LA-UR-07-6429
October 2007
EP2007-0569

Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary

Los Alamos
NATIONAL LABORATORY
EST. 1943

Prepared by the Environmental Programs Directorate

LA-UR-07-6429
EP2007-0569

Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary

October 2007

Responsible project leader:

John McCann		Project Leader	Environmental Programs	10-26-07
Printed Name	Signature	Title	Organization	Date

Responsible LANS representative:

Susan G. Stiger		Associate Director	Environmental Programs	10/28/07
Printed Name	Signature	Title	Organization	Date

Responsible DOE representative:

David Gregory		Federal Project Director	DOE-LASO	10/29/07
Printed Name	Signature	Title	Organization	Date

EXECUTIVE SUMMARY

This investigation work plan presents the proposed investigation activities at solid waste management units (SWMUs) and areas of concern (AOCs) (collectively referred to as sites) located at Technical Area (TA) 49 outside the nuclear environmental site (NES) boundary. The purpose of this work plan is to complete the Resource Conservation and Recovery Act facility investigation by defining the nature and extent of potential contamination at the sites included in this work plan and to obtain general site characterization data for the evaluation of remedial alternatives.

TA-49 sites will be investigated under two separate work plans in accordance with the March 1, 2005, Compliance Order on Consent (Consent Order): “Investigation Work Plan for the Technical Area 49 Sites Inside the Nuclear Environmental Site Boundary” and “Investigation Work Plan for the Technical Area 49 Sites Outside the Nuclear Environmental Site Boundary” (this document). TA-49 sites outside the NES boundary include nine SWMUs and AOCs. Two sites, SWMUs 49-007(a) and 49-007(b), are not included in this work plan because they were approved for no further action by the U.S. Environmental Protection Agency and do not require additional action under the Consent Order.

Seven SWMUs and AOCs are included in this work plan. However, surface-soil contamination at AOCs 49-008(a) and 49-008(b) is deferred per Table IV-2 of the Consent Order. Therefore, no surface investigation will be conducted at AOCs 49-008(a) and 49-008(b). Subsurface investigations will be conducted at all sites, including AOCs 49-008(a) and 49-008(b). This work plan also includes two nondeferred sites [AOC 49-005(b) and SWMU 49-006] contained within the boundaries of AOC 49-008(a), which is deferred per Table IV-2 of the Consent Order. Although this work plan does not propose surface sampling for the encompassing deferred sites, it does include subsurface sampling for nondeferred sites within the boundaries of deferred sites.

To facilitate the discussion of and activities proposed for these sites, the SWMUs and AOCs included in this work plan are subdivided into the following three areas according to their locations and operational histories:

- Area 5: AOC 49-005(b), SWMU 49-006, and AOC 49-008(a): Main Control Area
- Area 6: SWMU 49-004 and AOC 49-008(b): Burn Site and Landfill and General Support Area
- Area 10: AOC 49-002 and SWMU 49-005(a): Underground Calibration Chamber and Shafts and Landfill

The main activities associated with the investigations are (1) conducting geodetic and geophysical surveys to locate SWMUs and AOCs and associated subsurface structures, historical sampling locations, and proposed sampling locations; (2) sampling surface and near-surface soil; and (3) drilling boreholes and performing subsurface sampling.

CONTENTS

Figures

Tables

Appendixes

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 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 between 6200 and 7800 ft above mean sea level (amsl).

The Laboratory's Environmental Programs (EP) Directorate, formerly the Environmental Restoration Project, is participating in a national effort by DOE to clean up sites and facilities formerly involved in weapons research and development. The goal of the 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, the EP Directorate is 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 (NMHWA), 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 (Consent Order) issued pursuant to the NMHWA, New Mexico Statutes Annotated (NMSA) 1978, § 74-4-10, and the New Mexico Solid Waste Act, NNMSA 1978, § 74-9-36(D). This work plan describes proposed work activities that will be executed and completed in accordance with the Consent Order, as well as those activities needed to meet DOE requirements for radiological contamination.

Nine SWMUs and AOCs are located outside of the nuclear environmental site (NES) boundary: AOC 49-002; SWMUs 49-004 and 49-005(a); AOC 49-005(b); SWMU 49-006; and AOCs 49-007(a), 49-007(b), 49-008(a), and 49-008(b). Two of these, AOCs 49-007(a) and 49-007(b), are not included in this work plan because they have been approved for no further action (NFA) by the U.S. Environmental Protection Agency (EPA) (EPA 2005, 088464) and do not require additional action under the Consent Order. This work plan includes two nondeferred sites [AOC 49-005(b) and SWMU 49-006], which are contained within the boundaries of AOC 49-008(a). Surface-soil contamination at AOCs 49-008(a) and 49-008(b) is deferred per Table IV-2 of the Consent Order. Therefore, no surface investigations are proposed for AOCs 49-008(a) and 49-008(b), except for sampling at transformer pads located within AOC 49-008(a). Sampling will be conducted at the transformer pads because the associated contaminants are distinguishable from firing site activity contaminants. The nondeferred sites [AOC 49-005(b) and SWMU 49-006] are subsurface structures with no surface expression. Although this work plan does not propose sampling for the encompassing deferred sites, it does include subsurface sampling for AOC 49-005(b) and SWMU 49-006, which are located within the boundaries of the deferred site, AOC 49-008(a) (Table 1.1-1).

To facilitate the discussion of and activities proposed for these sites, the SWMUs and AOCs included in this work plan are subdivided into the following three areas according to their locations and operational histories:

- Area 5: AOC 49-005(b), SWMU 49-006, and AOC 49-008(a): Main Control Area
- Area 6: SWMU 49-004 and AOC 49-008(b): Burn Site and Landfill and General Support Area
- Area 10: AOC 49-002 and SWMU 49-005(a): Underground Calibration Chamber and Shafts and Landfill

The site descriptions and operations as well as historical investigations are summarized for each SWMU and AOC in the following sections and are included in detail in a separate historical investigation report (HIR) (LANL 2007, 098523).

1.1 General Site Information

Technical Area (TA) 49, also known as the Frijoles Mesa site, occupies approximately 1280 acres along the south-central boundary of the Laboratory. The mesa is centrally located on the Pajarito Plateau at an average elevation of approximately 7140 ft amsl. The plateau is roughly midway between the Jemez Mountains to the west and the White Rock Canyon of the Rio Grande to the east. TA-49 is located within the Ancho, North Ancho, and Water Canyon watersheds. The northern boundary of TA-49 is defined by the edge of the Frijoles Mesa, which overlooks Water Canyon, and forms the southern boundaries of TA-15 and TA-37. State Highway 4 forms the southwest boundary of TA-49 as well as the Laboratory's boundary with Bandelier National Monument. The southeast boundary of TA-49 is formed by TA-39. Table 1.1-1 lists all SWMUs and AOCs included in TA-49 outside the NES boundary.

A period of intense experimental activity at TA-49 took place from late 1959 to mid-1961, during which hydronuclear and related experiments deposited significant amounts of plutonium, uranium, lead, and beryllium in underground shafts. These experiments were conducted in subsurface shafts located at Material Disposal Area (MDA) AB (Areas 2, 2A, and 2B) and Areas 1, 3, and 4. These areas are the subject of the "Investigation Work Plan for the TA-49 Sites Inside the Nuclear Environmental Site Boundary" (LANL 2007, 098491). Facilities in Areas 5 and 10 were used to support the experiments at the test shaft areas. Uncontaminated materials generated at these facilities were deposited into a landfill and burn site in Area 6. Additionally, general site cleanups conducted in 1971 and 1984 resulted in the disposal of uncontaminated structure debris and materials into the Area 6 landfill and the creation of small landfills at Areas 5 and 10 (LANL 1992, 007670, pp. 6-4-6-9).

The location of TA-49 is shown in Figure 1.1-1, and the location of each TA-49 SWMU and AOC is presented in Figure 1.1-2.

1.2 Investigation Scope and Objectives

This investigation work plan describes the sampling supplemental to the Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) work plan for Operable Unit (OU) 1144 (LANL 1992, 007670) for Areas 5, 6, and 10. This investigation work plan complies with requirements specified in Section IV.C.4 of the Consent Order for the completion of TA-49 investigations, as well as the format requirements for investigation work plans. This investigation work plan presents the rationale for the remaining surface and subsurface sampling and analysis for Areas 5, 6, and 10. This work plan will determine the nature and extent of contamination in soil and sediment at TA-49 and obtain general site characterization data for the evaluation of remedial alternatives.

2.0 BACKGROUND

2.1 Site Operational History

Before 1959, the Laboratory recognized there were potential safety problems with nuclear weapons in the nation's stockpile. These problems were related to the possibility of a significant nuclear yield because of accidental detonation of the device's high-explosives (HE) component. The possibility of detonation during the assembly stage or while the device was stored in the arsenal required further investigation. Underground experiments were designed and conducted to assess this potential problem. Historical aspects of the decision to conduct the experiments are contained in a Laboratory report (Thorn and Westervelt 1987, 006672, pp. 1-3). The favorable environmental setting of Frijoles Mesa, combined with its relatively remote location and the flat terrain that afforded desirable operational characteristics, led to the selection of the site for the experiments. In fall 1959, TA-49 was created on Frijoles Mesa, and underground experiments were conducted through August 1961. The central portion of TA-49 was devoted to the underground experiments conducted in Areas 1, 2 (MDA AB), 3, and 4 (Figure 1.1-2). These areas are described in an HIR and investigation work plan for the sites within the NES boundary (LANL 2007, 098492; LANL 2007, 098491).

Between 1959 and 1961, auxiliary areas were operated to support the experiments conducted at TA-49. Area 5 served as the central control area for the hydronuclear and related experiments conducted at MDA AB and Areas 1, 3, and 4. Area 6 contains an inactive landfill and open burning area used for the disposal of solid material generated from activities conducted elsewhere at TA-49 and a general support area. Area 10 contains a calibration chamber used to perform tests related to the hydronuclear tests performed at TA-49. A network of buried cables radiating out from the main control area (Area 5) allowed for remote electronic measurements of the hydronuclear experiments. Most of these cables were later removed and disposed in landfills at TA-49 (LANL 1997, 056594, pp. 3-4). Lead shielding was used in Areas 5 and 10 and may be present in surface soil. Based on the detailed historical information available, it is evident that other chemicals were used in very limited quantities at TA-49 (LANL 1992, 007670, p. 3-8).

Between 1959 and 1961, nonradioactive materials were burned or buried at SWMU 49-004 in Area 6. This open burning/landfill area was also used for the burial of uncontaminated materials generated during general site cleanups in 1971 and 1984 (LANL 1992, 007670, p. 6.4-9). In 1977, the La Mesa fire burned much of TA-49, destroying essentially all remaining combustible structures at the site (LANL 1992, 007670, p. 3-10). As part of the 1984 cleanup, two small landfills [AOC 49-005(b) at Area 5 and SWMU 49-005(a) at Area 10] were created to bury uncontaminated construction debris (LANL 1992, 007670, p. 3-11). Extensive interviews with site personnel and archival searches indicate that all of these landfills were used for the burial of uncontaminated debris (LANL 1992, 007670, pp. 6.3-3-6.3-12). All radioactively contaminated surface debris from the various TA-49 cleanup campaigns was transported to the Laboratory's low-level radioactive waste disposal sites at TA-50 and TA-54 (LANL 1997, 056594, p. 4).

Since the hydronuclear experiments ceased in summer 1961, TA-49 has been used lightly and sporadically (DOE 1987, 008663; DOE 1987, 008664). In 1965, a Laboratory group studying atmospheric phenomena conducted lightning observation experiments using the photographic tower that remained in Area 5. The primary historic use of TA-49 as a buffer zone for activities at adjacent firing sites (TA-15 and TA-39) is expected to continue indefinitely according to the Laboratory's "Ten-Year Comprehensive Site Plan" (LANL 2001, 070210).

Currently, there are only a few small-scale on-site uses of TA-49. The Laboratory's High-Power Microwave Group occasionally uses the Day Room building 49-115 and its immediate vicinity for

equipment development and the roadway between Areas 10 and 12 as a microwave test range.
The Laboratory's Hazardous Devices Team (HDT) uses the HDT training facility building-49-113 and the associated HE magazine building 49-114 for small-scale explosives training exercises.

Building 49-113 also houses the Laboratory's Alternate Emergency Operations Center. This facility is equipped with extensive communications systems and computers. In addition, the building is used for routine classroom training and houses the HDT office. The Laboratory conducts electrical grounding measurements in a small area immediately west of the HDT's Training Facility.

The Laboratory also maintains the Bandelier Meteorological Station in the southeast portion of TA-49 as part of its network of meteorological stations (LANL 1992, 007670, p. 3-12).

2.2 Conceptual Site Model

Releases from the TA-49 sites outside the NES boundary can be organized into two general categories: (1) potential subsurface contamination associated with the sumps at Area 5, the open burning/landfill area at Area 6, and the calibration chamber at Area 10; and (2) localized surface and near-surface contamination associated with limited surface releases and subsequent transport via operational activities over corridors and the surface-water pathway.

The presence of surface contamination is primarily attributed to the tracking of contaminated material brought to the surface during the release event associated with the shaft 2-M incident (section 2.2 of the "Investigation Work Plan for the TA-49 Sites Inside the Nuclear Environmental Site Boundary") (LANL 2007, 098491) and, to a lesser extent, is associated with localized operations at the testing and support areas. Surface contamination observed during previous investigations indicates a sporadic heterogeneous distribution of contaminants with a generally low correlation of radionuclide and inorganic chemical collocation. Primary transport pathways focus on the potential for surface-water runoff and erosion by water and air. The mesa setting at TA-49 provides a predominately flat topography, with the exception of SWMU 49-005(a), which is located northeast of Area 10 on a slope toward Water Canyon.

Permeability and dominant transport potential are variable for the stratigraphic units beneath TA-49 (Figure 2.2-1). Generalized characteristics for each are described below.

- The Tshirege Member of the Bandelier Tuff (Qbt) is characterized by low matrix permeability and high fracture permeability where fractures are present. Fracturing is more abundant in the upper cliff-forming unit of Qbt 3 and characteristic of Qbt 2 (Broxton and Reneau 1995, 049726, pp. 15-17). In borehole location 49-02901, it was noted that only a few irregular fractures are present in the first 35 ft within the unit and four subvertical fractures with mineral coatings from 243 to 255 ft below ground surface (bgs) within Qbt 2 (Stimac et al. 2002, 073391, p. 8).
- Pumiceous units such as the Tsankawi Pumice Bed (Qbt t), the Cerro Toledo interval (Qct), and the surge bed at the base of Qbt 4 are characterized by low fracture permeability and high matrix permeability.
- The Otowi Member of the Bandelier Tuff (Qbo) is a relatively homogenous ash-flow tuff unit and is characterized by low fracture permeability and low matrix permeability.

The subsurface conceptual site model (CSM) at TA-49 includes the following key elements (LANL 1992, 007670, pp. 4-54-4-55).

- The transport of contaminants through the unsaturated zone to the regional aquifer is not a pathway of immediate concern because of the very thick unsaturated zone and low percolation rate at the site.
- The movement of contaminants by percolating water in the unsaturated zone is expected to occur primarily as suspended solids.
- Although fractures may facilitate contaminant transport, this should only occur above critical water content; therefore, matrix flow is expected to be the dominant transport mechanism.
- Unit contacts and characteristics (e.g., the surge bed at the base of Qbt 4, the vapor-phase notch at the base of Qbt 1v-c, the Tsankawi Pumice Bed [Qbt t], and the Cerro Toledo interval [Qct]) can strongly affect lateral flow.
- Significant saturated flow is unlikely, but transient, rather than steady conditions, may describe near-surface conditions.

The sites outside the NES boundary contain a low inventory of mobile constituents and a small inventory of strongly adsorbing constituents. The necessary drivers for contaminant mobility in the vadose zone include saturated or near-saturated conditions or a significant vapor phase; none of which are anticipated due to low present-day infiltration conditions across the site.

One-hundred forty-six boreholes and test shafts have been drilled at TA-49 to depths ranging from 10 to 1821 ft. No perched water was encountered in any of these boreholes and test shafts, and with the exception of core hole CH-2, the holes have remained dry since they were drilled.

Moisture-monitoring data at TA-49 support the CSM under native conditions. Since 1959, water content of tuff in native areas has been measured in the unsaturated zone. Moisture content tends to be very low, ranging from 5% to 10% by volume to depths of approximately 100 ft (Weir and Purtymun 1962, 011890, pp. A-1-A-3; LANL 2005, 092389). Near-surface water content measured from locations within the boundary of the evapotranspiration (ET) cover and the former asphalt pad at MDA AB tend to be slightly higher, ranging from 5% to 20% by volume to depths of approximately 30 ft (LANL 2005, 092389, pp. A-3-A-6). Continuous moisture monitoring of the near-surface cover material at Area 2 shows that seasonal impulses of water are readily removed in the spring and summer when ET is maximized.

No substantial direct human exposure routes (other than those created by deliberate excavation of the materials during remediation) have been identified for contaminants in deeply buried waste units at TA-49. The likelihood is high that future land use at TA-49 will not change significantly over the 100-yr period assumed for institutional control and it will remain industrial. Table 2.1-1 provides the industrial soil screening levels for TA-49.

2.2.1 Potential Receptors

A detailed discussion of potential receptors can be found in the “RFI Work Plan for OU 1144” (LANL 1992, 007670, pp. 4-47-4-50). At present, the relevant human receptor at TA-49 contaminants is an on-site worker. In the case of contaminated surface soil, inhalation, dermal contact, external irradiation, and incidental ingestion are identified as the most likely exposure pathways.

2.3 Area 5: Central Control Area

Area 5 served as the main control area for the hydronuclear and related experiments conducted at TA-49 from 1959 to 1961 (LANL 1992, 007670, p. 6.4-2). Area 5 originally consisted of an approximately 250 ft × 300 ft fenced area that was later expanded by an additional area of 90 ft × 150 ft to the northeast corner of the site. Figure 2.3-1 illustrates Area 5 with associated SWMUs and AOCs. A 1960 site sketch shows 25 structures (mostly transportable buildings, such as trailers) (LANL 1992, 007670, p. 6.4-6) (Figure 2.3-2). Many experimental support activities were also located in this area. Most of the structures were located in the eastern half of Area 5. An elevated tower (building 49-96), located in the northwest corner of Area 5, was used to photograph hydronuclear and related experiments in Areas 1 through 4. Photographic activities probably occurred for the most part in a trailer (J-13-3) that contained a darkroom with a drainline (LANL 1992, 007670, p. 6.4-2). Trailer J-11-4 housed a radiochemistry laboratory. Waste chemicals from operations in the laboratory were bottled for off-site disposal. Lead sheets (used in trailers J-11-4 and J-16-8) and lead bricks were used as shielding during the counting of low-level radioactive samples. Lead bricks were also stored on the north edge of Area 5 (LANL 1992, 007670, pp. 6.4-6.8).

The Zia Engineering diary indicates that in November 1959 two sump holes were drilled in Area 5 (1960-1962, 098490). The exact number of sumps drilled and their ultimate use is unknown, however, because no sumps are shown on any of the engineering drawings of Area 5 (LANL 1997, 056594, p. 67). The sumps possibly were used to dispose of small volumes of chemicals, notably, spent photographic solutions. Engineering drawings also show that the underground counting room (structure 49-67) was equipped with a concrete sump for drainage collection (LANL 1992, 007670, p. 6.4-2). It is unknown whether the sump ever collected chemical liquids. However, the small size of the sump (1.5 ft × 1.5 ft) indicates that the volume of collected liquids (if any) was very small.

Electrical transformers were located just west and north of the Area 5 fence. Transformer oil of unknown composition was used, but the volume is likely to have been very small (LANL 1992, 007670, p, 6.4-8).

During 1960 or 1961, an 8-ft-deep × 6-ft-diameter hole in the floor of structure 49-8 was used in calibration activities (LANL 1992, 007670, p. 6.4-2).

Operations in Area 5 never involved large amounts of hazardous or radioactive materials (LANL 1992, 007670, p. 6.4-8). Activities in Area 5 after 1961 were very limited, and almost all structures were removed or destroyed primarily during routine equipment removal in 1964 and major cleanup campaigns in 1971 and 1984. Other combustible structures were destroyed by the La Mesa fire in June 1977 (LANL 1992, 007670, p. 6.4-9).

Chemicals of potential concern (COPCs) are inorganic chemicals; radionuclides are around the structure locations; polychlorinated biphenyls (PCBs) are at the two electrical transformer locations; and semivolatile organic compounds (SVOCs) are at the sump and landfill. The total quantity of photographic solutions generated during all Area 5 activities probably was less than a few hundred gallons (LANL 1992, 007670, p. 6.4-9). Any release that might have occurred would likely have been through drains to the sump or to nearby soil. Airborne and other inadvertent transport of extremely low levels of radionuclides from Area 2 (and possibly from Areas 1, 2A, 2B, 4, and 11) to Area 5 soil is a possibility. Small amounts of metallic debris remain on the surface (LANL 1992, 007670, pp. 6.4-6.9).

2.3.1 AOC 49-005(b): Small Landfill

2.3.1.1 Site Description

AOC 49-005(b) is a small landfill that was used to dispose of uncontaminated construction debris from the 1984 cleanup operations at Area 5 (Figure 2.3.1). The landfill was created within the concrete-walled basement of the counting room and has dimensions of less than 10 ft × 10 ft × 10 ft (LANL 1992, 007670, p. 6.4-9).

2.3.1.2 1995 RFI

In 1995, a radiological survey was performed at Areas 5, 6, and 10 using a portable gamma spectrometer for field detection of low-energy radiation. The purpose of the survey was to detect the presence of low-energy, gamma-emitting radionuclides in surface soil. An area of elevated activity was defined as having a gamma spectrometer measurement corresponding to an activity of 10 pCi/g or greater (LANL 1997, 056594, p. 6).

The radiological survey at AOC 49-005(b) was performed as part of a larger grid (40 ft × 40 ft grid) survey conducted at AOC 49-008(b). Based on the field-screening radiation survey results, no radiologically contaminated areas were identified, and no additional surface sampling sites were selected at the landfill location (Blair 1996, 055332). Three surface samples were collected from the site of the landfill and analyzed by gamma spectroscopy at an analytical laboratory. A summary of the results is presented in section 2.4.2 within the context of the broader investigation at AOC 49-008(b).

Two boreholes were drilled into the landfill, which is contained within the concrete-walled basement of the counting room; the tops of the walls were still visible during the 1995 RFI. Each core was screened for radiation and organic vapors. There was no detectable alpha activity from the cores, and the beta/gamma measurements ranged between 120 and 200 counts per minute (cpm); the normal laboratory background is from 150 to 250 cpm. All photoionization detector (PID) measurements were less than 1 part per million (ppm). Boreholes could only be drilled to a depth of 5 ft before the concrete counting room floor was encountered (LANL 1997, 056594, p. 74).

Borehole samples from the 1995 Phase I RFI were collected and submitted for gamma spectroscopy, SVOC, and target analyte list (TAL) metals analyses. No SVOCs were detected in samples collected from AOC 49-005(b). Potassium was detected above background value (BV) in one surface soil sample. Total uranium was detected above BV in two surface soil and two fill samples. Cesium-137 and plutonium-238 were each detected in one fill sample; plutonium-239/240 was detected in two fill samples (LANL 1997, 056594, p. 77). Sample locations and concentrations detected above BVs are shown in Figures 2.3-2 and 2.3-3. Organic sampling locations are illustrated in Figure 2.3-4. Tables 2.3-1 and 2.3-2 present the inorganic chemical and radionuclide results detected or detected above BVs or fallout values (FVs) for AOC 49-005(b).

2.3.2 SWMU 49-006: Sump

2.3.2.1 Site Description

SWMU 49-006 is the location of a sump in Area 5 (Figure 2.3.1). Historical engineering documents discuss the construction of two sumps in Area 5 in 1959, although no other existing records or drawings confirm the presence of these sumps. Photographic liquids may have been discharged to a sump from a trailer that housed a darkroom. A radiochemistry laboratory in one of the trailers is another potential source of liquid at Area 5, although this material was reportedly disposed off-site (LANL 1992, 007670, p. 6.4-8).

2.3.2.2 Subsurface RFI

The 1995 RFI Phase I included performing a radiological survey of the site and installing a borehole at the purported sump location. Because no records defined the sump location, the sample location was based on the presence of vegetation believed to indicate increased infiltration associated with a sump. This location was also near the former location of the photography trailer. One 10-ft deep borehole was drilled at this location, and samples were collected from the surface and the depth interval of 5 ft to 10 ft. Each sample was submitted for gamma spectroscopy, SVOCs, and TAL metals analyses. No organic chemicals were detected in samples collected from SWMU 49-006. Cadmium, copper, lead, uranium, and zinc were detected above BVs in one surface soil sample. Plutonium-238 was detected in one sample collected in unit Qbt 4 (LANL 1997, 056594, pp. 67-83). Sample locations and concentrations detected above BVs are shown in Figures 2.3-2 and 2.3-3. Tables 2.3-3 and 2.3-4 present the inorganic chemical and radionuclide results detected or detected above BVs or FVs for SWMU 49-006.

2.3.3 AOC 49-008(a): Area of Potential Soil Contamination

2.3.3.1 Site Description

AOC 49-008(a) consists of contaminated surface soil from the central control area operations. These operations included a darkroom, radiochemistry laboratory, and calibration facility (Figure 2.3.1). The types of waste generated included

- photographic materials (potentially discharged to SWMU 49-006);
- perchloric, hydrofluoric, and hydrochloric acids and solvents (LANL 1992, 007670, p. 6.4-8); and
- radionuclides used at the calibration facility; however, the radioactive wastes are believed to have been disposed elsewhere at the Laboratory (LANL 1992, 007670, pp. 6.4-7-6.4-8).

Two electrical transformer pads are located directly outside the northeast and northwest corners of Area 5. It is not known whether the transformer oil contained PCBs. The “RFI Work Plan for OU 1144” described oil staining on the concrete pad that housed the northwest transformer station (structure 49-14) (LANL 1992, 007670, p. 6.4-8).

2.3.3.2 Surface RFI

A radiological survey was performed on a 40 ft × 40 ft grid within the fence at Area 5 using a portable gamma spectrometer. No elevated radiation levels were detected. Fifty-seven surface soil samples were collected (54 samples and 3 field duplicates) on the same grid used in the radiological survey. These samples were field screened for gross beta/gamma radiation and volatile organic compounds (VOCs) and sent to a laboratory for analysis of radionuclides by gamma spectroscopy. Additionally, 25% of the surface samples (14 samples) were randomly selected for analysis for TAL metals (LANL 1997, 056594, pp. 69-71).

Five surface samples were collected from the two transformer pads (two at each pad plus one field duplicate). Before sampling, each of the sample locations was field screened for beta and gamma radiation and VOCs. No elevated radiation levels were detected, and VOCs were measured at less than 1 ppm. The five samples were screened for gross alpha and beta radiation at the Laboratory’s Counting Facility and for PCBs at the Laboratory Organic Analysis Group.

Antimony, arsenic, cobalt, iron, lead, nickel, and silver were detected above BVs in one surface soil sample. Copper was detected above BV in four surface soil samples. Uranium was detected above BV in 15 surface soil samples. Zinc was detected above BV in two surface soil samples. Plutonium-239/240 was detected above its FV in one surface soil samples. Europium-152 was detected in three surface-soil samples. Aroclor-1260 was detected at the northeast transformer station location (LANL 1997, 056594, pp. 74-83). Sample locations and concentrations of sample analytes detected or detected above BVs are shown in Figures 2.3-2 and 2.3-3. Tables 2.3-5 and 2.3-6 present the inorganic chemicals and radionuclides detected above BVs or FVs for AOC 49-008(a). A summary of the organic chemical screening-level sample results is presented in Table 2.3-7.

2.4 Area 6 East: General Support Area and Area 6 West, Open Burning/Landfill Area

Area 6 consists of two primary areas: Area 6 East, a general support area, and Area 6 West, an open-burning/landfill area. Area 6 East contains two SWMUs that have been approved for NFA by EPA: AOC 49-007(a) was a septic system used to accommodate sanitary wastes from structures in Area 6 and the hazardous device team's training area and AOC 49-007(b) was a leach field associated with a septic system near the HDT's training facility (EPA 2005, 088464).

2.4.1 SWMU 49-004: Open Burning Area/Landfill

2.4.1.1 Site Description

SWMU 49-004 is an inactive open burning area and landfill in Area 6 West used from 1959 to 1961 for open-pit burning of combustible construction materials and for the burial of uncontaminated residues generated during hydronuclear and related activities in other areas of TA-49 (Purtymun and Stoker 1987, 006688). Wastes disposed at this site were reportedly screened for radioactivity before burial to verify that they were uncontaminated (LANL 1992, 007670, p. 6.3-6). No documentation exists concerning disposal of hazardous chemicals, but this is unlikely based on the nature of activities conducted at TA-49. During the 1971 cleanup of TA-49, the landfill was reopened for disposal of uncontaminated materials, principally from Area 11. Similarly, the site was reopened during a 1984 general cleanup of TA-49 when a disposal trench 30 ft × 100 ft × 15 ft was constructed for uncontaminated solid materials (LANL 1992, 007670, p. 6.3-7). Figure 2.4-1 illustrates Area 6 West.

The "RFI Work Plan for OU 1144" (LANL 1992, 007670) describes four open trenches located west of SWMU 49-004, although not part of SWMU 49-004. The work plan also indicates that these previously undocumented trenches were identified from a review of historical aerial photographs. The trenches were not present in photographs taken in 1935 but were present in photographs taken in 1954, 1965, and 1977. Construction of these trenches, therefore, appears to predate activities at TA-49. The trenches were examined during a 1991 field inspection and noted to be approximately 10 ft × 6 ft × 100 ft. One trench appeared to have been backfilled, and one passed through a prehistoric ruin. No evidence of debris was present in or around the trenches. The trenches may be related to mine-claim activities before the property was acquired in the 1940s. However, investigation of available regional mining records shows no reference to the TA-49 area (Eller 1991, 055331). The work plan also noted that interviews and archival searches did not identify additional information concerning these trenches (LANL 1992, 007670, pp. 6.3-11-6.3-12). The possibility that the trenches were utilized by the Laboratory for material disposal or other purposes cannot be categorically excluded (LANL 1997, 056594, p. 52).

2.4.1.2 Non-RFI

In 1987, an environmental survey (A411 survey) collected and analyzed surface soil and vegetation samples at the open burning/landfill. Soil-sample results showed elevated levels of some radionuclides, lead, and beryllium. However, these elevated concentrations were localized and discontinuous (LANL 1992, 007670, p. 6.3-7).

In June 1991, a geophysical survey was carried out at the open burning/landfill area to define the limits of the landfill. Strong magnetic and electromagnetic anomalies were observed for this area because of the considerable quantities of cable and other metallic debris known to be buried in the landfill. It is apparent that the trench extends northeast about 130 ft beyond the staked area and nearly to the edge of Water Canyon, indicating that the total landfill lateral dimensions are approximately 35 ft × 330 ft (LANL 1992, 007670, pp. 6.3-7-6.3-10).

Evaluation of the results of the geophysical survey revealed that the 1987 A411 sampling locations were not over the main body of the landfill (LANL 1992, 007670, p. 6.3-11).

2.4.1.3 1995 RFI

In 1995, a radiological survey was conducted on a 25 ft × 25 ft grid at SWMU 49-004. Based on the gamma spectroscopy survey, an additional 18 survey points were added at the northwest corner of the grid. No radiologically contaminated areas were identified, but several locations had field-screening results above background (Blair 1996, 055332). Twenty-seven surface samples were collected from 26 locations on a sampling grid established over the disposal area defined by the 1991 geophysical survey. The samples were field screened for beta/gamma radiation and VOCs and submitted for analysis by gamma spectroscopy. Fifty percent of the samples were also analyzed for isotopic plutonium, total uranium, and TAL metals. Radionuclides detected above BVs included americium-241, cesium-137, plutonium-239, and plutonium-240. Inorganic chemicals detected above BVs included copper, lead, manganese, mercury, potassium, uranium, and zinc (LANL 1997, 056594, pp. 53-67).

A gamma survey was conducted on a 10 ft × 10 ft grid over the open trenches. No radiologically contaminated areas were detected (LANL 1997, 056594, p. 53). Nine surface samples were collected from eight locations on the grid. Samples were field screened for beta/gamma radioactivity and VOCs. Five samples from four locations were submitted for analysis for inorganic chemicals by an analytical laboratory (LANL 1997, 056594, pp. 53-67).

Boreholes were drilled at seven locations approximately 50 ft apart along the longitudinal axis of the disposal area. Boreholes were advanced to a depth of 15 ft bgs or until undisturbed tuff was encountered, whichever occurred first. Cores were collected for each 5-ft interval; samples were collected from each core interval for laboratory analysis.

All samples were field screened for beta/gamma radiation and VOCs and submitted for analysis by gamma spectroscopy. Ten samples (at least one from each borehole) were submitted for laboratory analysis for TAL metals and SVOCs. Radionuclides detected above BVs included americium-241, cesium-137, plutonium-239, and plutonium-240. One organic chemical, 2-chloronaphthalene, was detected. Inorganic chemicals detected above BVs included aluminum, barium, calcium, chromium, copper, magnesium, manganese, nickel, potassium, uranium, vanadium, and zinc (LANL 2007, 098523).

Single auger holes were drilled at three of the four open trenches and the soil was examined. Each site had 1.5 to 3 ft of clay soil underlain by pumice. This same pumice material was on the piles of excavated soil at the ends of the trenches. No foreign debris was seen in the augered cuttings. Beta/gamma field screening of the cuttings indicated measurements below BV. Based on field observations, it appeared that no material was buried in the trenches (LANL 1997, 056594, p. 53). No further investigation is proposed for these trenches.

Sample locations are shown in Figures 2.4-2, 2.4-3, and 2.4-4. Tables 2.4-1, 2.4-2 and 2.4-3 present the organic chemical detected and inorganic chemicals and radionuclides detected or detected above BVs or FVs for SWMU 49-004. The inorganic chemical screening-level sample results are presented in Table 2.4-4.

2.4.2 AOC 49-008(b): Area of Potential Soil Contamination

2.4.2.1 Site Description

Area 6 East, AOC 49-008(b), occupies an approximately 150 ft × 700 ft area developed as a general support area for hydronuclear testing at TA-49 from 1959 to 1961. This site included storage and office buildings and structures used by carpenters and electricians. A small lead-casting shop may also have operated at Area 6. Materials formerly stored at Area 6 included cables, pipes, and sand for backfilling experimental shafts. In addition, a boneyard area of approximately 400 ft^2 was used to store lumber, fencing, and steel. To maintain a separation between construction support activities and experimental testing activities, as well as for security and safety reasons, Area 6 East was deliberately located at a distance away from the central testing area. There were no documented releases during the period of operation. All the structures were removed in 1977 (LANL 2004, 088048, p. 3). Figure 2.4-5 depicts Area 6 East and associated SWMUs and AOCs. Figure 2.4-6 depicts AOC 49-007(b) that received NFA approval from EPA.

After 1977, building 49-115 (used for equipment development and storage) and five storage trailers were located in the area. Currently, the area contains building 49-115 and two storage trailers (structures 49-131 and 49-132) used by the Laboratory's High Power Microwave Group (LANL 2004, 088048, pp. 3-4).

As described in the "RFI Work Plan for OU 1144," the only known contamination incident at Area 6 East was related to a 1960 release from an experimental shaft at MDA AB. Some of this contamination was reportedly tracked into Area 6 East. It is likely that this contamination was low level, very localized, and quickly cleaned up (LANL 1992, 007670, pp. 6.3-12-6.3-13).

2.4.2.2 Surface RFI Surface

In 1995, a radiological survey was performed across all of Area 6 East. No elevated radiation levels above BV were detected; therefore, 21 surface soil samples were randomly collected from the grid. Each sample was field screened for beta/gamma radiation and submitted for gamma spectroscopy analysis. Twelve samples collected from soil at AOC 49-008 (a) were analyzed for TAL metals, total uranium, and isotopic plutonium. Inorganic chemicals detected above BVs were mercury and thallium, each at a single discrete location. Total uranium was detected above BV in eight surface soil samples. No radionuclides were present above BVs or FVs (LANL 2004, 088048, pp. 6-9).

Sample locations and concentrations of sample analytes detected above BVs or FVs are shown in Figures 2.4-7 and 2.4-8. Table 2.4-5 presents the inorganic chemicals detected above BVs for AOC 49-008(b).

2.5 Area 10: Calibration Chamber and Small Landfill

In 1960 and 1961, experimental measurements and calibrations were performed in a calibration chamber located at Area 10 (AOC 49-002). The calibration tests were related to the hydronuclear tests performed elsewhere at TA-49. The calibration chamber consisted of two vertical shafts. One of the shafts was an elevator shaft used to transport personnel and equipment to the underground calibration chamber. The second shaft, known as the calibration shaft, was used to place a portable pulse neutron source over the samples in the calibration room (LANL 1992, 007670, p. 6.5-2). Figure 2.5-1 illustrates Area 10 and the related SWMUs and AOCs.

After 1961, the chamber was used for experiments that did not involve radioactive or hazardous materials, the only exception being small radioactive sources for radiochemical counting, which were thought to have been removed at the conclusion of each experiment (LANL 1997, 056594, pp. 24-25).

During the 1984 general site cleanup at TA-49, a small landfill, SWMU 49-005(a), was created to dispose of uncontaminated debris. The landfill was located 50 to 100 ft north east of the calibration chamber. The exact characteristics of the material disposed at the landfill are not known, but it is believed to be primarily composed of wood and small pieces of metal. The potential COPCs for SWMU 49-005(a) include inorganic chemicals and radionuclides (LANL 1997, 056594, pp. 24-25).

2.5.1 AOC 49-002: Calibration Chamber Facility

2.5.1.1 Site Description

AOC 49-002 is an underground experimental calibration chamber and two associated shafts located in Area 10. This site was used for calibration tests associated with hydronuclear experiments performed elsewhere at TA-49 in 1960 and 1961. Each shaft is approximately 6 ft to 7 ft × 64 ft One is an elevator shaft used to transport personnel and equipment; an elevator building previously located over the elevator shaft has been removed. The other shaft is the calibration shaft. The shafts are connected at the bottom by a tunnel or gallery that is 4 ft × 7 ft × 12 ft. The calibration room, which is 14 ft × 10 ft, was lined with 8 in. of reinforced concrete faced with a 1-in. steel plate. The calibration shaft was used to place a portable pulse neutron source over calibration samples placed in the calibration room. A hydraulic lift platform at the bottom of the calibration room was connected to a hydraulic oil reservoir at the surface. Concrete radiation shields at the top of the calibration shaft are still in place. A concrete pad around the top of both shafts served as a foundation for the elevator building and shielding wall and is still in place.

The entrances to both shafts have been covered with concrete blocks. The elevator shaft is believed to still be open, while the calibration shaft was reportedly backfilled with soil and crushed tuff. Other surface features, including the hydraulic oil reservoir, have been removed. Small amounts (e.g., milligram quantities) of enriched uranium were occasionally released through spallation from critical assemblies during tests, although this material generally was cleaned up. Operation of the pulse neutron source may have activated surrounding soil and structures, but by now, activation products should have decayed to undetectable levels. The total volume of hydraulic oil in the lift system was estimated to be less than 100 gal. and is not believed to contain PCBs. Use of the site after 1961 did not involve hazardous materials other than small radioactive sources used for radiochemical counting (LANL 1992, 007670, pp. 6.5-1-6.5-6).

2.5.1.2 Surface RFI

In 1995, a radiological survey was conducted; no measurements above BV were detected. Surface samples were collected from 12 locations determined using a sampling grid around the pads at the tops of the shafts. All 12 samples were field screened for beta/gamma radiation and submitted for analysis by gamma spectroscopy; 6 samples were also submitted for analysis of TAL metals. One additional sample was collected from the location of the former hydraulic oil reservoir. This sample was field screened for beta/gamma radiation and submitted for gamma spectroscopy, TAL metals, SVOC, and PCB analyses. No radionuclides were detected above BVs. Inorganic chemicals detected above their BVs included antimony, copper, lead, mercury, silver, and zinc. No organic chemicals were detected (LANL 1997, 056594, pp. 23-35).

Sample locations and concentrations of sample analytes detected above BVs are shown in Figures 2.5-2, 2.5-3, and 2.5-4. Table 2.5-1 presents the inorganic chemicals detected above BVs for AOC 49-008(a).

2.5.2 SWMU 49-005(a): Landfill

2.5.2.1 Site Description

SWMU 49-005(a) is an inactive landfill located east of Area 10 at TA-49. The landfill, described as a small pit, was constructed north of the road that runs east from Area 10 and is approximately 50 ft to 100 ft northeast of the Area 10 experimental chamber and shafts (AOC 49-002). SWMU 49-005(a) reportedly was constructed in 1984 as a disposal area for nonradiological contaminated debris that resulted from the 1984 general surface cleanup of TA-49 (LANL 1997, 056594, p. 25).

2.5.2.2 1995 RFI

In 1995, a radiological survey was conducted over the landfill area; no measurements above background were detected. Samples were collected from the surface intervals at two borehole locations and field screened for beta/gamma radiation and submitted for analysis by gamma spectroscopy, isotopic plutonium, TAL metals, and SVOCs. No radionuclides or organic chemicals were detected and no inorganic chemicals were detected above BVs (LANL 1997, 056594, pp. 25-35).

Two boreholes, one to a depth of 9 ft bgs and the other to a depth of 10 ft bgs, were drilled at the location of the landfill. One subsurface sample was collected from the lower 5-ft interval from each borehole. Samples were field screened for beta/gamma radiation and submitted for gamma spectroscopy, isotopic plutonium, total uranium, TAL metals, and SVOCs analyses. No radionuclides were detected above BVs. Plutonium-238 was detected above FV in one surface soil sample and was detected in one rock sample. Plutonium-239/240 was detected above FV in one surface soil sample. Inorganic chemicals detected above BVs were aluminum, barium, beryllium, calcium, chromium, cobalt, copper, iron, lead, magnesium, nickel, potassium, uranium, and vanadium. No organic chemicals were detected (LANL 1997, 056594, pp. 25-35).

Tables 2.5-2 and 2.5-3 present the inorganic chemicals and radionuclides detected above BVs at SWMU 49-005(a).

2.6 Non–RFI Surface Activities

Twelve sediment stations were established at TA-49 as part of the Environmental Surveillance program (LANL 1996, 054769). Two of the sediment stations, AB-2 and AB-3, were located in drainage areas to the northeast and northwest of Area 2. Radiochemical analyses conducted annually at these stations since 1979 have included tritium, cesium-137, plutonium-238, plutonium-239, gross alpha, gross beta, gross gamma, and total uranium. Two additional isotopes, americium-241 and strontium-90, were added in 1992 (LANL 2007, 098492).

The data for the two stations indicated that station AB-3 had levels of plutonium-238 and plutonium-239 greater than the other 11 stations, with the majority of the results being above background sediment values. All other constituents show a decreasing trend over time, and no other significant trends are observed with respect to the data. The data are summarized for sediment collection stations AB-2 and AB-3 in Table 3.8-3 of the HIR for the TA-49 sites inside the NES boundary (LANL 2007, 098492).

3.0 CONDITIONS

3.1 Topography

Soil at Areas 5, 6, and 10 has been disturbed. The soil was originally composed of Hackroy Series and Typic Eutroboralf soil. The soil is intermixed with patches of bedrock, which occurs predominantly near the edges of the mesa east of developed areas of TA-49. Hackroy soil is classified as Alfisols, in part reflecting the clayey subsurface horizon, and described in the “Soil Survey of Los Alamos County, New Mexico” (Nyhan et al. 1978, 005702) as, “The surface layer of the Hackroy soil is a brown sandy loam, or loam, about 10 cm thick. The subsoil is reddish brown clay, gravelly clay, or clay loam about 20 cm thick. The depth to tuff bedrock and effective rooting depth is 20 to 50 cm.” The fine-loamy Typic Eutroboralf soil consists of deep, well-drained soil formed in material weathered from tuff on nearly level to gently sloping mesa tops. The surface layer is a very dark grayish brown loam, sandy loam, or very fine sandy loam, about 5 cm thick. The subsoil is a brown loam over a clay loam about 55 cm thick. The substratum is a brown gravelly clay loam over reddish clay, which may or may not contain pumice. Permeability is considered moderately slow (Nyhan et al. 1978, 005702, p. 32).

Area 5 is located in the center of TA-49 where the slope is quite flat. At present, the only surface structures remaining in Area 5 are the DT-5A observation well enclosure (structure 49-101), the concrete pads of the former transformer station (structure 49-14), and the photographic tower (structure 49-96).

Areas 6 and 10 are located on relatively flat portions of Frijoles Mesa but have the greatest potential for runoff and erosion due to their proximity to Water Canyon. Area 6 (SWMU 49-004) is located northwest of Area 5 on the edge of the mesa near Water Canyon. Area 10 [AOC 49-002 and SWMU 49-005(a)] is located northeast of Area 5 on the edge of the mesa near Water Canyon (Figure 1.1-3). Surface structures in AOC 49-002 consist of six concrete pads. Two of the concrete pads cover the calibration and elevator shafts, which were a part of the calibration chamber. No surface structures remain at SWMUs 49-004 and 49-005(a).

3.2 Subsurface Conditions

The subsurface hydrology at TA-49 is dominated by unsaturated conditions. The top of the regional saturated zone occurs approximately 1170 ft bgs near the center of MDA AB at deep test well DT-5A. The upper 800 ft of the unsaturated zone is within the Bandelier Tuff (LANL 1992, 007670, p. 4-18). Refer to Figure 2.2-1 for a cross-sectional view of the site stratigraphy. The stratigraphy is based on data from well DT-5A (LANL 1992, 007670, p. 4-34). The stratigraphy from this well has been reinterpreted to match more recent stratigraphic nomenclature (Broxton and Reneau 1995, 049726).

Relatively small volumes of water move beneath the mesa tops of the Pajarito Plateau under natural conditions, due to low rainfall, high evaporation, and efficient water use by vegetation. During wetter years, vegetal growth is enhanced and is capable of removing larger volumes of available moisture. Atmospheric evaporation may extend within the mesas, further inhibiting downward flow (Rogers and Gallaher 1995, 049824, p. 27). Water content in the unsaturated zone within the tuff has been measured monthly or bimonthly in the unsaturated zone since 2000. It tends to range between 5% and 10% by volume under natural conditions (LANL 2005, 092389, pp. A-1-A-3).

3.2.1 Geology

A detailed description of the geology and regional setting of TA-49 can be found in Chapter 4 of the “RFI Work Plan for OU 1144” (LANL 1992, 007670, pp. 4-32-4-41). The information presented below summarizes the details of the OU work plan.

TA-49 lies on the east side of the Jemez Mountains volcanic field and on the west perimeter of the Española Basin of the Rio Grande rift. Factors that may affect the actual geometry and distribution of subsurface units beneath TA-49 include abrupt lateral and vertical facies variations in rock units, significant relief on paleotopographic surfaces on which rock units were deposited, and fault offsets in the older units that are masked by younger rocks. Exposed rock in the TA-49 vicinity is composed entirely of the Tshirege Member of the Bandelier Tuff (LANL 1992, 007670, p. 4-33).

In 1959, the stratigraphy of TA-49 was mapped using three deep test wells: DT-5A, DT-9, and DT-10 (Weir and Purtymun 1962, 011890, pp. 21-39). Later that year, four core holes (CH-1, CH-2, CH-3, and CH-4) provided additional information for mapping the stratigraphy of Area 2. Early studies used the 1960s nomenclature (Weir and Purtymun 1962, 011890, pp. 91-153). The rock column (from youngest to oldest) beneath TA-49 consists of the following.

- Approximately 640 to 670 ft of the Tshirege Member of the Bandelier Tuff, which is divided into six units, is based mainly on physical and mineralogical characteristics imparted by cooling. These units include multiple rhyolitic ignimbrite flow units, a widespread pyroclastic surge bed up to several feet thick, and numerous thin discontinuous surge deposits.
- Approximately 200 ft of the Otowi Member of the Bandelier Tuff. The Otowi Member also includes up to 91 ft of the Guaje Pumice Bed.
- Approximately 500 to 600 ft of deposits consists of interbedded Puye Formation conglomerates and Tschicoma Formation latites and quartz latites.
- Approximately 50 to 90 ft of the Totavi Lentil conglomerate (of the Puye Formation) has characteristic quartzite cobbles and other typical Precambrian lithologies.
- An undetermined thickness (at least 290 ft) is composed of undivided siltstones and sandstones of the Santa Fe Group.

A hydrogeologic report on TA-49 describes what now appears to be an unusual stratigraphic relation, given the current understanding of the stratigraphy. Some of the disputed layers and issues involve the Guaje Pumice Bed and the Tschicoma Formation quartz latites. Many of the discrepancies are due to variations in nomenclature for different units, but few of the discrepancies have been traced to misidentification of the lava source (Paliza Canyon Formation, Tschicoma Formation, and/or Cerros del Rio basalts) (Weir and Purtymun 1962, 011890, pp. 91-153).

In 1995, a revised stratigraphic nomenclature for the Bandelier Tuff was proposed to provide guidance for the consistent use of rock names to support a common stratigraphic framework for discussing the influence of geology on contaminant transport (Broxton and Reneau 1995, 049726).

In 1994, a 700-ft deep borehole (location 49-02901) was drilled southeast of Area 2 to provide supplemental information to the geologic map of TA-49 (Stimac et al. 2002, 073391, p. 1). Geologic field observations of adjacent canyons and geologic logs from borehole location 49-02901 indicate the following:

- The exposed bedrock stratigraphic sequence in Water Canyon is restricted to units of the Tshirege Member of the Bandelier Tuff. The Tshirege Member is a multiple-flow ash-flow sheet that forms a series of steplike vertical cliffs and sloping ledges along canyon walls. Canyon exposures immediately north of the borehole consist of, in ascending order, Qbt 1g, Qbt 1v, Qbt 2, Qbt 3, and Qbt 4 of the Tshirege Member.

- The borehole extended beneath the level of adjacent canyon floors; therefore, several unexposed units were discovered. These unexposed units included, in descending order, the Tsankawi Pumice Bed, tephras and volcaniclastic sediment of the Cerro Toledo interval, and the Otowi Member of the Bandelier Tuff. The bottom of the borehole coincided with the Otowi Member.
- Examination of moisture content indicates some lithologic control. The most prominent features of the moisture data indicate an abrupt increase in moisture content at the transition of the glassy (Qbt 1g) to devitrified (Qbt 1v) Tshirege Member, and at the Tsankawi Pumice Bed (Stimac et al. 2002, 073391, p. 1). The difference in moisture content between the Qbt 1g layer and the Qbt 1v layer may represent a preferential path for groundwater movement at the layer interface.

Figure 3.2-1 shows the stratigraphy encountered in borehole location 49-02901. In 1995, geologic logs, well construction records, and locations of wells drilled in Los Alamos were compiled and updated to address the evolution and current geologic nomenclature of the area (Purtymun 1995, 045344). Updated geologic nomenclature for select boreholes and monitoring wells within TA-49 are shown in Figures 3.2-2 through 3.2-12.

3.2.2 Surge Beds

Surge beds within the Bandelier Tuff are of particular interest with respect to the TA-49 subsurface hydrological conceptual model. A pyroclastic surge bed is found at a depth of about 60 ft in core hole CH-2. Surge beds tend to have a higher permeability than the surrounding tuff and may act as a capillary barrier, inhibiting downward transport of contaminants and promoting lateral flow, and potentially acting as a perching layer. For that reason, boreholes drilled through this surge bed are particularly important for searching for perched water.

At least 21 boreholes and 30 test shafts penetrate the surge bed layer located between Qbt 3 and Qbt 4 of the Bandelier Tuff at a depth of approximately 60 ft. No perched water was encountered at the surge bed layer within these boreholes and test shafts.

3.3 Exploratory Borings and Monitoring Wells

In 1959 and 1960, five deep test wells (DT-5, DT-5A, DT-5P, DT-9, and DT-10) were drilled through Frijoles Mesa. DT-5A, DT-9, and DT-10 were drilled into the regional aquifer and are used as groundwater-monitoring wells. These boreholes were drilled to determine the thickness of the tuff and volcanic sediment, the hydrologic characteristics of the regional aquifer, and to test for the presence of perched water. No perched water was found (Weir and Purtymun 1962, 011890). Table 3.3-1 provides a list of boreholes, completion details, and the current status of each well drilled at TA-49 greater than 15 ft deep. Figures 3.3-1 and 3.3-2 show borehole locations within TA-49.The basic construction of wells DT-5A, DT-9, and DT-10 is shown in Figure 3.3-3.

During the initial site characterization in 1959 and 1960, core holes CH-1, CH-2, CH-3, and CH-4 were drilled beneath MDA AB and cased with 2-in. galvanized pipe. These core holes, which range in depth from about 300 ft (CH-3 and CH-4) to 500 ft (CH-1 and CH-2), were drilled at the centers of the four main experimental areas to detail the geologic and hydrologic characteristics of the underlying tuff. The surface geology of the area was mapped and correlated with subsurface geology, as determined from logs of the test wells and other holes (Weir and Purtymun 1962, 011890).

Three additional boreholes (Alpha, Beta, and Gamma) were drilled in 1960 to acquire additional geologic information. Alpha was drilled just east of MDA AB, Beta was drilled into the floor of Water Canyon, and Gamma was drilled into the floor of Ancho Canyon (LANL 2007, 098492).

In 1994, seven RFI boreholes (four 10-ft boreholes, two 150-ft boreholes, and one 700-ft borehole) were drilled at locations within and near the asphalt pad at Area 2 (LANL 1997, 056594). Borehole location 49-02901 was drilled to a depth of 700 ft with a recovery to 692 ft. The primary objective of borehole location 49-02901 was to evaluate the potential contaminant transfer pathways for the near-surface and vadose zone to a depth of at least 700 ft across the potential water-perching Tshirege–Otowi contact.

Two 150-ft deep boreholes (locations 49-02906 and 49-02907) were drilled at or near proposed shot hole locations 2-G and 2-R in Area 2 (Figure 3.3-2) to evaluate the subsurface conditions below the depths of the shafts and to augment the existing moisture-monitoring holes, TH-1 through TH-5.

The 10-ft boreholes (locations 49-02902 through 49-02905) were drilled through the asphalt pad at Area 2 to provide information on the distribution of contaminants in the soil/fill material, to confirm the thickness and composition of the soil/fill, and to quantify the distribution of water underneath the pad at the soil/tuff interface.

3.4 Groundwater Conditions

3.4.1 Alluvial Groundwater

In 1990, three shallow monitoring wells were installed in Water Canyon downgradient of TA-49. No perched water zones were encountered during drilling activities. Springs and seeps are known to occur in the lower reaches of Water and Ancho Canyons, far downgradient of TA-49 (near the Rio Grande), but none have been identified within the boundaries of TA-49 (LANL 2007, 098492).

Lateral groundwater flow occurs between stratigraphic permeability barriers within the Bandelier Tuff. Lateral discharges from canyon walls or canyon bottoms could provide a potential for contaminant transport. However, this is not plausible, given the current average annual rainfall and infiltration quantities seen at TA-49 (LANL 1992, 007670, p. 4-21).

3.4.2 Perched Intermediate Groundwater

The three test wells (DT-5A, DT-9, DT-10) and other boreholes drilled within TA-49 have not indicated the presence of perched water in tuff or volcanics above the regional aquifer in spite of the presence of potential perching beds (Purtymun and Stoker 1987, 006688, p. 8). Perched groundwater beneath TA-49 has also not been indicated during subsurface moisture monitoring conducted at TA-49 from 2000 through 2005. The absence of perched water indicates that no recharge to the regional aquifer occurs through the Pajarito Plateau in the vicinity of TA-49 (Purtymun and Stoker 1987, 006688, p. 8).

3.4.3 Regional Groundwater

Deep groundwater beneath TA-49 is part of the regional aquifer that serves all of the municipal and industrial water use in Los Alamos County (Purtymun 1984, 006513). Little to no recharge occurs through the mesa tops of the Pajarito Plateau to the regional aquifer (LANL 2007, 098492).

The annual general facility information report provides updates to the topographic, geologic, and hydrologic data as they become available. Figure 3.4-1 shows the elevation of the top of the regional aquifer and groundwater-flow direction at the Laboratory (LANL 2007, 095364).

Beneath TA-49, the potentiometric surface of the regional aquifer beneath TA-49 lies completely within the Puye Formation and the Cerros del Rio basalt. Groundwater moves eastward and discharges into the Rio Grande through seeps and springs (Purtymun et al. 1980, 006048). Aquifer tests performed in the three deep test wells at TA-49 found the average groundwater velocity to be 345 ft/yr in the upper 490 ft of the aquifer. The gradient on the upper surface of the aquifer is about 40 to 60 ft/mi beneath the western and central portion of the plateau within the volcanic sediment portion. It steepens to 80 to 120 ft/mi as the aquifer moves into less permeable sediment of the Tesuque Formation (Purtymun and Ahlquist 1986, 014722).

Well DT-5A showed an approximate 4-ft water-level decline from 1960 to 1964. This decline was attributed to pumping of supply wells located to the north. Well DT-9 recorded a 3-ft water-level drop over a 21-yr period from 1960 to 1982. At well DT-10, water levels dropped 0.5 ft/yr from 1960 to 1967. These drops in water levels reflect the normal deep, groundwater-level trend for the region (Purtymun and Ahlquist 1986, 014722).

3.5 Surface-Water Conditions

Runoff and infiltration are the critical components of surface hydrology at TA-49. These mechanisms are the predominant pathways by which contaminants could be mobilized and transported from the site. There is no current evidence of a hydraulic connection between surface water and groundwater at TA-49. The surface hydrology features relevant to TA-49 include the following (LANL 1992, 007670, p. 4-12):

- Areas and pathways of surface water runoff and sediment deposition
- Rates of soil erosion, transport, and sedimentation
- Locations and sizes of areas of disturbed and undisturbed surface soil in drainages
- Infiltration versus runoff ratios
- Presence and effectiveness of sorptive media and/or hydraulic properties in retarding infiltration of waterborne contaminants
- Fate of infiltrating water on mesa tops (Weir and Purtymun 1962, 011890; Purtymun and Ahlquist 1986, 014722)

3.5.1 Surface-Water Runoff

Surface-water runoff potentially carries contaminants into surface water that drain off-site. The direction of surface-water runoff from Frijoles Mesa flows northward into Water Canyon, eastward into a tributary canyon to Ancho Canyon, or southward into Ancho Canyon (LANL 2007, 098492).

Runoff from summer storms on the Pajarito Plateau typically reaches a maximum discharge in less than 2 h and has duration of less than 24 h. (Purtymun et al. 1980, 006048). When the discharge rate is high, runoff can carry large masses of suspended and bed-load sediment as far as the Rio Grande. Spring snowmelt occurs at a much less intense rate (e.g., over a period of several weeks to months compared with a 24-h period). This lower flow rate also results in the movement of sediment but with less surface erosion than during the summer storms. Both Ancho Canyon and Water Canyon downgradient of TA-49 experience ephemeral flow caused by runoff during the intense summer storms and snowmelt events.

3.5.2 Surface-Water Quality

Surface-water-quality data have been collected for approximately 30 yr at the Beta borehole surface-water station in Water Canyon (about 2000 ft north of TA-49), in Water and Ancho Canyons at State Highway 4 and sporadically in drainages leading from the area following intense rainfall events.

No contamination of surface water at these locations by TA-49 contaminants has been identified in the 30 yr of monitoring (LANL 1992, 007670, p.4-45; LANL 2006, 093925).

3.5.3 Surface-Water Infiltration

Surface-water infiltration provides a potential mechanism by which contaminants may move into the subsurface (LANL 1992, 007670, p. 4-13). Surface-water infiltration studies conducted at Pajarito Canyon have indicated that infiltration through mesa-top soil into the tuff is not significant (LANL 2007, 098492). Surface-water infiltration pathways at TA-49 include

- native or disturbed soil,
- intact tuff,
- backfilled shafts, and
- fracture systems and boreholes.

ET processes limit the transfer of water to the Bandelier Tuff. The characteristics of the tuff (naturally low moisture content and high porosity) provide a large storage capacity for infiltrating fluid and likely inhibit infiltrating liquid from penetrating the thick unsaturated zone at TA-49 (LANL 1992, 007670, p. 4-14).

3.6 Institutional Controls

The current institutional controls at TA-49 include a fence with locked gate and security patrols of the area. These controls are expected to remain in effect throughout the institutional control period.

4.0 PROPOSED ACTIVITIES

4.1 Investigation Objectives

Upon review of the "RFI Work Plan for OU 1144" (LANL 1992, 007670) and documentation of RFI activities to date, it was determined that insufficient data exist to determine the nature and extent of contamination at Areas 5, 6, and 10. These include the following data needs.

- Vertical extent of subsurface radionuclide contamination in the center portion of Area 5, AOC 49-008(a) has not been defined.
- Nature and extent of potential contamination associated with the sump and drainlines in Area 5 (SWMU 49-006) have not been determined because these features have not been positively located.
- Vertical and lateral extent of inorganic chemical and radionuclide contamination for the open burning/landfill area in Area 6 (SWMU 49-004) and the small landfill associated with Area 10 [SWMU 49-005(a)] have not been defined.
- Vertical extent of contamination for the small landfill at Area 5 [SWMU 49-005(a)], which is located within the concrete walls and floor of the former counting room, has not been defined.
- Physical state of the calibration chamber and elevator shaft (AOC 49-002) and the extent of surface and subsurface contamination at Area 10 have not been determined.

The sampling proposed in this investigation work plan will define the nature and extent of surface and subsurface contamination at the nondeferred sites within Areas 5, 6, and 10. This approach has been developed to refine the surface and subsurface investigations prescribed in “RFI Work Plan for OU 1144” (LANL 1992, 007670), while satisfying the requirements of Section IV.C.4.c of the Consent Order.

4.2 Site Surveys

Before the initiation of investigation activities, the locations of all subsurface shafts and structures will be verified. Existing documentation (engineering drawings, surveys, site, and aerial photos) and site inspections will be evaluated against current coordinates in the Laboratory’s geographic information system database. Geodetic surveys will be conducted using existing surface expressions to correlate and verify the locations of disposal units, current and former monitoring locations, structures, and fence lines. Additional surveys such as ground-penetrating radar (GPR) or electromagnetic surveys may be used to refine and augment locations and dimensions of structures and utilities.

4.3 Surface Investigations

Previous investigations have identified sporadic low-level radionuclide and inorganic chemical contamination in surface soil (section 3.0 of the HIR associated with this work plan) (LANL 2007, 098523). The surface investigation strategy in this work plan focuses on defining the lateral extent of surface contamination at AOC 49-002, SWMUs 49-004 and SWMU 49-005(a), AOC 49-005(b), and SWMU 49-006, while providing additional data to define the nature of contaminants present. AOCs 49-008(a) and 49-008(b) are deferred per Table IV-2 of the Consent Order; therefore, no surface sampling is proposed for them in this work plan.

AOC 49-008(a) is a large area of potential soil contamination. Within the boundaries of AOC 49-008(a) are two nondeferred sites, SWMU 49-006 and AOC 49-005(b), which are subsurface structures with no surface expression, and two concrete transformer pads. Because AOC 49-008(a) is a deferred site, no surface sampling is proposed for it in this work plan. However, subsurface sampling is proposed for SWMU 49-006 and AOC 49-005(b). In addition, contaminant-specific surface sampling is proposed for the two transformer pads because the potential contaminants related to the transformers are distinguishable from the potential firing-site contaminants associated with AOC 49-008(a).

Before surface-soil sampling, a geophysical investigation will be conducted using GPR, electromagnetic surveys, or other appropriate methods to locate the sumps and SWMU 49-006 and to determine the extent of landfill SWMU 49-005(a). Before geophysical surveying is conducted, metal objects in the area of the survey, such as surface debris or metal fencing, will be removed to lessen background interference and increase the accuracy of these surveys.

4.3.1 Area 5: Transformer Pads

Surface sampling will be conducted at two transformer pads located within AOC 49-008 (a) because the potential contaminants related to the transformers are distinguishable from potential firing-site contaminants associated with this area. Eight surface samples will be collected around the perimeter (one sample on each side) of each transformer pad: four samples will be collected from 0 to 6 in. and another four will be collected from 6 to 18 in.

4.3.2 Area 6 West: SWMU 49-004 and Area 10: AOC 49-002 and SWMU 49-005(a)

The nature and extent of surface contamination in Area 6 West and Area 10 will be defined by a combination of systematic screening sampling and criteria-based biased analytical sampling that will bind the lateral extent of potential contamination. The results of previous sampling campaigns are used to establish a systematic sampling array in surrounding areas of previously detected inorganic chemicals or radionuclides (LANL 1997, 056594). Discrete samples will be collected from 0 to 6 in. and 6 to 18 in. on a 25-ft systematic grid that extends a minimum of 100 ft from the outermost historical concentrations above BVs or FVs. Each array consists of three categories of samples based on proximity to previous concentrations in excess of BVs or FVs (Figure 4.3-1). The categories are described below.

Soil samples will be collected using methods described in section 5.3.1. Dry decontamination methods will be utilized between sampling locations to avoid generation of liquid waste and minimize the investigation-derived-waste (IDW).

In order to characterize the nature and extent of contamination, two types of data will be collected from each grid array: (1) field-screening analyses will be conducted to determine gross alpha and gross beta levels, and (2) laboratory analyses will be conducted to obtain decision-level data to determine the nature and confirm the extent of contamination in surface soil. Two grab samples, one each from 0 to 6 in. and 6 to 18 in., will be collected from each sample location.

- Screening samples will be collected for gross alpha and gross beta analyses. These samples will be used to delineate locations with potential radiological contamination. To ensure quick turnaround of data, gross alpha, and gross beta samples will be screened at an on-site mobile radiological trailer or a local radiological laboratory. Sufficient sample material will be collected from each interval during sampling for subsequent submission of samples for laboratory analyses.
- Laboratory samples will be collected for gamma spectroscopy, isotopic americium, isotopic plutonium, isotopic uranium, and TAL metals analyses. Analytical suites and methods are presented in Table 4.3-1. Results will be obtained based on two criteria: previously defined contamination based on screening data and threshold values based on gross alpha and gross beta screening analyses. The threshold for conducting laboratory analysis is 25 pCi/g gross alpha and 50 pCi/g for gross beta. Appendix C provides the basis for gross alpha and gross beta thresholds.

Three categories of sampling locations are proposed within each sampling array.

Category 1—All sampling locations near historical concentrations of inorganic chemicals or radionuclides above BVs or FVs. For Category 1 sampling locations, the following samples will be collected.

- Screening samples—Discrete samples from 0 to 6 in. and 6 to 18 in. from all Category 1 sampling locations will be submitted for gross alpha and gross beta analyses.
- Biased laboratory samples—All Category 1 samples will be submitted for analyses for gamma spectroscopy, isotopic americium, isotopic plutonium, isotopic uranium, and TAL metals.
- Criteria-based biased samples—Discrete samples from 0 to 6 in. and 6 to 18 in. from all Category 1 sampling locations for which gross beta exceeds 50 pCi/g will be submitted for analyses for iodine-129, stronium-90, and technetium-99.

Category 2—Sampling locations within 50 ft of Category 2 sampling locations. For Category 2 locations, the following samples will be collected.

- Screening samples—Discrete samples from 0 to 6 in. and 6 to 18 in. from all Category 2 sampling locations will be submitted for gross alpha and gross beta analyses. Sufficient material will be collected from each interval for subsequent laboratory analyses based on criteria-based or systematic location selection.
- Systematic samples—Discrete samples from 0 to 6 in. and 6 to 18 in. from approximately 20% of Category 2 sampling locations will be submitted for laboratory analyses for gamma spectroscopy, isotopic americium, isotopic plutonium, isotopic uranium, and TAL metals. Category 2 systematic sampling locations have been preselected to provide spatial coverage around historical detections above BVs and FVs.
- Criteria-based biased samples—Discrete samples from 0 to 6 in. and 6 to 18 in. from all Category 2 sampling locations for which gross alpha results exceed 25 pCi/g will be submitted for laboratory analyses for gamma spectroscopy, isotopic americium, isotopic plutonium, isotopic uranium, and TAL metals. Sampling locations for which gross beta exceeds 50 pCi/g will also be submitted for analyses for iodine-129, stronium-90, and technetium-99.

Category 3—Sampling locations approximately 50 ft to 100 ft from Category 3 locations. Initial Category 3 sampling locations are spaced 50 ft apart across rows, with locations staggered between rows to provide spatial coverage. For Category 3 locations, the following samples will be collected.

- Screening samples—Discrete samples from 0 to 6 in. and 6 to 18 in. from all Category 3 sampling locations will be submitted for gross alpha and gross beta analyses. Sufficient material will be collected from each interval for subsequent laboratory analyses based on systematic or criteria-based selection.
- Systematic samples—Discrete samples from 0 to 6 in. and 6 to 18 in. from approximately 10% of Category 3 sampling locations will be submitted for analyses for gamma spectroscopy, isotopic americium, isotopic plutonium, isotopic uranium, and TAL metals. Category 3 systematic sampling locations have been preselected to provide spatial coverage around historical detections above BVs and FVs.
- Criteria-based biased analytical samples—Discrete samples from 0 to 6 in. and 6 to 18 in. from all Category 3 sampling locations for which gross alpha exceeds 25 pCi/g will be submitted for analyses for gamma spectroscopy, isotopic americium, isotopic plutonium, isotopic uranium, and TAL metals. Sampling locations for which gross beta exceeds 50 pCi/g will also be submitted for analyses for iodine-129, stronium-90, and technetium-99.
- If a Category 3 sample exceeds either of the criteria-based threshold values, all adjacent unsampled 25-ft grid locations will be submitted for gross alpha and gross beta analyses. The grid will be expanded at 25-ft increments to allow for complete characterization of extent of contamination. Any additional sampling locations exceeding gross alpha or gross beta thresholds will be submitted for appropriate laboratory analyses.

4.3.3 SWMU 49-004

SWMU 49-004 will be investigated to evaluate the nature and extent of contamination resulting from historical activities related to the landfill at Area 6 West. Figure 4.3-1 illustrates the surface-sampling grid pattern to be used for SWMU 49-004. Twenty-five Category 1 samples will be collected for field screening and laboratory analyses. One hundred twelve Category 2 samples will collected for screening, and a minimum of 23 Category 2 samples will be submitted for analyses (additional samples may be submitted for laboratory analyses based on the field-screening results). Sixty-eight Category 3 samples will be collected for screening, and a minimum of 14 Category 3 samples will be submitted for laboratory analyses (additional samples may be submitted for laboratory analyses based on the field-screening results).

4.3.4 AOC 49-008(b)

AOC 49-008(b) is deferred per Table IV-2 of the Consent Order. Therefore, no surface investigations are proposed for AOC 49-008(b) in this work plan.

4.3.5 AOC 49-002 and SWMU 49-005(a)

AOC 49-002 and SWMU 49-005(a) will be investigated to evaluate the nature and extent of contamination resulting from historical activities related to the calibration chamber and former debris landfill. Figure 4.3-2 illustrates the surface-sampling grid pattern to be used for AOC 49-002 and SWMU 49-005(a). Eight Category 1 samples will be collected for field screening and laboratory analyses in the vicinity of the former calibration chamber and shafts and the landfill. Sixty-three Category 2 samples will be collected for field screening gross alpha and gross beta analyses, and a minimum of 13 Category 2 samples will be submitted for laboratory analyses (additional samples may be submitted for laboratory analyses based on the gross alpha and gross beta field-screening results). Forty-six Category 3 samples will be collected for field screening gross alpha and gross beta analyses, and a minimum of 10 Category 3 samples will be submitted for laboratory analyses (additional samples may be submitted for laboratory analyses based on the field-screening results).

4.3.6 Sediment in Drainage Channels

The investigation of contamination potentially transported from SWMUs and AOCs into drainages and canyons downgradient of TA-49 is included in the "Investigation Work Plan for Technical Area 49 Sites Inside the Nuclear Environmental Site Boundary" (LANL 2007, 098491). The proposed investigation is designed to provide a comprehensive snapshot of contaminant inventory with each drainage feature at TA-49.

4.4 Subsurface Investigations

The following subsurface activities will be performed to characterize the nature and extent of contamination:

- Drilling of a vertical borehole down the center of each sump (2 possible) at SWMU 49-006
- Drilling of one angled borehole at the landfill at AOC 49-005(b)
- Drilling of four angled (45°) boreholes perpendicular to the landfill at SWMU 49-004

- Drilling of three vertical boreholes adjacent to and one angled (45°) borehole beneath the small landfill at SWMU 49-005(a)
- Collection of core samples from angled and vertical boreholes at regular (between 3 ft and 5ft dependent on borehole) intervals (Table 4.4-1)

The angled boreholes will allow sampling of soil beneath the landfills without disturbing the contents.

4.4.1 SWMU 49-006 and AOC 49-005(b)

Based on engineering records (LANL 1992, 007670, pp. 6.4-6.8), the two sumps of SWMU 49-006 are located at a depth of 40 ft and are 24 in. in diameter. The exact location of the sumps within Area 5 is unknown, and the sumps are thought to be filled with aggregate. The location of each sump will be determined using geophysical methods described in section 4.2. If located, one borehole will be drilled through each sump to a depth 5 ft beyond the total depth (TD) of the sump (approximately 40 ft) or 10 ft below the deepest detected contamination based on field screening. Subsurface samples will be collected every 5 ft for laboratory analyses for radionuclides, TAL metals, and organic chemicals (Table 4.4-1). The objective of these boreholes is to define the vertical extent of potential contamination associated with the sumps.

AOC 49-005(b) is a small landfill created within the concrete-walled basement of the former counting room. During the 1995 RFI, two boreholes were drilled into the structure encountering an obstruction (believed to be the basement floor) at a depth of 5 ft. The location of the landfill will be confirmed using methods described in section 4.2, and one angled borehole will be drilled such that it passes beneath the landfill approximately 10 ft below the base of the obstruction to determine the nature and extent of contamination beneath the concrete structure. Table 4.4-1 details the number of samples collected and which analyses will be performed. The borehole will be advanced along the center line of the landfill to a TD below the walls of the basement foundation or 10 ft below the deepest detected contamination based on field screening (Figure 4.4-1).

4.4.2 SWMU 49-004

Four angled (45° from horizontal) boreholes will be drilled beneath the SWMU 49-004 landfill at three surveyed points to characterize the nature and extent of contamination beneath the landfill. See Figure 4.4-2 for a schematic of these boreholes. The north and south boreholes will be drilled from the east side of the landfill to a depth of 55 ft (length of 78 ft). The central borehole will be drilled from the west and will have a depth of 65 ft (length of 92 ft). These boreholes will be located to ensure that they will be more than 5 ft distant from the landfill as it was documented by the 1991 geophysical survey (Geophex 1991, 008887). The boreholes will be continuously cored and field screened for radioactivity. Samples will be collected from the surface (0 to 6 in.), from the soil just above the soil (fill)/tuff interface, from the tuff immediately below the soil (fill)/tuff interface, and at the TD of the borehole and submitted for laboratory analyses. A minimum of 12 total samples will be collected and submitted for laboratory analyses for radionuclides and TAL metals (Table 4.4-1).

4.4.3 AOC 49-002 and SWMU 49-005(a)

The SWMU 49-005(a) landfill is believed to be located approximately 50 ft to 100 ft northeast of the calibration chamber. The exact location of the landfill and its lateral boundaries will be determined using geophysical techniques presented in section 4.2. Once the boundaries of the landfill have been defined, three vertical boreholes and one angled borehole will be drilled to determine the nature and extent of contamination in the subsurface (Figure 4.4-3). The vertical boreholes will be drilled to a minimum of 10 ft bgs or until field screening indicates that no contaminants are present. The angled borehole will be located 20 ft west of borehole location 49-07512 and will be drilled under the center line of the landfill from west to east a minimum of 20 ft terminating beneath the eastern edge of the landfill. All boreholes will be continuously cored and samples will be collected from the surface (0 to 6 in.) and from 5-ft intervals until TD. These samples will be submitted for laboratory analyses for radionuclides, SVOCs, VOCs, and TAL metals (Table 4.4-1).

A field assessment of AOC 49-002, calibration chamber, and elevator shaft will be made to ensure it can be safely sampled. Based on the findings of the field assessment, a geophysical survey of the underground chamber may be performed to determine the amount of fill in the shafts. Removal of the concrete pads and shielding will not occur. No sampling is proposed until stability of each shaft is determined.

4.4.4 Drilling Plan

Advancement of boreholes at AOC 49-002, SWMU 49-004s and SWMU 49-005(a), AOC 49-005(b), and SWMU 49-006 will be achieved by the air-rotary drilling method or hollow-stem auger (HSA). Air rotary is the preferred drilling method when access for a future monitoring system needs to be maintained. Drill bit control is necessary to avoid highly contaminated zones or exposure to potential hazards is possible.

Otherwise, HSA or hand augers for shallow boreholes will be utilized. The HSA 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 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 that samples may be retrieved during drilling operations. The hollow stem also acts to case the borehole core temporarily so that a well casing (riser) may be inserted down through the center of the auger once the desired depth is reached, minimizing the risk of possible collapse of the borehole.

Boreholes will be drilled in order of difficulty (from simple to complex) to optimize performance and minimize risk to workers, the public, and the environment. All core samples will be field screened for gross alpha, gross beta, and gross gamma activity before release and shipment to an analytical laboratory.

4.4.5 Sampling Plan

Core sampling will be conducted from intervals beginning at the ground surface to TD in all boreholes to determine the extent of subsurface contamination associated with each SWMU or AOC. All boreholes will be continuously cored to TD. One core barrel sample will be collected from every 5 ft of drill core. Additional samples will be collected from the following intervals:

- At the soil/tuff interface
- At the depth immediately below the base of the SWMU or AOC
- At first encounter with geologic units of different lithology, structural or textural characteristics, or relatively higher or lower permeability
- Soil or rock types more likely to sorb or retain contaminants than the surrounding lithology, field determination
- At first encounter with shallow or intermediate saturated zones, if present

- At intervals suspected of being source or contaminated zones
- At the maximum depth of each boring

The number of samples and intervals for each borehole is presented in Table 4.4-1. All samples will be field screened for gross alpha, gross beta, and gross gamma activity.

4.4.6 Analysis Plan

The selection of core samples to be submitted to an analytical laboratory will be based on the following criteria:

- The sample exhibiting the highest field-screening detection
- The sample obtained from the maximum depth in each boring that displays field-screening evidence of contamination
- The sample located at the base of a SWMU or AOC

Additional core samples may be collected based on field observations (such as the presence of fracturing, staining, and elevated moisture content) or to assess key lithologic or permeability characteristics (e.g., the surge bed at the base of Qbt 4 and the contact between the Tshirege and Otowi Members of the Bandelier Tuff).

All subsurface core samples will be submitted to an analytical laboratory for analyses of HE compounds, perchlorate, nitrate, cyanide, and TAL metals. If indicated by field screening, samples will also be analyzed for isotopic americium, isotopic plutonium, isotopic uranium, tritium, VOCs, and SVOCs . A summary of proposed boreholes and sampling is presented in Tables 4.4-1 and 4.4-2.

All new boreholes penetrating the surge bed (exceeding depths of approximately 60 ft) will be subject to geophysical testing, including borehole video, neutron logging, and natural gamma logging. If the borehole video indicates diameter variations, calipers will be used to measure the borehole diameter at depth.

Selected sections of core samples from the vertical boreholes at AOC 49-002, SWMU 49-005(a), AOC 49-005(b), SWMUs 49-004 and 49-006 will be analyzed for hydrogeologic properties such as unsaturated hydraulic conductivity, permeability, and van Genuchten hydraulic properties. Representative samples will be collected from each SWMU or AOC based on field determinations and in areas suspected to have contamination present. All boreholes will penetrate the surge bed (base of Qbt 4) if laterally present and at the base of Qbt 3. Based on the stratigraphy encountered in nearby well DT-5A, stratigraphic units potentially present at this depth include the Otowi Member, Guaje Pumice Bed, and the upper Puye Formation.

A summary of proposed boreholes and sampling is presented in Table 4.4-1. Analytical methods are presented in Table 4.4-2.

4.4.7 Groundwater Monitoring

For a discussion of groundwater monitoring, refer to “Investigation Work Plan for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary” (LANL 2007, 098491).

4.5 IDW

IDW generated during field investigation activities may include, but is 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 contaminants.

All IDW generated during the TA-49 field-investigation activities will be managed in accordance with applicable standard operating procedures (SOPs). These SOPs incorporate the requirements of all applicable EPA and NMED regulations, DOE orders, and Laboratory implementation requirements. Appendix B details the IDW management plan.

5.0 INVESTIGATION METHODS

A summary of investigation methods to be implemented is presented in Table 5.0-1. The SOPs used to implement these methods are available on the Laboratory Environmental and Remediation Support Services Division web page 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 (SOW) (LANL 2000, 071233). Accredited contract laboratories will use the most recent EPA and industry-accepted extraction and analytical methods for chemical analyses for analytical suites.

5.1 Field Surveys

The following sections describe the field surveys that will be conducted at Areas 5, 6, and 10.

5.1.1 Geodetic Surveys

Geodetic surveys will be conducted by a land surveyor in accordance with the latest version of SOP-03.11, Coordinating and Evaluating Geodetic Surveys, to locate historical structures and to document field activities such as proposed sampling and excavation locations. The surveyors will use a Trimble GeoXT hand-held global positioning system (GPS) or equivalent. 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 utilized will meet the accuracy requirements specified in the SOP.

5.1.2 Geophysical Surveys

Geophysical surveys may be performed at selected sites to verify the location, dimensions, total depth, base profile, topography, low elevation point, and downslope end of each disposal unit at Areas 5, 6, and 10 if such cannot be determined using as-built construction drawings and boring logs. The surveys will verify locations determined from engineering drawings, site reconnaissance, and geodetic surveys and will refine assessments of the subsurface structures and disposal areas. Geophysical methods employed may include electromagnetic, gravity, and GPR as appropriate to effectively delineate the materials or feature being surveyed.

5.2 Subsurface Characterization

5.2.1 Drilling Methods for Boreholes

Proposed boreholes at Areas 5, 6, and 10 will be drilled by HSA, air-rotary, or hand-auger methods as indicated in section 4.4.4. A brief description of these methods is provided below. More information can be found in SOP-04.01, Drilling Methods and Drill Site Management. Selected boreholes will be geophysically logged with caliper, camera, neutron, and natural gamma tools according to the current version of SOP-04.04, Contract Geophysical Logging, and SOP-07.05, Subsurface Moisture Measurements Using a Neutron Probe.

5.2.1.1 Air Rotary

The air-rotary method uses a drill pipe or drill stem coupled to a drill bit that rotates and cuts through soil and rock. The cuttings produced from the rotation of the drill bit are transported to the surface by compressed air, which is forced down the borehole through the drill pipe and returns to the surface through the annular space (between the drill pipe and the borehole wall). The circulation of the compressed air not only removes the cuttings from the borehole, but it also helps to cool the drill bit. The use of air-rotary drilling is best suited for hard-rock formations. In soft unconsolidated formations, casing is driven to keep the formation from caving. When air rotary is used, the air compressor will have an inline organic filter system to filter the air coming from the compressor. The organic filter system shall be inspected regularly to ensure that the system is functioning properly. In addition, a cyclone-velocity dissipater or similar air-containment/dust-suppression system will be used to funnel the cuttings to one location instead of allowing the cuttings to discharge uncontrolled from the borehole. Air rotary that employs the dual-tube (reverse-circulation) drilling system is acceptable because the cuttings are contained within the drill stem and are discharged through a cyclone-velocity dissipater to the ground surface.

5.2.1.2 HSA

The HSA 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 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 that samples may be retrieved during drilling operations. The hollow stem also acts to case the borehole core temporarily so that a well casing (riser) may be inserted down through the center of the auger once the desired depth is reached, minimizing the risk of possible collapse of the borehole. A bottom plug or pilot bit can be fastened onto the bottom of the auger to keep out most of the soil and/or water that have a tendency to clog the bottom of the augers during drilling. Drilling without a center plug is acceptable if the soil plug, formed in the bottom of the auger, is removed before sampling or installing a well casing. The soil plug can be removed by washing out the plug using a side-discharge rotary bit or auguring out the plug with a solid-stem auger bit sized to fit inside the HSA.

5.2.1.3 Hand Auger

Hand augers may be used to bore shallow holes (0 to 15 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. Motorized units for one or two operators may be used and can reach depths up to 30 ft under certain conditions.

5.2.2 Groundwater-Monitoring Well Installation

Section IV.C.4.c.vi of the Consent Order requires the installation of one groundwater-monitoring well, which intersects intermediate perched groundwater, if such groundwater is present beneath the site. If perched groundwater is encountered, the borehole will be completed as a single-completion well in accordance with the current versions of SOP-5.01, Well Construction, and SOP-5.02, Well Development. A plan for construction of the well will be submitted to NMED for approval before construction begins.

5.2.3 Vapor-Monitoring Well Installation

No vapor-monitoring wells are currently planned. If field screening indicates the presence of VOCs, samples will be collected and submitted for laboratory analysis. Vapor-monitoring wells will be installed if vapor-phase contamination is confirmed by field-screening results. Before vapor well construction, a vapor monitoring and sampling plan will be submitted to the NMED for approval.

5.2.4 Borehole Abandonment

All boreholes will be abandoned by one of the following methods.

- Boreholes, with a TD of 20 ft or less, will be abandoned by filling the borehole with bentonite chips and subsequently hydrated. Chips will be hydrated in 1–2-ft lifts. The borehole will be visually inspected while the bentonite chips are being added to ensure that bridging does not occur.
- Boreholes, greater than 20 ft in depth, will be pressure-grouted from the bottom of the borehole to the surface using the tremie pipe method. Acceptable grout materials include cement or bentonite grout, neat cement, or concrete.

The use of backfill materials such as bentonite and concrete will be documented in a field logbook with regard to volume (calculated and actual), intervals of placement, and additives used to enhance backfilling. All borehole abandonment information will be provided in the investigation report.

5.3 Sample Collection

5.3.1 Surface Samples

Although surface and shallow subsurface samples will be collected during drilling activities, the most common method for collecting these predominantly soil samples will be consistent with 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 over-the-counter cleaner, such as Fantastik or equivalent. Disposable tools made of polystyrene or Teflon will also be used, if necessary. In some cases, for deeper sample intervals, hand-augering tools, including power augers, will be used to collect subsurface samples if geologic material conditions permit. The tools to be used and their applicability are described in the current version of SOP-06.10, Hand Auger and Thin-Wall Tube Sampling. If the surface location is at bedrock, an axe or hammer and chisel will be used to collect samples.

Soil samples will be field screened using the methodologies described in the following sections and placed in the appropriate sample container(s) as grab samples collected with hand augers, scoops, or chiseling devices in accordance with the sampling guidance document and appropriate SOPs (SOP-01.01 through SOP-01.08).

5.3.2 Subsurface Samples

Following the current version of SOP-06.24, Sample Collection from Split-Spoon Samplers and Shelby Tube Samplers, and SOP-06.26, Core Barrel Sampling for Subsurface Earth Materials, subsurface samples will be collected from core extracted in a split-spoon core barrel. Samples collected for chemical analysis will be placed in the appropriate sample containers depending on the analytical method requirement in accordance with the current version of SOP-ENV-DO-206, General Instructions for Field Investigations. The analytical suites for the samples from each borehole will vary according to the data requirements as described in section 4.0 of this work plan.

Quality assurance/quality control (QA/QC) samples will include field duplicate samples, rinsate blanks, equipment blanks, trip blanks, and reagent blanks. These samples will be collected following the current version of SOP-01.05, 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 remain with analytical samples when collecting samples for VOC analysis. QA/QC samples are used to monitor the validity of the sample collection procedures.

Following the current version of SOP-12.01, field documentation of samples collected from fractures will include a detailed physical description of the fracture-fill material and rock matrix sampled. The volumes of fracture-fill and rock-matrix material included in the sample will be estimated from field measurements. Additional samples will be collected from the rock matrix adjacent to the fracture sample material allowing for comparison.

Field documentation will also 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.

5.3.3 Groundwater Samples

Perched intermediate groundwater may be encountered while the boreholes are advanced. If saturation is encountered as a borehole advances, drilling will be stopped to determine whether sufficient water volume is available for analysis. The total water volume required is approximately 0.5–1 L. If this minimum volume of groundwater cannot be collected, the borehole will be advanced to the targeted depth until saturation is encountered again and the process is repeated or until the required TD is achieved.
A porous cup lysimeter or absorbent membrane will be installed at the depth of saturation to monitor the zone if the borehole is completed for monitoring. Insufficient water-sample volumes from discrete depths will not be composited to make up the required volume for screening analysis.

If a sufficient volume exists, a groundwater sample will be collected and analyzed for TAL metals, explosive compounds, nitrate, VOCs, SVOCs, perchlorate, radionuclides (by alpha and gamma spectroscopy), alkalinity, nitrate, total organic carbon, total inorganic carbon, and total dissolved solids at a Laboratory-certified geochemistry laboratory. Typically, results of groundwater-screening samples are available within 48 h. During this time, the borehole may be advanced to the targeted depth, and the perched zone (and subsequent perched zones encountered during drilling) will be isolated to prevent downhole migration.

Geophysical logging will be conducted according to SOP-04.04, Contract Geophysical Logging, and SOP-05.07, Operation of LANL Owned Borehole Logging Trailer. Geophysical logging will determine the thickness of the zone of saturation and the characteristics of the perching horizon. A monitoring well design will be submitted to NMED for approval. Following approval of the design, the well will be installed, and a groundwater-monitoring plan will be included in the investigation report or the appropriate annual update of the "2007 Interim Facility-Wide Groundwater Monitoring Plan" (LANL 2007, 096665).

Groundwater samples from developed wells will be collected in accordance with SOP-06.01, Purging and Sampling Methods for Single Completion Wells. After a groundwater sample has been collected and processed, aliquots of the sample are placed in appropriate containers and preserved according to SOP-ENV-DO-206, Sample Container and Preservation. Requirements for sample volume, containerization, hold times, and detection limits are provided in the analytical services SOW (LANL 2000, 071233).

5.4 Field-Screening Method

The primary field-screening methods to be used on subsurface core include (1) visual examination and (2) radiological screening.

5.4.1 Radiological Screening

Radiological screening will target gross alpha-, beta-, and gamma-emitting radionuclides. Field screening will be conducted within 1 in. of the sampled material by a radiation control technician. All radiological screening will be conducted using an Eberline E-600 radiation meter with an SHP-380AB alpha/beta scintillation detector, or equivalent. This equipment consists of a dual phosphor plate covered by two mylar windows housed in a light-excluding metal body. The phosphor plate is a plastic scintillator for the detection of beta emissions and is thinly coated with zinc sulfide for detecting alpha emissions. The operational range varies from trace emissions to 1 million disintegrations per minute

Local background levels will be collected, at a minimum, twice daily, once in the morning and once in the afternoon. If more than one site is visited in a day, background levels will be calculated before work begins at each new site. Background will be measured from 10 locations surrounding the site and from known or suspected areas of radiological contamination. An average will be calculated to determine the local background level for the site. Radiological field screening will be conducted in accordance with SOP-10.14, Performing and Documenting Gross Gamma Radiation Scoping Surveys. All local background checks, background ranges, and calibration procedures will be documented daily in the field logbook in accordance with the current version of SOP-MAQ-011, Logbook Use and Control.

Boreholes completed using mechanical drilling methods will be advanced 25 ft beyond elevated field-screening results. If elevated field-screening results are recorded within 10 ft of the target depth, the borehole will be advanced using mechanical drilling methods in 5-ft intervals until no elevated field-screening results are recorded over a 10-ft interval.

5.5 Laboratory Analytical Methods

The analytical suites required for laboratory analyses vary by SWMU/AOC as specified in the scope of investigation activities for each area. All laboratory analytical suites are presented in the SOW for analytical laboratories (LANL 2000, 071233). Sample collection and analysis will be coordinated with the Sample Management Office (SMO).

5.6 Equipment Decontamination

Equipment for drilling and sampling shall be decontaminated before and after drilling and sampling activities (as well as between boreholes) to minimize the potential for cross-contamination.

Drilling/exploration equipment that may come in contact with the borehole will be decontaminated by steam cleaning, hot-water pressure washing, or by another method before drilling each new boring. All sampling and measuring equipment including, but not limited to, stainless-steel sampling tools, split-barrel or core samplers, well developing or purging equipment, groundwater quality measurement instruments, and water-level measurement instruments, will be decontaminated in accordance with SOP-01.08, Field Decontamination of Drilling and Sampling Equipment. The equipment will be pressure-washed with 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. All parts of the drilling equipment, including the undercarriage, wheels, tracks, chassis, and cab, will be thoroughly cleaned. Air filters on equipment operating in the exclusion zone will be contaminated, removed, and replaced before the equipment leaves the site. Sites identified as radiological control areas based upon surface radiological surveys will have all equipment surveyed by a health and safety radiation control division technician before it is released from the site.

6.0 MONITORING AND SAMPLING PROGRAMS

6.1 Air

A meteorological station located in the southeastern portion of TA-49 has provided data on air quality and meteorology since 1987. Air-monitoring station 23, located at the main gate to TA-49, and air-monitoring station 32, located in Area 12, measure levels of airborne radionuclides (tritium, uranium, plutonium, and americium). During the 10-plus years of operation, air-monitoring station, 23 results indicated where tritium concentrations above background on only a few occasions (Purtymun and Stoker 1987, 006688). These events involved tritium levels below existing air-quality guidelines and are attributed to releases elsewhere at the Laboratory. Air-monitoring station 23 has detected levels of airborne plutonium and americium above background only during one quarterly sampling period (LANL 1992, 007670, p. 4-44). Air monitoring continues to occur at TA-49 (LANL 2007, 098644). The concentrations detected were below DOE action guidelines (LANL 1992, 007670, p. 4-44). It is highly probable that the airborne radioactivity was derived from the transport of known low-level soil contamination in Area 2 during dry, windy conditions. Air monitoring continues as part of the Laboratory's annual environmental surveillance program (LANL 2007, 098644).

A series of thermoluminescent dosimeter (TLD) stations located around MDA AB and a second array of background TLDs near well DT-9 have measured penetrating radiation levels at TA-49 for many years. The Laboratory's annual environmental surveillance reports indicate that doses at TA-49 are indistinguishable from regional background levels (LANL 1992, 007670, p. 4-44).

6.2 Sediment and Surface Water

A sediment sampling program was initiated by the Environmental Studies and Assessment Group in 1979. Twelve sediment stations were set up in and around TA-49 (Figure 2.5-1). Sediment sample stations AB-2 and AB-3 are located in drainage areas to the northeast and northwest of Area 2. The remaining 10 stations are scattered around TA-49 in drainage areas. Radiochemical analyses conducted annually at these stations since 1979 have detected cesium-137, plutonium-238, plutonium-239, plutonium-240, gross alpha, gross beta, gross gamma, and total uranium. Americium-241 and strontium-90 were added to the analytical suite in 1992. The most recent data reported are included in the 2006 Environmental Surveillance Report (LANL 2007, 098644).

Surface-water gauging stations within TA-49 are monitored under the Federal Facilities Compliance Agreement (FFCA) established to regulate stormwater discharges from SWMUs and AOCs (LANL 2006, 093925, p. 52). This monitoring will continue under the FFCA. Surface-water and sediment sampling locations for TA-49 are shown in Figure 6.2-1.

6.3 Groundwater

Section IV.C.4.c.viii of the Consent Order requires monitoring and sampling of the wells within the Water Canyon/Cañon de Valle and Ancho Canyon watersheds as part of the “2007 Interim Facility-Wide Groundwater Monitoring Plan” (LANL 2007, 096665). Based on the results of the investigations in this work plan and after completing the installation of additional monitoring wells in the Water Canyon/Cañon de Valle and Ancho Canyon watersheds, a watershed-specific groundwater-monitoring plan will be submitted to NMED for review and approval. Upon NMED approval, the requirements of the monitoring plan will apply and supersede the requirements of the Water Canyon/Cañon de Valle and Ancho Canyons watershed sections of the “2007 Interim Facility-Wide Groundwater Monitoring Plan” (LANL 2007, 096665).

7.0 SCHEDULE

The scheduled notice date for NMED to approve this investigation work plan is February 28, 2008. Field activities will not begin before approval of this work plan. The investigation report for SWMUs 49-005(a), 49-004, and 49-006,and AOCs 49-002, 49-005(b), 49-008(a), and 49-008(b) (Areas 5, 6, and 10) is due to NMED by May 31, 2010.

8.0 REFERENCES AND DATA MAP SOURCES

8.1 References

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID number. This information is also included in text citations. ER ID numbers 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; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; 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.

Blair, A., December 19, 1996. “TA-49 FIDLER Survey,” Los Alamos National Laboratory memorandum (ESH-19:96-0456) to A. Dye (ESH-19) from B. Art (ESH-19), Los Alamos, New Mexico. (Art 1996, 055332)

Broxton, D.E., and S.L. Reneau, August 1995. “Stratigraphic Nomenclature of the Bandelier Tuff for the Environmental Restoration Project at Los Alamos National Laboratory,” Los Alamos National Laboratory report LA-13010-MS, Los Alamos, New Mexico. (Broxton and Reneau 1995, 049726)

DOE (U.S. Department of Energy), October 1987. "Phase I: Installation Assessment, Los Alamos National Laboratory," draft, Volume 1 of 2, Comprehensive Environmental Assessment and Response Program, Environment and Health Division, Environmental Programs Branch, Albuquerque Operations Office, Albuquerque, New Mexico. (DOE 1987, 008663)

DOE (U.S. Department of Energy), October 1987. "Phase I: Installation Assessment, Los Alamos National Laboratory," draft, Volume 2 of 2, Comprehensive Environmental Assessment and Response Program, Environment and Health Division, Environmental Programs Branch, Albuquerque Operations Office, Albuquerque, New Mexico. (DOE 1987, 008664)

Eller, P.G., December 15, 1991. "W.C. Francis Memos on TA-49 No Further Action Units," Los Alamos National Laboratory memorandum (INC-DO-92-44) to file from P.G. Eller, Los Alamos, New Mexico. (Eller 1991, 055331)

EPA (U.S. Environmental Protection Agency), January 21, 2005. "EPA's Prior Decisions on SWMU/AOC Sites at Los Alamos National Laboratory (LANL)," U.S. Environmental Protection Agency letter to J. Bearzi (NMED-HRMB) from L.F. King (EPA Federal Facilities Section Chief), Dallas, Texas. (EPA 2005, 088464)

Geophex, August 1991. "A Pilot Study on the Applicability of Selected Geophysical Methods to the Investigation of Three Environmental Sites in TA-49, Los Alamos National Laboratory," report prepared for Los Alamos National Laboratory, Los Alamos, New Mexico. (Geophex 1991, 008887)

Krowell, K., October 2007. Geospatial Data Created for Maps Appearing in TA-49 HIRs and IWPs, October 2007, Apogen Technologies, Los Alamos, New Mexico. (Kelly 2007, 098702)

LANL (Los Alamos National Laboratory), May 1992. "RFI Work Plan for Operable Unit 1144," Los Alamos National Laboratory document LA-UR-92-900, Los Alamos, New Mexico. (LANL 1992, 007670)

LANL (Los Alamos National Laboratory), July 1996. "Environmental Surveillance at Los Alamos During 1994," Los Alamos National Laboratory report LA-13047-ENV, Los Alamos, New Mexico. (LANL 1996, 054769)

LANL (Los Alamos National Laboratory), August 1997. "RFI Report for Technical Area 49 Potential Release Sites (Areas 5, 6, 10, and 11)," Los Alamos National Laboratory document LA-UR-97-2786, Los Alamos, New Mexico. (LANL 1997, 056594)

LANL (Los Alamos National Laboratory), September 22, 1998. "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory," Los Alamos National Laboratory document LA-UR-98-4847, Los Alamos, New Mexico. (LANL 1998, 059730)

LANL (Los Alamos National Laboratory), December 2000. "University of California, Los Alamos National Laboratory (LANL), I8980SOW0-8S, Statement of Work for Analytical Laboratories," Rev. 1, Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2000, 071233)

LANL (Los Alamos National Laboratory), 2001. "Comprehensive Site Plan 2001," Los Alamos National Laboratory document LA-UR-01-1838, Los Alamos, New Mexico. (LANL 2001, 070210)

LANL (Los Alamos National Laboratory), October 2004. "RFI Report for Area of Concern 49-008(b) at Technical Area 49 (Potential Area of Surface Contamination at Area 6 East), Revision 1," Los Alamos National Laboratory document LA-UR-04-6969, Los Alamos, New Mexico. (LANL 2004, 088048)

LANL (Los Alamos National Laboratory), December 2005. "2005 Annual Moisture Monitoring Report for Material Disposal Area AB at Technical Area 49," Los Alamos National Laboratory document LA-UR-05-8256, Los Alamos, New Mexico. (LANL 2005, 092389)

LANL (Los Alamos National Laboratory), September 2006. "Environmental Surveillance at Los Alamos During 2005," Los Alamos National Laboratory report LA-14304-ENV, Los Alamos, New Mexico. (LANL 2006, 093925)

LANL (Los Alamos National Laboratory), March 2007. "2007 General Facility Information," Los Alamos National Laboratory document LA-UR-07-1839, Los Alamos, New Mexico. (LANL 2007, 095364)

LANL (Los Alamos National Laboratory), May 2007. "2007 Interim Facility-Wide Groundwater Monitoring Plan," Los Alamos National Laboratory document LA-UR-07-3271, Los Alamos, New Mexico. (LANL 2007, 096665)

LANL (Los Alamos National Laboratory), September 2007. "Environmental Surveillance at Los Alamos During 2006," Los Alamos National Laboratory report LA-14341-ENV, Los Alamos, New Mexico. (LANL 2007, 098644)

LANL (Los Alamos National Laboratory), October 2007. "Historical Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary," Los Alamos National Laboratory document LA-UR-07-6428, Los Alamos, New Mexico. (LANL 2007, 098523)

LANL (Los Alamos National Laboratory), October 2007. "Investigation Work Plan for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary," Los Alamos National Laboratory document LA-UR-07-6076, Los Alamos, New Mexico. (LANL 2007, 098491)

LANL (Los Alamos National Laboratory), October 2007. "Historical Investigation Report for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary," Los Alamos National Laboratory document LA-UR-07-6078, Los Alamos, New Mexico. (LANL 2007, 098492)

NMED (New Mexico Environment Department), June 2006. "Technical Background Document for Development of Soil Screening Levels, Revision 4.0, Volume 1, Tier 1: Soil Screening Guidance Technical Background Document," New Mexico Environment Department, Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program, Santa Fe, New Mexico. (NMED 2006, 092513)

Nyhan, J.W., L.W. Hacker, T.E. Calhoun, and D.L. Young, June 1978. "Soil Survey of Los Alamos County, New Mexico," Los Alamos Scientific Laboratory report LA-6779-MS, Los Alamos, New Mexico. (Nyhan et al. 1978, 005702)

Purtymun, W.D., January 1984. "Hydrologic Characteristics of the Main Aquifer in the Los Alamos Area: Development of Ground Water Supplies," Los Alamos National Laboratory report LA-9957-MS, Los Alamos, New Mexico. (Purtymun 1984, 006513)

Purtymun, W.D., January 1995. "Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area," Los Alamos National Laboratory report LA-12883-MS, Los Alamos, New Mexico. (Purtymun 1995, 045344)

Purtymun, W.D., and A.J. Ahlquist, 1986. "Geologic and Hydrologic Evaluation of Technical Area 49," Los Alamos National Laboratory document HSE-8-86-1183, Los Alamos, New Mexico. (Purtymun and Ahlquist 1986, 014722)

Purtymun, W.D., R.J. Peters, and J.W. Owens, December 1980. “Geohydrology of White Rock Canyon of the Rio Grande from Otowi to Frijoles Canyon,” Los Alamos Scientific Laboratory report LA-8635-MS, Los Alamos, New Mexico. (Purtymun et al. 1980, 006048)

Purtymun, W.D., and A.K. Stoker, November 1987. “Environmental Status of Technical Area 49, Los Alamos, New Mexico,” Los Alamos National Laboratory report LA-11135-MS, Los Alamos, New Mexico. (Purtymun and Stoker 1987, 006688)

Rogers, D.B., and B.M. Gallaher, September 1995. “The Unsaturated Hydraulic Characteristics of the Bandelier Tuff,” Los Alamos National Laboratory report LA-12968-MS, Los Alamos, New Mexico. (Rogers and Gallaher 1995, 049824)

Stimac, J.A., D.E. Broxton, E.C. Kluk, S.J. Chipera, and J.R. Budahn, July 2002. “Stratigraphy of the Tuffs from Borehole 49-2-700-1 at Technical Area 49, Los Alamos National Laboratory, New Mexico,” Los Alamos National Laboratory report LA-13969, Los Alamos, New Mexico. (Stimac et al. 2002, 073391)

Thorn, R.N., and D.R. Westervelt, February 1987. “Hydronuclear Experiments,” Los Alamos National Laboratory report LA-10902-MS, Los Alamos, New Mexico. (Thorn and Westervelt 1987, 006672)

Weir, J.E., Jr., and W.D. Purtymun, 1962. “Geology and Hydrology of Technical Area 49, Frijoles Mesa, Los Alamos County, New Mexico,” U.S. Geological Survey Administrative Release, Albuquerque, New Mexico. (Weir and Purtymun 1962, 011890)

Zia Company, 1960-1962. “Zia Diary, 2-13-60 through 4-3-62,” daily work log, Zia Company, Los Alamos, New Mexico. (Zia Company 1960-1962, 098490)

8.2 Data Sources for Base Themes

Data sources used in original maps created for this report are described below. Themes used in base layouts for map creation are described first, followed by a separate table describing specialized themes.

Legend Item	Data Source
2-ft elevation contour	Hypsography, 2 Foot Contour Interval; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; 1991.
10-ft elevation contour	Hypsography, 10 Foot Contour Interval; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; 1991.
100-ft elevation contour	Hypsography, 100 Foot Contour Interval; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; 1991.
Fence	Security and Industrial Fences and Gates; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 6 January 2004; as published 10 September 2007.
Former Structure	Former Structures of the Los Alamos Site; Los Alamos National Laboratory, Environment and Remediation Support Services Division, EP2007-0587; 1:2,500 Scale Data; 17 September 2007.
Structure	Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 6 January 2004; as published 10 September 2007.
Paved road	Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 6 January 2004; as published 10 September 2007.

Legend Item	Data Source
Unpaved road	Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 6 January 2004; as published 10 September 2007.
TA boundary	Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Division; 19 September 2007.

8.3 Data Source Statements for Specialized Themes

Legend Item	Data Source	Figures
Biointrusion barrier	Polyline Feature, Western and Southern Extents of Biointrusion Barrier Within ET Cover, TA-49 Area 2; 1:1,200 Scale Data; Apogen Technologies; ER ID (Krowell 2007, 098702); 15 October 2007.	3.3-2
Borehole	Features: 49-Alpha, 49-Beta, 49-Gamma— Penetrations; Los Alamos National Laboratory, Environment and Remediation Support Services, EP2007-0442; 1:2,500 Scale Data; 16 July 2007. All Other Features— Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Environment and Remediation Support Services Division, EP2007-0613; 27 September 2007.	3.3-1 3.3-2
Deep test well (monitoring well)	Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Environment and Remediation Support Services Division, EP2007-0613; 27 September 2007.	3.3-1
Former asphalt pad	Polygon Feature, Asphalt Pad Formerly Covering Experimental Shafts, TA-49 Area 2; 1:1,200 Scale Data; Apogen Technologies; ER ID (Krowell 2007, 098702); 15 October 2007.	3.3-2
Former structure (Area 10 only)	Polygon Feature, Approximate location of Buildings 49-61 and 49-62, TA-49 Area 10; 1:1,200 Scale Data; Apogen Technologies; ER ID (Krowell 2007, 098702);15 October 2007.	2.5-1 2.5-2 2.5-3 2.5-4 4.3-2
General SWMU or AOC location (boundary not defined)	Not a feature layer; intended to illustrate extents of area-specific map figures	1.1-2 3.5-1 6.2-1
HDT activity-related structure	Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 6 January 2004; as published 10 September 2007.	2.4-6
Landfill (approx.)	Polygon Feature, Approximate Location of Open Burning Pit/Landfill, TA-49, Area 6 (West); 1:2,500 Scale Data; Apogen Technologies; ER ID (Krowell 2007, 098702); 15 October 2007.	4.3-2
Moisture monitoring location	Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Environment and Remediation Support Services Division, EP2007-0613; 27 September 2007.	3.5-1
Proposed borehole Proposed borehole (specific	Point Feature, Approximate Locations Proposed for Placement of Boreholes, TA-49; 1:1,200 Scale Data; Apogen Technologies;	4.4-1 4.4-3

Legend Item	Data Source	Figures
location(s) to be identified by geophysical survey)	ER ID (Krowell 2007, 098702);15 October 2007.	
Proposed angled borehole (with associated path)	Point Feature, Approximate Locations Proposed for Placement of Boreholes, TA-49; 1:1,200 Scale Data; Apogen Technologies; ER ID (Krowell 2007, 098702); 15 October, 2007. Polyline Feature, Approximate Subsurface Path of Proposed Directional Boreholes, TA-49; 1:1,200 Scale Data; Apogen Technologies; ER ID (Krowell 2007, 098702); 15 October 2007.	4.4-1 4.4-2 4.4-3
Regraded area	Polygon Feature, Approximate Extent of 1998 Re-grading Operations, TA-49 Areas 2, 2A, and 2B; 1:1,200 Scale Data; Apogen Technologies; ER ID (Krowell 2007, 098702); 15 October 2007.	3.3-2
Sampling location with screening-level results Sampling location with decision-level results Sampling location with detected decision-level results Sampling location with nondetected decision-level results Sampling location with decision-level results above BV Sampling location with decision-level results detected or detected above FV	Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Environment and Remediation Support Services Division, EP2007-0613; 27 September 2007.	2.3-2 2.3-3 2.3-4 2.4-2 2.4-3 2.4-4 2.4-7 2.4-8 2.5-2 2.5-3 2.5-4 6.2-1
Prev. sampling location Prev. sampling location—result above BV/FV	Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Environment and Remediation Support Services Division, EP2007-0613; 27 September 2007.	4.3-1 4.3-2
Sampling location type	Point Feature, Approximate Locations Proposed for Surface Sampling, TA-49; 1:1,200 Scale Data; Apogen Technologies; ER ID (Krowell 2007, 098702); 15 October 2007.	4.3-1 4.3-2
Sediment and/or surface-water sampling location	Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Environment and Remediation Support Services Division, EP2007-0613; 27 September 2007.	6.2-1
Shaft	Point Feature, Approximate Locations of Experimental Shafts, TA-49, Areas 1, 2, 2A, 2B, 3, and 4; 1:1,200 Scale Data; Apogen Technologies; ER ID (Krowell 2007, 098702); 15 October 2007.	3.3-2
Suspected landfill (SWMU 49-005(a))	Not a feature layer; Graphic layer intended to illustrate approximate location of a possible landfill, TA-49, Area 10.	4.3-2
TDR array	Point Feature, Locations of TDR Arrays for Moisture Monitoring, TA-49 Area 2; 1:1,200 Scale Data; Apogen Technologies; ER ID (Krowell 2007, 098702); 9 October 2002.	3.5-1

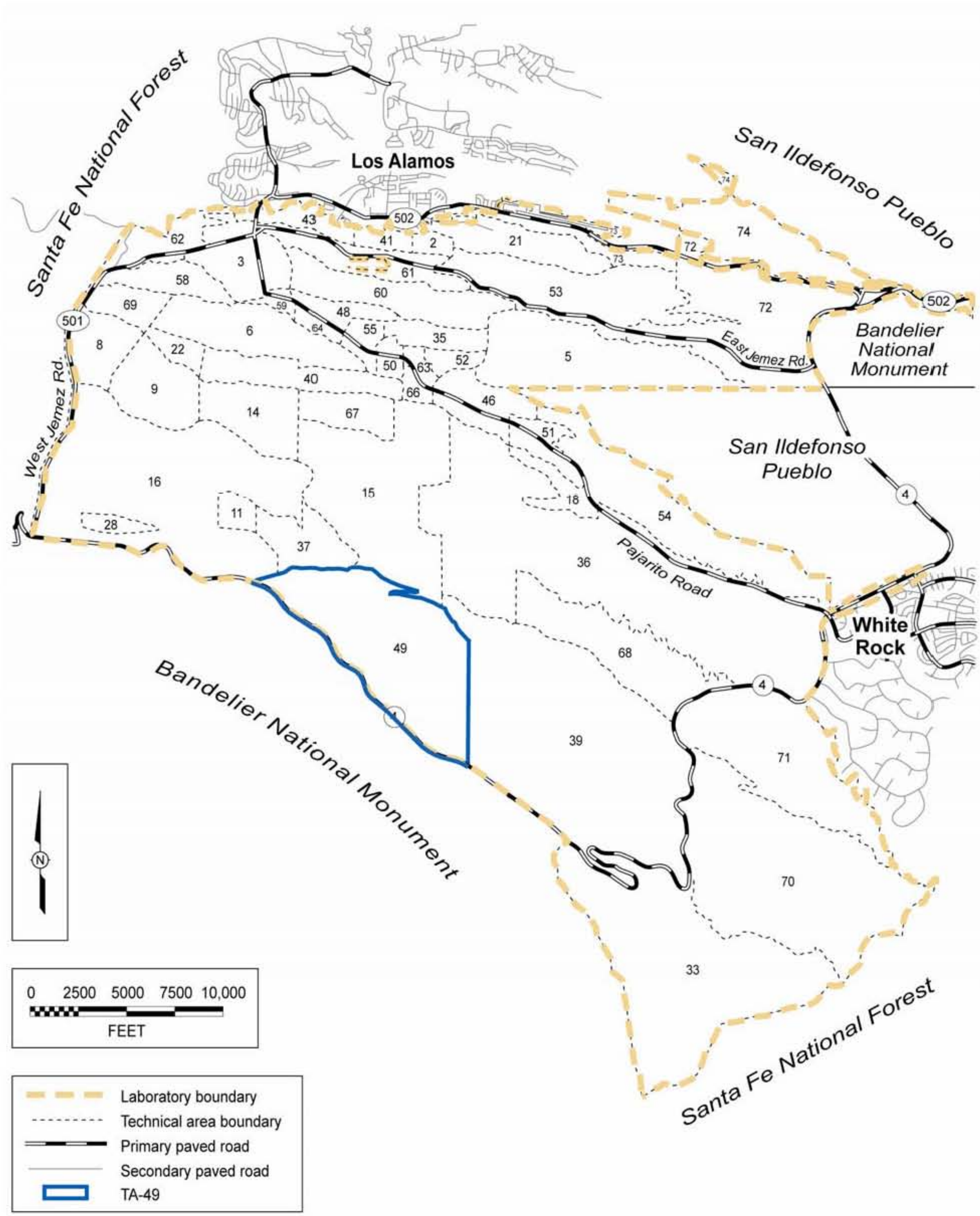


Figure 1.1-1 Location of TA-49 with respect to Laboratory's technical areas and surrounding land holdings

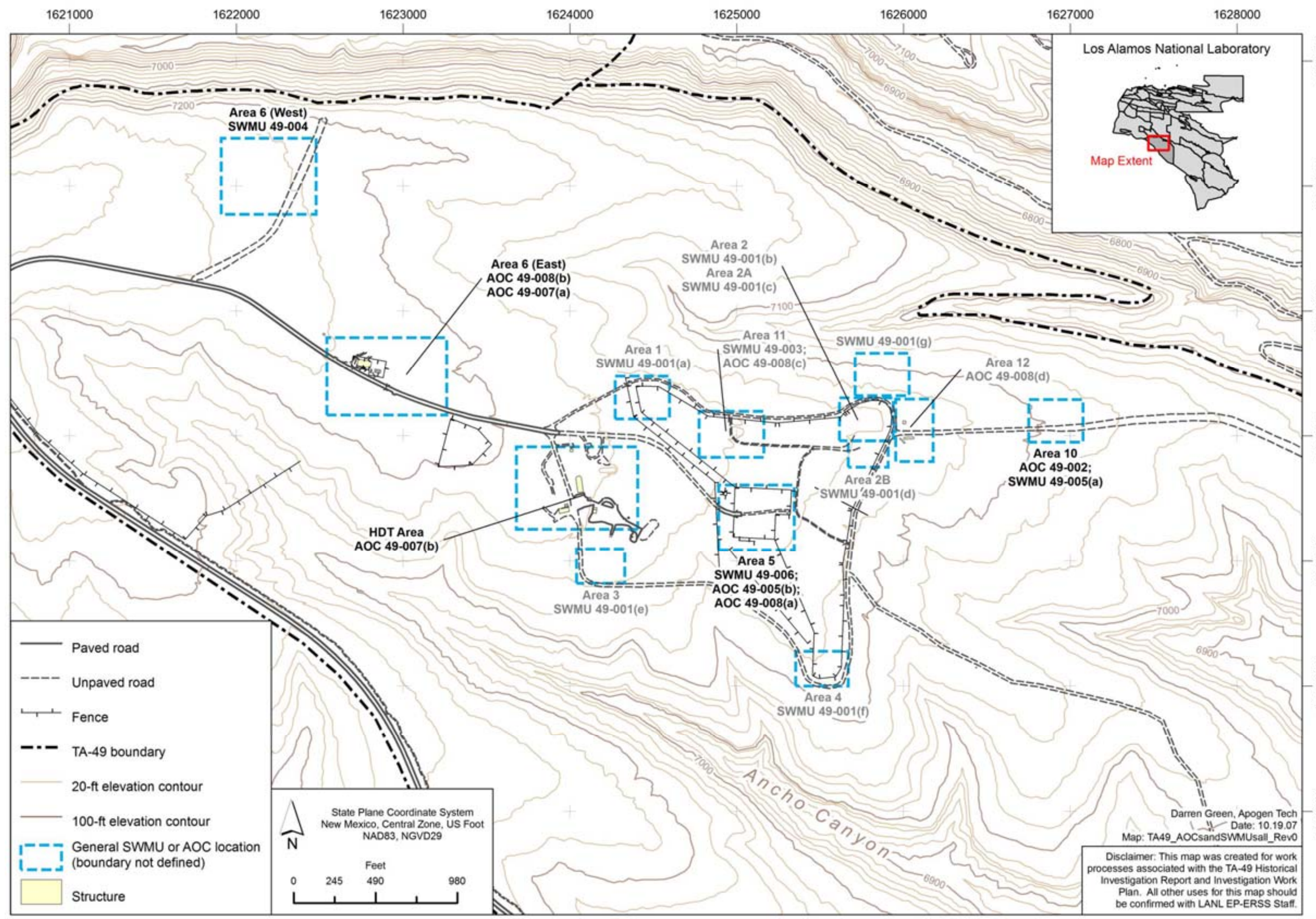
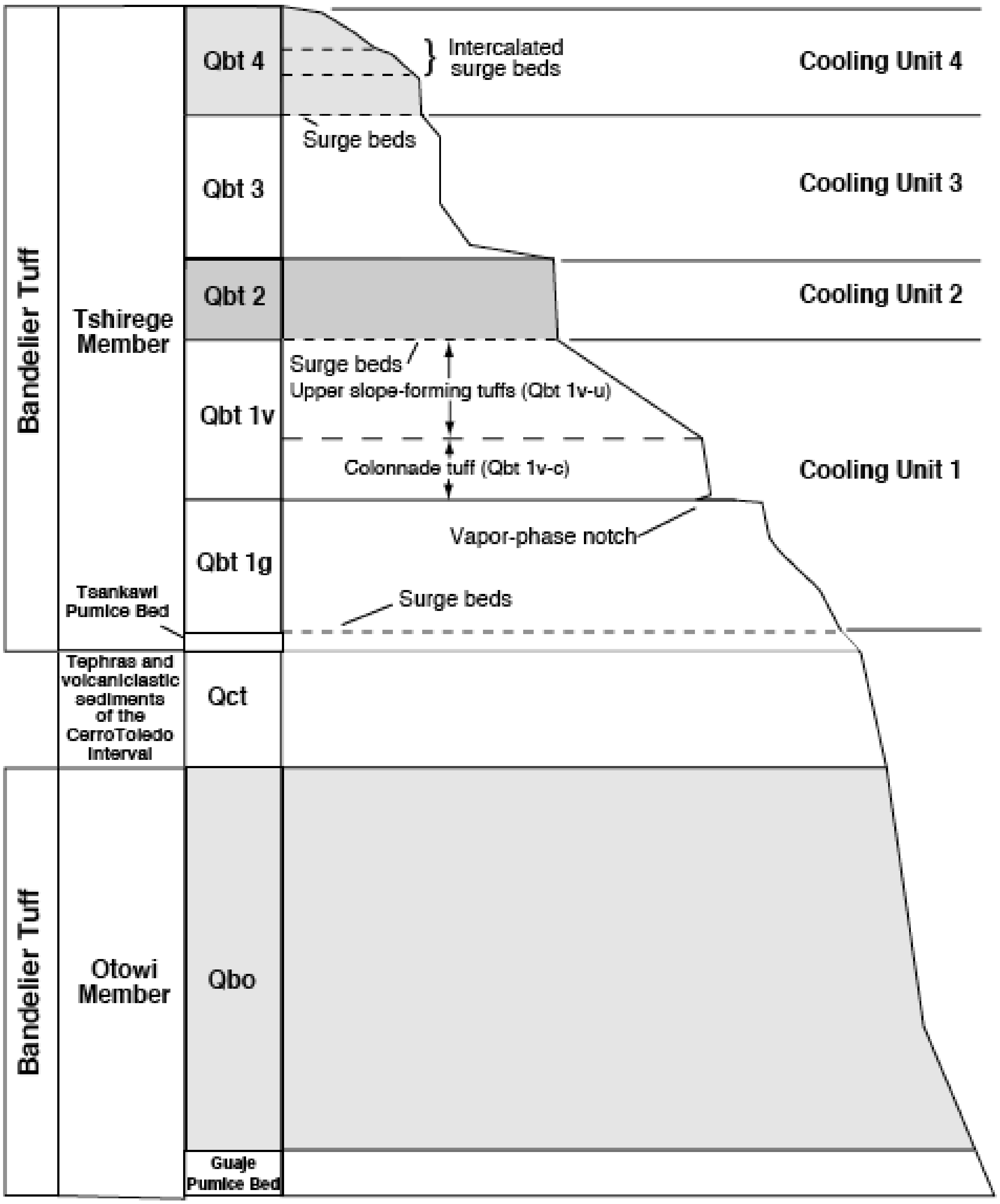


Figure 1.1-2 TA-49 SWMUs and AOCs

Note: Sites outside the NES boundary are in bold



Source: Broxton and Reneau (1995, 049726)

Figure 2.2-1 Stratigraphy of the Bandelier Tuff

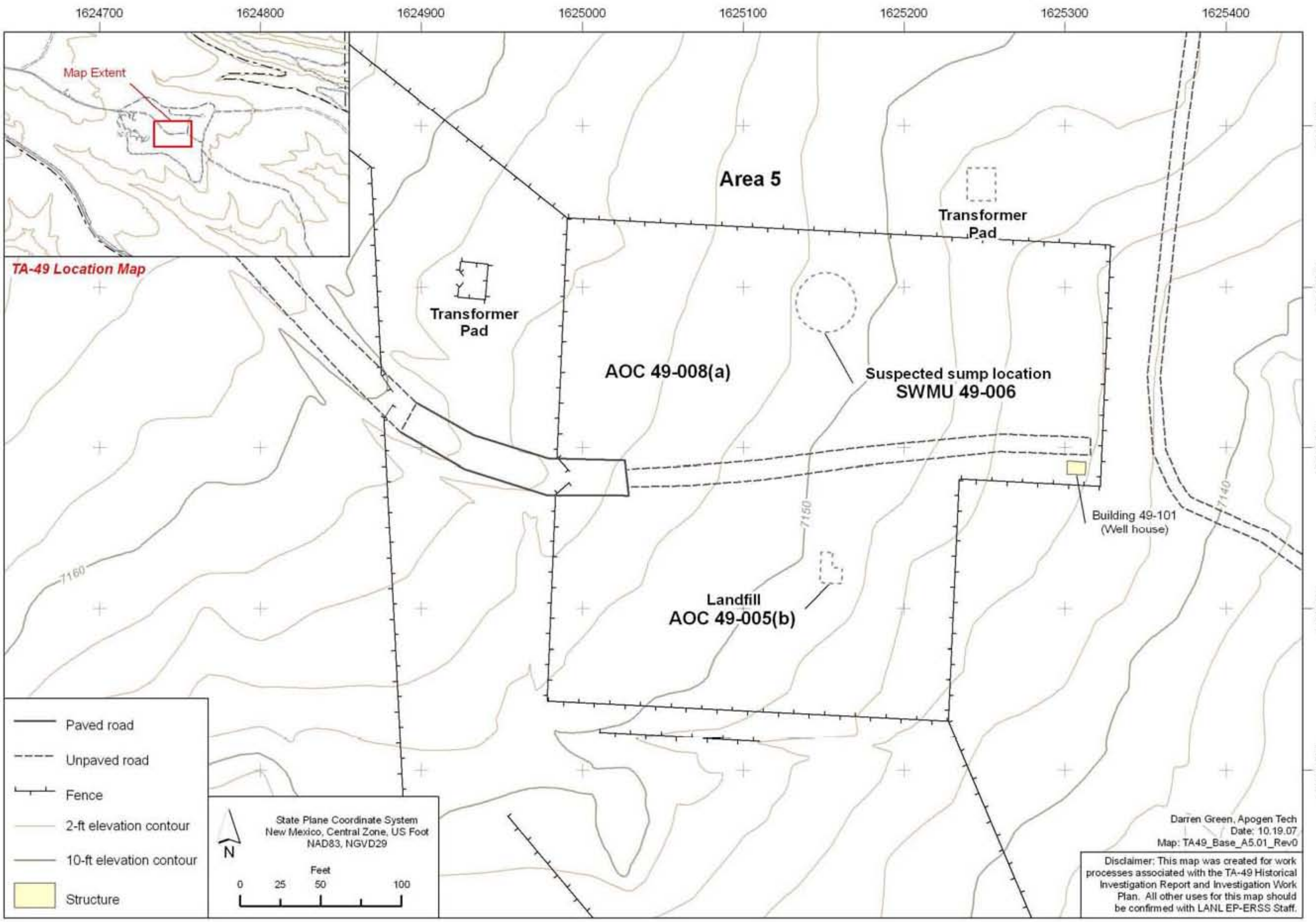


Figure 2.3-1 General site layout of Area 5 with associated SWMUs and AOCs

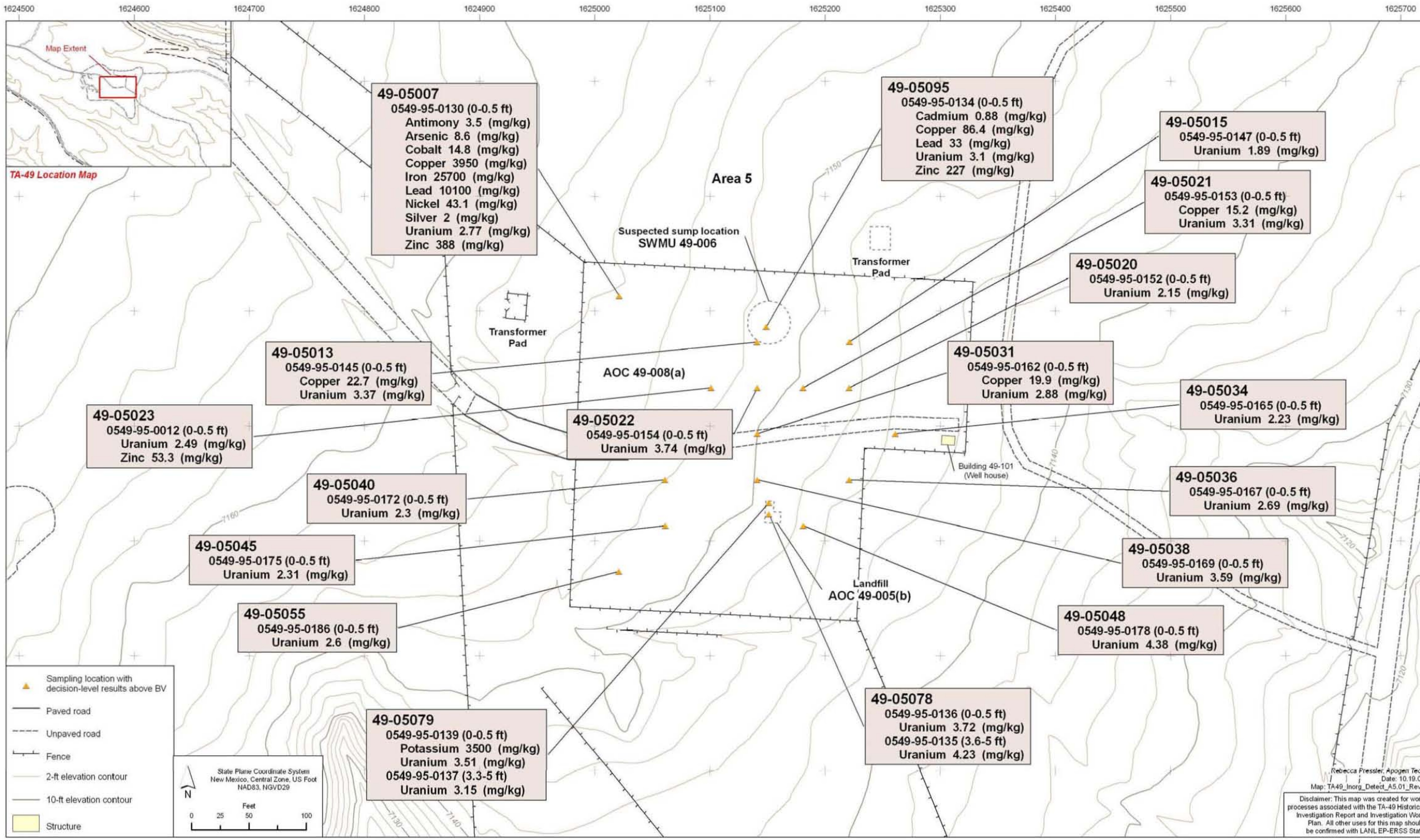


Figure 2.3-2 Area 5 inorganic chemical sampling locations and results above BVs

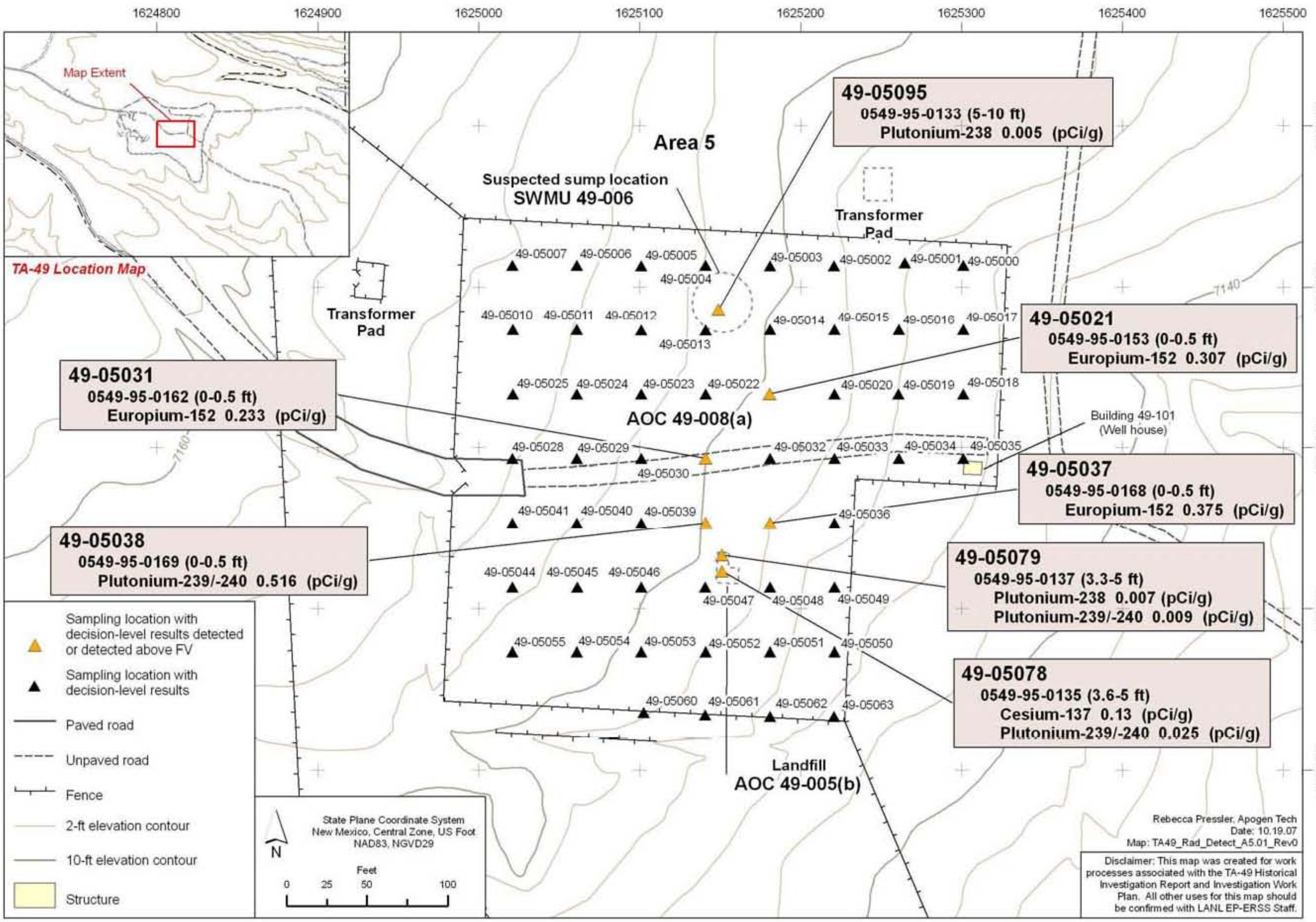


Figure 2.3-3 Area 5 radionuclide sampling locations and results detected or detected above FVs

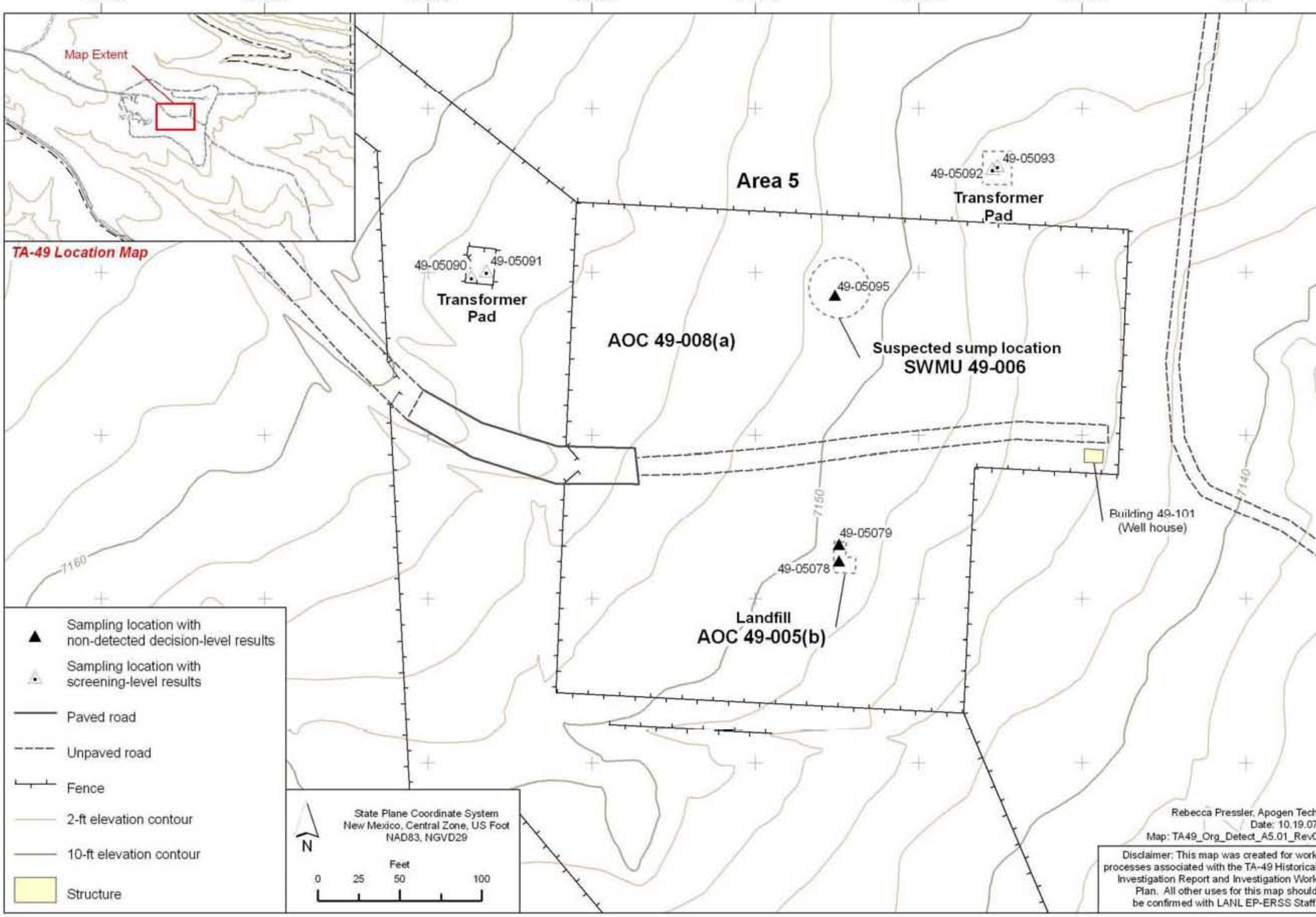


Figure 2.3-4 Area 5 organic chemical sampling locations

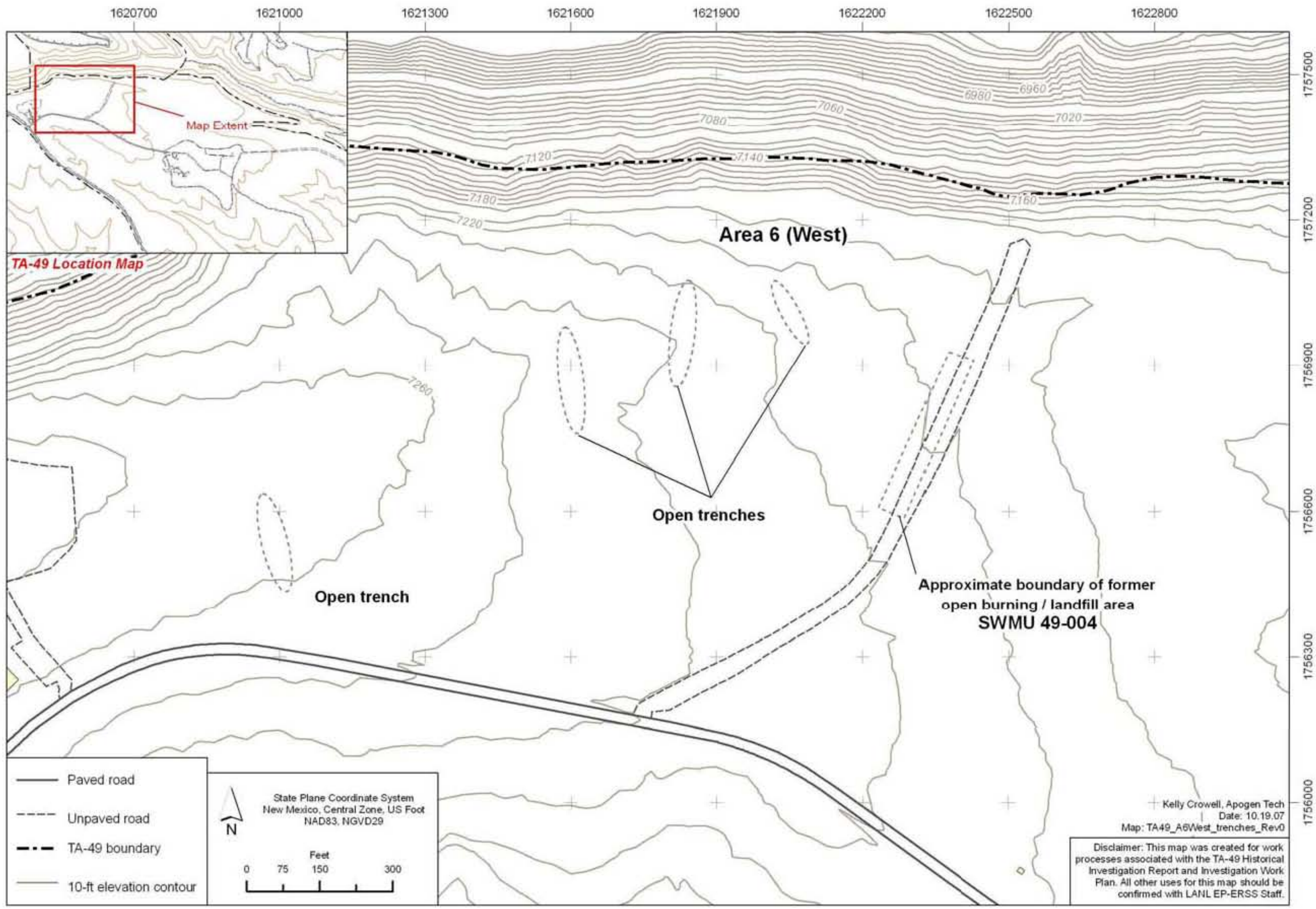


Figure 2.4-1 Area 6 West

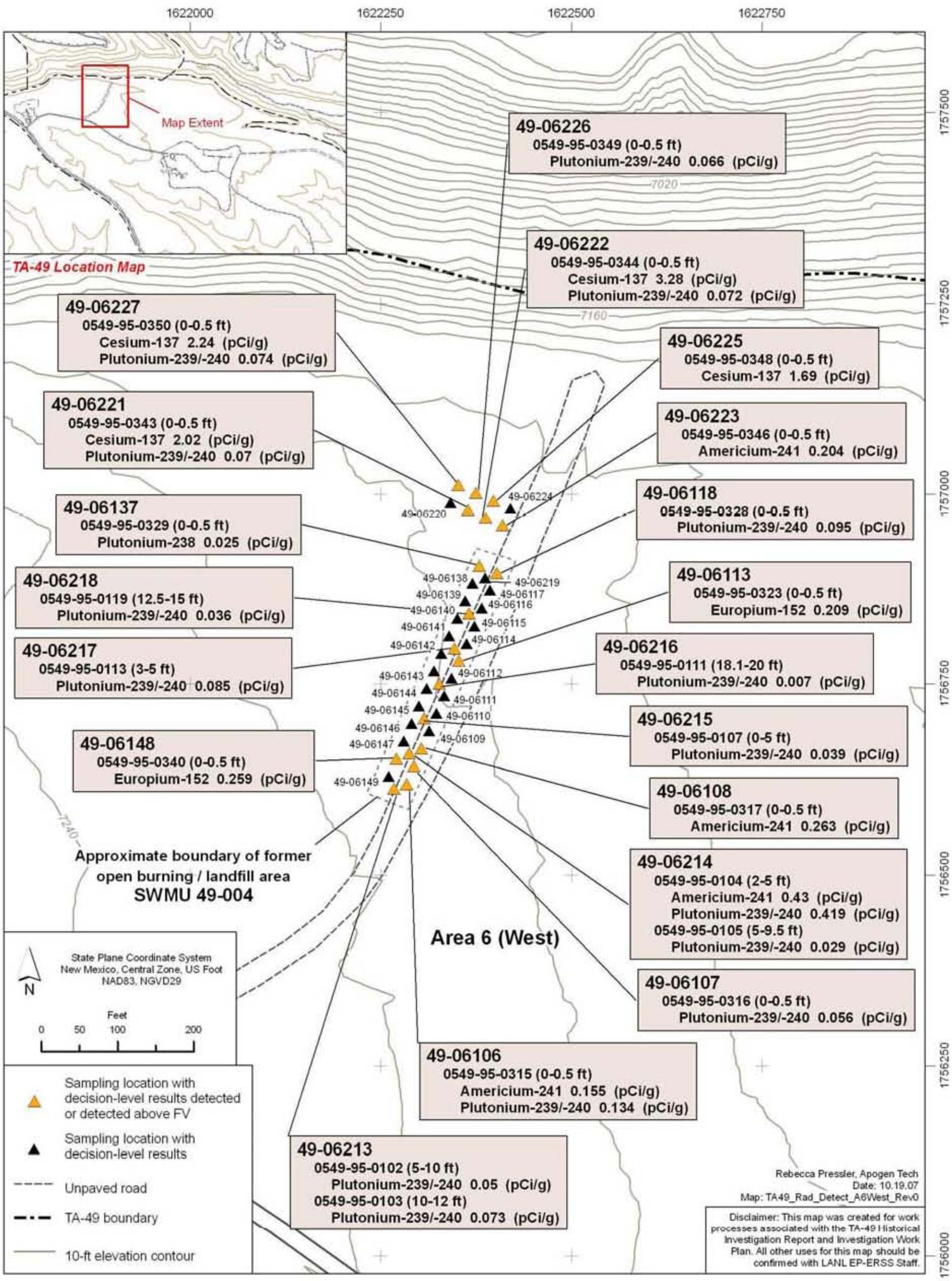


Figure 2.4-2 Area 6 West radionuclide sampling locations and results detected or detected above FVs

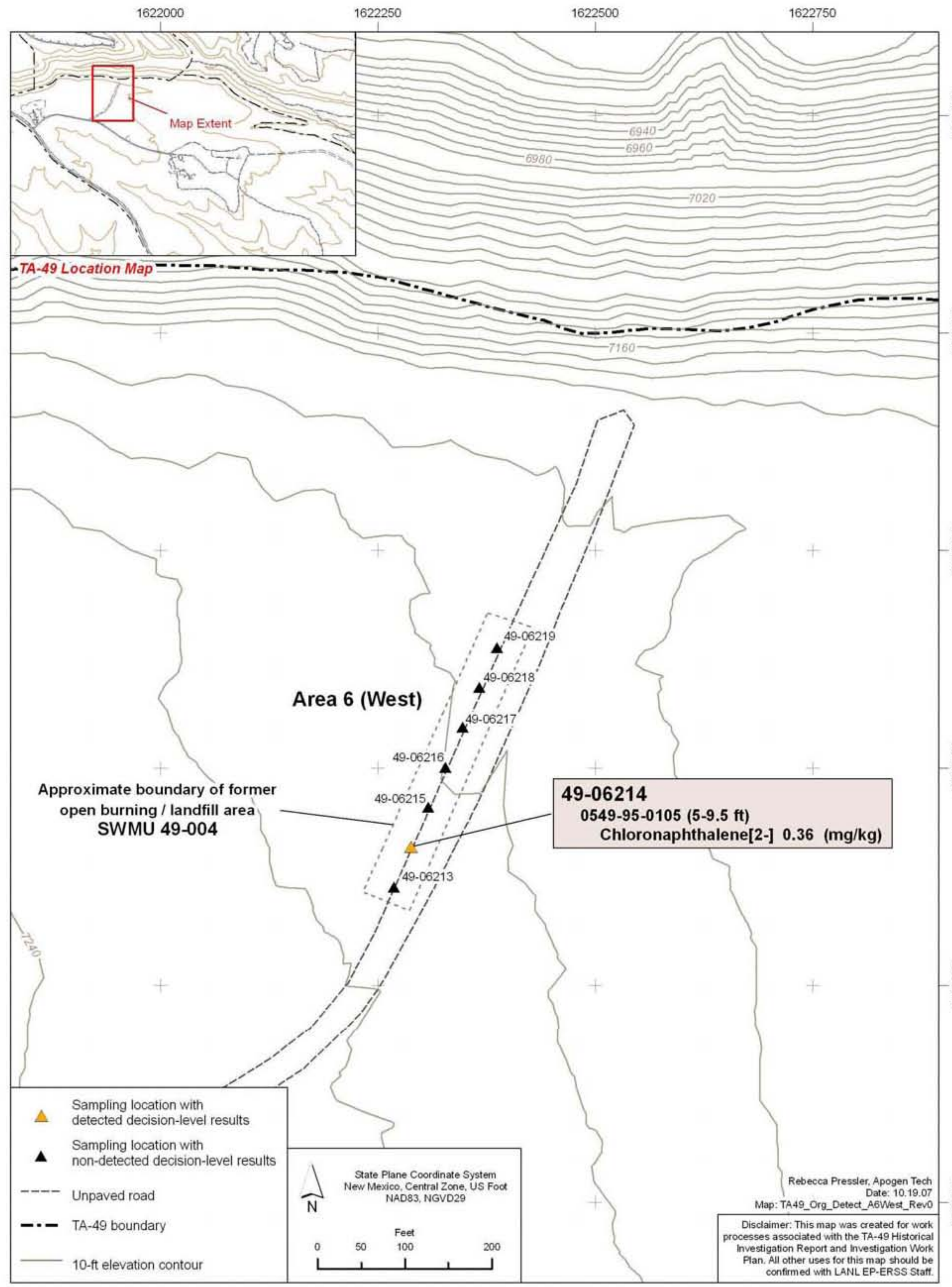


Figure 2.4-3 Area 6 West organic chemical sampling locations and detected results

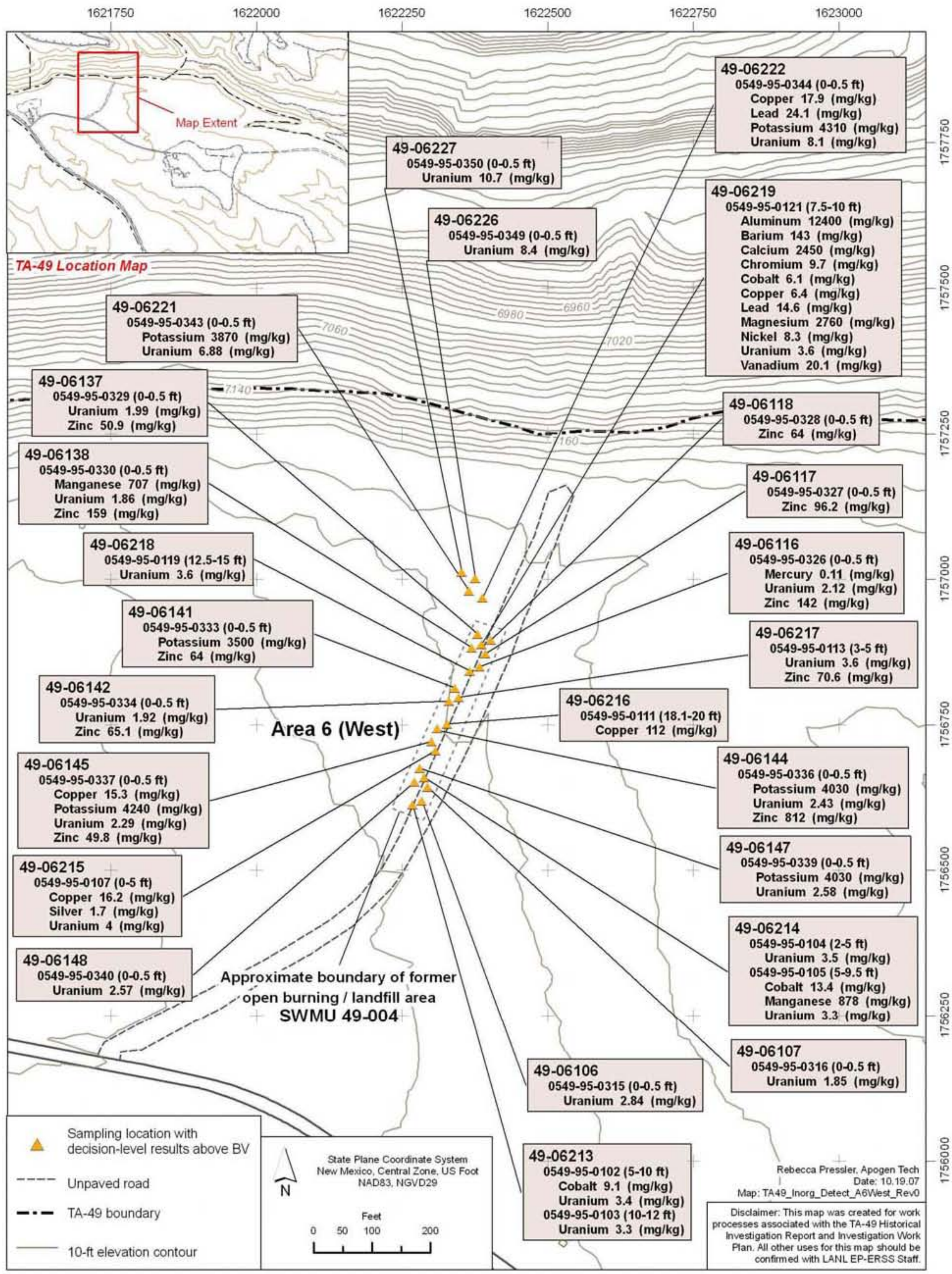


Figure 2.4-4 Area 6 West inorganic chemical sampling locations and results above BVs

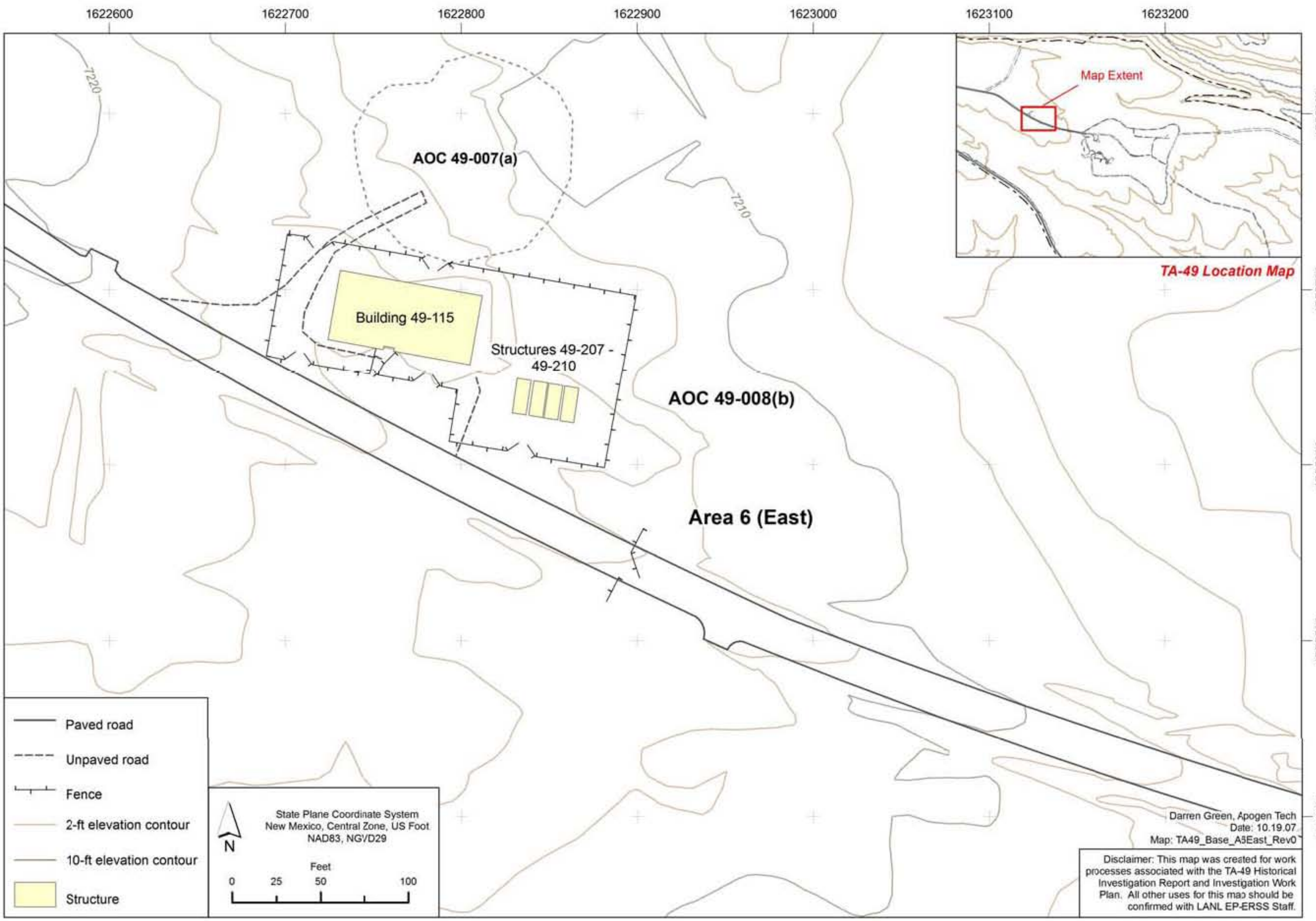


Figure 2.4-5 General site layout of Area 6 East

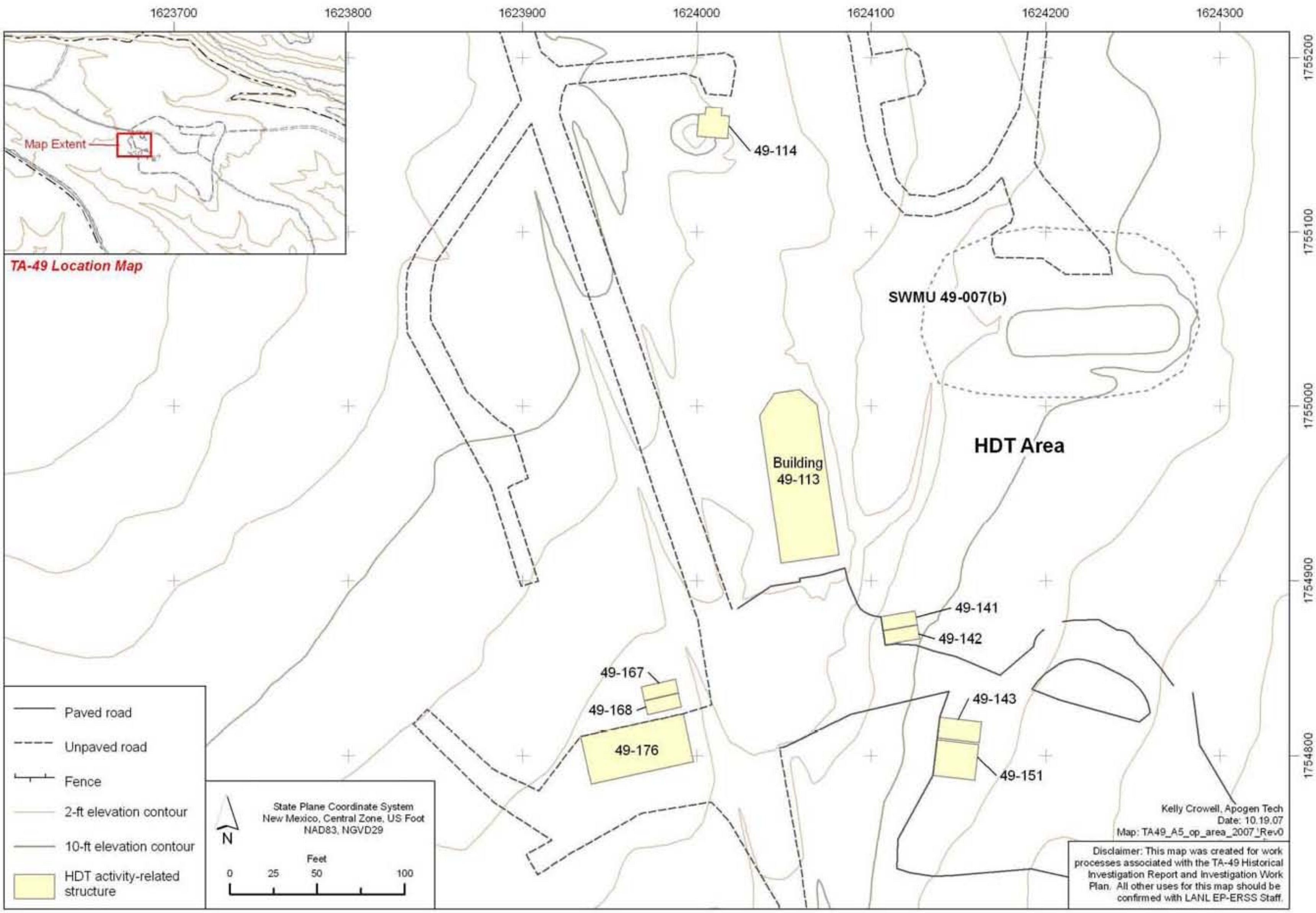


Figure 2.4-6 General site layout of HDT area and SWMU 49-007(b)

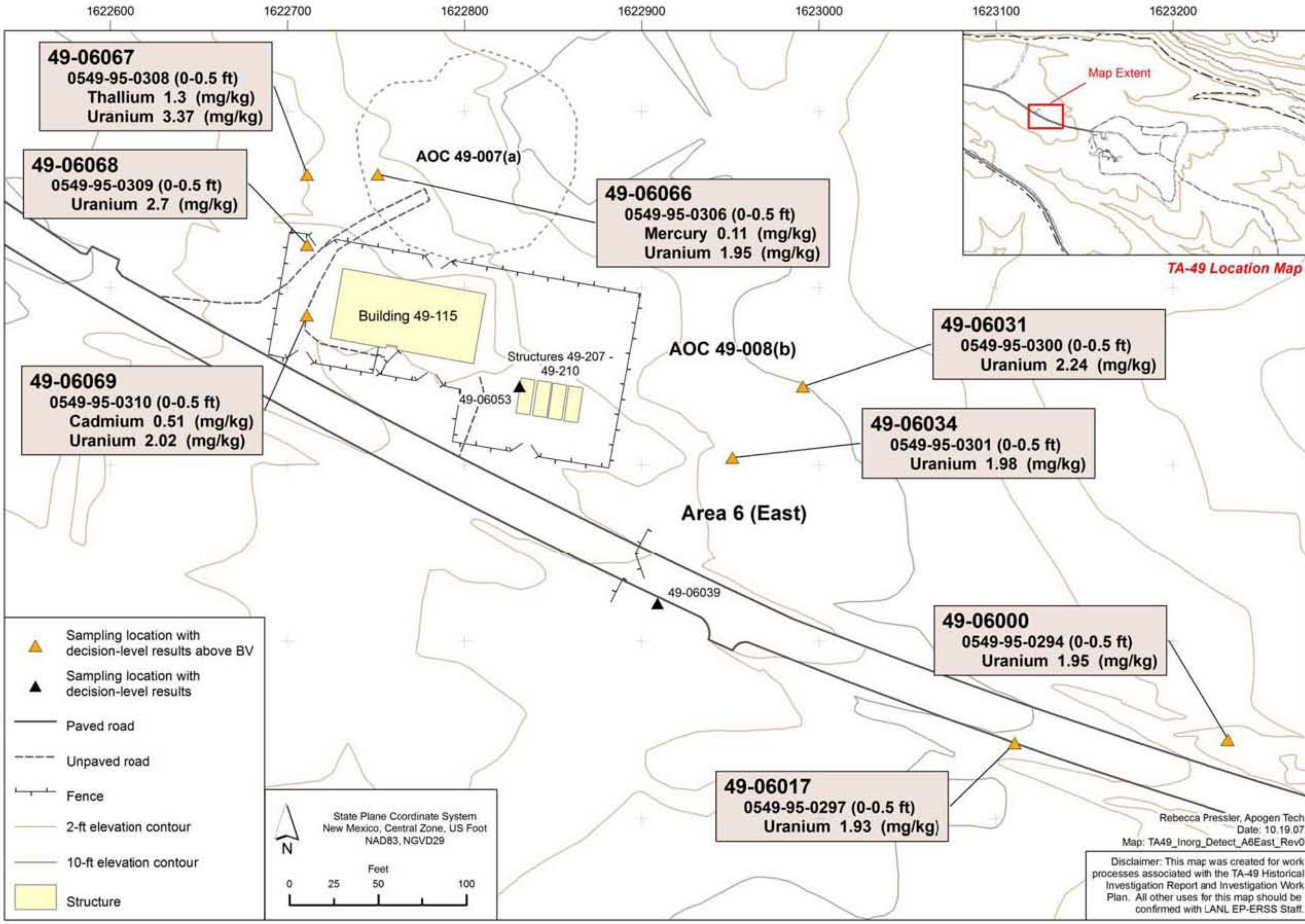


Figure 2.4-7 Area 6 (East) inorganic chemical sampling locations and results above BVs

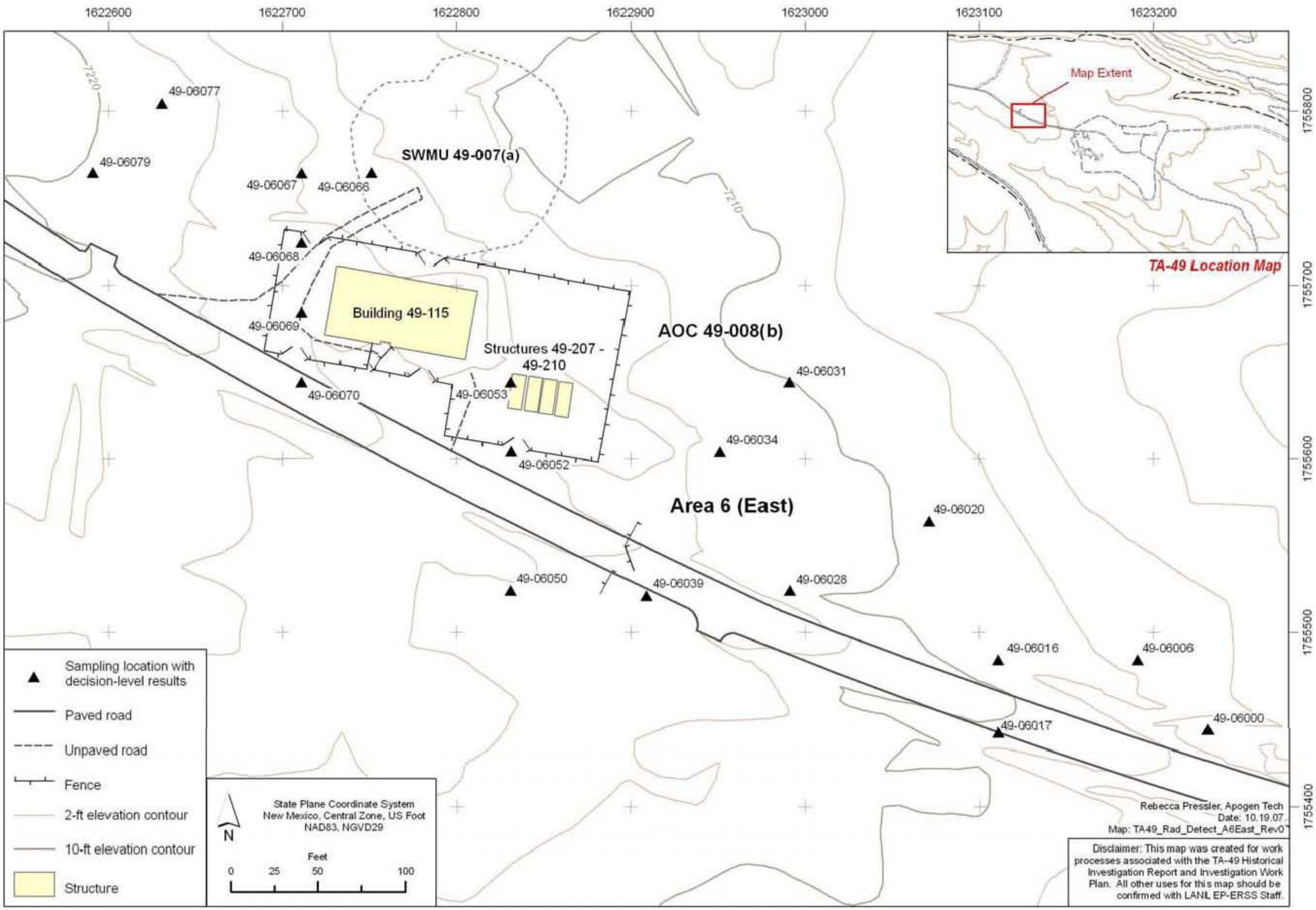


Figure 2.4-8 Area 6 (East) radionuclide sampling locations

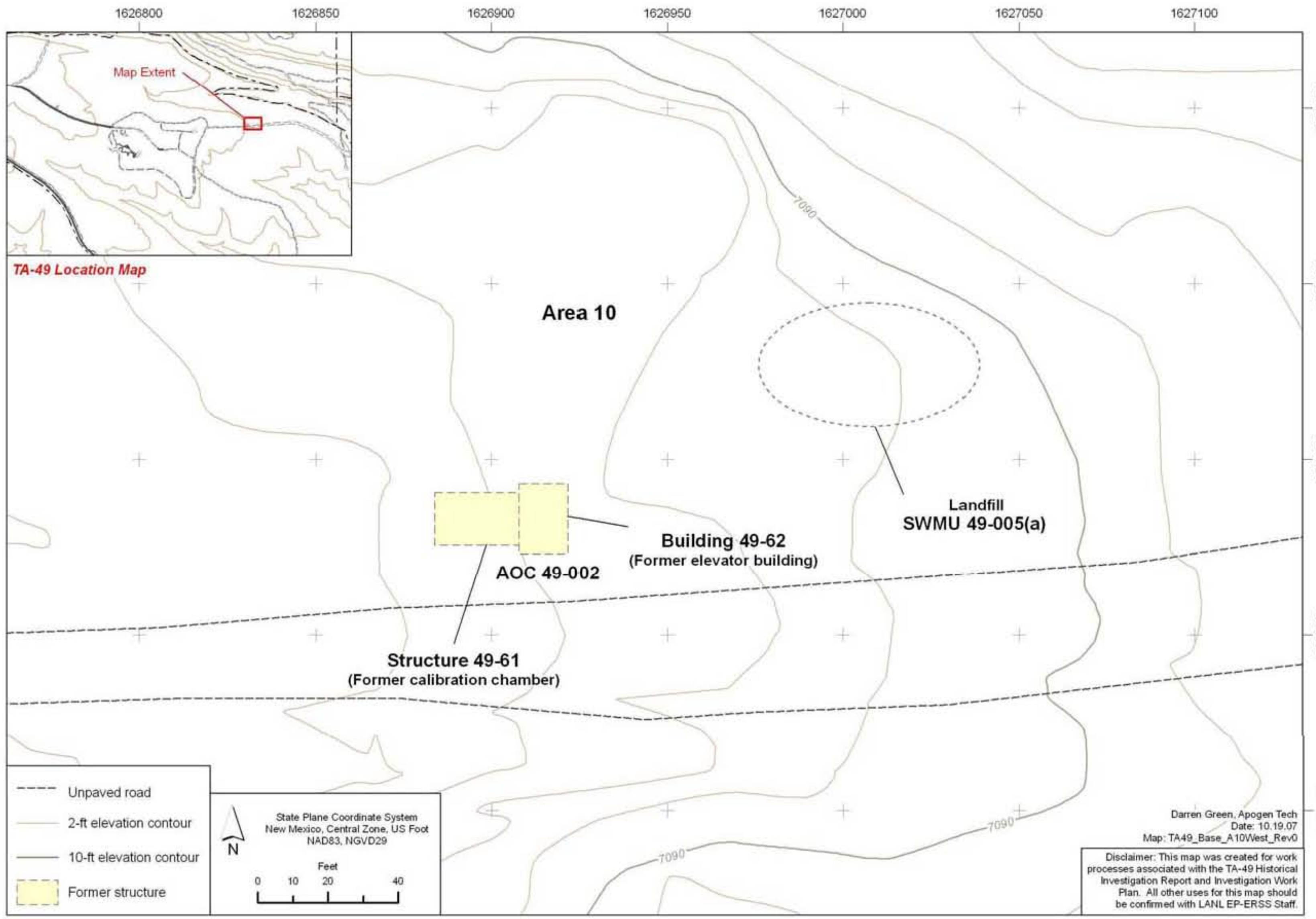


Figure 2.5.1 General site layout of Area 10

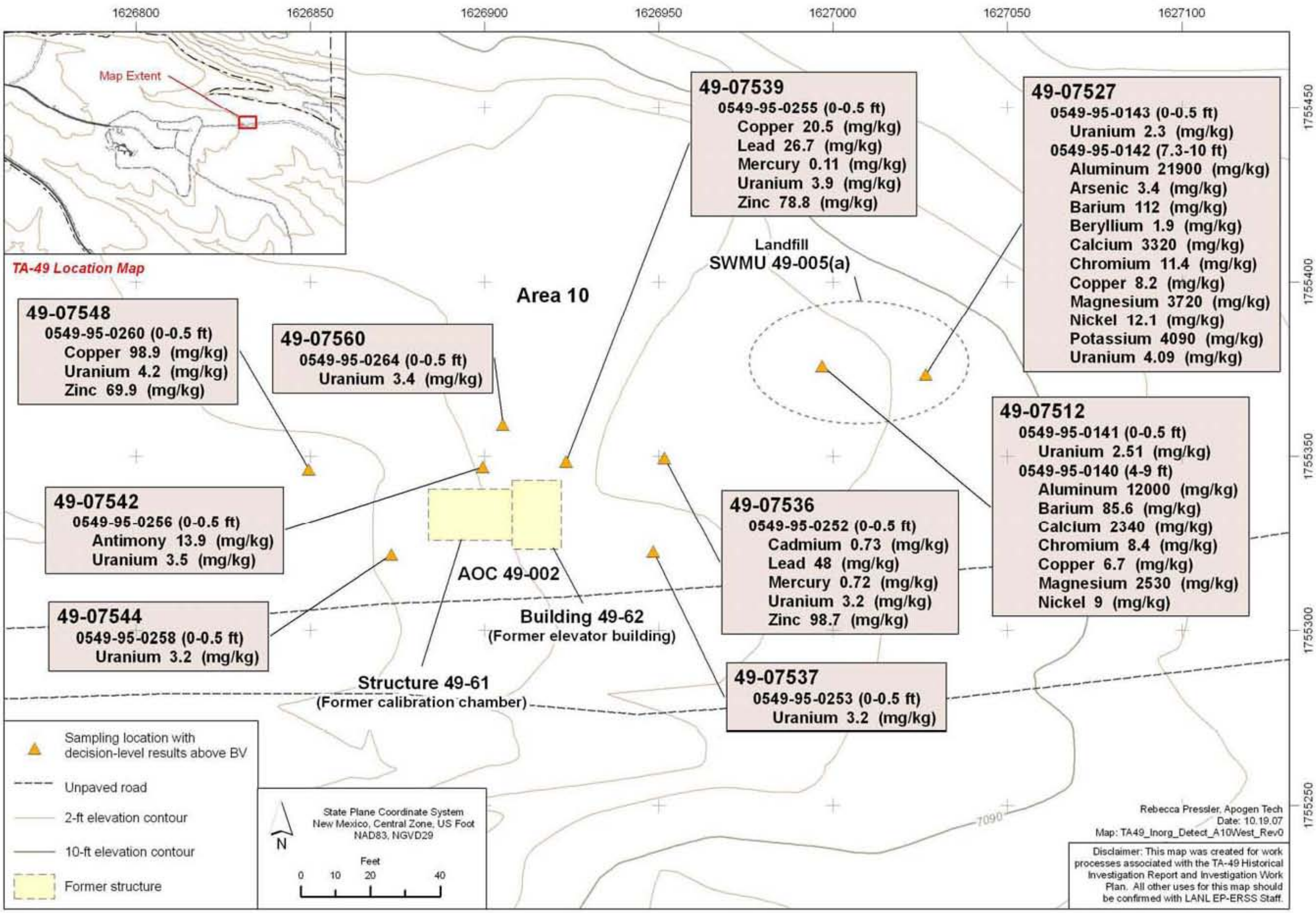


Figure 2.5.2 Area 10 inorganic chemical sampling locations and results above BVs

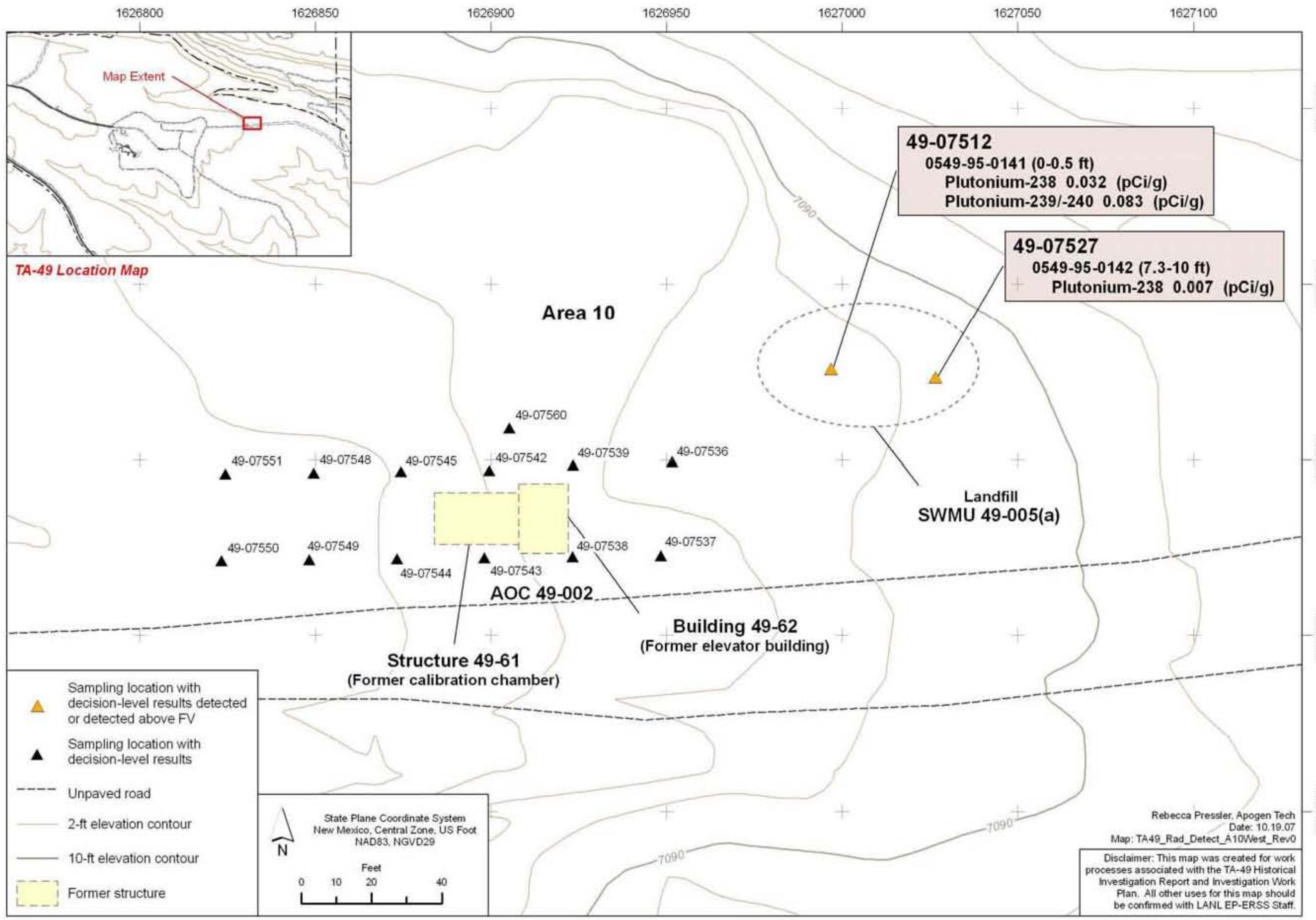


Figure 2.5.3 Area 10 radionuclide sampling locations and results detected or detected above FVs

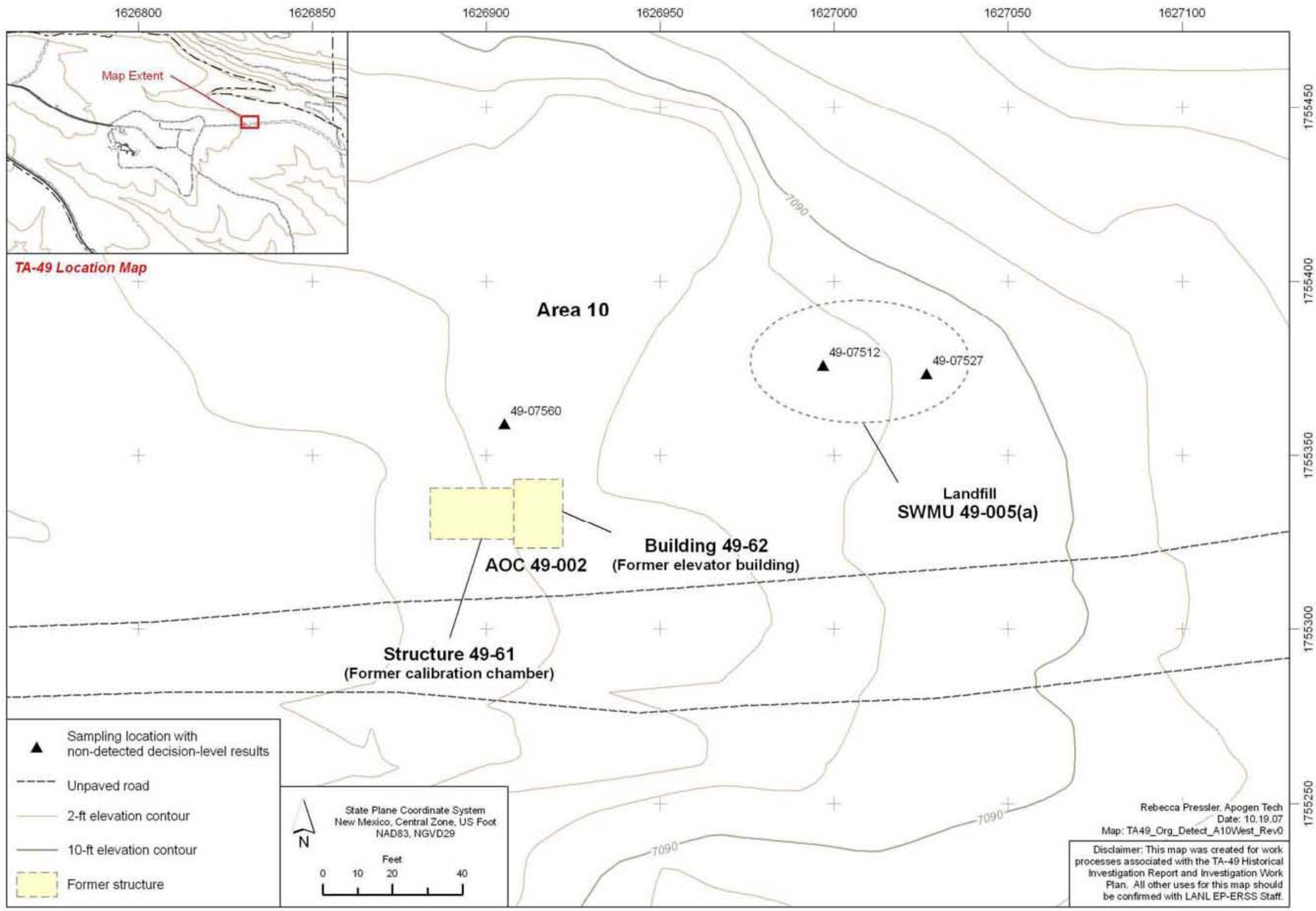
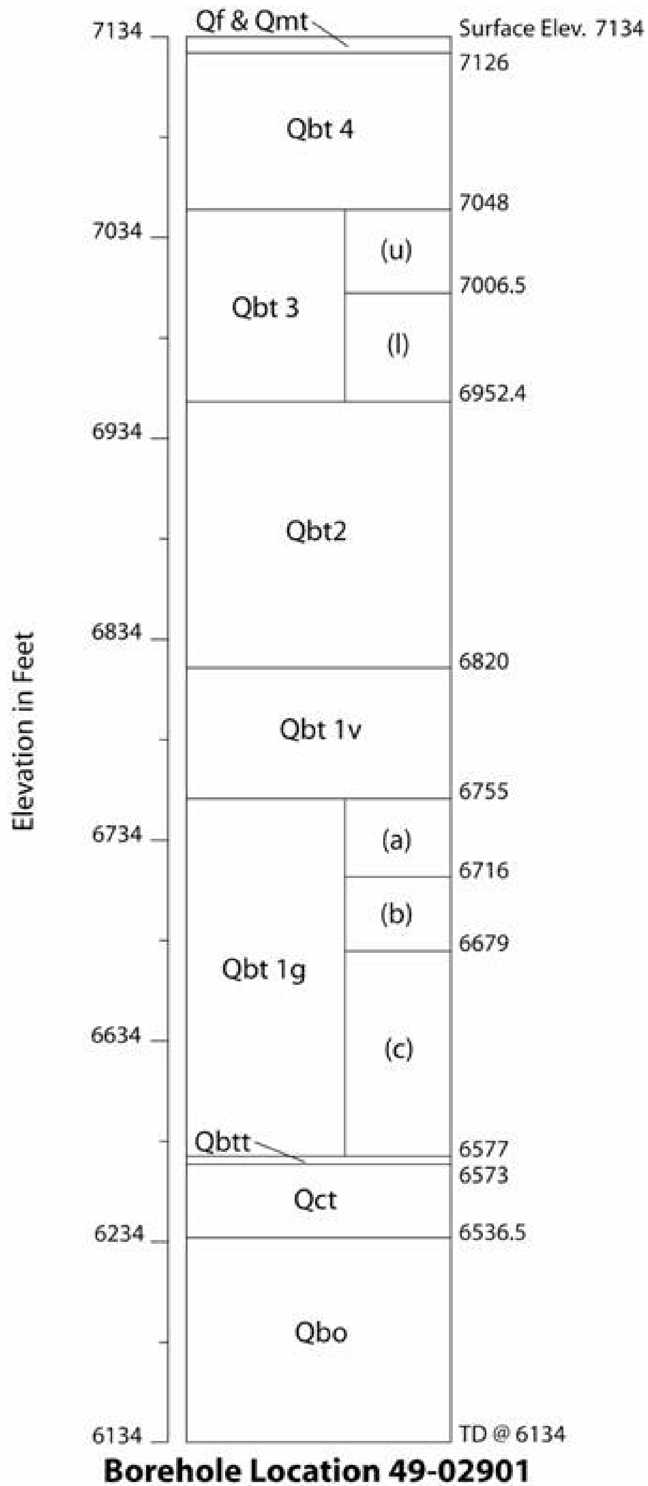
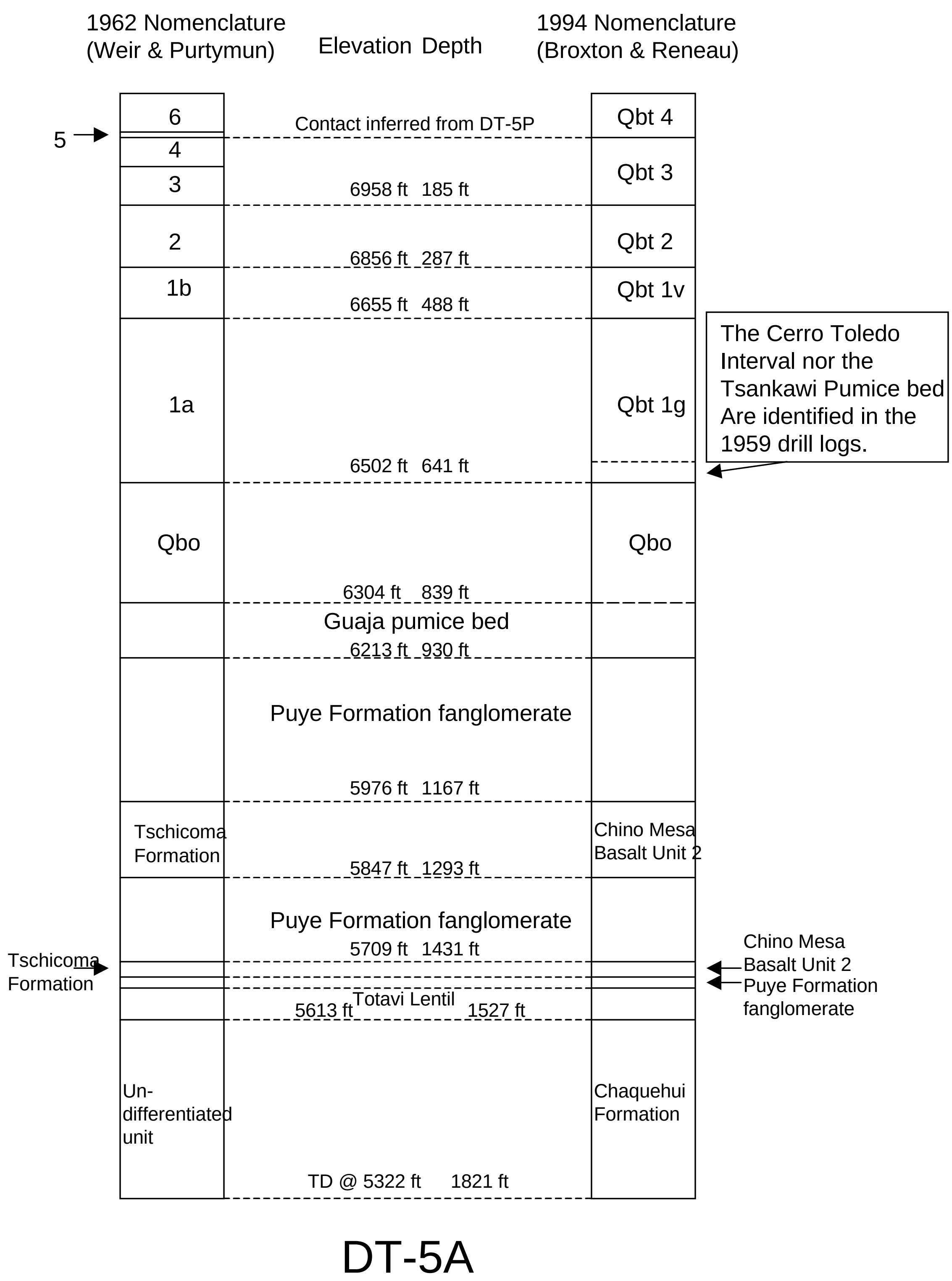


Figure 2.5.4 Area 10 organic chemical sampling locations



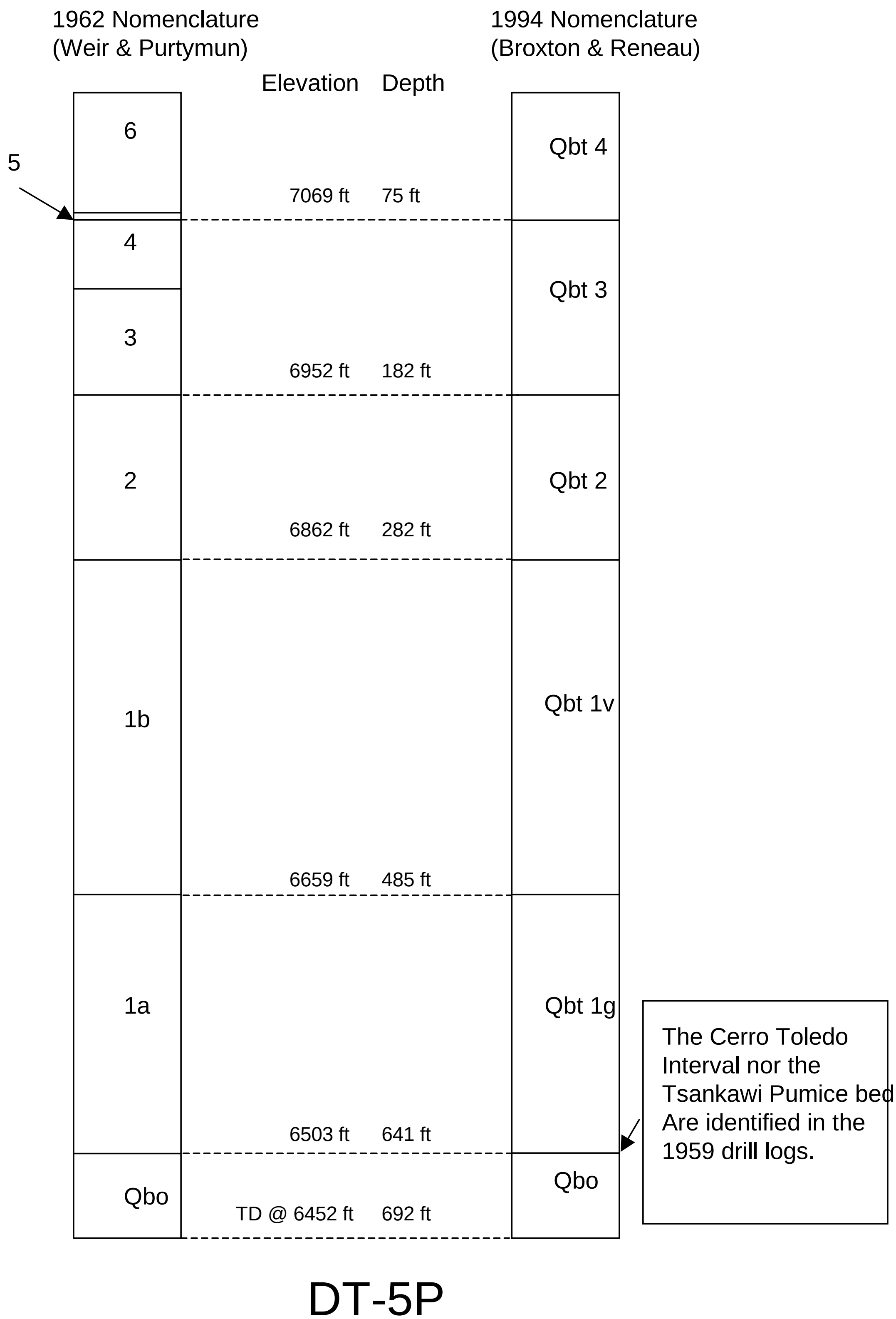
Adapted from Stimac et al. (2002, 073391)

Figure 3.2-1 Stratigraphy of borehole location 49-02901



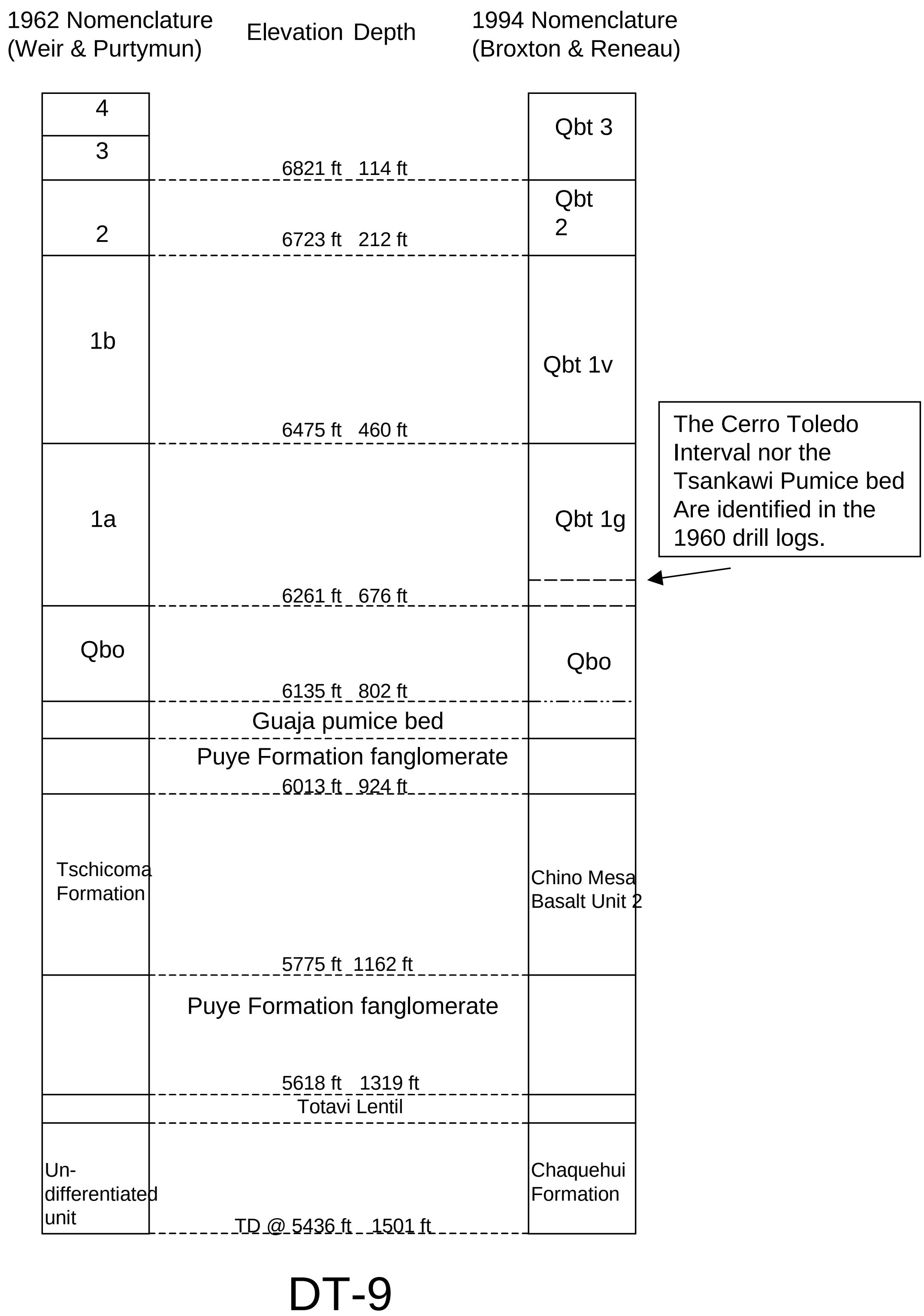
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-2 Stratigraphic units of DT-5A



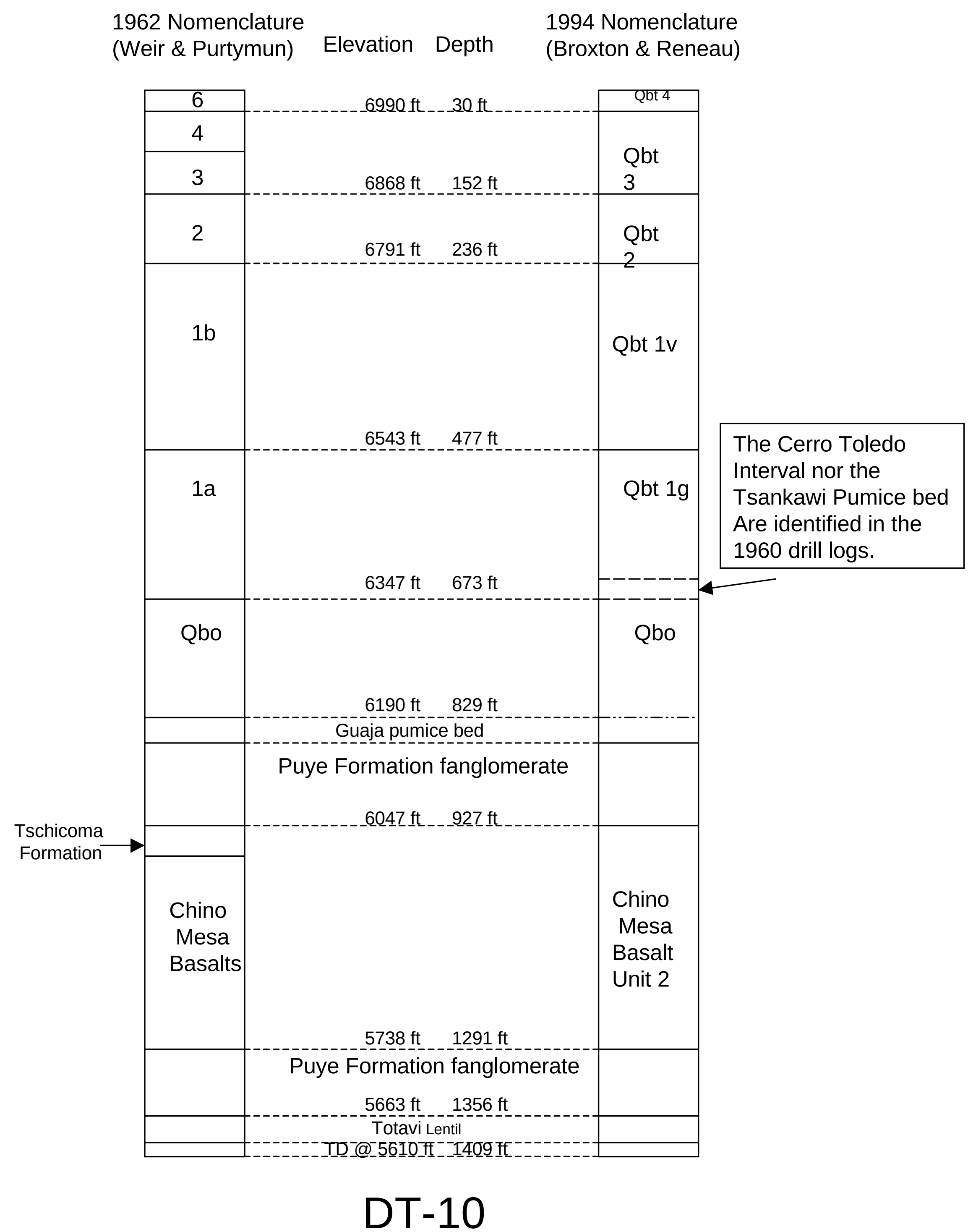
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-3 Stratigraphic units of DT-5P



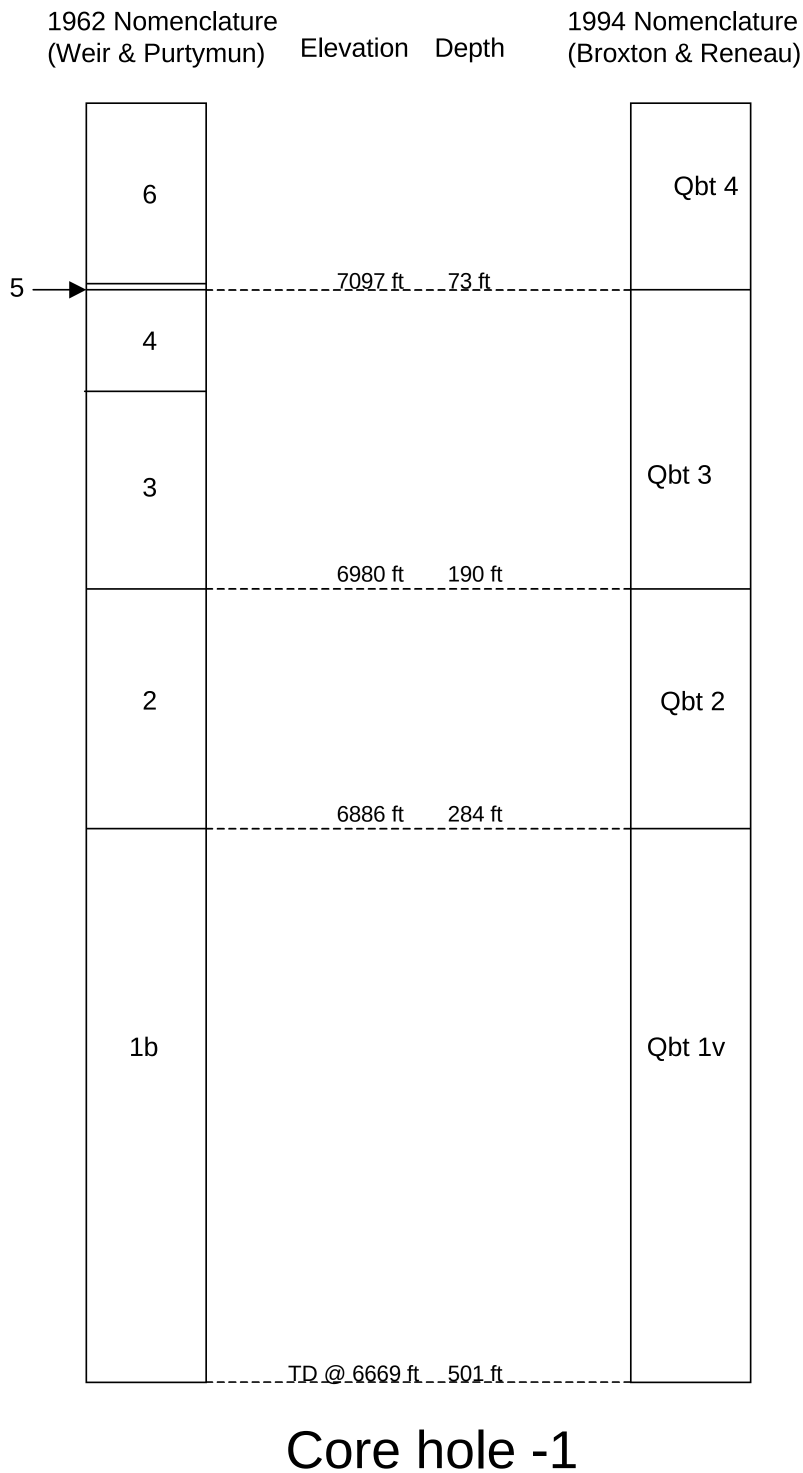
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-4 Stratigraphic units of DT-9



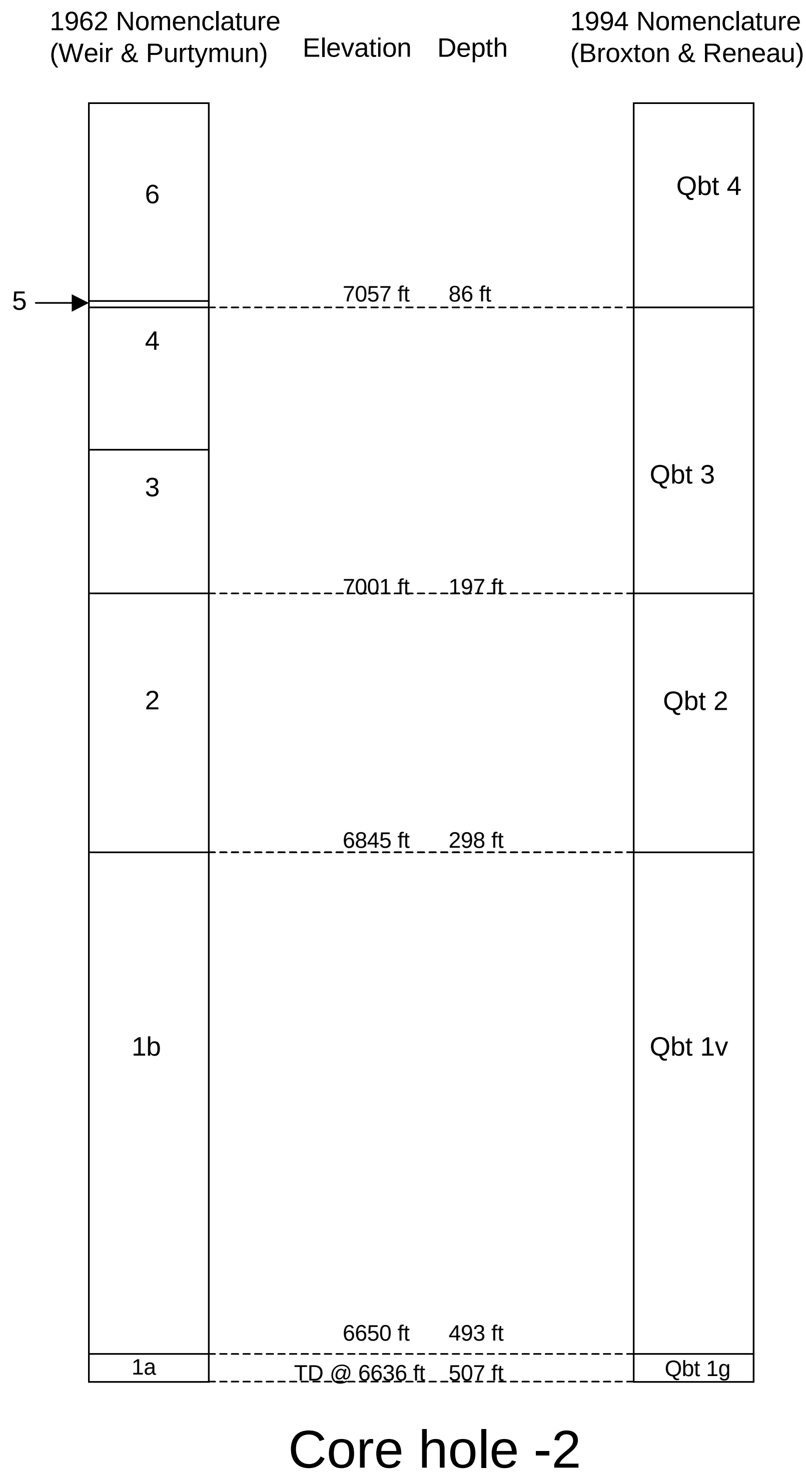
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-5 Stratigraphic units of DT-10



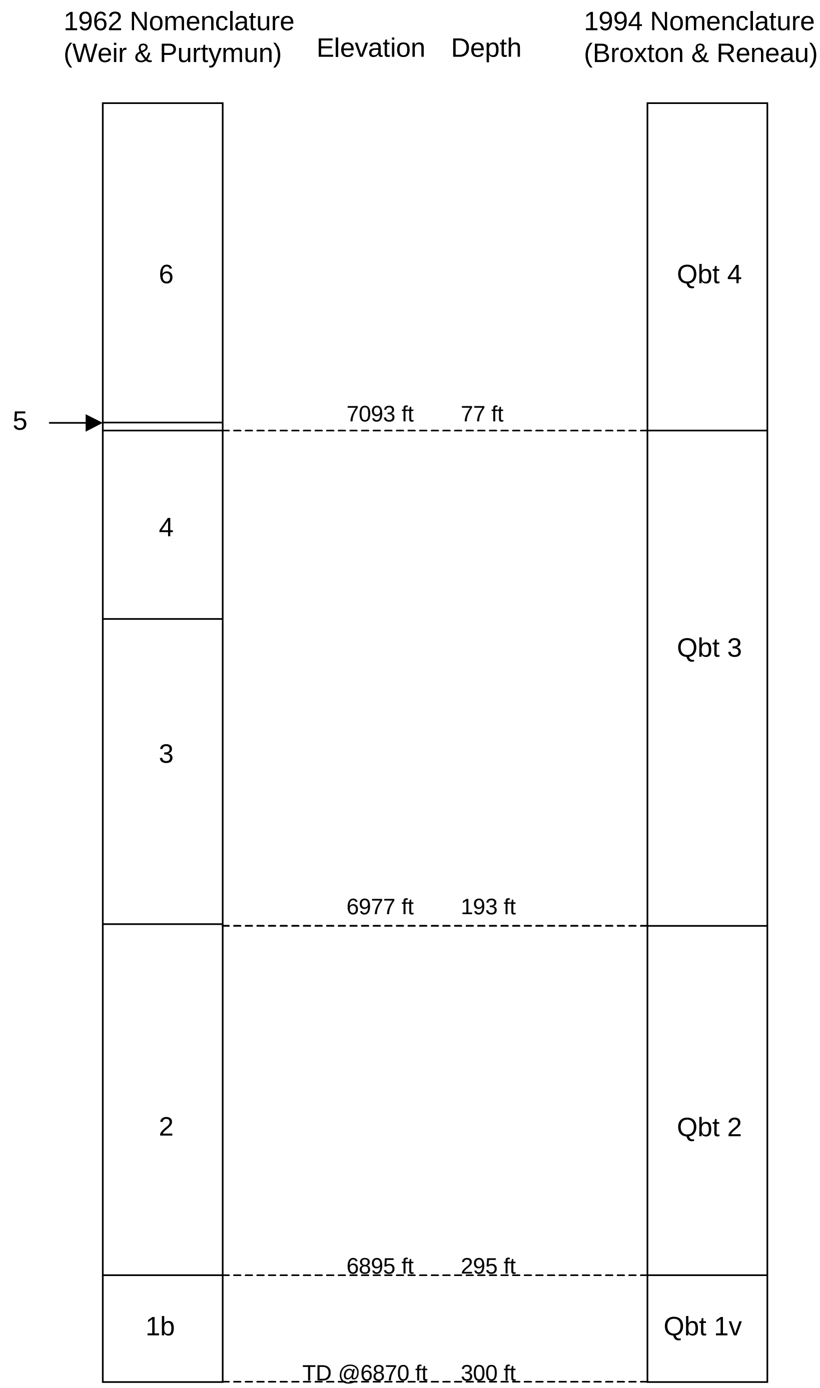
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-6 Stratigraphic units of CH-1



Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

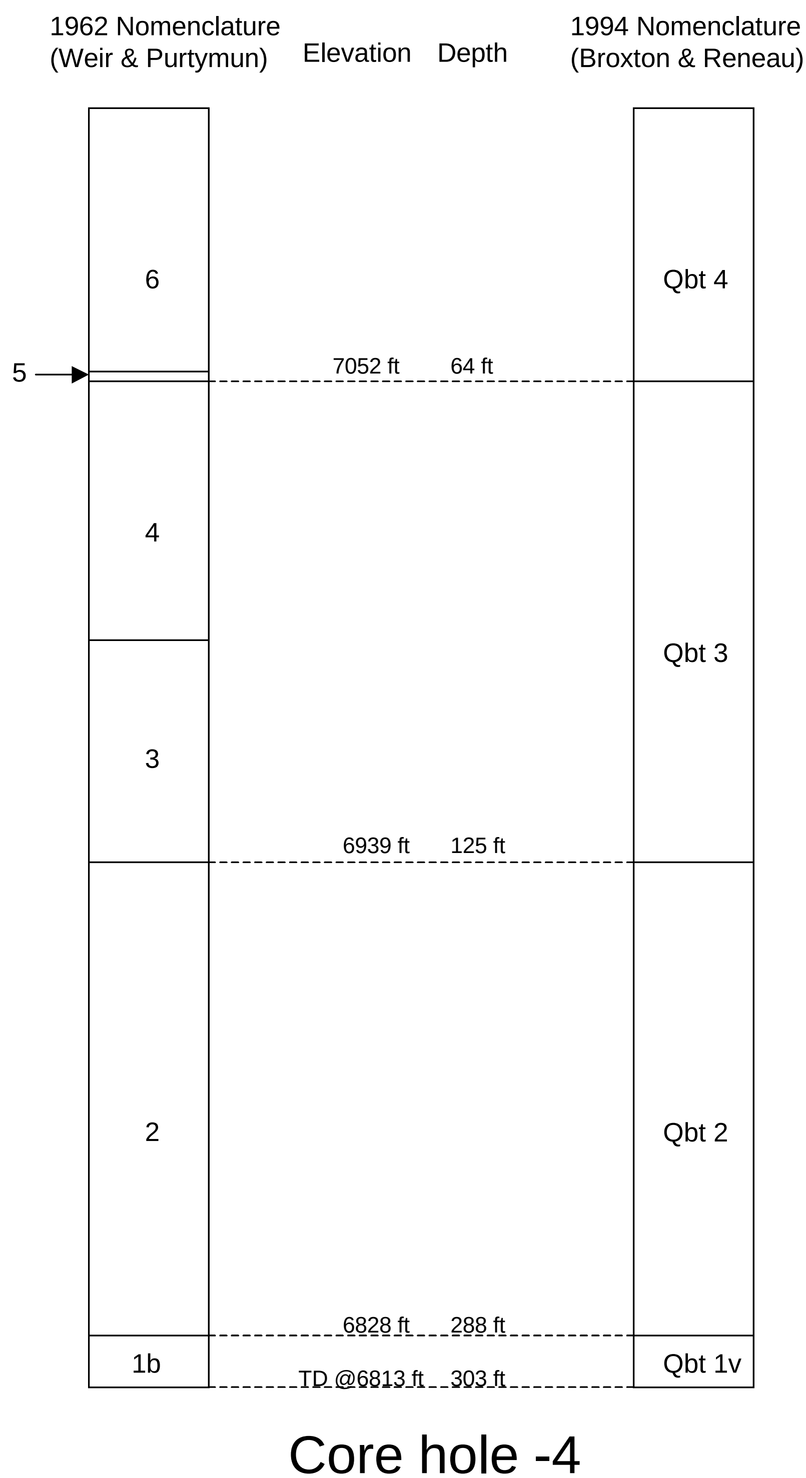
Figure 3.2-7 Stratigraphic units of CH-2



Core hole -3

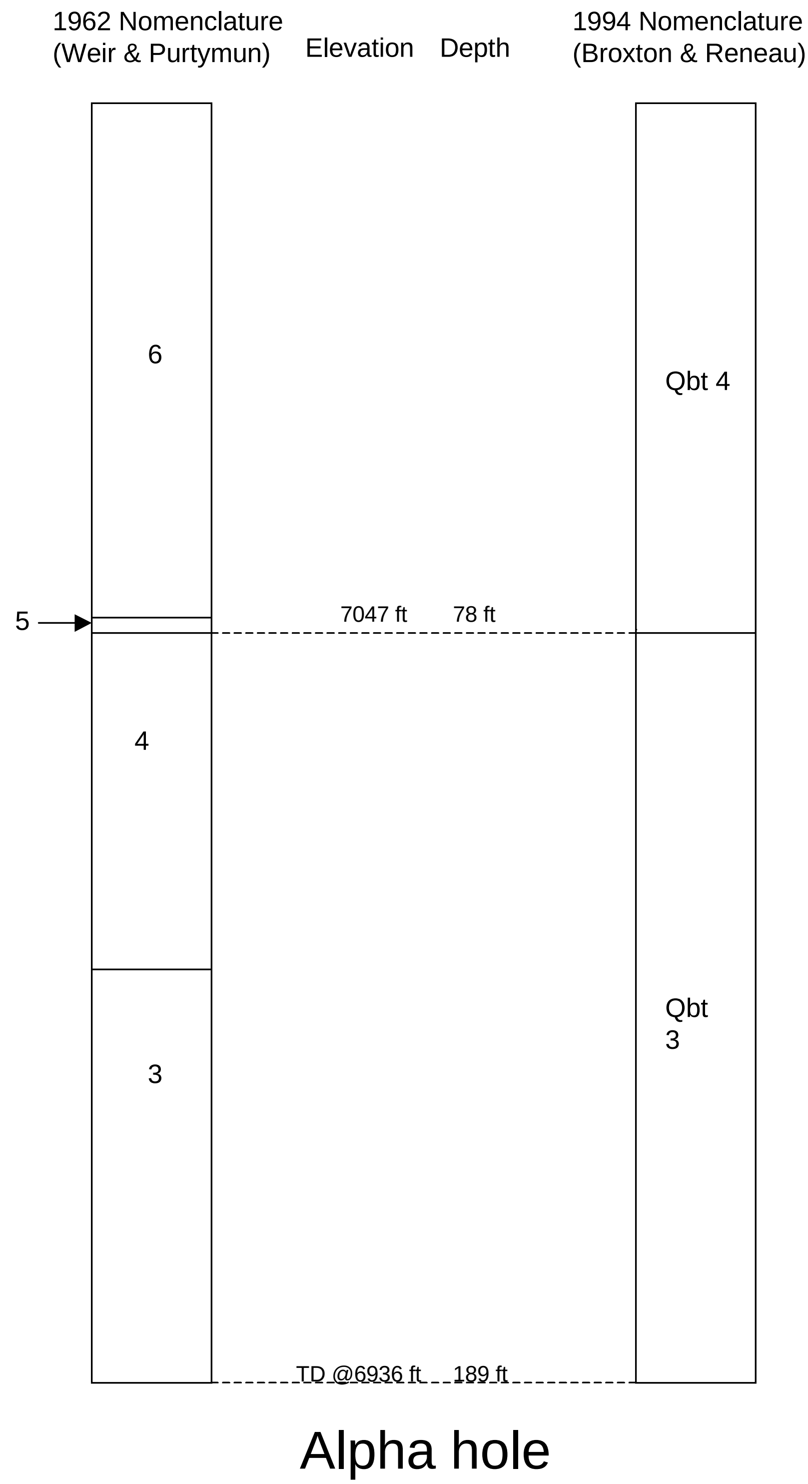
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-8 Stratigraphic units of CH-3 (



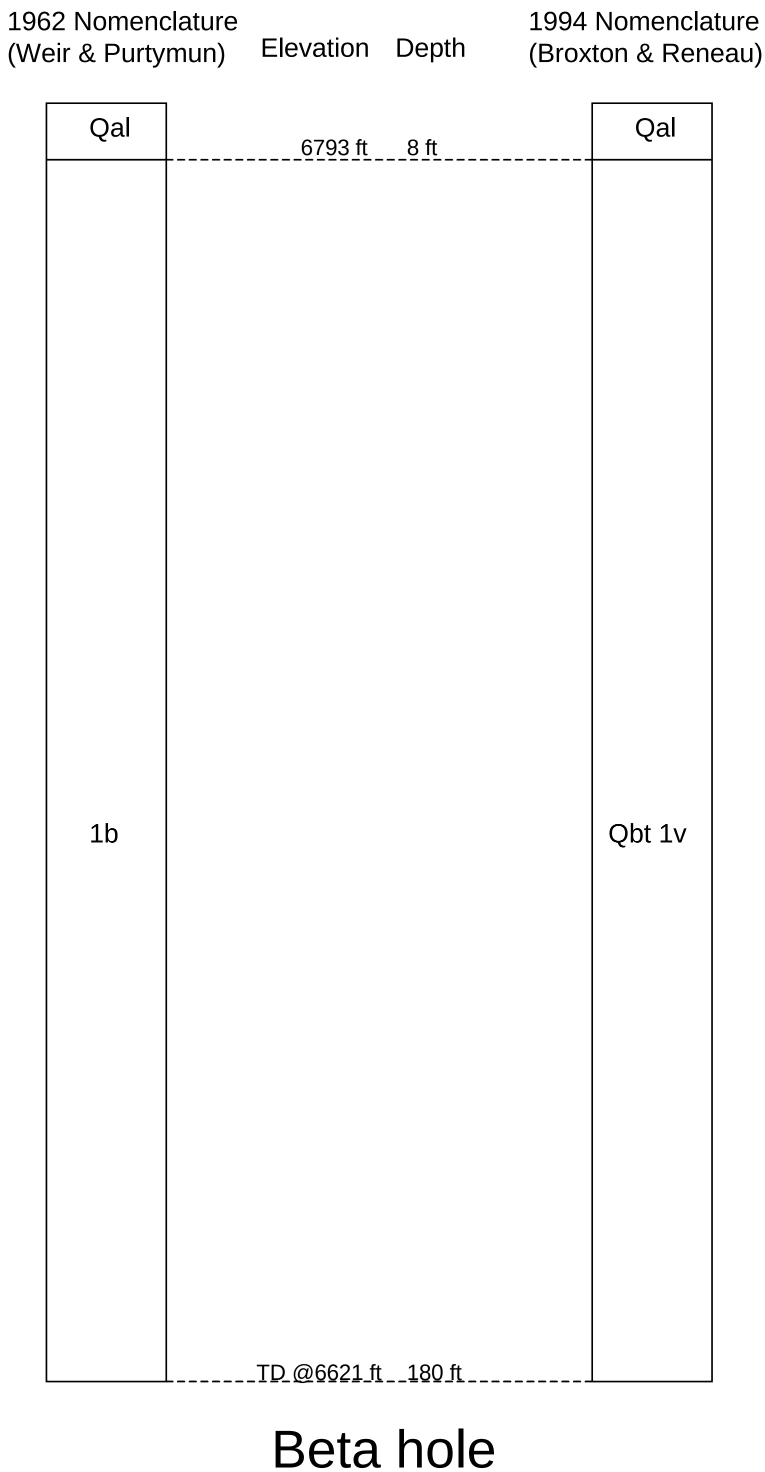
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-9 Stratigraphic units of CH-4



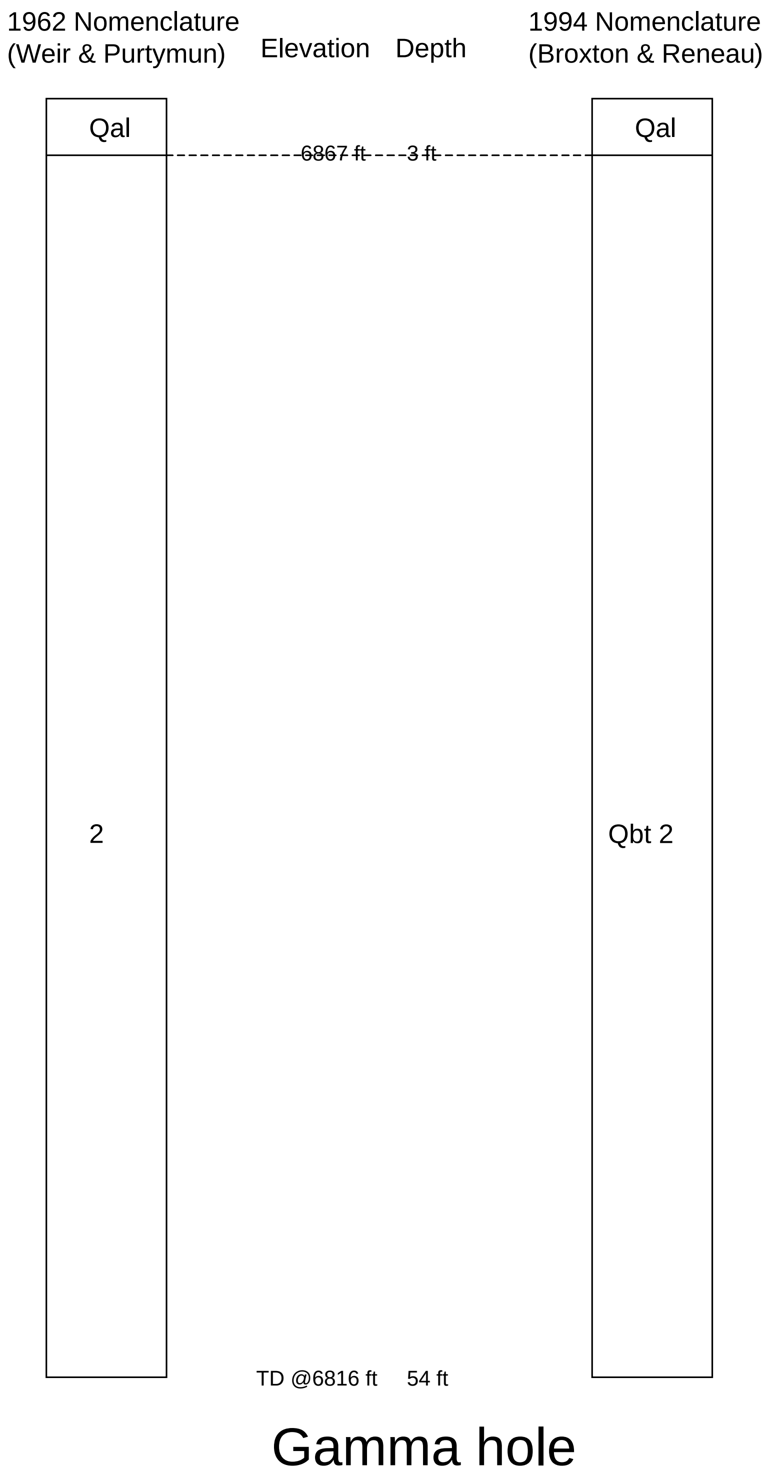
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-10 Stratigraphic units of Alpha hole



Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-11 Stratigraphic units of Beta hole



Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-12 Stratigraphy of Gamma hole

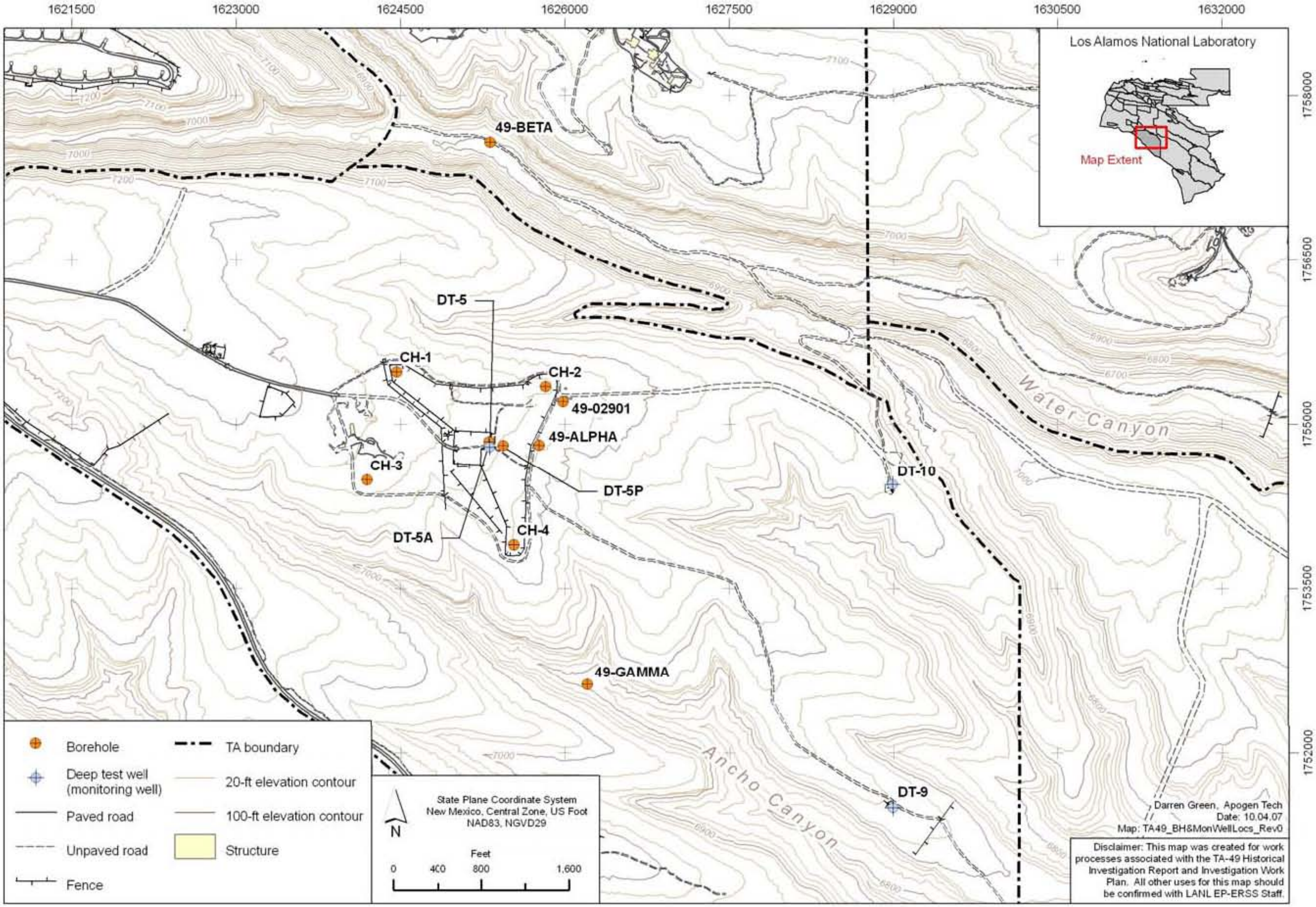


Figure 3.3-1 Locations of deep test wells and select boreholes at TA-49

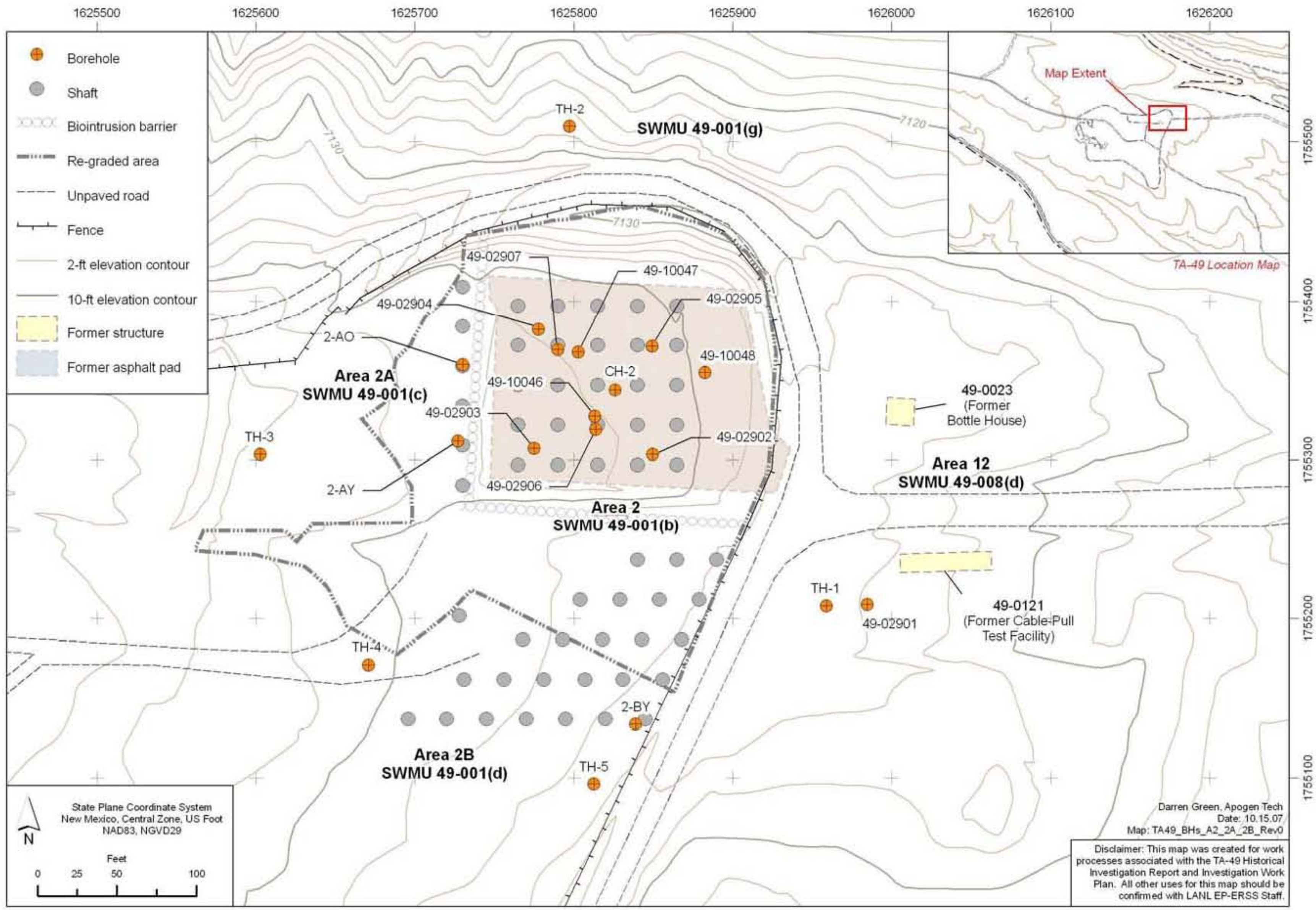
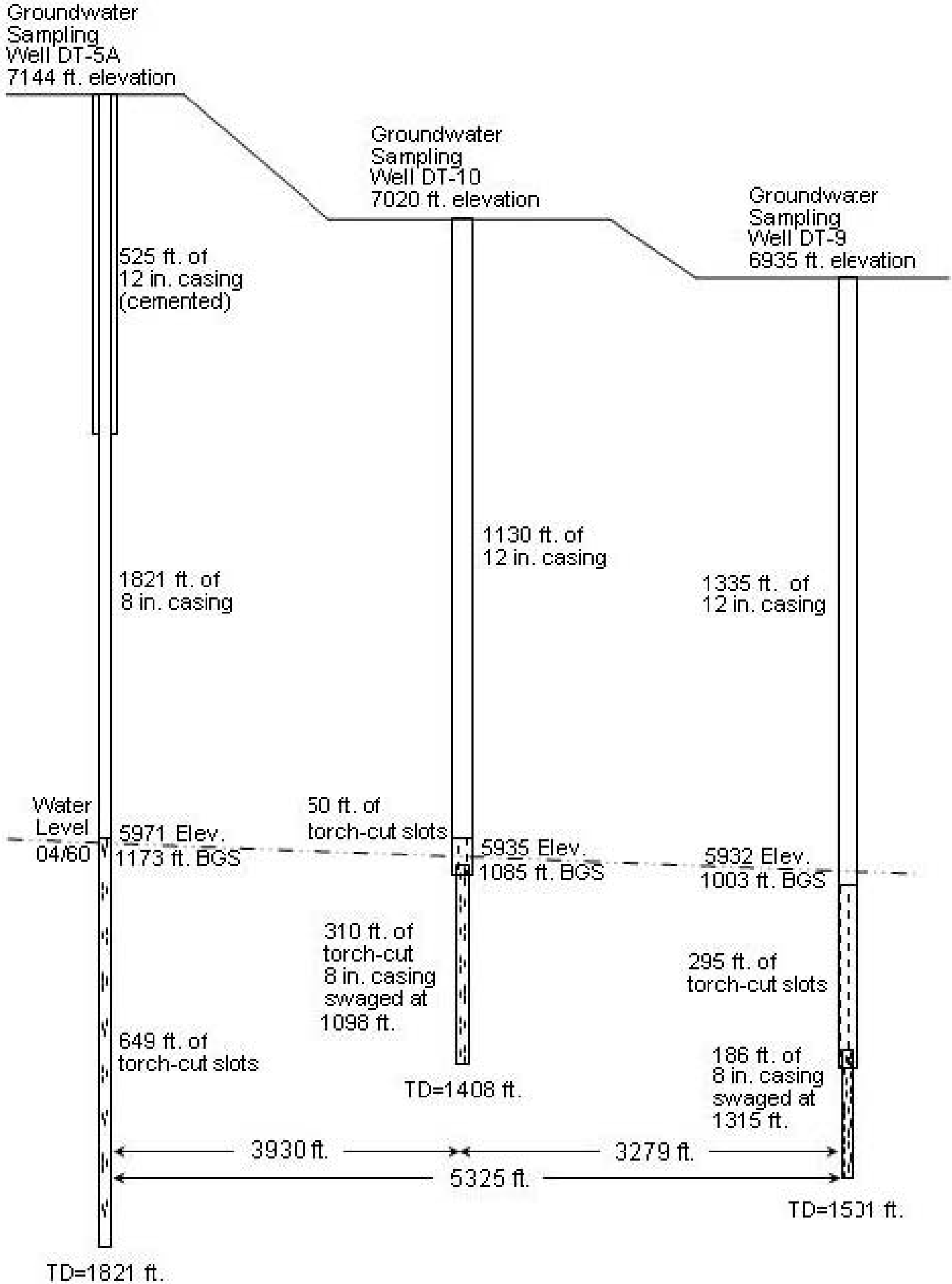
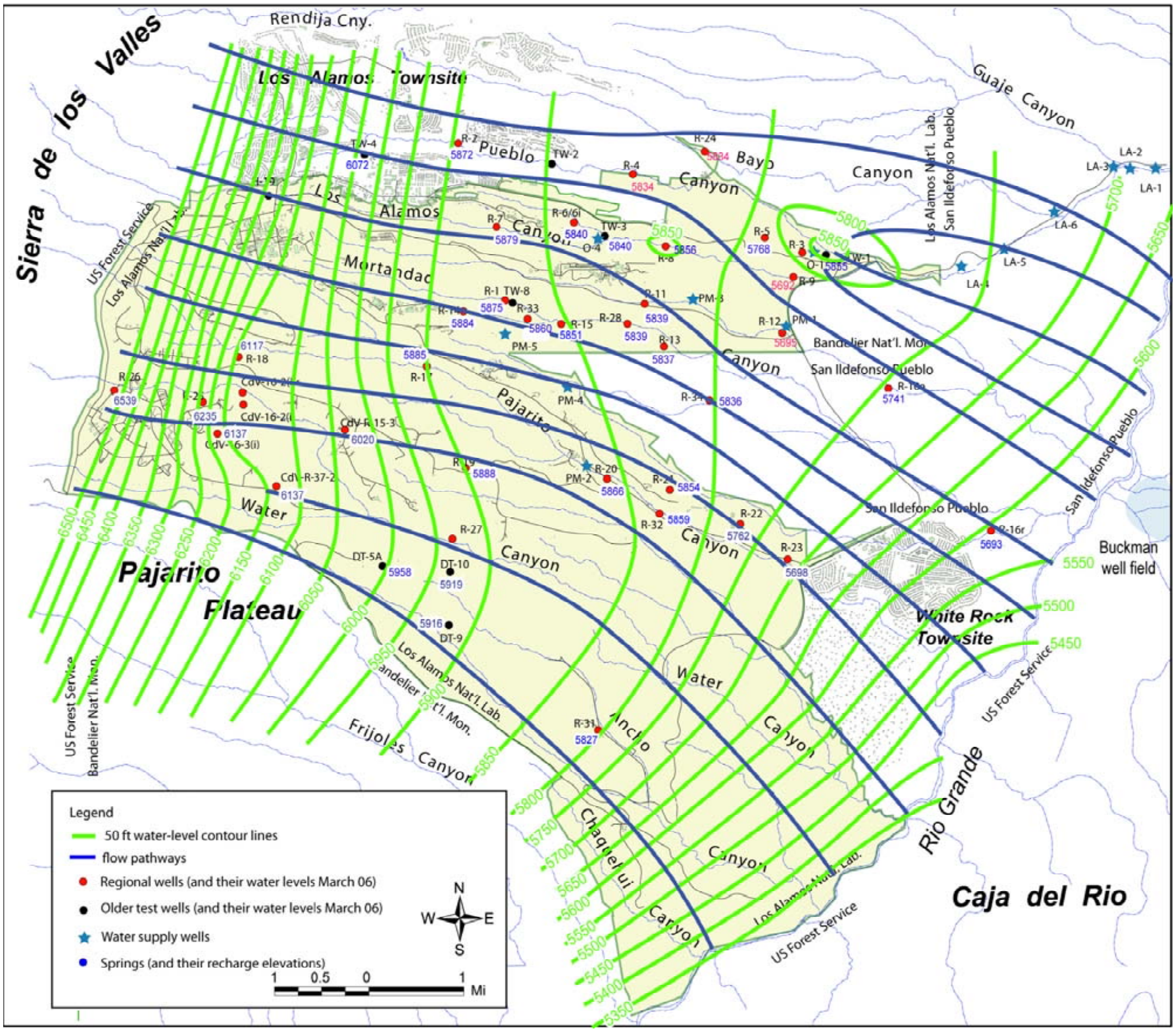


Figure 3.3-2 Areas 2, 2A, 2B, and Area 12 borehole locations



Adapted from Weir and Purtymun (1962, 011890)

Figure 3.3-3 Construction details for groundwater wells DT-5A, DT-10, and DT-9



Source: LANL (2007, 095364, p. C-15)

Figure 3.4-1 Contour map of average regional water-table elevations and flow pathways in March 2006

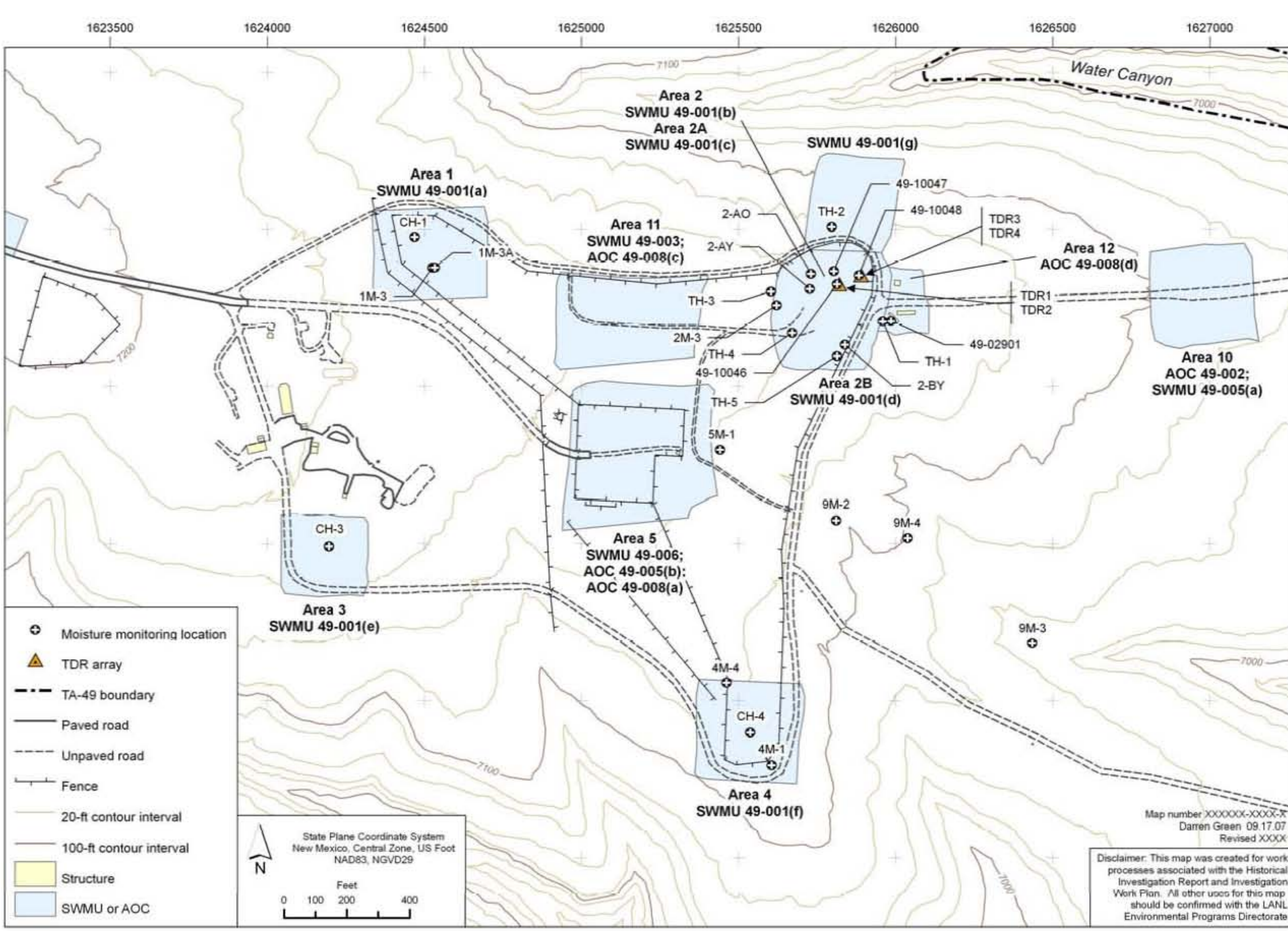


Figure 3.5-1 TA-49 moisture monitoring locations

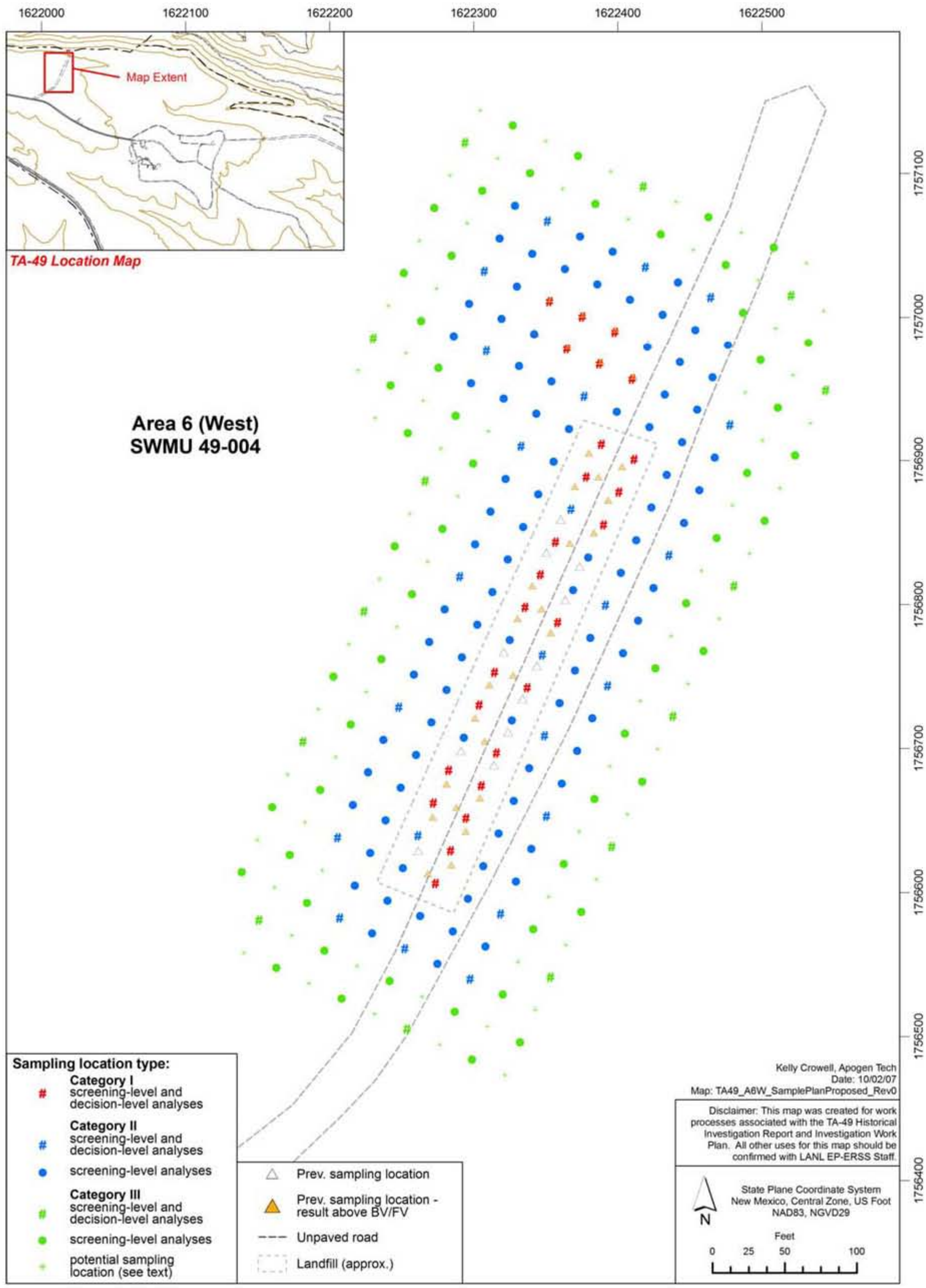


Figure 4.3-1 Area 6 West proposed surface-sampling grid

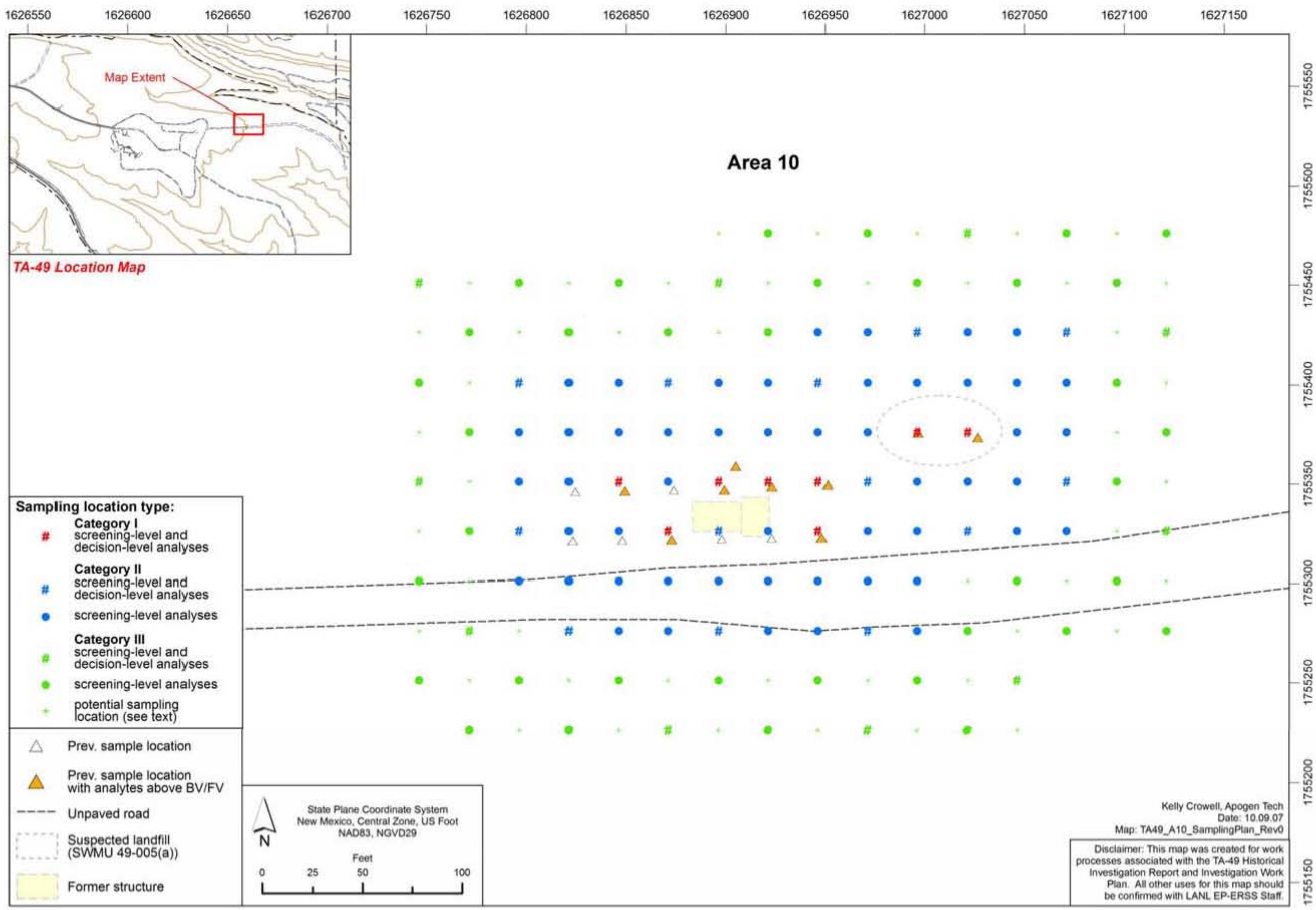


Figure 4.3-2 Area 10 proposed surface-sampling grid

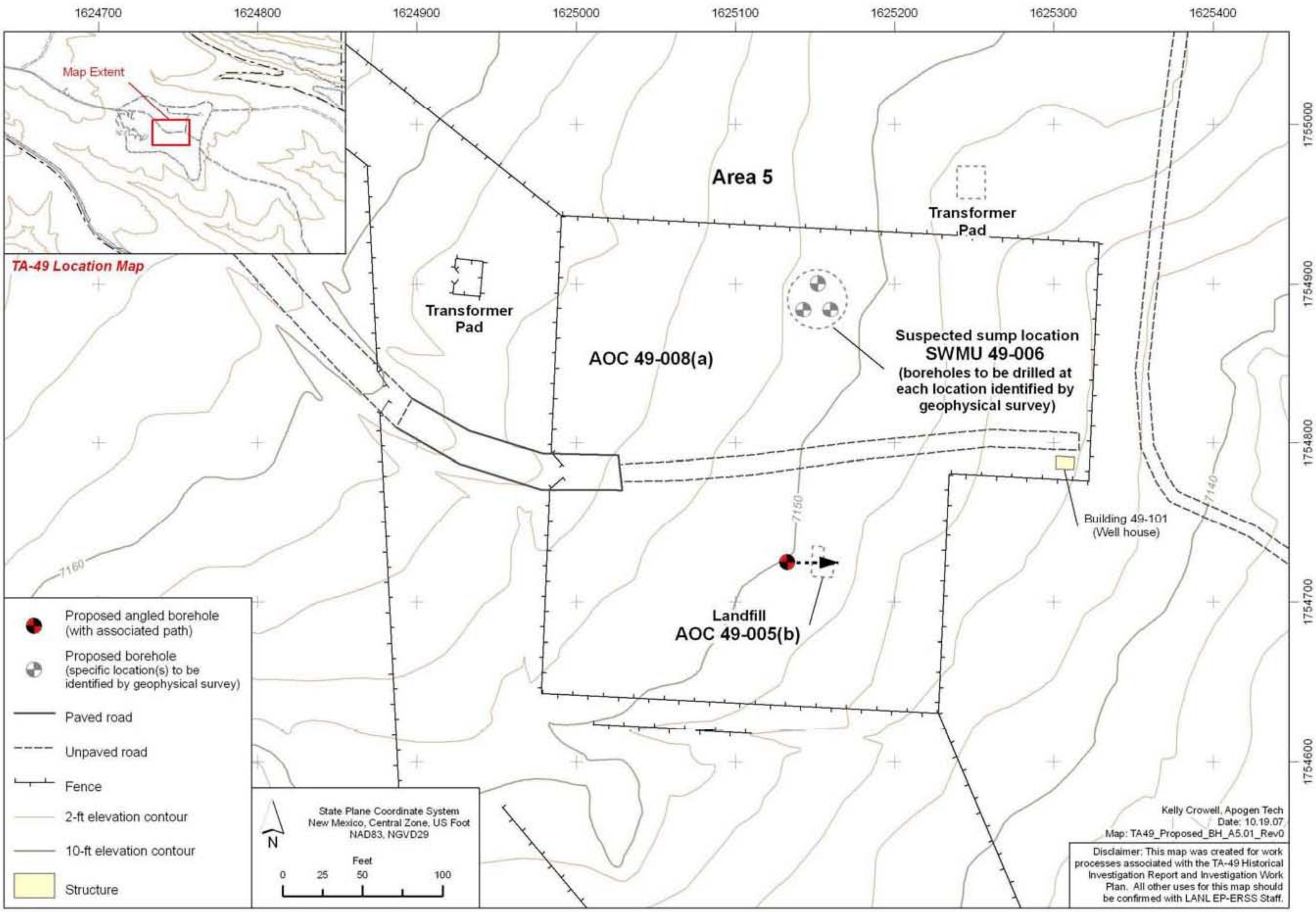


Figure 4.4-1 Area 5 proposed angled borehole for AOC 49-005(b) and vertical boreholes for SWMU 49-006

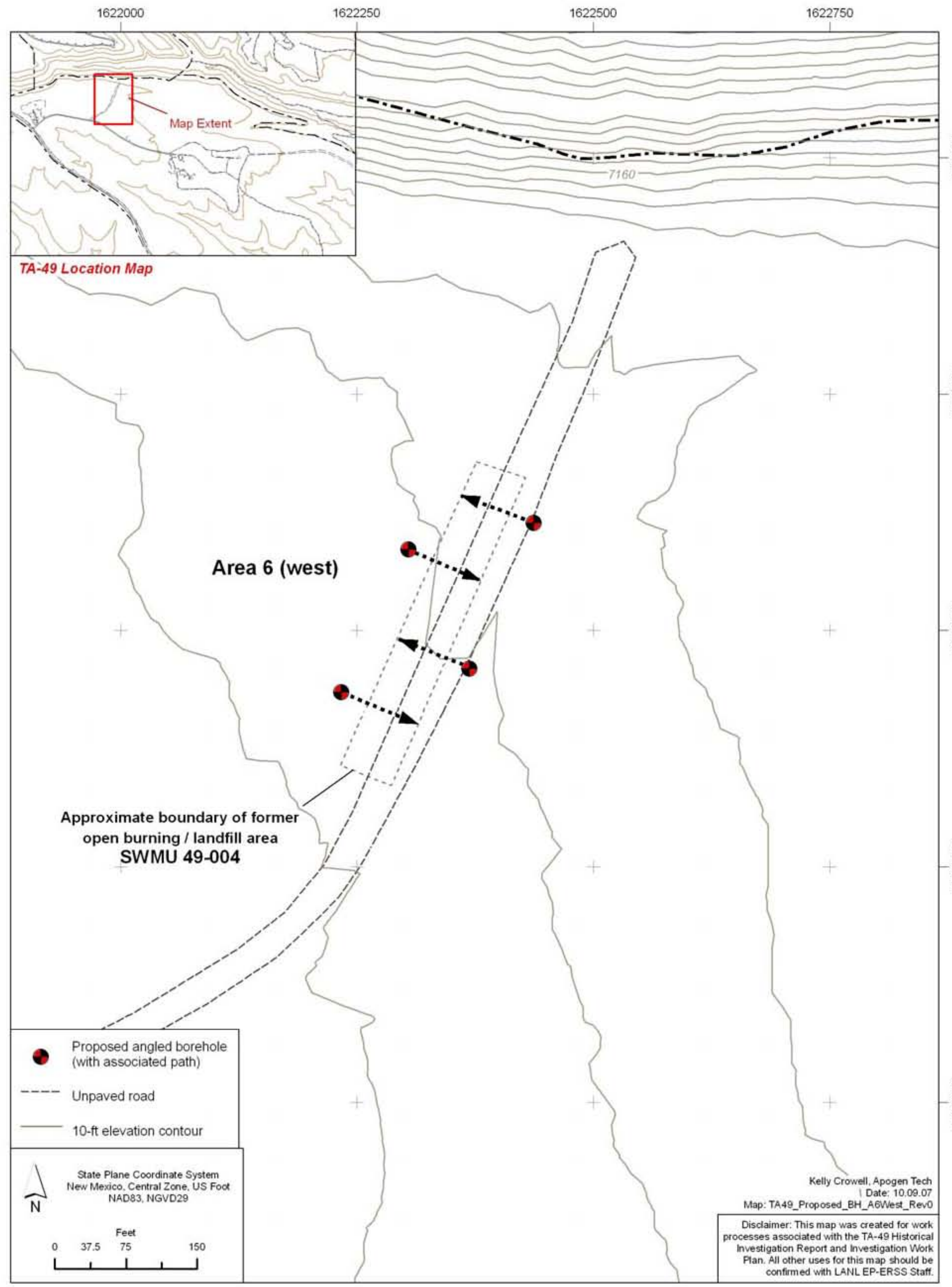


Figure 4.4-2 Area 6 West proposed angled borehole for AOC 49-004

TA-49 Sites Outside NES Investigation Work Plan

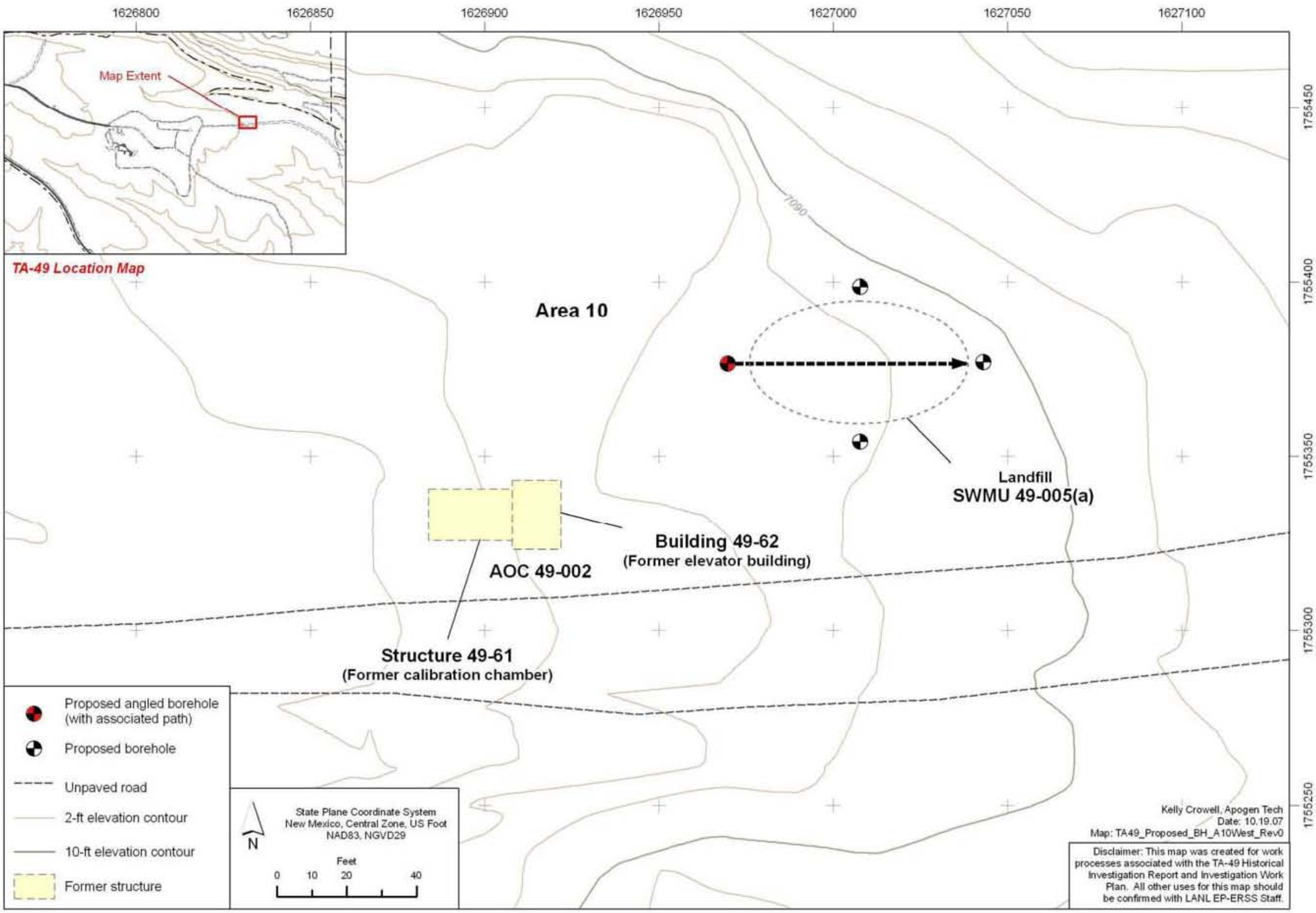


Figure 4.4-3 Area 10 proposed angled borehole and perimeter boreholes for AOC 49-005(a)

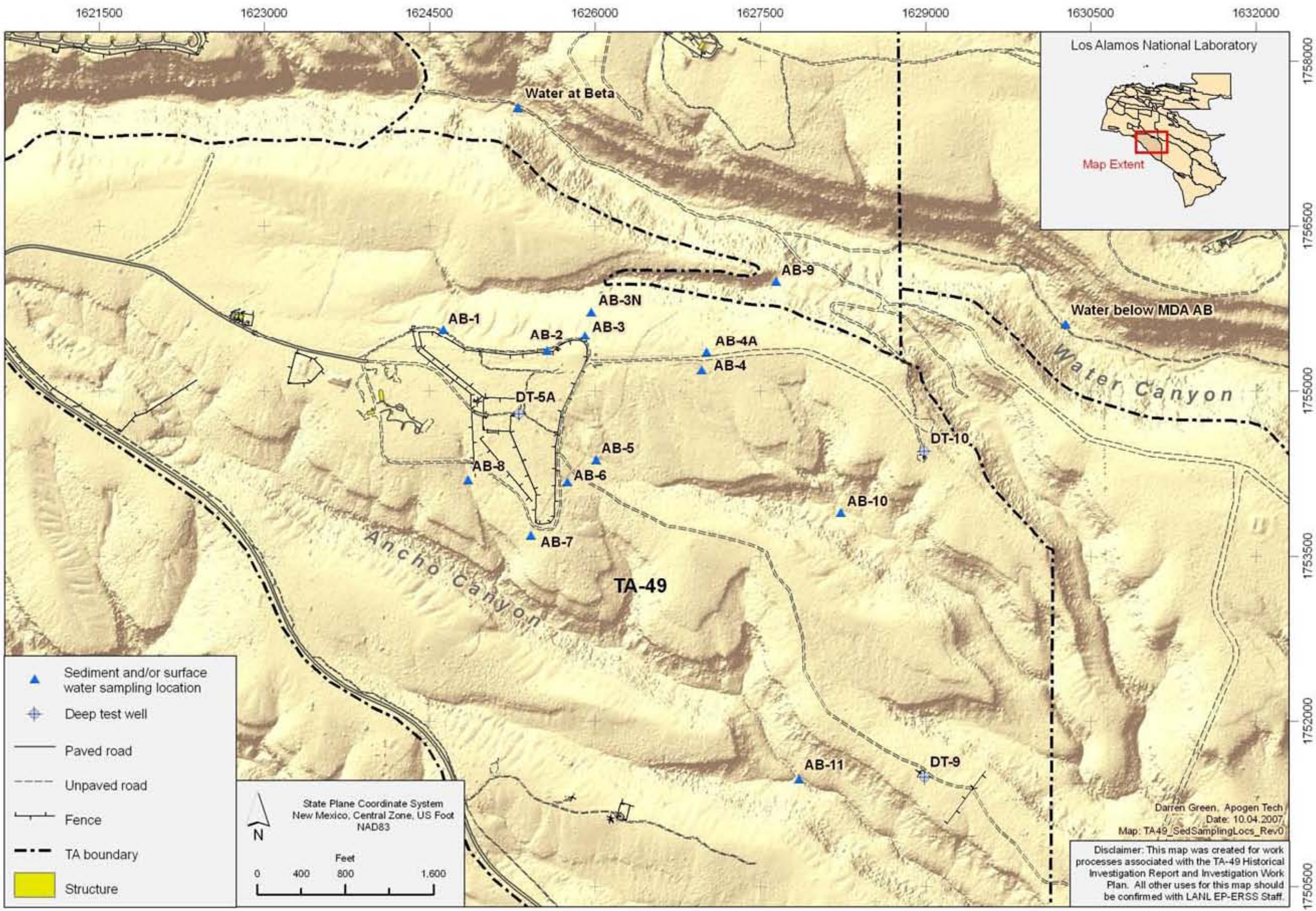


Figure 6.2-1 TA-49 sediment and surface-water sampling locations

TA-49 Sites Outside NES Investigation Work Plan

Table 1.1-1
List of TA-49 SWMUs and AOCs Outside the NES Boundary

SWMU/AOC	Description	Comment	Proposed Activity	Reference/ Location
AOC 49-002	Underground calibration chamber at Area 10	This site is included in both the HIR and investigation work plan.	Investigation sampling	Investigation work plan sections 2.4.1, 4.3.2, and 4.4.3
SWMU 49-004	Open burning/landfill area at Area 6 west	SWMU 49-004 is contained entirely within the boundaries of AOC 49-008(b), which is deferred per Table IV-2 in the Consent Order. Therefore, the investigation of the surface soil contamination for SWMU 49-004 is also deferred as part of AOC 49-008(b). However, an investigation of subsurface soil contamination is proposed. This site is included in both the HIR and investigation work plan.	Subsurface investigative sampling only, no surface sampling	Investigation work plan sections 2.3.1 and 4.4.2
SWMU 49-005(a)	Small debris landfill at Area 10	This site is included in both the HIR and investigation work plan.	Investigation sampling	Investigation work plan sections 2.4.2, 4.3.2, and 4.4.3
AOC 49-005(b)	Small debris landfill at Area 5	AOC 49-005(b) is contained entirely within the boundaries of AOC 49-008(a), which is deferred per Table IV-2 in the Consent Order. Therefore, the investigation of the surface soil contamination for AOC 49-005(b) is also deferred as part of AOC 49-008(a). However, an investigation of subsurface soil contamination is proposed as is surface of the transformer pads only. This site is included in both the HIR and investigation work plan.	Subsurface investigative sampling and surface sampling of transformer pads only.	Investigation work plan sections 2.2.1, 4.3.1, and 4.4.1
SWMU 49-006	Sump	SWMU 49-006 is contained entirely within the boundaries of AOC 49-008(a), which is deferred per Table IV-2 in the Consent Order. Therefore, the investigation of the surface soil contamination for SWMU 49-006 is also deferred as part of AOC 49-008(a). However, an investigation of subsurface soil contamination is proposed. This site is included in both the HIR and investigation work plan.	Subsurface investigative sampling only, no surface sampling.	Investigation work plan sections 2.2.2, and 4.4.1
AOC 49-007(a)	Septic system at Area 6 east	This site has been approved for NFA by EPA.	None	(2005, 088464); investigation work plan section 2.3

Table 1.1-1 (continued)

SWMU/AOC	Description	Comment	Proposed Activity	Reference/ Location
AOC 49-007(b)	Septic system at HDT Training Area	This site has been approved for NFA by EPA.	None	(2005, 088464); investigation work plan section 2.3
AOC 49-008(a)	Area of potential soil contamination at Area 5	AOC 49-008(a) is deferred per Table IV-2 as specified in the Consent Order. This site is included in both the HIR and investigation work plan.	Subsurface investigative sampling only, no surface sampling.	Investigation work plan sections 2.2.3 and 4.4.1
AOC 49-008(b)	Area of potential soil contamination at Area 6 east	AOC 49-008(b) is deferred per Table IV-2 as specified in the Consent Order. This site is included in both the HIR and investigation work plan.	Subsurface investigative sampling only, no surface sampling.	Investigation work plan sections 2.3.2 and 4.4.2

Table 2.1-1
Human Health Industrial Soil Screening Levels

Chemical	Industrial Soil Screening Level[a]	End Point[b]
Inorganic Chemicals (mg/kg)		
Aluminum	100,000[c]	max
Antimony	454	nc
Arsenic	17.7	ca
Barium	100,000[c]	max
Beryllium	2250[d]	nc
Boron	100,000[c]	max
Cadmium	564	nc
Chromium (total)	100,000[c]	max
Chromium (hexavalent)	3400	nc
Cobalt	20,500	nc
Copper	45,400	nc
Cyanide (total)	13,700	nc
Iron	100,000[c]	max
Lead	800[d]	IEBUK[d]
Manganese	48,400	nc
Mercury	100,000[c]	max
Nickel	22,700	nc
Nitrate-Nitrite as N	100,000[c]	max
Perchlorate	795[e]	nc
Selenium	5680	nc

Table 2.1.1 (continued)

Chemical	Industrial Soil Screening Level[a]	End Point[b]
Silver	5680	nc
Thallium	74.9	nc
Titanium	100,000[c,f]	max
Uranium	200[f]	nc
Vanadium	1140	nc
Zinc	100,000[c]	max
Organics (mg/kg)		
Acenaphthene	33,500	nc
Acetone	100,000	max
Acrolein	0.752	nc
Aldrin	1.12	ca
Anthracene	100,000	max
Benzene	25.8	ca
Benzo(a)anthracene	23.4	ca
Benzo(a)pyrene	2.34	ca
Benzo(b)fluoranthene	23.4	ca
Benzo(k)fluoranthene	234	ca
a-BHC (HCH)	3.99	ca
b-BHC (HCH)	14	ca
g-BHC	19.3	ca
Bis(2-chloroethyl) ether	7.45	ca
Bis(2-ethylhexyl) phthalate	1370	ca
Bromobenzene	137	nc
Bromodichloromethane	37.2	ca
Bromomethane	32.8	nc
2-Butanone	48,700	sat
Methyl ether butyl ethe	984	ca
n-Butylbenzene	62.1	sat
tert-Butylbenzene	106	sat
Carbon disulfide	460	sat
Carbon tetrachloride	8.64	ca
Chlordane	71.9	ca
Chlorobenzene	245	sat
Chloroethane	154	ca
Chloroform	9.59	ca
Chloromethane	53.4	ca
b-Chloronaphthalene	27800	nc
2-Chlorophenol	885	nc
o-Chlorotoluene	202	sat

Table 2.1.1 (continued)

Chemical	Industrial Soil Screening Level[a]	End Point[b]
Chrysene	2310	ca
Cumene (isopropylbenzene)	389	sat
DDD	111	ca
DDE	78.1	ca
DDT	78.1	ca
Dibenz(a,h)anthracene	2.34	ca
Dibenzofuran	1620	nc
1,2-Dibromo-3-chloropropane	9.68	nc
Dibromochloromethane	39.5	ca
1,2-Dibromoethane	1.31	ca
1,2-Dichlorobenzene	37.4	sat
1,3-Dichlorobenzene	37.4	sat
1,4-Dichlorobenzene	103	ca
3,3-Dichlorobenzidine	42.6	ca
Dichlorodifluoromethane	211	sat
1,1-Dichloroethane	1420	sat
1,2-Dichloroethane	15.2	ca
cis-1,2-Dichloroethene	300	nc
trans-1,2-Dichloroethene	429	nc
1,1-Dichloroethene	777	nc
2,4-Dichlorophenol	2050	nc
1,2-Dichloropropane	14.9	ca
Dieldrin	1.2	ca
Diethyl phthalate	100,000	max
Dimethyl phthalate	100,000	max
2,4-Dimethylphenol	13700	nc
4,6-Dinitro-o-cresol	68.4	nc
2,4-Dinitrophenol	1370	nc
2,4-Dinitrotoluene	1370	nc
Endrin	205	nc
Ethyl chloride	154	ca
Ethyl methacrylate	52.7	sat
Ethylbenzene	128	sat
Fluoranthene	24,400	nc
Fluorene	26,500	nc
Heptachlor	4.26	ca
Hexachlorobenzene	12	ca
Hexachloro-1,3-butadiene	137	nc
Hexachlorocyclopentadiene	4100	nc

Table 2.1.1 (continued)

Chemical	Industrial Soil Screening Level[a]	End Point[b]
Hexachloroethane	684	nc
HMX	34,200	nc
Indeno(1,2,3-c,d)pyrene	23.4	ca
Isophorone	20,200	ca
Methacrylonitrile	22	nc
Methyl methacrylate	2920	sat
Methylene bromide	785	nc
Methylene chloride	490	ca
Naphthalene	300	nc
Nitrobenzene	147	nc
N-Nitrosodimethylamine	0.376	ca
N-Nitrosodiphenylamine	3910	ca
m-Nitrotoluene	569	sat
o-Nitrotoluene	32.3	ca
p-Nitrotoluene	437	ca
Pentachlorophenol	100	ca
Phenanthrene	20,500	nc
Phenol	100,000	max
Aroclor 1016	41.3	nc
Aroclor 1221	8.26	ca
Aroclor 1232	8.26	ca
Aroclor 1242	8.26	ca
Aroclor 1248	8.26	ca
Aroclor 1254	8.26	ca
Aroclor 1260	8.26	ca
n-Propylbenzene	62.1	sat
Pyrene	30,900	nc
RDX	174	ca
Styrene	100	sat
1,1,1,2-Tetrachloroethane	114	ca
1,1,2,2-Tetrachloroethane	14.6	ca
Tetrachloroethene	31.6	ca
Toluene	252	sat
Toxaphene	17.4	ca
Tribromomethane	2460	ca
1,1,2-Trichloro-1,2,2-trifluoroethane	3280	sat
1,2,4-Trichlorobenzene	269	nc

Table 2.1.1 (continued)

Chemical	Industrial Soil Screening Level[a]	End Point[b]
1,1,1-Trichloroethane	563	sat
1,1,2-Trichloroethane	30.2	ca
Trichloroethylene	1.56	ca
Trichlorofluoromethane	983	sat
2,4,5-Trichlorophenol	68,400	nc
2,4,6-Trichlorophenol	68.4	nc
1,2,3-Trichloropropane	0.209	ca
1,2,4-Trimethylbenzene	213	nc
1,3,5-Trimethylbenzene	69.2	sat
2,4,6-Trinitrotoluene	342	nc
Vinyl acetate	3680	sat
Vinyl chloride (adult)	14	ca
o-Xylene	99.5	sat
Xylenes	82	sat
Radionuclides (pCi/g)p		
Americium-241	180	—[g]
Cesium-137	23	—
Plutonium-238	240	—
Plutonium-239	210	—
Strontium-90	1900	—
Tritium	440,000	—
Uranium-234	1500	—
Uranium-235	87	—
Uranium-238	430	—

[a] SSLs are from the "Technical Background Document for Development of Soil Screening Levels (NMED 2006, 092513).

[b] Max = Maximum, sat = saturated, nc = noncarcinogen, c = carcinogen.

[c] SSL exceeds 105 mg/kg.

[d] IEUBK = Integrated exposure uptake biokinetic.

[e] SSL from 2006 Region 6 Risk-Based Human Health Screening Values (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm).

[f] SSL from 2006 Region 9 Preliminary Remediation Goals (www.epa.gov/region09/waste/sfund/prg).

[g] — = Not detected.

Table 2.3-1
Summary of Inorganic Chemicals above BVs at Area 5: AOC 49-005(b)

Sample ID	Location ID	Depth (ft)	Media	Mercury	Potassium	Thallium	Uranium
Soil Background Value[a]				**0.1**	**3460**	**0.73**	**1.82**
0549-95-0136	49-05078	0.00-0.50	Soil	0.12 (U)	—[b]	1.5 (U)	3.72
0549-95-0135	49-05078	3.60-5.00	Fill	0.12 (U)	—	1.4 (U)	4.23
0549-95-0139	49-05079	0.00-0.50	Soil	—	3500	1.5 (U)	3.51
0549-95-0137	49-05079	3.30-5.00	Fill	0.11 (U)	—	1.4 (U)	3.15

Notes: All values are in mg/kg. See Appendix A for data qualifier definitions.
[a] BVs are from LANL (1998, 059730).
[b] — = Not detected above BV.

Table 2.3-2
Summary of Radionuclides Detected at Area 5: AOC 49-005(b)

Sample ID	Location ID	Depth (ft)	Media	Cesium-137	Plutonium-238	Plutonium-239/240
Soil Background/Fallout Value[a]				**1.65**	**0.023**	**0.054**
0549-95-0135	49-05078	3.60-5.00	Fill	0.13	—[b]	0.025
0549-95-0137	49-05079	3.30-5.00	Fill	—	0.007	0.009

Notes: All values are in pCi/g.
[a] BVs/FVs are from LANL (1998, 059730).
[b] — = Not detected.

Table 2.3-3
Summary of Inorganic Chemicals above BVs at Area 5: SWMU 49-006

Sample ID	Location ID	Depth (ft)	Media	Antimony	Cadmium	Copper	Lead	Mercury	Selenium	Thallium	Uranium	Zinc
Soil Background Value[a]				**0.83**	**0.4**	**14.7**	**22.3**	**0.1**	**1.52**	**0.73**	**1.82**	**48.8**
Qbt 2,3,4 Background Value				**0.5**	**1.63**	**4.66**	**11.2**	**0.1**	**0.3**	**1.1**	**2.4**	**63.5**
0549-95-0134	49-05095	0.00–0.50	Soil	0.84 (UJ)	0.88 (J)	86.4	33	0.12 (U)	—[b]	1.5 (U)	3.1	227
0549-95-0133	49-05095	5.00–10.00	Qbt 4	0.75 (UJ)	—	—	—	—	0.82 (U)	1.4 (U)	—	—

Notes: All values are in mg/kg. See Appendix A for data qualifier definitions.

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

[b] — = Not detected above BV.

Table 2.3-4
Summary of Radionuclides Detected at Area 5: SWMU 49-006

Sample ID	Location ID	Depth (ft)	Media	Plutonium-238
Qbt 2,3,4 Background/Fallout Value[a]				**na[b]**
0549-95-0133	49-05095	5.00–10.00	Qbt 4	0.005

Note: All values are in pCi/g.

[a] BVs/FVs are from (1998, 059730).

[b] na = Not available.

Table 2.3-5
Summary of Inorganic Chemicals above BVs at Area 5: AOC 49-008(a)

Sample ID	Location ID	Depth (ft)	Media	Antimony	Arsenic	Cadmium	Cobalt	Copper	Iron	Lead
Soil Background Value[a]				**0.83**	**8.17**	**0.4**	**8.64**	**14.7**	**21500**	**22.3**
0549-95-0130	49-05007	0.00–0.50	Soil	3.5 (J-)	8.6	0.61 (U)	14.8	3950	25700	10100
0549-95-0145	49-05013	0.00–0.50	Soil	—[b]	—	—	—	22.7	—	—
0549-95-0147	49-05015	0.00–0.50	Soil	—	—	—	—	—	—	—
0549-95-0152	49-05020	0.00–0.50	Soil	—	—	—	—	—	—	—
0549-95-0153	49-05021	0.00–0.50	Soil	—	—	—	—	15.2	—	—
0549-95-0154	49-05022	0.00–0.50	Soil	—	—	—	—	—	—	—
0549-95-0012	49-05023	0.00–0.50	Soil	—	—	—	—	—	—	—
0549-95-0162	49-05031	0.00–0.50	Soil	—	—	—	—	19.9	—	—
0549-95-0165	49-05034	0.00–0.50	Soil	—	—	—	—	—	—	—
0549-95-0167	49-05036	0.00–0.50	Soil	—	—	—	—	—	—	—
0549-95-0169	49-05038	0.00–0.50	Soil	—	—	—	—	—	—	—
0549-95-0172	49-05040	0.00–0.50	Soil	—	—	—	—	—	—	—
0549-95-0175	49-05045	0.00–0.50	Soil	—	—	—	—	—	—	—
0549-95-0178	49-05048	0.00–0.50	Soil	—	—	—	—	—	—	—
0549-95-0186	49-05055	0.00–0.50	Soil	—	—	—	—	—	—	—

Table 2.3-5 (continued)

Sample ID	Location ID	Depth (ft)	Media	Mercury	Nickel	Silver	Thallium	Uranium	Zinc
Soil Background Value[a]				**0.1**	**15.4**	**1**	**0.73**	**1.82**	**48.8**
0549-95-0130	49-05007	0.00–0.50	Soil	0.11 (U)	43.1	2 (J)	1.5 (U)	2.77	388
0549-95-0145	49-05013	0.00–0.50	Soil	0.11 (U)	—	—	1.5 (U)	3.37	—
0549-95-0147	49-05015	0.00–0.50	Soil	0.12 (U)	—	—	1.4 (U)	1.89	—
0549-95-0152	49-05020	0.00–0.50	Soil	0.11 (U)	—	—	1.5 (U)	2.15	—
0549-95-0153	49-05021	0.00–0.50	Soil	0.12 (U)	—	—	1.4 (U)	3.31	—
0549-95-0154	49-05022	0.00–0.50	Soil	0.11 (U)	—	—	1.5 (U)	3.74	—
0549-95-0012	49-05023	0.00–0.50	Soil	0.11 (U)	—	—	1.4 (U)	2.49	53.3
0549-95-0162	49-05031	0.00–0.50	Soil	—	—	—	1.4 (U)	2.88	—
0549-95-0165	49-05034	0.00–0.50	Soil	0.11 (U)	—	—	1.5 (U)	2.23	—
0549-95-0167	49-05036	0.00–0.50	Soil	0.12 (U)	—	—	1.5 (U)	2.69	—
0549-95-0169	49-05038	0.00–0.50	Soil	—	—	—	—	3.59	—
0549-95-0172	49-05040	0.00–0.50	Soil	—	—	—	1.3 (U)	2.3	—
0549-95-0175	49-05045	0.00–0.50	Soil	—	—	—	1.3 (U)	2.31	—
0549-95-0178	49-05048	0.00–0.50	Soil	0.11 (U)	—	—	1.5 (U)	4.38	—
0549-95-0186	49-05055	0.00–0.50	Soil	0.11 (U)	—	—	1.3 (U)	2.6	—

Notes: All values are in mg/kg. See Appendix A for data qualifier definitions.

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

[b] — = Not detected above BV.

Table 2.3-6
Summary of Radionuclides Detected or Detected above BVs/FVs at Area 5: AOC 49-008(a)

Sample ID	Location ID	Depth (ft)	Media	Europium-152	Plutonium-239/240
Soil Background/Fallout Value[a]				na[b]	0.054
0549-95-0153	49-05021	0.00–0.50	Soil	0.307	—[c]
0549-95-0162	49-05031	0.00–0.50	Soil	0.233	—
0549-95-0168	49-05037	0.00–0.50	Soil	0.375	—
0549-95-0169	49-05038	0.00–0.50	Soil	—	0.516

Note: All values are in pCi/g.
[a] BVs/FVs are from LANL (1998, 059730).
[b] na = No BVs/FVs are available.
[c] — = Not detected or detected above FV.

Table 2.4-2
Summary of Decision-Level Organic Chemical Results Detected at Area 6 West SWMU 49-004

Sample ID	Location ID	Depth (ft)	Media	Chloronaphthalene[2-]
0549-95-0105	49-06214	5.00–9.50	Fill	0.36

Note: All values are in mg/kg.

Table 2.4-3
Summary of Inorganic Chemicals above BVs at Area 6 West: SWMU 49-004

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Barium	Cadmium	Calcium	Chromium	Cobalt	Copper	Lead	Magnesium
Soil Background Value[a]				**29200**	**0.83**	**295**	**0.4**	**6120**	**19.3**	**8.64**	**14.7**	**22.3**	**4610**
Qbt 2,3,4 Background Value				**7340**	**0.5**	**46**	**1.63**	**2200**	**7.14**	**3.14**	**4.66**	**11.2**	**1690**
0549-95-0315	49-06106	0.00–0.50	Soil	—[b]	—	—	—	—	—	—	—	—	—
0549-95-0316	49-06107	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0549-95-0326	49-06116	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0549-95-0327	49-06117	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0549-95-0328	49-06118	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0549-95-0329	49-06137	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0549-95-0330	49-06138	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0549-95-0333	49-06141	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0549-95-0334	49-06142	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0549-95-0336	49-06144	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0549-95-0337	49-06145	0.00–0.50	Soil	—	—	—	—	—	—	—	15.3	—	—
0549-95-0339	49-06147	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0549-95-0340	49-06148	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0549-95-0102	49-06213	5.00–10.00	Soil	—	6 (UJ)	—	0.69 (U)	—	—	9.1 (J)	—	—	—
0549-95-0103	49-06213	10.00–12.00	Qbt 4	—	5.7 (UJ)	—	—	—	—	—	—	—	—
0549-95-0104	49-06214	2.00–5.00	Fill	—	5.8 (UJ)	—	0.62 (U)	—	—	—	—	—	—
0549-95-0105	49-06214	5.00–9.50	Fill	—	6 (UJ)	—	0.64 (U)	—	—	13.4	—	—	—
0549-95-0107	49-06215	0.00–5.00	Fill	—	6 (UJ)	—	0.64 (U)	—	—	—	16.2	—	—
0549-95-0111	49-06216	18.10–20.00	Fill	—	—	—	—	—	—	—	112	—	—
0549-95-0113	49-06217	3.00–5.00	Soil	—	6.4 (UJ)	—	0.68 (U)	—	—	—	—	—	—
0549-95-0119	49-06218	12.50–15.00	Qbt 4	—	6.5 (UJ)	—	—	—	—	—	—	—	—
0549-95-0121	49-06219	7.50–10.00	Qbt 4	12400	6.2 (UJ)	143 (J-)	—	2450	9.7	6.1 (J)	6.4	14.6	2760
0549-95-0343	49-06221	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0549-95-0344	49-06222	0.00–0.50	Soil	—	—	—	—	—	—	—	17.9	24.1	—
0549-95-0349	49-06226	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—
0549-95-0350	49-06227	0.00–0.50	Soil	—	—	—	—	—	—	—	—	—	—

Table 2.4-3 (continued)

Sample ID	Location ID	Depth (ft)	Media	Manganese	Mercury	Nickel	Potassium	Silver	Thallium	Uranium	Vanadium	Zinc
Soil/Fill Background Value[a]				**671**	**0.1**	**15.4**	**3460**	**1**	**0.73**	**1.82**	**39.6**	**48.8**
Qbt 2,3,4 Background Value				**482**	**0.1**	**6.58**	**3500**	**1**	**1.16**	**2.4**	**17**	**63.5**
0549-95-0315	49-06106	0.00–0.50	Soil	—	—	—	—	—	1.2 (U)	2.84	—	—
0549-95-0316	49-06107	0.00–0.50	Soil	—	—	—	—	—	1.2 (U)	1.85	—	—
0549-95-0326	49-06116	0.00–0.50	Soil	—	0.11	—	—	—	1.2 (U)	2.12	—	142
0549-95-0327	49-06117	0.00–0.50	Soil	—	—	—	—	—	1.3 (U)	—	—	96.2
0549-95-0328	49-06118	0.00–0.50	Soil	—	—	—	—	—	1.2 (U)	—	—	64
0549-95-0329	49-06137	0.00–0.50	Soil	—	—	—	—	—	1.3 (U)	1.99	—	50.9
0549-95-0330	49-06138	0.00–0.50	Soil	707 (J-)	0.11 (U)	—	—	—	1.3 (U)	1.86	—	159
0549-95-0333	49-06141	0.00–0.50	Soil	—	—	—	3500	—	1.3 (U)	—	—	64
0549-95-0334	49-06142	0.00–0.50	Soil	—	—	—	—	1.4 (U)	1.3 (U)	1.92	—	65.1
0549-95-0336	49-06144	0.00–0.50	Soil	—	—	—	4030	1.4 (U)	1.3 (U)	2.43	—	812
0549-95-0337	49-06145	0.00–0.50	Soil	—	0.11 (U)	—	4240	1.5 (U)	1.3 (U)	2.29	—	49.8
0549-95-0339	49-06147	0.00–0.50	Soil	—	—	—	4030	1.5 (U)	1.3 (U)	2.58	—	—
0549-95-0340	49-06148	0.00–0.50	Soil	—	—	—	—	1.4 (U)	1.3 (U)	2.57	—	—
0549-95-0102	49-06213	5.00–10.00	Soil	—	—	—	—	—	—	3.4	—	—
0549-95-0103	49-06213	10.00–12.00	Qbt 4	—	—	—	—	—	—	3.3	—	—
0549-95-0104	49-06214	2.00–5.00	Fill	—	—	—	—	—	—	3.5	—	—
0549-95-0105	49-06214	5.00–9.50	Fill	878 (J)	—	—	—	—	—	3.3	—	—
0549-95-0107	49-06215	0.00–5.00	Fill	—	—	—	—	1.7 (J)	—	4	—	—
0549-95-0111	49-06216	18.10–20.00	Fill	—	0.12 (U)	—	—	—	1.4 (U)	—	—	—
0549-95-0113	49-06217	3.00–5.00	Soil	—	—	—	—	—	—	3.6	—	70.6
0549-95-0119	49-06218	12.50–15.00	Qbt 4	—	—	—	—	—	—	3.6	—	—
0549-95-0121	49-06219	7.50–10.00	Qbt 4	—	—	8.3 (J)	—	—	—	3.6	20.1	—
0549-95-0343	49-06221	0.00–0.50	Soil	—	—	—	3870	1.5 (U)	1.3 (U)	6.88	—	—
0549-95-0344	49-06222	0.00–0.50	Soil	—	0.11 (U)	—	4310	1.6 (U)	1.4 (U)	8.1	—	—
0549-95-0349	49-06226	0.00–0.50	Soil	—	—	—	—	1.4 (U)	1.2 (U)	8.4	—	—
0549-95-0350	49-06227	0.00–0.50	Soil	—	—	—	—	1.4 (U)	1.3 (U)	10.7	—	—

Notes: All values are in mg/kg. See Appendix A for data qualifier definitions.

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

[b] — = Not detected above BV.

Table 2.4-4
Summary of Radionuclides Detected or Detected above BVs/FVs at Area 6 West: SWMU 49-004

Sample ID	Location ID	Depth (ft)	Media	Americium-241	Cesium-137	Europium-152	Plutonium-238	Plutonium-239/240
Soil Background/Fallout Value[a]				**0.013**	**1.65**	**na**	**0.023**	**0.054**
Qbt 2,3,4 Background Value				**na[b]**	**0.1**	**na**	**na**	**na**
0549-95-0105	49-06214	5.00–9.50	Fill	—[c]	—	—	—	0.029
0549-95-0107	49-06215	0.00–5.00	Fill	—	—	—	—	0.039
0549-95-0111	49-06216	18.10–20.00	Fill	—	—	—	—	0.007
0549-95-0315	49-06106	0.00–0.50	Soil	0.155	—	—	—	0.134
0549-95-0316	49-06107	0.00–0.50	Soil	—	—	—	—	0.056
0549-95-0317	49-06108	0.00–0.50	Soil	0.263	—	—	—	—
0549-95-0323	49-06113	0.00–0.50	Soil	—	—	0.209	—	—
0549-95-0328	49-06118	0.00–0.50	Soil	—	—	—	—	0.095
0549-95-0329	49-06137	0.00–0.50	Soil	—	—	—	0.025	—
0549-95-0340	49-06148	0.00–0.50	Soil	—	—	0.259	—	—
0549-95-0102	49-06213	5.00–10.00	Soil	—	—	—	—	0.05
0549-95-0103	49-06213	10.00–12.00	Qbt 4	—	—	—	—	0.073
0549-95-0104	49-06214	2.00–5.00	Fill	0.43	—	—	—	0.419
0549-95-0113	49-06217	3.00–5.00	Soil	—	—	—	—	0.085
0549-95-0119	49-06218	12.50–15.00	Qbt 4	—	—	—	—	0.036
0549-95-0343	49-06221	0.00–0.50	Soil	—	2.02	—	—	0.07
0549-95-0344	49-06222	0.00–0.50	Soil	—	3.28	—	—	0.072
0549-95-0346	49-06223	0.00–0.50	Soil	0.204	—	—	—	—
0549-95-0348	49-06225	0.00–0.50	Soil	—	1.69	—	—	—
0549-95-0349	49-06226	0.00–0.50	Soil	—	—	—	—	0.066
0549-95-0350	49-06227	0.00–0.50	Soil	—	2.24	—	—	0.074

Note: All values are in pCi/g.

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

[b] na = No BVs/FVs are available.

[c] — = Not detected above BV/FV.

Table 2.4-5
Summary of Inorganic Chemicals above BVs at Area 6 East: AOC 49-008(b)

Sample ID	Location ID	Depth (ft)	Media	Cadmium	Mercury	Thallium	Uranium
Soil Background Value[a]				**0.4**	**0.1**	**0.73**	**1.82**
0549-95-0294	49-06000	0.00–0.50	Soil	—[b]	—	1.3 (U)	1.95
0549-95-0297	49-06017	0.00–0.50	Soil	—	—	1.2 (U)	1.93
0549-95-0300	49-06031	0.00–0.50	Soil	—	—	1.2 (U)	2.24
0549-95-0301	49-06034	0.00–0.50	Soil	—	—	1.2 (U)	1.98
0549-95-0302	49-06039	0.00–0.50	Soil	—	—	1.3 (U)	—
0549-95-0305	49-06053	0.00–0.50	Soil	—	—	1.3 (U)	—
0549-95-0306	49-06066	0.00–0.50	Soil	—	0.11	1.2 (U)	1.95
0549-95-0308	49-06067	0.00–0.50	Soil	—	—	1.3 (J)	3.37
0549-95-0309	49-06068	0.00–0.50	Soil	—	—	1.2 (U)	2.7
0549-95-0310	49-06069	0.00–0.50	Soil	0.51 (J)	—	1.3 (U)	2.02

Notes: All values are in mg/kg. See Appendix A for data qualifier definitions.

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

[b] — = Not detected above BV.

Table 2.5-1
Summary of Inorganic Chemicals above BVs at Area 10: AOC 49-002

Sample ID	Location ID	Depth (ft)	Media	Antimony	Cadmium	Copper	Lead	Mercury	Uranium	Zinc
Soil Background Value[a]				**0.83**	**0.4**	**14.7**	**22.3**	**0.1**	**1.82**	**48.8**
0549-95-0252	49-07536	0.00–0.50	Soil	5.7 (U)	0.73 (J)	—[b]	48 (J-)	0.72	3.2	98.7
0549-95-0253	49-07537	0.00–0.50	Soil	5.5 (U)	0.59 (U)	—	—	—	3.2	—
0549-95-0255	49-07539	0.00–0.50	Soil	5.6 (U)	0.6 (U)	20.5	26.7 (J-)	0.11	3.9	78.8
0549-95-0256	49-07542	0.00–0.50	Soil	13.9	0.59 (U)	—	—	—	3.5	—
0549-95-0258	49-07544	0.00–0.50	Soil	5.5 (U)	0.59 (U)	—	—	—	3.2	—
0549-95-0260	49-07548	0.00–0.50	Soil	5.6 (U)	0.59 (U)	98.9	—	—	4.2	69.9
0549-95-0264	49-07560	0.00–0.50	Soil	5.6 (U)	0.6 (U)	—	—	—	3.4	—

Notes: All values are in mg/kg. See Appendix A for data qualifier definitions.

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

[b] — = Not detected above BV.

Table 2.5-2
Summary of Inorganic Chemicals above BVs at Area 10: SWMU 49-005(a)

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Arsenic	Barium	Beryllium	Calcium	Chromium
Soil/Fill Background Value[a]				**29,200**	**0.83**	**8.17**	**295**	**1.83**	**6120**	**19.3**
Qbt 2,3,4 Background Value				**7340**	**0.5**	**2.79**	**46**	**1.21**	**2200**	**7.14**
0549-95-0141	49-07512	0.00–0.50	Soil	—[b]	—	—	—	—	—	—
0549-95-0140	49-07512	4.00–9.00	Qbt 4	12000	0.75 (UJ)	—	85.6	—	2340	8.4
0549-95-0143	49-07527	0.00–0.50	Soil	—	—	—	—	—	—	—
0549-95-0142	49-07527	7.30–10.00	Qbt 4	21900	0.81 (UJ)	3.4	112	1.9	3320	11.4

Table 2.5-2(continued)

Sample ID	Location ID	Depth (ft)	Media	Copper	Magnesium	Mercury	Nickel	Potassium	Selenium	Thallium	Uranium
Soil Background Value				**14.7**	**4610**	**0.1**	**15.4**	**3460**	**1.52**	**0.73**	**1.82**
Qbt 2,3,4 Background Value				**4.66**	**1690**	**0.1**	**6.58**	**3500**	**0.3**	**1.1**	**2.4**
0549-95-0141	49-07512	0.00–0.50	Soil	—	—	0.11 (U)	—	—	—	1.4 (U)	2.51
0549-95-0140	49-07512	4.00–9.00	Qbt 4	6.7	2530	—	9	—	0.81 (U)	1.4 (U)	—
0549-95-0143	49-07527	0.00–0.50	Soil	—	—	0.11 (U)	—	—	—	1.4 (U)	2.3
0549-95-0142	49-07527	7.30–10.00	Qbt 4	8.2	3720	0.12 (U)	12.1	4090	0.88 (U)	1.5 (U)	4.09

Notes: All values are in mg/kg. See Appendix A for data qualifier definitions.

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

[b] — = Not detected above BV.

Table 2.5-3
Summary of Radionuclides Detected or Detected above BVs/FVs at Area 10: SWMU 49-005(a)

Sample ID	Location ID	Depth (ft)	Media	Plutonium-238	Plutonium-239/240
Soil Background/Fallout Value[a]				**0.023**	**0.054**
Qbt 2,3,4 Background Value				**na**[b]	**na**
0549-95-0141	49-07512	0.00–0.50	Soil	0.032	0.083
0549-95-0142	49-07527	7.30–10.00	Qbt 4	0.007	—[c]

Note: All values are in pCi/g.

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

[b] na = No BVs/FVs are available.

[c] — = Not detected or not detected above BV/FV.

Table 3.3-1
Borehole Locations, Construction Details, and Status

Well or Borehole	Year Drilled	Elevation (ft)	Depth (ft)	Water Level Completion (ft)	Diam. (in.)	Construction Details	Location	Logsa	Status
DT-5P	1959	7144	692	Dry	Unk[b]	n/a[c]	1754804 N 1625442 E	None	Abandon ed and plugged in 1959
DT-5	1959	7143	927 [2]	Dry	8	Cased from 0 to 180 ft, open from 180 to 962 ft	1754842 N 1625310 E	IND, GRN, TEMP	Unk
DT-5A	1959	7144	1821	1173	12	Cased to 1821 ft, pump equipped	1754789 N 1625310 E	LL, IND, ML, SL, GRN, TEMP	Open, sampled quarterly
DT-9	1960	6935	1501	1103	12	Cased to 1501 ft, pump equipped	1751498 N 1628993 E	IND, GRN, SL, TEMP, LL	Open, sampled quarterly
DT-10	1960	7020	1409	1085	12	Cased to 1409 ft, pump equipped	1754448 N 1628994 E	IND, GRN, TEMP, SL	Open, sampled quarterly
CH-1	1959	7170	501	Dry	2	Cased to 500 ft	1755478 N 1624469 E	GR	Open
CH-2	1959	7137	507	Dry	2	Cased to 507 ft, grouted and abandoned	1755344 N 1625826 E	EL, GRN, TEMP	Grouted and abandon ed
CH-3	1960	7170	300	Dry	2	Cased 10 to 300 ft	1754493 N 1624196 E	GR	Open
CH-4	1960	7116	303	Dry	2	Cased to 303 ft	1753898 N 1625537 E	GR	Open
Alpha	1960	7125	189	Dry	24	Cased from 0 to 7 ft, open from 7 to 189 ft	1754807 N 1625769 E	IND, GRN, VL	Unk
Beta	1960	6801	180	Dry	24	Cased from 0 to 13 ft, open from 13 to 180 ft	83+63 S 91+89 E	VL	Unk

Table 3.3-1 (continued)

Well or Borehole	Year Drilled	Elevation (ft)	Depth (ft)	Water Level Completion (ft)	Diam. (in.)	Construction Details	Location	Logs[a]	Status
Gamma	1960	6870	54	Dry	4	Cased from 0 to 8 ft, open from 8 to 54 ft	1752630 N 1626278 E	Unk	Unk
TH-1	1980	7135	123	Dry	5	Casing at surface only	1755262 N 1625944 E	GRN	Open, neutron logged quarterly
TH-2	1980	7120	123	Dry	5	Casing at surface only	1755507 N 1625802 E	GRN	Open, neutron logged quarterly
TH-3	1980	7144	123	Dry	5	Casing at surface only	1755360 N 1625739 E	GRN	Open, neutron logged quarterly
TH-4	1980	7143	123	Dry	5	Casing at surface only	1755162 N 1625644 E	GRN	Open, neutron logged quarterly
TH-5	1980	7135	123	Dry	5	Casing at surface only	1755132 N 1625833 E	GRN	Open, neutron logged quarterly
2A-O	1980	7154	74	Dry	2	Casing to 56 ft, collapsed below 56 ft	1755360 N 1625730 E	GRN	Open, neutron logged quarterly
2A-Y	1980	7155	80	Dry	2	Casing to 29 ft, collapsed below 29 ft	1755312 N 1625727 E	GRN	Open, neutron logged quarterly
2B-Y	1980	7149	80	Dry	2	Casing to 30 ft, collapsed below 30 ft	1755134 N 1625839 E	GRN	Open, neutron logged quarterly
49-2901	1998	7134	700	Dry	8	Casing at surface only	1755209 N 1625985 E	Unk	Open
49-2906	1998	7142	150	Dry	8	Double cased	1755319N 1625814 E	Unk	Casing removed and backfilled
49-2907	1998	7141	150	Dry	8	Double cased	1755369 N 1625790 E	Unk	Casing removed and backfilled

Table 3.3-1 (continued)

Well or Borehole	Year Drilled	Elevation (ft)	Depth (ft)	Water Level Completion (ft)	Diam. (in.)	Construction Details	Location	Logs[a]	Status
49-10046	2000	7165	15	Dry	2	Casing to 15 ft	1755327 N 1625813 E	GRN	Open, neutron logged quarterly
49-10047	2000	7160	15	Dry	2	Casing to 15 ft	1755368 N 1625803 E	GRN	Open, neutron logged quarterly
49-10048	2000	7159	15	Dry	2	Casing to 15 ft	1755355 N 1625883 E	GRN	Open, neutron logged quarterly

[a] Geologic logs are available for all holes. Other borehole logs that are available include IND (induction/electrical and spontaneous potential), LL (lateral), SL (sonic), TEMP (temperature), GRN (gamma ray neutron), ML (microlog-caliper), EL (electrical), GR (gamma ray), VL (video). Weir and Purtymun (1962, 011890) and Purtymun (1995, 045344) list borehole depth at 962 ft.

[b] unk= Unknown.

[c] n/a = Not applicable.

Table 3.5-1
Results of Moisture Content Study in Soil and Upper Bandelier Tuff at TA-49

	Thickness of Soil (ft)		Depth Which Moisture Content Was Less Than 10% (ft)		Depth At Which Moisture Content Was Less Than 5% (ft)	
	Range	Average	Range	Average	Range	Average
15 test holes in well-drained areas	0.5–12.4	3.5	2.5–9.0	4.7	7.0–14.0	
8 test holes near arroyos and ditches and in poorly drained areas	2.2–9.0	5.3	4.0–19.0+	9.5		

Note: Source: Weir and Purtymun (1962, 011890).

Table 4.3-1
Analytical Methods for Preliminary Characterization

Analytical Method	Analytical Description	Analytical Suite
Inorganic Methods		
EPA SW-846: 9045C	Electrometric	pH
EPA Method 300	Ion chromatography (IC)	Anions (nitrates)
EPA SW-846: 9012A	Colorimetric	Cyanide
EPA SW-846: 6010B/6020	Inductively coupled plasma emission spectrometry—atomic emission spectroscopy (ICPES-AES)	Aluminum, antimony, arsenic, barium, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, sodium, silver, thallium, uranium, vanadium, and zinc (TAL metals)
EPA SW-846: 6850	Liquid chromatography/ mass spectrometry (LC/MS)	Perchlorate
EPA SW-846:7471A	Cold vapor atomic absorption (CVAA)	Mercury (TAL metal)
Organic Methods		
EPA SW-846:8321A	LC/MS	Explosives
EPA SW-846:8270C	Gas chromatograph/ mass spectrometry (GC/MS)	SVOCs
EPA SW-846:8260B	GC/MS	VOCs
EPA SW-846:8082	GC	PCBs
EPA SW-846:8015B	GC	Total petroleum hydrocarbons–diesel range organic
Radionuclide Methods		
EPA 901.1	Gamma spectroscopy	Gamma-emitting radionuclides (e.g., cesium-137)
HASL-300	Chemical separation/alpha spectroscopy	Isotopic plutonium, isotopic uranium, americium-241
HASL-300	Chemical separation/alpha spectroscopy	Iodine-129
HASL-300	Chemical separation/alpha spectroscopy	Technetium-99
EPA 905.0	Gel permeation chromatography	Strontium-90

Table 4.4-1
Summary of Proposed Boreholes and Sampling

Proposed Borehole Dimensions			Analyses, Number of Samples, and Proposed Intervals			
Area	Borehole ID	Depth (ft)	HE, Perchlorate, TAL Metals, Cyanide, Isotopic Americium, Isotopic Plutonium, Isotopic Uranium, Tritium	Vapor-Phase Sampling (proposed intervals)	Geophysical, Video, and Neutron Logging	Hydrogeologic Properties and/or Fractures
5	1 Sump	40	5	5	—[a]	—
	2 Sump	40	5	5	—	—
	Angled	15	5	5	X[b]	TBD[c]
6	Angled	55	3	—	X	TBD
	Angled	55	3	—	X	TBD
	Angled	55	3	—	X	TBD
	Angled	55	3	—	X	TBD
10	1	10	5	5	X	—
	2	10	5	5	X	—
	3	10	5	5	X	—
	Angled	10	5	5	X	—

[a] — = Not proposed.
[b] X = Analysis will be performed.
[c] TBD = To be determined.

Table 4.4-2
Analytical Methods for Preliminary Characterization

Analytical Method	Analytical Description	Analytical Suite
Inorganic Methods		
EPA Method 300	IC	Anions (nitrates)
EPA SW-846: 9045C	Electrometric	pH
EPA SW-846: 9012A	Colorimetric	Cyanide
EPA SW-846: 6010B/6020	ICPES-AES	Aluminum, antimony, arsenic, barium, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, sodium, silver, thallium, vanadium, and zinc (TAL metals)
EPA SW-846: 6850	LC/MS	Perchlorate
EPA SW-846:7471A	CVAA	Mercury (TAL metal)

Table 4.4-2 (continued)

Analytical Method	Analytical Description	Analytical Suite
Organic Methods		
EPA SW-846:8321A	LC/MS	Explosives
EPA SW-846:8270C	GC/MS	SVOCs
EPA SW-846:8260B	GC/MS	VOCs
EPA SW-846:8082	GC	PCBs
EPA SW-846:8081A	GC	Organochlorinated pesticides
EPA SW-846:8015B	GC	Total petroleum hydrocarbons–diesel range organic (TPH-DRO)
Radionuclide Methods		
EPA 901.1	Gamma spectroscopy	Gamma-emitting radionuclides (e.g., cesium-137)
HASL-300	Low-energy gamma spectroscopy	Isotopic plutonium, isotopic uranium, americium-241
EPA 906	Liquid scintillation	Tritium

Table 4.4-3
Analytical Suites for Groundwater Samples

Chemical Class	Analytical Suite	Analytical Method
Inorganic	Perchlorate	EPA Method 6850
Chemicals	TAL metals	EPA Methods 6010B, 6020, and 7471A
	Total cyanide	EPA Method 9012A
Organic Chemicals	Explosive compounds	EPA Method 8321A_MOD
	SVOCs	EPA Method 8270C
	VOCs	EPA Method 8260B
Radionuclides	Isotopic americium	HASL 300 (alpha spectroscopy)
	Isotopic plutonium	HASL 300 (alpha spectroscopy)
	Isotopic uranium	HASL 300 (alpha spectroscopy)
	Tritium	EPA Method 906.0
Other	General inorganics	(Varies)
Measurements	Total Kjeldahl nitrogen	EPA Method 351.1
	NO_3/NO_2	EPA Method 353.3
	TOC	EPA Method 9060
	Stable isotopes	No test method
Field Parameters	Dissolved oxygen	
	pH	EPA SW-846:9045C
	Specific conductance	
	Turbidity	
	Water levels	

Table 5.0-1
Summary of Investigation Methods

Method	Summary
Spade and Scoop Collection of Soil Samples	This method is typically used to collect shallow (e.g., approximately 0–12 in.) soil or sediment samples. The spade-and-scoop method involves digging a hole to the desired depth, as prescribed in the sampling and analysis plan, and collecting a discrete grab sample. The sample is typically placed in a clean, stainless-steel bowl for transfer into various sample containers.
Hand Auger Sampling	This method is typically used for sampling soil or sediment at depths of less than 10–15 ft but 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.-inner diameter), creating a vertical hole which can be advanced to the desired sample depth. When the desired depth is reached, the auger is decontaminated before advancing the hole through the sample depth. The sample material is transferred from the auger bucket to a stainless-steel sampling bowl before filling the various required sample containers.
Headspace Vapor Screening	Individual soil, rock, or sediment samples may be field-screened for VOCs by placing a portion of the sample in a plastic sample bag or in a glass container with a foil-sealed cover. The container is sealed and gently shaken and allowed to equilibrate for 5 minutes. The sample is then screened by inserting a PID probe into the container and measuring and recording any detected vapors. PIDs must use lamps with voltage of 10.6 eV or higher.
Handling, Packaging, and Shipping of Samples	Field team member seal and label samples before packing and ensure that the sample containers and the containers used for transport are free of external contamination. Field team members package all samples so as to minimize the possibility of breakage during transportation. After all environmental samples are collected, packaged, and preserved; a field team member transports the samples to either the SMO or an SMO-approved radiation screening laboratory under chain-of-custody. The SMO arranges for shipping of samples to analytical laboratories. The field team member must inform the SMO and/or the radiation screening laboratory coordinator when levels of radioactivity are in the action-level or limited-quantity ranges.
Sample Control and Field Documentation	The collection, screening, and transport of samples are documented on standard forms generated by the SMO. These include sample collection logs, chain-of-custody forms, and sample container labels. Collection logs are completed at the time of sample collection and are signed by the sampler and a reviewer who verifies the logs for completeness and accuracy. Corresponding labels are initialed and applied to each sample container, and custody seals are placed around container lids or openings. Chain-of-custody forms are completed and assigned to verify that the samples are not left unattended. Site attributes (e.g., former and proposed soil sampling locations, sediment sampling locations) are located by using a GPS. Horizontal locations will be measured to the nearest 0.5 ft The survey results for this field event will be presented as part of the investigation report. Sample coordinates will be uploaded into the Environmental Restoration Database.

Table 5.0-1 (continued)

Method	Summary
Field Quality Control Samples	Field-quality control samples are collected as directed in the Consent Order as follows: Field Duplicate: At a frequency 10%; collected at the same time as a regular sample and submitted for the same analyses. Equipment Rinsate Blank: At a frequency of 10%; collected by rinsing sampling equipment with deionized water, which is collected in a sample container and submitted for laboratory analysis. Trip Blanks: Required for all field events that include the collection of samples for VOC analysis. Trip blanks containers of certified clean sand that are opened and kept with the other sample containers during the sampling process.
Field Decontamination of Drilling and Sampling Equipment	Dry decontamination is the preferred method to minimize generating liquid waste. Dry decontamination may include the use of a wire brush or other tool to remove soil or other material adhering to the sampling equipment, followed by use of a commercial cleaning agent (nonacid, waxless cleaners) and paper wipes. Dry decontamination may be followed by wet decontamination if necessary. Wet decontamination may include washing with a nonphosphate detergent and water, followed by a water rinse and a second rinse with deionized water. Alternatively, steam cleaning may be used.
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 quality assurance. Specific requirements for each sample are printed on the sample collection logs provided by the sample management office (size and type of container (glass, amber glass, polyethylene, preservative, etc.). All samples are preserved by placing in insulated containers with ice to maintain a temperature of 4°C. Other requirements such as nitric acid or other preservatives may apply to different media or analytical requests.
Management, Characterization, and Storage of IDW	IDW is 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 shall be adequate to comply with on-site or off-site waste acceptance criteria. All stored IDW will be marked with appropriate signage and labels, as appropriate. Drummed IDW will be stored on pallets to prevent the containers from deterioration. Generators are required to reduce the volume of waste generated as much as technically and economically feasible. Means to store, control, and transport each potential waste type and classification shall be determined before field operations that generate waste begin A waste storage area shall be established before generating waste. Waste storage areas located in controlled areas of the laboratory shall be controlled as needed to prevent inadvertent addition or management of wastes by unauthorized personnel. Each container of waste generated shall be individually labeled as to waste classification, item identification number, and radioactivity (if applicable), immediately following containerization. All waste shall be segregated by classification and compatibility to prevent cross-contamination. See Appendix B for additional information.
Geodetic Surveys	This method describes the methodology for coordinating and evaluating geodetic surveys and establishing QA and QC for geodetic survey data. The procedure covers evaluating geodetic survey requirements, preparing to perform a geodetic survey, performing geodetic survey field activities, preparing geodetic survey data for QA review, performing QA review of geodetic survey data, and submitting geodetic survey data.
HSA Drilling Methods	In this method, HSAs (sections of seamless pipe with auger flights welded to the pipe) act as a screw conveyor to bring cuttings of sediment, soil, and/or rock to the surface. Auger sections are typically 5 ft long and have outside diameters of 4.25 to 14 in. Drill rods, split-spoon core barrels, Shelby tubes, and other samplers can pass through the center of the hollow-stem auger sections for collection of discrete samples from desired depths. HSAs are used as temporary casings when setting wells to prevent cave-ins of the borehole walls.

Table 5.0-1 (continued)

Method	Summary
Field-Portable X-Ray Fluorescence Instrumentation	This method describes the process for operating and using the Spectrace 9000 field-portable X-ray fluorescence analyzer to screen for hazardous or potentially hazardous inorganic materials. The data that are generated allow for rapid evaluation of the extent of contamination. Samples are analyzed for elements of atomic number 13 (aluminum) through 92 (uranium), with proper x-ray source selection and instrument calibration. Environmental applications include measuring elemental metals in soil and on filters and measuring lead in paint.
Gross Gamma Radiation Scoping Surveys	This method describes the process for performing and documenting gross gamma radiation scoping surveys in buildings and soil. Scoping surveys are conducted after an assessment of the site history is completed and consist of judgmental measurements based on historical site information and data. If the scoping survey locates contamination, a characterization survey is typically performed.

Appendix A

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

A-1.0 ACRONYMS AND ABBREVIATIONS

AK	acceptable knowledge
amsl	above mean sea level
AOC	area of concern
bgs	below ground surface
BV	background value
COPC	chemical of potential concern
cpm	count(s) per minute
CPTF	Cable Pull Test Facility
CSM	conceptual site model
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DRO	diesel range organics
EM	electromagnetic
EP	Environmental Programs
EPA	U.S. Environmental Protection Agency
ET	evapotranspiration
FFCA	Federal Facilities Compliance Agreement
FV	fallout value
GC/MS	gas chromatograph/mass spectrometry
GPR	ground-penetrating radar
GPS	global positioning system
HE	high explosives
HIR	historical investigation report
HMX	1,3,5,7-tetranitro-1,3,5,7-tetrazocine [also high-melting explosive]
HSA	hollow-stem auger
HDT	Hazardous Devices Team
HWA	Hazardous Waste Act
HWFP	Hazardous Waste Facility Permit
IC	Ion chromatography
IDW	investigation derived waste
ICPES-AES	inductively coupled plasma emission spectrometry—atomic emission spectroscopy
IM	interim measure

LANL	Los Alamos National Laboratory
LASL	Los Alamos Scientific Laboratory
LC/MS	liquid chromatography/mass spectrometry
LIR	Laboratory implementation requirements
LLW	low-level waste
MAQ	Meteorology and Air Quality
MDA	material disposal area
NES	nuclear environmental site
NFA	no further action
NMED	New Mexico Environment Department
NMHWA	New Mexico Hazardous Waste Act
NMSA	New Mexico Statues Annotated
NPDES	National Pollutant Discharge Elimination System
PCB	polychlorinated biphenyl
PID	photoionization detector
PPE	personal protective equipment
ppm	part per million
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine [also research department explosive]
RFI	RCRA facility investigation
SMO	Sample Management Office
SOP	standard operating procedure
SOW	statement of work
SSL	soil screening level
SVOC	semivolatile organic compound
SWMU	solid waste management unit
SWSC	Sanitary Wastewater Systems Consolidation
TA	technical area
TAL	target analyte list [EPA]
TCLP	toxicity characteristic leaching procedure
TD	total depth

TLD	thermoluminescent dosimeter
TDR	time-domain reflectometry
TNT	2,4,6-trinitrotoluene [dynamite]
TPH	total petroleum hydrocatbons
UTL	upper tolerance limit
VCA	voluntary corrective action
VOC	volatile organic compound
WAC	waste acceptance criteria
WCSF	waste characterization strategy form
WWTP	wastewater treatment plant

A-2.0 GLOSSARY

aggregate—At the Los Alamos National Laboratory, an area within a *watershed* containing solid waste management units (SWMUs) and/or areas of concern (AOCs), and the media affected or potentially affected by releases from those SWMUs and/or AOCs. Aggregates are designated to promote efficient and effective corrective action activities.

aquifer—An underground geological formation (or group of formations) containing water that is the source of groundwater for wells and springs.

area of concern—(1) A release that may warrant investigation or remediation and is not a solid waste management unit (SWMU). (2) An area at Los Alamos National Laboratory that may have had a release of a hazardous waste or a hazardous constituent but is not a SWMU.

analysis—A critical evaluation, usually made by breaking a subject (either material or intellectual) down into its constituent parts, then describing the parts and their relationship to the whole. Analyses may include physical analysis, chemical analysis, toxicological analysis, and knowledge-of-process determinations.

analyte—The element, nuclide, or ion a chemical analysis seeks to identify and/or quantify; the chemical constituent of interest.

analytical method—A procedure or technique for systematically performing an activity.

background level—(1) The concentration of a substance in an environmental medium (air, water, or soil) that occurs naturally or is not the result of human activities. (2) In exposure assessment, the concentration of a substance in a defined control area over a fixed period of time before, during, or after a data-gathering operation.

background value (BV)—A statistically derived concentration (i.e., the upper tolerance limit [UTL]) of a chemical used to represent the background data set. If a UTL cannot be derived, either the detection limit or maximum reported value in the background data set is used.

canyon—A stream-cut chasm or gorge, the sides of which are composed of cliffs or a series of cliffs rising from the chasm's bed. Canyons are characteristic of arid or semiarid regions where downcutting by streams greatly exceeds weathering.

catchment—(1) A structure, such as a basin or reservoir, used for collecting or draining water. (2) The amount of water collected in such a structure. (3) A catching or collecting of water, especially rainwater.

chemical—Any naturally occurring or human-made substance characterized by a definite molecular composition.

chemical of potential concern (COPC)—A detected chemical compound or element that has the potential to adversely affect human receptors as a result of its concentration, distribution, and toxicity.

cleanup—A series of actions taken to deal with the release, or threat of a release, of a hazardous substance that could affect humans and/or the environment. The term cleanup is sometimes used interchangeably with the terms remedial action, removal action, or corrective action.

Compliance Order on Consent (Consent Order)—For the Environmental Remediation and Surveillance Program, an enforcement document signed by the New Mexico Environment Department, the U.S. Department of Energy, and the Regents of the University of California on March 1, 2005, which prescribes the requirements for corrective action at Los Alamos National Laboratory. The purposes of the Consent Order are (1) to define the nature and extent of releases of contaminants at, or from, the facility; (2) to identify and evaluate, where needed, alternatives for corrective measures to clean up contaminants in the environment and prevent or mitigate the migration of contaminants at, or from, the facility; and (3) to implement such corrective measures. The Consent Order supersedes the corrective action requirements previously specified in Module VIII of the Laboratory's Hazardous Waste Facility Permit.

Consent Order—See Compliance Order on Consent.

consolidated unit—A group of solid waste management units (SWMUs), or SWMUs and areas of concern, which generally are geographically proximate and have been combined for the purposes of investigation, reporting, or remediation.

contaminant—(1) Chemicals and radionuclides present in environmental media or on debris above background levels. (2) According to the March 1, 2005, Compliance Order on Consent (Consent Order), any hazardous waste listed or identified as characteristic in 40 Code of Federal Regulations (CFR) 261 (incorporated by 20.4.1.200 New Mexico Administrative Code [NMAC]); any hazardous constituent listed in 40 CFR 261 Appendix VIII (incorporated by 20.4.1.200 NMAC) or 40 CFR 264 Appendix IX (incorporated by 20.4.1.500 NMAC); any groundwater contaminant listed in the Water Quality Control Commission (WQCC) Regulations at 20.6.3.3103 NMAC; any toxic pollutant listed in the WQCC Regulations at 20.6.2.7 NMAC; explosive compounds; nitrate; and perchlorate. (Note: Under the Consent Order, the term "contaminant" does not include radionuclides or the radioactive portion of mixed waste.)

corrective action—(1) In the Resource Conservation and Recovery Act, an action taken to rectify conditions potentially adverse to human health or the environment. (2) In the quality assurance field, the process of rectifying and preventing nonconformances.

data validation—A systematic process that applies a defined set of performance-based criteria to a body of data and that may result in the qualification of the data. The data-validation process is performed independently of the analytical laboratory that generates the data set and occurs before conclusions are drawn from the data. The process may include a standardized data review (routine data validation) and/or a problem-specific data review (focused data validation).

decommissioning—The permanent removal of facilities and their components from service after the discontinued use of structures or buildings that are deemed no longer useful. Decommissioning must take place in accordance with regulatory requirements and applicable environmental policies.

decontamination—The removal of unwanted material from the surface of, or from within, another material.

detect (detection)—An analytical result, as reported by an analytical laboratory, that denotes a chemical or radionuclide to be present in a sample at a given concentration.

detection limit—The minimum concentration that can be determined by a single measurement of an instrument. A detection limit implies a specified statistical confidence that the analytical concentration is greater than zero.

discharge—The accidental or intentional spilling, leaking, pumping, pouring, emitting, emptying, or dumping of hazardous waste into, or on, any land or water.

disposal—The discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into, or on, any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwaters.

effluent—Wastewater (treated or untreated) that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters.

Environmental Restoration (ER) Project—A Los Alamos National Laboratory project established in 1989 as part of a U.S. Department of Energy nationwide program, and precursor of today's Environmental Remediation and Surveillance (ERS) Program. This program is designed (1) to investigate hazardous and/or radioactive materials that may be present in the environment as a result of past Laboratory operations, (2) to determine if the materials currently pose an unacceptable risk to human health or the environment, and (3) to remediate (clean up, stabilize, or restore) those sites where unacceptable risk is still present.

facility—All contiguous land (and structures, other appurtenances, and improvements on the land) used for treating, storing, or disposing of hazardous waste. A facility may consist of several treatment, storage, or disposal operational units. For the purpose of implementing a corrective action, a facility is all the contiguous property that is under the control of the owner or operator seeking a permit under Subtitle C of the Resource Conservation and Recovery Act.

groundwater—Interstitial water that occurs in saturated earth material and is capable of entering a well in sufficient amounts to be used as a water supply.

Hazardous and Solid Waste Amendments (HSWA)—Public Law No. 98-616, 98 Stat. 3221, enacted in 1984, which amended the Resource Conservation and Recovery Act of 1976 (42 United States Code § 6901 et seq).

hazardous constituent (hazardous waste constituent)—According to the March 1, 2005, Compliance Order of Consent (Consent Order), any constituent identified in Appendix VIII of Part 261, Title 40 Code of Federal Regulations (CFR) (incorporated by 20.4.1.200 New Mexico Administrative Code [NMAC]) or any constituent identified in 40 CFR 264, Appendix IX (incorporated by 20.4.1.500 NMAC).

Hazardous Waste Facility Permit—The authorization issued to Los Alamos National Laboratory (the Laboratory) by the New Mexico Environment Department that allows the Laboratory to operate as a hazardous waste treatment, storage, and disposal facility.

HSWA module—See Module VIII.

infiltration—(1) The penetration of water through the ground surface into subsurface soil. (2) The technique of applying large volumes of wastewater to land to penetrate the surface and percolate through the underlying soil.

intermittent stream—A stream that flows only in certain reaches as a result of the channel bed's losing and gaining characteristics.

laboratory control sample (LCS)—A known matrix that has been spiked with compound(s) representative of target analytes. LCSs are used to document laboratory performance, and the acceptance criteria for LCSs are method-specific.

LANL (Los Alamos National Laboratory) data validation qualifiers—The Los Alamos National Laboratory data qualifiers which are defined by, and used, in the Environmental Remediation and Surveillance (ERS) Program validation process. The qualifiers describe the general usability (or quality) of data. For a complete list of data qualifiers applicable to any particular analytical suite, consult the appropriate ERS standard operating procedure.

material disposal area (MDA)—A subset of the solid waste management units at Los Alamos National Laboratory (the Laboratory) that include disposal units such as trenches, pits, and shafts. Historically, various disposal areas (but not all) were designated by the Laboratory as MDAs.

medium (environmental)—Any material capable of absorbing or transporting constituents. Examples of media include tuffs, soils and sediments derived from these tuffs, surface water, soil water, groundwater, air, structural surfaces, and debris.

method detection limit (MDL)—The minimum concentration of a substance that can be measured and reported with a known statistical confidence that the analyte concentration is greater than zero. After subjecting samples to the usual preparation, the MDL is determined by analyzing those samples of a given matrix type that contain the analyte. The MDL is used to establish detection status.

migration—The movement of inorganic and organic chemical species through unsaturated or saturated materials.

migration pathway—A route (e.g., a stream or subsurface flow path) for the potential movement of contaminants to environmental receptors (plants, humans, or other animals).

model—A schematic description of a physical, biological, or social system, theory, or phenomenon that accounts for its known or inferred properties and may be used for the further study of its characteristics.

Module VIII—Module VIII of the Los Alamos National Laboratory (the Laboratory) Hazardous Waste Facility Permit. This permit allows the Laboratory to operate as a hazardous-waste treatment, storage, and disposal facility. From 1990 to 2005, Module VIII included requirements from the Hazardous and Solid Waste Amendments. These requirements have been superceded by the March 1, 2005, Compliance Order on Consent (Consent Order).

National Pollutant Discharge Elimination System—The national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits to discharge wastewater or storm water, and for imposing and enforcing pretreatment requirements under the Clean Water Act.

no further action (NFA)—Under the Resource Conservation and Recovery Act, a corrective-action determination whereby, based on evidence or risk, no further investigation or remediation is warranted.

operable units (OUs)—At Los Alamos National Laboratory, 24 areas originally established for administering the Environmental Remediation and Surveillance Program. Set up as groups of potential release sites, the OUs were aggregated according to geographic proximity for the purposes of planning and conducting Resource Conservation and Recovery Act (RCRA) facility assessments and RCRA facility investigations. As the project matured, it became apparent that there were too many areas to allow efficient communication and to ensure consistency in approach. In 1994, the 24 OUs were reduced to 6 administrative field units.

outfall—A place where effluent is discharged into receiving waters.

permit—An authorization, license, or equivalent control document issued by the U.S. Environmental Protection Agency or an approved state agency to implement the requirements of an environmental regulation.

polychlorinated biphenyls (PCBs)—Any chemical substance limited to the biphenyl molecule that has been chlorinated to varying degrees, or any combination that contains such substances. PCBs are colorless, odorless compounds that are chemically, electrically, and thermally stable and have proven to be toxic to both humans and other animals.

quality assurance/quality control—A system of procedures, checks, audits, and corrective actions set up to ensure that all U.S. Environmental Protection Agency research design and performance, environmental monitoring and sampling, and other technical and reporting activities are of the highest achievable quality.

radiation—A stream of particles or electromagnetic waves emitted by atoms and molecules of a radioactive substance as a result of nuclear decay. The particles or waves emitted can consist of neutrons, positrons, alpha particles, beta particles, or gamma radiation.

radioactive material—For purposes of complying with U.S. Department of Transportation regulations, any material having a specific activity (activity per unit mass of the material) greater than 2 nanocuries per gram (nCi/g) and in which the radioactivity is evenly distributed.

radionuclide—Radioactive particle (human-made or natural) with a distinct atomic weight number.

RCRA facility investigation (RFI)—A Resource Conservation and Recovery Act (RCRA) investigation that determines if a release has occurred and characterizes the nature and extent of contamination at a hazardous waste facility. The RFI is generally equivalent to the remedial investigation portion of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process.

regional aquifer—Geologic material(s) or unit(s) of regional extent whose saturated portion yields significant quantities of water to wells, contains the regional zone of saturation, and is characterized by the regional water table or potentiometric surface.

release—Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of hazardous waste or hazardous constituents into the environment.

Resource Conservation and Recovery Act—The Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act of 1976 (Public Law [PL] 94-580, as amended by PL 95-609 and PL 96-482, United States Code 6901 et seq.).

runoff—The portion of the precipitation on a drainage area that is discharged from the area.

run-on—Surface water that flows onto an area as a result of runoff occurring higher up on a slope.

sample—A portion of a material (e.g., rock, soil, water, or air), which, alone or in combination with other portions, is expected to be representative of the material or area from which it is taken. Samples are typically either sent to a laboratory for analysis or inspection or are analyzed in the field. When referring to samples of environmental media, the term field sample may be used.

sediment—(1) A mass of fragmented inorganic solid that comes from the weathering of rock and is carried or dropped by air, water, gravity, or ice. (2) A mass that is accumulated by any other natural agent and that forms in layers on the earth's surface (e.g., sand, gravel, silt, mud, fill, or loess). (3) A solid material that is not in solution and is either distributed through the liquid or has settled out of the liquid.

site characterization—Defining the pathways and methods of migration of hazardous waste or constituents, including the media affected; the extent, direction and speed of the contaminants; complicating factors influencing movement; or concentration profiles.

soil—(1) A material that overlies bedrock and has been subject to soil-forming processes. (2) A sample media group that includes naturally occurring and artificial fill materials.

solid waste management unit (SWMU)—(1) Any discernible site at which solid wastes have been placed at any time, whether or not the site use was intended to be the management of solid or hazardous waste. SWMUs include any site at a facility at which solid wastes have been routinely and systematically released. This definition includes regulated sites (i.e., landfills, surface impoundments, waste piles, and land treatment sites), but does not include passive leakage or one-time spills from production areas and sites in which wastes have not been managed (e.g., product storage areas). (2) According to the March 1, 2005, Compliance Order on Consent (Consent Order), any discernible site at which solid waste has been placed at any time, and from which the New Mexico Environment Department determines there may be a risk of a release of hazardous waste or hazardous waste constituents (hazardous constituents), whether or not the site use was intended to be the management of solid or hazardous waste. Such sites include any area in Los Alamos National Laboratory at which solid wastes have been routinely and systematically released; they do not include one-time spills.

split-spoon sampler—A hollow, tubular sampling device below a drill stem that is driven by a weight to retrieve soil samples. The core barrel can be opened to remove samples. This is a sampling method commonly used with auger drilling. The split-spoon sampler can be driven into the ground or can be advanced inside hollow-stem augers.

standard operating procedure—A document that details the officially approved method(s) for an operation, analysis, or action, with thoroughly prescribed techniques and steps.

surface sample—A sample taken at a collection depth that is (or was) representative of the medium's surface during the period of investigative interest. A typical depth interval for a surface sample is 0 to 6 in. for mesa-top locations, but may be up to several feet in sediment-deposition areas within canyons.

target analyte—A chemical or parameter, the concentration, mass, or magnitude of which is designed to be quantified by a particular test method.

technical area (TA)—At Los Alamos National Laboratory, an administrative unit of operational organization (e.g., TA-21).

topography—The physical or natural features of an object or entity and their structural relationships.

transport (transportation)—(1) The movement of a hazardous waste by air, rail, highway, or water. (2) The movement of a contaminant from a source through a medium to a receptor.

tuff—Consolidated volcanic ash, composed largely of fragments produced by volcanic eruptions.

U.S. Department of Energy—The federal agency that sponsors energy research and regulates nuclear materials for weapons production.

U.S. Environmental Protection Agency (EPA)—The federal agency responsible for enforcing environmental laws. Although state regulatory agencies may be authorized to administer some of this responsibility, EPA retains oversight authority to ensure the protection of human health and the environment.

vadose zone—The zone between the land surface and the water table within which the moisture content is less than saturation (except in the capillary fringe) and pressure is less than atmospheric. Soil pore space also typically contains air or other gases. The capillary fringe is included in the vadose zone.

A-3.0 METRIC CONVERSION

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

A-4.0 DATA QUALIFIER DEFINITIONS

Qualifier	Explanation
U	The analyte was analyzed for but not detected. Reported value is the sample-specific EQL or detection limit.
J	The reported value should be regarded as estimated.
J+	The reported value should be regarded as estimated and biased high.
J-	The reported value should be regarded as estimated and biased low.
UJ	The analyte was analyzed for but not detected. Reported value is an estimate of the sample-specific quantitation limit or detection limit.
R	The sample results were rejected because of serious deficiencies in the ability to analyze the sample and meet quality control criteria; presence or absence cannot be verified.

Appendix B

Management Plan for Investigation-Derived Waste

B-1.0 INTRODUCTION

This appendix describes the management of investigation-derived waste (IDW) generated during the investigation of sites comprising Technical Area (TA) 49 at Los Alamos National Laboratory (LANL or the Laboratory). This waste is generated during field-investigation activities that 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 contaminants.

B-2.0 IDW

All IDW generated during the nuclear environmental site (NES) TA-49 field-investigation activities will also be managed in accordance with applicable standard operating procedures (SOPs). These SOPs incorporate the requirements of all applicable U.S. Environmental Protection Agency (EPA) and New Mexico Environment Department regulations, U.S. Department of Energy (DOE) orders, and Laboratory implementation requirements. Two SOPs are applicable to the characterization and management of IDW:

- SOP-01.06, Management of Environmental Restoration Project Waste
- SOP-01.10, Waste Characterization.

These SOPs are available at http://www.lanl.gov/environment/all/qa.shtml.

All IDW will be placed in a hazardous waste accumulation area until it is characterized and found to be not hazardous.

Investigation activities will be conducted in a manner that minimizes the generation of waste. Waste minimization will be accomplished by implementing the requirements of the Environmental Programs Directorate's portion of the "Los Alamos National Laboratory Hazardous Waste Minimization Report" (LANL 2006, 096015). This report is updated annually to meet a requirement of Module VIII of the Laboratory's Hazardous Waste Facility Permit, which was issued by EPA on May 23, 1990, and modified on May 19, 1994 (EPA 1990, 001585; EPA 1994, 044146).

The waste streams that will be generated and managed during the field investigation at TA-49 sites are described below.

B-2.1 Drill Cuttings

The drill cuttings waste stream will consist of cuttings from boreholes that will be drilled in and around TA-49 sites. Drill cuttings will be collected and placed in containers at a hazardous waste accumulation area until they are characterized and found to be not hazardous. The drill cuttings waste stream will be characterized using analytical results from core samples and augmented by direct sampling of the containerized cuttings, if necessary. Potential contaminants of concern include radionuclides, inorganic chemicals, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs) in Area 5, and high explosives (HE). The maximum detected concentrations of radionuclides will be compared with the background values (BVs) or fallout values (FVs). If the maximum detected concentrations exceed these values, the drill cuttings will be designated as low-level radioactive waste. Maximum concentrations of toxicity characteristic leaching procedure (TCLP) constituents will be compared with 20 times the TCLP regulatory level. If the concentrations are less than 20 times the regulatory level, the drill cuttings will be designated as nontoxicity characteristic nonhazardous waste. If the concentrations exceed 20 times the regulatory level, the drill cuttings will be sampled and analyzed using the TCLP to determine whether it is a toxicity characteristic hazardous (or mixed) waste. Based on the results of previous investigations, the Laboratory expects the majority of these drill cuttings to be designated as nonhazardous, nonradioactive waste that will be used either for cover material at TA-54 or disposed of at an off-site disposal facility permitted for the disposal of industrial waste. Potentially, some drill cuttings may be designated as low-level radioactive or mixed waste because of the presence of depleted uranium, metals, and/or HE. Low-level waste (LLW) will be disposed of on-site at TA-54 or off-site at a licensed facility. Mixed waste will be sent to an off-site facility permitted for treating and/or disposing of mixed waste. If the concentration of HE in the waste characterizes it as detonable, the waste would be treated by open burning or open detonation on-site to remove the reactivity characteristic of HE. It would then be sent to an off-site facility for further treatment, if needed, or disposal.

B-2.2 Soil

Soil will be placed into containers appropriate to the waste volume generated (drums and/or rolloff containers), secured, and temporarily stored at a hazardous waste accumulation area until it is characterized and found to be not hazardous. Potential contaminants of concern include radionuclides, inorganic chemicals, VOCs, SVOCs, PCBs, and HE in Area 5. The maximum detected concentrations of radionuclides will be compared with the BVs or FVs. If the maximum concentrations exceed these values, the soil will be designated as low-level radioactive waste. Maximum concentrations of TCLP constituents will be compared with 20 times the TCLP regulatory level. If the concentrations are less than 20 times the regulatory level, the drill cuttings will be designated as nontoxicity characteristic nonhazardous waste. If the concentrations exceed 20 times the regulatory level, the drill cuttings will be sampled and analyzed using the TCLP to determine whether it is a toxicity characteristic hazardous (or mixed) waste. Based on the results of previous investigations, the Laboratory expects these wastes to be designated as nonhazardous, nonradioactive waste that will be used either for cover material at TA-54 or will be disposed of at an off-site disposal facility permitted for the disposal of industrial waste. Potentially, some soil may be designated as low-level radioactive or mixed waste because of the presence of depleted uranium, metals, PCBs, and/or HE. LLW will be disposed of at TA-54 or off-site at a licensed facility. Mixed waste will be sent to an off-site facility permitted for the treatment and/or disposal of mixed waste. If the concentration of HE in the waste characterizes it as detonable, the waste would be treated by open burning or open detonation on-site to remove the reactivity characteristic of HE. It would then be sent to an off-site facility for further treatment, if needed, or disposal.

B-2.3 Purge Water

Purge water will be managed and characterized in accordance with the methodology described in the “2007 Interim Facility-Wide Groundwater Monitoring Plan” (LANL 2007, 096665).

B-2.4 Spent PPE and Disposable Sampling Supplies

The spent PPE waste stream will consist of PPE that has come into contact with contaminated environmental media (e.g., core and/or drill cuttings) and cannot be decontaminated. The bulk of this waste stream will consist of protective clothing, such as coveralls, gloves, shoe covers, and (if required) respirator cartridges. Spent PPE will be collected in containers at personnel decontamination stations, secured, and temporarily stored at a hazardous waste accumulation area until it is characterized and found not be hazardous. Characterization of this waste stream will be performed through acceptable knowledge (AK) of the waste materials, the methods of generation, and the levels of contamination observed in the associated environmental media. The Laboratory expects spent PPE to be designated as nonhazardous, nonradioactive waste that will be disposed of at an off-site disposal facility permitted for the disposal of industrial waste.

The disposable sampling supplies waste stream will consist of all equipment and materials that are necessary for collecting samples and have come into direct contact with contaminated environmental media and cannot be decontaminated. This waste stream also includes residues associated with field-test kits and wastes associated with dry decontamination activities. The latter will consist primarily of paper and plastic items collected in bags at a hazardous waste accumulation area until the area is characterized and found to be not hazardous. Characterization of this waste stream will be performed through AK of the waste materials, the methods of generation, and the levels of contamination observed in the associated environmental media. The Laboratory expects disposable sampling supplies to be designated as nonhazardous, nonradioactive waste, with the exception of residues from some field-test kits, which will be deemed hazardous. Nonhazardous wastes will be disposed of at an off-site disposal facility permitted for the disposal of industrial waste. Hazardous wastes will be sent to an off-site facility permitted for the treatment and/or disposal of hazardous waste.

B-2.5 Decontamination Fluids

The decontamination fluids waste stream will consist of liquid wastes from decontamination activities (e.g., decontamination solutions and rinse waters). Following 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 and transferred to accumulation drums. Decontamination fluids will be accumulated in drums and temporarily stored at a hazardous waste accumulation area until they are characterized and found to be not hazardous. The Laboratory expects that the majority of decontamination fluids will be designated as nonhazardous, nonradioactive liquid waste. A potential exists for some decontamination rinsate to be designated as low-level radioactive or mixed waste at several of the sites because of presence of radionuclides, metals, and/or HE. Nonhazardous and radioactive liquid wastes may be treated and discharged by several Clean Water Act-permitted on-site treatment facilities, provided the waste meets the facility's waste acceptance criteria (WAC). Mixed waste and waste that do not meet the WAC of Laboratory treatment facilities will be sent to permitted off-site treatment facilities.

B-2.6 Returned or Excess Samples

Soil samples either returned from or obtained but not submitted to the analytical laboratory will be containerized in a 5-gal. bucket or 55-gal. drum and stored at a hazardous waste accumulation area until they are characterized and found to be not hazardous. Returned soil samples will be managed in a manner consistent with analytical results, and it is anticipated that the returned soil samples will be classified as nonhazardous, nonradioactive solid waste. The returned soil samples will be disposed of at a Laboratory-approved off-site industrial waste facility.

The selection of waste containers will be based on the appropriate U.S. Department of Transportation (DOT) requirements and the type and amount of IDW planned to be generated. Immediately following containerization, each waste container will be individually labeled by waste classification, item identification number, radioactivity (if applicable), and date generated. Waste containers will be managed in clearly marked and appropriately constructed waste accumulation areas. Waste accumulation area posting, regulated storage duration, and inspection requirements will be based on the type of IDW and its classification. Container and storage requirements will be detailed in the waste characterization strategy form (WCSF) and approved before waste generation.

B-2.7 Spent Immunoassay Test Kits (D TECH)

Sampling containers and materials from used test kits include glass ampules, soil, and miscellaneous plastic/Teflon. Due to the solvents present, the sampling containers and materials are assumed to be hazardous based on their ignitability. This waste will be stored in a 55-gal. drum at a waste accumulation area until a final waste determination is made. Nonhazardous wastes will be disposed of at an off-site disposal facility permitted for the disposal of industrial waste. Hazardous wastes will be sent to an off-site facility permitted for the treatment and/or disposal of hazardous waste.

B-3.0 WASTE MANAGEMENT

All wastes will be managed in accordance with applicable federal, state, DOE, and Laboratory requirements. The IDW waste streams, expected waste types, estimated waste volumes, and other data are listed in Table B-3.0-1.

All waste drums and containers (rolloff bins) will remain at a hazardous waste accumulation area until analytical results have been received and waste characterization has been completed.

Before field-investigation activities begin, a WCSF will be prepared and approved as required by the current version of SOP-01.10. The WCSF will provide detailed information about IDW characterization, management, containerization, and potential volume generation for each subaggregate.

The IDW will be characterized through existing data and/or documentation, direct sampling of the IDW, or sampling of the media being investigated (e.g., surface soil, subsurface soil). If sampling is necessary, the procedures will be described in a sampling and analysis plan that will be developed in conjunction with the WCSF.

Some wastes will be characterized on the basis of AK rather than direct waste analysis. The AK characterization will consist of the results of analyzing the environmental media associated with each waste stream. For example, spent PPE and disposable sampling supplies that have potentially come into contact with contaminated media will be characterized based on the analytical results for samples of that media. Similarly, borehole drill cuttings will be characterized by the analytical results for the core samples from that borehole. If decontamination fluids are to be sent off-site for disposal, they will be sampled to demonstrate compliance with the WAC of the receiving facility.

B-4.0 WASTE CONTAINERS AND TRANSPORTATION

The selection of waste containers will be based on both the appropriate DOT requirements and the type and amount of IDW anticipated to be generated. Immediately following containerization, each waste container will be individually labeled to identify the waste classification, the item identification number, its radioactivity (if applicable), and the date of generation. Waste containers will be managed in clearly marked and appropriately constructed waste accumulation areas. Waste accumulation area postings, regulated storage duration, and inspection requirements will be based on IDW type and classification. The wastes will be stored in accordance with Laboratory hazardous and mixed waste requirements documents.

Packaging and transportation of IDW will comply with appropriate DOT requirements. Transportation and disposal requirements will be detailed in the WCSF and approved before the generation of waste.

B-5.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID number. This information is also included in text citations. ER ID numbers 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; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; 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.

EPA (U.S. Environmental Protection Agency), April 10, 1990. "Module VIII of RCRA Permit No. NM0890010515, issued to Los Alamos National Laboratory, Los Alamos, New Mexico," EPA Region VI, Hazardous Waste Management Division, Dallas, Texas. (EPA 1990, 001585)

EPA (U.S. Environmental Protection Agency), April 19, 1994. "Module VIII of RCRA Permit No. NM0890010515, EPA, Region 6, New Requirements Issued to Los Alamos National Laboratory, Los Alamos, New Mexico," EPA Region 6, Hazardous Waste Management Division, Dallas, Texas. (EPA 1994, 044146)

LANL (Los Alamos National Laboratory), November 2006. "Los Alamos National Laboratory Hazardous Waste Minimization Report," Los Alamos National Laboratory document LA-UR-06-8175, Los Alamos, New Mexico. (LANL 2006, 096015)

LANL (Los Alamos National Laboratory), May 2007. "2007 Interim Facility-Wide Groundwater Monitoring Plan," Los Alamos National Laboratory document LA-UR-07-3271, Los Alamos, New Mexico. (LANL 2007, 096665)

Table B-3.0-1
Generation and Management of the
Estimated IDW for TA-49

Waste Stream	Expected Waste Type	Estimated Volume*	Characterization Method	On-Site Management	Expected Disposition
Drill Cuttings	Industrial waste, nonhazardous, nonradioactive	1 yd^3	Analytical results from waste samples and core samples	Accumulation in 55-gal. drums, covered rolloff containers, or cubic-yard soft-sided containers	Permitted off-site facility for which waste meets acceptance criteria
Soil*	Industrial waste, nonhazardous, nonradioactive	1.30 yd^3	Analytical results from waste samples	Accumulation in covered rolloff containers	Permitted off-site facility for which waste meets acceptance criteria
Purge Water	Liquid waste, nonhazardous or low-level radioactive	5 gal.	Analytical results from waste samples	Accumulation in 55-gal. drums	On-site Clean Water Act-permitted off-site treatment facility for which waste meets acceptance criteria
Spent PPE and Disposable Sampling Supplies	Industrial waste, nonhazardous, nonradioactive	0.3 yd^3	AK	Accumulation in 55-gal. drums	Permitted off-site facility for which waste meets acceptance criteria
Decontamination Fluids	Liquid waste, nonhazardous or low-level radioactive	113 gal.	Analytical results from waste samples	Accumulation in 55-gal. drums	On-site Clean Water Act-permitted treatment facility for which waste meets acceptance criteria
Returned or Excess Samples	Industrial waste, nonhazardous, nonradioactive	0.65 yd^3	AK from sample analytical data and method of generation	Accumulation in a 5-gal. bucket or 55-gal. drum, stored on Laboratory property	Permitted off-site facility for which waste meets acceptance criteria
Spent Immunoassay Test Kits (D TECH)	Liquid waste, hazardous, nonradioactive	7 gal.	AK spent soil and acetone	Accumulation in a 55-gal. drum	Permitted off-site industrial waste facility for which waste meets acceptance criteria
	Liquid waste, nonhazardous, nonradioactive	109 gal.	AK glass ampules, miscellaneous plastic/Teflon	Accumulation in 55-gal. drums	Permitted off-site facility for which waste meets acceptance criteria

*Sample depths, numbers, and/or locations are yet to be determined.

Appendix C

Alpha and Beta Speciation Threshold Determination

C-1.0 INTRODUCTION

This appendix discusses the methods used to determine gross alpha and gross beta threshold concentrations above which samples will be sent for analytical speciation by isotopic alpha or isotopic beta analyses. Because gross alpha and gross beta analyses can be conducted quickly, their analyses can be used to identify areas that have been impacted by laboratory activities and to direct ongoing sampling. These threshold concentrations represent the estimated total alpha and beta activities due to naturally occurring isotopes present in soils at Los Alamos National Laboratory (LANL or the Laboratory). The threshold concentrations to be utilized at Technical Area (TA) 49 to determine samples for additional analyses are 25 pCi/g for gross alpha and 50 pCi/g for gross beta.

The half-lives of radionuclides produced from the radioactive decay of uranium-238, uranium-235, and thorium-232 are much shorter than those of their respective parents. As a result, the rate of decay of the parent and progeny radionuclides comes into equilibrium. This condition, known as secular equilibrium, exists in unimpacted soils and rock at the Laboratory. When secular equilibrium is present, the activities of the parent radionuclide and all progeny will be the same. The principle of secular equilibrium is used to determine the total alpha and beta activity expected in unimpacted soils at the Laboratory and then is also used to determine the threshold at which alpha and beta activity rise above background levels.

The decay of three naturally occurring radionuclides—uranium-238, uranium-235, and thorium-232—and their alpha particle-emitting progeny account for over 99.5% of alpha particle activity in unimpacted soils at the Laboratory. The beta particle-emitting daughter radionuclides resulting from the decay from these same three radionuclides and naturally occurring potassium-40 account for over 95% of beta particle activity in unimpacted soils at the Laboratory. Fallout from atmospheric testing of nuclear weapons in the 1950s account for the remaining alpha and beta particle activity in unimpacted soils at the Laboratory.

A defensible and Laboratory-wide set of background data was collected and characterized in the Laboratory background study (LANL 1998, 059730). These results form the basis for determining threshold values for speciation of gross alpha and gross beta analyses. Threshold values from the Laboratory background study then are compared with sediment environmental monitoring data collected at TA-49 to ensure the reasonableness of the statistically derived values.

C-2.0 GROSS ALPHA GROSS BETA THRESHOLD DETERMINATION

Threshold values are statistically derived using the same analytical data used to generate the Laboratory background study (LANL 1998, 059730). In the Laboratory background study, 24 sediment samples received analyses of uranium-238, uranium-235, and thorium-232. These three isotopes and their progeny form three long-lived naturally occurring decay chains. Also analyzed in these 24 sediment samples was potassium-40, which is the other major naturally occurring contributor to beta activity. Isotopic uranium, isotopic thorium, and potassium-40 results from these 24 sediment samples are presented in Table C-2.0-1. These samples were not analyzed for the fallout isotopes cesium-137 or strontium-90, so those isotopes are not included in the gross alpha/beta threshold calculations.
The uranium-238 decay chain includes eight alpha emitters and six beta emitters in secular equilibrium. The uranium-235 decay chain includes seven alpha emitters and four beta emitters in secular equilibrium. The thorium-232 decay chain includes six alpha emitters and four beta emitters in secular equilibrium. Potassium-40 decays by beta directly to the stable calcium-40. Table C-2.0-2 summarizes the number of alpha- and beta-emitting progeny produced by each naturally occurring decay chain. The sum of alpha and beta emitters for each sediment sample used in the background study is presented in Table C-2.0-3.

Several data preparation steps are needed before statistical calculations can be performed on the background data. First, the sums of alpha and beta emitters are determined for each sample using the decay chain and assuming secular equilibrium. Next, the data must be evaluated to determine whether the sums of alpha and beta emitters are derived from a single population. This can be demonstrated by fitting the background data to a standard statistical distribution. The fit of the sum of alpha emittors from the long-lived decay chains, the sum of the beta emittors from the long-lived decay chains, and potassium-40 can each be fitted to a normal statistical distribution as shown in Figures C-2.0-1, C-2.0-2, and C-2.0-3. Probability plots of the sums of alpha emittors from the long-lived decay chains, the sum of the beta emittors from the long-lived decay chains, and potassium-40 are also presented in Figures C-2.0-1, C-2.0-2, and C-2.0-3. In each probability plot, normality may be assumed because the Anderson-Darling test statistic is small (significantly less than 1). The corresponding p-value is greater than a significance level of 0.05 (otherwise stated, the 95% confidence limit), thus accepting the null hypothesis that the distribution is normal (the null hypothesis is rejected if the p-value is less than the significance level).

Because the sum of the alpha-emitting isotopes from the long-lived decay chains, the sum of the beta-emitting isotopes from the long-lived decay chains, and potassium-40 are each normally distributed, an upper threshold limit (UTL) is calculated for each using Equation C-2.0-1 (LANL 1998, 059730). The k-factor is 1.714 with 24 samples in the data set at a 95% confidence interval (EPA 2006, 098701, Table A-2).

$$UTL_{0.95} = \text{mean} + (\text{standard deviation} \times \text{k-factor}) \qquad \textbf{Equation C-2.0-1}$$

UTLs for each alpha-emitting isotope from the long-lived decay chains, for beta-emitting isotopes from the long-lived decay chains, and potassium-40 are calculated using the summarized data presented in Table C-2.0-3. UTLs calculated for each normally distributed suite of isotopes are presented in Table C-2.0-4.

C-3.0 REVIEW OF UTL REASONABLENESS

Material Disposal Area (MDA) AB canyon sediment samples collected during 2001, 2002, 2003, and 2004 were analyzed for gross alpha, gross beta, isotopic uranium, isotopic thorium, isotopic plutonium, and isotopic beta analyses. Refer to Table 3.8-3 in the historic investigation report for isotopic alpha and isotopic beta analytical results. Table C-3.0-1 presents the gross alpha and gross beta analytical results associated with these isotopic analyses. A correlation of these results to their UTLs indicates that one sample from MDA AB-3 and one sample from MDA AB-3N would have been speciated for isotopic alpha, and no samples would have been speciated for isotopic beta at the UTLs. Graphs showing the correlation of isotopic and gross analyses are presented in Figures C-3.0-1 and C-3.0-2.

The gross beta UTL of 50 pCi/g does not exclude any samples from speciation that contained elevated beta-emitting radionuclides. The gross alpha UTL of 25 pCi/g excluded three samples that contained plutonium-239/240 and americium-241 above fallout values (FVs). The following assumptions made in the determination of the gross alpha and gross beta UTLs suggest that comparison of project specific data to the UTLs is justified.

- Secular equilibrium assumes a closed system. Some radionuclides in the decay chain, e.g., radon-220, are gasses, while others are more or less soluble in water. For the purposes of determining UTLs, the media evaluated are assumed to be part of a closed system.
- Gross alpha and gross beta analyses are not 100% efficient. Some proportion of alpha and beta particles emitted are not counted because of sampling, preparation, and analysis losses. Corrections performed during analysis are not capable of compensating for all of the losses.
- Several uranium-235 and uranium-238 results were not detected and are qualified with U. These nondetected values have been incorporated into the statistical data set without modification.
- Background values (BVs) of several radionuclides of concern including plutonium-239/240 and americium-241 are small compared with concentrations of isotopic uranium and thorium present in background samples at the Laboratory. Small concentration increases that put isotopic plutonium and americium over BVs are not always translated into gross alpha or gross beta results above UTLs.

Manual review of these sediment data presented in Figures C-3.0-1 and C-3.0-2 indicate that a project-specific gross alpha UTL of 25 pCi/g captured two of five plutonium-239/240 and two of five americium 241 results with concentrations above FVs.

Where Category 2 or Category 3 gross alpha analyses exceed 25 pCi/g, then samples will be submitted for laboratory analyses of isotopic alpha-emitting radionuclides, including americium-241, plutonium-238, plutonium-239/240, uranium-234, uranium-235, and uranium-238. Where any gross beta analyses exceed 50 pCi/g, then samples will be submitted for laboratory analyses of isotopic beta-emitting radionuclides, including iodine-129, strontium-90, and technetium-99. If either gross alpha or gross beta exceeds its respective project-specific threshold values in Category 3 analyses, then samples collected from that location will receive analysis of target analyte list metals and gamma-emitting radionuclides.

C-4.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID number. This information is also included in text citations. ER ID numbers 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; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; 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.

EPA (U.S. Environmental Protection Agency), February 2006. "Data Quality Assessment: Statistical Methods for Practitioners," EPA QA/G-9S, EPA/240/B-06/003, Office of Environmental Information, Washington, D.C. (EPA 2006, 098701)

LANL (Los Alamos National Laboratory), September 22, 1998. "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory," Los Alamos National Laboratory document LA-UR-98-4847, Los Alamos, New Mexico. (LANL 1998, 059730)

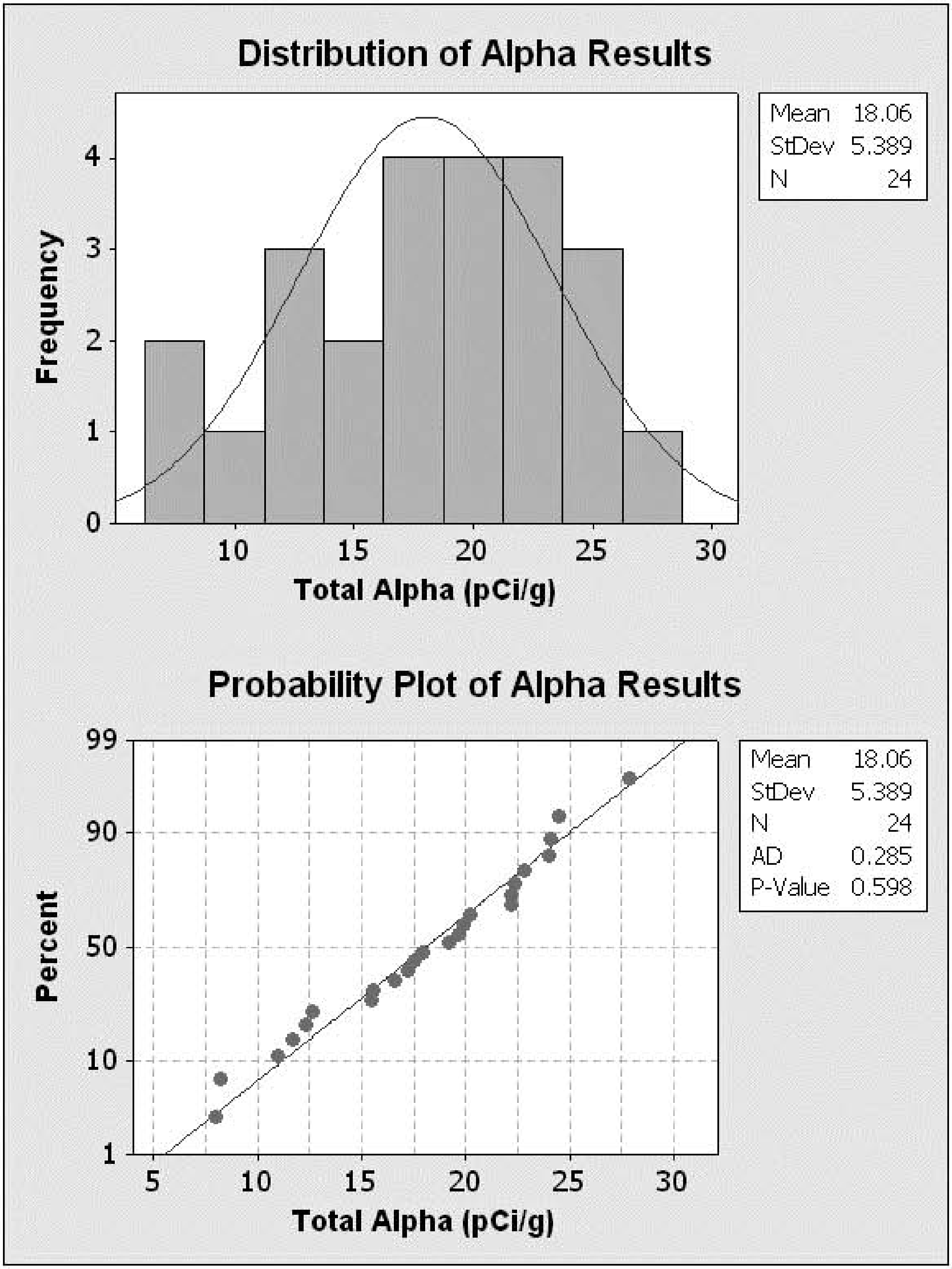


Figure C-2.0-1 Distribution and probability plot of total alpha results

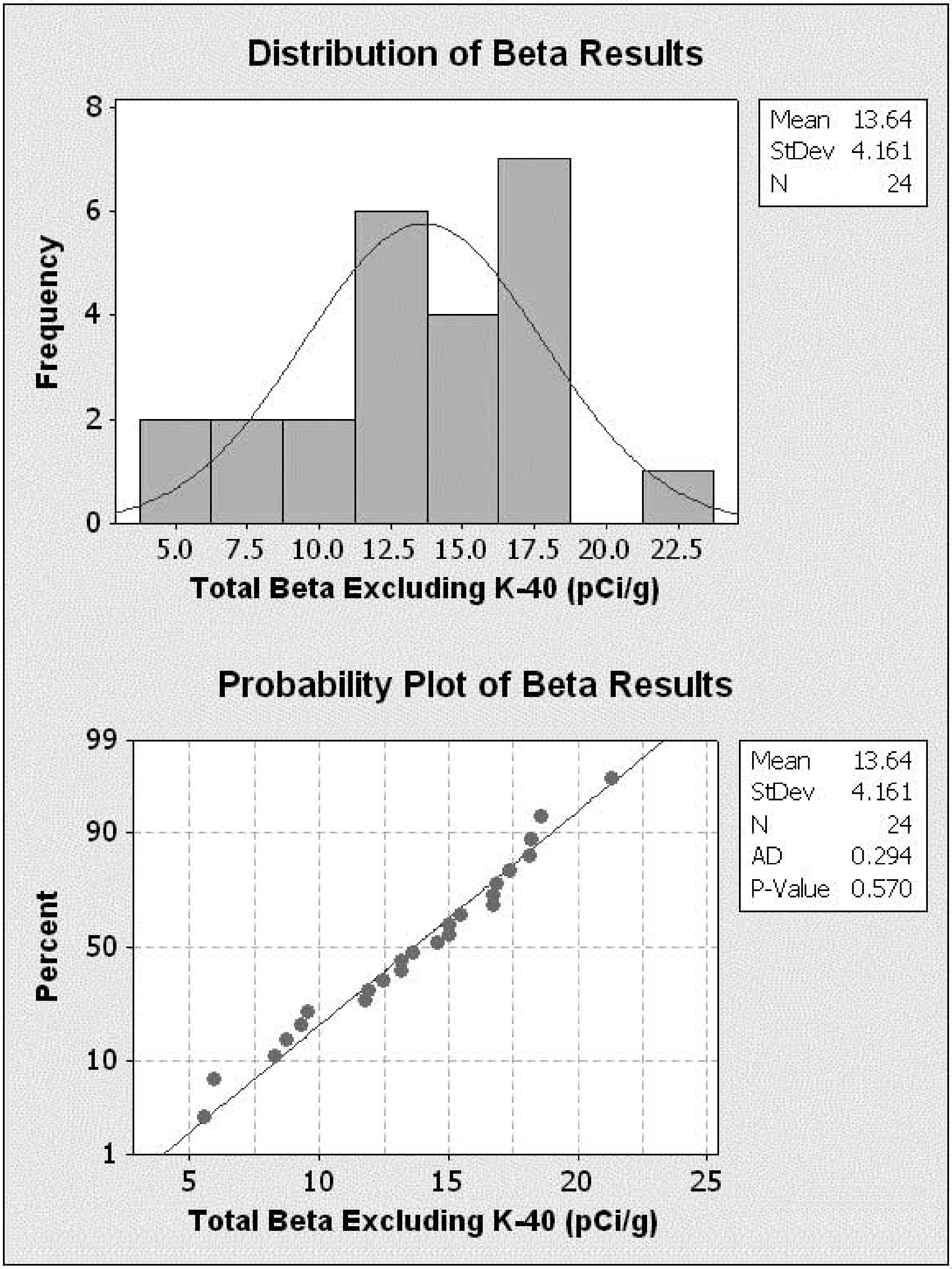


Figure C-2.0-2 Distribution and probability plot of decay chain beta results

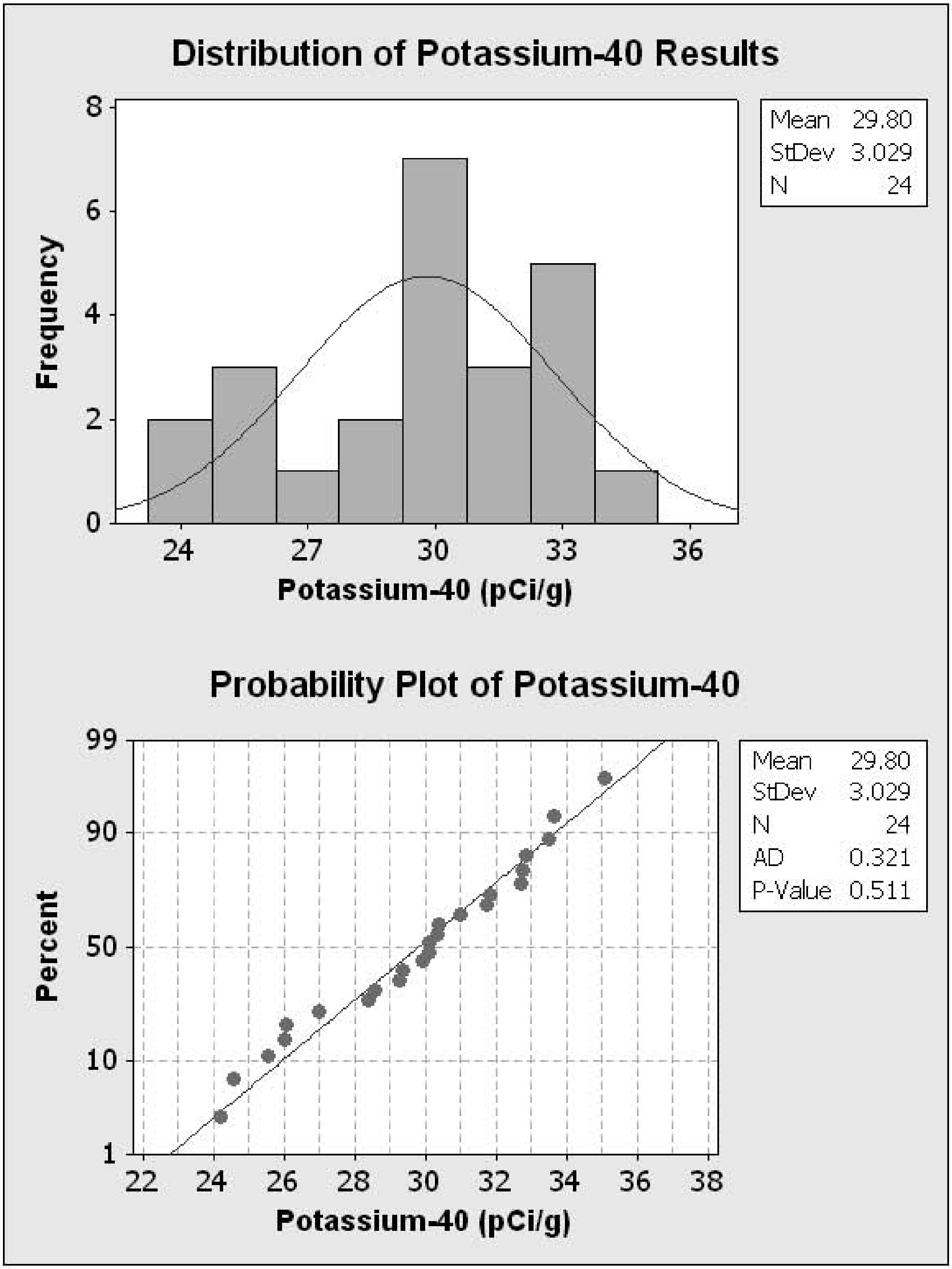


Figure C-2.0-3 Distribution and probability plot of potassium-40 results

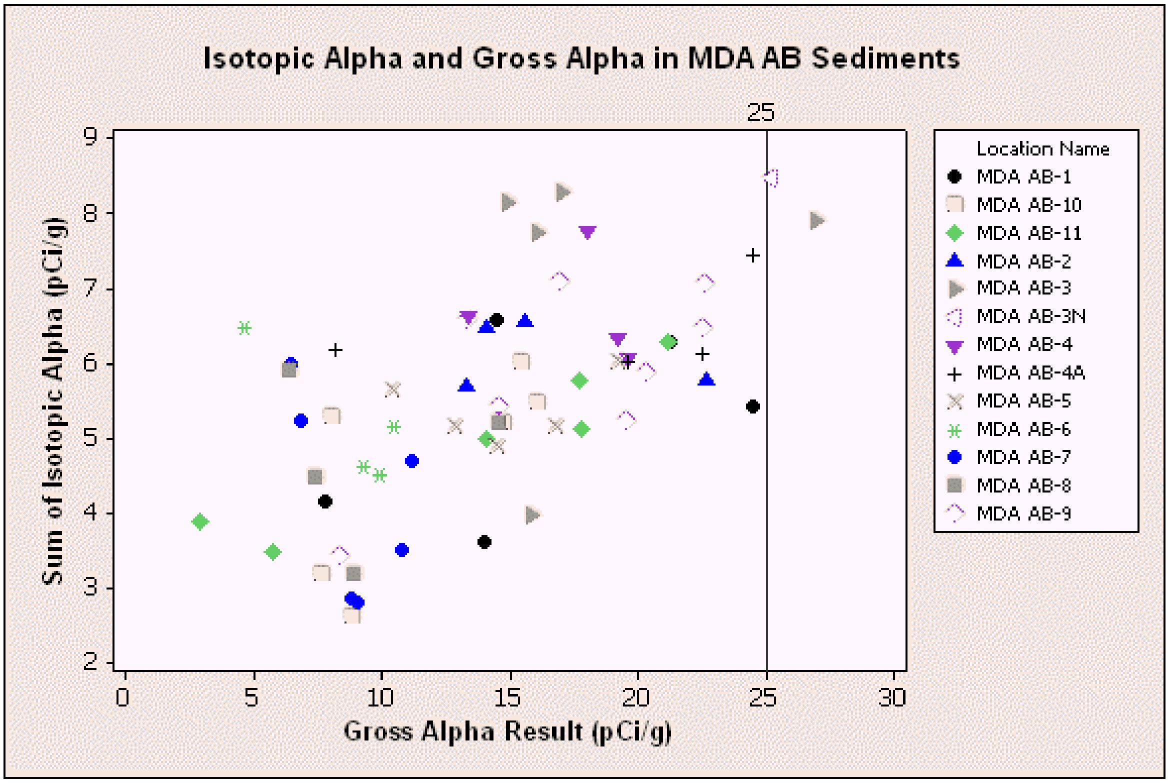


Figure C-3.0-1 Correlation of isotopic alpha and gross alpha analyses in MDA AB sediment

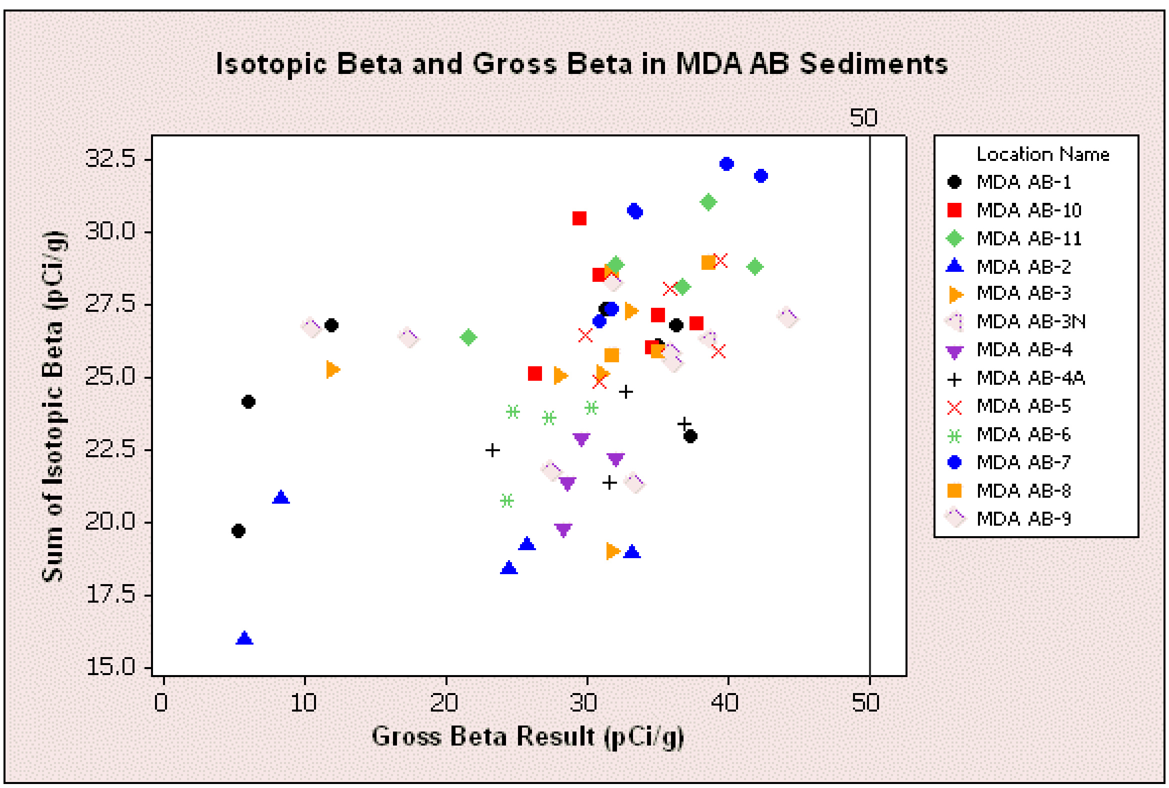


Figure C-3.0-2 Correlation of isotopic beta and gross beta analyses in MDA AB sediment

Table C-2.0-1
Background Study Sample Results

Sample ID	Media	Analyte	Result (pCi/g)
04GU-96-0001	Sediment	Potassium-40	31
04GU-96-0002	Sediment	Potassium-40	28.38
04GU-96-0003	Sediment	Potassium-40	30.11
04GU-96-0004	Sediment	Potassium-40	28.59
04GU-96-0005	Sediment	Potassium-40	29.91
04GU-96-0006	Sediment	Potassium-40	29.28
04GU-96-0007	Sediment	Potassium-40	24.21
04LA-96-0050	Sediment	Potassium-40	30.37
04LA-96-0051	Sediment	Potassium-40	24.57
04LA-96-0052	Sediment	Potassium-40	32.86
04LA-96-0053	Sediment	Potassium-40	32.79
04LA-96-0054	Sediment	Potassium-40	33.65
04LA-96-0055	Sediment	Potassium-40	33.53
04LA-96-0056	Sediment	Potassium-40	29.39
04PU-96-0010	Sediment	Potassium-40	35.1
04PU-96-0011	Sediment	Potassium-40	31.85
04PU-96-0012	Sediment	Potassium-40	30.12
04PU-96-0013	Sediment	Potassium-40	32.75
04PU-96-0014	Sediment	Potassium-40	31.76
04PU-96-0015	Sediment	Potassium-40	30.41
04PU-96-0016	Sediment	Potassium-40	26.98
04PU-96-0017	Sediment	Potassium-40	26.08
04PU-96-0018	Sediment	Potassium-40	26.03
04PU-96-0019	Sediment	Potassium-40	25.53
04GU-96-0001	Sediment	Thorium-232	1.54
04GU-96-0002	Sediment	Thorium-232	1.65
04GU-96-0003	Sediment	Thorium-232	1.43
04GU-96-0004	Sediment	Thorium-232	1.83
04GU-96-0005	Sediment	Thorium-232	0.99
04GU-96-0006	Sediment	Thorium-232	1.8
04GU-96-0007	Sediment	Thorium-232	1.23
04LA-96-0050	Sediment	Thorium-232	1.36
04LA-96-0051	Sediment	Thorium-232	0.94
04LA-96-0052	Sediment	Thorium-232	2.02
04LA-96-0053	Sediment	Thorium-232	1.32
04LA-96-0054	Sediment	Thorium-232	1.38
04LA-96-0055	Sediment	Thorium-232	1.99

Table C-2.0-1 (continued)

Sample ID	Media	Analyte	Result (pCi/g)
04LA-96-0056	Sediment	Thorium-232	1.86
04PU-96-0010	Sediment	Thorium-232	0.89
04PU-96-0011	Sediment	Thorium-232	1.01
04PU-96-0012	Sediment	Thorium-232	1.55
04PU-96-0013	Sediment	Thorium-232	1.41
04PU-96-0014	Sediment	Thorium-232	1.23
04PU-96-0015	Sediment	Thorium-232	1.12
04PU-96-0016	Sediment	Thorium-232	1.29
04PU-96-0017	Sediment	Thorium-232	0.66
04PU-96-0018	Sediment	Thorium-232	2.03
04PU-96-0019	Sediment	Thorium-232	1.88
04GU-96-0001	Sediment	Uranium-235	0.12
04GU-96-0002	Sediment	Uranium-235	0.15
04GU-96-0003	Sediment	Uranium-235	0.12
04GU-96-0004	Sediment	Uranium-235	0.13
04GU-96-0005	Sediment	Uranium-235	0.1
04GU-96-0006	Sediment	Uranium-235	0.13
04GU-96-0007	Sediment	Uranium-235	0.06 (U)*
04LA-96-0050	Sediment	Uranium-235	0.14
04LA-96-0051	Sediment	Uranium-235	0.11
04LA-96-0052	Sediment	Uranium-235	0.16
04LA-96-0053	Sediment	Uranium-235	0.13
04LA-96-0054	Sediment	Uranium-235	0.12
04LA-96-0055	Sediment	Uranium-235	0.14
04LA-96-0056	Sediment	Uranium-235	0.14
04PU-96-0010	Sediment	Uranium-235	0.06 (U)
04PU-96-0011	Sediment	Uranium-235	0.06
04PU-96-0012	Sediment	Uranium-235	0.06 (U)
04PU-96-0013	Sediment	Uranium-235	0.06 (U)
04PU-96-0014	Sediment	Uranium-235	0.06 (U)*
04PU-96-0015	Sediment	Uranium-235	0.06 (U)
04PU-96-0016	Sediment	Uranium-235	0.06
04PU-96-0017	Sediment	Uranium-235	0.06 (U)
04PU-96-0018	Sediment	Uranium-235	0.06 (U)
04PU-96-0019	Sediment	Uranium-235	0.06 (U)
04GU-96-0001	Sediment	Uranium-238	1.4
04GU-96-0002	Sediment	Uranium-238	1.7
04GU-96-0003	Sediment	Uranium-238	1.4
04GU-96-0004	Sediment	Uranium-238	1.5

Table C-2.0-1 (continued)

Sample ID	Media	Analyte	Result (pCi/g)
04GU-96-0005	Sediment	Uranium-238	0.86
04GU-96-0006	Sediment	Uranium-238	1.5
04GU-96-0007	Sediment	Uranium-238	1.1
04LA-96-0050	Sediment	Uranium-238	1.5
04LA-96-0051	Sediment	Uranium-238	0.75
04LA-96-0052	Sediment	Uranium-238	2.1
04LA-96-0053	Sediment	Uranium-238	1.3
04LA-96-0054	Sediment	Uranium-238	1.2
04LA-96-0055	Sediment	Uranium-238	1.6
04LA-96-0056	Sediment	Uranium-238	1.7
04PU-96-0010	Sediment	Uranium-238	0.74
04PU-96-0011	Sediment	Uranium-238	0.84
04PU-96-0012	Sediment	Uranium-238	1.5
04PU-96-0013	Sediment	Uranium-238	1.1
04PU-96-0014	Sediment	Uranium-238	0.06 (U)
04PU-96-0015	Sediment	Uranium-238	1.2
04PU-96-0016	Sediment	Uranium-238	1.3
04PU-96-0017	Sediment	Uranium-238	0.51
04PU-96-0018	Sediment	Uranium-238	1.7
04PU-96-0019	Sediment	Uranium-238	1.5 (U)

*U = The result is not detected at the concentration reported.

Table C-2.0-2
Background Study Statistics

Analyte	Media	Number of Alpha Progeny	Number of Beta Progeny
Potassium-40	Sediment	0	1
Thorium-232	Sediment	6	4
Uranium-235	Sediment	7	4
Uranium-238	Sediment	8	6

Table C-2.0-3
Background Study Sample Results Summation

Sample ID	Matrix	Total Alpha (pCi/g)	Beta (pCi/g) from Potassium-40	Beta (pCi/g) from Decay Chain	Total Beta (pCi/g)
04GU-96-0001	Sediment	19.88	31	15.04	46.04
04GU-96-0002	Sediment	22.85	28.38	17.4	45.78
04GU-96-0003	Sediment	19.22	30.11	14.6	44.71
04GU-96-0004	Sediment	22.39	28.59	16.84	45.43
04GU-96-0005	Sediment	12.66	29.91	9.52	39.43
04GU-96-0006	Sediment	22.21	29.28	16.72	46
04GU-96-0007	Sediment	15.5	24.21	11.76	35.97
04LA-96-0050	Sediment	19.64	30.37	15	45.37
04LA-96-0051	Sediment	11.66	24.57	8.7	33.27
04LA-96-0052	Sediment	27.94	32.86	21.32	54.18
04LA-96-0053	Sediment	17.93	32.79	13.6	46.39
04LA-96-0054	Sediment	17.52	33.65	13.2	46.85
04LA-96-0055	Sediment	24.12	33.53	18.12	51.65
04LA-96-0056	Sediment	24.04	29.39	18.2	47.59
04PU-96-0010	Sediment	10.94	35.1	8.24	43.34
04PU-96-0011	Sediment	12.36	31.85	9.32	41.17
04PU-96-0012	Sediment	20.22	30.12	15.44	45.56
04PU-96-0013	Sediment	16.58	32.75	12.48	45.23
04PU-96-0014	Sediment	8.22	31.76	5.52	37.28
04PU-96-0015	Sediment	15.54	30.41	11.92	42.33
04PU-96-0016	Sediment	17.26	26.98	13.2	40.18
04PU-96-0017	Sediment	7.95	26.08	5.94	32.02
04PU-96-0018	Sediment	24.5	26.03	18.56	44.59
04PU-96-0019	Sediment	22.2	25.53	16.76	42.29

Table C-2.0-4
Background Study UTL Calculations

Analytes	Calculation	UTL at 95% Confidence (pCi/g)
Decay Chain Isotopic Alpha Emitters	19.31 + (5.825 × 1.714)	29.3
Decay Chain Istopic Beta Emitters	13.64 + (4.161 ×1.714)	20.8
Potassium-40 Beta	29.80 + (3.029 × 1.714)	35.0

Table C-3.0-1
Gross Alpha and Gross Beta Results in MDA AB Sediments

Year	Analyte	Location Name	Result (pCi/g)
2001	Gross alpha	MDA AB-1	7.77
2001	Gross alpha	MDA AB-1	14
2001	Gross alpha	MDA AB-10	7.6
2001	Gross alpha	MDA AB-11	21.2
2001	Gross alpha	MDA AB-2	22.7
2001	Gross alpha	MDA AB-3	15.8
2001	Gross alpha	MDA AB-3N	25.2
2001	Gross alpha	MDA AB-4	19.6
2001	Gross alpha	MDA AB-4A	22.5
2001	Gross alpha	MDA AB-5	19.2
2001	Gross alpha	MDA AB-6	9.31
2001	Gross alpha	MDA AB-7	9.09
2001	Gross alpha	MDA AB-8	8.9
2001	Gross alpha	MDA AB-9	22.6
2001	Gross beta	MDA AB-1	36.3
2001	Gross beta	MDA AB-1	31.4
2001	Gross beta	MDA AB-10	37.8
2001	Gross beta	MDA AB-11	36.8
2001	Gross beta	MDA AB-2	33.2
2001	Gross beta	MDA AB-3	33
2001	Gross beta	MDA AB-3N	38.6
2001	Gross beta	MDA AB-4	32.1
2001	Gross beta	MDA AB-4A	31.6
2001	Gross beta	MDA AB-5	39.3
2001	Gross beta	MDA AB-6	30.4
2001	Gross beta	MDA AB-7	33.5
2001	Gross beta	MDA AB-8	35.1
2001	Gross beta	MDA AB-9	44.3

Table C-3.0-1 (continued)

Year	Analyte	Location Name	Result (pCi/g)
2002	Gross alpha	MDA AB-1	24.5
2002	Gross alpha	MDA AB-10	8.81
2002	Gross alpha	MDA AB-11	17.7
2002	Gross alpha	MDA AB-2	13.3
2002	Gross alpha	MDA AB-3	26.9
2002	Gross alpha	MDA AB-4	18
2002	Gross alpha	MDA AB-4A	24.5
2002	Gross alpha	MDA AB-5	14.5
2002	Gross alpha	MDA AB-6	10.5
2002	Gross alpha	MDA AB-7	10.8
2002	Gross alpha	MDA AB-8	14.6
2002	Gross alpha	MDA AB-9	20.3
2002	Gross beta	MDA AB-1	11.9
2002	Gross beta	MDA AB-10	30.9
2002	Gross beta	MDA AB-11	32
2002	Gross beta	MDA AB-2	8.22
2002	Gross beta	MDA AB-3	11.9
2002	Gross beta	MDA AB-4	28.6
2002	Gross beta	MDA AB-4A	36.9
2002	Gross beta	MDA AB-5	35.9
2002	Gross beta	MDA AB-6	27.3
2002	Gross beta	MDA AB-7	39.9
2002	Gross beta	MDA AB-8	38.6
2002	Gross beta	MDA AB-9	10.4
2003	Gross alpha	MDA AB-1	14.5
2003	Gross alpha	MDA AB-10	8.04
2003	Gross alpha	MDA AB-11	2.91
2003	Gross alpha	MDA AB-2	15.6
2003	Gross alpha	MDA AB-3	16.1
2003	Gross alpha	MDA AB-4	13.4
2003	Gross alpha	MDA AB-4A	8.2
2003	Gross alpha	MDA AB-5	10.4
2003	Gross alpha	MDA AB-6	4.62
2003	Gross alpha	MDA AB-7	6.45
2003	Gross alpha	MDA AB-8	6.41
2003	Gross alpha	MDA AB-9	13.3
2003	Gross beta	MDA AB-1	37.3
2003	Gross beta	MDA AB-10	26.3
2003	Gross beta	MDA AB-11	21.6

Table C-3.0-1 (continued)

Year	Analyte	Location Name	Result (pCi/g)
2003	Gross beta	MDA AB-2	25.8
2003	Gross beta	MDA AB-3	31.8
2003	Gross beta	MDA AB-4	28.3
2003	Gross beta	MDA AB-4A	23.3
2003	Gross beta	MDA AB-5	30.9
2003	Gross beta	MDA AB-6	24.3
2003	Gross beta	MDA AB-7	30.9
2003	Gross beta	MDA AB-8	31.7
2003	Gross beta	MDA AB-9	27.5
2004	Gross alpha	MDA AB-1	21.3
2004	Gross alpha	MDA AB-10	15.4
2004	Gross alpha	MDA AB-11	17.8
2004	Gross alpha	MDA AB-2	14.1
2004	Gross alpha	MDA AB-3	17
2004	Gross alpha	MDA AB-4	19.2
2004	Gross alpha	MDA AB-4A	19.6
2004	Gross alpha	MDA AB-5	12.8
2004	Gross alpha	MDA AB-6	9.89
2004	Gross alpha	MDA AB-7	11.2
2004	Gross alpha	MDA AB-8	7.42
2004	Gross alpha	MDA AB-9	22.5
2004	Gross beta	MDA AB-1	35.1
2004	Gross beta	MDA AB-10	34.7
2004	Gross beta	MDA AB-11	42
2004	Gross beta	MDA AB-2	24.4
2004	Gross beta	MDA AB-3	31.1
2004	Gross beta	MDA AB-4	29.6
2004	Gross beta	MDA AB-4A	32.8
2004	Gross beta	MDA AB-5	29.9
2004	Gross beta	MDA AB-6	24.7
2004	Gross beta	MDA AB-7	33.4
2004	Gross beta	MDA AB-8	31.7
2004	Gross beta	MDA AB-9	35.9