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Investigation Work Plan for Lower Mortandad/Cedro Canyons Aggregate Area

Los Alamos
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EXECUTIVE SUMMARY

This investigation work plan presents the investigation activities at solid waste management units (SWMUs) and areas of concern (AOCs) located within the Lower Mortandad/Cedro Canyons Aggregate Area. The Lower Mortandad/Cedro Canyons Aggregate Area includes a total of four SWMUs and two AOCs located in Technical Area 05 at Los Alamos National Laboratory. Of these six sites, one AOC has been previously investigated and requires no further investigation, and one AOC has been approved for no further action. This investigation work plan identifies and describes the activities needed to complete the investigation of the remaining four SWMUs. Details of previous investigations and analytical results for the four sites included in this work plan are provided in the historical investigation report for Lower Mortandad/Cedro Canyons Aggregate Area.

The objective of this work plan is to evaluate the historical data and, based on that evaluation, to propose additional sampling as necessary to define the nature and extent of contamination associated with the SWMUs within the Lower Mortandad/Cedro Canyons Aggregate Area.

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1.0 INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) is a multidisciplinary research facility owned by the U.S. Department of Energy (DOE) and managed by Los Alamos National Security, LLC. The Laboratory is located in north-central New Mexico approximately 60 mi northeast of Albuquerque and 20 mi northwest of Santa Fe. The Laboratory site covers 40 mi^2 of the Pajarito Plateau, which consists of a series of fingerlike mesas separated by deep canyons containing perennial and intermittent streams running from west to east. Mesa tops range in elevation from approximately 6200 to 7800 ft above mean sea level. The location of Lower Mortandad/Cedro Canyons Aggregate Area with respect to the Laboratory technical areas (TAs) is shown in Figure 1.0-1.

The Laboratory's Environmental Programs (EP) Directorate, which includes the former Environmental Restoration (ER) Project, is participating in a national effort by DOE to reduce risk to human health and the environment at its facilities. The goal of EP Directorate is to ensure that past operations do not threaten human or environmental health and safety in and around Los Alamos County, New Mexico. To achieve this goal, EP is currently investigating sites potentially contaminated by past Laboratory operations. The sites under investigation are designated as either solid waste management units (SWMUs) or areas of concern (AOCs).

The SWMUs and AOCs addressed in this investigation work plan are potentially contaminated with both hazardous and radioactive components. The New Mexico Environment Department (NMED), pursuant to the New Mexico Hazardous Waste Act, regulates cleanup of hazardous wastes and hazardous constituents. DOE regulates cleanup of radioactive contamination, pursuant to DOE Order 5400.5, "Radiation Protection of the Public and the Environment," and DOE Order 435.1, "Radioactive Waste Management." Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to NMED in accordance with DOE policy.

Corrective actions at the Laboratory are subject to the March 1, 2005, Compliance Order on Consent (the Consent Order). This work plan describes work activities that will be conducted and completed in accordance with the Consent Order.

1.1 Work Plan Overview

The Lower Mortandad/Cedro Canyons Aggregate Area consists of four SWMUs and two AOCs located in TA-05 at the Laboratory. Historical details of previous investigations and data for these sites are provided in the historical investigation report (HIR) for Lower Mortandad/Cedro Canyons Aggregate Area (LANL 2009, 107102). Table 1.1-1 provides the investigation status of the six sites within the Lower Mortandad/Cedro Canyons Aggregate Area. Of the six sites, one AOC has been previously approved for no further action (NFA), and one AOC was included in the investigation of the Middle Mortandad/Ten Site Canyons Aggregate Area (LANL 2008, 102187). This work plan addresses the remaining four sites using the information from previous field investigations to evaluate current conditions at each site. Figure 1.1-1 shows the locations of the sites under investigation in the Lower Mortandad/Cedro Canyons Aggregate Area.

Section 2 of this work plan presents the general site information, operational history, and the preliminary conceptual site model of the Lower Mortandad/Cedro Canyons Aggregate Area. General site conditions are described in section 3. The specific site descriptions and proposed investigation activities are discussed in section 4. The investigation methods for proposed field activities are described in section 5. Ongoing monitoring and sampling programs in the Lower Mortandad/Cedro Canyons Aggregate Area are presented in section 6, and an overview of the anticipated schedule of the investigation and reporting activities is presented in section 7. The references cited in this work plan and the map data sources are provided in section 8. Appendix A contains a list of acronyms and abbreviations used in this investigation work plan, a metric conversion table, and a data qualifier definitions table. Appendix B describes the management of investigation-derived waste (IDW).

1.2 Work Plan Objectives

The objective of the investigation activities described in this work plan is to finalize determination of nature and extent of releases from the four sites. To accomplish this objective, this work plan presents historical and background information on the sites, describes the rationale for proposed data collection activities, and identifies and proposes appropriate methods and protocols for collecting and analyzing samples and evaluating data to characterize these sites.

2.0 BACKGROUND

2.1 General Site Information

TA-05 is located on the eastern side of the Laboratory (Figure 1.0-1) and is situated on a small finger mesa, Mesita del Buey that extends eastward from the main mesa between Mortandad and Pajarito Canyons. The western portion of TA-05 is located within the Middle Mortandad/Ten Site Canyons Aggregate Area, and the eastern portion is located within Lower Mortandad/Cedro Canyons Aggregate Area. That portion of TA-05 within the Lower Mortandad/Cedro Canyons Aggregate Area is bounded by TA-53 and TA-72 to the north and east, Middle Mortandad/Ten Site Canyons Aggregate Area to the north and west, and Pueblo de San Ildefonso to the south. TA-05 is currently used as a security buffer zone and contains several physical support facilities, including an electrical substation and a water-supply well.

2.2 Operational History

TA-05, also known as Beta Site, was established in 1944 as an adjunct test firing site to TA-04 (Alpha Site). Firing activities were conducted at two small firing sites located within the Middle Mortandad/Ten Site portion of TA-05 and one large firing site, known as Far Point Site, within the Lower Mortandad/Cedro portion of TA-05. Far Point Site was used briefly during 1944 and 1945 for half-scale mockup tests of the Trinity device (LANL 2008, 102187, p. 3). TA-05 was used as a firing site for implosion studies until 1947. After firing activities were halted, several Laboratory groups used the site for a variety of experiments, including the study of hydrogen fires, animal radiation experiments, and beryllium combustion experiments. In late 1959, two experimental reactors known as “Little Eva” and “Godiva” were brought to TA-05 and operated briefly (Ulery 1995, 046037). Little Eva was located inside a trailer, and Godiva was located in an underground chamber (SWMU 05-003). TA-05 was taken out of service in 1959 and underwent decontamination and demolition in 1985 as part of the Los Alamos Site Characterization Program (LASCP). The 1985 LASCP addressed only radioactive contamination.

2.3 Conceptual Site Model

The sampling proposed in this work plan uses a conceptual site model to predict areas of potential contamination and to allow for adequate characterization of these areas. A conceptual site model describes potential contaminant sources, transport mechanisms, and receptors and pathways.

2.3.1 Potential Contaminant Sources

Releases at sites within Lower Mortandad/Cedro Canyons Aggregate Area may have occurred as a result of waste disposal, air emissions, or effluent discharges. Previous sampling results indicate contamination from inorganic chemicals, organic chemicals, and radionuclides. Additional sampling is needed to determine the nature and extent of contamination.

Potential contaminant sources include an underground chamber that housed an experimental reactor, past discharges from outfalls and a septic system, pouring of chemicals to the ground surface, and residual soil contamination associated with destruction of a former building by burning.

2.3.2 Potential Contaminant Transport Mechanisms

Current potential transport mechanisms that may lead to exposure include

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

2.3.3 Potential Receptors and Pathways

Potential receptors and pathways may include

- Laboratory workers and
- plants and animals both on-site and in areas immediately surrounding the sites.

Laboratory workers could potentially be exposed to contaminants in soil, tuff, and sediment by direct contact, ingestion, or inhalation. Ecological receptors may also be exposed to soil and sediment contaminants.

2.3.4 Cleanup Standards

As specified in Section VIII.B.1 of the Consent Order, screening levels will be used as soil cleanup levels unless they are determined to be impracticable or unless values do not exist for the current and reasonably foreseeable future land use. The current and reasonably foreseeable land use for all the SWMUs proposed for investigation in this work plan is industrial (i.e., continued Laboratory use). Soil screening levels (SSLs) for the industrial scenario are presented in Table 2.3-1 for previously detected inorganic and organic chemicals. The screening action levels (SALs) for the industrial scenario are also provided in Table 2.3-1 for previously detected radionuclides.

2.4 Data Overview

Data evaluated in this work plan include historical data collected from 1995 through 1998, as part of Resource Conservation and Recovery Act (RCRA) facility investigations (RFI) and other corrective actions. All data records in the Sample Management Database include a vintage code field denoting how and where samples were submitted for analyses. The data vintage is considered when the quality of historical data is evaluated. All historical data evaluated in this report are validated or revalidated by current quality control (QC) metrics.

Samples described in this work plan have undergone analyses at both on- and off-site laboratories. Because analytical practices and documentation of analyses vary in quality and completeness, analytical data are either screening-level or decision-level data. Screening-level data are appropriate for applications requiring only a determination of gross contamination areas and/or site characterization. Screening-level data are also used to specify areas where samples should be collected. Decision-level data are used to quantify the nature and extent of releases and to perform risk assessments. Decision-level data presented in this work plan have been validated for such use and provide supporting information for the investigation activities proposed in this work plan. All historical data presented in this work plan are decision-level data.

Data presented in this report consist of inorganic chemicals and radionuclides above background and detected organic chemicals. Inorganic chemical and radionuclide data from previous investigations are compared with background values (BVs) and fallout values (FVs) (LANL 1998, 059730, p. 6-2). Fallout radionuclides in soil greater than a depth of 1 ft or in rock and organic chemicals are evaluated based on detection status.

This work plan summarizes the available decision-level data to determine whether the nature and extent of contamination are defined for each site. In addition, this work plan proposes sampling activities and analyses for those sites where the nature and extent of contamination have not been defined. The data collected during this investigation, along with appropriate existing decision-level data, will be used to define nature and extent and perform risk-screening assessments. In some cases, previous sampling locations will be resampled because previous results may no longer be representative of current site conditions. In these cases, only current data will be used to define nature and extent and to perform risk-screening assessments.

3.0 SITE CONDITIONS

3.1 Surface Conditions

3.1.1 Soil

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

The mesa-top soil where the Lower Mortandad/Cedro Canyons Aggregate Area SWMUs are located is mapped as the Hackroy-Rock outcrop complex. The Hackroy-Rock outcrop complex consists of small areas of Hackroy soil and 70% rock outcrop that are so intermingled that they could not be separated at the scale selected for mapping. Shallow, well-drained Hackroy soil makes up about 20% of the complex, and Nyjack soil and very shallow undeveloped soil make up about 10% of the unit. The Hackroy-Rock outcrop complex exhibits slow permeability and low available water capacity. It has a moderate to severe water erosion hazard and medium to high runoff (Nyhan et al. 1978, 005702, p. 25).

3.1.2 Surface Water

Most surface water in the Los Alamos area occurs as ephemeral, intermittent, or interrupted streams in canyons cut into the Pajarito Plateau. Springs on the flanks of the Jemez Mountains, west of the Laboratory's western boundary, supply flow to the upper reaches of Cañon de Valle and to Guaje, Los Alamos, Pajarito, and Water Canyons (Purtymun 1975, 011787; Stoker 1993, 056021). These springs discharge water perched in the Bandelier Tuff and Tschicoma Formation at rates from 2 to 135 gal./min (Abeele et al. 1981, 006273). The volume of flow from the springs maintains natural perennial reaches of varying lengths in each of the canyons.

Mortandad Canyon has a relatively small drainage area (4.7 mi^2) that originates on Laboratory property within TA-03 at an elevation of approximately 7410 ft above sea level (asl). The canyon has a length of 10 mi and trends east-southeast across Laboratory property and Pueblo de San Ildefonso before reaching the Rio Grande in White Rock Canyon. Named tributaries include Cañada del Buey and Effluent and Ten Site Canyons on Laboratory property and Cedro Canyon on Pueblo de San Ildefonso.

Mortandad Canyon contains a small entirely ephemeral stream. No perennial springs or natural perennial reaches occur. Snowmelt runoff and stormwater runoff flow for a limited distance in the upper part of the canyon. Surface water flows from the National Pollutant Discharge Elimination System (NPDES) permitted outfall at the TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF) but typically extends less than 1 mi below the outfall (LANL 1997, 056835, p. 3-2).

3.1.3 Land Use

Currently, land use of the Lower Mortandad/Cedro Canyons Aggregate Area is industrial. TA-05 is currently used as a security buffer zone and contains physical support facilities such as an electrical substation, a water-supply well, test wells, several archeological sites, and environmental monitoring and buffer areas. In the past, the gravel road extending along the length of Mesita del Buey has been used by Laboratory employees for recreational activities such as walking or jogging but is currently inaccessible for such use. TA-05 is not accessible to the public. The current land use is not expected to change for the reasonably foreseeable future.

3.2 Subsurface Conditions

3.2.1 Anticipated Stratigraphic Units

The stratigraphy of the Lower Mortandad/Cedro Canyons Aggregate Area is summarized in this section. Additional information on the geologic setting of the area and information on the Pajarito Plateau can be found in the Laboratory's 2005 hydrogeologic synthesis report (Collins et al. 2005, 092028).

The bedrock at or near the surface of the mesa top is the Bandelier Tuff. There are approximately 1200 ft of volcanic and sedimentary materials between the mesa top and the regional aquifer. The stratigraphic units underlying the Lower Mortandad/Cedro Canyons Aggregate Area from the surface to the regional aquifer are described briefly in the following sections. The descriptions begin with the oldest (deepest) and proceed to the youngest (topmost). These descriptions are taken from the Mortandad Canyon work plan (LANL 1997, 056835) and use the following designations for areas within Mortandad Canyon:

- upper Mortandad Canyon extends from the head of the canyon at TA-03 for about 1.4 mi to the confluence with Effluent Canyon;
- middle Mortandad Canyon is a deep, narrow portion of the canyon that extends from Effluent Canyon about 1.1 mi to near Test Well (TW) 8 and Mortandad Canyon observation (MCO) well MCO-5; and
- lower Mortandad Canyon is the wider portion of the canyon that extends from near TW-8 about 2 mi to the Laboratory boundary.

Figure 3.2-1 shows the generalized stratigraphy described below.

3.2.1.1 Santa Fe Group

In the general area of Mortandad Canyon, the Santa Fe Group was penetrated by water-supply wells PM-3 (located to the north in Sandia Canyon), PM-4 (located to the south in Cañada del Buey), and PM-5 (located on Mesita del Buey just west of Lower Mortandad/Cedro Canyons Aggregate Area) and by borehole EGH-LA-1 (located in Mortandad Canyon). Based on borehole lithological and geophysical logs, Purtymun (1995, 045344, p. 4) informally divided the Santa Fe Group into three formations, which include (in ascending order) the Tesuque Formation, the Chamita Formation, and a coarse-grained upper facies.

Tesuque Formation

In PM-4, the Tesuque Formation consists of poorly consolidated, light pinkish-brown, silty sandstone, siltstone, and claystone (Purtymun 1967, 011829). The sandstones are predominately fine-to-medium-grained, and the sand grains are subrounded to well-rounded. Although not described in the Mortandad Canyon area, the Tesuque Formation also contains subordinate gravel and cobble layers in boreholes for wells located in other parts of the Pajarito Plateau.

Chamita Formation

The Chamita Formation is similar in appearance to the Tesuque Formation, but the former reportedly contains a larger proportion of volcanic and granitic clasts in its gravel layers (Galusha and Blick 1971, 021526) and Paleozoic limestone cobbles in its conglomerate layers (Dethier and Manley 1985, 021506). The Chamita Formation contains lithologically distinct quartzitic gravels (Galusha and Blick 1971, 021526).

The Chamita Formation is 80 ft thick in PM-5 but is absent in PM-3 (Purtymun 1995, 045344). It is similar in appearance to the Tesuque Formation but reportedly contains a larger proportion of volcanic and granitic clasts in its gravel layers (Galusha and Blick 1971, 021526) and Paleozoic limestone cobbles in its conglomerate layers (Dethier and Manley 1985, 021506). The Chamita Formation contains lithologically distinct quartzitic gravels (Galusha and Blick 1971, 021526, p. 71). Upper layers of the Chamita Formation may contain cobbles of Jemez volcanic rocks, primarily andesites and dacites. However, because of similarities of appearance, obvious time overlaps, and interfingering relations, differentiation of the Chamita Formation from Tesuque Formation deposits is often difficult, particularly in borehole investigations.

Coarse-Grained Upper Facies of the Santa Fe Group

The coarse-grained upper facies of the Santa Fe Group is composed of a mixture of volcanic debris from the Sierra de los Valles and arkosic and granitic debris from the highlands to the north and east of the Pajarito Plateau. This distinctive group of coarse-grained sediment at the top of the Santa Fe Group is the “Chaquehui Formation” (Purtymun 1995, 045344, p. 6). The name “Chaquehui Formation” as related to Santa Fe Group sediment is a potentially confusing designation because the type section of the “Chaquehui Formation” in Chaquehui Canyon is much younger than the coarse-grained upper facies of the Santa Fe Group identified in boreholes on the Pajarito Plateau. The Chaquehui Formation constitutes quartzite clast-bearing maar deposits of the Cerros del Rio volcanic field. In PM-3, the upper coarse-grained facies consists of medium- to coarse-grained sandstone, conglomerate, and siltstone (Purtymun 1967, 011829, p. 9). Because of the high-permeability characteristics of this facies, it is an important aquifer zone for the development of high-yield, low-drawdown municipal and industrial water-supply wells on the Pajarito Plateau.

All the deep boreholes in the Mortandad Canyon area encountered basaltic lava flows interbedded with the sedimentary deposits of the upper Santa Fe Group. These basalts range in thickness from 30 ft to 480 ft (9.1 m to 146 m). They generally are described as dark gray and dense, but red vesicular zones are also present (Cooper et al. 1965, 008582, p. 60; Purtymun 1967, 011829, p. 9; Purtymun 1995, 045344, p. 263).

3.2.1.2 Puye Formation, Tschicoma Formation, and Cerros del Rio Basalts

The Puye Formation is a fanglomerate deposit generally consisting of poorly sorted boulders, cobbles, and coarse sands. At PM-3, the clasts are composed of latite, rhyolite, and fragments of basalt and pumice (Purtymun 1967, 011829, p. 8). In TW-8, the fanglomerate consists predominately of fine- to coarse-grained sands and interbedded clay, silt, and gravel (Baltz et al. 1963, 008402). The lower fanglomerate includes more than 95 ft (29 m) of light tan to light gray tuff and tuffaceous sand. Confined groundwater representing the top of the regional aquifer was found in these tuffs and tuffaceous sands between the depths of 985 and 990 ft below ground surface (bgs) during drilling of the borehole for TW-8 (Balz et al. 1963, 008402). The water rose in the borehole to the depth of 962.3 ft bgs, which indicates confined conditions. The nature of the confining beds could not be determined from drill cuttings, but Balz et al. (1963, 008402) believe the beds were clay.

In TW-8, a sequence of brown and gray basaltic lava flows split the fanglomerate into the main lower part and a thin upper part (Balz et al. 1963, 008402). Similar basalts were penetrated in the Puye Formation by other deep boreholes in the area. These basalts are stratigraphically equivalent to the basaltic rocks of the Cerros del Rio volcanic field, and they probably represent an extension of that volcanic field beneath the Pajarito Plateau. Dacite, presumably representing the distal edge of a Tschicoma Formation lava flow, was found in the upper part of the fanglomerate in borehole SHB-1 (located west of TA-55). Similar dacite flows may underlie the headwaters of Mortandad Canyon.

The lower Puye Formation includes coarse sand and boulder deposits interpreted to represent an axial facies deposit of the ancestral Rio Grande as described by Manley (1976, 057673) and Dethier (1997, 049843). The axial facies deposit was previously (informally) called the “Totavi Lentil” (Griggs and Hem 1964, 092516). At PM-3, this deposit is composed of gravel and boulders of dacite, rhyolite, and quartzite (Purtymun 1967, 011829, p. 9). The thickness of the axial facies deposit varies from 40 ft at PM-4 to 70 ft at PM-5 (Purtymun 1995, 045344, pp. 275–277). The axial facies deposit interfingers with the fanglomerates of the Puye Formation and basaltic rocks of the Cerros del Rio volcanic field in White Rock Canyon.

3.2.1.3 Otowi Member of the Bandelier Tuff

The Otowi Member is a nonwelded, poorly consolidated ignimbrite sheet composed of stacked ash-flow units. These units are composed of pumice lapilli supported by a matrix of ash and crystal fragments. The Otowi Member varies in reported thickness from 184 ft in borehole SHB-1 to 465 ft in borehole EGH-LA-1. The deposits of the Otowi Member beneath middle Mortandad Canyon (near TW-8 and EGH-LA-1) are among the thickest on the Pajarito Plateau from deposition in a pre-Bandelier Tuff paleovalley (see Figure 5 in Broxton and Reneau 1996, 055429, p. 330). The Otowi Member thins eastward against a north-trending basaltic highland that crosses Mortandad Canyon near NM 4. The Otowi Member is absent in lower Mortandad Canyon where it either was not deposited or was removed by erosion before the Tshirege Member was deposited.

The basal part of the Otowi Member includes the Guaje Pumice Bed, a sequence of well-stratified pumice-fall and ash-fall deposits. The Guaje Pumice Bed typically is 30 ft to 35 ft thick beneath middle and upper Mortandad Canyon (Purtymun 1995, 045344).

3.2.1.4 Tephra and Volcaniclastic Sediment of the Cerro Toledo Interval

Tephra and volcaniclastic sediment of the Cerro Toledo interval are an informal name given to a complex sequence of epiclastic sediment and tephra of mixed provenance (Broxton and Reneau 1995, 049726, p. 11). This unit includes well-stratified tuffaceous sandstones and siltstones, primary ash-fall and pumice-fall deposits, and dacite-rich gravel and boulder deposits. The Cerro Toledo deposits, which vary in thickness from 0 to more than 100 ft (30 m), were deposited partly in erosional channels developed on top of the Otowi Member before deposition of the Tshirege Member and partly on paleotopographic drainage divides. Erosion of the Cerro Toledo interval may have occurred in places before deposition of the Tshirege Qbt 1 unit, which created locally variable thickness. The Cerro Toledo interval is approximately 140 ft thick in borehole SHB-1 (Gardner et al. 1993, 012582, p. 9) and approximately 80 ft (24 m) thick in borehole 35-2028 located in Ten Site Canyon (Laughlin et al. 1993, 054424, p. 2-3).

3.2.1.5 Tshirege Member of the Bandelier Tuff

The Tshirege Member is a multiple-flow ignimbrite sheet that underlies the alluvium on the floor of upper and middle Mortandad Canyon and forms the prominent cliffs and mesas next to the canyon. The Tshirege Member includes a number of subunits that can be recognized based on differences in physical and weathering properties. This work plan follows the nomenclature of Broxton and Reneau (1995, 049726, p. 8), which was adopted for use as a standard by the former ER Project. Both Purtymun and Kennedy (1971, 004798) and Rogers (1995, 054419) applied different systems of stratigraphic nomenclature to subunits of the Tshirege Member.

Tsankawi Pumice Bed

The Tsankawi Pumice Bed (Qbtt) is the basal pumice outfall deposit of the Tshirege Member. The pumice bed is typically 1 to 3 ft thick in this part of the Laboratory. It is composed of angular to subangular clast-supported pumice lapilli up to 2.4 in. in diameter. Qbtt is exposed at the surface in areas of Mortandad Canyon east of NM 4.

Tshirege Member Unit 1g

Tshirege Member unit 1g (Qbt 1g) is the lowermost unit in the thick ignimbrite sheet that makes up most of the Tshirege Member. Qbt 1g is a porous, nonwelded, poorly sorted, vitric ignimbrite. It is poorly indurated but nonetheless forms steep cliffs because a resistant bench near the top of the unit forms a protective cap over the softer underlying tuff. Qbt 1g underlies the broad canyon floor west of the sediment traps and forms the lower parts of cliff walls in the middle and upper sections of lower Mortandad Canyon.

Tshirege Member Unit 1v

Tshirege Member unit 1v (Qbt 1v) is a series of cliff- and slope-forming outcrops composed of porous, nonwelded, devitrified ignimbrite. The base of the unit is a thin, horizontal zone of preferential weathering that marks the abrupt transition from vitric tuffs below to devitrified tuffs above. This feature forms a mappable marker horizon on canyon walls in portions of upper and middle Mortandad Canyon. The lower part of Qbt 1v is a resistant orange-brown colonnade tuff (Qbt 1v-c) that forms a distinctive low cliff characterized by columnar jointing. The colonnade tuff is overlain by a distinctive white band of slope-forming tuffs. Qbt 1v is exposed in canyon walls in middle and lower Mortandad Canyon and subcrops beneath the canyon floor west of TW-8.

Tshirege Member Unit 2

Unit 2 of the Tshirege Member of the Bandelier Tuff (Qbt 2) forms a distinctive, medium-brown, vertical, cliff-forming unit that stands out in marked contrast to the slope-forming, lighter colored tuffs above and below. This unit is devitrified, is relatively highly welded, forms the steep, narrow canyon walls of middle and upper Mortandad Canyon, and underlies the canyon floor at the head of Mortandad Canyon. Qbt 2 forms a resistant caprock on mesa tops in lower Mortandad Canyon.

Tshirege Member Unit 3

Unit 3 of the Tshirege Member of the Bandelier Tuff (Qbt 3) is a nonwelded to partially welded, devitrified ignimbrite. The basal part of Qbt 3 consists of a soft, nonwelded tuff that forms a broad, gently sloping bench on the top of Qbt 2 in canyon wall exposures and on the broad canyon floor in upper Mortandad Canyon. The upper part of Qbt 3 is a partially welded tuff that forms the caprock on mesas next to upper and middle Mortandad Canyon.

Tshirege Member Unit 4

Unit 4 of the Tshirege Member of the Bandelier Tuff (Qbt 4) is a partially to densely welded ignimbrite characterized by small, sparse pumices and numerous intercalated surge deposits. Qbt 4 is exposed on the mesa tops in the western part of upper Mortandad Canyon.

3.2.1.6 Alluvium

Alluvium of Pleistocene and Holocene age rests unconformably on the Bandelier Tuff in Mortandad Canyon west of NM 4. The alluvium consists mostly of detritus eroded from the Tshirege Member of the Bandelier Tuff, which forms the steep walls of the canyon. The alluvium also contains sediment derived from eolian sources and fallout pumice deposits. In the upper canyon, the alluvium is thin and consists of boulders, cobbles, and pebbles of tuff intermixed with sand, silt, and clay. The sand consists mainly of fine- to coarse-grained crystals of quartz and sanidine and is relatively thin, ranging from a few inches up to about 18 ft.

In middle and lower Mortandad Canyon, the alluvium generally consists of finer-grained materials, including sand, silt, and clay. The alluvium is significantly thicker and wider in this part of the canyon, ranging from 18 ft to about 60 ft.

3.2.2 Hydrogeology

The hydrogeology of the Pajarito Plateau is generally separable in terms of mesas and canyons forming the plateau. Mesas are generally devoid of water, both on the surface and within the rock forming the mesa. Canyons range from wet to relatively dry; the wettest canyons contain continuous streams and contain perennial groundwater in the canyon-bottom alluvium. Dry canyons have only occasional stream flow and may lack alluvial groundwater. Intermediate-perched groundwater has been found at certain locations on the plateau at depths ranging between 100 and 400 ft. The regional aquifer is found at depths of about 600 to 1200 ft.

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

3.2.2.1 Groundwater

In the Los Alamos area, groundwater occurs as (1) water in shallow alluvium in some of the larger canyons, (2) intermediate-perched groundwater (a perched groundwater body lies above a less permeable layer and is separated from the underlying aquifer by an unsaturated zone), and (3) the regional aquifer. Numerous wells have been installed at the Laboratory and in the surrounding area to investigate the presence of groundwater in these zones and to monitor groundwater quality.

Alluvial Groundwater

Intermittent and ephemeral stream flows in the canyons of the Pajarito Plateau have deposited alluvium that can be as thick as 100 ft. The alluvium in canyons of the Jemez Mountains is generally composed of sand, gravel, pebbles, cobbles, and boulders derived from the Tschicoma Formation and Bandelier Tuff. The alluvium in canyons is finer grained, consisting of clay, silt, sand, and gravel derived from the Bandelier Tuff.

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

The downgradient extent of alluvial saturation in Mortandad Canyon is about 2300 ft below the confluence of Mortandad and Ten Site Canyons (LANL 2006, 094161, p. 60). The Lower Mortandad/Cedro Canyons Aggregate Area sites addressed in this work plan are located in TA-05 approximately 0.25 mi south of the confluence of Mortandad and Ten Site Canyons. Thus, alluvial groundwater is present in Ten Site Canyon to the north of the investigation sites. The unnamed canyon to the south of the investigation sites, the canyon receiving runoff from these sites, is a small tributary to Mortandad Canyon. This tributary does not join Mortandad Canyon until approximately 1 mi below the extent of alluvial saturation. Given the small drainage area of the tributary canyon and the absence of active outfalls, alluvial groundwater is not expected to the south of the investigation sites.

Perched-Intermediate Waters

Perched-intermediate waters are infrequently encountered on the Pajarito Plateau. Perched-intermediate waters are thought to form mainly at horizons where medium properties change dramatically, such as at paleosol horizons containing clay or caliche. It is not known whether perched-intermediate water bodies are isolated or connected and to what degree they may influence travel times and pathways for contaminants in the vadose zone.

Two known locations of perched-intermediate groundwater have been identified in the vicinity of TA-05. One occurs near the confluence Mortandad and Ten Site Canyons. At this location, a thin zone of saturation is found at a depth of approximately 520 ft at the top of the Cerros del Rio basalts. The other location is in Mortandad Canyon approximately 1150 ft east of the confluence with Ten Site Canyon. Perched water is encountered at this location in the lower part of the Cerros del Rio basalts at depths ranging from about 646 to 729 ft (LANL 2006, 094161, pp. 64–65).

Regional Groundwater

The regional aquifer is the only aquifer capable of large-scale municipal water supply in the Los Alamos area (Purtymun 1984, 006513). The surface of the regional aquifer rises westward from the Rio Grande within the Santa Fe Group into the lower part of the Puye Formation beneath the central and western part of the Pajarito Plateau. The depths to the regional aquifer below the mesa tops range between about 1200 ft along the western margin of the plateau and about 600 ft at the eastern margin. The location of wells and generalized water-level contours on top of the regional aquifer are described in the annual General Facility Information report (LANL 2008, 101932). The regional aquifer is typically separated from the alluvial groundwater and intermediate-perched zone groundwater by 350 to 620 ft of tuff, basalt, and sediments (LANL 1993, 023249).

The regional aquifer is a complex, heterogeneous system that includes confined and unconfined zones. The degree of hydraulic communication between these zones is thought to be spatially variable. The shallow portion of the regional aquifer (near the water table) is predominantly under phreatic (unconfined) conditions and has limited thickness (approximately 30 to 50 m [98 to 164 ft]). Groundwater flow and contaminant transport directions in this zone generally follow the gradient of the regional water table; the flow is generally east/southeastward. The direction and gradient of flow at the regional water table are predominantly controlled by areas of recharge (e.g., the Sierra de los Valles and variably within some Pajarito Plateau canyons) and discharge (White Rock Canyon springs and the Rio Grande). The deep portion of the regional aquifer is predominantly under confined conditions, and it is stressed by Pajarito Plateau water-supply pumping. The pumping probably has a small impact on the flow directions in the phreatic zone because of poor hydraulic communication (LANL 2007, 098938, p. 7).

Regional well R-14 is located in Ten Site Canyon, approximately one-half mile west of the investigation sites. The depth to the regional aquifer at this location is approximately 1200 ft. Supply well PM-5 is located on Mesita del Buey just west of the investigation sites, and the depth to the regional aquifer at this location is at least 1200 ft (LANL 2008, 102187, p. 38).

4.0 SITE DESCRIPTIONS AND PROPOSED INVESTIGATION ACTIVITIES

The following sections present site descriptions, summaries of previous investigation activities, and proposed sampling activities. Table 4.0-1 summarizes the investigation strategy for each SWMU and identifies analytical methods for the site characterization activities proposed in this work plan.

Several of the sites in the Lower Mortandad/Cedro Canyons Aggregate Area were previously investigated during a RFI and/or other previous corrective actions. The decision-level data for these sites were evaluated to determine whether nature and extent had been defined. At some sites, RFI samples were collected at only one depth at each location. For these sites, vertical extent is not defined, and additional samples will be collected at deeper depths from the RFI sampling locations and additional locations. Lateral extent was evaluated based on frequency of detection and decreasing concentration trends with distance from contaminant sources. At sites where lateral extent is not defined, step-out samples are proposed at greater distances from source areas than the original RFI samples. The number of samples and step-out distances were selected based on the spatial distribution of contaminants detected in the RFI samples.

For most sites, the proposed analytical suites are expanded beyond those in the RFI. The RFI utilized limited analysis of organic chemicals; therefore, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and explosive compounds have been added for most sites. Anion analysis (i.e., cyanide, nitrate, and perchlorate) was not performed during the RFI, and these analytes have been added to those sites where they may have potentially been used or disposed of in the past. RFI samples were generally analyzed for metals and all proposed samples will be analyzed for target analyte list (TAL) metals. Although there is no documented use of polychlorinated biphenyls (PCBs) at the sites being investigated, 20% of samples collected will be submitted for PCB analysis. Similarly, analysis for dioxins and furans will be performed on 20% of the samples at a site where a former structure was destroyed by burning.

Samples collected during previous investigations and corrective actions and analyses requested are presented in Table 4.0-2. Decision-level data for inorganic chemicals, organic chemicals, and radionuclides are presented in Tables 4.0-3, 4.0-4, and 4.0-5, respectively. All laboratory analytical data (both decision-level and screening-level) are also provided in Appendix B of the HIR (LANL 2009, 107102). Figures 4.1-1 to 4.3-5 present base maps; maps showing inorganic chemicals detected above BVs, detected organic chemicals, and radionuclides detected or detected above BVs/FVs; and maps showing the proposed sampling locations.

4.1 SWMU 05-003, Former Calibration Chamber

4.1.1 Site Description

SWMU 05-003 is a former underground calibration chamber (structure 05-21) located at the west end of TA-05 near the edge of Mortandad Canyon (Figure 4.1-1). The construction of the 7-ft × 7-ft chamber was completed in 1959, and the chamber was used to calibrate neutron detector systems for experiments at TA-49. The approximate dimensions and layout of the facility have been obtained through interviews with people who worked on the project, personal logs, and site inspections (Pratt 1995, 091206; Koch 1995, 091204) as well as historical drawings. The facility consisted of a 6-ft-diameter, 35-ft-deep shaft with an approximately 7-ft cubical room located at the base of the shaft, to the west. The shaft and room were connected by an 8-ft-tall, 9.5-ft-long tunnel. The connecting tunnel may have had a downward slope toward the room. A ladder was attached to the 6-ft-diameter shaft to access the underground chamber. A second 24-in.-diameter shaft extended from the center of the room to the surface. The shafts were separated by 15 ft (center to center). The smaller shaft was lined with a 16-in.-diameter casing and capped with concrete, with a 3-in.-diameter opening in the concrete cap. This shaft was used to direct neutrons from the underground chamber to detectors located above the shaft. The floor of the tunnel and chamber may have been covered with wood planking. An 8-ft × 12-ft × 8-ft-high wooden building (structure 05-20) was constructed at the surface over the large shaft.

The neutron source used in the calibration facility was a critical assembly called Godiva. This assembly used highly enriched uranium (HEU) and was operated in the underground chamber beneath the smaller shaft. Neutron detectors were placed on the ground surface above the opening in the small shaft. The Godiva assembly could be pulsed every 2 h and produced 2×10^{16} fissions per pulse. Small amounts of HEU would spall off the source with each pulse (Pratt 1995, 091206). Borated paraffin and lead bricks were used as shielding and heavy water was used to moderate the energy and intensity of the neutrons.

The Godiva assembly was installed in the underground chamber on November 16, 1959 (Pratt 1995, 091206). TA-05 was officially abandoned on December 18, 1959 (Montoya 1976, 004547), and the Godiva assembly is presumed to have been removed at that time. During a radiation survey of TA-05 in 1973, structure 05-20 was noted to be locked and could not be entered (Martin 1973, 004544). A subsequent inspection in January 1974 noted there was a hole in the side of the building and that the door was unlocked. Because of safety concerns, a cover was placed over the shaft (Bacastow 1974, 000756). A radiation survey of structure 05-20 was conducted in May 1976 to prepare for removing the remaining structures from TA-05. This survey showed no detectable radioactivity (Blackwell 1976, 004546). The structures were removed sometime around 1976, and the shaft is presumed to have been backfilled at that time. Although the 1992 RFI work plan for Operable Unit 1129 indicates that the lead shielding bricks had not been removed before backfilling (LANL 1992, 007666, p. 3-16), a subsequent review of records and interviews with former site staff concluded that the lead bricks were removed before the shaft was backfilled (Pratt 1995, 091206).

The corrugated metal pipe (CMP) liner for the large shaft is still present at the site and extends approximately 2.5 ft above the ground surface. The inside of the CMP contains backfill and some vegetation is presently growing in the backfill. An 8.75-ft × 12.5-ft concrete pad extends around the CMP. Currently, there is no evidence of the smaller shaft.

4.1.2 Previous Investigations

In 1995, an engineering survey was conducted at the site of the former calibration chamber to locate the 24-in.-diameter shaft that was reported to be present at the site. This shaft was found 15 ft west of the 6-ft-diameter shaft. An 8.75- × 12.25-ft concrete pad was present around the 6-ft-diameter shaft and a smaller 1.5- × 5-ft concrete pad was located just north of the 24-in.-diameter shaft (Koch 1995, 091204). The larger pad was presumably the foundation for structure 05-20. The site was surveyed for potential high explosives (HE) materials in May 1995. Fragments of white material were found near the shaft but were determined to be paraffin rather than HE (Koch 1995, 048943.21).

No previous sampling has been performed at SWMU 05-003, and there are no analytical data for this site.

4.1.3 Proposed Activities

The nature and extent of contaminant releases from this site have not been determined. The potential source of contamination is the former calibration chamber that housed the critical assembly used to generate neutrons. To determine whether releases from the chamber have occurred, two boreholes will be drilled on the downgradient side of the chamber (Figure 4.1-2). The boreholes will be advanced to a total depth of 56 ft bgs, and samples will be collected at intervals of 5–6 ft, 15–16 ft, 25–26 ft, 35–36 ft, 45–46 ft, and 55–56 ft bgs. If the results of field screening indicate the presence of contamination in the deepest sample, the borehole depth will be extended by 10-ft intervals until contamination is no longer detected. Based on the materials used at this site (metals and uranium) and potentially produced during operation (activation products), all samples will be analyzed for TAL metals, perchlorate, isotopic uranium, and gamma-emitting radionuclides. Table 4.0-1 summarizes the proposed sampling locations, depths, and analytical suites.

4.2 SWMU 05-004, Former Septic Tank

4.2.1 Site Description

SWMU 05-004 is a former septic tank (structure 05-13), associated drainlines, and outfall that were located at the west end of TA-05 near the edge of Mortandad Canyon (Figure 4.1-1). From 1948 to 1949, the tank received industrial waste from a laboratory (building 05-1). The tank was constructed in May 1948 and abandoned in place in December 1959 (LANL 1992, 007666, p. 3-14). It was constructed of reinforced concrete and was 5 ft × 5 ft × 7 ft deep (LANL 1990, 007511). As-built drawings show the presence of an inlet line running from building 05-1 to the septic tank and an outlet line discharging south into an unnamed tributary of Mortandad Canyon. Historical information shows the tank was free of radiation and HE contamination but notes it contained unspecified toxic chemicals (LANL 1990, 007511). A 1952 memorandum states that septic tank 05-13 was no longer needed to support use of building 05-1 and the structure was being returned to Engineering Division for disposition (Vogt 1952, 004379). A 1959 memorandum states that the tank had been monitored for radioactivity, and no radioactivity above background was found (Blackwell 1959, 000761). A site inspection conducted in January 1974 identified the septic tank as an open concrete pit, at least 3 ft deep, and having a 3-ft × 3-ft opening with a rotted wooden cover. The wooden cover was replaced with a metal grating cover (Bacastow 1974, 000756). Notes from a radiation survey conducted at TA-05 during May 1976 describe structure 05-13 as “an acid septic tank filled with liquid” (Blackwell 1976, 004546).

The types of materials used in building 05-1 are not known. Building 05-1 was inspected in 1959 and found to be free of contamination by toxic materials (Schulte 1959, 000894). A radiation survey of building 05-1 in 1973 detected no radioactive contamination (Martin 1973, 004544). During LASCP activities conducted in 1985, building 05-1 was determined to be free of radioactive and HE contamination and was removed. The 1985 LASCP investigation confirmed removal of the tank and piping, and no evidence of radioactively contaminated soil was detected at that time (NUS Corporation 1990, 012571, p. 3-10). A 1988 survey detected gamma activity slightly above-background. Notes taken during this survey described evidence of an outfall near the former location of structure 05-13. A site inspection conducted in December 1994 noted the location of an approximately 2-ft-wide × 1-ft-deep outfall trench cut into the tuff. The trench, which was filled with plant debris, flowed to the south onto a natural bedrock rill/gully to the canyon (Koch 1994, 048943.12). This trench presumably contained the discharge drainline that was removed.

The site currently contains no evidence of the tank or drainline. The outfall trench previously noted at the site was located at the edge of the mesa. No evidence of significant erosion or runoff from the site was found, and stormwater best management practices (BMPs), including straw wattles, are in place above and downslope of the site.

4.2.2 Previous Investigations

A radiation grid survey of the site was performed in October 1994. Radiation measurements were obtained from 84 grid locations spaced at approximately 10-ft intervals located at SWMUs 05-003 and

05-004. Beta/gamma radiation measurements were within background levels. Phase I sampling was performed in June 1995. Three surface samples (0 to 0.5 ft) were collected, two hand-auger holes were drilled to a depth of 3 ft, and one borehole was drilled to a depth of 15 ft. The hand-auger and surface samples were collected in the outfall trench between the septic tank location and the edge of the canyon. Three samples were collected from each hand-augered hole at depth intervals of 0 to 1 ft, 1 to 2 ft, and 2 to 3 ft. The borehole was drilled at the former location of the septic tank. Three samples were collected from the borehole at depth intervals of the 3.5 to 4.5 ft, 8.8 to 9.8 ft, and 14 to 15 ft. All samples were submitted for laboratory analysis of isotopic plutonium and isotopic uranium. One sample from one hand-augered hole was also submitted for laboratory analysis of SVOCs, and one sample from another hand-augered hole was submitted for laboratory analysis of VOCs, gross-alpha, gross-beta, and gamma-emitting radionuclides. One sample from the 15-ft borehole was also submitted for laboratory analysis of metals, and one of the surface samples was submitted for analysis of HE. The samples collected in 1995 and the analyses requested are presented in Table 4.0-2, and sampling locations are shown in Figure 4.1-1.

Decision-level data from the 1995 RFI are presented in Tables 4.0-4 and 4.0-5. Sampling locations and results for organic chemicals detected and radionuclides detected or detected above BVs/FVs are shown in Figures 4.2-1 and 4.2-2, respectively.

No metals were detected above BV or had detection limits above BV during the 1995 RFI. Benzoic acid, the only organic chemical detected, was detected in one sample at 0.61 mg/kg. Plutonium-239/240, the only radionuclide detected, was detected at 0.098 pCi/g in one subsurface sample.

A second sampling event was conducted at this site in 1998. A deeper borehole was advanced at the location of the former septic tank and 11 samples were collected at 1-ft intervals from 14 ft to 25 ft. Additional samples were collected downslope of the outfall. Surface samples (0 to 0.5 ft) were collected at five locations and subsurface samples (0.5 to 1.0 ft) were collected at three of these locations. All samples were submitted for laboratory analysis of metals, SVOCs, and HE. The samples collected in 1998 and the analyses requested are presented in Table 4.0-2, and sampling locations are shown in Figure 4.1-1.

Decision-level data from the 1998 RFI are presented in Table 4.0-3. No metals were detected above BV during the 1998 sampling. Mercury had detection limits above the BVs for two soil samples and one sediment sample. Selenium had detection limits above the BV in two sediment samples.

No organic chemicals were detected and no samples were analyzed for radionuclides.

4.2.3 Proposed Activities

Although the results of the sampling previously conducted at this site showed very limited detections of potential contaminants, these results are not sufficient to define the nature and extent of contamination. The analytical suites used in the previous investigation were very limited, and reconnaissance of the site during preparation of this work plan indicated some of the previously collected samples may not have been optimally located. Therefore, additional sampling with an expanded analytical suite is needed to determine nature and extent of contamination.

The proposed investigation approach includes

- resampling RFI locations, including collecting samples at greater depths to define vertical extent, and analyzing these samples with an expanded analytical suite and
- collecting samples at new locations in the drainage downslope of the outfall to define lateral extent.

The proposed sampling locations are shown in Figure 4.1.2.

Previous locations that will be resampled are

- location 05-02001 at the former septic tank;
- locations 05-02002, 05-02003, and 05-02005 along the outfall trench and at the outfall; and
- location 05-02089 downslope of the outfall.

Because samples were not collected along the inlet drainline between building 05-1 and the septic tank during the previous investigation, three locations will be sampled along this former drainline: one at the point the drainline exited building 05-1, one along the drainline, and one at the inlet to the former septic tank (Figure 4.1-2). The depth of the former drainline is not known but is assumed to be no greater than 3 ft bgs. Therefore, samples will be collected at depth intervals of 3–4 ft and 5–6 ft bgs.

At location 05-02001, a new borehole will be advanced to 25 ft bgs, and samples will be collected at depth intervals of 5–6 ft, 9–10 ft, 14–15 ft, 19–20 ft, and 24–25 ft bgs. If the results of field screening indicate the presence of contamination in the deepest sample, the borehole depth will be extended by 5-ft intervals until contamination is no longer detected. The three locations along the outfall trench and at the outfall will be sampled at 3–4 ft and 5–6 ft bgs, which is deeper than previously sampled (maximum depth 2–3 ft bgs). At location 05-02089 downslope of the outfall, samples will be collected at the surface (0–1 ft), at the soil/tuff interface, and 1 ft into the tuff.

To ensure extent is defined, additional samples will be collected in the drainage downstream of the outfall at four new locations near previous location 05-02089, which was the farthest downstream location. Two new locations will be sampled upstream of location 05-02089, and two new locations will be sampled downstream of 05-02089 (Figure 4.1-2). At each location, samples will be collected at the surface (0–1 ft), at the soil-tuff interface, and 1 ft into the tuff.

The analytical suite will be expanded from that previously used because the materials used at building 05-1 are not known. The expanded suite will also include contaminants generally associated with septic systems. All samples will be analyzed for TAL metals, cyanide, nitrate, perchlorate, SVOCs, explosive compounds, and isotopic uranium (Table 4.0-1). All samples will also be analyzed for isotopic plutonium because of the previous detection of plutonium-239/240. All subsurface samples will be analyzed for VOCs. In addition, 20% of the samples will be analyzed for PCBs. The samples for PCB analysis will be biased towards locations near the potential source (i.e., near the septic tank and outfall), and locations farthest downgradient to define extent. Table 4.0-1 summarizes the proposed sampling locations, depths, and analytical suites.

4.3 Consolidated Unit 05-005(b)-00

Consolidated Unit 05-005(b)-00 consists of SWMU 05-005(b), a former outfall, and SWMU 05-006(c), an area of potential soil contamination associated with a former building. Because these sites are collocated it is more efficient to investigate them as a consolidated unit rather than as discrete areas. The description and past investigation of each site is discussed separately, but the proposed investigation addresses both sites together.

4.3.1 SWMU 05-005(b), Former Outfall

4.3.1.1 Site Description

SWMU 05-005(b) is an area of potentially contaminated soil associated with a former outfall located at the edge of Mortandad Canyon (Figure 4.3-1). The outfall, which is associated with building 05-5, was identified during a 1987 ER Project site reconnaissance (LANL 1992, 007666, p. 3-17). The outfall was located on the edge of the canyon, approximately 80 ft south of building 05-5. This building, which is associated with SWMU 05-006(c), was used as a shop, a calibration facility, and a photographic darkroom. The building was used as a darkroom from 1944 to 1947 to process photographs of experiments conducted at the TA-05 firing sites. In 1952, building 05-5 was used to calibrate high-range radiation meters. The building was operational from about 1944 to 1959, and was destroyed by burning in May 1960 (Wingfield 1960, 029398). The outfall is believed to have also operated from 1944 to 1959.

The site currently contains no evidence of the outfall. A capped pipe is present at the ground surface at the former location of building 05-5. This pipe may have been the drainline from the building. A drainage channel that collects most of the runoff from the site is present at the edge of the mesa. No evidence of significant erosion or runoff from the site was found, and stormwater BMPs, including straw wattles, are in place above and downslope of the site.

4.3.1.2 Previous Investigations

A Phase I RFI was conducted at SWMU 05-005(b) in 1994 and 1995. Preliminary RFI activities included an interview with a former Beta Site supervisor and engineering surveys to identify sampling locations. The engineering surveys consisted of reviews of archival aerial photos and engineering drawings, site environmental surveys, and site visits and walkovers to locate the former building and site features. The location of the outfall was surveyed for potential HE contamination in May 1995, and no contamination was found (Koch 1995, 048943.21). A radiation grid survey was performed on July 7, 1995. The radiation grid covered an area of approximately 70 ft × 120 ft and provided contiguous coverage of SWMUs 05-005(b) and 05-006(c). The radiation grid locations were spaced at 20-ft intervals. Beta/gamma radiation measurements were within background levels.

Phase I RFI sampling was performed in July 1995. Nine soil and tuff samples were collected from three locations at and below the outfall. At each location, samples were collected from depth intervals of 0 to 1 ft, 1 to 2 ft, and 2 to 3 ft. All samples were submitted for laboratory analysis of metals, isotopic uranium, and isotopic plutonium. One sample was also submitted for laboratory analysis of HE and another sample for laboratory analysis of SVOCs. The samples collected in 1995 and the analyses requested are presented in Table 4.0-2, and the sampling locations are shown in Figure 4.3-1.

Decision-level data from the 1995 RFI are presented in Tables 4.0-3, 4.0-4 and 4.0-5. The sampling locations and the results for inorganic chemicals detected above BVs, organic chemicals detected, and radionuclides detected or detected above BVs/FVs are shown in Figures 4.3-2, 4.3-3, and 4.3-4, respectively.

Metals detected above BVs in the 1995 sampling were chromium and nickel, each detected above its BV in four tuff samples with maximum concentrations 6 and 4 times the BVs, respectively. Antimony and selenium had detection limits above the tuff BV. Bis(2-ethylhexyl)phthalate, the only organic chemical detected, was detected in one sample at 0.29 mg/kg. Plutonium-238, the only radionuclide detected or detected above BV/FV, was detected at 0.0225 pCi/g in one sample.

4.3.2 SWMU 05-006(c), Area of Potential Soil Contamination

4.3.2.1 Site Description

SWMU 05-006(c) is an area of potentially contaminated soil associated with the location of a former shop and darkroom, building 05-5 (Figure 4.3-1). The shop was 16 ft × 16 ft and the darkroom was 9 ft × 6 ft (LANL 1990, 007511). The building was operational from about 1944 to 1959. The structure was originally used to support firing site activities, including processing photographs of experiments conducted at the firing sites. In 1952, J Division temporarily used the building to calibrate high-range meters (LANL 1992, 007666, p. 3-12). A 1959 memorandum indicates this structure was contaminated with HE (Penland 1959, 000806). This site is one of several areas of potential soil contamination at TA-05 identified during surveys conducted in 1958, 1959, and 1985. Potential soil contamination at these sites was reported to include HE and uranium. A 1959 list generated by the Laboratory’s H-3 Group listed building 05-5 as an HE-contaminated structure. Building 05-5 was destroyed by burning on March 5, 1960 (Wingfield 1960, 029398).

Cleanup of the site of the former building was included in the 1985 LASCP. Surface debris, including wood, copper wire, scrap metal, and other building debris, was removed. No radioactive contamination was detected (NUS Corporation 1990, 012571). A mound of burned debris, including charred wood and melted glass, was noted to be present at the site during an inspection in September 1994 (Koch 1994, 048943.13).

Currently, a small amount of burned debris (charred wood, melted glass, and metal) is still present at the former location of building 05-5. Also present is a capped pipe at the ground surface. The site slopes to the south toward the edge of the mesa. No evidence of significant erosion or runoff from the site was found, and stormwater BMPs, including straw wattles, are in place above and downslope of the site.

4.3.2.2 Previous Investigations

A Phase I RFI was conducted at SWMU 05-006(c) in 1994 and 1995. Preliminary RFI activities included an interview with a former Beta Site supervisor and engineering surveys to identify sampling locations. The engineering surveys consisted of reviews of archival aerial photos and engineering drawings, site environmental surveys, site visits and walkovers to locate the former buildings, and the staking of sampling locations. The location of the outfall was surveyed for potential HE contamination in May 1995 and no contamination was found (Koch 1995, 048943.21). A radiation grid survey was performed on July 7, 1995, covering an area of approximately 70 ft × 120 ft, and provided contiguous coverage of SWMUs 05-005(b) and 05-006(c). The radiation grid locations were spaced at 20-ft intervals. Beta/gamma radiation measurements were within background levels.

Phase I RFI sampling was performed in July 1995. Thirteen soil and tuff samples were collected from seven locations. To characterize potential contamination from chemical disposal, nine soil and tuff samples were collected from three locations around three sides of the former building at areas where chemicals may have been poured on the ground. At each location, samples were collected from depth intervals of 0 to 1 ft, 1 to 2 ft, and 2 to 3 ft. All samples were submitted for laboratory analysis of metals, isotopic uranium, and isotopic plutonium. One sample was also submitted for analysis of gross-alpha and gross-beta radioactivity and gamma-emitting radionuclides. Four additional samples were collected to characterize potential contamination associated with the debris remaining from destruction of the building.

A surface (0 to 0.5 ft) soil or sediment sample was collected at each of four locations at and downslope of the debris pile. All samples were submitted for laboratory analysis of metals. No samples were analyzed for organic chemicals. The samples collected in 1995 and the analyses requested are presented in Table 4.0-2, and the sampling locations are shown in Figure 4.3-1.

Decision-level data from the 1995 RFI are presented in Table 4.0-3. Sampling locations and results for inorganic chemicals detected above BV are shown in Figure 4.3-2. No radionuclides were detected or detected above BVs or FVs.

Metals detected above BV in the 1995 sampling were antimony, arsenic, barium, cadmium, calcium, chromium, copper, iron, lead, nickel, selenium, silver, and zinc. Antimony, cadmium, and silver were each detected above their BVs for one soil sample with maximum concentrations 91, 13, and 21 times the BVs, respectively. Arsenic was detected slightly above the BV in one soil sample and slightly above the BV in one tuff sample. Barium was detected at less than 2 times the BV in one tuff sample, and calcium was detected at 2.5 times the BV in one tuff sample. Chromium was detected above the BV in six tuff samples with a maximum concentration 26 times the BV. Copper was detected above the BV in three soil samples with a maximum concentration 9 times the BV. Iron and selenium were each detected slightly above the BVs in one soil sample. Lead was detected above the BV in four soil samples and one tuff sample with a maximum concentration 1970 times the BV. Nickel was detected above the BV for two soil samples and five tuff samples with a maximum concentration 14 times the BV. Zinc was detected above the BV in three soil samples with a maximum concentration 6 times the BV. Mercury had detection limits above the soil BV in one sample.

4.3.3 Proposed Activities

The results of the sampling previously conducted at SWMUs 05-005(b) and 05-006(c) showed elevated levels of several metals in the vicinity of the former building and associated debris pile. Only one organic chemical was detected in one sample at SWMU 05-005(b), but only two samples were submitted for analysis of SVOCs. One radionuclide was detected in one sample at SWMU 05-005(b), with most samples submitted for radionuclide analysis.

Proposed sampling locations are shown in Figure 4.3-5. The proposed investigation approach includes

- Collecting samples within the footprint of the former building, which was not previously sampled;
- Collecting samples upslope of the former building to define lateral extent;
- Resampling locations around the former building and debris pile and below the outfall and analyzing these samples with an expanded analytical suite; and
- Collecting samples at new locations along the drainage in the canyon bottom below the outfall to define lateral extent.

Previous locations that will be resampled are

- locations 05-02039, 05-02040, and 05-02041 around the perimeter of the former building;
- location 05-02070 to the west of the former building;
- locations 05-02071 and 05-02072 to the east of the former building in the vicinity of the debris pile;
- locations 05-02042 and 05-02043 at and below the outfall on the mesa top; and
- Location 05-02044 below the outfall in the canyon bottom.

Before sampling is conducted, all remaining debris will be removed and soil beneath the debris pile will be surveyed using x-ray fluorescence (XRF). All soil containing metals above industrial SSLs will be removed and confirmation samples collected from removed soil areas.

Samples within the footprint of the former building, within the debris pile, around the building and debris pile, and at and below the outfall on the mesa top will be collected at depth intervals of 0–1 ft, 2–3 ft, and 5–6 ft bgs.

Samples will be collected from 0–1 ft at locations in the canyon bottom, at the soil/tuff interface, and 1 ft into the tuff.

The analytical suite will be expanded from that previously used to include contaminants generally associated with shops, darkrooms, and firing sites. All samples will be analyzed for TAL metals, cyanide, nitrate, perchlorate, VOCs, SVOCs, explosive compounds, and isotopic uranium. All samples will also be analyzed for isotopic plutonium because plutonium-238 had been detected previously. In addition, 20% of the samples will be analyzed for PCBs. The samples for PCB analysis will be biased towards locations near the potential source (i.e., near the former building) and farthest downgradient locations to define extent. Because building 05-5 was destroyed by burning, 20% of the samples will also be analyzed for dioxins and furans. The samples collected for dioxin and furan analysis will be biased towards locations near the building footprint, and farthest downgradient locations to define extent. Table 4.0-1 summarizes the proposed sampling locations, depths, and analytical suites.

5.0 INVESTIGATION METHODS

A summary of investigation methods to be implemented is presented in Table 5.0-1. The standard operating procedures (SOPs) used to implement these methods are available at http://www.lanl.gov/environment/all/qa.shtml.

Summaries of the field-investigation methods are provided below. Additional procedures may be added as necessary to describe and document quality-affecting activities.

Chemical analyses will be performed in accordance with the analytical statement of work (LANL 2000, 071233). Accredited contract analytical laboratories will use the most recent U.S. Environmental Protection Agency– (EPA-) and industry-accepted extraction and analytical methods for chemical analyses of analytical suites. The analytical methods for surface and subsurface characterization are presented in Table 5.0-2.

5.1 Field Surveys

The following sections describe the field surveys to be conducted at the Lower Mortandad/Cedro Canyons Aggregate Area sites.

5.1.1 Geodetic Surveys

Geodetic surveys will be conducted at selected sites by a land surveyor in accordance with the latest version of EP-ERSS-SOP-5028, Coordinating and Evaluating Geodetic Surveys, to locate historical sampling locations and to document field activities such as sampling and soil removal locations. The surveyors will use a Trimble GeoXT hand-held global-positioning system (GPS) or equivalent for the surveys. The coordinate values will be expressed in the New Mexico State Plane Coordinate System (transverse mercator), Central Zone, North American Datum 1983. Elevations will be reported as per the

National Geodetic Vertical Datum of 1929. All GPS equipment used will meet the accuracy requirements specified in the SOP.

5.1.2 XRF Survey

A survey of the debris pile area at Consolidated Unit 05-005(b)-00 will be conducted using a field XRF to identify areas of elevated metal concentrations (i.e., chromium, copper, lead, and zinc). Lead was previously detected above the industrial SSL at the site, and the survey will be conducted using an instrument having sufficient sensitivity for lead (i.e., 100 mg/kg or less) to identify areas contaminated above the 800 mg/kg industrial SSL. The instrument will be operated according to the manufacturer's instructions, including collecting and preparing samples and analyzing standard samples. The survey will initially be performed on a regular grid having a spacing of 5 ft.

5.2 Field Screening

Because of the infrequent detection of contaminants in previous investigations [with the exception of metals at Consolidated Unit 05-005(b)-00], field screening will be conducted primarily for health and safety purposes. The Laboratory's proposed field-screening approach will be to (1) visually examine all samples for evidence of contamination, (2) screen for organic vapors, and (3) screen for radioactivity. The field-screening methods are discussed below.

5.2.1 Volatile Organic Compounds

Because VOCs are not known to have been used at the sites being investigated, VOC screening will be conducted primarily to ensure worker health and safety rather than to direct sampling. Screening will be conducted using a photoionization detector (PID) capable of measuring quantities as low as 1 ppm. Vapor screening of soil, sediment, and subsurface core for VOCs will be conducted using a PID equipped with an 11.7 electron volt (eV) lamp. All samples will be screened for VOCs in headspace gas in accordance with SOP-06.33, Headspace Vapor Screening with a Photo Ionization Detector.

The PID will be calibrated daily to the manufacturer's standard for instrument operation, and the daily calibration results will be documented in the field logbooks. All instrument background checks, background ranges, and calibration procedures will be documented daily in the field logbooks in accordance with EP-ERSS-SOP-5181, Notebook Documentation for Waste and Environmental Services Technical Field Activities.

5.2.2 Radioactivity

Based on the results of past sampling, field screening for radioactivity will be conducted primarily to ensure worker health and safety rather than to direct sampling. Radiological screening will target gross-alpha, -beta, and -gamma radiation. Field screening for alpha, beta, and gamma radiation will be conducted within 6 in. from soil and core material using appropriate field instruments as determined by the Laboratory's Health Physics Operations Group. Instruments will be calibrated in accordance with the Health Physics Operations Group procedures or equivalent procedures. All instrument calibration activities will be documented daily in the field logbooks in accordance with EP-ERSS-SOP-5181, Notebook Documentation for Waste and Environmental Services Technical Field Activities.

5.3 Sample Collection

All samples will be placed in appropriate containers in accordance with EP-ERSS-SOP 5056, Sample Container and Preservation. Quality assurance (QA)/QC samples will include field duplicate samples, rinsate blanks, and trip blanks. These samples will be collected following the current version of EP-ERSS-SOP 5059, Field Quality Control Samples, and will comply with a frequency of 10% of total samples collected for field duplicates and rinsate blanks. Trip blanks will be supplied and will remain with the analytical samples when samples are collected for VOC analysis. Trip blanks will be collected at a frequency of one per day or one per 20 VOC samples, whichever is greater. QA/QC samples are used to monitor the validity of the sample collection procedures.

5.3.1 Surface Samples

Surface and shallow subsurface soil and sediment samples will be collected according to SOP-06.09, Spade and Scoop Method for the Collection of Soil Samples. Stainless-steel shovels, spades, scoops, and bowls will be used for ease of decontamination. Decontamination will be completed using a dry decontamination method with disposable paper towels and an over-the-counter cleaner, such as Fantastik or an equivalent. If the surface location is at bedrock, an axe or hammer and chisel will be used to collect samples.

5.3.2 Subsurface Samples

Subsurface samples will be collected using hand- or hollow-stem auger methods, depending on the depth of the samples and the material being sampled. A brief description of these methods is provided below.

5.3.2.1 Hand Auger

Hand augers may be used to bore shallow holes (e.g., 0 to 10 ft). The hand auger is advanced by turning or pounding the auger into the soil until the barrel is filled. The auger is removed, and the sample is dumped out into a clean bowl. Hand-auger samples will be collected in accordance with SOP-06.10, Hand Auger and Thin-Wall Tube Sampler.

5.3.2.2 Hollow-Stem Auger

Hollow-stem augers will be used to collect subsurface samples where hand-augering is impractical because of the sampling depth or the material being sampled. Hollow-stem auger sampling is only expected to be needed for the two 56-ft boreholes to be advanced next to the former calibration chamber at SWMU 05-003 and the 25-ft borehole to be advanced at the location of the former septic tank at SWMU 05-004. The hollow-stem auger consists of a hollow-steel shaft with a continuous spiraled steel flight welded onto the exterior of the stem. The stem is connected to an auger bit; when the auger is rotated, it transports cuttings to the surface. The hollow stem of the auger allows insertion of drill rods, split-spoon core barrels, Shelby tubes, and other samplers through the center of the auger so samples may be retrieved during drilling operations.

During sampling, the auger will be advanced to just above the desired sampling interval, and the sample will be collected by driving a split-spoon sampler into undisturbed soil/tuff to the desired depth. Samples will be collected according to SOP-06.26, Core Barrel Sampling for Subsurface Earth Materials. Immediately after sampling is completed, the boreholes will be abandoned using bentonite chips or a bentonite/concrete mixture. All borehole cuttings will be managed as IDW, as described in Appendix B of this work plan. Borehole abandonment information will be provided in the Lower Mortandad/Cedro Canyons Aggregate Area investigation report.

Field documentation will include detailed borehole logs for each borehole drilled. The borehole logs will document the matrix material in detail and will include the results of all field screening; fractures and matrix samples will be assigned unique identifiers. All field documentation will be completed in accordance with the current version of SOP-12.01, Field Logging, Handling, and Documentation of Borehole Materials.

5.3.3 Sediment Samples

Sediment samples will be collected from areas of sediment accumulation that include sediment determined to be representative of the historical period of Laboratory operations. The locations will be selected by the field geologist based on geomorphic relationships in areas likely to have been affected by discharges from Laboratory operations. Guidance for identifying such areas in contained in EP-ERSS-SOP-5027, Geomorphic Characterization. Preliminary sediment sampling locations in drainages are shown in section 4 figures. Because sediment systems are dynamic and subject to redistribution by runoff events, however, some locations may need to be adjusted when this work plan is implemented. In the course of collecting sediment samples, it may be determined that the selected location is not appropriate because of conditions observed during sampling (e.g., the sediment is much shallower than anticipated, the sediment is predominantly coarse-grained, or the sediment shows evidence of being older than the target age). Sediment sampling locations may be adjusted as appropriate. Any changes to sediment sampling locations will be documented in the investigation report as deviations from this work plan.

5.4 Laboratory Methods

Analytical suites vary by site as indicated in Table 4.0-1. All analytical suites are presented in the statement of work for analytical laboratories (LANL 2000, 071233). The specific analytical methods to be used are specified in Table 5.0-2. Sample collection and analysis will be coordinated with the Sample Management Office (SMO).

5.5 Health and Safety

The field investigations described in this investigation work plan will comply with all applicable requirements pertaining to worker health and safety. An integrated work document and a site-specific health and safety plan will be in place before fieldwork is performed.

5.6 Equipment Decontamination

Equipment for drilling and sampling will be decontaminated before and after drilling and sampling activities (as well as between drilling boreholes) to minimize the potential for cross-contamination. Dry decontamination methods are preferred and will be given priority because they do not generate liquid wastes. Residual material adhering to the equipment will be removed using dry decontamination methods, including wire-brushing and scraping, as described in EP-ERSS-SOP-5061, Field Decontamination of Equipment. Dry decontamination of sampling equipment may include use of a nonphosphate detergent such as Fantastik on a paper towel, and the equipment is wiped so no liquid waste is generated.

If dry decontamination methods are not effective, equipment may be decontaminated by steam-cleaning or hot water pressure-washing, as described in EP-ERSS-SOP-5061. Wet decontamination methods will be conducted on a high-density polyethylene liner on a temporary decontamination pad. Cleaning solutions and wash water will be collected and contained for proper disposal. Decontamination solutions will be sampled and analyzed to determine the final disposition of the wastewater and the effectiveness of the decontamination procedures.

5.7 Investigation-Derived Waste

The IDW generated during field-investigation activities may include, but are not limited to, drill cuttings; contaminated soil; contaminated personal protective equipment (PPE), sampling supplies, and plastic; fluids from the decontamination of PPE and sampling equipment; and all other waste that has potentially come into contact with contamination.

All IDW generated during field-investigation activities will be managed in accordance with applicable SOPs. These SOPs incorporate the requirements of all applicable EPA and NMED regulations, DOE orders, and Laboratory implementation requirements. Appendix B presents the IDW management plan.

5.8 Debris Removal

A small area of debris (approximately 5 ft × 5 ft) was observed at Consolidated Unit 05-005(b)-00. This debris is believed to be associated with the destruction of former building 05-5 by burning. Because this debris appears to be associated with the elevated levels of metals, especially lead, detected during the RFI sampling, it will be removed. Because of the small volume of debris present, it will be removed using hand tools and placed in 55-gal. drums. Following removal of the debris, soil at the debris area will be surveyed using a field XRF. Any soil containing lead or other metals above the industrial SSL will be excavated by hand and placed in a 55-gal. drum. Following removal of the debris and soil, soil samples will be collected to confirm cleanup and determine extent of contamination.

6.0 MONITORING PROGRAMS

6.1 Groundwater

Section IV.B.2.b.ii of the Consent Order requires monitoring and sampling of monitoring wells in the Mortandad Canyon watershed. No monitoring is specifically being done to address sites in Lower Mortandad/Cedro Canyons Aggregate Area. Regional wells, R-14 and R-33 are located in Ten Site Canyon to the north of Lower Mortandad/Cedro Canyons Aggregate Area. Well R-33 is located approximately 0.25 mi north of the investigation sites, and well R-14 is located approximately 0.6 mi to the west. All wells in the Mortandad Canyon watershed are monitored as part of the latest version of the Interim Facility-Wide Groundwater Monitoring Plan (LANL 2009, 106115).

6.2 Sediment and Surface Water

Monitoring of surface water in Mortandad Canyon has been and is being performed under the NPDES Multi-Sector General Permit (MSGP) and Federal Facility Compliance Agreement/Administrative Order (FFCA/AO) and the NPDES individual permit (IP) for discharge of stormwater from SWMUs and AOCs issued by EPA Region 6 in February 2009. Monitoring under the MSGP, FFCA/AO, and IP is performed using site-monitoring areas (SMAs), which monitor stormwater runoff from individual SWMUs and AOCs or groups of SWMUs and AOCs, and by gaging stations, which monitor runoff in stream channels. The SWMUs and AOCs in the Lower Mortandad/Cedro Canyons Aggregate Area subject to SMA monitoring under the MSGP, FFCA/AO, and IP are SWMU 05-004, which is monitored by SMA M-SMA-12.6, and

SWMUs 05-005(b) and 05-006(c), which are monitored by SMA M-SMA-12.5. No downstream gaging stations are associated with these sites. Monitoring results are reported periodically to EPA Region 6, with copies provided to NMED.

7.0 SCHEDULE

The scheduled notice date for NMED to approve this investigation work plan is January 29, 2010. Preparation of investigation activities is scheduled to start by October 1, 2010. Fieldwork is expected to start on February 24, 2011, and will take approximately 2 months to complete. Fieldwork is scheduled to be completed by April 21, 2011. The investigation report is proposed to be delivered to NMED on or before August 25, 2011.

8.0 REFERENCES AND MAP DATA SOURCES

8.1 References

The following list includes all documents cited in this plan. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

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Roads

Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 15 October 2008. Paved Parking; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 12 August 2002; as published 15 October 2008.

Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 15 October 2008.

Security and Industrial Fences and Gates; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 15 October 2008.

Storm Drain Line Distribution System; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 15 October 2008.

Structures

Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 15 October 2008. Structures; County of Los Alamos, Information Services; as published 29 October 2007.

Primary Landscape Features; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 15 October 2008.

Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Division; 04 June 2008. Los Alamos Scientific Laboratory Drawing ENG-C 1660, Site and Road Plan – Details, Re-Locate Assembly Building from TA-18 to TA-5, October 28, 1947. Los Alamos Scientific Laboratory Drawing ENG-C 28300, Plan View, Holes at TA-5-16, undated.

Utilities

Communication Lines; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 08 August 2002; as published 15 October 2008.

Primary Electric Grid; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 15 October 2008.

Sewer Line System; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 15 October 2008.

Water Lines; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 15 October 2008. Los Alamos Scientific Laboratory Drawing ENG-C 1661, Utility Plan & Details, Re-Locate Assembly Building from TA-18 to TA-5, November 21, 1947.

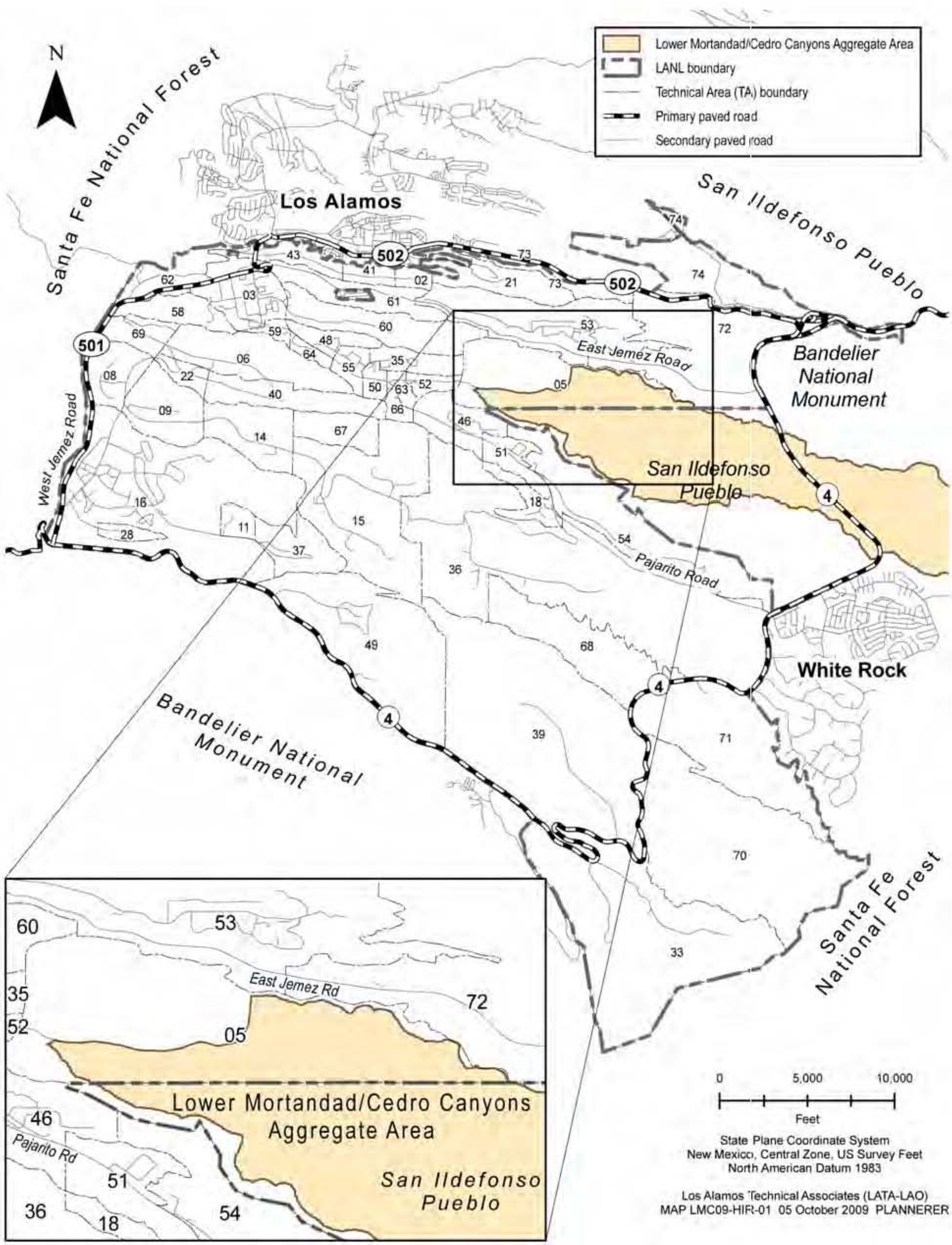

Figure 1.0-1 Location of Lower Mortandad/Cedro Canyons Aggregate Area

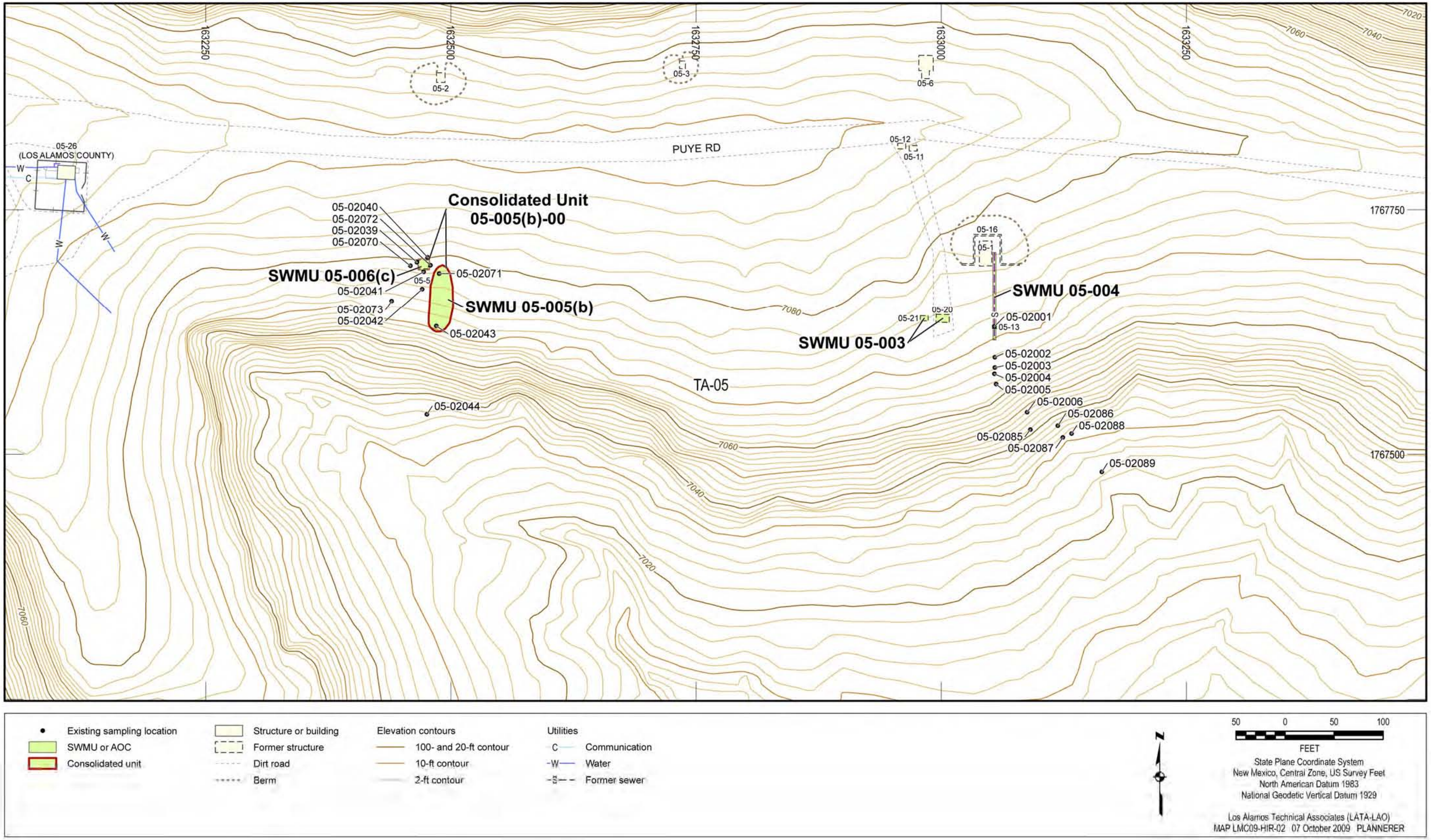

Figure 1.1-1 Locations of sites in Lower Mortandad/Cedro Canyons Aggregate Area

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

Figure 3.2-1 Generalized stratigraphy of bedrock geologic units of the Pajarito Plateau

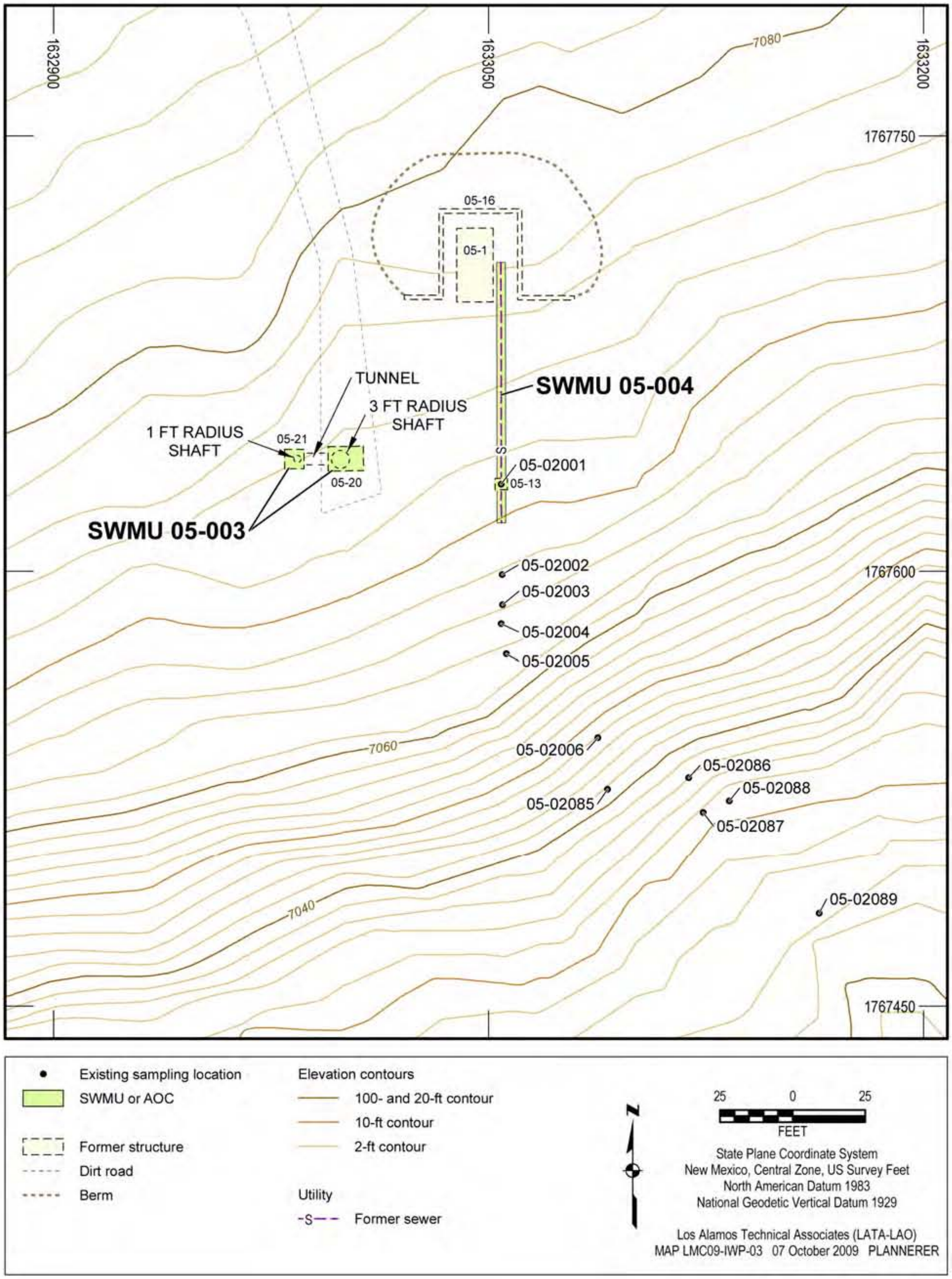

Figure 4.1-1 Site features and historical sampling locations for SWMUs 05-003 and 05-004

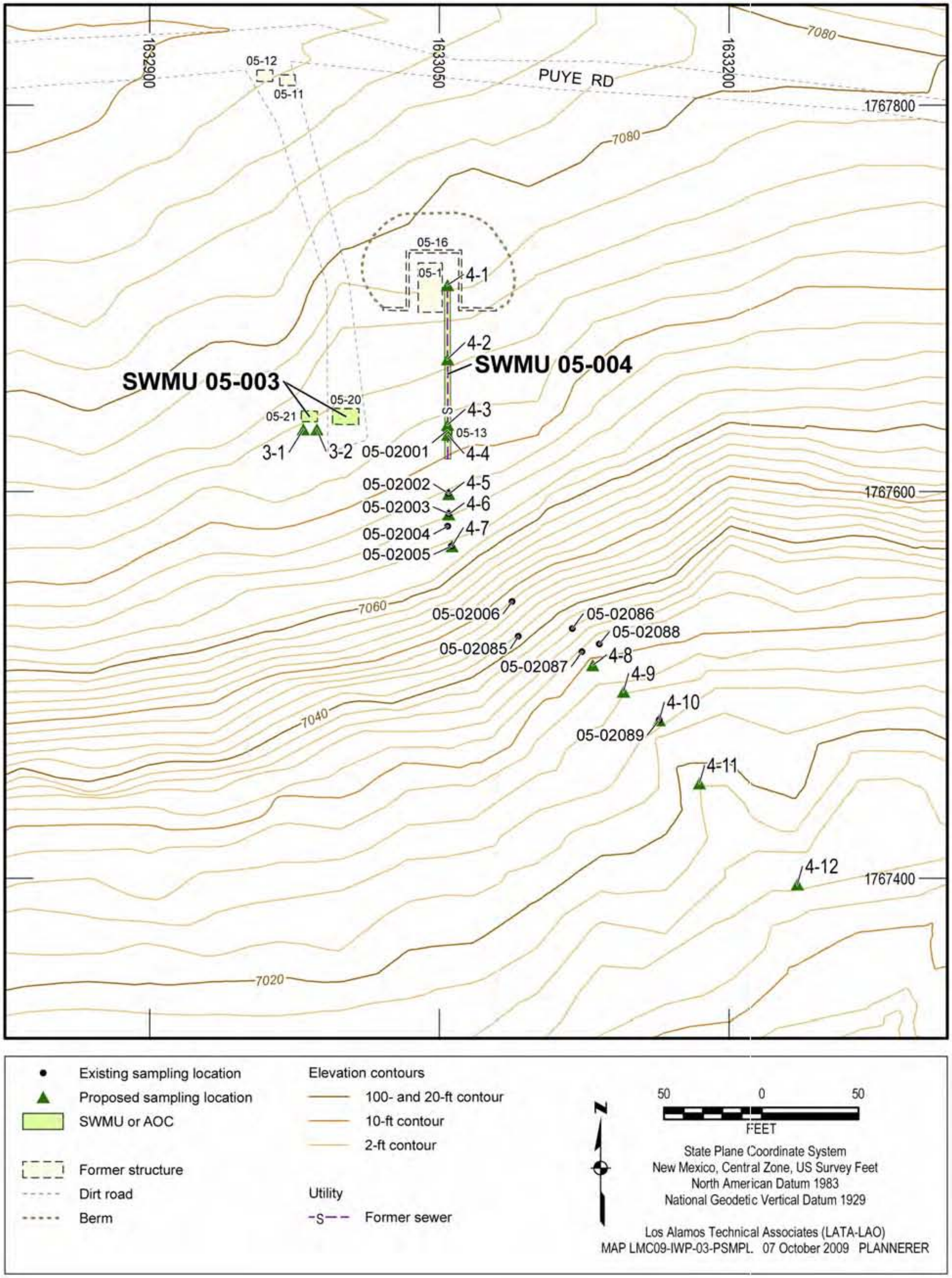

Figure 4.1-2 Proposed sampling locations for SMWUs 05-003 and 05-004

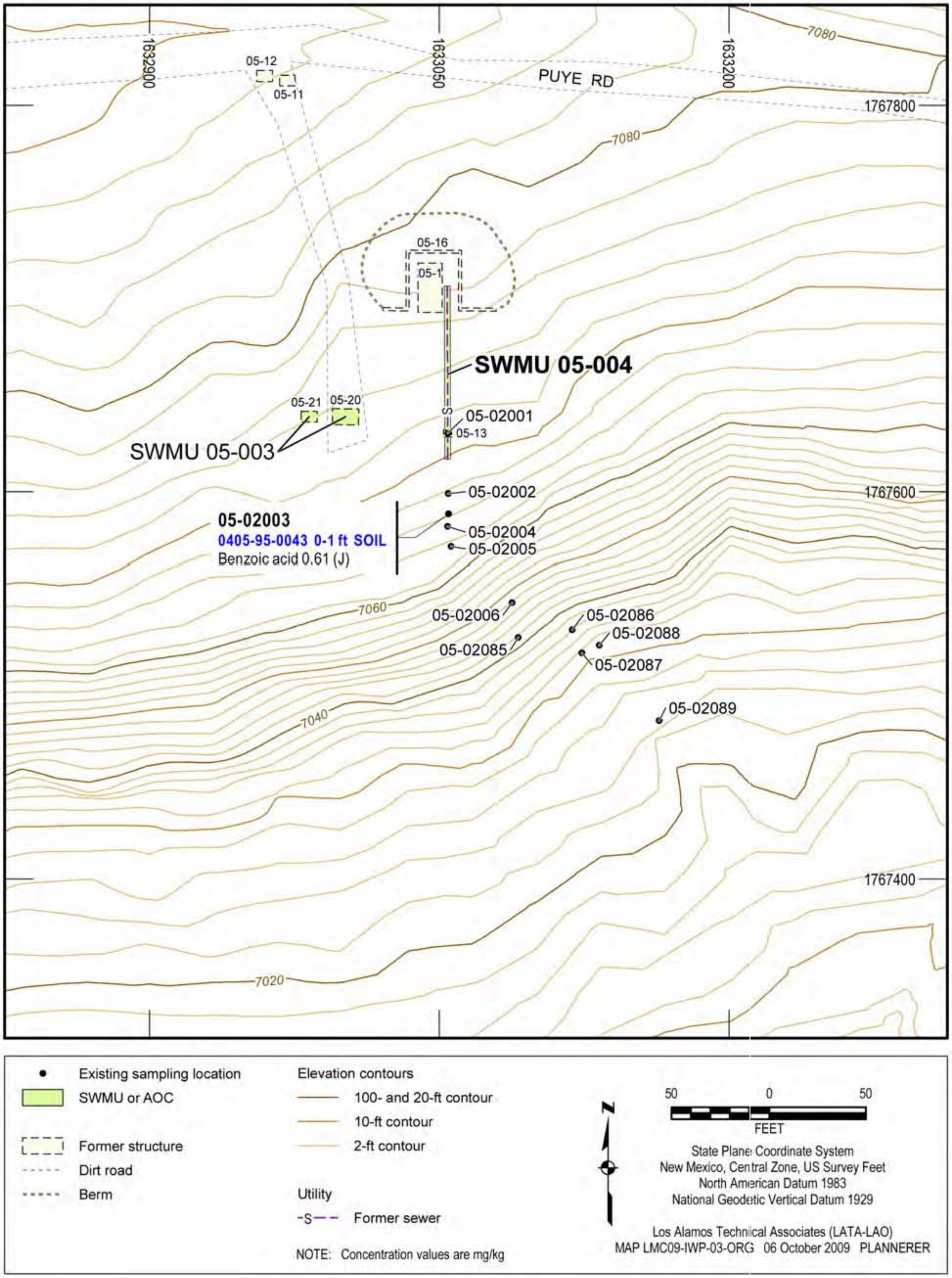

Figure 4.2-1 Organic chemical detected at SWMU 05-004

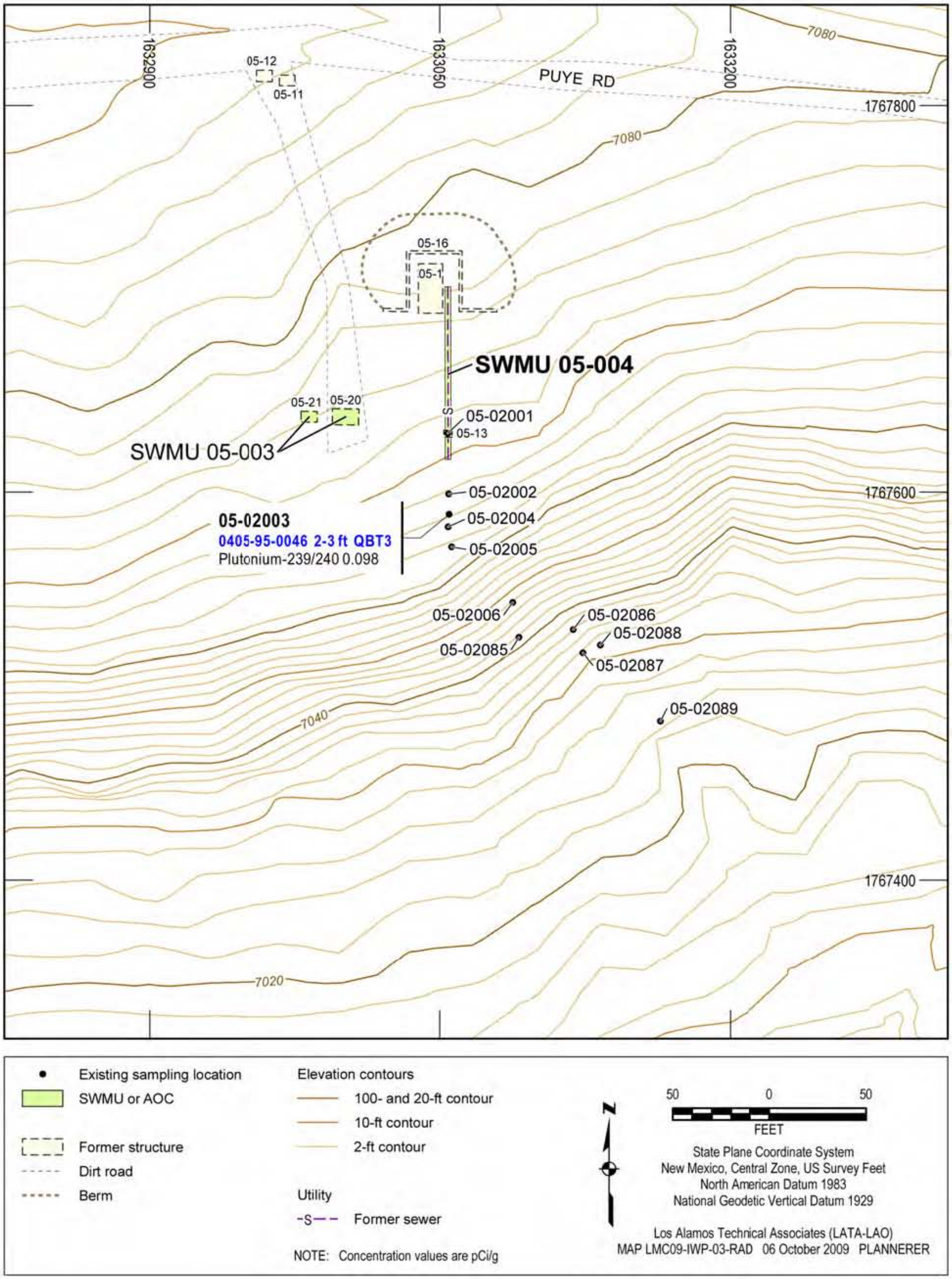

Figure 4.2-2 Radionuclide detected or detected above BV/FV at SWMU 05-004

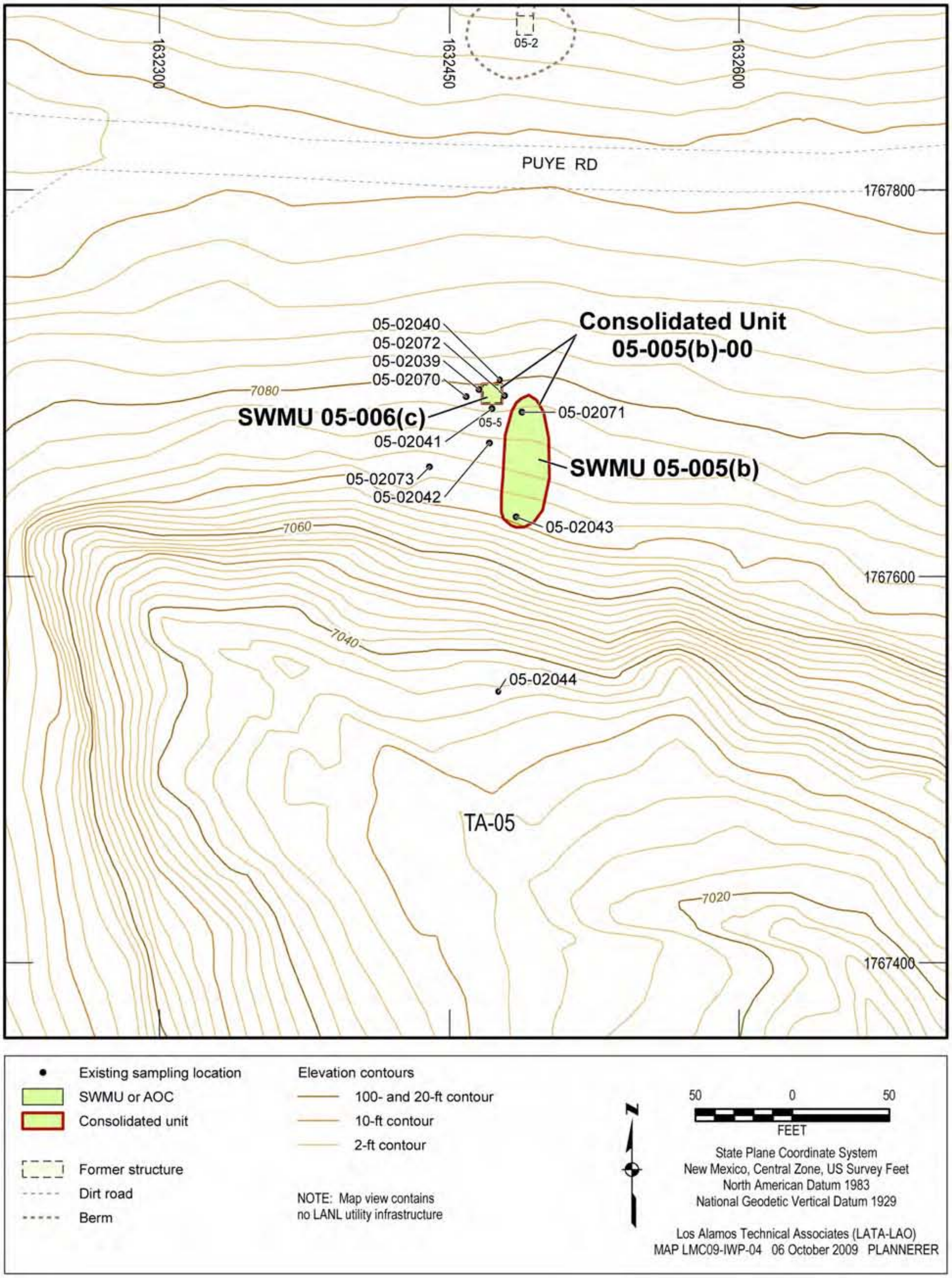

Figure 4.3-1 Site features and historical sampling locations for SWMUs 05-005(b) and 05-006(c)

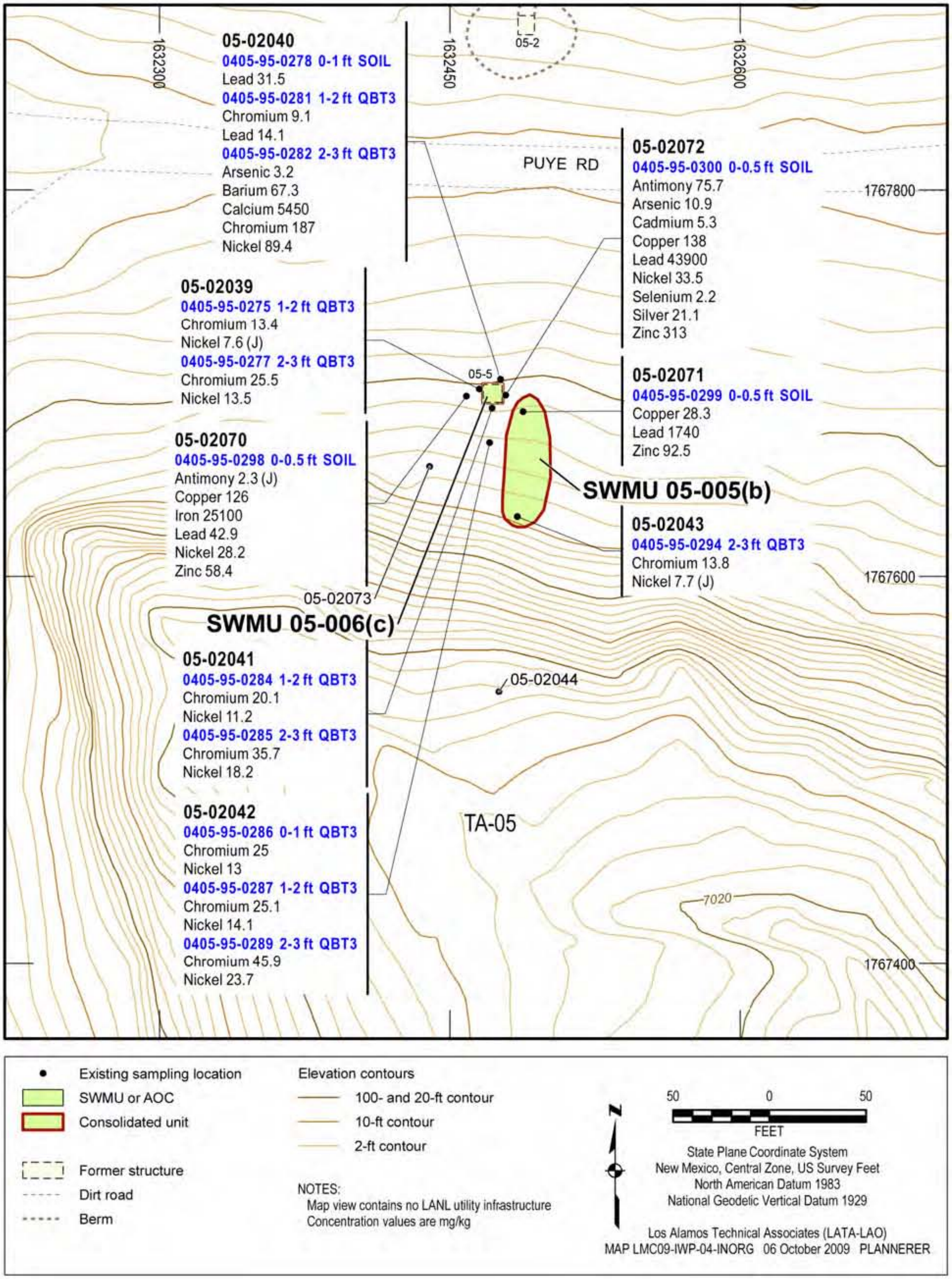

Figure 4.3-2 Inorganic chemicals detected above BVs at SWMUs 05-005(b) and 05-006(c)

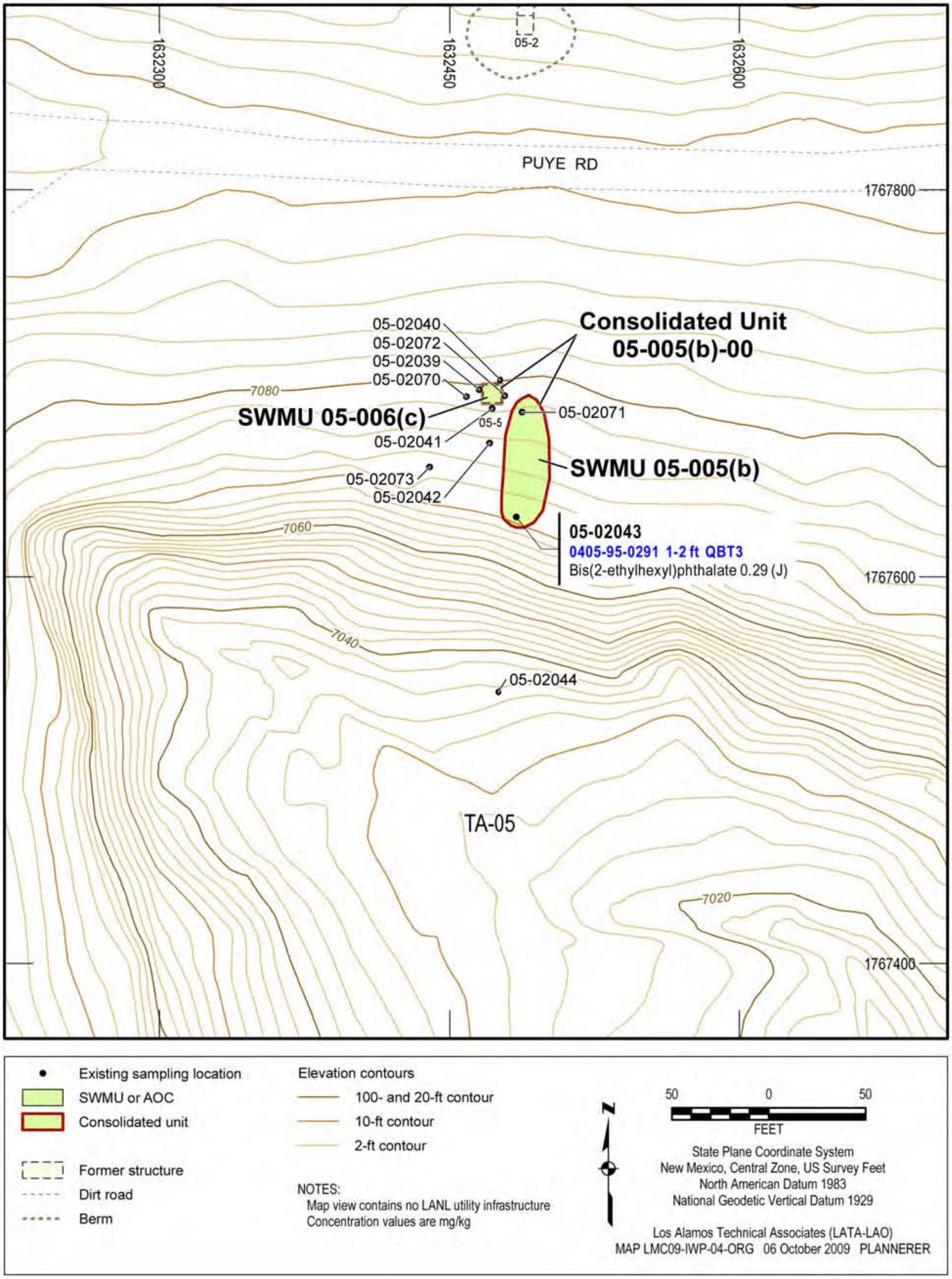

Figure 4.3-3 Organic chemical detected at SWMUs 05-005(b) and 05-006(c)

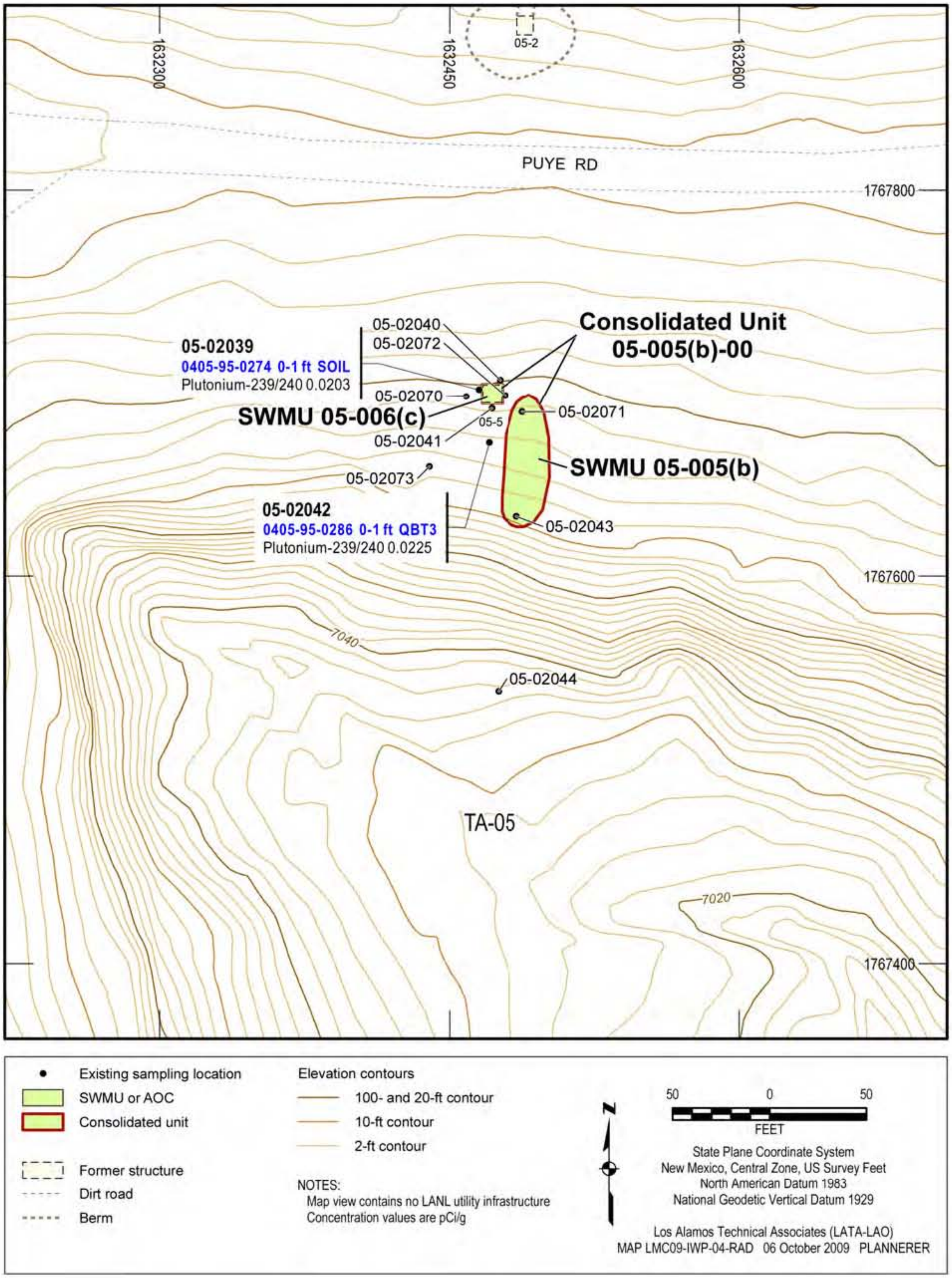

Figure 4.3-4 Radionuclides detected or detected above BV/FV at SWMUs 05-005(b) and 05-006(c)

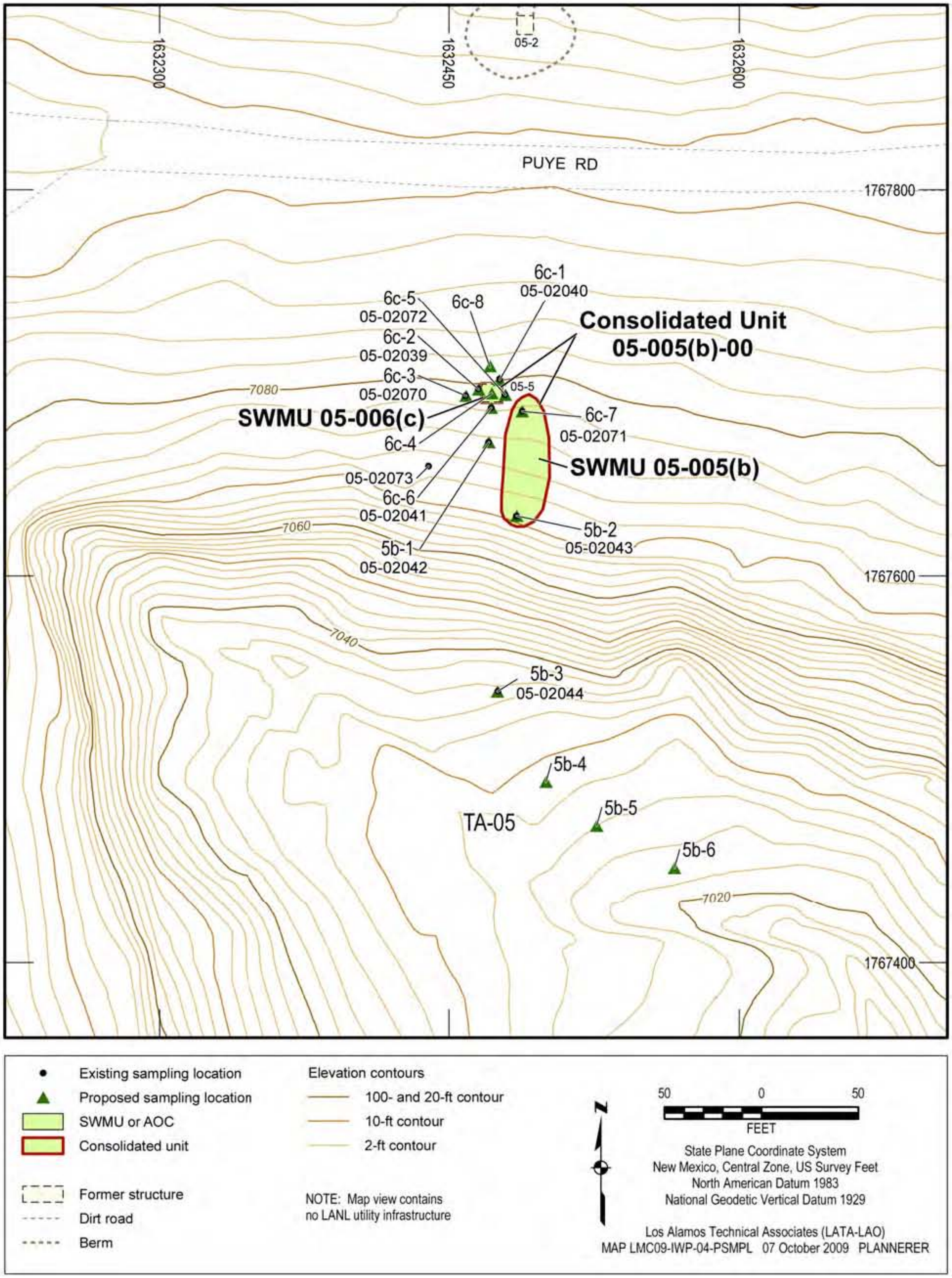

Figure 4.3-5 Proposed sampling locations for SMWUs 05-005(b) and 05-006(c)

Table 1.1-1
Status of SWMUs and AOCs in Lower Mortandad/Cedro Canyons Aggregate Area

Consolidated Unit	Site ID	Brief Description	Site Status	Reference
	AOC 05-001(c)	Firing site	Investigation completed as part of Middle Mortandad/ Ten Site Aggregate Area	LANL 2008, 102187 NMED 2008, 101115
	SWMU 05-003	Former calibration chamber	Under investigation	Work plan section 4.1
	SWMU 05-004	Former septic tank	Under investigation	Work plan section 4.2
05-005(b)-00	SWMU 05-005(b)	Former outfall associated with former building 05-5	Under investigation	Work plan section 4.3
	SWMU 05-006(c)	Area of potential soil contamination from former building 05-5	Under investigation	Work plan section 4.3
	AOC 05-006(a)	Former building location	NFA approved, 01/21/05	EPA 2005, 088464

Table 2.3-1
Industrial SSLs and SALs

Chemical	Industrial SSL[a] (Inorganic and Organic chemicals) or Industrial SAL[b] (Radionuclides)
Inorganic Chemicals (mg/kg)	
Antimony	454
Arsenic	17.7
Barium	224000
Cadmium	1120
Calcium	na[c]
Chromium	14000[d]
Copper	45400
Iron	795000
Lead	800
Mercury	310[d]
Nickel	22700
Selenium	5680
Silver	5680
Zinc	341000
Organic Chemicals (mg/kg)	
Benzoic acid	2500000[d]
Bis(2-ethylhexyl)phthalate	1370
Radionuclides (pCi/g)	
Plutonium-238	240
Plutonium-239/240	210

[a] SSLs from NMED (2009, 106420), unless otherwise noted.

[b] SALs from LANL (2005, 088493).

[c] na = Not available.

[d] SSL is from EPA regional screening tables (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm).

Table 4.0-1
Summary of Proposed Samples and Analyses

Site	Sampling Justification	Number of Locations and Samples	Depth (ft)	Media	TAL Metals	Cyanide	Nitrate	Perchlorate	VOCs[a]	SVOCs	Explosive Compounds	Dioxins/Furans[b]	PCBs[c]	Isotopic Uranium	Isotopic Plutonium	Gamma Spectroscopy
TA-05																
SWMU 05-003	Sample two new boreholes downgradient of underground chamber to determine whether releases from chamber have occurred. (Locations 3–1 and 3–2)	2 locations, 12 samples	5–6, 15–16, 25–26, 35–36, 45–46, 55–56[d]	Soil, tuff	X[e]	—[f]	—	X	—	—	—	—	—	X	—	X
SWMU 05-004	Sample 3 new locations along inlet drain line to characterize potential releases. (Locations 4–1, 4–2, and 4–3)	3 locations, 6 samples	3–4, 5–6	Soil, tuff	X	X	X	X	X	X	X	—	X	X	X	—
	Resample RFI borehole at location of septic tank and analyze for expanded analytical suite. (Location 4-4)	1 location, 5 samples	5–6, 9–10, 14–15, 19–20, 24–25[d]	Soil, tuff	X	X	X	X	X	X	X	—	X	X	X	—
	Resample 3 RFI locations along outfall trench at deeper depths and analyze for expanded analytical suite. (Locations 4–5, 4–6, and 4–7)	3 locations, 6 samples	3–4, 5–6	Soil, tuff	X	X	X	X	X	X	X	—	X	X	X	—
	Sample 4 new locations downgradient of outfall to define extent. (Locations 4–8, 4–9, 4–11, and 4–12)	4 locations, 12 samples	0–1, soil/tuff interface, 1 ft into tuff	Soil, tuff	X	X	X	X	X	X	X	—	X	X	X	—
	Resample 1 RFI location below outfall at deeper depths and analyze for expanded analytical suite. (Location 4–10)	1 location, 3 samples	0–1, soil/tuff interface, 1 ft into tuff	Soil, tuff	X	X	X	X	X	X	X	—	X	X	X	—
Consolidated Unit 05-005(b)-00 [SWMUs 05-005(b) and 05-006(c)]	Resample RFI locations at outfall and below outfall on mesa top. (Locations 5b–1 and 5b–2)	2 locations, 6 samples	0–1, 2–3, 5–6	Soil, tuff	X	X	X	X	X	X	X	X	X	X	X	—
	Sample 1 RFI and 3 new locations downgradient of outfall in canyon bottom to determine extent. (Locations 5b–3, 5b–4, 5b–5, and 5b–6)	4 locations, 12 samples	0–1, soil/tuff interface, 1 ft into tuff	Soil, tuff	X	X	X	X	X	X	X	X	X	X	X	—
	Resample RFI locations around footprint of former building at deeper depths and analyze for expanded analytical suite to define lateral and vertical extent. (Locations 6c–1, 6c–2, 6c-3, and 6c–6)	4 locations, 12 samples	0–1, 2–3, 5-6	Soil, tuff	X	X	X	X	X	X	X	X	X	X	X	—
	Sample new location in footprint of former building 05-5. (Location 6c–4)	1 location, 3 samples	0–1, 2–3, 5–6	Soil, tuff	X	X	X	X	X	X	X	X	X	X	X	—
	Sample new location upslope of former building to define extent. (Location 6c–8)	1 location, 3 samples	0–1, 2–3, 5–6	Soil, tuff	X	X	X	X	X	X	X	X	X	X	X	—
	Resample RFI locations near debris pile following removal of debris to define extent. (Locations 6c–5 and 6c-7)	2 locations, 6 samples	0–1, 2–3, 5–6	Soil, tuff	X	X	X	X	X	X	X	X	X	X	X	—
	Collect confirmation samples from excavated soil areas.	To be determined	0–1, 2–3, 5–6	Soil, tuff	X	X	X	X	X	X	X	X	X	X	X	—

[a] VOCs in subsurface samples only.

[b] 20% of samples from Consolidated Unit 05-005(b)-00 will be analyzed for dioxins/furans. Locations for dioxin/furan analysis will be biased towards potential source locations and farthest downgradient to define extent.

[c] 20% of samples will be analyzed for PCBs. Locations for PCB analysis will be biased towards potential source locations and farthest downgradient to define extent.

[d] Additional sampling depth may be required if field screening indicates presence of contamination.

[e] X = Analysis proposed.

[f] — = Analysis will not be performed.

Table 4.0-2
Summary of Historical Samples Collected and Analyses Requested

Sample ID	Location ID	Depth (ft)	Media	Metals	VOCs	SVOCs	HE	Isotopic Plutonium	Isotopic Uranium	Gamma Spectroscopy	Gross Alpha	Gross Beta
SWMU 05-004												
0405-95-0037	05-02001	3.5–4.5	Fill	540[a]	—[b]	—	—	541	541	—	—	—
0405-95-0039	05-02001	8.8–9.8	Qbt 3	—	—	—	—	541	541	—	—	—
0405-95-0041	05-02001	14–15	Qbt 3	—	—	—	—	541	541	—	—	—
RE05-98-0001	05-02001	14–15	Qbt 3	4368R	—	4366R	4367R	—	—	—	—	—
RE05-98-0002	05-02001	15–16	Qbt 3	4368R	—	4366R	4367R	—	—	—	—	—
RE05-98-0003	05-02001	16–17	Qbt 3	4368R	—	4366R	4367R	—	—	—	—	—
RE05-98-0004	05-02001	17–18	Qbt 3	4368R	—	4366R	4367R	—	—	—	—	—
RE05-98-0005	05-02001	18–19	Qbt 3	4368R	—	4366R	4367R	—	—	—	—	—
RE05-98-0006	05-02001	19–20	Qbt 3	4368R	—	4366R	4367R	—	—	—	—	—
RE05-98-0008	05-02001	20–21	Qbt 3	4368R	—	4366R	4367R	—	—	—	—	—
RE05-98-0009	05-02001	21–22	Qbt 3	4368R	—	4366R	4367R	—	—	—	—	—
RE05-98-0010	05-02001	22–23	Qbt 3	4368R	—	4366R	4367R	—	—	—	—	—
RE05-98-0012	05-02001	23–24	Qbt 3	4368R	—	4366R	4367R	—	—	—	—	—
RE05-98-0013	05-02001	24–25	Qbt 3	4368R	—	4366R	4367R	—	—	—	—	—
0405-95-0042	05-02002	0–0.5	Soil	—	—	—	—	541	541	—	—	—
0405-95-0043	05-02003	0–1.0	Soil	—	—	539	—	541	541	—	—	—
0405-95-0045	05-02003	1.0–2.0	Qbt 3	—	—	—	—	541	541	—	—	—
0405-95-0046	05-02003	2.0–3.0	Qbt 3	—	—	—	—	541	541	—	—	—
0405-95-0047	05-02004	0–1.0	Soil	—	—	—	—	541	541	—	—	—
0405-95-0048	05-02004	1.0–2.0	Qbt 3	—	539	—	—	541	541	541	541	541
0405-95-0051	05-02004	2.0–3.0	Qbt 3	—	—	—	—	541	541	—	—	—
0405-95-0053	05-02005	0–0.5	Soil	—	—	—	—	541	541	—	—	—

Table 4.0-2 (continued)

Sample ID	Location ID	Depth (ft)	Media	Metals	VOCs	SVOCs	HE	Isotopic Plutonium	Isotopic Uranium	Gamma Spectroscopy	Gross Alpha	Gross Beta
0405-95-0054	05-02006	0–0.5	Soil	—	—	—	487	541	541	—	—	—
RE05-98-0007	05-02085	0–0.5	Soil	4348R	—	4347R	4349R	—	—	—	—	—
RE05-98-0011	05-02086	0–0.5	Soil	4348R	—	4347R	4349R	—	—	—	—	—
RE05-98-0015	05-02087	0–0.5	Soil	4348R	—	4347R	4349R	—	—	—	—	—
RE05-98-0016	05-02087	0.5–1.0	Soil	4348R	—	4347R	4349R	—	—	—	—	—
RE05-98-0019	05-02088	0–0.5	Soil	4348R	—	4347R	4349R	—	—	—	—	—
RE05-98-0020	05-02088	0.5–1.0	Soil	4348R	—	4347R	4349R	—	—	—	—	—
RE05-98-0023	05-02089	0–0.5	Sed	4348R	—	4347R	4349R	—	—	—	—	—
RE05-98-0024	05-02089	0.5–1.0	Sed	4348R	—	4347R	4349R	—	—	—	—	—
SWMU 05-005(b)												
0405-95-0286	05-02042	0–1.0	Qbt 3	647	—	—	—	648	648	—	—	—
0405-95-0287	05-02042	1.0–2.0	Qbt 3	647	—	—	646	648	648	—	—	—
0405-95-0289	05-02042	2.0–3.0	Qbt 3	647	—	—	—	648	648	—	—	—
0405-95-0290	05-02043	0–1.0	Qbt 3	647	—	—	—	648	648	—	—	—
0405-95-0291	05-02043	1.0–2.0	Qbt 3	647	—	646	—	648	648	—	—	—
0405-95-0294	05-02043	2.0–3.0	Qbt 3	647	—	—	—	648	648	—	—	—
0405-95-0295	05-02044	0–1.0	Soil	647	—	—	—	648	648	—	—	—
0405-95-0296	05-02044	1.0–2.0	Soil	647	—	—	—	648	648	—	—	—
0405-95-0297	05-02044	2.0–3.0	Soil	647	—	—	—	648	648	—	—	—
SWMU 05-006(c)												
0405-95-0274	05-02039	0–1.0	Soil	647	—	—	—	648	648	—	—	—
0405-95-0275	05-02039	1.0–2.0	Qbt 3	647	—	—	—	648	648	—	—	—
0405-95-0277	05-02039	2.0–3.0	Qbt 3	647	—	—	—	648	648	—	—	—
0405-95-0278	05-02040	0–1.0	Soil	647	—	—	—	648	648	648	648	648

Table 4.0-2 (continued)

Sample ID	Location ID	Depth (ft)	Media	Metals	VOCs	SVOCs	HE	Isotopic Plutonium	Isotopic Uranium	Gamma Spectroscopy	Gross Alpha	Gross Beta
0405-95-0281	05-02040	1.0–2.0	Qbt 3	647	—	—	—	648	648	—	—	—
0405-95-0282	05-02040	2.0–3.0	Qbt 3	647	—	—	—	648	648	—	—	—
0405-95-0283	05-02041	0–1.0	Soil	647	—	—	—	648	648	—	—	—
0405-95-0284	05-02041	1.0–2.0	Qbt 3	647	—	—	—	648	648	—	—	—
0405-95-0285	05-02041	2.0–3.0	Qbt 3	647	—	—	—	648	648	—	—	—
0405-95-0298	05-02070	0–0.5	Soil	647	—	—	—	—	—	—	—	—
0405-95-0299	05-02071	0–0.5	Soil	647	—	—	—	—	—	—	—	—
0405-95-0300	05-02072	0–0.5	Soil	647	—	—	—	—	—	—	—	—
0405-95-0301	05-02073	0–0.5	Soil	647	—	—	—	—	—	—	—	—

[a] Request numbers.

[b] — = Analysis not requested.

Table 4.0-3
Inorganic Chemicals Detected above BV during Historical Investigations

Sample ID	Location ID	Depth (ft)	Media	Antimony	Arsenic	Barium	Cadmium	Calcium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Selenium	Silver	Zinc
Soil BV[a]				**0.83**	**8.17**	**295**	**0.4**	**6120**	**19.3**	**14.7**	**21500**	**22.3**	**0.1**	**15.4**	**1.52**	**1**	**48.8**
Sediment BV[a]				**0.83**	**3.98**	**127**	**0.4**	**6120**	**10.5**	**11.2**	**21500**	**19.7**	**0.1**	**9.38**	**0.3**	**1**	**60.2**
Qbt 2, 3, 4 BV[a]				**0.5**	**2.79**	**46**	**1.63**	**2200**	**7.14**	**4.66**	**14500**	**11.2**	**0.1**	**6.58**	**0.3**	**1**	**63.5**
SWMU 05-004																	
RE05-98-0019	05-02088	0.0–0.5	Soil	—[b]	—	—	—	—	—	—	—	—	0.11 (U)	—	—	—	—
RE05-98-0020	05-02088	0.5–1.0	Soil	—	—	—	—	—	—	—	—	—	0.11 (U)	—	—	—	—
RE05-98-0023	05-02089	0.0–0.5	Sed	—	—	—	—	—	—	—	—	—	—	—	0.51 (UJ)	—	—
RE05-98-0024	05-02089	0.5–1.0	Sed	—	—	—	—	—	—	—	—	—	0.11 (U)	—	1.1 (UJ)	—	—
SWMU 05-005(b)																	
0405-95-0286	05-02042	0.0–1.0	Qbt 3	—	—	—	—	—	25	—	—	—	—	13	0.45 (U)	—	—
0405-95-0287	05-02042	1.0–2.0	Qbt 3	0.52 (U)	—	—	—	—	25.1	—	—	—	—	14.1	0.44 (U)	—	—
0405-95-0289	05-02042	2.0–3.0	Qbt 3	—	—	—	—	—	45.9	—	—	—	—	23.7	0.44 (U)	—	—
0405-95-0290	05-02043	0.0–1.0	Qbt 3	—	—	—	—	—	—	—	—	—	—	—	0.44 (U)	—	—
0405-95-0291	05-02043	1.0–2.0	Qbt 3	0.56 (U)	—	—	—	—	—	—	—	—	—	—	0.43 (U)	—	—
0405-95-0294	05-02043	2.0–3.0	Qbt 3	0.56 (U)	—	—	—	—	13.8	—	—	—	—	7.7 (J)	0.43 (U)	—	—
SWMU 05-006(c)																	
0405-95-0275	05-02039	1.0–2.0	Qbt 3	—	—	—	—	—	13.4	—	—	—	—	7.6 (J)	0.45 (U)	—	—
0405-95-0277	05-02039	2.0–3.0	Qbt 3	0.55 (U)	—	—	—	—	25.5	—	—	—	—	13.5	0.44 (U)	—	—
0405-95-0278	05-02040	0.0–1.0	Soil	0.85 (U)	—	—	—	—	—	—	—	31.5	—	—	—	—	—
0405-95-0281	05-02040	1.0–2.0	Qbt 3	0.59 (U)	—	—	—	—	9.1	—	—	14.1	—	—	0.44 (U)	—	—
0405-95-0282	05-02040	2.0–3.0	Qbt 3	1.2 (U)	3.2	67.3	—	5450	187	—	—	—	—	89.4	0.44 (U)	—	—
0405-95-0284	05-02041	1.0–2.0	Qbt 3	0.74 (U)	—	—	—	—	20.1	—	—	—	—	11.2	0.43 (U)	—	—
0405-95-0285	05-02041	2.0–3.0	Qbt 3	—	—	—	—	—	35.7	—	—	—	—	18.2	0.43 (U)	—	—
0405-95-0298	05-02070	0.0–0.5	Soil	2.3 (J)	—	—	—	—	—	126	25100	42.9	—	28.2	—	—	58.4
0405-95-0299	05-02071	0.0–0.5	Soil	1.2 (U)	—	—	—	—	—	28.3	—	1740	0.11 (U)	—	—	—	92.5
0405-95-0300	05-02072	0.0–0.5	Soil	75.7	10.9	—	5.3	—	—	138	—	43900	—	33.5	2.2	21.1	313

Notes: Units are mg/kg. Data qualifiers are defined in Appendix A.
[a] BVs from LANL 1998, 059730.
[b] — = Result was not detected or was below the BV.

Table 4.0-4
Organic Chemicals Detected during Historical Investigations

Sample ID	Location ID	Depth (ft)	Media	Benzoic Acid	Bis(2-ethylhexyl)phthalate
SWMU 05-004					
0405-95-0043	05-02003	0.0–1.0	Soil	0.61 (J)	—*
SWMU 05-005(b)					
0405-95-0291	05-02043	1.0–2.0	Qbt 3	—	0.29 (J)

Notes: Units are mg/kg. Data qualifiers are defined in Appendix A.
*— = Result was not detected.

Table 4.0-5
Radionuclides Detected or Detected above BV/FV during Historical Investigations

Sample ID	Location ID	Depth (ft)	Media	Plutonium-238	Plutonium-239/240
Qbt 3 BV/FV[a]				**na[b]**	**na**
SWMU 05-004					
0405-95-0046	05-02003	2.0–3.0	Qbt 3	—[c]	0.098
SWMU 05-005(b)					
0405-95-0286	05-02042	0.0–1.0	Qbt 3	0.0225	—

Note: Units are pCi/g.
[a] BVs/FVs from LANL 1998, 059730.
[b] na = Not available.
[c] — = Result was not detected or was below the BV/FV.

Table 5.0-1
Summary of Investigation Methods

Method	Summary
Spade-and-Scoop Collection of Soil Samples	This method will be used to collect surface (i.e., 0–1 ft) soil or sediment samples. A hole will be dug to the desired depth, as prescribed in the work plan, and a discrete grab sample collected. The sample will be homogenized in a decontaminated stainless-steel bowl before it is transferred to the appropriate sample containers.
Hand Auger Collection of Soil Samples	This method will typically be used for sampling soil or sediment at depths of less than 10–15 ft but may in some cases be used for collecting samples of weathered or nonwelded tuff. The method involves hand-turning a stainless-steel bucket auger (typically 3–4 in. inside diameter [I.D.]), creating a vertical hole that can be advanced to the desired sampling depth. When the desired depth is reached, the auger is decontaminated before the hole is advanced through the sampling depth. The sample material is transferred from the auger bucket to a stainless-steel sampling bowl before the various required sample containers are filled.
Split-Spoon Core-Barrel Sampling	The split-spoon core barrel is a cylindrical barrel split lengthwise so the two halves can be separated to expose the core sample. The stainless-steel core barrel (3 in. I.D. and 5 ft long) is pushed directly into the subsurface media with a hollow-stem auger drilling rig. A continuous length of core is extracted with the core barrel. Once it is extracted, the section of core will be screened for radioactivity and organic vapors, photographed, and described in a lithologic log. If it is located within a targeted sampling interval, a portion of the core will be collected for fixed laboratory analysis.
Field Logging, Handling, and Documentation of Borehole Materials	Once they reach the surface, the core barrels will be immediately opened for field screening, logging, and sampling. Logging of borehole materials includes run number, core recovery in feet, depth interval (in 5-ft increments), field-screening results, lithological and structural description, and photographs. Once the core material is logged, selected samples will be taken from discrete intervals of the core. All borehole material not sampled will be managed as IDW.
Headspace Vapor Screening	All soil and tuff samples will be field screened for VOCs by placing a portion of the sample in a glass jar. The jar will be sealed with foil and gently shaken and allowed to equilibrate for approximately 5 min. The sample will then be screened by inserting a PID probe equipped with an 11.7-eV lamp into the container. The results will be recorded in units of ppm.
XRF Screening	Soil samples will be screened in the field using XRF to delineate areas of inorganic chemical contamination. The XRF used will have a detection limit equal to approximately 10% to 20% of the soil screening level. Samples will be collected and analyzed in accordance with the XRF manufacturer's instructions, including analysis of standards and other QA/QC samples.
Handling, Packaging, and Shipping of Samples	Samples will be sealed and labeled before being packed in ice. Sample and transport containers will be examined to ensure they are free of external contamination. Samples will be packaged to minimize the possibility of breakage during transport. After environmental samples are collected, packaged, and preserved, they will be transported to the SMO. A split of each sample will be sent to an SMO-approved radiation-screening laboratory under chain of custody (COC). Once radiation-screening results are received, the SMO will send the corresponding analytical samples to fixed laboratories for full analysis.
Containers and Preservation of Samples	Specific requirements/processes for sample containers, preservation techniques, and holding times are based on EPA guidance for environmental sampling, preservation, and QA. Specific requirements for each sample will be printed in the sample collection logs (SCLs) provided by the SMO (size and type of container, preservatives, etc.). All samples will be preserved by placing them in insulated containers with ice to maintain a temperature of 4°C.

Table 5.0-1 (continued)

Method	Summary
Sample Control and Field Documentation	The collection, screening, and transport of samples will be documented on standard forms generated by the SMO. These forms include SCLs, COC forms, and sample container labels. Collection logs will be completed at the time the samples are collected and signed by the sampler and a reviewer who verifies that the logs are complete and accurate. Corresponding labels will be initialed and applied to each sample container, and custody seals will be placed around container lids or openings. The COC forms will be completed and assigned to verify that the samples are not left unattended.
Coordinating and Evaluating Geodetic Surveys	Geodetic surveys will focus on obtaining survey data of acceptable quality to use during project investigations. Geodetic surveys will be conducted with a Trimble 5700 DGPS. The survey data will conform to Laboratory Information Architecture project standards IA CB02, "GIS Horizontal Spatial Reference System," and IA-D802, "Geospatial Positioning Accuracy Standard for A/E/C/ and Facility Management." All coordinates will be expressed as State Plane Coordinate System, North American Datum 83, New Mexico Central Zone, U.S. survey ft. All elevation data will be reported relative to the National Geodetic Vertical Datum of 1983.
Management, Characterization, and Storage of IDW	The IDW will be managed, characterized, and stored in accordance with an approved waste characterization strategy form that documents site history, field activities, and the characterization approach for each waste stream managed. Waste characterization will comply with on- or off-site waste acceptance criteria, as appropriate. All stored IDW will be marked with appropriate signs and labels. Each waste generated container will be individually labeled with waste classification, item identification, and radioactivity (if applicable) immediately following containerization. All waste will be segregated by classification and compatibility to prevent cross-contamination.
Field Quality Control Samples	Field QC samples will be collected as follows. Field duplicate samples and equipment blanks will be collected at a frequency of 10% at the same time as a regular sample is collected and submitted for the same analyses. Trip blanks will be collected whenever samples were collected for VOC analysis. Trip blanks will be collected at a frequency of one sample per day or 1 per 20 VOC samples, whichever is greater, when VOC samples are collected. Trip-blank containers will consist of certified clean sand that are opened and kept with the other sample containers during the sampling process.
Field Decontamination of Equipment	Dry decontamination will be the preferred method to minimize generating liquid waste. Dry decontamination will include using a wire brush or other tool to remove soil or other material adhering to the sampling equipment, followed by applying a commercial cleaning agent (i.e., Fantastik) and paper wipes.

Table 5.0-2
Analytical Methods for Surface and Subsurface Characterization

Analytical Method	Analytical Description	Analytical Suite
Inorganic Methods		
EPA Method 300	Ion chromatography	Anions (nitrates)
EPA SW-846: 9012A	Colorimetric	Cyanide
EPA SW-846: 6010B/6020	Inductively coupled plasma emission spectrometry—atomic emission spectroscopy	Aluminum, antimony, arsenic, barium, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, sodium, silver, thallium, vanadium, and zinc (TAL metals)
EPA SW-846: 6850	Liquid chromatography/ mass spectrometry	Perchlorate
Organic Methods		
EPA SW-846:8270C	Gas chromatograph/ mass spectrometry	SVOCs
EPA SW-846:8260B	Gas chromatograph/ mass spectrometry	VOCs
EPA SW-846:8082	Gas chromatograph	PCBs
EPA SW-846:8330	High performance liquid chromatography	Explosive compounds
EPA SW-846:8280A/8290	Gas chromatography/ high-resolution mass spectrometry	Dioxin/furans
Radionuclide Methods		
HASL-300	Chemical separation/ alpha spectrometry	Isotopic plutonium, isotopic uranium
EPA 901.1M	Gamma spectroscopy	Cesium-134, cesium-137, cobalt-60, europium-152, sodium-22, and ruthenium-106

Appendix A

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

A-1.0 ACRONYMS AND ABBREVIATIONS

AK	acceptable knowledge
AOC	area of concern
asl	above sea level
bgs	below ground surface
BMP	best management practice
BV	background value
CMP	corrugated metal pipe
COC	chain of custody
DOE	U.S. Department of Energy (U.S.)
EP	Environmental Programs (Directorate)
EPA	Environmental Protection Agency (U.S.)
ER	Environmental Restoration Project
eV	electron volt
FFCA/AO	Federal Facility Compliance Agreement/Administrative Order
FV	fallout value
GPS	global-positioning system
HE	high explosives
HEU	highly enriched uranium
HIR	historical investigation report
I.D.	inside diameter
IDW	investigation-derived waste
IP	individual permit
LANL	Los Alamos National Laboratory
LASCP	Los Alamos Site Characterization Program
LLW	low-level radioactive waste
MCO	Mortandad Canyon observation
MSGP	Multi-Sector General Permit
NMED	New Mexico Environment Department
NOI	notice of intent
NPDES	National Pollutant Discharge Elimination System
NFA	no further action
PCB	polychlorinated biphenyl

PID	photoionization detector
PPE	personal protective equipment
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RLWTF	Radioactive Liquid Waste Treatment Facility
RPF	Records Processing Facility
SAL	screening action level
SCL	sample collection log
SMA	site monitoring area
SMO	Sample Management Office
SOP	standard operating procedure
SSL	soil screening level
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TA	technical area
TAL	target analyte list
TPH	total petroleum hydrocarbon
TW	test well
VOC	volatile organic compound
WAC	waste acceptance criteria
WCSF	waste characterization strategy form
XRF	x-ray fluorescence

A-2.0 METRIC CONVERSION TABLE

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

A-3.0 DATA QUALIFIER DEFINITIONS

Data Qualifier	Definition
U	The analyte was analyzed for but not detected.
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.
J+	The analyte was positively identified, and the result is likely to be biased high.
J-	The analyte was positively identified, and the result is likely to be biased low.
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.
R	The data are rejected as a result of major problems with quality assurance/quality control (QA/QC) parameters.

Appendix B

Management Plan for Investigation-Derived Waste

B-1.0 INTRODUCTION

This appendix describes how investigation-derived waste (IDW) generated during the Lower Mortandad/Cedro Canyons Aggregate Area investigation will be managed by Los Alamos National Laboratory (the Laboratory). IDW may include, but is not limited to, drill cuttings, excavated media, excavated man-made debris, contact waste, decontamination fluids, and all other waste that has potentially come into contact with contamination.

B-2.0 IDW

All IDW generated during investigation activities will be managed in accordance with the current version of standard operating procedure (SOP) EP-ERSS-SOP-5238, Characterization and Management of Environmental Program Waste (http://www.lanl.gov/environment/all/qa/adep.shtml). This SOP incorporates the requirements of all applicable U.S. Environmental Protection Agency (EPA) and New Mexico Environment Department (NMED) regulations, U.S. Department of Energy orders, and Laboratory requirements.

The most recent version of the Laboratory's Hazardous Waste Minimization Report will be implemented during the investigation to minimize waste generation. The Hazardous Waste Minimization Report is updated annually as a requirement of Module VIII of the Laboratory's Hazardous Waste Facility Permit.

A waste characterization strategy form (WCSF) will be prepared and approved per requirements of EP-ERSS-SOP-5238, Characterization and Management of Environmental Program Waste. The WCSF will provide detailed information on IDW characterization methods, management, containerization, and potential volumes. IDW characterization is completed through review of sampling data and/or documentation, or by direct sampling of the IDW or the media being investigated (e.g., surface soil, subsurface soil, etc.). Waste characterization may include a review of historical information and process knowledge to identify whether listed hazardous waste may be present (i.e., due diligence reviews). If low levels of listed hazardous waste are identified, a "contained in" determination may be submitted for approval to NMED. Data currently available for the aggregate area do not identify polychlorinated biphenyl (PCB) concentrations greater than 1 mg/kg.

Wastes will be containerized and placed 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. The initial management of waste will rely on the data from previous investigations and/or process knowledge. Container and storage requirements will be detailed in the WCSF and approved before the waste is generated. Table B-2.0-1 summarizes how waste will be managed.

The waste streams anticipated to be generated during work plan implementation are described below.

B-2.1 Drill Cuttings

This waste stream consists of soil and rock chips generated by the drilling of boreholes for the intent of sampling. Drill cuttings include excess core sample not submitted for analysis and any returned samples sent for analysis. Drill cuttings will be containerized in 55-gal. drums or other appropriate containers at the point of generation. The initial management of cuttings will rely on the data from previous investigations and/or process knowledge. Cuttings will be managed in secure, designated areas appropriate to the type of waste. If new analytical data changes the expected waste category, the waste will be managed in accumulation areas appropriate to the final waste determination.

Cuttings will be land applied if they meet the criteria in the NMED-approved Notice of Intent (NOI) Decision Tree for Land Application of Investigation Derived Waste Solids from Construction of Wells and Boreholes. This waste stream will be characterized based either on direct sampling of the waste or on the results from core samples collected during drilling. If directly sampled, the following analyses will be performed: volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), explosive compounds and nitrates (if screening indicates the presence of explosives), radionuclides, total metals, and if needed, toxicity characteristic metals. If process knowledge, odors, or staining indicate the cuttings may be contaminated with petroleum products, the materials will also be analyzed for total petroleum hydrocarbons (TPH) and PCBs. Other constituents may be analyzed as necessary to meet the waste acceptance criteria (WAC) for a receiving facility. The Laboratory expects most cuttings will be land applied or disposed of as a low-level waste at Technical Area 54 (TA-54), Area G.

B-2.2 Excavated Environmental Media

A small amount (i.e., approximately 1 yd^3) of contaminated soil is expected to be excavated at Consolidated Unit 05-005(b)-00. This material will be field screened for metals, radioactivity, and VOCs during the excavation process. Soils that the screening data indicate are contaminated with metals above industrial soil screening levels will be excavated and placed in 55-gal. drums or other appropriate containers at the point of generation. A representative sample of the excavated soil will be collected and analyzed for VOCs; target analyte list (TAL) metals; explosive compounds, if screening indicates the presence of explosives; radionuclides; and toxicity characteristic metals, as needed. Other constituents may be analyzed as necessary to meet the WAC for a receiving facility. If process knowledge, odors, or staining indicate the soils may be contaminated with petroleum products, the materials will also be analyzed for TPH and PCBs. Based on existing data, the Laboratory expects excavated soils to be designated as industrial waste or low-level radioactive waste (LLW).

B-2.3 Excavated Man-made Debris

A small amount (i.e., less than 55 gal.) of debris from burning a former structure is expected to be excavated at Consolidate Unit 05-005(b)-00. This debris includes melted glass, electrical fixtures, and charred wood. As debris is removed, it will be placed in 55-gal. drums or other appropriate containers at the point of generation. The debris will be characterized by acceptable knowledge (AK) (i.e., observation of the materials present, field screening, and the results of sampling of the soil beneath the debris). If necessary, a representative sample of the debris will be collected and analyzed for VOCs; TAL metals; explosive compounds, if screening indicates the presence of explosives; radionuclides; and toxicity characteristic metals, as needed. Other constituents may be analyzed as necessary to meet the WAC for a receiving facility. If process knowledge, odors, or staining indicate the debris may be contaminated with petroleum products, the materials will also be analyzed for PCBs. Based on existing data, the Laboratory expects debris to be designated as industrial waste or LLW.

B-2.4 Contact Waste

The contact waste stream consists of potentially contaminated materials that “contacted” waste during sampling and excavation. This waste stream consists primarily of, but is not limited, to personal protective equipment (PPE) such as gloves; decontamination wastes such as paper wipes; and disposable sampling supplies. Characterization of this waste stream will use AK of the waste materials, the methods of generation, and analysis of the material contacted (e.g., drill cuttings, soil, etc.). Contact waste will be managed in secure, designated areas appropriate to the type of the waste. If new analytical data change the expected waste category, the waste will be managed in accumulation areas appropriate to the final waste determination. The Laboratory expects most of the contact waste to be designated as nonhazardous, nonradioactive waste that will be disposed of at an authorized facility or as LLW to be disposed of at TA-54, Area G.

B-2.5 Decontamination Fluids

The decontamination fluids waste stream will consist of liquid wastes from decontamination activities (i.e., decontamination solutions and rinse waters). Consistent with waste minimization practices, the Laboratory employs dry decontamination methods to the extent possible. If dry decontamination cannot be performed, liquid decontamination wastes will be collected in containers at the point of generation. The decontamination fluids will be characterized through AK of the waste materials, the levels of contamination measured in the environmental media (e.g., the results of the associated drill cuttings), and, if necessary, direct sampling of the containerized waste. If the waste is directly sampled, the following analyses will be performed: VOCs, SVOCs, radionuclides, total metals, and, if needed, toxicity characteristic metals. Additional analyses may be required by the WAC of the facility that will treat the waste. The Laboratory expects most of these wastes to be nonhazardous liquid waste or radioactive liquid waste that will be sent to one of the Laboratory's wastewater treatment facilities whose WAC allow the waste to be received.

Table B-2.0-1
Summary of Estimated IDW Generation and Management

Waste Stream	Expected Waste Type	Expected Disposition
Drill cuttings	LLW if not reusable	Land application or disposal at TA-54, Area G
Excavated environmental media	Industrial, hazardous, LLW, or mixed	Disposal at an approved off-site disposal facility or on-site at TA-54, Area G
Excavated man-made debris	Industrial or LLW	Disposal at an approved off-site disposal facility or on-site at TA-54, Area G
Contact waste	Nonhazardous or LLW	Disposal at an approved off-site solid waste disposal facility or on-site at TA-54, Area G
Decontamination fluids	Nonhazardous or LLW	Treatment at an on-site wastewater treatment facility