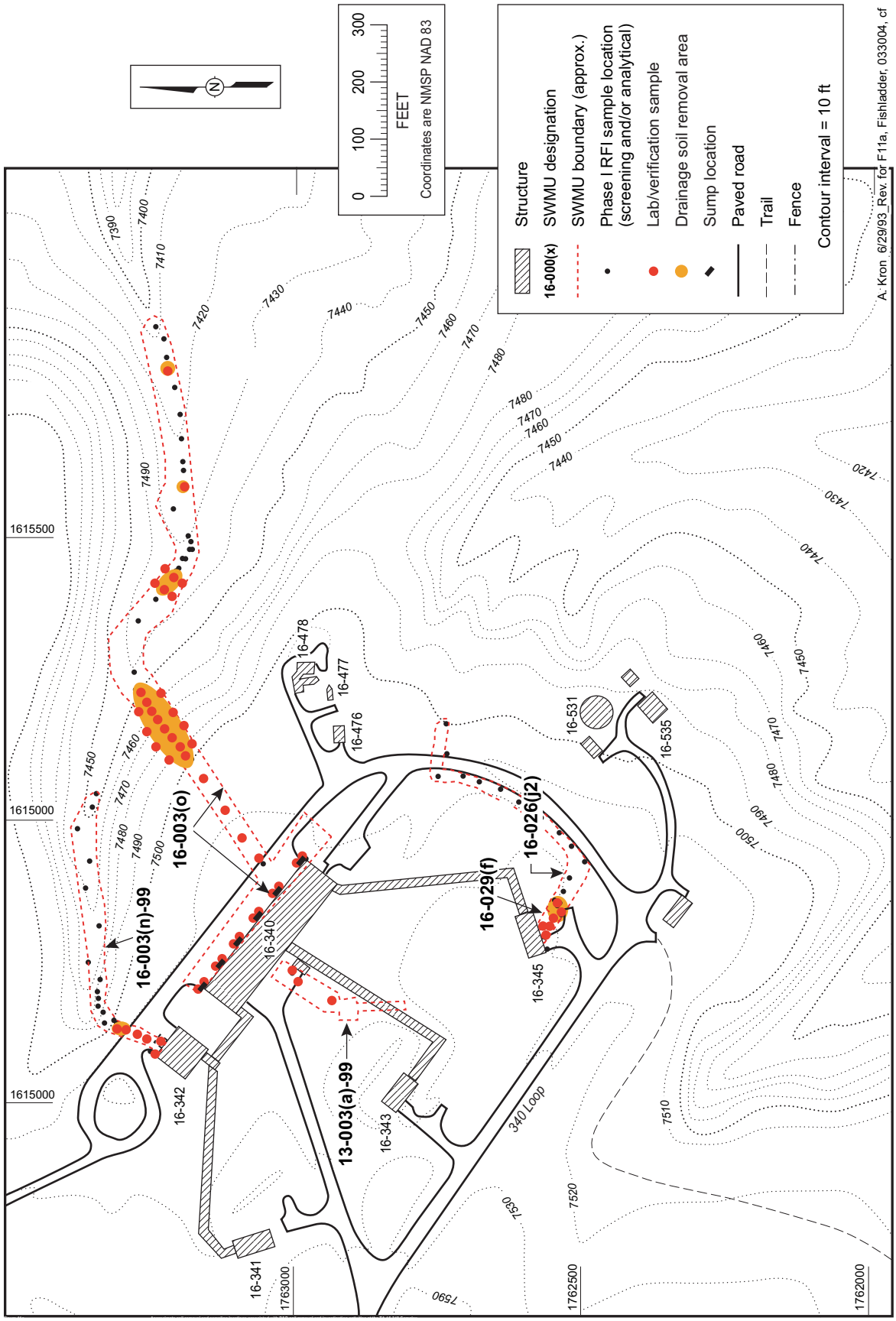


Figure 11a. Approximate soil removal and sampling locations associated with D&D soil removal and investigation activities at the TA-16-340 Complex

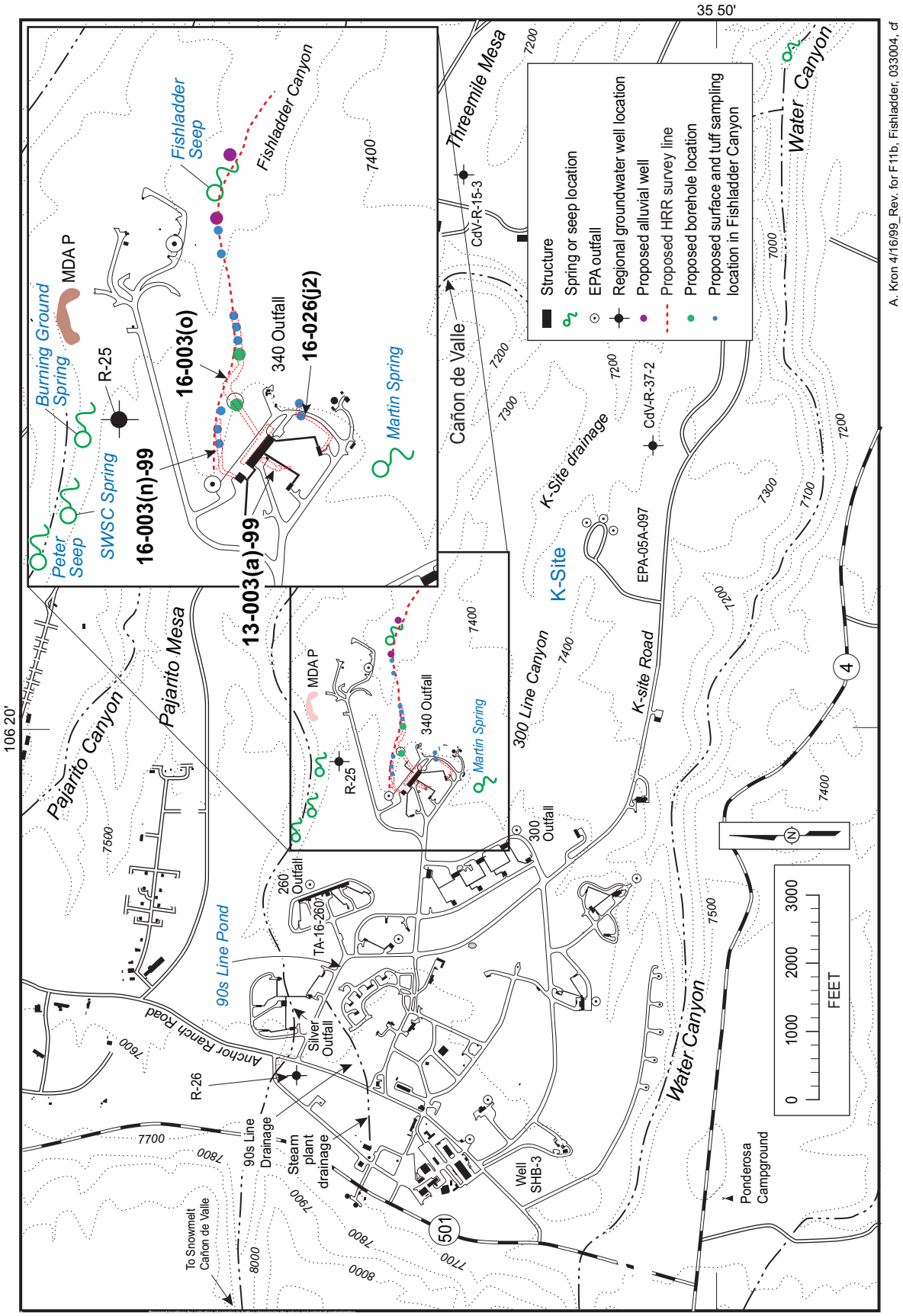


Figure 11b. Proposed locations for collection of samples for further characterization of the nature and extent of contamination

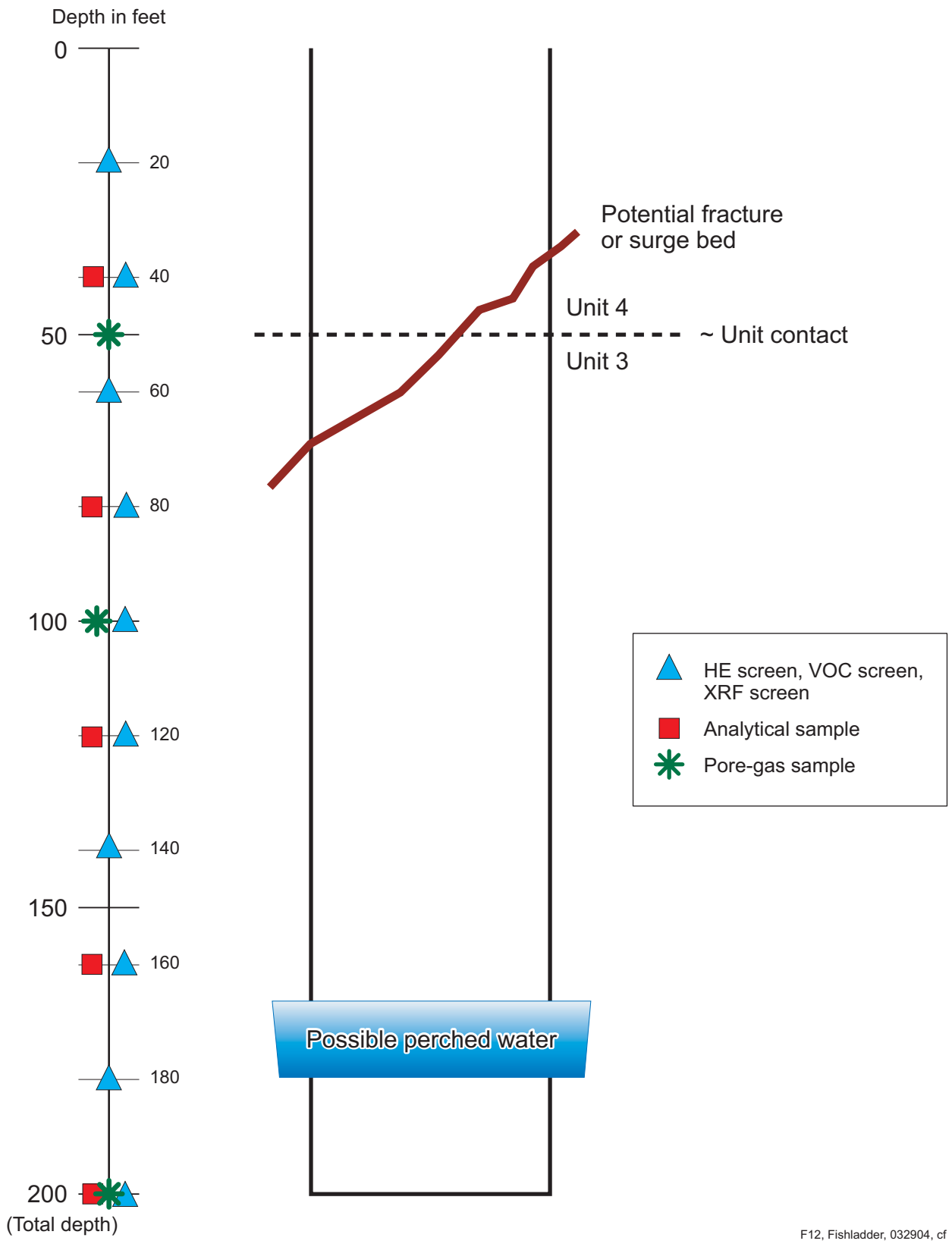


Figure 12. Schematic representation of proposed borehole sampling plan

Table 1
Industrial Outdoor Worker SSLs and 50% of SSLs

Analyte[a]	Interim Cleanup Levels (Industrial Outdoor Worker SSL[b]) (mg/kg)	Interim Action Levels (50% of SSLs) (mg/kg)
Acenaphthene	33000	16500
Acenaphthylene	32000	16000
Acetone	100000	50000
Aluminum	100000	50000
Amino-2,6-dinitrotoluene[4-]	680	340
Amino-4,6-dinitrotoluene[2-]	680	340
Anthracene	100000	50000
Antimony	450	225
Arsenic	1.8	0.9
Barium	79000	39500
Benz(a)anthracene	2.3	1.15
Benzo(a)pyrene	0.23	0.115
Benzo(b)fluoranthene	2.3	1.15
Benzo(g,h,i)perylene	32000	16000
Benzo(k)fluoranthene	23	11.5
Benzoic Acid	100000	50000
Benzyl Alcohol	100000	50000
Beryllium	2200	1100
Bis(2-ethylhexyl)phthalate	140	70
Butanone[2-]	34000	17000
Butylbenzylphthalate	240	120
Cadmium	560	280
Chromium	500	250
Chrysene	230	115
Cobalt	2100	1050
Copper	42000	21000
Cyanide (Total)	14000	7000
Dibenz(a,h)anthracene	0.23	0.115
Dibenzofuran	1700	850
Diethylphthalate	100000	50000
Di-n-butylphthalate	68000	34000
Dinitrobenzene[1,3-]	68	34
Dinitrotoluene[2,4-]	1400	700
Di-n-octylphthalate	27000	13500
Fluoranthene	24000	12000
Fluorene	26000	13000
HMX	34000	17000

Table 1 (continued)

Analyte[a]	Interim Cleanup Levels (Industrial Outdoor Worker SSL[b]) (mg/kg)	Interim Action Levels (50% of SSLs) (mg/kg)
Indeno(1,2,3-cd)pyrene	2.3	1.15
Iron	100000	50000
Isopropyltoluene[4-]	580	290
Lead	800	400
Manganese	35000	17500
Mercury	340	170
Methylnaphthalene[2-]	210	105
Methylphenol[4-]	3400	1700
Naphthalene	210	105
Nickel	23000	11500
Nitrobenzene	110	55
Phenanthrene	32000	16000
Pyrene	32000	16000
RDX	17	8.5
Selenium	5700	2850
Silver	5700	2850
Tetryl	10000	5000
Thallium	79	39.5
Trinitrotoluene[2,4,6-]	64	32
Uranium	200	100
Vanadium	1100	550
Zinc	100000	50000

[a] Where industrial outdoor worker SSLs were unavailable, surrogate chemicals were used as follows (chemical: surrogate):
acenaphthylene: pyrene
amino-2,6-dinitrotoluene[4-]: dinitrotoluene[2,6-]
amino-4,6-dinitrotoluene[4-]: dinitrotoluene[2,6-]
benzo(g,h,i)perylene: pyrene
isopropyltoluene[4-]: isopropylbenzene
methylnapthalene[2-]: naphthalene
phenanthrene: pyrene.

[b] The SSLs for contaminants are from EPA Region 6 (EPA 2003, 81724), with the exceptions of the SSL for uranium, from EPA Region 9 (EPA 2002, 85203) and the SSL for tetryl, from EPA Region 3 (EPA 1999, 85202).

Table 2
Minimum Number of Sample Locations for the TA-16-340 Complex SWMUs

SWMU	Location	Screening[a]	D-Tech[b]	Laboratory[c]
13-003(a(-99)	Septic line	11	6	3
16-003(n)-99	Sump	8	4	2
	Drainline	6	3	2
	Drainage	8	4	5
16-003(o)	Sump	48	24	12
	Drainline	12	6	4
	Drainage	32	96	~29
16-026(j2) and 16-029(f)	Sump	8	4	2
	Drainline	2	1	2
	Drainage	8	4	4

Note The values for the numbers of sample locations are estimates, particularly in the case of SWMU 16-003(o) where volumes of soil to be removed are uncertain.

[a] Screening sample locations will be screened by XRF, HE spot test, PID, and for radioactivity. Additional screening samples may be needed depending upon initial screening results, particularly when screening results are used to bound soil removal volumes.

[b] D-Tech sample locations are samples screened for HE. The D-Tech detection limit for HE is 1 ppm.

[c] Laboratory sample locations are for samples that will be sent to off-site laboratories for analyses. Laboratory samples may be collected to define nature and extent or to confirm the removal of contaminated soil.

Appendix A

Acronyms and Metric Conversion Table

A-1.0 LIST OF ACRONYMS

AOC	area of concern
BV	background value
CMS	corrective measures study
D&D	decommissioning and decontamination
DOE	US Department of Energy
EPA	US Environmental Protection Agency
ER	Environmental Restoration
HA	health advisory
HE	high explosives
HIR	historical investigation report
HMX	1,3,5,7-tetranitro-1,3,5,7-tetrazacyclo-octane (cyclotetramethylenetetranitramine)
HRR	high-resolution resistivity
IDW	investigation-derived waste
IWP	investigation work plan
LANL	Los Alamos National Laboratory
MDA	material disposal area
NMED	New Mexico Environment Department
NMHWA	New Mexico Hazardous Waste Act
NPDES	National Pollutant Discharge Elimination System
OU	operable unit
PAH	polyaromatic hydrocarbon
PID	photoionization detector
PPE	personal protective equipment
QA/QC	quality assurance/quality control
QP	quality procedure
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine (cyclotrimethylenetrinitramine)
RFI	RCRA facility investigation
RRES-RS	Risk Reduction & Environmental Stewardship–Remeditation Services
SMO	Sample Management Office
SOP	standard operating procedure
SSL	soil screening level
SVOC	semivolatile organic compound

SWMU	solid waste management unit
SWSC	sanitary wastewater system consolidation
TA	technical area
TAL	target analyte list
TNT	trinitrotoluene
VOC	volatile organic compound
WCSF	Waste Characterization Strategy Form
XRF	x-ray fluorescence

A-2.0 METRIC CONVERSION TABLE

Metric to US Customary Unit Conversions

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

Historical Investigation Report

This historical investigation report (HIR) provides a summary of the field investigations and associated environmental data collected to date for the TA-16-340 Complex. The purpose of the HIR is to provide supporting information for the proposed sampling design presented in section 4 of the investigation work plan. The sampling is necessary to define nature and extent of contamination associated with the TA-16-340 Complex and for investigations associated with decommissioning and decontamination (D&D) activities at the site.

B-1.0 TA-16-340 COMPLEX OPERATIONAL HISTORY

Technical Area 16 (TA-16) was established for the purposes of developing explosive formulations, casting and machining explosive charges, and assembling and testing explosive components for the US nuclear weapons program. Almost all of the work at TA-16 has been conducted in support of the development, testing, and production of explosive charges for the implosion method. Present-day use of this TA is essentially the same, although facilities have been upgraded and expanded as explosive and manufacturing technologies have advanced.

The TA-16-340 Complex, which operated from 1952 to 1999, was a production facility for plastic-bonded explosives and processed large quantities of high explosives (HE). Plastic bonded explosives are produced by slurrying HE and solvents together with inert binders. HE- and solvent-contaminated wash waters were routed as waste to the six sumps associated with Building 16-340 and the single sump associated with Building 16-342. Historically, discharge from the Building 16-340 sumps was routed to the Building 16-340 outfall (also known as the fishladder because the air stripper, installed at the outfall in the late 1980s, resembled a fishladder). During a mid-1990s evaluation of TA-16 National Pollutant Discharge Elimination System (NPDES) outfall flow volumes, discharge to the Building 16-340 outfall was measured at over 3.5 million gal./yr and discharge to the Building 16-342 outfall was measured at 4600 gal./yr (Los Alamos National Laboratory [LANL] 1994, 76858).

During the late 1970s, the Building 16-340 outfall was permitted to operate by the US Environmental Protection Agency (EPA) as EPA Outfall No. 05A054, under the NPDES permit for the Laboratory and the Building 16-342 outfall was permitted as EPA Outfall 05A062 (EPA 1990, 12454.2). The Building 16-345 sump and outfall were never permitted under NPDES. The latest NPDES permitting effort for the Building 16-340 outfall occurred in 1994. The NPDES-permitted Building 16-340 outfall was deactivated July 20, 1998, and the NPDES-permitted TA-16-342 outfall was deactivated July 31, 1996.

B-1.1 Waste Inventory and Disposal History

Historical information indicates the release of volatile organic compounds (VOCs) (e.g., acetone, n-butyl acetate, toluene, and butanone[2-]), inorganic chemicals (e.g., barium) and HE (e.g., cyclotrimethylenetrinitramine [RDX], cyclotetramethylenetetranitramine [HMX], and trinitrotoluene [TNT]) in sump water from Building 16-340, with possible releases of smaller amounts of similar chemicals at Buildings 16-342 and 16-345. Less information is available on chemicals discharged to the P-Site septic system, but these chemicals likely include firing-site-related compounds such as VOCs, inorganic chemicals, HE, and radionuclides.

No detailed waste inventory exists for the TA-16-340 Complex. Wastes likely to have been discharged to the environment at the TA-16-340 Complex need to be determined from a combination of fragmentary historical records, pre-RFI sampling data, and the 1995 Resource Conservation and Recovery Act (RCRA) field investigation (RFI) sampling data (i.e., this HIR). A description of wastes likely to have been discharged at the TA-16-340 Complex is provided in the approved “RFI Work Plan for Operable Unit [OU] 1082” (LANL 1993, 20948, pp. 5-42–5-49). The most useful historical information on chemical usage in the

TA-16-340 Complex is the 1971 GMX Group chemical inventory for TA-16, which noted that 700 lb of acetone, 500 lb of ammonium sulfate, 330 lb of n-butyl-acetate, 3 lb of chloroform, 55 lb of 1,2-dichloroethane, 11 lb of ethyl acetate, 72 lb of isopropyl alcohol, 110 lb of methanol, 72 lb of methylene chloride, 750 lb of butanone[2-], and 110 lb of toluene had been used at Building 16-340 between November 1970 and April 1971 (Panowski and Salgado as summarized in LANL 1993, 20948, p. 5-49). This inventory showed that the quantities of solvents used at Building 16-340 were the largest at TA-16.

Pre-RFI sampling data confirmed the presence of HE in soils (RDX, HMX, and TNT) at the Building 16-340 and Building 16-342 outfalls and of solvents (e.g., butanone[2-]), inorganic chemicals (e.g., chromium and uranium), and HE (e.g., RDX) in sump waters (e.g., material summarized in LANL 1993, 20948, p. 5-43–5-48).

This HIR provides data from the Phase I RFI investigations showing a number of HE compounds, inorganic chemicals, and organic chemicals had been released to soils in the vicinities of the outfalls for Buildings 16-340, 16-342, and 16-345. Water sampling was conducted at Fishladder Seep and the confluence of Fishladder Canyon with Cañon de Valle as a component of the RFI and corrective measures study for the TA-16-260 outfall. These sampling data are also provided, because the locations sampled are downgradient from the Building 16-340 and Building 16-342 outfalls.

B-1.2 Previous (pre-RFI) Field Investigations

The following information regarding field investigations conducted at the TA-16-340 Complex before the Phase I RFI is summarized from Section 5.2 of the approved “RFI Work Plan for OU 1082” (LANL 1993, 20948, p. 5-42–5-49).

Sampling and analysis activities to ascertain the presence of potential environmental contamination at the TA-16-340 Complex began in 1970. Baytos (as summarized in the “RFI Work Plan for OU 1082” [LANL 1993, 20948, p. 5-43) analyzed soils samples from the Building 16-340, Building 16-342, and Building 16-345 outfalls for HE. He found a maximum of 0.6 wt% at the Building 16-340 outfall in 1970, with levels of 0.2 wt% in 1984 and 1985. The Building 16-342 outfall contained a maximum of 0.2 wt% HE in 1984 with lower levels detected in 1971, 1973, 1976, and 1985. The Building 16-345 outfall was sampled in 1970 only, and no HE was detected.

Sump water at Building 16-340 was sampled for HE and a limited suite of solvents (VOCs) in 1988 over a period of ten days. HMX was detected at levels up to 0.41 ppm and solvents were not detected (LANL 1993, 20948, p. 5-45).

Three sediment samples and six water samples from the Building 16-340 outfall were collected by a US Department of Energy (DOE) subcontractor in the late 1980s (LANL 1993, 20948, p. 5-46). Acetone and butanone[2-] (methylethylketone) were detected in waters at levels up to 390 ppm for butanone[2-]. Beryllium, chromium, uranium, and RDX were each detected in one to two water samples. Sediments contained barium, cadmium, chromium, RDX, uranium, and cesium-137.

Three sediment samples from the Building 16-342 outfall were also collected by a DOE subcontractor in the late 1980s (LANL 1993, 20948, p. 5-48). Barium, chromium, cesium-137, trichloroethane[1,1,1-] HMX, and dinitrotoluene[2,4-] were all detected. Barium and HMX were identified as being above health-based screening levels in the RFI workplan (LANL 1993, 20948, p. 5-48).

B-2.0 PHASE I RFI FIELD INVESTIGATIONS AND REVIEW OF FIELD SCREENING AND LABORATORY RESULTS

Field Investigations Summary

Phase I RFI fieldwork was conducted at the TA-16-340 Complex primarily in 1995. The approved "RFI Work Plan for OU 1082" specified the sampling of surface soil and sediment, subsurface soil, and subsurface bedrock (tuff), with analysis of samples for inorganic chemicals, VOCs, semivolatile organic compounds (SVOCs), HE, and radionuclides (LANL 1993, 20948, p. 5-66). The objectives of the Phase I RFI were to determine whether COPCs were present and if additional investigative or corrective actions were warranted. Of particular concern were HE in drainages associated with TA-16-340 Complex sumps and outfalls. All samples were screened for radionuclides, HE, and VOCs for health and safety purposes and to bias laboratory sample selection. All radiation surveys at OU 1082 were performed using a 2-in. long, 2-in. tall crystal sodium iodide high energy detector at 1 cm above the ground surface. Organic vapors were screened using a photoionization detector (PID). HE was screened using the HE spot test.

Sampling was based on data quality objectives from the RFI work plan. The outfalls and drainages were sampled in the center of each drainage because it was thought unlikely that contaminants had migrated upslope out of the well-defined drainages and that the highest contamination would be near the drainage center. HE screening locations proceeded from each outfall downgradient at 10-ft intervals until the first negative HE spot test. At this location a 0–6-in. sample was collected for analysis in off-site laboratories. Two more 0–6-in. samples were collected at 20-ft intervals down-drainage. Screening was continued down-drainage from the third sample location at 40-ft intervals for 500 ft from the outfall. Two 0–6-in. samples were selected from this region based on geomorphology, HE screening, or radiation surveying.

Subsurface samples were taken by hand auger or a hollow-stem auger. The 0–6-in. interval and the deepest interval of each core were sent for analysis. Locations for screening and analytical samples are shown in Figure B-1.

Unless otherwise noted, the term *sample* refers to a sample sent to a fixed off-site analytical laboratory. Screening samples are specifically identified as such.

Solid Waste Management Unit (SWMU) 13-003(a)-99. Five subsurface screening samples and two subsurface analytical samples were collected at SWMU 13-003(a)-99 at location 13-00001. The core was screened on 12-in. intervals because a 6-in. interval in a 1.55-in. inner diameter split spoon provides insufficient material for full suite analysis.

Two ground penetrating radar geophysical surveys were conducted at SWMU 13-003(a)-99 in an effort to locate subsurface drainlines. No evidence for the drainlines was found. Drainlines were never intersected during drilling, probably because the drainline pipe was removed during the placement of the underground utilities for Building 16-340 during the early 1950s. Samples were collected from two intervals in the borehole near the north end of the SWMU (location 13-00001). The first sample was collected from the depth where the drainline pipe was expected (based on knowledge of engineering practices). The second sample was collected from the interval that brackets the fill–tuff interface.

SWMU 16-026(j2). All samples prescribed in the RFI work plan for SWMU 16-026(j2) were collected during the 1995 field campaign. A total of 12 subsurface screening samples and 14 surface screening samples were collected. Nine surface samples and seven subsurface analytical samples were collected. An additional surface sample analyzed for VOCs only was collected at location 16-01555 because elevated PID readings (Table B-1) were reported near this location. A re-sampling effort at the outfall and

sediment trap boreholes was conducted because the initial analytical samples from the two boreholes (16-01551 and 16-01665) arrived at the analytical laboratory at ambient temperature.

High PID readings were reported during the drilling and collection of samples at borehole 16-01665. As a result, an effort was made to evaluate the nature and extent of the apparent contamination during re-sampling. An extensive PID-screening sampling scheme was used to determine the location with the highest near-subsurface concentration of organic vapors in the area around the outfall and boreholes. A new borehole (borehole 16-02166) was drilled at this location. A hand auger was used to excavate through the soil layer down to the soil–tuff interface and a PID was used to determine the organic vapor concentration in the auger hole. The auger holes were sited on 5.0-ft intervals; the interval was reduced to 2.5 ft around locations with elevated PID readings. Nine locations were screened along the center line of the drainage channel in the area between the outfall and 45 ft down-drainage from the outfall. Four locations were screened perpendicular to the drainage channel along a transect that includes location 16-01665. Borehole 16-02166 is located 22 ft down-drainage from the outfall where the highest PID reading (95 ppm) was observed during the screening (Table B-1).

SWMU 16-003(n)-99. A total of 14 surface screening samples were collected (Table B-2). Four subsurface samples and six surface samples were collected at SWMU 16-003(n)-99. At the first sediment trap down-drainage from the outfall a surface analytical sample (0316-95-0217) was not collected. The soil–tuff interface is only 2 in. deep at this location and therefore only a soil–tuff interface sample was collected.

SWMU 16-003(o). A total of 25 surface screening samples were collected (Table B-3). Eight subsurface samples and 11 surface samples were collected at SWMU 16-003(o). The HE screening in the upper part of the drainage was initially conducted on a 20-ft interval instead of a 10-ft interval. The field team resumed screening on a 10-ft interval at 62 ft down-drainage. The positive screening results for HE in the upper drainage start at the outfall location and end 92 ft from the outfall. There were no positive screening results for HE farther than 92 ft from the outfall.

At the outfall location, at the first sediment trap down-drainage from the outfall, and at the first sediment trap down-drainage from the discharge of the aerator, a surface sample was not collected. The soil–tuff interface is 4 in. deep or less at these locations and therefore only a soil–tuff interface sample was collected. Boreholes 16-01536, 16-01663, and 16-01537 (Figure B-1, Table B-4) were not drilled 3 ft into tuff. In all three boreholes the specified depth of the deepest sample was not reached because the sampling team met refusal during drilling at a shallower depth. At borehole 16-01536, a Simco drill rig, which has greater downward power, was used to collect the deepest sample. A Minute Man drill rig was needed to drill borehole 16-01663 because the Simco drill rig could not be driven to this location. However, the Minute Man drill rig has significantly less downward power than the Simco drill rig. Refusal was met at a total depth of 18 in., 1 ft into tuff. The Minute Man drill rig was also needed to drill Borehole 16-01537. The sampling team met refusal at 3.5 ft total depth, 1.5 ft into tuff.

B-2.1 Screening Results

Screening results are shown in Tables B-1 through B-3 and in Figure B-2. For 13-003(a)-99 the screening results for all samples were nondetects or were within the range of local background. For SWMU 16-026(j2) VOCs were detected by PID at three sampling locations (16-01555, 16-01665, 16-02166), two close to the outfall and one approximately 200 ft farther down-drainage (Table B-1, Figure B-2). Note that location 16-02166 was drilled based on high PID values detected as part of the sampling scheme outlined in section B-2.0. SWMU 16-003(n)-99 had one positive PID result and three positive HE spot tests at locations close to the outfall (Table B-2, Figure B-2). One positive PID and seven positive HE spot test results were reported at SWMU 16-003(o), all close to the outfall (Table B-3, Figure B-2).

B-2.2 Soil, Sediment and Bedrock Investigation

Samples taken, frequency above background, and sample identification tables are provided in Tables B-4 through B-9 for sediment, soil, and tuff. Figures B-3 through B-5 show locations where industrial outdoor worker soil screening levels (SSLs) are exceeded for RDX, arsenic, and benzo(a)pyrene. These locations are highlighted to show where soil removal will be located. The site is expected to remain industrial and requesting no further action at this time is not anticipated for SWMU 16-003(o). Benzo(a)pyrene is representative of the other polyaromatic hydrocarbons (PAHs) in the sense that there are no locations where other PAHs are present above SSLs that benzo(a)pyrene is not also present above SSLs. Benzo(a)pyrene also has the lowest industrial outdoor worker SSLs of all of the PAHs.

Evaluation of Inorganic Chemicals

SWMU 13-003(a)-99. Five inorganic chemicals are detected above background value (BV) in the tuff that are not detected above BV in overlying soils (aluminum, barium, calcium, chromium, and copper; Table B-6). Uranium concentrations in tuff are slightly higher than in overlying soils, with both above BV. The tuff BV is higher than the soil BV (Table B-6). Additional samples are needed to bound vertical nature and extent of inorganic chemical contamination at this SWMU.

SWMU 16-003(n)-99. All inorganic chemicals are below BVs in the three samples collected farthest down the drainage, so lateral extent of contamination is defined (see Figure B-3). For two locations (16-01529 and 16-01662, both at the Building 16-342 outfall) where there are detects above BVs in tuff there are (1) chemicals above BV in the tuff whereas the same analytes are not above BV in overlying soils or sediment (arsenic, chromium, and aluminum; Table B-6) and (2) chemicals that show increases in concentration from soil to tuff (arsenic and lead; Table B-6). Inorganic chemicals in these samples that show decreasing trends with depth but have above BVs in tuff include barium, cobalt, copper, and vanadium. Vertical nature and extent of contamination requires further characterization at this SWMU, at least in the proximity of the outfall.

SWMU 16-003(o). Many inorganic chemicals are above BVs even at the farthest point sampled downgradient along the drainage (see Table B-6; Figure B-3). Concentration trends with distance from the outfall are weak and contaminant distribution is highly heterogeneous (see Figure B-3). Near the upslope portion of the SWMU (i.e., near the outfall) there are many inorganic chemicals above BVs in the tuff but not above BVs in the overlying soil (Table B-6). There are also several inorganic chemicals that show decreasing trends from soil to tuff but are still above BVs in the tuff (Table B-6). This indicates that nature and extent of inorganic contaminants are ill-defined both vertically and laterally at this SWMU.

SWMU 16-026(j2). The inorganic chemical concentrations in the analytical samples taken farthest along the drainage are below BVs (see Figure B-3) with the exception of lead, which occurs in a heterogeneous distribution (i.e., no trends) along the drainage (Table B-6). Metals above BV in tuff but not above BV in the overlying soil and sediment (or showing increasing trends from soil/sediment to tuff) are found in the two locations closest to the outfall (16-01551 and 16-02166; chromium, copper, and nickel; Table B-6). These results indicate that lateral nature and extent is defined for inorganic chemicals, with the exception of lead, but that vertical nature and extent are not defined and need to be further characterized close to the outfall.

Evaluation of Organic Chemicals

SWMU 13-003(a)-99. Two organic chemicals, diethylphthalate and di-n-octylphthalate, were detected in the tuff but not in the overlying soil, indicating that vertical nature and extent are not defined for these phthalates (Table B-8).

SWMU 16-003(n)-99. The distal location along the SWMU drainage has no detected organic chemicals except for nitrobenzene (Table B-8). There are sporadic detects of organic chemicals along the SWMU as

opposed to clear decreasing trends (Table B-8). At locations with detects in tuff (16-01529 and 16-01662 at the Building 16-342 outfall) there are a few organic chemicals detected in the tuff that are not detected in the overlying soil (acetone, dinitrobenzene[1,3-], dinitrotoluene[2,4-], TNT, butanone[2-], and diethylphthalate). HMX shows a decreasing trend from soil to tuff at one sample location (16-01662) but is still detected in tuff, indicating that vertical extent of contamination is not defined.

SWMU 16-003(o). The farthest two locations in the downgradient lateral trend have no detected organic chemicals, thereby defining lateral nature and extent for organic contamination at this SWMU. For the location near the outfall (16-01536), organic chemicals show decreasing trends from the soil to tuff but are still detected in tuff, although at concentrations one to two orders of magnitude lower (Table B-8). Acetone is detected in the tuff but not the soil at this location. This is true for other locations along the SWMU (16-01537, 16-01663, and 16-01664), one of which (16-01664) also had diethylphthalate detected in tuff.

SWMU 16-026(j2). The farthest sampling location along the drainage has detected PAHs, though they are generally part of a decreasing trend with distance. At location 16-02166 near the outfall acetone is found in the tuff but not in the overlying soil. Nature and extent of contamination for organic chemicals are not fully defined for this SWMU.

Evaluation of Radionuclides

Laboratory samples for radionuclides were all nondetect (Table B-9) at SWMU 13-003(a)-99, which is the only one of these sites that has radionuclides as potential contaminants.

B-2.3 Water Investigations

As part of the TA-16-340 Complex investigation, surface water samples collected at Fishladder Seep and at the confluence of Fishladder Canyon and Cañon de Valle are presented (Figure B-6). Samples taken and analytical results are shown in Tables B-10 through B-16. Maximum concentrations for selected contaminants are shown in Figure B-6.

Evaluation of Inorganic Chemicals

Several inorganic chemicals are detected at Fishladder Seep and the confluence of Fishladder Canyon and Cañon de Valle. Of these, aluminum, barium, iron, and manganese exceed the New Mexico Water Quality Control Council groundwater standards for human health, domestic water supply, and irrigation as contained in section 20.6.2 of the New Mexico Administrative Code (September 2002) (Table B-11).

Evaluation of Organic Chemicals

Organic chemicals detected at Fishladder Seep include acetone, dichloroethene[cis-1,2-], HMX, RDX, tetrachloroethene, and trichloroethene (Table B-14). At the confluence location only HMX and RDX were detected (Table B-14). Tetrachloroethene and trichloroethene exceed EPA drinking water maximum contaminant levels.

Evaluation of Radionuclides

Tritium was detected at both the seep and the confluence location indicating a young water (<50 yrs) component to discharge at these locations (Tables B-15 and B-16).

These results indicate that released chemicals from the TA-16-340 Complex are transported in alluvial water downgradient from the SWMUs. The seep has been wet infrequently during ongoing drought and further characterization will likely have to await a wetter period.

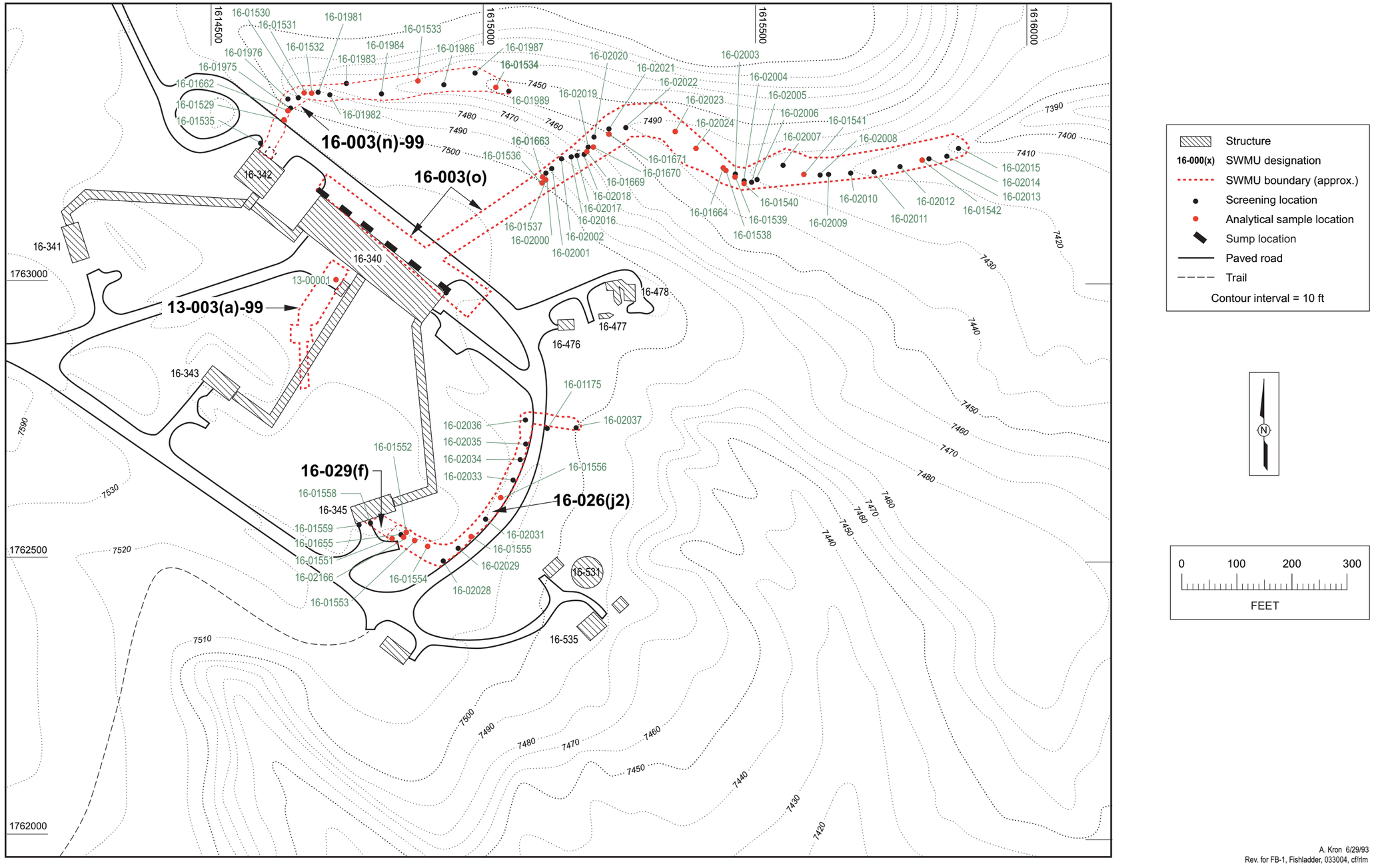


Figure B-1. TA-16-340 Complex Phase I RFI sampling locations

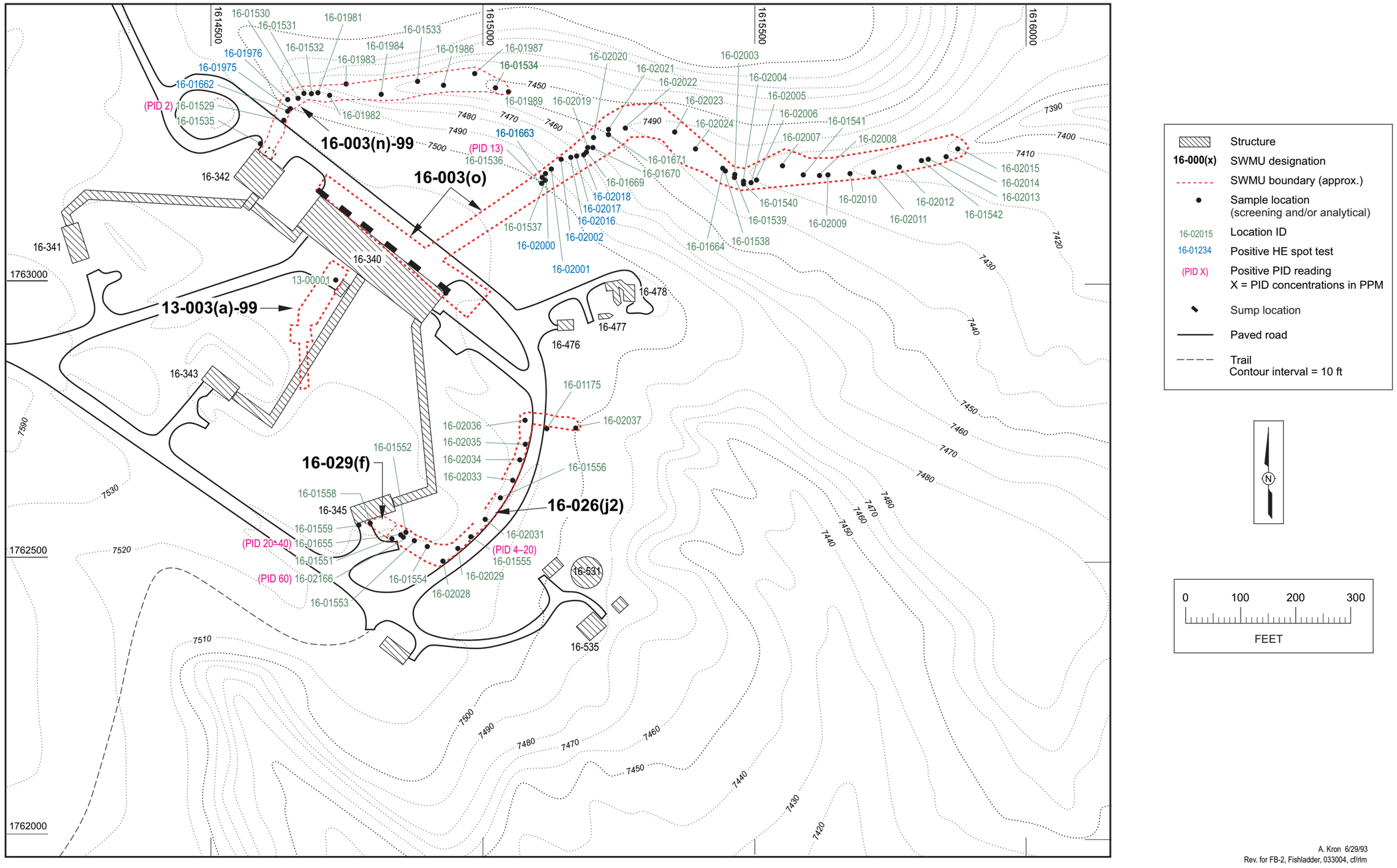


Figure B-2. TA-16-340 soil, sediment, and tuff screening locations with positive HE spot test and PID results

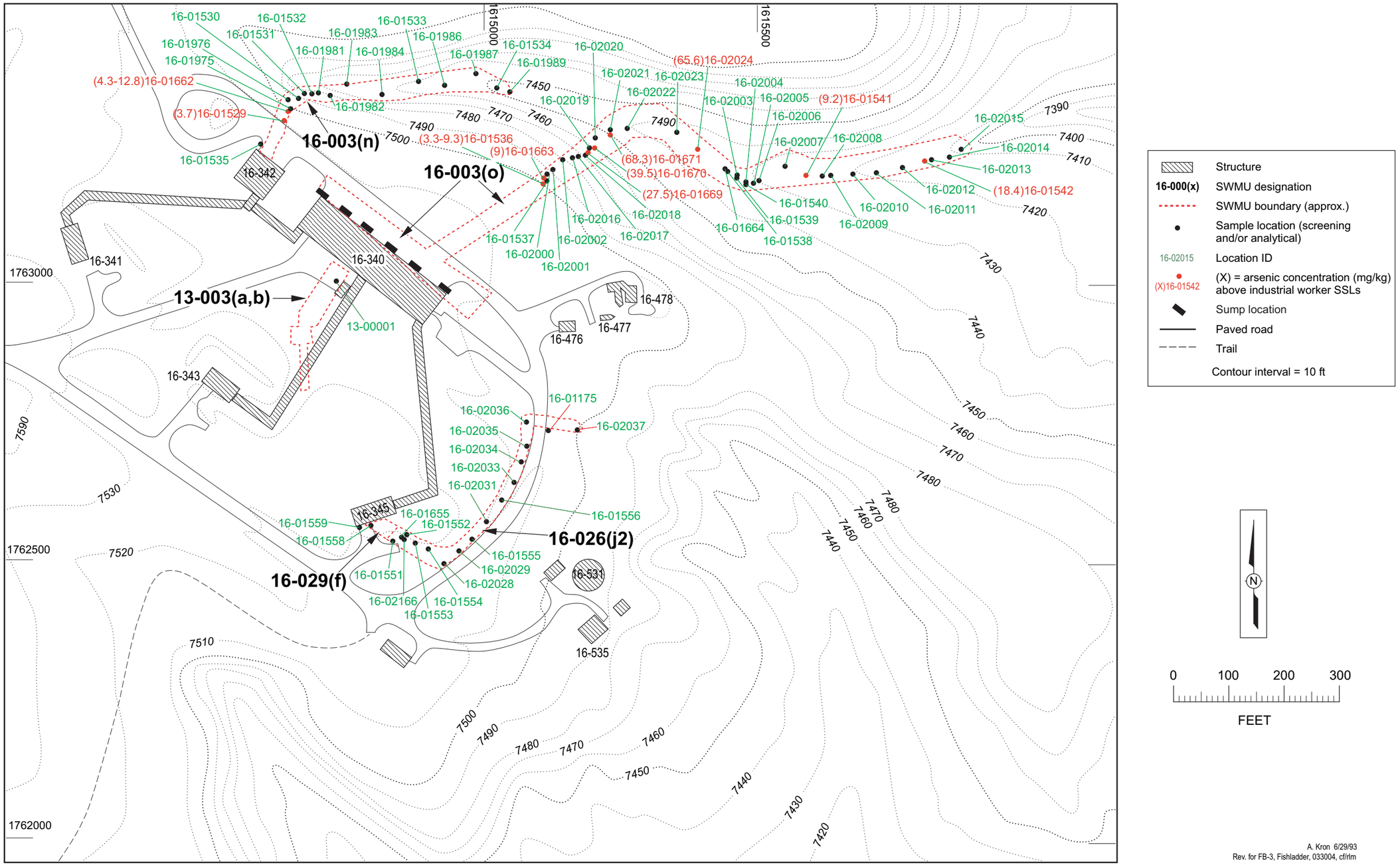


Figure B-3. TA-16-340 Complex soil, sediment, and tuff locations with arsenic concentrations above background and outdoor industrial worker SSLs

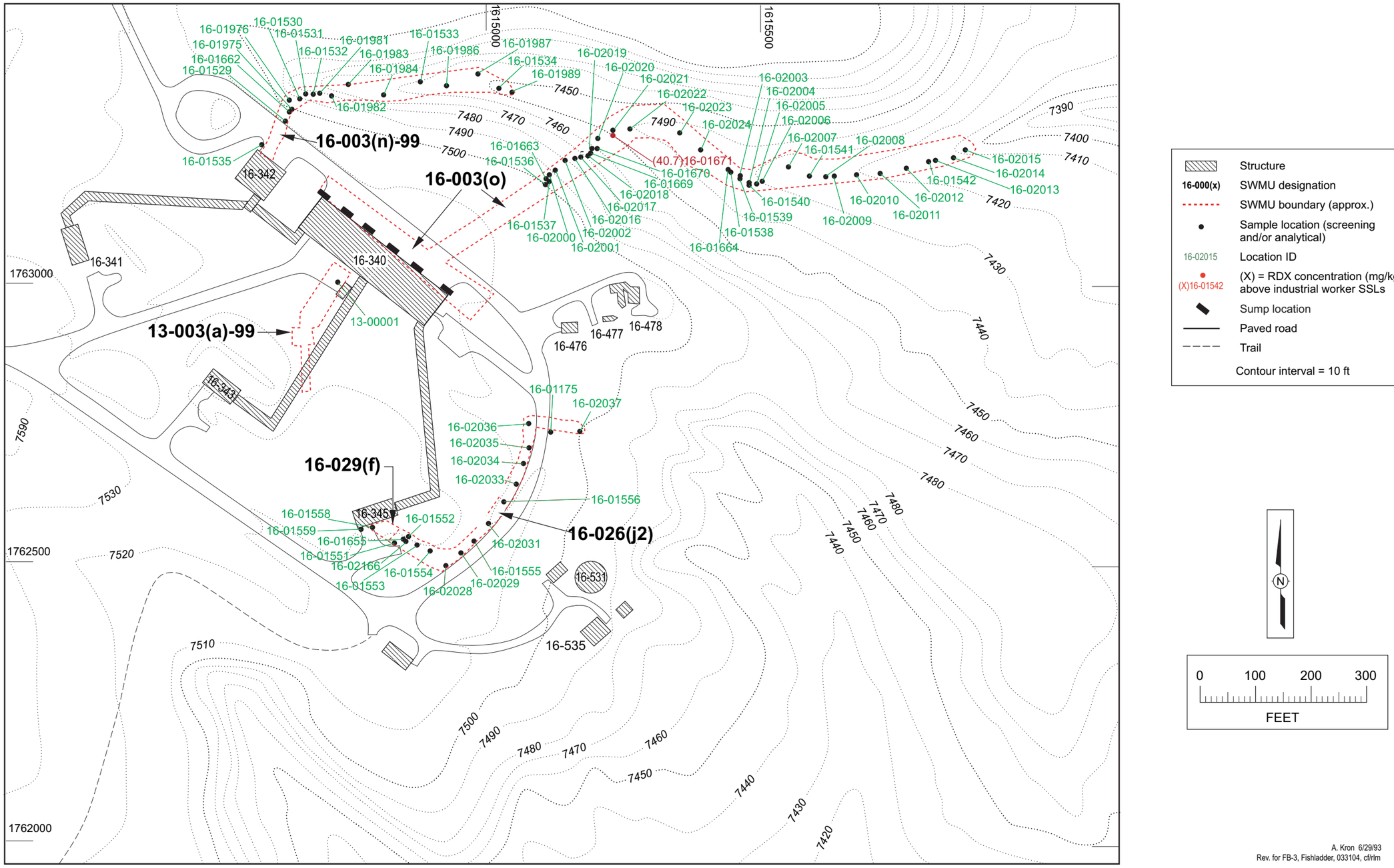


Figure B-4. TA-16-340 Complex soil, sediment, and tuff locations with RDX concentrations above industrial outdoor worker SSLs

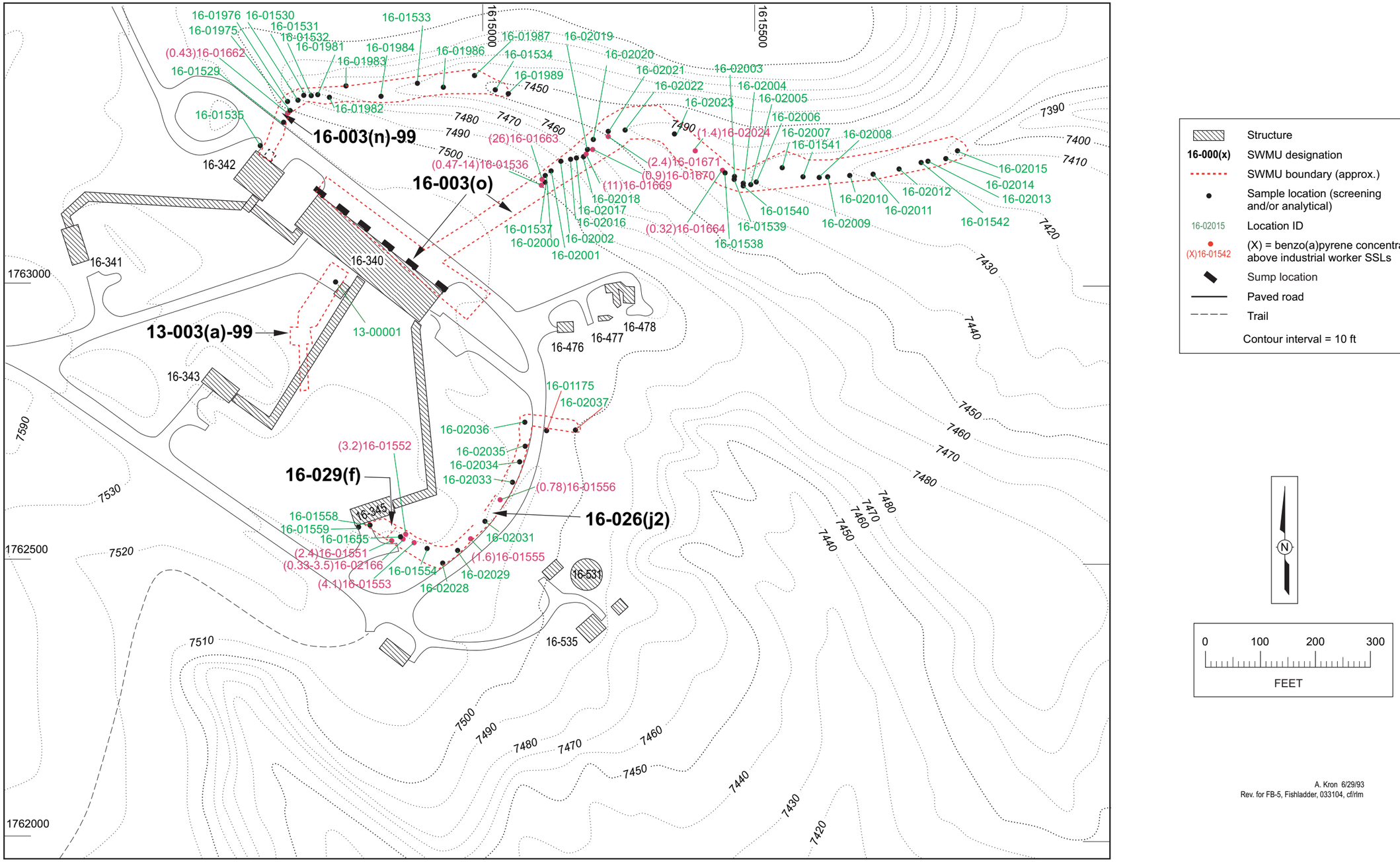


Figure B-5. TA-16-340 Complex soil, sediment, and tuff locations with benzo(a)pyrene concentrations above industrial outdoor worker SSLs

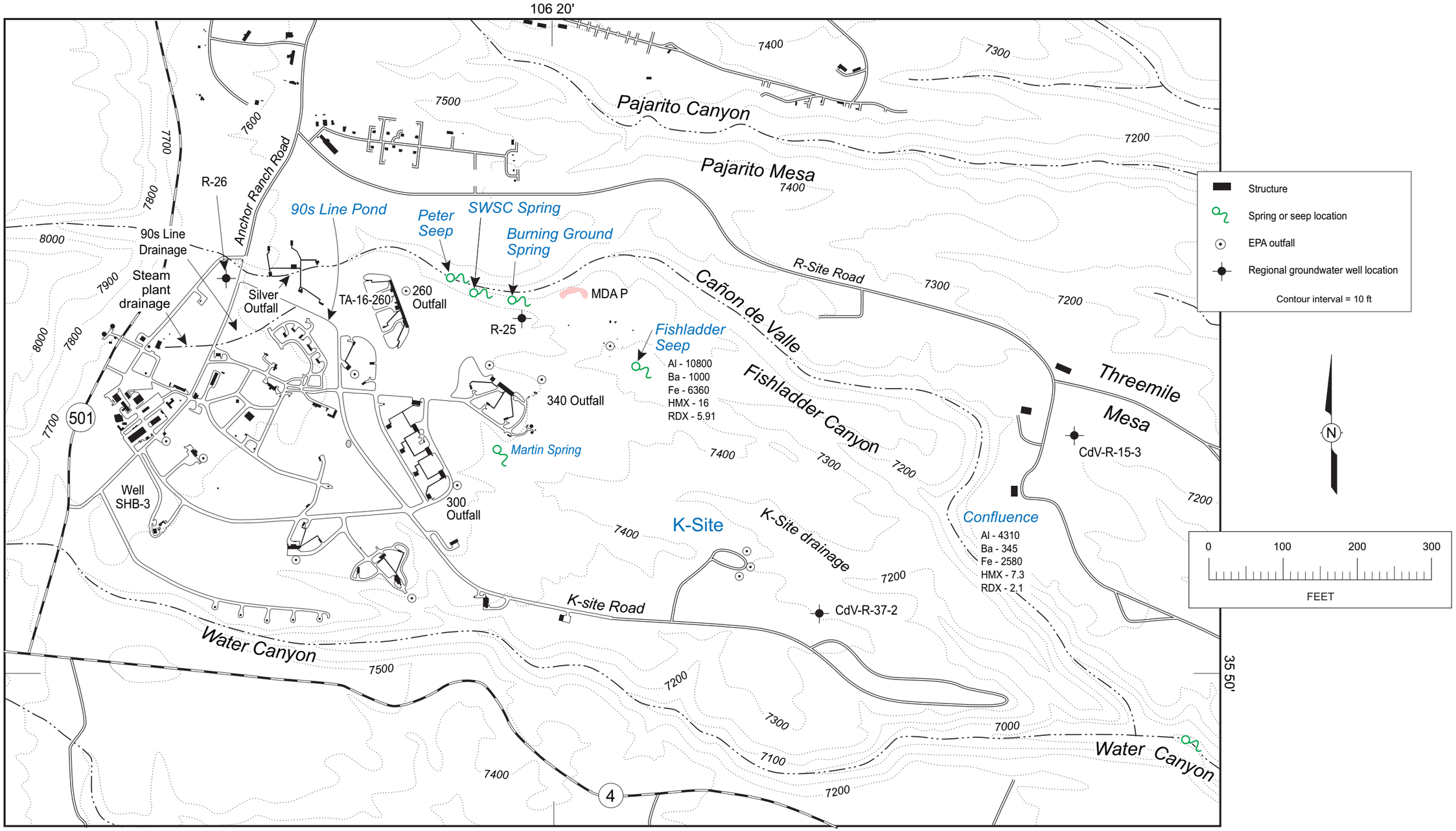


Figure B-6. Maximum concentrations for selected analytes by location at Fishladder Seep and the confluence of Fishladder Canyon and Cañon de Valle

Table B-1
RFI Screening Data from SWMU 16-026(j2)

Sample ID	Location ID	Screening Method/Result
0316-95-0248	16-01665	PID: 20 ppm
0316-95-0249	16-01665	PID: 20 ppm
0316-95-0250	16-01665	PID: 40 ppm
0316-95-0254	16-01555	PID: 4 ppm
0316-95-0500	16-01555	PID: 20 ppm
0316-95-0504	16-02166	PID: 60 ppm
PID Screening	N/A	PID: 25 ppm
PID Screening	N/A	PID: 30 ppm
PID Screening	N/A	PID: 40 ppm
PID Screening	N/A	PID: 62 ppm
PID Screening	N/A	PID: 20 ppm
PID Screening	N/A	PID: 20 ppm
PID Screening	16-02166	PID: 95 ppm
PID Screening	N/A	PID: 65 ppm
PID Screening	N/A	PID: 50 ppm
PID Screening	N/A	PID: 60 ppm
PID Screening	N/A	PID: 50 ppm
PID Screening	N/A	PID: 55 ppm

Notes: PID screening data for which no location ID is provided (N/A) represent a series of PID analyses in a zone of high VOCs based on field screening. The highest PID location was selected for laboratory analysis. All other screening data for HE, VOCs, and radionuclides were nondetects or in the range of background.

Table B-2
RFI Screening Data from SWMU 16-003(n)-99

Sample ID	Location ID	Screening Method/Result
0316-95-0214	16-01529	PID: 2 ppm
0316-95-0218	16-01662	HE spot test: Positive
0316-95-1211	16-01975	HE spot test: Positive
0316-95-1212	16-01976	HE spot test: Positive

Notes: HE screening samples were collected at a 0- to 6-in. depth from the surface. All other screening data for HE, VOCs, and radionuclides were non-detects or in the range of background.

Table B-3
RFI Screening Data from SWMU 16-003(o)

Sample ID	Location ID	Screening Method/Result
0316-95-0226	16-01536	HE spot test: Positive
0316-95-0227	16-01536	PID: 13 ppm
0316-95-0229	16-01663	HE spot test: Positive
0316-95-1226	16-02000	HE spot test: Positive
0316-95-1227	16-02001	HE spot test: Positive
0316-95-1228	16-02002	HE spot test: Positive
0316-95-1242	16-02016	HE spot test: Positive
0316-95-1243	16-02017	HE spot test: Positive
0316-95-1244	16-02018	HE spot test: Positive

Notes: HE screening samples were collected at a 0- to 6-in. depth from the surface. All other screening data for HE, VOCs, and radionuclides were nondetects or in the range of background.

Table B-4
Soil, Sediment, and Tuff Samples Taken in Association with the TA-16-340 Complex

Sample ID	Location ID	Depth (ft)	Medium	Cyanide	Metals	HE	SVOCs	VOCs	Gamma Spectroscopy
0313-95-0001	13-00001	1.5–2.5	Soil	1243	1244	1242	1242	1242	1244
0313-95-0002	13-00001	3–4	Qbt 4	1243	1244	1242	1242	1242	1244
0316-95-0214	16-01529	0–0.5	Sediment	970	971	969	969	—*	—
0316-95-0215	16-01529	2–2.5	Soil	970	971	969	969	969	—
0316-95-0216	16-01529	4–5	Qbt 4	1053	1054	1052	1052	1052	—
0316-95-0220	16-01530	0–0.5	Sediment	206	208	215	—	—	—
0316-95-0221	16-01531	0–0.5	Sediment	206	208	215	—	—	—
0316-95-0222	16-01532	0–0.5	Sediment	206	208	215	—	—	—
0316-95-0223	16-01533	0–0.5	Sediment	206	208	215	—	—	—
0316-95-0224	16-01534	0–0.5	Sediment	206	208	215	—	—	—
0316-95-0226	16-01536	0–0.33	Soil	1008	1009	1007	1007	1007	—
0316-95-0227	16-01536	3–3.5	Qbt 4	1053	1054	1052	1052	1052	—
0316-95-0234	16-01537	0–0.5	Soil	970	971	969	969	—	—
0316-95-0235	16-01537	1.5–2	Soil	970	971	969	969	969	—
0316-95-0236	16-01537	2.5–3.5	Qbt 4	1298	1299	1297	1297	1297	—
0316-95-0240	16-01538	0–0.5	Soil	299	300	298	298	—	—
0316-95-0241	16-01539	0–0.5	Soil	299	300	298	298	—	—
0316-95-0242	16-01540	0–0.5	Soil	299	300	298	298	—	—
0316-95-0243	16-01541	0–0.5	Soil	299	300	298	298	—	—
0316-95-0244	16-01542	0–0.5	Soil	299	300	298	298	—	—
0316-97-0607	16-01551	0–1	Soil	—	3676R	3677R	3675R	3675R	—
0316-97-0608	16-01551	0.5–2.5	Soil	—	3676R	3677R	3675R	3675R	—

Table B-4 (continued)

Sample ID	Location ID	Depth (ft)	Medium	Cyanide	Metals	HE	SVOCs	VOCs	Gamma Spectroscopy
0316-97-0609	16-01551	2.5–4	Qbt 4	—*	3676R	3677R	3675R	3675R	—
0316-95-0251	16-01552	0–0.5	Sediment	223	223	222	222	—	—
0316-95-0252	16-01553	0–0.5	Sediment	223	223	222	222	—	—
0316-95-0253	16-01554	0–0.5	Sediment	223	223	222	222	—	—
0316-95-0254	16-01555	0–0.5	Sediment	223	223	222	222	—	—
0316-95-0500	16-01555	0–0.5	Sediment	—	—	—	—	289	—
0316-95-0255	16-01556	0–0.5	Sediment	223	223	222	222	—	—
0316-95-0218	16-01662	0–0.16	Sediment	1008	1009	1007	1007	1007	—
0316-95-0219	16-01662	2.5–3.5	Qbt 4	1223	1224	1222	1222	1222	—
0316-95-0229	16-01663	0–0.33	Soil	1008	1009	1007	1007	1007	—
0316-95-0230	16-01663	0.5–1.5	Qbt 4	1298	1299	1297	1297	1297	—
0316-95-0238	16-01664	0–0.33	Soil	970	971	969	969	969	—
0316-95-0239	16-01664	2–3.5	Qbt 4	1298	1299	1297	1297	1297	—
0316-95-0231	16-01669	0–0.5	Soil	299	300	298	298	—	—
0316-95-0232	16-01670	0–0.5	Soil	299	300	298	298	—	—
0316-95-0233	16-01671	0–0.5	Soil	299	300	298	298	—	—
0316-95-0498	16-02023	0–0.5	Soil	299	300	298	298	—	—
0316-95-0499	16-02024	0–0.5	Soil	299	300	298	298	—	—
0316-95-0501	16-02166	0–0.5	Sediment	730	730	731	729	—	—
0316-95-0502	16-02166	0.5–1.17	Soil	730	730	731	729	729	—
0316-95-0504	16-02166	0.5–1.17	Soil	730	730	731	729	729	—
0316-95-0503	16-02166	5–7	Qbt 4	730	730	731	729	729	—
0316-97-0610	16-02166	8.9–9	Qbt 4	—	3676R	—	—	—	—

Note: Numbers in the analysis columns are analytical request numbers.

*— = Not analyzed.

Table B-5
Frequency of Inorganic Chemicals above Background Values in Soil, Sediment, and Tuff at the TA-16-340 Complex

Analyte	Medium	Number of Analyses	Number of Detects	Concentration Range* (mg/kg)	Background Value (mg/kg)	Frequency of Detects above Background Value	Frequency of Nondetects above Background Value
Aluminum	Soil	21	21	2360 to 17,300	29,200	0/21	0/21
	Sediment	13	13	1080 to 9480	15,400	0/13	0/13
	Qbt 4	10	10	1900 to 10,200	7340	4/10	0/10
Antimony	Soil	19	0	[5.1 to 20.7]	0.83	0/19	19/19
	Sediment	13	0	[5.03 to 14]	0.83	0/13	13/13
	Qbt 4	8	0	[5.1 to 13]	0.5	0/8	8/8
Arsenic	Soil	21	19	1.4 to 68.3	8.17	8/21	0/21
	Sediment	13	12	0.406 to 4.3	3.98	1/13	0/13
	Qbt 4	10	9	0.49 to 12.8	2.79	3/10	0/10
Barium	Soil	21	21	66 to 424	295	5/21	0/21
	Sediment	13	13	35.9 to 5910	127	3/13	0/13
	Qbt 4	10	9	14.7 to 884	46	5/10	0/10
Beryllium	Soil	21	9	[0.51] to 2.2	1.83	1/21	1/21
	Sediment	13	4	[0.503] to 1.3	1.31	0/13	0/13
	Qbt 4	10	2	[0.4 to 1.1]	1.21	0/10	0/10
Cadmium	Soil	21	5	[0.51] to 3.7	0.4	5/21	16/21
	Sediment	13	1	[0.503 to 1.2]	0.4	1/13	12/13
	Qbt 4	10	0	[0.51 to 1.1]	1.63	0/10	0/10
Calcium	Soil	21	21	691 to 9170	6120	1/21	0/21
	Sediment	13	13	632 to 4280	4420	0/13	0/13
	Qbt 4	10	9	486 to 5350	2200	2/10	0/10
Chromium	Soil	21	21	4.7 to 192	19.3	10/21	0/21
	Sediment	13	12	[1.1] to 9.99	10.5	0/13	0/13
	Qbt 4	10	10	1.4 to 260	7.14	8/10	0/10
Cobalt	Soil	21	16	1.3 to 12.5	8.64	1/21	2/21
	Sediment	13	12	1.4 to [12]	4.73	2/13	1/13
	Qbt 4	10	8	[1.1 to 11]	3.14	2/10	1/10
Copper	Soil	21	19	3.8 to 1420	14.7	11/21	0/21
	Sediment	13	13	1.7 to 62.6	11.2	2/13	0/13
	Qbt 4	10	9	4.8 to 100	4.66	9/10	1/10
Cyanide (Total)	Soil	19	0	[0.57 to 4.17]	0.5	0/19	19/19
	Sediment	13	0	[0.58 to 1.6]	0.82	0/13	12/13
	Qbt 4	8	0	[0.56 to 1.2]	0.5	0/8	8/8

Table B-5 (continued)

Analyte	Medium	Number of Analyses	Number of Detects	Concentration Range* (mg/kg)	Background Value (mg/kg)	Frequency of Detects above Background Value	Frequency of Nondetects above Background Value
Iron	Soil	21	21	3370 to 44400	21500	1/21	0/21
	Sediment	13	13	2220 to 12400	13800	0/13	0/13
	Qbt 4	10	10	3800 to 17500	14500	1/10	0/10
Lead	Soil	21	21	1.6 to 190	22.3	9/21	0/21
	Sediment	13	13	2.98 to 71.5	19.7	6/13	0/13
	Qbt 4	10	10	1.2 to 134	11.2	3/10	0/10
Magnesium	Soil	21	20	355 to 2510	4610	0/21	0/21
	Sediment	13	12	239 to 1590	2370	0/13	0/13
	Qbt 4	10	9	87 to 1460	1690	0/10	0/10
Manganese	Soil	21	21	28.5 to 365	671	0/21	0/21
	Sediment	13	13	91.1 to 450	543	0/13	0/13
	Qbt 4	10	10	49 to 1080	482	1/10	0/10
Mercury	Soil	21	11	[0.05] to 1.78	0.1	10/21	4/21
	Sediment	13	4	[0.048 to 0.12]	0.1	0/13	2/13
	Qbt 4	9	1	[0.05 to 0.12]	0.1	0/9	3/9
Nickel	Soil	21	19	1.5 to 22.3	15.4	1/21	0/21
	Sediment	13	12	2.05 to [9.3]	9.38	0/13	0/13
	Qbt 4	10	9	2.42 to 21	6.58	3/10	1/10
Potassium	Soil	21	19	468 to 1740	3460	0/21	0/21
	Sediment	13	12	215 to [1200]	2690	0/13	0/13
	Qbt 4	10	9	486 to 1200	3500	0/10	0/10
Selenium	Soil	19	9	0.26 to 4.6	1.52	7/19	0/19
	Sediment	13	0	[0.258 to 1.2]	0.3	0/13	5/13
	Qbt 4	8	0	[0.26 to 1.1]	0.3	0/8	2/8
Silver	Soil	21	3	[0.51] to 4.1	1	3/21	8/21
	Sediment	13	0	[0.503 to 2.3]	1	0/13	1/13
	Qbt 4	10	0	[0.51 to 2.4]	1	0/10	3/10
Sodium	Soil	21	18	100 to 1520	915	2/21	2/21
	Sediment	13	12	281 to [1200]	1470	0/13	0/13
	Qbt 4	10	9	233 to [1100]	2770	0/10	0/10
Thallium	Soil	21	0	[0.25 to 2.3]	0.73	0/21	6/21
	Sediment	13	0	[0.258 to 2.3]	0.73	0/13	1/13
	Qbt 4	10	2	[0.22 to 2.2]	1.1	0/10	3/10
Uranium	Soil	17	17	1.9 to 17.3	1.82	17/17	0/17
	Sediment	7	7	1.08 to 6.6	2.22	2/7	0/7
	Qbt 4	7	7	1.42 to 2.64	2.4	2/7	0/7

Table B-5 (continued)

Analyte	Medium	Number of Analyses	Number of Detects	Concentration Range* (mg/kg)	Background Value (mg/kg)	Frequency of Detects above Background Value	Frequency of Nondetects above Background Value
Vanadium	Soil	21	19	5.9 to 265	39.6	11/21	0/21
	Sediment	13	12	4.9 to 27	19.7	3/13	0/13
	Qbt 4	10	9	1.71 to 26.6	17	2/10	0/10
Zinc	Soil	21	21	15 to 967	48.8	10/21	0/21
	Sediment	13	13	6.97 to 229	60.2	2/13	0/13
	Qbt 4	10	10	9 to 133	63.5	2/10	0/10

* Values in brackets are below detection limits, although some chemicals may be detected at values within this range.

Table B-6
Summary of Samples with Inorganic Chemicals above Background Values in Soil, Sediment, and Tuff at the TA-16-340 Complex

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Cyanide (Total)	Iron
Soil Background Value				**29200**	**0.83**	**8.17**	**295**	**1.83**	**0.4**	**6120**	**19.3**	**8.64**	**14.7**	**0.5**	**21500**
Qbt 2,3,4 Background Value				**7340**	**0.5**	**2.79**	**46**	**1.83**	**1.63**	**2200**	**7.14**	**3.14**	**4.66**	**0.5**	**14500**
Sediment Background Value				**15400**	**0.83**	**3.98**	**127**	**1.31**	**0.4**	**4420**	**10.5**	**4.73**	**11.2**	**0.82**	**13800**
SWMU 13-003(a)-99															
0313-95-0001	13-00001	1.50–2.50	Soil	—[a]	6.2 (U)[b]	—	—	—	0.62 (U)	—	—	—	—	1.3 (U)	—
0313-95-0002	13-00001	3.00–4.00	Qbt 4	10200	6.2 (U)	—	110	—	—	5350	17.8	—	4.8	1.2 (U)	—
SWMU 16-003(n)-99															
0316-95-0214	16-01529	0.00–0.50	Sediment	—	5.87 (U)	—	3040	—	0.587 (U)	—	—	5.31 (J)[c]	21	1.19 (U)	—
0316-95-0215	16-01529	2.00–2.50	Soil	—	5.37 (U)	—	424	—	0.537 (U)	—	—	—	—	1.11 (U)	—
0316-95-0216	16-01529	4.00–5.00	Qbt 4	—	5.7 (U)	3.7	143	—	—	—	190	3.5 (J)	5.3	1.2 (U)	—
0316-95-0218	16-01662	0.00–0.16	Sediment	—	7.7 (U)	4.3	5910	—	1.1	—	—	—	62.6	1.6 (U)	—
0316-95-0219	16-01662	2.50–3.50	Qbt 4	9540	5.1 (U)	12.8 (J-)[d]	884 (J-)	—	—	—	7.7	—	13.7	1.1 (U)	—
0316-95-0220	16-01530	0.00–0.50	Sediment	—	6.6 (U)	—	564	—	0.66 (U)	—	—	—	—	1.3 (U)	—
0316-95-0221	16-01531	0.00–0.50	Sediment	—	5.6 (U)	—	—	—	0.56 (U)	—	—	5.6	—	1.1 (U)	—
0316-95-0222	16-01532	0.00–0.50	Sediment	—	5.3 (U)	—	—	—	0.53 (U)	—	—	—	—	1.1 (U)	—
0316-95-0223	16-01533	0.00–0.50	Sediment	—	6.6 (U)	—	—	—	0.66 (U)	—	—	—	—	1.3 (U)	—
0316-95-0224	16-01534	0.00–0.50	Sediment	—	5.5 (U)	—	—	—	0.55 (U)	—	—	—	—	1.1 (U)	—
SWMU 16-003(o)															
0316-95-0226	16-01536	0.00–0.33	Soil	—	7.8 (U)	9.3	—	2.2	3.7	9170	192	—	1420	1.6 (U)	44400
0316-95-0227	16-01536	3.00–3.50	Qbt 4	8840	5.7 (U)	3.3	52.3	—	—	2360	17.6	—	14.8	1.2 (U)	—
0316-95-0234	16-01537	0.00–0.50	Soil	—	5.97 (U)	—	—	—	0.597 (U)	—	—	—	—	1.2 (U)	—
0316-95-0235	16-01537	1.50–2.00	Soil	—	6.35 (U)	—	—	—	0.635 (U)	—	—	—	—	1.3 (U)	—
0316-95-0236	16-01537	2.50–3.50	Qbt 4	8960	5.76 (U)	—	174	—	—	—	7.9	8.53 (J)	91.9 (J)	1.18 (U)	17500
0316-95-0229	16-01663	0.00–0.33	Soil	—	10.6 (U)	9	—	—	2.4	—	145	—	838	2.1 (U)	—
0316-95-0230	16-01663	0.50–1.50	Qbt 4	—	5.44 (U)	—	—	—	—	—	—	—	37.1 (J)	1.12 (U)	—
0316-95-0231	16-01669	0.00–0.50	Soil	—	7.8 (U)	27.5	—	—	1.8	—	190	—	805	1.6 (U)	—
0316-95-0232	16-01670	0.00–0.50	Soil	—	8.3 (U)	39.5	314	—	2.7	—	137	—	736	1.7 (U)	—
0316-95-0233	16-01671	0.00–0.50	Soil	—	7.5 (U)	68.3	358	—	1.2	—	40.1	12.5	175	1.5 (U)	—

Table B-6 (continued)

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Cyanide (Total)	Iron
Soil Background Value				**29200**	**0.83**	**8.17**	**295**	**1.83**	**0.4**	**6120**	**19.3**	**8.64**	**14.7**	**0.5**	**21500**
Qbt 2,3,4 Background Value				**7340**	**0.5**	**2.79**	**46**	**1.83**	**1.63**	**2200**	**7.14**	**3.14**	**4.66**	**0.5**	**14500**
Sediment Background Value				**15400**	**0.83**	**3.98**	**127**	**1.31**	**0.4**	**4420**	**10.5**	**4.73**	**11.2**	**0.82**	**13800**
0316-95-0498	16-02023	0.00–0.50	Soil	—	5.1 (U)	—	—	—	0.51 (U)	—	—	—	—	1 (U)	—
0316-95-0499	16-02024	0.00–0.50	Soil	—	11.5 (U)	65.6	370	—	1.2 (U)	—	167	—	329	2.3 (U)	—
0316-95-0238	16-01664	0.00–0.33	Soil	—	20.7 (U)	—	—	2.1 (U)	2.07 (U)	—	31	—	102	4.17 (U)	—
0316-95-0239	16-01664	2.00–3.50	Qbt 4	—	5.96 (U)	—	—	—	—	—	—	—	13 (J)	1.2 (U)	—
0316-95-0240	16-01538	0.00–0.50	Soil	—	6.42 (U)	—	—	—	0.64 (U)	—	—	—	19.1	1.3 (U)	—
0316-95-0241	16-01539	0.00–0.50	Soil	—	6.7 (U)	—	—	—	0.67 (U)	—	—	—	—	1.4 (U)	—
0316-95-0242	16-01540	0.00–0.50	Soil	—	12.8 (U)	—	—	—	1.3 (U)	—	—	—	32.6	2.6 (U)	—
0316-95-0243	16-01541	0.00–0.50	Soil	—	10.2 (U)	9.2	—	—	1 (U)	—	53.1	—	125	2.1 (U)	—
0316-95-0244	16-01542	0.00–0.50	Soil	—	16.8 (U)	18.4	336	—	1.7 (U)	—	68.3	—	146	3.4 (U)	—
SWMU 16-026(j2)															
0316-97-0607	16-01551	0.00–1.00	Soil	—	—	—	—	—	0.57 (U)	—	—	—	—	—	—
0316-97-0608	16-01551	0.50–2.50	Soil	—	—	—	—	—	0.59 (U)	—	27	—	—	—	—
0316-97-0609	16-01551	2.50–4.00	Qbt 4	—	—	—	—	—	—	—	12	—	100	—	—
0316-95-0501	16-02166	0.00–0.50	Sediment	—	14 (UJ)[e]	—	—	—	1.2 (U)	—	—	12 (U)	—	—	—
0316-95-0502	16-02166	0.50–1.17	Soil	—	14 (UJ)	—	—	—	1.1 (U)	—	—	11 (U)	—	0.57 (U)	—
0316-95-0504	16-02166	0.50–1.17	Soil	—	14 (UJ)	—	—	—	1.2 (U)	—	—	12 (U)	—	0.58 (U)	—
0316-95-0503	16-02166	5.00–7.00	Qbt 4	—	13 (UJ)	—	—	—	—	—	260	11 (U)	5.6 (U)	0.56 (U)	—
0316-97-0610	16-02166	8.90–9.00	Qbt 4	—	—	—	—	—	—	—	77	—	56	—	—
0316-95-0251	16-01552	0.00–0.50	Sediment	—	5.04 (U)	—	—	—	0.504 (U)	—	—	—	—	1.1 (U)	—
0316-95-0252	16-01553	0.00–0.50	Sediment	—	5.03 (U)	—	—	—	0.503 (U)	—	—	—	—	1 (U)	—
0316-95-0253	16-01554	0.00–0.50	Sediment	—	5.3 (U)	—	—	—	0.53 (U)	—	—	—	—	1.1 (U)	—
0316-95-0254	16-01555	0.00–0.50	Sediment	—	5.57 (U)	—	—	—	0.557 (U)	—	—	—	—	1.1 (U)	—
0316-95-0255	16-01556	0.00–0.50	Sediment	—	6.29 (U)	—	—	—	0.629 (U)	—	—	—	—	1.3 (U)	—

Table B-6 (continued)

Sample ID	Location ID	Depth (ft)	Media	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Sodium	Thallium	Uranium	Vanadium	Zinc
Soil Background Value				**22.3**	**671**	**0.1**	**15.4**	**1.52**	**1**	**915**	**0.73**	**1.82**	**39.6**	**48.8**
Qbt 2,3,4 Background Value				**11.2**	**482**	**0.1**	**6.58**	**0.3**	**1**	**2770**	**1.1**	**2.4**	**17**	**63.5**
Sediment Background Value				**19.7**	**543**	**0.1**	**9.38**	**0.3**	**1**	**1470**	**0.73**	**2.22**	**19.7**	**60.2**
SWMU 13-003(a)-99														
0313-95-0001	13-00001	1.50–2.50	Soil	—	—	—	—	—	—	—	—	2.57	—	—
0313-95-0002	13-00001	3.00–4.00	Qbt 4	—	—	—	—	0.31 (UJ)	—	—	—	2.64	—	—
SWMU 16-003(n)-99														
0316-95-0214	16-01529	0.00–0.50	Sediment	20.4	—	0.11 (U)	—	—	—	—	—	—	23.9	101 (J-)
0316-95-0215	16-01529	2.00–2.50	Soil	—	—	—	—	—	—	—	—	2.05	—	—
0316-95-0216	16-01529	4.00–5.00	Qbt 4	—	—	—	—	—	—	—	—	—	—	—
0316-95-0218	16-01662	0.00–0.16	Sediment	46.3	—	—	—	0.4 (U)	—	—	—	6.6	25.4	229
0316-95-0219	16-01662	2.50–3.50	Qbt 4	134	—	—	—	—	—	—	—	—	19.4	—
0316-95-0220	16-01530	0.00–0.50	Sediment	—	—	—	—	0.33 (U)	—	—	—	2.58	—	—
0316-95-0221	16-01531	0.00–0.50	Sediment	28.7	—	—	—	—	—	—	—	—	27	—
0316-95-0222	16-01532	0.00–0.50	Sediment	—	—	—	—	—	—	—	—	—	—	—
0316-95-0223	16-01533	0.00–0.50	Sediment	—	—	—	—	0.32 (U)	—	—	—	—	—	—
0316-95-0224	16-01534	0.00–0.50	Sediment	—	—	—	—	—	—	—	—	—	—	—
SWMU 16-003(o)														
0316-95-0226	16-01536	0.00–0.33	Soil	190	—	1.21	22.3	4.6	4.1	—	—	11.4	78.7	967
0316-95-0227	16-01536	3.00–3.50	Qbt 4	11.4	—	—	—	—	—	—	—	—	—	—
0316-95-0234	16-01537	0.00–0.50	Soil	—	—	—	—	—	—	—	—	1.9	—	—
0316-95-0235	16-01537	1.50–2.00	Soil	—	—	—	—	—	—	—	—	2.16	—	—
0316-95-0236	16-01537	2.50–3.50	Qbt 4	—	1080	—	11.4 (J-)	—	—	—	—	—	26.6 (J)	133 (J+)[f]
0316-95-0229	16-01663	0.00–0.33	Soil	120	—	1.78	—	4.6	3.3	—	—	6.75	49	515
0316-95-0230	16-01663	0.50–1.50	Qbt 4	—	—	—	—	—	—	—	—	—	—	—
0316-95-0231	16-01669	0.00–0.50	Soil	111	—	1	—	1.7	1.4 (J)	—	—	16.3	134	494
0316-95-0232	16-01670	0.00–0.50	Soil	78.9	—	0.43	—	2.7	—	—	—	13.3	170	493

Table B-6 (continued)

Sample ID	Location ID	Depth (ft)	Media	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Sodium	Thallium	Uranium	Vanadium	Zinc
Soil Background Value				**22.3**	**671**	**0.1**	**15.4**	**1.52**	**1**	**915**	**0.73**	**1.82**	**39.6**	**48.8**
Qbt 2,3,4 Background Value				**11.2**	**482**	**0.1**	**6.58**	**0.3**	**1**	**2770**	**1.1**	**2.4**	**17**	**63.5**
Sediment Background Value				**19.7**	**543**	**0.1**	**9.38**	**0.3**	**1**	**1470**	**0.73**	**2.22**	**19.7**	**60.2**
0316-95-0233	16-01671	0.00–0.50	Soil	50.5	—	0.26	—	1.7	—	—	—	12.3	193	255
0316-95-0498	16-02023	0.00–0.50	Soil	—	—	—	—	—	—	—	—	2.32	41.5	—
0316-95-0499	16-02024	0.00–0.50	Soil	103	—	0.83	—	2	1.2 (U)	—	—	17.3	265	72.2
0316-95-0238	16-01664	0.00–0.33	Soil	31.4	—	0.38 (J)	—	—	2.07 (U)	1520 (J)	1 (U)	3.44	50.8	152 (J-)
0316-95-0239	16-01664	2.00–3.50	Qbt 4	14.9	—	—	—	—	—	—	—	2.46	—	—
0316-95-0240	16-01538	0.00–0.50	Soil	—	—	—	—	—	—	—	—	2.36	—	—
0316-95-0241	16-01539	0.00–0.50	Soil	—	—	—	—	—	—	—	—	2.83	—	—
0316-95-0242	16-01540	0.00–0.50	Soil	—	—	0.11 (J)	—	—	1.3 (U)	—	—	5.24	75	104
0316-95-0243	16-01541	0.00–0.50	Soil	29	—	0.14 (J)	—	—	—	—	—	6.77	106	210
0316-95-0244	16-01542	0.00–0.50	Soil	33.7	—	0.2 (J)	—	1.6 (J)	1.7 (U)	1120 (J)	0.83 (U)	8.13	103	269
SWMU 16-026(j2)														
0316-97-0607	16-01551	0.00–1.00	Soil	—	—	0.11 (U)	—	—	2.3 (U)	—	1.4 (U)	—	—	—
0316-97-0608	16-01551	0.50–2.50	Soil	—	—	0.12 (U)	—	—	2.4 (U)	—	1.5 (U)	—	—	—
0316-97-0609	16-01551	2.50–4.00	Qbt 4	—	—	0.11 (U)	21	—	2.2 (U)	—	1.4 (U)	—	—	83
0316-95-0501	16-02166	0.00–0.50	Sediment	33	—	0.12 (U)	—	1.2 (UJ)	2.3 (U)	—	2.3 (U)	—	—	—
0316-95-0502	16-02166	0.50–1.17	Soil	—	—	0.11 (U)	—	—	2.3 (U)	1100 (U)	2.3 (U)	—	—	—
0316-95-0504	16-02166	0.50–1.17	Soil	—	—	0.12 (U)	—	—	2.3 (U)	1200 (U)	2.3 (U)	—	—	—
0316-95-0503	16-02166	5.00–7.00	Qbt 4	—	—	0.11 (U)	9 (U)	1.1 (UJ)	2.2 (U)	—	2.2 (U)	—	—	—
0316-97-0610	16-02166	8.90–9.00	Qbt 4	—	—	0.12 (U)	14	—	2.4 (U)	—	1.5 (U)	—	—	—
0316-95-0251	16-01552	0.00–0.50	Sediment	—	—	—	—	—	—	—	—	—	—	—
0316-95-0252	16-01553	0.00–0.50	Sediment	—	—	—	—	—	—	—	—	—	—	—
0316-95-0253	16-01554	0.00–0.50	Sediment	31.3	—	—	—	—	—	—	—	—	—	—

Table B-6 (continued)

Sample ID	Location ID	Depth (ft)	Media	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Sodium	Thallium	Uranium	Vanadium	Zinc
Soil Background Value				**22.3**	**671**	**0.1**	**15.4**	**1.52**	**1**	**915**	**0.73**	**1.82**	**39.6**	**48.8**
Qbt 2,3,4 Background Value				**11.2**	**482**	**0.1**	**6.58**	**0.3**	**1**	**2770**	**1.1**	**2.4**	**17**	**63.5**
Sediment Background Value				**19.7**	**543**	**0.1**	**9.38**	**0.3**	**1**	**1470**	**0.73**	**2.22**	**19.7**	**60.2**
0316-95-0254	16-01555	0.00–0.50	Sediment	71.5	—	—	—	—	—	—	—	—	—	—
0316-95-0255	16-01556	0.00–0.50	Sediment	—	—	—	—	0.306 (U)	—	—	—	—	—	—

Notes: Units are mg/kg.

[a] — = Value not above background value for corresponding media.

[b] U = The analyte was analyzed for but not detected.

[c] J = The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.

[d] J- = The analyte was positively identified, and the result is likely to be biased low.

[e] UJ = The analyte was not positively identified in the sample, and the associated value is an estimate of the sample-specific detection or quantitation limit.

[f] J+ = The analyte was positively identified, and the result is likely to be biased high.

Table B-7
Frequency of Detected Organic Chemicals in Soil, Sediment, and Tuff at the TA-16-340 Complex

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range* (mg/kg)	Frequency of Detects
Acenaphthene	Soil	21	6	[0.18] to 9.8	6/21
Acenaphthene	Sediment	8	5	0.083 to [1.9]	5/8
Acenaphthene	Qbt 4	9	1	0.12 to [16]	1/9
Acenaphthylene	Sediment	8	1	0.045 to [1.9]	1/8
Acetone	Soil	10	1	[0.006] to [0.083]	1/10
Acetone	Qbt 4	9	6	0.007 to 0.058	6/9
Amino-2,6-dinitrotoluene[4-]	Soil	21	1	[0.086] to 1.07	1/21
Amino-2,6-dinitrotoluene[4-]	Sediment	13	1	[0.091] to 0.446	1/13
Amino-4,6-dinitrotoluene[2-]	Sediment	13	1	[0.075] to 0.714	1/13
Anthracene	Soil	21	6	[0.18] to 14	6/21
Anthracene	Sediment	8	6	0.05 to [1.9]	6/8
Anthracene	Qbt 4	9	1	[0.18] to [16]	1/9
Benz(a)anthracene	Soil	21	9	0.22 to 26	9/21
Benz(a)anthracene	Sediment	8	8	0.094 to 3.3	8/8
Benz(a)anthracene	Qbt 4	9	1	[0.18] to [16]	1/9
Benzo(a)pyrene	Soil	21	12	0.053 to 26	12/21
Benzo(a)pyrene	Sediment	8	8	0.11 to 4.1	8/8
Benzo(a)pyrene	Qbt 4	9	1	[0.18] to [16]	1/9
Benzo(b)fluoranthene	Soil	21	14	0.071 to 38	14/21
Benzo(b)fluoranthene	Sediment	8	8	0.13 to 4.9	8/8
Benzo(b)fluoranthene	Qbt 4	9	1	[0.18] to [16]	1/9
Benzo(g,h,i)perylene	Soil	21	8	[0.18] to 8.7	8/21
Benzo(g,h,i)perylene	Sediment	8	8	0.074 to 3	8/8
Benzo(g,h,i)perylene	Qbt 4	9	1	[0.18 to 16]	1/9
Benzo(k)fluoranthene	Soil	21	9	[0.18] to 13	9/21
Benzo(k)fluoranthene	Sediment	8	7	0.057 to 3	7/8
Benzo(k)fluoranthene	Qbt 4	9	1	[0.18] to [16]	1/9
Benzoic Acid	Soil	21	1	[0.91] to [52]	1/21
Benzoic Acid	Sediment	8	4	0.11 to [9.5]	4/8
Benzyl Alcohol	Sediment	8	1	0.25 to [6.8]	1/8
Bis(2-ethylhexyl)phthalate	Soil	21	5	[0.038] to 150	5/21
Butanone[2-]	Qbt 4	9	1	0.003 to [0.025]	1/9
Butylbenzylphthalate	Sediment	8	1	[0.35] to 13	1/8
Chrysene	Soil	21	12	0.057 to 35	12/21
Chrysene	Sediment	8	8	0.12 to 4.2	8/8
Chrysene	Qbt 4	9	1	[0.18] to [16]	1/9
Dibenz(a,h)anthracene	Soil	21	7	0.16 to 2.9	7/21

Table B-7 (continued)

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range* (mg/kg)	Frequency of Detects
Dibenz(a,h)anthracene	Sediment	8	5	0.062 to [1.9]	5/8
Dibenz(a,h)anthracene	Qbt 4	9	1	0.062 to [16]	1/9
Dibenzofuran	Soil	21	5	0.082 to 6.2	5/21
Dibenzofuran	Sediment	8	4	0.094 to [1.9]	4/8
Dibenzofuran	Qbt 4	9	1	0.066 to [16]	1/9
Diethylphthalate	Qbt 4	9	3	0.046 to [16]	3/9
Di-n-butylphthalate	Soil	21	1	[0.18] to [5.2]	1/21
Di-n-butylphthalate	Sediment	8	1	0.18 to [1.9]	1/8
Dinitrobenzene[1,3-]	Soil	21	1	[0.068] to [0.25]	1/21
Dinitrobenzene[1,3-]	Qbt 4	9	1	[0.068] to [0.25]	1/9
Dinitrotoluene[2,4-]	Soil	42	1	[0.054] to [5.2]	1/42
Dinitrotoluene[2,4-]	Sediment	21	2	[0.054] to [1.9]	2/21
Dinitrotoluene[2,4-]	Qbt 4	18	1	[0.056] to [16]	1/18
Di-n-octylphthalate	Sediment	8	1	[0.35] to 4.5	1/8
Di-n-octylphthalate	Qbt 4	9	1	0.13 to [16]	1/9
Fluoranthene	Soil	21	15	0.098 to 51	15/21
Fluoranthene	Sediment	8	7	0.25 to [8.6]	7/8
Fluoranthene	Qbt 4	9	1	[0.18] to [16]	1/9
Fluorene	Soil	21	6	[0.18] to 9.7	6/21
Fluorene	Sediment	8	5	0.069 to [1.9]	5/8
Fluorene	Qbt 4	9	1	0.11 to [16]	1/9
HMX	Soil	21	10	[0.165] to 312	10/21
HMX	Sediment	13	3	[0.165] to 624	3/13
HMX	Qbt 4	9	2	[0.162] to [2.2]	2/9
Indeno(1,2,3-cd)pyrene	Soil	21	7	[0.18] to 10	7/21
Indeno(1,2,3-cd)pyrene	Sediment	8	8	0.078 to 2.5	8/8
Indeno(1,2,3-cd)pyrene	Qbt 4	9	1	[0.18] to [16]	1/9
Isopropyltoluene[4-]	Sediment	2	1	[0.008] to 0.021	1/2
Methylnaphthalene[2-]	Soil	21	3	[0.18] to [5]	3/21
Methylnaphthalene[2-]	Sediment	8	3	0.065 to [1.9]	3/8
Methylnaphthalene[2-]	Qbt 4	9	1	0.039 to [16]	1/9
Methylphenol[4-]	Soil	21	2	0.12 to [5.2]	2/21
Naphthalene	Soil	21	6	0.1 to 9.7	6/21
Naphthalene	Sediment	8	4	0.16 to [1.9]	4/8
Naphthalene	Qbt 4	9	1	0.099 to [16]	1/9
Nitrobenzene	Soil	42	1	[0.091] to [5.2]	1/42
Nitrobenzene	Sediment	21	1	[0.092] to [1.9]	1/21
Phenanthrene	Soil	21	15	0.054 to 43	15/21

Table B-7 (continued)

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range* (mg/kg)	Frequency of Detects
Phenanthrene	Sediment	8	8	0.14 to 5.6	8/8
Phenanthrene	Qbt 4	9	1	[0.18] to [16]	1/9
Pyrene	Soil	21	15	0.099 to 43	15/21
Pyrene	Sediment	8	8	0.23 to 8.7	8/8
Pyrene	Qbt 4	9	1	[0.18] to [16]	1/9
RDX	Soil	21	6	[0.164] to 40.7	6/21
RDX	Sediment	13	1	[0.164] to 4.44	1/13
Tetryl	Soil	21	3	[0.093] to 3.04	3/21
Trinitrotoluene[2,4,6-]	Soil	21	4	[0.08] to 3.03	4/21
Trinitrotoluene[2,4,6-]	Qbt 4	9	1	[0.085] to [0.25]	1/9

*Values in brackets are below detection limits, although some chemicals may be detected at values within this range.

Table B-8
Summary of Samples with Detected Organic Chemicals in Soil, Sediment at Tuff at the TA-16-340 Complex

Sample ID	Location ID	Depth (ft)	Media	Acenaphthene	Acenaphthylene	Acetone	Amino-2,6-dinitrotoluene[4-]	Amino-4,6-dinitrotoluene[2-]	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene
SWMU 13-003(a)-99													
0313-95-0001	13-00001	1.50–2.50	Soil	—[a]	—	—	—	—	—	—	—	—	—
0313-95-0002	13-00001	3.00–4.00	Qbt 4	—	—	—	—	—	—	—	—	—	—
SWMU 16-003(n)-99													
0316-95-0214	16-01529	0.00–0.50	Sediment	—	—	—	—	—	0.05 (J)[b]	0.14 (J)	0.18 (J)	0.27 (J)	0.081 (J)
0316-95-0216	16-01529	4.00–5.00	Qbt 4	—	—	0.015 (J)	—	—	—	—	—	—	—
0316-95-0218	16-01662	0.00–0.16	Sediment	0.083 (J)	—	—	—	—	0.11 (J)	0.33	0.43	0.61	0.19 (J)
0316-95-0219	16-01662	2.50–3.50	Qbt 4	—	—	—	—	—	—	—	—	—	—
0316-95-0220	16-01530	0.00–0.50	Sediment	—	—	—	0.446	0.714	—	—	—	—	—
0316-95-0224	16-01534	0.00–0.50	Sediment	—	—	—	—	—	—	—	—	—	—
SWMU 16-003(o)													
0316-95-0226	16-01536	0.00–0.33	Soil	4.5	—	—	1.07	—	7.1	14	14	18	5.2
0316-95-0227	16-01536	3.00–3.50	Qbt 4	0.12 (J)	—	0.012 (J)	—	—	0.19 (J)	0.39	0.47	0.59	0.26 (J)
0316-95-0235	16-01537	1.50–2.00	Soil	—	—	0.008 (J)	—	—	—	—	—	—	—
0316-95-0236	16-01537	2.50–3.50	Qbt 4	—	—	0.026	—	—	—	—	—	—	—
0316-95-0229	16-01663	0.00–0.33	Soil	9.8	—	—	—	—	14	26	26	38	8.7
0316-95-0230	16-01663	0.50–1.50	Qbt 4	—	—	0.007 (J)	—	—	—	—	—	—	—
0316-95-0231	16-01669	0.00–0.50	Soil	3.8 (J)	—	—	—	—	5.7	9.6	11	14	5.1 (J)
0316-95-0232	16-01670	0.00–0.50	Soil	—	—	—	—	—	—	—	0.9 (J)	1.1 (J)	0.43 (J)
0316-95-0233	16-01671	0.00–0.50	Soil	0.71 (J)	—	—	—	—	1.2 (J)	1.9 (J)	2.4 (J)	2.9 (J)	1.3 (J)

Table B-8 (continued)

Sample ID	Location ID	Depth (ft)	Media	Acenaphthene	Acenaphthylene	Acetone	Amino-2,6-dinitrotoluene[4-]	Amino-4,6-dinitrotoluene[2-]	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene
0316-95-0498	16-02023	0.00–0.50	Soil	—	—	—	—	—	—	—	0.053 (J)	0.076 (J)	—
0316-95-0499	16-02024	0.00–0.50	Soil	0.22 (J)	—	—	—	—	0.37 (J)	1	1.4	2	0.59 (J)
0316-95-0238	16-01664	0.00–0.33	Soil	—	—	—	—	—	—	0.24 (J)	0.32 (J)	0.51 (J)	—
0316-95-0239	16-01664	2.00–3.50	Qbt 4	—	—	0.034	—	—	—	—	—	—	—
0316-95-0241	16-01539	0.00–0.50	Soil	—	—	—	—	—	—	—	—	0.071 (J)	—
0316-95-0242	16-01540	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0316-95-0243	16-01541	0.00–0.50	Soil	—	—	—	—	—	—	—	0.13 (J)	0.19 (J)	—
0316-95-0244	16-01542	0.00–0.50	Soil	—	—	—	—	—	—	—	—	0.2 (J)	—
SWMU 16-026(j2)													
0316-97-0607	16-01551	0.00–1.00	Soil	0.53	—	—	—	—	0.7	2	2.4	1.6	1.3
0316-95-0501	16-02166	0.00–0.50	Sediment	—	—	—	—	—	—	3.3	3.5	2.9	3
0316-95-0502	16-02166	0.50–1.17	Soil	—	—	—	—	—	—	0.36	0.33	0.28	0.22
0316-95-0504	16-02166	0.50–1.17	Soil	—	—	—	—	—	—	0.22	0.2	0.2	—
0316-95-0503	16-02166	5.00–7.00	Qbt 4	—	—	0.058	—	—	—	—	—	—	—
0316-95-0251	16-01552	0.00–0.50	Sediment	0.68	0.045 (J)	—	—	—	0.79	2.9	3.2	4.3	1.8
0316-95-0252	16-01553	0.00–0.50	Sediment	0.93 (J)	—	—	—	—	1.4 (J)	2.1	4.1	4.9	2.4
0316-95-0253	16-01554	0.00–0.50	Sediment	—	—	—	—	—	—	0.094 (J)	0.11 (J)	0.13 (J)	0.074 (J)
0316-95-0254	16-01555	0.00–0.50	Sediment	0.67 (J)	—	—	—	—	1	1.5	1.6	2	0.77
0316-95-0500	16-01555	0.00–0.50	Sediment	—	—	—	—	—	—	—	—	—	—
0316-95-0255	16-01556	0.00–0.50	Sediment	0.21 (J)	—	—	—	—	0.26 (J)	0.69	0.78	0.99	0.4 (J)

Table B-8 (continued)

Sample ID	Location ID	Depth (ft)	Media	Benzo(k)fluoranthene	Benzoic Acid	Benzyl Alcohol	Bis(2-ethylhexyl)phthalate	Butanone[2-]	Butylbenzylphthalate	Chrysene	Dibenz(a,h)anthracene	Dibenzofuran	Diethylphthalate
SWMU 13-003(a)-99													
0313-95-0001	13-00001	1.50–2.50	Soil	—	—	—	0.16 (J)	—	—	—	—	—	—
0313-95-0002	13-00001	3.00–4.00	Qbt 4	—	—	—	—	—	—	—	—	—	0.046 (J)
SWMU 16-003(n)-99													
0316-95-0214	16-01529	0.00–0.50	Sediment	0.11 (J)	1 (J)	—	—	—	—	0.22 (J)	—	—	—
0316-95-0216	16-01529	4.00–5.00	Qbt 4	—	—	—	—	—	—	—	—	—	—
0316-95-0218	16-01662	0.00–0.16	Sediment	0.31 (J)	1.2 (J)	0.25 (J)	—	—	13	0.5	0.062 (J)	—	—
0316-95-0219	16-01662	2.50–3.50	Qbt 4	—	—	—	—	0.003 (J)	—	—	—	—	0.26 (J)
0316-95-0220	16-01530	0.00–0.50	Sediment	—	—	—	—	—	—	—	—	—	—
0316-95-0224	16-01534	0.00–0.50	Sediment	—	—	—	—	—	—	—	—	—	—
SWMU 16-003(o)													
0316-95-0226	16-01536	0.00–0.33	Soil	7.3	—	—	17	—	—	18	1.7	2.7	—
0316-95-0227	16-01536	3.00–3.50	Qbt 4	0.27 (J)	—	—	—	—	—	0.6	0.062 (J)	0.066 (J)	—
0316-95-0235	16-01537	1.50–2.00	Soil	—	—	—	—	—	—	—	—	—	—
0316-95-0236	16-01537	2.50–3.50	Qbt 4	—	—	—	—	—	—	—	—	—	—
0316-95-0229	16-01663	0.00–0.33	Soil	13	—	—	150	—	—	35	2.9 (J)	6.2	—
0316-95-0230	16-01663	0.50–1.50	Qbt 4	—	—	—	—	—	—	—	—	—	—
0316-95-0231	16-01669	0.00–0.50	Soil	6.5	—	—	—	—	—	11	1.5 (J)	1.5 (J)	—
0316-95-0232	16-01670	0.00–0.50	Soil	0.47 (J)	—	—	—	—	—	0.61 (J)	0.61 (J)	—	—
0316-95-0233	16-01671	0.00–0.50	Soil	1.3 (J)	—	—	64	—	—	2.4 (J)	1.1 (J)	—	—
0316-95-0498	16-02023	0.00–0.50	Soil	—	—	—	—	—	—	0.057 (J)	—	—	—

Table B-8 (continued)

Sample ID	Location ID	Depth (ft)	Media	Benzo(k)fluoranthene	Benzoic Acid	Benzyl Alcohol	Bis(2-ethylhexyl)phthalate	Butanone[2-]	Butylbenzylphthalate	Chrysene	Dibenz(a,h)anthracene	Dibenzofuran	Diethylphthalate
0316-95-0499	16-02024	0.00–0.50	Soil	0.88	—	—	8	—	—	1.4	0.16 (J)	0.082 (J)	—
0316-95-0238	16-01664	0.00–0.33	Soil	0.22 (J)	1.2 (J)	—	—	—	—	0.41 (J)	—	—	—
0316-95-0239	16-01664	2.00–3.50	Qbt 4	—	—	—	—	—	—	—	—	—	0.23 (J)
0316-95-0241	16-01539	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0316-95-0242	16-01540	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0316-95-0243	16-01541	0.00–0.50	Soil	—	—	—	—	—	—	0.14 (J)	—	—	—
0316-95-0244	16-01542	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
SWMU 16-026(j2)													
0316-97-0607	16-01551	0.00–1.00	Soil	2.1	—	—	—	—	—	2.6	0.58	0.24	—
0316-95-0501	16-02166	0.00–0.50	Sediment	3	—	—	—	—	—	4.2	—	—	—
0316-95-0502	16-02166	0.50–1.17	Soil	0.28	—	—	—	—	—	0.4	—	—	—
0316-95-0504	16-02166	0.50–1.17	Soil	—	—	—	—	—	—	0.25	—	—	—
0316-95-0503	16-02166	5.00–7.00	Qbt 4	—	—	—	—	—	—	—	—	—	—
0316-95-0251	16-01552	0.00–0.50	Sediment	1.4	0.11 (J)	—	—	—	—	3.6	0.5	0.2 (J)	—
0316-95-0252	16-01553	0.00–0.50	Sediment	—	2.1 (J)	—	—	—	—	3.3	0.61 (J)	0.33 (J)	—
0316-95-0253	16-01554	0.00–0.50	Sediment	0.057 (J)	—	—	—	—	—	0.12 (J)	—	—	—
0316-95-0254	16-01555	0.00–0.50	Sediment	0.8	—	—	—	—	—	1.8	0.2 (J)	0.28 (J)	—
0316-95-0500	16-01555	0.00–0.50	Sediment	—	—	—	—	—	—	—	—	—	—
0316-95-0255	16-01556	0.00–0.50	Sediment	0.42	—	—	—	—	—	0.84	0.092 (J)	0.094 (J)	—

Table B-8 (continued)

Sample ID	Location ID	Depth (ft)	Media	Di-n-butylphthalate	Dinitrobenzene[1,3-]	Dinitrotoluene[2,4-]	Di-n-octylphthalate	Fluoranthene	Fluorene	HMX	Indeno(1,2,3-cd)pyrene	Isopropyltoluene[4-]
SWMU 13-003(a)-99												
0313-95-0001	13-00001	1.50–2.50	Soil	—	—	—	—	—	—	—	—	-
0313-95-0002	13-00001	3.00–4.00	Qbt 4	—	—	—	0.13 (J)	—	—	—	—	-
SWMU 16-003(n)-99												
0316-95-0214	16-01529	0.00–0.50	Sediment	—	—	—	—	0.33 (J)	—	3.35	0.086 (J)	-
0316-95-0216	16-01529	4.00–5.00	Qbt 4	—	0.077	0.073	—	—	—	—	—	-
0316-95-0218	16-01662	0.00–0.16	Sediment	0.18 (J)	—	0.21 (J)	4.5	0.63	0.069 (J)	624	0.22 (J)	-
0316-95-0219	16-01662	2.50–3.50	Qbt 4	—	—	—	—	—	—	0.931	—	-
0316-95-0220	16-01530	0.00–0.50	Sediment	—	—	0.612	—	—	—	0.35	—	-
0316-95-0224	16-01534	0.00–0.50	Sediment	—	—	—	—	—	—	—	—	-
SWMU 16-003(o)												
0316-95-0226	16-01536	0.00–0.33	Soil	0.18 (J)	—	—	—	26	4.6	2.28	5.9	-
0316-95-0227	16-01536	3.00–3.50	Qbt 4	—	—	—	—	1	0.11 (J)	2.05	0.27 (J)	-
0316-95-0235	16-01537	1.50–2.00	Soil	—	—	—	—	—	—	0.178	—	-
0316-95-0236	16-01537	2.50–3.50	Qbt 4	—	—	—	—	—	—	—	—	-
0316-95-0229	16-01663	0.00–0.33	Soil	—	0.114	—	—	51	9.7	312	10	-
0316-95-0230	16-01663	0.50–1.50	Qbt 4	—	—	—	—	—	—	—	—	-
0316-95-0231	16-01669	0.00–0.50	Soil	—	—	0.136	—	24	3 (J)	7.59	5.7	-
0316-95-0232	16-01670	0.00–0.50	Soil	—	—	—	—	0.96 (J)	—	6.67	0.47 (J)	-
0316-95-0233	16-01671	0.00–0.50	Soil	—	—	—	—	5.5	0.62 (J)	25.2	1.3 (J)	-
0316-95-0498	16-02023	0.00–0.50	Soil	—	—	—	—	0.098 (J)	—	—	—	-
0316-95-0499	16-02024	0.00–0.50	Soil	—	—	—	—	2.9	0.18 (J)	2.28	0.67 (J)	-

Table B-8 (continued)

Sample ID	Location ID	Depth (ft)	Media	Di-n-butylphthalate	Dinitrobenzene[1,3-]	Dinitrotoluene[2,4-]	Di-n-octylphthalate	Fluoranthene	Fluorene	HMX	Indeno(1,2,3-cd)pyrene	Isopropyltoluene[4-]
0316-95-0238	16-01664	0.00–0.33	Soil	—	—	—	—	0.69 (J)	—	—	—	-
0316-95-0239	16-01664	2.00–3.50	Qbt 4	—	—	—	—	—	—	—	—	-
0316-95-0241	16-01539	0.00–0.50	Soil	—	—	—	—	0.14 (J)	—	—	—	-
0316-95-0242	16-01540	0.00–0.50	Soil	—	—	—	—	0.16 (J)	—	0.443	—	-
0316-95-0243	16-01541	0.00–0.50	Soil	—	—	—	—	0.26 (J)	—	0.339	—	-
0316-95-0244	16-01542	0.00–0.50	Soil	—	—	—	—	0.3 (J)	—	0.839	—	-
SWMU 16-026(j2)												
0316-97-0607	16-01551	0.00–1.00	Soil	—	—	—	—	4.4	0.48	—	1.3	-
0316-95-0501	16-02166	0.00–0.50	Sediment	—	—	—	—	7.3	—	—	2.2	-
0316-95-0502	16-02166	0.50–1.17	Soil	—	—	—	—	0.74	—	—	—	-
0316-95-0504	16-02166	0.50–1.17	Soil	—	—	—	—	0.44	—	—	—	-
0316-95-0503	16-02166	5.00–7.00	Qbt 4	—	—	—	—	—	—	—	—	-
0316-95-0251	16-01552	0.00–0.50	Sediment	—	—	—	—	4.8	0.5	—	2.1	-
0316-95-0252	16-01553	0.00–0.50	Sediment	—	—	—	—	—	0.76 (J)	—	2.5	-
0316-95-0253	16-01554	0.00–0.50	Sediment	—	—	—	—	0.25 (J)	—	—	0.078 (J)	-
0316-95-0254	16-01555	0.00–0.50	Sediment	—	—	—	—	3.3	0.62 (J)	—	0.87	-
0316-95-0500	16-01555	0.00–0.50	Sediment	—	—	—	—	—	—	—	—	0.021
0316-95-0255	16-01556	0.00–0.50	Sediment	—	—	—	—	1.6	0.16 (J)	—	0.44	-

Table B-8 (continued)

Sample ID	Location ID	Depth (ft)	Media	Methylnaphthalene[2-]	Methylphenol[4-]	Naphthalene	Nitrobenzene	Phenanthrene	Pyrene	RDX	Tetryl	Trinitrotoluene[2,4,6-]
SWMU 13-003(a)-99												
0313-95-0001	13-00001	1.50–2.50	Soil	—	—	—	—	—	—	—	—	—
0313-95-0002	13-00001	3.00–4.00	Qbt 4	—	—	—	—	—	—	—	—	—
SWMU 16-003(n)-99												
0316-95-0214	16-01529	0.00–0.50	Sediment	—	—	—	—	0.22 (J)	0.35 (J)	—	—	—
0316-95-0216	16-01529	4.00–5.00	Qbt 4	—	—	—	—	—	—	—	—	0.242
0316-95-0218	16-01662	0.00–0.16	Sediment	—	—	—	—	0.59	1.4	4.44	—	—
0316-95-0219	16-01662	2.50–3.50	Qbt 4	—	—	—	—	—	—	—	—	—
0316-95-0220	16-01530	0.00–0.50	Sediment	—	—	—	—	—	—	—	—	—
0316-95-0224	16-01534	0.00–0.50	Sediment	—	—	—	0.101	—	—	—	—	—
SWMU 16-003(o)												
0316-95-0226	16-01536	0.00–0.33	Soil	1.7	—	3.6	0.215	22	22	0.688	3.04	3.03
0316-95-0227	16-01536	3.00–3.50	Qbt 4	0.039 (J)	—	0.099 (J)	—	0.78	0.72	—	—	—
0316-95-0235	16-01537	1.50–2.00	Soil	—	—	—	—	—	—	—	—	—
0316-95-0236	16-01537	2.50–3.50	Qbt 4	—	—	—	—	—	—	—	—	—
0316-95-0229	16-01663	0.00–0.33	Soil	4.2	—	9.7	—	43	43	0.953	1.27	—
0316-95-0230	16-01663	0.50–1.50	Qbt 4	—	—	—	—	—	—	—	—	—
0316-95-0231	16-01669	0.00–0.50	Soil	0.92 (J)	—	2.7 (J)	—	19	22	5.3	0.226	0.222
0316-95-0232	16-01670	0.00–0.50	Soil	—	—	—	—	0.58 (J)	0.72 (J)	6.32	—	—
0316-95-0233	16-01671	0.00–0.50	Soil	—	—	0.77 (J)	—	4.5 (J)	4.8 (J)	40.7	—	0.316
0316-95-0498	16-02023	0.00–0.50	Soil	—	—	—	—	0.054 (J)	0.099 (J)	—	—	—
0316-95-0499	16-02024	0.00–0.50	Soil	—	—	0.1 (J)	—	1.6	2.3	3.92	—	0.356

Table B-8 (continued)

Sample ID	Location ID	Depth (ft)	Media	Methylnaphthalene[2-]	Methylphenol[4-]	Naphthalene	Nitrobenzene	Phenanthrene	Pyrene	RDX	Tetryl	Trinitrotoluene[2,4,6-]
0316-95-0238	16-01664	0.00–0.33	Soil	—	1 (J)	—	—	0.39 (J)	0.51 (J)	—	—	—
0316-95-0239	16-01664	2.00–3.50	Qbt 4	—	—	—	—	—	—	—	—	—
0316-95-0241	16-01539	0.00–0.50	Soil	—	—	—	—	0.11 (J)	0.11 (J)	—	—	—
0316-95-0242	16-01540	0.00–0.50	Soil	—	—	—	—	0.1 (J)	0.12 (J)	—	—	—
0316-95-0243	16-01541	0.00–0.50	Soil	—	—	—	—	0.13 (J)	0.2 (J)	—	—	—
0316-95-0244	16-01542	0.00–0.50	Soil	—	0.12 (J)	—	—	0.19 (J)	0.24 (J)	—	—	—
SWMU 16-026(j2)												
0316-97-0607	16-01551	0.00–1.00	Soil	—	—	0.3	—	3.5	4.4	—	—	—
0316-95-0501	16-02166	0.00–0.50	Sediment	—	—	—	—	3.6	8.7	—	—	—
0316-95-0502	16-02166	0.50–1.17	Soil	—	—	—	—	0.46	0.83	—	—	—
0316-95-0504	16-02166	0.50–1.17	Soil	—	—	—	—	0.31	0.52	—	—	—
0316-95-0503	16-02166	5.00–7.00	Qbt 4	—	—	—	—	—	—	—	—	—
0316-95-0251	16-01552	0.00–0.50	Sediment	0.1 (J)	—	0.22 (J)	—	3.2	8.7	—	—	—
0316-95-0252	16-01553	0.00–0.50	Sediment	—	—	0.41 (J)	—	5.6	6.9	—	—	—
0316-95-0253	16-01554	0.00–0.50	Sediment	—	—	—	—	0.14 (J)	0.23 (J)	—	—	—
0316-95-0254	16-01555	0.00–0.50	Sediment	0.18 (J)	—	0.47 (J)	—	3.1	4.6	—	—	—
0316-95-0500	16-01555	0.00–0.50	Sediment	—	—	—	—	—	—	—	—	—
0316-95-0255	16-01556	0.00–0.50	Sediment	0.065 (J)	—	0.16 (J)	—	1.2	2.5	—	—	—

Notes: Units are mg/kg.

[a] — = Not detected.

[b] J = The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.

Table B-9
Frequency of Radionuclides Detected above Background Values or Fallout Values or Detected in Soil and Tuff at the TA-16-340 Complex

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range[a] (pCi/g)	Background Value (pCi/g)	Frequency of Detects above Background Value
Americium-241	Soil	1	0	[-0.134]	0.013	0/1
Americium-241	Qbt 4	1	0	[0.01]	n/a[b]	0/1
Cesium-137	Soil	1	0	[-0.036]	1.65	0/1
Cesium-137	Qbt 4	1	0	[-0.005]	n/a	0/1
Cobalt-60	Soil	1	0	[0.022]	n/a	0/1
Cobalt-60	Qbt 4	1	0	[-0.0008]	n/a	0/1
Europium-152	Soil	1	0	[0.031]	n/a	0/1
Europium-152	Qbt 4	1	0	[0.176]	n/a	0/1
Ruthenium-106	Soil	1	0	[0.263]	n/a	0/1
Ruthenium-106	Qbt 4	1	0	[-0.22]	n/a	0/1
Sodium-22	Soil	1	0	[-0.016]	n/a	0/1
Sodium-22	Qbt 4	1	0	[-0.042]	n/a	0/1

[a] Values in brackets are below detection limits, although some chemicals may be detected at values within this range.
[b] n/a = Not applicable.

Table B-10
Surface Water Samples Collected at Fishladder Seep (location ID 16-02654)
and the Fishladder Canyon—Cañon de Valle Confluence (location ID 16-06121)

Sample ID	Location ID	Field Preparation	Depth (ft)	Media	Alkalinity	Ammonia	Anions	Cyanide	Metals	High-Explosive	SVOCs	TOC	VOCs	Tritium
0316-97-3103	16-02654	Filtered	0–0	Surface Water	3746R	—*	3746R	—	3746R	3745R	3744R	—	—	—
RE16-00-3134	16-02654	Filtered	0–0	Surface Water	—	—	—	—	6664R	—	—	—	—	—
RE16-01-3127	16-02654	Filtered	0–0	Surface Water	—	—	—	—	8684R	—	—	—	—	—
RE16-03-50738	16-02654	Filtered	0–0	Surface Water	—	—	—	—	1683S	—	—	—	—	—
RE16-98-3020	16-02654	Filtered	0–0	Surface Water	4192R	4192R	4192R	4192R	4192R	4191R	4190R	4192R	4190R	—
0316-97-3102	16-02654	Unfiltered	0–0	Surface Water	3746R	—	3746R	—	3746R	3745R	3744R	—	3744R	—
RE16-00-3133	16-02654	Unfiltered	0–0	Surface Water	6664R	—	6665R	—	6666R	6663R	—	—	6662R	6669R
RE16-01-3126	16-02654	Unfiltered	0–0	Surface Water	8684R	—	8685R	—	8684R	8686R	8683R	—	8683R	8688R
RE16-03-50737	16-02654	Unfiltered	0–0	Surface Water	1683S	—	1683S	—	1683S	1683S	—	—	1683S	1681S
RE16-98-3021	16-02654	Unfiltered	0–0	Surface Water	4192R	4192R	4192R	4192R	4192R	4191R	4190R	4192R	4190R	—
RE16-01-3141	16-06121	Filtered	0–0	Surface Water	—	—	—	—	8710R	—	—	—	—	—
RE16-01-3140	16-06121	Unfiltered	0–0	Surface Water	8710R	—	8716R	—	8710R	8709R	8708R	—	8708R	8712R
RE16-98-3084	16-06121	Unfiltered	0–0	Surface Water	—	—	5091R	—	5101R	5090R	5089R	—	5089R	5102R

Note: Numbers in the analysis columns are analytical request numbers.

*— = Not analyzed.

Table B-11
Frequency of Detected Inorganic Chemicals in Surface Water at Fishladder Seep and the Fishladder Canyon–Cañon de Valle Confluence

Analyte	Field Preparation	Number of Analyses	Number of Detects	Concentration Range[a] (µg/L)	Drinking Water MCL (µg/L)	Frequency of Detects above Drinking Water MCL	NMED Groundwater Standard (µg/L)	Frequency of Detects above NMED Groundwater Standard
Alkalinity-CO_3	Unfiltered	3	0	[5000 to 5000]	n/a[b]	n/a	n/a	n/a
Alkalinity-CO_3	Filtered	1	0	[5000 to 5000]	n/a	n/a	n/a	n/a
Alkalinity-CO_3+HCO_3	Filtered	1	1	92000 to 92000	n/a	n/a	n/a	n/a
Alkalinity-CO_3+HCO_3	Unfiltered	2	2	20600 to 84000	n/a	n/a	n/a	n/a
Alkalinity-HCO_3	Filtered	1	1	11000 to 11000	n/a	n/a	n/a	n/a
Alkalinity-HCO_3	Unfiltered	4	3	[5000] to 38000	n/a	n/a	n/a	n/a
Aluminum	Filtered	6	6	470 to 10800	50	6/6	5000	3/6
Aluminum	Unfiltered	7	7	1000 to 21300	n/a	n/a	n/a	n/a
Ammonia	Unfiltered	1	0	[500 to 500]	n/a	n/a	n/a	n/a
Ammonia	Filtered	1	0	[500 to 500]	n/a	n/a	n/a	n/a
Antimony	Unfiltered	7	2	0.647 to [20]	n/a	n/a	n/a	n/a
Antimony	Filtered	6	1	0.546 to [20]	6	0/6	n/a	n/a
Arsenic	Unfiltered	7	4	[2.3] to 21	n/a	n/a	n/a	n/a
Arsenic	Filtered	6	3	[1.7] to 20	50	0/6	100	0/6
Barium	Filtered	5	5	330 to 1000	2000	0/5	1000	1/5
Barium	Unfiltered	6	6	343 to 1100	n/a	n/a	n/a	n/a
Beryllium	Filtered	6	2	[0.13 to 4]	4	0/6	n/a	n/a
Beryllium	Unfiltered	7	4	0.15 to [4]	n/a	n/a	n/a	n/a
Boron	Filtered	6	5	32 to [500]	n/a	n/a	750	0/6
Boron	Unfiltered	6	5	49.7 to [500]	n/a	n/a	n/a	n/a
Bromide	Unfiltered	7	1	[20] to 2000	n/a	n/a	n/a	n/a
Bromide	Filtered	2	0	[200 to 2000]	n/a	n/a	n/a	n/a
Cadmium	Unfiltered	7	0	[0.26 to 5]	n/a	n/a	n/a	n/a

Table B-11 (continued)

Analyte	Field Preparation	Number of Analyses	Number of Detects	Concentration Range[a] (µg/L)	Drinking Water MCL (µg/L)	Frequency of Detects above Drinking Water MCL	NMED Groundwater Standard (µg/L)	Frequency of Detects above NMED Groundwater Standard
Cadmium	Filtered	6	0	[0.256 to 5]	5	0/6	10	0/6
Calcium	Filtered	6	6	5430 to 19000	n/a	n/a	n/a	n/a
Calcium	Unfiltered	7	7	7620 to 18000	n/a	n/a	n/a	n/a
Cesium	Unfiltered	1	1	500 to 500	n/a	n/a	n/a	n/a
Cesium	Filtered	1	1	700 to 700	n/a	n/a	n/a	n/a
Chloride	Unfiltered	7	7	2700 to 21500	n/a	n/a	n/a	n/a
Chloride	Filtered	2	2	4000 to 4500	250000	0/2	250000	0/2
Chromium	Unfiltered	7	6	0.77 to 11.2	n/a	n/a	n/a	n/a
Chromium	Filtered	6	4	0.49 to [10]	100	0/6	50	0/6
Cobalt	Filtered	6	3	[1.3 to 20]	n/a	n/a	50	0/6
Cobalt	Unfiltered	7	4	[0.5 to 20]	n/a	n/a	n/a	n/a
Copper	Unfiltered	7	5	0.94 to [20]	n/a	n/a	n/a	n/a
Copper	Filtered	6	4	2 to [20]	1300	0/6	1000	0/6
Cyanide (Total)	Filtered	1	0	[10 to 10]	200	0/1	200	0/1
Cyanide (Total)	Unfiltered	1	0	[10 to 10]	n/a	n/a	n/a	n/a
Fluoride	Filtered	2	2	100 to 200	4000	0/2	1600	0/2
Fluoride	Unfiltered	7	7	96 to 256	n/a	n/a	n/a	n/a
Iodide	Filtered	1	1	50 to 50	n/a	n/a	n/a	n/a
Iodide	Unfiltered	1	0	[50 to 50]	n/a	n/a	n/a	n/a
Iron	Filtered	6	6	410 to 6360	300	6/6	1000	5/6
Iron	Unfiltered	7	7	1200 to 17700	n/a	n/a	n/a	n/a
Lead	Filtered	6	3	[0.77] to 6.07	15	0/6	50	0/6
Lead	Unfiltered	7	5	[1] to 14.6	n/a	n/a	n/a	n/a
Lithium	Unfiltered	1	1	25.8 to 25.8	n/a	n/a	n/a	n/a
Lithium	Filtered	1	1	18.1 to 18.1	n/a	n/a	n/a	n/a

Table B-11 (continued)

Analyte	Field Preparation	Number of Analyses	Number of Detects	Concentration Range[a] (µg/L)	Drinking Water MCL (µg/L)	Frequency of Detects above Drinking Water MCL	NMED Groundwater Standard (µg/L)	Frequency of Detects above NMED Groundwater Standard
Magnesium	Filtered	6	6	1840 to 4200	n/a	n/a	n/a	n/a
Magnesium	Unfiltered	7	7	2200 to 4500	n/a	n/a	n/a	n/a
Manganese	Filtered	6	6	42.1 to 2700	50	5/6	200	1/6
Manganese	Unfiltered	7	7	15.6 to 3200	n/a	n/a	n/a	n/a
Mercury	Unfiltered	7	1	[0.011 to 0.2]	n/a	n/a	2	0/7
Mercury	Filtered	6	1	[0.011 to 0.2]	2	0/6	n/a	n/a
Molybdenum	Unfiltered	1	1	6.3 to 6.3	n/a	n/a	n/a	n/a
Molybdenum	Filtered	1	0	[2.9 to 2.9]	n/a	n/a	n/a	n/a
Nickel	Filtered	6	5	1.5 to [40]	100	0/6	200	0/6
Nickel	Unfiltered	7	6	2.2 to [40]	n/a	n/a	n/a	n/a
Nitrate	Unfiltered	2	0	[200 to 200]	n/a	n/a	n/a	n/a
Nitrate	Filtered	1	0	[200 to 200]	10000	0/1	10000	0/1
Nitrate-Nitrite as N	Unfiltered	4	3	40 to 110	n/a	n/a	n/a	n/a
Nitrite	Filtered	1	0	[100 to 100]	1000	0/1	n/a	n/a
Nitrite	Unfiltered	2	0	[100 to 100]	n/a	n/a	n/a	n/a
Oxalate	Unfiltered	4	0	[190 to 1000]	n/a	n/a	n/a	n/a
Perchlorate	Unfiltered	4	1	[4] to 17.1	n/a	n/a	n/a	n/a
Phosphorus, Orthophosphate (Expressed as PO_4)	Filtered	1	0	[200 to 200]	n/a	n/a	n/a	n/a
Phosphorus, Orthophosphate (Expressed as PO_4)	Unfiltered	2	0	[200 to 200]	n/a	n/a	n/a	n/a
Potassium	Filtered	6	6	2000 to 4980	n/a	n/a	n/a	n/a
Potassium	Unfiltered	7	7	2800 to 4860	n/a	n/a	n/a	n/a
Rubidium	Filtered	1	0	[500 to 500]	n/a	n/a	n/a	n/a

Table B-11 (continued)

Analyte	Field Preparation	Number of Analyses	Number of Detects	Concentration Range[a] (µg/L)	Drinking Water MCL (µg/L)	Frequency of Detects above Drinking Water MCL	NMED Groundwater Standard (µg/L)	Frequency of Detects above NMED Groundwater Standard
Rubidium	Unfiltered	1	0	[500 to 500]	n/a	n/a	n/a	n/a
Selenium	Filtered	6	2	1.4 to [5]	50	0/6	50	0/6
Selenium	Unfiltered	7	1	[1.2 to 5]	n/a	n/a	n/a	n/a
Silicon	Unfiltered	1	1	16000 to 16000	n/a	n/a	n/a	n/a
Silicon	Filtered	1	1	16000 to 16000	n/a	n/a	n/a	n/a
Silicon Dioxide	Unfiltered	1	1	14200 to 14200	n/a	n/a	n/a	n/a
Silicon Dioxide	Filtered	1	1	15000 to 15000	n/a	n/a	n/a	n/a
Silver	Filtered	6	1	0.7 to [10]	100	0/6	50	0/6
Silver	Unfiltered	7	1	0.75 to [10]	n/a	n/a	n/a	n/a
Sodium	Filtered	6	6	7370 to 13200	n/a	n/a	n/a	n/a
Sodium	Unfiltered	7	7	7700 to 13200	n/a	n/a	n/a	n/a
Strontium	Filtered	1	1	39.5 to 39.5	n/a	n/a	n/a	n/a
Strontium	Unfiltered	1	1	57.7 to 57.7	n/a	n/a	n/a	n/a
Sulfate	Filtered	2	2	9000 to 9000	250000	0/2	600000	0/2
Sulfate	Unfiltered	7	7	7500 to 31700	n/a	n/a	n/a	n/a
Thallium	Filtered	6	1	0.147 to [5]	2	0/6	n/a	n/a
Thallium	Unfiltered	7	1	0.269 to [5]	n/a	n/a	n/a	n/a
Uranium	Filtered	1	0	[80.4 to 80.4]	20	0/1	5000	0/1
Uranium	Unfiltered	3	1	0.323 to [80.4]	n/a	n/a	n/a	n/a
Vanadium	Filtered	6	5	1.8 to 14.4	n/a	n/a	n/a	n/a
Vanadium	Unfiltered	7	6	3.2 to 33.1	n/a	n/a	n/a	n/a
Zinc	Unfiltered	7	6	[9.5] to 59	n/a	n/a	n/a	n/a
Zinc	Filtered	6	6	8.5 to 50	5000	0/6	10000	0/6

[a] Values in brackets are below detection limits, although some chemicals may be detected at values within this range.

[b] n/a = Not applicable.

Table B-12
Summary of Samples with Detected Inorganic Chemicals in Water at Fishladder Seep and the Fishladder Canyon—Cañon de Valle Confluence

Analyte	Field Preparation	Location ID	Sample ID	Sample (µg/L)	MCL[a]	LW[b]	WH[c]	GW[d]	DCG[e]
Alkalinity-CO_3+HCO_3	Unfiltered	16-02654	0316-97-3102	84000	n/a[f]	n/a	n/a	n/a	n/a
Alkalinity-CO_3+HCO_3	Filtered	16-02654	0316-97-3103	92000	n/a	n/a	n/a	n/a	n/a
Alkalinity-CO_3+HCO_3	Unfiltered	16-02654	RE16-03-50737	20600	n/a	n/a	n/a	n/a	n/a
Alkalinity-HCO_3	Unfiltered	16-02654	RE16-00-3133	10000	n/a	n/a	n/a	n/a	n/a
Alkalinity-HCO_3	Filtered	16-02654	RE16-98-3020	11000	n/a	n/a	n/a	n/a	n/a
Alkalinity-HCO_3	Unfiltered	16-02654	RE16-98-3021	14000	n/a	n/a	n/a	n/a	n/a
Aluminum	Unfiltered	16-02654	0316-97-3102	1000	n/a	n/a	n/a	n/a	n/a
Aluminum	Filtered	16-02654	0316-97-3103	800	50	5000	n/a	5000	n/a
Aluminum	Unfiltered	16-02654	RE16-00-3133	1300	n/a	n/a	n/a	n/a	n/a
Aluminum	Filtered	16-02654	RE16-00-3134	470	50	5000	n/a	5000	n/a
Aluminum	Unfiltered	16-02654	RE16-01-3126	13000	n/a	n/a	n/a	n/a	n/a
Aluminum	Filtered	16-02654	RE16-01-3127	10800	50	5000	n/a	5000	n/a
Aluminum	Unfiltered	16-02654	RE16-03-50737	21300	n/a	n/a	n/a	n/a	n/a
Aluminum	Filtered	16-02654	RE16-03-50738	10600	50	5000	n/a	5000	n/a
Aluminum	Filtered	16-02654	RE16-98-3020	5870	50	5000	n/a	5000	n/a
Aluminum	Unfiltered	16-02654	RE16-98-3021	14000	n/a	n/a	n/a	n/a	n/a
Antimony	Unfiltered	16-02654	RE16-00-3133	3.3 (J)[g]	n/a	n/a	n/a	n/a	n/a
Antimony	Unfiltered	16-02654	RE16-03-50737	0.647 (J)	n/a	n/a	n/a	n/a	n/a
Antimony	Filtered	16-02654	RE16-03-50738	0.546 (J)	6	n/a	n/a	n/a	n/a
Arsenic	Unfiltered	16-02654	0316-97-3102	21	n/a	n/a	n/a	n/a	n/a
Arsenic	Filtered	16-02654	0316-97-3103	20	50	200	n/a	100	n/a
Arsenic	Unfiltered	16-02654	RE16-01-3126	3.4 (J)	n/a	n/a	n/a	n/a	n/a
Arsenic	Filtered	16-02654	RE16-01-3127	2.4 (J)	50	200	n/a	100	n/a
Arsenic	Unfiltered	16-02654	RE16-03-50737	5.54	n/a	n/a	n/a	n/a	n/a

Table B-12 (continued)

Analyte	Field Preparation	Location ID	Sample ID	Sample Concentration (µg/L)	MCL[a]	LW[b]	WH[c]	GW[d]	DCG[e]
Arsenic	Filtered	16-02654	RE16-03-50738	4.48 (J)	50	200	n/a	100	n/a
Arsenic	Unfiltered	16-02654	RE16-98-3021	8.3 (J)	n/a	n/a	n/a	n/a	n/a
Barium	Unfiltered	16-02654	0316-97-3102	1100	n/a	n/a	n/a	n/a	n/a
Barium	Filtered	16-02654	0316-97-3103	1000	2000	n/a	n/a	1000	n/a
Barium	Unfiltered	16-02654	RE16-00-3133	360	n/a	n/a	n/a	n/a	n/a
Barium	Filtered	16-02654	RE16-00-3134	330	2000	n/a	n/a	1000	n/a
Barium	Unfiltered	16-02654	RE16-03-50737	553	n/a	n/a	n/a	n/a	n/a
Barium	Filtered	16-02654	RE16-03-50738	382	2000	n/a	n/a	1000	n/a
Barium	Filtered	16-02654	RE16-98-3020	417	2000	n/a	n/a	1000	n/a
Barium	Unfiltered	16-02654	RE16-98-3021	979	n/a	n/a	n/a	n/a	n/a
Beryllium	Unfiltered	16-02654	RE16-00-3133	0.15 (J)	n/a	n/a	n/a	n/a	n/a
Beryllium	Unfiltered	16-02654	RE16-01-3126	0.51 (J)	n/a	n/a	n/a	n/a	n/a
Beryllium	Filtered	16-02654	RE16-01-3127	0.45 (J)	4	n/a	n/a	n/a	n/a
Beryllium	Unfiltered	16-02654	RE16-03-50737	1.06	n/a	n/a	n/a	n/a	n/a
Beryllium	Filtered	16-02654	RE16-03-50738	0.561	4	n/a	n/a	n/a	n/a
Boron	Unfiltered	16-02654	RE16-00-3133	55 (J)	n/a	n/a	n/a	n/a	n/a
Boron	Filtered	16-02654	RE16-00-3134	56 (J)	n/a	5000	n/a	750	n/a
Boron	Unfiltered	16-02654	RE16-01-3126	54.3 (J)	n/a	n/a	n/a	n/a	n/a
Boron	Filtered	16-02654	RE16-01-3127	53.2 (J)	n/a	5000	n/a	750	n/a
Boron	Unfiltered	16-02654	RE16-03-50737	70.7	n/a	n/a	n/a	n/a	n/a
Boron	Filtered	16-02654	RE16-03-50738	67.7	n/a	5000	n/a	750	n/a
Boron	Filtered	16-02654	RE16-98-3020	32 (J)	n/a	5000	n/a	750	n/a
Boron	Unfiltered	16-02654	RE16-98-3021	49.7 (J)	n/a	n/a	n/a	n/a	n/a
Bromide	Unfiltered	16-02654	0316-97-3102	2000	n/a	n/a	n/a	n/a	n/a
Calcium	Unfiltered	16-02654	0316-97-3102	18000	n/a	n/a	n/a	n/a	n/a
Calcium	Filtered	16-02654	0316-97-3103	19000	n/a	n/a	n/a	n/a	n/a

Table B-12 (continued)

Analyte	Field Preparation	Location ID	Sample ID	Sample Concentration (µg/L)	MCL[a]	LW[b]	WH[c]	GW[d]	DCG[e]
Calcium	Unfiltered	16-02654	RE16-00-3133	8700	n/a	n/a	n/a	n/a	n/a
Calcium	Filtered	16-02654	RE16-00-3134	8700	n/a	n/a	n/a	n/a	n/a
Calcium	Unfiltered	16-02654	RE16-01-3126	14900	n/a	n/a	n/a	n/a	n/a
Calcium	Filtered	16-02654	RE16-01-3127	9500	n/a	n/a	n/a	n/a	n/a
Calcium	Unfiltered	16-02654	RE16-03-50737	9090	n/a	n/a	n/a	n/a	n/a
Calcium	Filtered	16-02654	RE16-03-50738	8210	n/a	n/a	n/a	n/a	n/a
Calcium	Filtered	16-02654	RE16-98-3020	5430	n/a	n/a	n/a	n/a	n/a
Calcium	Unfiltered	16-02654	RE16-98-3021	7620	n/a	n/a	n/a	n/a	n/a
Cesium	Filtered	16-02654	RE16-98-3020	700	n/a	n/a	n/a	n/a	n/a
Cesium	Unfiltered	16-02654	RE16-98-3021	500	n/a	n/a	n/a	n/a	n/a
Chloride	Unfiltered	16-02654	0316-97-3102	4000	n/a	n/a	n/a	n/a	n/a
Chloride	Filtered	16-02654	0316-97-3103	4000	250000	n/a	n/a	250000	n/a
Chloride	Unfiltered	16-02654	RE16-00-3133	21500	n/a	n/a	n/a	n/a	n/a
Chloride	Unfiltered	16-02654	RE16-01-3126	13700	n/a	n/a	n/a	n/a	n/a
Chloride	Unfiltered	16-02654	RE16-03-50737	6070	n/a	n/a	n/a	n/a	n/a
Chloride	Filtered	16-02654	RE16-98-3020	4500	250000	n/a	n/a	250000	n/a
Chloride	Unfiltered	16-02654	RE16-98-3021	4000	n/a	n/a	n/a	n/a	n/a
Chromium	Unfiltered	16-02654	RE16-00-3133	1.8 (J)	n/a	n/a	n/a	n/a	n/a
Chromium	Filtered	16-02654	RE16-00-3134	0.49 (J)	100	1000	n/a	50	n/a
Chromium	Unfiltered	16-02654	RE16-01-3126	7.9 (J)	n/a	n/a	n/a	n/a	n/a
Chromium	Filtered	16-02654	RE16-01-3127	6.2 (J)	100	1000	n/a	50	n/a
Chromium	Unfiltered	16-02654	RE16-03-50737	11.2	n/a	n/a	n/a	n/a	n/a
Chromium	Filtered	16-02654	RE16-03-50738	5.78	100	1000	n/a	50	n/a
Chromium	Unfiltered	16-02654	RE16-98-3021	10.4	n/a	n/a	n/a	n/a	n/a
Cobalt	Unfiltered	16-02654	RE16-00-3133	1.4 (J)	n/a	n/a	n/a	n/a	n/a
Cobalt	Filtered	16-02654	RE16-00-3134	1.6 (J)	n/a	1000	n/a	50	n/a

Table B-12 (continued)

Analyte	Field Preparation	Location ID	Sample ID	Sample Concentration (µg/L)	MCL[a]	LW[b]	WH[c]	GW[d]	DCG[e]
Cobalt	Unfiltered	16-02654	RE16-01-3126	1.9 (J)	n/a	n/a	n/a	n/a	n/a
Cobalt	Unfiltered	16-02654	RE16-03-50737	3.31 (J)	n/a	n/a	n/a	n/a	n/a
Cobalt	Filtered	16-02654	RE16-03-50738	1.68 (J)	n/a	1000	n/a	50	n/a
Cobalt	Filtered	16-02654	RE16-98-3020	1.4 (J)	n/a	1000	n/a	50	n/a
Cobalt	Unfiltered	16-02654	RE16-98-3021	12.9 (J)	n/a	n/a	n/a	n/a	n/a
Copper	Unfiltered	16-02654	RE16-00-3133	3.2 (J)	n/a	n/a	n/a	n/a	n/a
Copper	Filtered	16-02654	RE16-00-3134	2 (J)	1300	500	n/a	1000	n/a
Copper	Unfiltered	16-02654	RE16-01-3126	18.5 (J)	n/a	n/a	n/a	n/a	n/a
Copper	Filtered	16-02654	RE16-01-3127	7.2 (J)	1300	500	n/a	1000	n/a
Copper	Unfiltered	16-02654	RE16-03-50737	11.1	n/a	n/a	n/a	n/a	n/a
Copper	Filtered	16-02654	RE16-03-50738	8.23	1300	500	n/a	1000	n/a
Copper	Filtered	16-02654	RE16-98-3020	6.6 (J)	1300	500	n/a	1000	n/a
Copper	Unfiltered	16-02654	RE16-98-3021	13 (J)	n/a	n/a	n/a	n/a	n/a
Fluoride	Unfiltered	16-02654	0316-97-3102	200	n/a	n/a	n/a	n/a	n/a
Fluoride	Filtered	16-02654	0316-97-3103	200	4000	n/a	n/a	1600	n/a
Fluoride	Unfiltered	16-02654	RE16-00-3133	96	n/a	n/a	n/a	n/a	n/a
Fluoride	Unfiltered	16-02654	RE16-01-3126	256	n/a	n/a	n/a	n/a	n/a
Fluoride	Unfiltered	16-02654	RE16-03-50737	153	n/a	n/a	n/a	n/a	n/a
Fluoride	Filtered	16-02654	RE16-98-3020	100	4000	n/a	n/a	1600	n/a
Fluoride	Unfiltered	16-02654	RE16-98-3021	100	n/a	n/a	n/a	n/a	n/a
Iodide	Filtered	16-02654	RE16-98-3020	50	n/a	n/a	n/a	n/a	n/a
Iron	Unfiltered	16-02654	0316-97-3102	6600	n/a	n/a	n/a	n/a	n/a
Iron	Filtered	16-02654	0316-97-3103	1100	300	n/a	n/a	1000	n/a
Iron	Unfiltered	16-02654	RE16-00-3133	1200	n/a	n/a	n/a	n/a	n/a
Iron	Filtered	16-02654	RE16-00-3134	410	300	n/a	n/a	1000	n/a
Iron	Unfiltered	16-02654	RE16-01-3126	8260	n/a	n/a	n/a	n/a	n/a

Table B-12 (continued)

Analyte	Field Preparation	Location ID	Sample ID	Sample Concentration (µg/L)	MCL[a]	LW[b]	WH[c]	GW[d]	DCG[e]
Iron	Filtered	16-02654	RE16-01-3127	6360	300	n/a	n/a	1000	n/a
Iron	Unfiltered	16-02654	RE16-03-50737	12400	n/a	n/a	n/a	n/a	n/a
Iron	Filtered	16-02654	RE16-03-50738	6210	300	n/a	n/a	1000	n/a
Iron	Filtered	16-02654	RE16-98-3020	5700	300	n/a	n/a	1000	n/a
Iron	Unfiltered	16-02654	RE16-98-3021	17700	n/a	n/a	n/a	n/a	n/a
Lead	Unfiltered	16-02654	0316-97-3102	3	n/a	n/a	n/a	n/a	n/a
Lead	Unfiltered	16-02654	RE16-01-3126	5.7	n/a	n/a	n/a	n/a	n/a
Lead	Filtered	16-02654	RE16-01-3127	4.2	15	100	n/a	50	n/a
Lead	Unfiltered	16-02654	RE16-03-50737	11.7	n/a	n/a	n/a	n/a	n/a
Lead	Filtered	16-02654	RE16-03-50738	6.07	15	100	n/a	50	n/a
Lead	Filtered	16-02654	RE16-98-3020	4.8	15	100	n/a	50	n/a
Lead	Unfiltered	16-02654	RE16-98-3021	14.6	n/a	n/a	n/a	n/a	n/a
Lithium	Filtered	16-02654	RE16-98-3020	18.1	n/a	n/a	n/a	n/a	n/a
Lithium	Unfiltered	16-02654	RE16-98-3021	25.8	n/a	n/a	n/a	n/a	n/a
Magnesium	Unfiltered	16-02654	0316-97-3102	4000	n/a	n/a	n/a	n/a	n/a
Magnesium	Filtered	16-02654	0316-97-3103	4200	n/a	n/a	n/a	n/a	n/a
Magnesium	Unfiltered	16-02654	RE16-00-3133	2200	n/a	n/a	n/a	n/a	n/a
Magnesium	Filtered	16-02654	RE16-00-3134	2100	n/a	n/a	n/a	n/a	n/a
Magnesium	Unfiltered	16-02654	RE16-01-3126	4500 (J)	n/a	n/a	n/a	n/a	n/a
Magnesium	Filtered	16-02654	RE16-01-3127	3090 (J)	n/a	n/a	n/a	n/a	n/a
Magnesium	Unfiltered	16-02654	RE16-03-50737	3910	n/a	n/a	n/a	n/a	n/a
Magnesium	Filtered	16-02654	RE16-03-50738	2760	n/a	n/a	n/a	n/a	n/a
Magnesium	Filtered	16-02654	RE16-98-3020	1840 (J)	n/a	n/a	n/a	n/a	n/a
Magnesium	Unfiltered	16-02654	RE16-98-3021	3210 (J)	n/a	n/a	n/a	n/a	n/a
Manganese	Unfiltered	16-02654	0316-97-3102	3200	n/a	n/a	n/a	n/a	n/a
Manganese	Filtered	16-02654	0316-97-3103	2700	50	n/a	n/a	200	n/a

Table B-12 (continued)

Analyte	Field Preparation	Location ID	Sample ID	Sample Concentration (µg/L)	MCL[a]	LW[b]	WH[c]	GW[d]	DCG[e]
Manganese	Unfiltered	16-02654	RE16-00-3133	130	n/a	n/a	n/a	n/a	n/a
Manganese	Filtered	16-02654	RE16-00-3134	53	50	n/a	n/a	200	n/a
Manganese	Unfiltered	16-02654	RE16-01-3126	131	n/a	n/a	n/a	n/a	n/a
Manganese	Filtered	16-02654	RE16-01-3127	87.6	50	n/a	n/a	200	n/a
Manganese	Unfiltered	16-02654	RE16-03-50737	102	n/a	n/a	n/a	n/a	n/a
Manganese	Filtered	16-02654	RE16-03-50738	59.6	50	n/a	n/a	200	n/a
Manganese	Filtered	16-02654	RE16-98-3020	74.4	50	n/a	n/a	200	n/a
Manganese	Unfiltered	16-02654	RE16-98-3021	1260	n/a	n/a	n/a	n/a	n/a
Mercury	Unfiltered	16-02654	RE16-03-50737	0.09 (J)	n/a	10	0.77	2	n/a
Mercury	Filtered	16-02654	RE16-03-50738	0.065 (J)	2	n/a	n/a	n/a	n/a
Molybdenum	Unfiltered	16-02654	RE16-98-3021	6.3 (J)	n/a	n/a	n/a	n/a	n/a
Nickel	Unfiltered	16-02654	RE16-00-3133	2.2 (J)	n/a	n/a	n/a	n/a	n/a
Nickel	Filtered	16-02654	RE16-00-3134	1.8 (J)	100	n/a	n/a	200	n/a
Nickel	Unfiltered	16-02654	RE16-01-3126	6.4 (J)	n/a	n/a	n/a	n/a	n/a
Nickel	Filtered	16-02654	RE16-01-3127	4.4 (J)	100	n/a	n/a	200	n/a
Nickel	Unfiltered	16-02654	RE16-03-50737	8.64	n/a	n/a	n/a	n/a	n/a
Nickel	Filtered	16-02654	RE16-03-50738	5.35	100	n/a	n/a	200	n/a
Nickel	Filtered	16-02654	RE16-98-3020	4.6 (J)	100	n/a	n/a	200	n/a
Nickel	Unfiltered	16-02654	RE16-98-3021	9.2 (J)	n/a	n/a	n/a	n/a	n/a
Nitrate-Nitrite as N	Unfiltered	16-02654	RE16-00-3133	110	n/a	n/a	n/a	n/a	n/a
Nitrate-Nitrite as N	Unfiltered	16-02654	RE16-03-50737	40 (J)	n/a	n/a	n/a	n/a	n/a
Perchlorate	Unfiltered	16-02654	RE16-00-3133	17.1	n/a	n/a	n/a	n/a	n/a
Potassium	Unfiltered	16-02654	0316-97-3102	3000	n/a	n/a	n/a	n/a	n/a
Potassium	Filtered	16-02654	0316-97-3103	2000	n/a	n/a	n/a	n/a	n/a
Potassium	Unfiltered	16-02654	RE16-00-3133	2800	n/a	n/a	n/a	n/a	n/a
Potassium	Filtered	16-02654	RE16-00-3134	2700	n/a	n/a	n/a	n/a	n/a

Table B-12 (continued)

Analyte	Field Preparation	Location ID	Sample ID	Sample Concentration (µg/L)	MCL[a]	LW[b]	WH[c]	GW[d]	DCG[e]
Potassium	Unfiltered	16-02654	RE16-01-3126	4650 (J)	n/a	n/a	n/a	n/a	n/a
Potassium	Filtered	16-02654	RE16-01-3127	2610 (J)	n/a	n/a	n/a	n/a	n/a
Potassium	Unfiltered	16-02654	RE16-03-50737	4050	n/a	n/a	n/a	n/a	n/a
Potassium	Filtered	16-02654	RE16-03-50738	2770	n/a	n/a	n/a	n/a	n/a
Potassium	Filtered	16-02654	RE16-98-3020	3060 (J)	n/a	n/a	n/a	n/a	n/a
Potassium	Unfiltered	16-02654	RE16-98-3021	4610 (J)	n/a	n/a	n/a	n/a	n/a
Selenium	Filtered	16-02654	RE16-01-3127	1.4 (J)	50	50	n/a	50	n/a
Selenium	Unfiltered	16-02654	RE16-98-3021	3.7 (J)	n/a	n/a	5	n/a	n/a
Silicon	Unfiltered	16-02654	0316-97-3102	16000	n/a	n/a	n/a	n/a	n/a
Silicon	Filtered	16-02654	0316-97-3103	16000	n/a	n/a	n/a	n/a	n/a
Silicon Dioxide	Filtered	16-02654	RE16-98-3020	15000	n/a	n/a	n/a	n/a	n/a
Silicon Dioxide	Unfiltered	16-02654	RE16-98-3021	14200	n/a	n/a	n/a	n/a	n/a
Silver	Unfiltered	16-02654	RE16-00-3133	0.75 (J)	n/a	n/a	n/a	n/a	n/a
Silver	Filtered	16-02654	RE16-00-3134	0.7 (J)	100	n/a	n/a	50	n/a
Sodium	Unfiltered	16-02654	0316-97-3102	7700	n/a	n/a	n/a	n/a	n/a
Sodium	Filtered	16-02654	0316-97-3103	8200	n/a	n/a	n/a	n/a	n/a
Sodium	Unfiltered	16-02654	RE16-00-3133	12000	n/a	n/a	n/a	n/a	n/a
Sodium	Filtered	16-02654	RE16-00-3134	13000	n/a	n/a	n/a	n/a	n/a
Sodium	Unfiltered	16-02654	RE16-01-3126	11900	n/a	n/a	n/a	n/a	n/a
Sodium	Filtered	16-02654	RE16-01-3127	10500	n/a	n/a	n/a	n/a	n/a
Sodium	Unfiltered	16-02654	RE16-03-50737	13200	n/a	n/a	n/a	n/a	n/a
Sodium	Filtered	16-02654	RE16-03-50738	13200	n/a	n/a	n/a	n/a	n/a
Sodium	Filtered	16-02654	RE16-98-3020	7370	n/a	n/a	n/a	n/a	n/a
Sodium	Unfiltered	16-02654	RE16-98-3021	7700	n/a	n/a	n/a	n/a	n/a
Strontium	Filtered	16-02654	RE16-98-3020	39.5	n/a	n/a	n/a	n/a	n/a
Strontium	Unfiltered	16-02654	RE16-98-3021	57.7	n/a	n/a	n/a	n/a	n/a

Table B-12 (continued)

Analyte	Field Preparation	Location ID	Sample ID	Sample Concentration (µg/L)	MCL[a]	LW[b]	WH[c]	GW[d]	DCG[e]
Sulfate	Unfiltered	16-02654	0316-97-3102	8000	n/a	n/a	n/a	n/a	n/a
Sulfate	Filtered	16-02654	0316-97-3103	9000	250000	n/a	n/a	600000	n/a
Sulfate	Unfiltered	16-02654	RE16-00-3133	31700	n/a	n/a	n/a	n/a	n/a
Sulfate	Unfiltered	16-02654	RE16-01-3126	15500	n/a	n/a	n/a	n/a	n/a
Sulfate	Unfiltered	16-02654	RE16-03-50737	23800	n/a	n/a	n/a	n/a	n/a
Sulfate	Filtered	16-02654	RE16-98-3020	9000	250000	n/a	n/a	600000	n/a
Sulfate	Unfiltered	16-02654	RE16-98-3021	10000	n/a	n/a	n/a	n/a	n/a
Thallium	Unfiltered	16-02654	RE16-03-50737	0.269 (J)	n/a	n/a	n/a	n/a	n/a
Thallium	Filtered	16-02654	RE16-03-50738	0.147 (J)	2	n/a	n/a	n/a	n/a
Uranium	Unfiltered	16-02654	RE16-00-3133	0.323	n/a	n/a	n/a	n/a	n/a
Vanadium	Unfiltered	16-02654	RE16-00-3133	3.8 (J)	n/a	n/a	n/a	n/a	n/a
Vanadium	Filtered	16-02654	RE16-00-3134	1.8 (J)	n/a	100	n/a	n/a	n/a
Vanadium	Unfiltered	16-02654	RE16-01-3126	18.6 (J)	n/a	n/a	n/a	n/a	n/a
Vanadium	Filtered	16-02654	RE16-01-3127	14.3 (J)	n/a	100	n/a	n/a	n/a
Vanadium	Unfiltered	16-02654	RE16-03-50737	28.4	n/a	n/a	n/a	n/a	n/a
Vanadium	Filtered	16-02654	RE16-03-50738	14.4	n/a	100	n/a	n/a	n/a
Vanadium	Filtered	16-02654	RE16-98-3020	12.3 (J)	n/a	100	n/a	n/a	n/a
Vanadium	Unfiltered	16-02654	RE16-98-3021	33.1 (J)	n/a	n/a	n/a	n/a	n/a
Zinc	Unfiltered	16-02654	0316-97-3102	40 (J)	n/a	n/a	n/a	n/a	n/a
Zinc	Filtered	16-02654	0316-97-3103	50 (J)	5000	25000	n/a	10000	n/a
Zinc	Unfiltered	16-02654	RE16-00-3133	22	n/a	n/a	n/a	n/a	n/a
Zinc	Filtered	16-02654	RE16-00-3134	19 (J)	5000	25000	n/a	10000	n/a
Zinc	Unfiltered	16-02654	RE16-01-3126	44.6	n/a	n/a	n/a	n/a	n/a
Zinc	Filtered	16-02654	RE16-01-3127	27	5000	25000	n/a	10000	n/a
Zinc	Unfiltered	16-02654	RE16-03-50737	52.7	n/a	n/a	n/a	n/a	n/a
Zinc	Filtered	16-02654	RE16-03-50738	28.6	5000	25000	n/a	10000	n/a

Table B-12 (continued)

Analyte	Field Preparation	Location ID	Sample ID	Sample Concentration (µg/L)	MCL[a]	LW[b]	WH[c]	GW[d]	DCG[e]
Zinc	Filtered	16-02654	RE16-98-3020	26.8	5000	25000	n/a	10000	n/a
Zinc	Unfiltered	16-02654	RE16-98-3021	59	n/a	n/a	n/a	n/a	n/a
Alkalinity-HCO_3	Unfiltered	16-06121	RE16-01-3140	38000	n/a	n/a	n/a	n/a	n/a
Aluminum	Unfiltered	16-06121	RE16-01-3140	5180	n/a	n/a	n/a	n/a	n/a
Aluminum	Filtered	16-06121	RE16-01-3141	4310	50	5000	n/a	5000	n/a
Aluminum	Unfiltered	16-06121	RE16-98-3084	3440	n/a	n/a	n/a	n/a	n/a
Barium	Unfiltered	16-06121	RE16-01-3140	343	n/a	n/a	n/a	n/a	n/a
Barium	Filtered	16-06121	RE16-01-3141	345	2000	n/a	n/a	1000	n/a
Barium	Unfiltered	16-06121	RE16-98-3084	918	n/a	n/a	n/a	n/a	n/a
Beryllium	Unfiltered	16-06121	RE16-01-3140	0.57 (J)	n/a	n/a	n/a	n/a	n/a
Boron	Unfiltered	16-06121	RE16-01-3140	51.8 (J)	n/a	n/a	n/a	n/a	n/a
Boron	Filtered	16-06121	RE16-01-3141	47.5 (J)	n/a	5000	n/a	750	n/a
Calcium	Unfiltered	16-06121	RE16-01-3140	14100	n/a	n/a	n/a	n/a	n/a
Calcium	Filtered	16-06121	RE16-01-3141	14700	n/a	n/a	n/a	n/a	n/a
Calcium	Unfiltered	16-06121	RE16-98-3084	10200	n/a	n/a	n/a	n/a	n/a
Chloride	Unfiltered	16-06121	RE16-01-3140	5130	n/a	n/a	n/a	n/a	n/a
Chloride	Unfiltered	16-06121	RE16-98-3084	2700	n/a	n/a	n/a	n/a	n/a
Chromium	Unfiltered	16-06121	RE16-01-3140	4.4 (J)	n/a	n/a	n/a	n/a	n/a
Chromium	Filtered	16-06121	RE16-01-3141	2.4 (J)	100	1000	n/a	50	n/a
Chromium	Unfiltered	16-06121	RE16-98-3084	0.77 (J)	n/a	n/a	n/a	n/a	n/a
Copper	Unfiltered	16-06121	RE16-98-3084	0.94 (J)	n/a	n/a	n/a	n/a	n/a
Fluoride	Unfiltered	16-06121	RE16-01-3140	236	n/a	n/a	n/a	n/a	n/a
Fluoride	Unfiltered	16-06121	RE16-98-3084	200	n/a	n/a	n/a	n/a	n/a
Iron	Unfiltered	16-06121	RE16-01-3140	3240	n/a	n/a	n/a	n/a	n/a
Iron	Filtered	16-06121	RE16-01-3141	2580	300	n/a	n/a	1000	n/a
Iron	Unfiltered	16-06121	RE16-98-3084	2560	n/a	n/a	n/a	n/a	n/a

Table B-12 (continued)

Analyte	Field Preparation	Location ID	Sample ID	Sample Concentration (µg/L)	MCL[a]	LW[b]	WH[c]	GW[d]	DCG[e]
Lead	Unfiltered	16-06121	RE16-01-3140	1.4 (J)	n/a	n/a	n/a	n/a	n/a
Magnesium	Unfiltered	16-06121	RE16-01-3140	3900 (J)	n/a	n/a	n/a	n/a	n/a
Magnesium	Filtered	16-06121	RE16-01-3141	3900 (J)	n/a	n/a	n/a	n/a	n/a
Magnesium	Unfiltered	16-06121	RE16-98-3084	3430 (J)	n/a	n/a	n/a	n/a	n/a
Manganese	Unfiltered	16-06121	RE16-01-3140	82.7	n/a	n/a	n/a	n/a	n/a
Manganese	Filtered	16-06121	RE16-01-3141	42.1	50	n/a	n/a	200	n/a
Manganese	Unfiltered	16-06121	RE16-98-3084	15.6	n/a	n/a	n/a	n/a	n/a
Nickel	Unfiltered	16-06121	RE16-01-3140	2.6 (J)	n/a	n/a	n/a	n/a	n/a
Nickel	Filtered	16-06121	RE16-01-3141	1.5 (J)	100	n/a	n/a	200	n/a
Nickel	Unfiltered	16-06121	RE16-98-3084	2.4 (J)	n/a	n/a	n/a	n/a	n/a
Nitrate-Nitrite as N	Unfiltered	16-06121	RE16-01-3140	93.7 (J-)[h]	n/a	n/a	n/a	n/a	n/a
Potassium	Unfiltered	16-06121	RE16-01-3140	4860 (J)	n/a	n/a	n/a	n/a	n/a
Potassium	Filtered	16-06121	RE16-01-3141	4980 (J)	n/a	n/a	n/a	n/a	n/a
Potassium	Unfiltered	16-06121	RE16-98-3084	3120 (J)	n/a	n/a	n/a	n/a	n/a
Selenium	Filtered	16-06121	RE16-01-3141	1.9 (J)	50	50	n/a	50	n/a
Sodium	Unfiltered	16-06121	RE16-01-3140	9640	n/a	n/a	n/a	n/a	n/a
Sodium	Filtered	16-06121	RE16-01-3141	9580	n/a	n/a	n/a	n/a	n/a
Sodium	Unfiltered	16-06121	RE16-98-3084	8260	n/a	n/a	n/a	n/a	n/a
Sulfate	Unfiltered	16-06121	RE16-01-3140	23000	n/a	n/a	n/a	n/a	n/a
Sulfate	Unfiltered	16-06121	RE16-98-3084	7500	n/a	n/a	n/a	n/a	n/a
Vanadium	Unfiltered	16-06121	RE16-01-3140	6 (J)	n/a	n/a	n/a	n/a	n/a
Vanadium	Filtered	16-06121	RE16-01-3141	4.8 (J)	n/a	100	n/a	n/a	n/a
Vanadium	Unfiltered	16-06121	RE16-98-3084	3.2 (J)	n/a	n/a	n/a	n/a	n/a

Table B-12 (continued)

Analyte	Field Preparation	Location ID	Sample ID	Sample Concentration (µg/L)	MCL[a]	LW[b]	WH[c]	GW[d]	DCG[e]
Zinc	Unfiltered	16-06121	RE16-01-3140	24.5	n/a	n/a	n/a	n/a	n/a
Zinc	Filtered	16-06121	RE16-01-3141	8.5 (J)	5000	25000	n/a	10000	n/a

[a] MCL = EPA SDWA maximum contaminant level.
[b] LW = NMED surface water standard for livestock.
[c] WH = NMED surface water standard for wildlife.
[d] GW = NMED groundwater standard.
[e] DCG = Dose concentration guideline (DOE).
[f] n/a = Not applicable.
[g] J = The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.
[h] J- = The analyte was positively identified, and the result is likely to be biased low.

Table B-13
Frequency of Detected Organic Chemicals in Surface Water at Fishladder Seep and the Fishladder Canyon–Cañon de Valle Confluence

Analyte	Screen	Field Preparation	Number of Analyses	Number of Detects	Concentration Range[a] (µg/L)	Drinking Water MCL (µg/L)	Frequency of Detects above Drinking Water MCL	NMED Groundwater Standard (µg/L)	Frequency of Detects above NMED Groundwater Standard
Acetone		Filtered	1	1	25	n/a[b]	n/a	n/a	n/a
Acetone		Unfiltered	6	2	[3.2] to 40	n/a	n/a	n/a	n/a
Dichloroethene[cis-1,2-]		Filtered	1	1	9	n/a	n/a	n/a	n/a
Dichloroethene[cis-1,2-]		Unfiltered	5	4	[5] to 27	70	0/5	n/a	n/a
HMX		Filtered	2	1	[1] to 3.42	n/a	n/a	n/a	n/a
HMX		Unfiltered	7	6	[1] to 16	n/a	n/a	n/a	n/a
MNX		Unfiltered	1	1	0.055	n/a	n/a	n/a	n/a
RDX		Filtered	2	1	[0.84] to 5.4	n/a	n/a	n/a	n/a
RDX		Unfiltered	7	5	[0.84] to 5.91	n/a	n/a	n/a	n/a
Tetrachloroethene		Filtered	1	1	10	n/a	n/a	n/a	n/a
Tetrachloroethene		Unfiltered	7	4	[1] to 42	5	3/7	20	2/7
Total Organic Carbon		Filtered	1	1	14000	n/a	n/a	n/a	n/a
Total Organic Carbon		Unfiltered	1	1	22000	n/a	n/a	n/a	n/a
Trichloroethene		Unfiltered	7	3	0.25 to 10	5	2/7	100	0/7

[a] Values in brackets are below detection limits, although some chemicals may be detected at values within this range.
[b] n/a = Not applicable.

Table B-14
Summary of Samples with Detected Organic Chemicals in
Surface Water at Fishladder Seep and the Fishladder Canyon–Cañon de Valle Confluence

Analyte	Field Preparation	Location ID	Sample ID	Sample Concentration (g/L)	MCL[a]	LW[b]	WH[c]	GW[d]	DCG[e]
Acetone	Unfiltered	16-02654	0316-97-3102	40	n/a[f]	n/a	n/a	n/a	n/a
Acetone	Filtered	16-02654	RE16-98-3020	25 (J-)[g]	n/a	n/a	n/a	n/a	n/a
Acetone	Unfiltered	16-02654	RE16-98-3021	27 (J-)	n/a	n/a	n/a	n/a	n/a
Dichloroethene[cis-1,2-]	Unfiltered	16-02654	0316-97-3102	19	70	n/a	n/a	n/a	n/a
Dichloroethene[cis-1,2-]	Unfiltered	16-02654	RE16-00-3133	27	70	n/a	n/a	n/a	n/a
Dichloroethene[cis-1,2-]	Unfiltered	16-02654	RE16-03-50737	6.3 (J+)[h]	70	n/a	n/a	n/a	n/a
Dichloroethene[cis-1,2-]	Filtered	16-02654	RE16-98-3020	9 (J-)	n/a	n/a	n/a	n/a	n/a
Dichloroethene[cis-1,2-]	Unfiltered	16-02654	RE16-98-3021	9 (J-)	70	n/a	n/a	n/a	n/a
HMX	Unfiltered	16-02654	RE16-00-3133	16	n/a	n/a	n/a	n/a	n/a
HMX	Unfiltered	16-02654	RE16-01-3126	13.9	n/a	n/a	n/a	n/a	n/a
HMX	Unfiltered	16-02654	RE16-03-50737	6.1 (J-)	n/a	n/a	n/a	n/a	n/a
HMX	Filtered	16-02654	RE16-98-3020	3.42	n/a	n/a	n/a	n/a	n/a
HMX	Unfiltered	16-02654	RE16-98-3021	4.16	n/a	n/a	n/a	n/a	n/a
MNX	Unfiltered	16-02654	RE16-03-50737	0.055 (J-)	n/a	n/a	n/a	n/a	n/a
RDX	Unfiltered	16-02654	RE16-00-3133	2.2	n/a	n/a	n/a	n/a	n/a
RDX	Unfiltered	16-02654	RE16-01-3126	4.5	n/a	n/a	n/a	n/a	n/a
RDX	Filtered	16-02654	RE16-98-3020	5.4	n/a	n/a	n/a	n/a	n/a
RDX	Unfiltered	16-02654	RE16-98-3021	5.91	n/a	n/a	n/a	n/a	n/a
Tetrachloroethene	Unfiltered	16-02654	RE16-00-3133	42	5	n/a	n/a	20	n/a
Tetrachloroethene	Unfiltered	16-02654	RE16-01-3126	1.2	5	n/a	n/a	20	n/a
Tetrachloroethene	Unfiltered	16-02654	RE16-03-50737	39.1	5	n/a	n/a	20	n/a
Tetrachloroethene	Filtered	16-02654	RE16-98-3020	10 (J-)	n/a	n/a	n/a	n/a	n/a
Tetrachloroethene	Unfiltered	16-02654	RE16-98-3021	12 (J-)	5	n/a	n/a	20	n/a
Total Organic Carbon	Filtered	16-02654	RE16-98-3020	14000	n/a	n/a	n/a	n/a	n/a

Table B-14 (continued)

Analyte	Field Preparation	Location ID	Sample ID	Sample Concentration (g/L)	MCL[a]	LW[b]	WH[c]	GW[d]	DCG[e]
Total Organic Carbon	Unfiltered	16-02654	RE16-98-3021	22000	n/a	n/a	n/a	n/a	n/a
Trichloroethene	Unfiltered	16-02654	RE16-00-3133	10	5	n/a	n/a	100	n/a
Trichloroethene	Unfiltered	16-02654	RE16-01-3126	0.25 (J)[i]	5	n/a	n/a	100	n/a
Trichloroethene	Unfiltered	16-02654	RE16-03-50737	9.9	5	n/a	n/a	100	n/a
HMX	Unfiltered	16-06121	RE16-01-3140	2.7	n/a	n/a	n/a	n/a	n/a
HMX	Unfiltered	16-06121	RE16-98-3084	7.3	n/a	n/a	n/a	n/a	n/a
RDX	Unfiltered	16-06121	RE16-01-3140	0.94	n/a	n/a	n/a	n/a	n/a
RDX	Unfiltered	16-06121	RE16-98-3084	2.1	n/a	n/a	n/a	n/a	n/a

[a] MCL = EPA SDWA max contaminant level.
[b] LW = NMED surface water standard for livestock.
[c] WH = NMED surface water standard for wildlife.
[d] GW = NMED groundwater standard.
[e] DCG = Dose concentration guideline (DOE).
[f] n/a = Not applicable.
[g] J- = The analyte was positively identified, and the result is likely to be biased low.
[h] J+ = The analyte was positively identified, and the result is likely to be biased high.
[i] J = The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.

Table B-15
Frequency of Detected Radionuclides in Surface Water at Fishladder Seep and the Fishladder Canyon–Cañon de Valle Confluence

Analyte	Screen	Field Preparation	Number of Analyses	Number of Detects	Concentration Range[a] (pCi/L)	Drinking Water MCL (pCi/L)	Frequency of Detects above Drinking Water MCL	NMED Groundwater Standard (pCi/L)	Frequency of Detects above NMED Groundwater Standard
Tritium		Unfiltered	5	5	79 to 250.2528	20000	0/5	n/a[b]	n/a

[a] Values in brackets are below detection limits, although some chemicals may be detected at values within this range.
[b] n/a = Not applicable.

Table B-16
Summary of Samples with Detected Radionuclides in Surface Water at Fishladder Seep and the Fishladder Canyon–Cañon de Valle Confluence

Analyte	Field Preparation	Location ID	Sample ID	Sample Concentration (pCi/L)	MCL[a]	LW[b]	WH[c]	GW[d]	DCG[e]
Tritium	Unfiltered	16-02654	RE16-00-3133	120	20000	20000	n/a[f]	n/a	n/a
Tritium	Unfiltered	16-02654	RE16-01-3126	167	20000	20000	n/a	n/a	n/a
Tritium	Unfiltered	16-02654	RE16-03-50737	250	20000	20000	n/a	n/a	n/a
Tritium	Unfiltered	16-06121	RE16-01-3140	155	20000	20000	n/a	n/a	n/a
Tritium	Unfiltered	16-06121	RE16-98-3084	79	20000	20000	n/a	n/a	n/a

[a] MCL = EPA SDWA max contaminant level.
[b] LW = NMED surface water standard for livestock.
[c] WH = NMED surface water standard for wildlife.
[d] GW = NMED groundwater standard.
[e] DCG = Dose concentration guideline (DOE).
[f] n/a = Not applicable.

Appendix C

Phase I RFI Results
(CD on inside back cover of this report)

Appendix D

Investigation-Derived Waste Management Plan

D-1.0 INTRODUCTION

This appendix describes how investigation-derived waste (IDW) generated during the field investigation and associated soil removal at the TA-16-340 Complex at Los Alamos National Laboratory (LANL or the Laboratory) will be managed. IDW is solid waste generated as a result of field investigation activities and may include, but is not limited to, drill cuttings; purge water; contaminated personal protective equipment (PPE), sampling supplies, and plastic; fluids from the decontamination of PPE and sampling equipment; and all other wastes potentially having had contact with contaminants. Certain field investigation activities may also displace environmental media, which are defined as naturally occurring material indigenous to the environment and include groundwater, surface water, surface and subsurface soils, rocks, bedrock, and gravel. Consistent with the US Environmental Protection Agency (EPA) "area of contamination" policy (EPA 1996, 82288, pp. 4–7), environmental media are not considered to be waste (and, hence, not IDW) if they are returned to their point of origin. IDW generated during the investigation of the TA-16-340 Complex will be managed to protect human health and the environment, to comply with applicable regulatory requirements, and to adhere to Laboratory waste minimization goals.

All IDW generated during field investigation activities will be managed in accordance with applicable Risk Reduction and Environmental Stewardship–Remediation Services (RRES-RS) Project standard operating procedures (SOPs). These SOPs incorporate the requirements of all applicable EPA and New Mexico Environment Department (NMED) regulations, US Department of Energy (DOE) orders, and Laboratory implementation requirements. RRES-RS SOPs applicable to the characterization and management of IDW (and specifically addressed in this appendix) are

SOP-01.06, "Management of Environmental Restoration (ER) Project Waste"

SOP-01.08, "Field Decontamination of Drilling and Sampling Equipment"

SOP-01.10, "Waste Characterization"

SOP-01.12, "Field Site Closeout Checklist"

These SOPs are among the SOPs applicable to the investigation at the TA-16-340 Complex and are available at the following URL: http://erproject.lanl.gov/documents/procedures.html.

Investigation activities will be conducted in a manner that minimizes waste generation by implementing the requirements of the RRES-RS portion of the 2003 Pollution Prevention Roadmap (LANL 2003, 85205), which is updated annually as a requirement of Module VIII of the Laboratory's Hazardous Waste Facility Permit, ID# NM0890010515-1, issued by EPA on May 23, 1990, and modified on May 19, 1994 (EPA 1990, 01585; EPA 1994, 44146).

Before the start of field investigation activities, a waste characterization strategy form (WCSF) will be prepared and approved in accordance with the requirements of SOP-01.10. The WCSF will provide detailed information on IDW characterization, management, containerization, and potential volume generation. IDW characterization will be achieved through existing data and/or documentation, through direct sampling of the IDW, or sampling of the media being investigated (i.e., surface soil, subsurface soil, etc.). If sampling is necessary, it will be described in a sampling and analysis plan developed in conjunction with the WCSF.

The selection of waste containers will be based on the appropriate US Department of Transportation requirements and the type and amount of IDW expected to be generated. Immediately following containerization, each waste container will be individually labeled by waste classification, item identification number, radioactivity (if applicable), and date generated. Waste containers will be managed in clearly marked and appropriately constructed waste accumulation areas. Waste accumulation area

postings, regulated storage duration, and inspection requirements will be based on the type of IDW and its classification.

D-1.1 Waste Management and Disposal

Waste management and disposal activities for the TA-16-340 Complex include the following tasks:

- management of all environmental media and wastes, including used immunoassay test kits (D-Tech kits), in accordance with all applicable EPA and NMED regulations and DOE, Laboratory, and RRES-RS implementing requirements
- establishment of less-than-90-day waste accumulation area(s) for potential hazardous waste and/or potential New Mexico Special Waste (components of used immunoassay test kits are assumed to be hazardous waste until receipt of waste characterization results confirm otherwise)
- collection of waste characterization samples for analysis within 24 hrs of generating the waste
- ensuring that all returned samples, whether for site or waste characterization, are managed, characterized, and disposed of properly
- ensuring that all waste, including but not limited to returned samples, used PPE, used immunoassay test kits, contaminated media, debris, equipment, and other IDW, are properly characterized and disposed

D-1.2 Estimated Types and Volumes of Waste

Five separate waste streams are anticipated from this field investigation. The waste streams, expected waste types, and volumes are summarized in Table D-1. For wastes generated solely during remediation activities (e.g., PPE, equipment, and removed soil), it is assumed that the waste contaminants will be identical to the contaminants found in the soil. Therefore, characterization of these wastes will be based on results of the fixed laboratory analysis of the characterization and confirmation samples for soil. Waste stream descriptions, including the principal components of the waste and any uncertainties in volume calculations, are described in the following paragraphs.

Potentially contaminated soil and fixtures. This waste stream will be composed of chemical and unconsolidated soil waste and associated fixtures that will not be removed by decommissioning and decontamination (D&D) (e.g., distal drainlines and the Fishladder structure). Characterization of this waste will be determined from the contamination levels found in the soil based on historical and waste sampling analytical results. Based on previous remediation activities at Technical Area 16, we anticipate analyzing wastes on 100 yd^3 lots for toxicity characteristic leaching procedure metals, volatile organic compounds, semivolatile organic compounds, high explosives, polychlorinated biphenyls, and uranium. The Laboratory anticipates requesting a no-longer-contained-in determination for F-listed solvents in this waste stream.

Decontamination waters. This waste stream will be composed of washing liquids generated from the decontamination of sampling equipment. However, the majority of equipment decontamination will be performed using dry techniques in accordance with SOP-01.08, “Field Decontamination of Drilling and Sampling Equipment.”

Plastics, PPE, and sampling wastes. This waste stream will include various types of plastic sheeting (e.g., tarps and contamination control covers), disposable gloves and coveralls, and sampling supplies such as plastic scoops, plastic bags, jars, and dry decontamination waste. Plastics, PPE, and sampling-

related wastes have the potential to become contaminated through direct contact with contaminated environmental media and debris. Because this waste is generated only during remediation activities, it is assumed that the waste contaminants will be identical to the contaminants found in the soil. Therefore, characterization of this waste will be based on results of the fixed laboratory analysis of the characterization and confirmation samples for soil.

Spent immunoassay test kits. This waste stream will include sampling containers and materials from used test kits. This waste stream consists of glass ampules, soil, and miscellaneous plastic/Teflon. This solid waste is assumed to be hazardous based on its ignitability, until a flash point test determines it to be nonhazardous. This waste will be stored in a 55-gal. drum at a satellite accumulation area on-site until a final waste determination is made, and it is transported off-site to an appropriately permitted facility for disposal.

Spent methanol from test kits. This is a Resource Conservation and Recovery Act (RCRA) hazardous waste (F003) because of its ignitability. Methanol from each individual immunoassay test/sample vial will be transferred to a polyethylene storage bottle with a threaded/sealed top. The material safety data sheet for methanol will be the basis of acceptable knowledge for this waste stream. This waste will be stored in a sealed secondary container at a satellite accumulation area on site until a final waste determination is made and it is transported offsite to an appropriate permitted facility for disposal.

Table D-1
Waste Streams, Types, and Volumes Estimated for TA-16-340 Complex

Waste Stream	Waste Type	Anticipated Volume
Potentially contaminated soil and associated fixtures	Solid, potentially hazardous, low-level radioactive (bulk)	Several hundred cubic yards covered in piles or rolloffs (for hazardous wastes)
Decontamination and purge waters	Liquid, wastewater	Less than 6 gal./day discharged on site
PPE, plastic sheeting, and disposable sampling equipment	Solid industrial waste	One 55-gal. drum with polyethylene liner
Spent immunoassay test kits	Solid industrial waste	Approximately five 1-gal., resealable bags stored in a 55-gal. steel drum
Spent methanol from test kits	Chemical, RCRA hazardous waste (F003)	Less than 1 L stored in secondary container