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Phase II Investigation Work Plan for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary

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Responsible project manager:

Stephani Fuller		Project Manager	Environmental Programs	3/15/11
Printed Name	Signature	Title	Organization	Date

Responsible LANS representative:

Michael J. Graham		Associate Director	Environmental Programs	3/16/11
Printed Name	Signature	Title	Organization	Date

Responsible DOE representative:

George J. Rael		Manager	DOE-LASO	3-17-2011
Printed Name	Signature	Title	Organization	Date

EXECUTIVE SUMMARY

Technical Area 49 sites inside the nuclear environmental site boundary consist of 11 solid waste management units (SWMUs) and areas of concern (AOCs) at Los Alamos National Laboratory. Of the 11 sites, 1 site has been approved for no further action (AOC 49-009). At each of the 10 remaining sites, previous investigations did not define the extent of contamination for one or more contaminants. This Phase II investigation work plan identifies and describes the additional sampling activities needed to complete the investigation of the remaining eight SWMUs [49-001(a, b, c, d, e, f, g) and 49-003] and two AOCs [49-008(c, d)].

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1.0 INTRODUCTION

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

The Laboratory 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 Laboratory’s efforts is to ensure past operations do not threaten human or environmental health and safety in and around Los Alamos County, New Mexico. To achieve this goal, the Laboratory is currently investigating sites potentially contaminated by past Laboratory operations. These sites are designated as either solid waste management units (SWMUs) or areas of concern (AOCs).

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

Corrective actions at the Laboratory are subject to a Compliance Order on Consent (the Consent Order). This Phase II investigation work plan describes work activities that will be executed and completed in accordance with the Consent Order.

1.1 Work Plan Overview

Technical Area 49 (TA-49), also known as the Frijoles Mesa site, occupies approximately 1280 acres along the south-central boundary of the Laboratory (Figure 1.1-1). The TA-49 sites inside the nuclear environmental site (NES) boundary consist of 11 SWMUs and AOCs located within 8 areas (Figure 1.1-2). The status of each site is presented in Table 1.1-1. One AOC (49-009) was previously approved for no further action by the U.S. Environmental Protection Agency (EPA) (2005, 088464). The surface investigation at AOC 49-008(c) is deferred per Table IV-2 of the Consent Order; however, subsurface samples were collected at AOC 49-008(c) during the 2010 investigation. This Phase II investigation work plan identifies and describes the activities needed to complete the investigation of the remaining eight SWMUs and two AOCs [other than the surface investigation of AOC 49-008(c)] based on the results from previous investigations.

Section 2 provides summaries of previous investigations and data collected and presents the scope of proposed activities for each site. Section 3 discusses the vertical extent evaluation of shallow Qbt 4 samples and the proposed Qbt 4 background study. Section 4 describes investigation methods for proposed field activities. Ongoing monitoring and sampling programs at TA-49 are summarized in section 5. Section 6 is an overview of the anticipated schedule of the investigation and reporting activities. The references cited in this Phase II investigation work plan and the map data sources are provided in section 7. Appendix A of this work plan includes a list of acronyms and abbreviations, a metric conversion table, and data qualifier definitions. Appendix B describes the management of investigation-derived waste (IDW).

1.2 Work Plan Objectives

The objective of this Phase II investigation work plan is to complete the determination of the extent of contamination at 10 sites:

- SWMU 49-001(a) in Area 1—lateral extent of plutonium-238 and lateral and vertical extent of cesium-134
- SWMUs 49-001(b, c, d, g) in Areas 2, 2A, and 2B (Material Disposal Area [MDA] AB)—lateral extent of lead, vertical extent of americium-241 and plutonium-238, and lateral and vertical extent of plutonium-239/240
- SWMU 49-001(e) in Area 3—vertical extent of arsenic and cesium-137 and lateral and vertical extent of copper, lead, and cesium-134
- SWMU 49-001(f) in Area 4—lateral and vertical extent of chromium
- SWMU 49-003 and AOC 49-008(c) in Area 11—lateral and vertical extent of perchlorate and tritium
- AOC 49-008(d) in Area 12—vertical extent of antimony and plutonium-239/240 and lateral and vertical extent of thallium

To accomplish these objectives, this Phase II investigation work plan

- presents summaries of site background and current site conditions;
- describes the rationale and proposed scope of activities for each site, based on the results and recommendations in the approved investigation report (LANL 2010, 110656.17; NMED 2010, 111226);
- identifies and proposes appropriate methods and protocols for collecting, analyzing, and evaluating data to finalize characterization of these sites; and
- provides a proposed schedule for conducting investigation activities and reporting results.

1.3 Cleanup Levels

NMED soil screening levels (SSLs) (NMED 2009, 108070) or LANL screening action levels (LANL 2009, 107655) will be used as soil cleanup levels unless they are determined to be impractical or unless values do not exist for the current and reasonably foreseeable future land-use scenarios. If NMED SSLs do not exist, EPA regional screening values will be used (http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm).

1.4 Site Conditions

Surface and subsurface features and geologic characteristics of TA-49 in the vicinity of sites inside the NES boundary are described in detail in the approved investigation work plan (LANL 2008, 102691; NMED 2008, 100464). Conditions at the sites included in this Phase II investigation work plan are predominantly influenced by

- a semiarid climate with low precipitation and a high evapotranspiration rate that limits the extent of subsurface moisture percolation and therefore the amount of moisture available to transport radionuclides or hazardous waste constituents in the subsurface, and
- a thick, relatively dry unsaturated (vadose) zone that greatly restricts or prevents downward migration of contaminants to the regional aquifer.

Topographically, the area consists of a mesa top centrally located on the Pajarito Plateau at an average elevation of approximately 7140 ft amsl. The TA-49 sites inside the NES boundary addressed in this Phase II investigation work plan are located within the Ancho and Water canyons watersheds.

These and other elements of the environmental setting at TA-49 are considered when evaluating investigation data with respect to the fate and transport of contaminants.

1.5 Operational History

Between 1959 and 1961, hydronuclear and related experiments that deposited plutonium, uranium, lead, and beryllium in underground shafts took place at TA-49. These experiments were conducted in subsurface shafts located at MDA AB (Areas 2, 2A, and 2B) and Areas 1, 3, and 4 (Figure 1.1-2). These areas are the subject of the investigation of the TA-49 sites inside the NES boundary (LANL 2010, 110656.17; NMED 2010, 111226). Investigation results for TA-49 sites outside the NES boundary were presented in a separate investigation report (LANL 2010, 110654.16; NMED 2010, 110859).

Area 11 is the site of a former radiochemistry laboratory, associated leach field, and subsurface test-shot area. Area 12 includes the former Bottle House and Cable Pull Test Facility (CPTF). Sporadic and noncontinuous areas of surface soil contaminated with hazardous and radioactive materials have historically been associated with each area.

2.0 SITE DESCRIPTIONS AND PROPOSED INVESTIGATION ACTIVITIES

This section presents a brief description and operational history, summary of the nature and extent of contamination, and proposed investigation activities for each TA-49 site inside the NES boundary requiring additional investigation. More complete descriptions of the sites and previous investigations are presented in the approved investigation work plan (LANL 2008, 102691; NMED 2087, 100464) and the approved investigation report (LANL 2010, 110656.17; NMED 2010, 111226). Additional sampling proposed in this section is based upon the results of the approved investigation report (LANL 2010, 110656.17; NMED 2010, 111226).

2.1 SWMU 49-001(a), Experimental Shafts

2.1.1 Site Description and Operational History

SWMU 49-001(a), known as Area 1, consists of experimental shafts located in the northwest corner of the MDA AB NES boundary at TA-49 (Figure 2.1-1). Twenty-two shafts were drilled at Area 1 within a 100 ft × 100 ft area to depths ranging from 31 to 85 ft below ground surface (bgs). Ten of the 22 shafts were used for shot testing using radioactive materials, 5 of the shafts were used for containment testing using high explosives (HE) only, 6 of the shafts were not used and were backfilled, and 1 shaft was used as a gas-expansion hole. Substantial amounts of lead generally were present in the experimental packages, and small amounts of beryllium may have been used in some experiments (LANL 2007, 098492).

2.1.2 Nature and Extent of Contamination

The approved investigation report (LANL 2010, 110656.17; NMED 2010, 111226) concluded that nature and extent had been defined for all chemicals and radionuclides detected at SWMU 49-001(a), except for the following:

- lateral extent of plutonium-238 to the south and west of location 49-611038 (overland corridor location)
- lateral and vertical extent of cesium-134 at location 49-610288 (lateral extent is not defined to the south and west of this location)

Sampling locations and results for radionuclides detected or detected above background values (BVs) or fallout values (FVs) are shown on Plate 1 for the overland corridors and on Plate 2 for SWMU 49-001(a). Locations of the overland corridors are shown on Figure 1.1-2.

2.1.3 Proposed Activities at SWMU 49-001(a)

Two new boreholes (locations 1a-1 and 1a-2) will be drilled west and south of overland corridor location 49-611038 to define the lateral extent of plutonium-238. Samples will be collected from 0 to 1 ft, 3 to 4 ft, and 6 to 7 ft bgs and analyzed for plutonium-238.

Subsurface samples will be collected at previously sampled location 49-610288, extending the depth at this sampling location to define the vertical extent of cesium-134. Samples will be collected from 3 to 4 ft and 6 to 7 ft bgs (1.5 and 4.5 ft below the deepest 2010 sample depth). In addition, two new boreholes (locations 1a-3 and 1a-4) will be drilled west and south of location 49-610288 to define the lateral extent of cesium-134. Samples will be collected from 0 to 1 ft, 3 to 4 ft, and 6 to 7 ft bgs. All samples will be analyzed for cesium-134.

Proposed sampling locations for SWMU 49-001(a) are shown in Figure 2.1-2 for the overland corridors and Figure 2.1-3 for SWMU 49-001(a). Table 2.1-1 summarizes the proposed sampling locations, depths, and analyses.

2.2 MDA AB [SWMUs 49-001(b, c, d, g)]

2.2.1 Site Description and Operational History

In the approved work plan (LANL 2008, 102215), SWMUs 49-001(b, c, d, g) are referred to as MDA AB (Figure 2.2-1). With the exception of SWMU 49-001(g), all of the SWMUs are associated with hydronuclear and related experiments conducted at TA-49 from late 1959 to mid-1961. These experiments were conducted in underground shafts (typically 6 ft in diameter) drilled into the tuff at Areas 1, 2, 2A, 2B, 3, and 4 and involved the use of HE and radioactive materials, such as special nuclear materials (plutonium-239 and uranium-235). SWMU 49-001(g) is a site of contaminated surface soil associated with Area 2 activities (LANL 2007, 098492). Before being used for hydronuclear experiments, some of the shafts were used to conduct containment shots using HE without radioactive materials (LANL 1992, 007670, pp. 7-18–7-19).

2.2.2 Nature and Extent of Contamination

The approved investigation report (LANL 2010, 110656.17; NMED 2010, 111226) concluded that nature and extent had been defined for all chemicals and radionuclides detected at MDA AB, except for the following:

- Lateral extent of lead to the north of location 49-610943
- Vertical extent of americium-241 at location 49-610151
- Vertical extent of plutonium-238 at location 49-610151
- Vertical extent of plutonium-239/240 at location 49-610151 and lateral extent of plutonium-239/240 to the east of location 49-610131

Although the investigation report noted that americium-241 and plutonium-239/240 activities increased with depth at locations 49-610890 and 49-610894, the report did not explicitly state whether vertical extent was defined. Vertical extent of americium-241 and plutonium-239/240 at these sampling locations (sampling depths 0 to 0.5 ft and 0.5 to 1.5 ft bgs) is defined by nondetected results in nearby 130-ft-deep borehole location 49-610943 (Plate 4). Similarly, the investigation report noted that plutonium-239/240 activities increased with depth at location 49-610131, but did not state whether vertical extent was defined. Vertical extent at this sampling location (sampling depths 0 to 0.5 ft and 0.5 to 1.5 ft bgs) is also defined by nondetected results in nearby 130-ft-deep borehole location 49-610943 (Plate 4).

Sampling locations and results for inorganic chemicals detected above BVs and radionuclides detected or detected above BVs/FVs are shown on Plates 3 and 4, respectively.

2.2.3 Proposed Activities at MDA AB [SWMUs 49-001(b, c, d, g)]

One new borehole (location 1g-1) will be drilled north of location 49-610943 to define the lateral extent of lead. Samples will be collected from 11 to 12 ft and 14 to 15 ft bgs and analyzed for lead.

Subsurface samples will be collected at previously sampled location 49-610151, extending the depth at this sampling location to define the vertical extent of americium-241, plutonium-238, and plutonium-239/240. Samples will be collected from 3 to 4 ft and 6 to 7 ft bgs (1.5 and 4.5 ft below the deepest 2010 sampling depth). All samples will be analyzed for americium-241, plutonium-238, and plutonium-239/240. In addition, one new borehole (location 1b-1) will be drilled east of location 49-610131 to define the lateral extent of plutonium-239/240. Samples will be collected from 0 to 1 ft, 3 to 4 ft, and 6 to 7 ft bgs and analyzed for plutonium 239/240.

Proposed sampling locations for MDA AB are shown in Figure 2.2-2. Table 2.2-1 summarizes proposed sampling locations, depths, and analyses.

2.3 SWMU 49-001(e), Experimental Shafts

2.3.1 Site Description and Operational History

SWMU 49-001(e), known as Area 3, consists of experimental shafts located in the southwest corner of the MDA AB NES boundary (Figure 2.3-1). Area 3 is approximately 100 ft long × 100 ft wide. Thirteen shafts, ranging between 57 and 142 ft deep, were drilled in a grid-like pattern in a 100 ft × 100 ft area. Seven of the shafts were shot with a tracer, four of the shafts were used for containment shots, and the remaining two shafts were not used and backfilled (LANL 2007, 098492). Area 3 was used exclusively for developing confinement and sample-recovery techniques used in the other experimental areas.

2.3.2 Nature and Extent of Contamination

The approved investigation report (LANL 2010, 110656.17; NMED 2010, 111226) concluded that nature and extent had been defined for all chemicals and radionuclides detected at SWMU 49-001(e), except for the following:

- Vertical extent of arsenic at location 49-609317
- Lateral and vertical extent of copper at overland corridor location 49-610026 (lateral extent not defined to the south of this location)
- Lateral and vertical extent of lead at location 49-609329 (lateral extent not defined to the south and west of this location); vertical extent of lead at location 49-609317
- Lateral and vertical extent of cesium-134 at location 49-609336 (lateral extent not defined to the north and east of this location)
- Vertical extent of cesium-137 at locations 49-609324, 49-609328, and 49-609330 and overland corridor location 49-610013

Sampling locations and results for inorganic chemicals detected above BVs are shown on Plate 5 for the overland corridors and Plate 6 for SWMU 49-001(e). Radionuclides detected or detected above BVs/FVs are shown on Plate 2 for overland corridor locations and on Plate 7 for locations at SWMU 49-001(e).

2.3.3 Proposed Activities at SWMU 49-001(e)

Subsurface samples will be collected at previously sampled locations 49-609317, 49-609324, 49-609328, 49-609329, 49-609330, and 49-609336 and previously sampled overland corridor locations 49-610013 and 49-610026, extending the depth at each sampling location to define the vertical extent of arsenic, lead, copper, cesium-134, and/or cesium-137. Samples will be collected from 3 to 4 ft bgs and 6 to 7 ft bgs (1.5 and 4.5 ft below the deepest 2010 sample depth). Samples will be analyzed as follows:

- Samples collected from location 49-609317 will be analyzed for arsenic and lead.
- Samples collected from location 49-609329 will be analyzed for lead.
- Samples collected from overland corridor location 49-610026 will be analyzed for copper.
- Samples collected from location 49-609336 will be analyzed for cesium-134.
- Samples collected from locations 49-609324, 49-609328, and 49-609330 and overland corridor location 49-610013 will be analyzed for cesium-137.

One new borehole (location 1e-1) will be drilled south of overland corridor location 49-610026 to define the lateral extent of copper. Samples will be collected from 0 to 1 ft, 3 to 4 ft, and 6 to 7 ft bgs and will be analyzed for copper.

Two new boreholes (locations 1e-2 and 1e-3) will be drilled south and west of location 49-609329 to define the lateral extent of lead. Samples will be collected from 0 to 1 ft, 3 to 4 ft, and 6 to 7 ft bgs and will be analyzed for lead.

Two new boreholes (locations 1e-4 and 1e-5) will be drilled north and east of location 49-609336 to define the lateral extent of cesium-134. Samples will be collected from 0 to 1 ft, 3 to 4 ft, and 6 to 7 ft bgs and will be analyzed for cesium-134.

Proposed sampling locations for SWMU 49-001(e) are shown in Figure 2.1-2 for the overland corridors. and Figure 2.3-2 for SWMU 49-001(e). Table 2.3-1 summarizes proposed sampling locations, depths, and analyses.

2.4 SWMU 49-001(f), Experimental Shafts

2.4.1 Site Description and Operational History

SWMU 49-001(f), known as Area 4, consists of experimental shafts located in the southeast corner of the MDA AB NES boundary (Figure 2.4-1). Area 4 was designed to contain 26 shafts on a uniform grid, but only 21 shafts were drilled in a 100 ft × 100 ft area. The 21 shafts drilled at Area 4 ranged between 58 and 108 ft deep. Thirteen of the shafts were shot with radioactive material, one shaft was used for containment testing, one shaft was used as a gas-expansion hole, three shafts were used for disposal of debris, and the remaining three shafts were not used and were backfilled (LANL 2007, 098492).

2.4.2 Nature and Extent of Contamination

The approved investigation report (LANL 2010, 110656.17; NMED 2010, 111226) concluded that nature and extent had been defined for all chemicals and radionuclides detected at SWMU 49-001(f), except for the following:

- Lateral and vertical extent of chromium at location 49-609682 (lateral extent not defined to the north and west of this location)
- Vertical extent of tritium at location 49-610940

The conclusion that vertical extent of tritium was not defined at location 49-610940 was based on a slight increase of tritium activity from 0.255 pCi/g at a depth of 110 to 113 ft bgs (sample RE49-10-8982) to 0.288 pCi/g at a depth of 156 to 158 ft bgs (sample RE49-10-8993). In reviewing the laboratory analytical results, however, it was noted that the analytical laboratory reported a one-sigma total propagated uncertainty of 0.074 pCi/g for these results. Because this uncertainty is larger than the difference between the two sample results (0.033 pCi/g), the results do not provide a definite indication of increasing activity with depth. Therefore, vertical extent of tritium is defined at this location.

Sampling locations and results for inorganic chemicals detected above BVs at SWMU 49-001(f) are shown on Plate 8.

2.4.3 Proposed Activities at SWMU 49-001(f)

Subsurface samples will be collected at previously sampled location 49-609682, extending the depth at this sampling location to define the vertical extent of chromium. Samples will be collected from 3 to 4 ft and 6 to 7 ft bgs (1.5 and 4.5 ft below the deepest 2010 sample depth). In addition, two new boreholes (locations 1f-1 and 1f-2) will be drilled north and west of location 49-609682 to define the lateral extent of chromium. Samples will be collected from 0 to 1 ft, 3 to 4 ft, and 6 to 7 ft bgs. All samples will be analyzed for chromium.

Proposed sampling locations at SWMU 49-001(f) are shown in Figure 2.4-2. Table 2.4-1 summarizes the proposed sampling locations, depths, and analyses.

2.5 SWMU 49-003, Inactive Drain Field and Associated Drainlines

2.5.1 Site Description and Operational History

SWMU 49-003 is an inactive drain field and associated drainlines at Area 11 within the northern MDA AB NES boundary (Figure 2.5-1). The drain field is located approximately 20 to 25 ft east of the location of former building 49-15 and was connected to the former building by a drainline. The drain field is constructed of vitrified clay pipe installed in gravel bedding. Former building 49-15 housed a radiochemistry laboratory and change house. The former building 49-15 laboratory was used to analyze samples collected during the experiments conducted in the experimental shafts at Areas 2, 2A, 2B, and 4. Perchlorate was reportedly used in the former laboratory. The estimated total volume of wastewater discharged to the drain field was less than several hundred gallons and less than 50 gal. of organic chemicals. Former building 49-15 and related structures including latrines, a storage building, and propane and butane tanks in Area 11 were decontaminated, demolished, and removed in 1970 and 1971; the drain field and drainlines were left in place (LANL 1992, 007670, pp. 6 2–6-6; LANL 2007, 098492).

2.5.2 Nature and Extent of Contamination

The approved investigation report (LANL 2010, 110656.17; NMED 2010, 111226) concluded that nature and extent had been defined for all chemicals and radionuclides detected at SWMU 49-003, except for the following:

- Lateral and vertical extent of perchlorate
- Lateral and vertical extent of tritium at location 49-610496 (lateral extent is not defined to the south and west of this location)

The investigation report did not specifically identify where lateral and vertical extent of perchlorate were not defined, other than to note that perchlorate was detected in seven samples, and concentrations increased with depth at locations 49-610496 and 49-610498. Vertical extent is not defined at location 49-610496 because concentrations increased with depth, and the deeper result is above the estimated quantitation limit (EQL). Vertical extent is defined at location 49-610498 because perchlorate was only detected in the deepest sample, and the result is below the EQL. Perchlorate was also detected above the EQL at locations 49-610497 and 49-610500. Concentrations decreased laterally, except to the south of location 49-610496, to the east of location 49-6610497, and to the north and west of location 49-610500, where there were no other sampling locations. Lateral extent of perchlorate is not defined to the south of location 49-610496, to the east of location 49-610497, and to the north and west of location 49-610500.

The investigation report notes that lateral extent of tritium is not defined to the west of location 49-610496 because activities increased to the west at location 49-610493. The latter sampling location is associated with AOC 49-008(c), and tritium activities decreased further to the west at locations 49-610492 and 49-610495. Therefore, lateral extent of tritium is defined to the west of location 49-610496.

Sampling locations and results for inorganic chemicals detected above BVs and radionuclides detected or detected above BVs/FVs are shown on Plates 9 and 10, respectively.

2.5.3 Proposed Activities at SWMU 49-003

Subsurface samples will be collected at previously sampled location 49-610496, extending the depth at this sampling location to define the vertical extent of perchlorate and tritium. Samples will be collected from 12 to 13 ft and 15 to 16 ft bgs (2 and 5 ft below the deepest 2010 sample depth). All samples will be analyzed for perchlorate and tritium.

To determine the lateral extent of perchlorate, samples will be collected just outside the drain field boundary from one new borehole (location 3-1) south of location 49-610496, one new borehole (location 3-2) east of location 49-610497, and from two new boreholes (locations 3-3 and 3-4) north and west of location 49-610500. At each new borehole location, samples will be collected at the same depth intervals as the corresponding 2010 sampling locations where lateral extent was not defined: 0 to 2 ft and 8 to 10 ft bgs at new location 3-1; 0 to 2 ft, 13 to 15 ft, and 18 to 20 ft bgs at new location 3-2; and 0 to 2 ft, 8 to 10 ft, and 18 to 20 ft bgs at new locations 3-3 and 3-4. Additionally, a sample will be collected at 15 to 16 ft bgs at new location 3-1 to correspond to the deeper vertical extent sample to be collected at location 49-610496. All samples will be analyzed for perchlorate.

To determine the lateral extent of tritium, samples will be collected from one new borehole (location 3-1) south of location 49-610496 just outside the drain field boundary. Samples will be collected from 0 to 2 ft, 8 to 10 ft, and 15 to 16 ft bgs. All samples will be analyzed for tritium.

Proposed sampling locations at SWMU 49-003 are shown in Figure 2.5-2. Table 2.5-1 summarizes proposed sampling locations, depths, and analyses.

2.6 AOC 49-008(c), Area of Potential Soil Contamination

2.6.1 Site Description and Operational History

AOC 49-008(c) consists of an area of potentially contaminated soil from historical radiochemistry operations and small-scale containment experiments at Area 11 within the northern portion of the MDA AB NES boundary (Figure 2.5-1). Area 11 is an approximately 220 ft × 300 ft area. Activities conducted at Area 11 from 1959 to 1961 supported hydronuclear experiments conducted elsewhere at TA-49 (LANL 1992, 007670). Radiochemistry operations were conducted in a former laboratory and change house (former building 49-15) that was the main structure at Area 11. Other structures included a small storage building, latrines, and butane and propane tanks. The former building 49-15 laboratory was used to analyze samples collected during experiments in the experimental shafts at Areas 2, 2A, 2B, and 4. Laboratory processes included sample dissolution in acids (nitric, hydrochloric, hydrofluoric, sulfuric, and perchloric) and solvent extraction using methyl isobutyl ketone, ammonium hydroxide, and sodium hydroxide. Wastes generated during radiochemical operations were typically collected in containers and taken to radioactive waste disposal facilities elsewhere at the Laboratory. Interim waste storage boxes were stored south of former building 49-15. Some liquid wastes reportedly discharged to a drain field (SWMU 49-003). Small-scale containment experiments were conducted in 13 underground shafts located on the west side of Area 11. These shafts were drilled to a depth of 12 ft and lined with 10-in.-diameter steel casing. HE was placed in the shafts, which were backfilled to contain the explosions. Small amounts of irradiated uranium-238 tracer were used in some experiments. The structures in Area 11 were decontaminated and removed in 1970 and 1971. Contamination was detected in sinks, ducts, and hoods in former building 49-15. Contaminated debris was removed and disposed of at TA-54, and uncontaminated debris (approximately 2160 ft^3) was taken to the open-burning/landfill area at Area 6 (SWMU 49-004) (LANL 2007, 098492).

2.6.2 Nature and Extent of Contamination

The approved investigation report (LANL 2010, 110656.17; NMED 2010, 111226) concluded that nature and extent had been defined for all chemicals and radionuclides detected at AOC 49-008(c), except for the following:

- Lateral and vertical extent of perchlorate
- Vertical extent of tritium at location 49-610493 and lateral extent of tritium to the north, east, south and west of locations 49-610489 and 49-610490 at the small-scale shot area

The investigation report did not specifically identify where lateral and vertical extent of perchlorate were not defined, other than to note that perchlorate was detected in nine samples, and concentrations increased with depth at locations 49-610491, 49-610492, 49-610493, and 49-610494. Vertical extent is defined at locations 49-610491 and 49-610493 because all perchlorate results at these sampling locations are below the EQL. Vertical extent is not defined at locations 49-610492 and 49-610494 because concentrations increased with depth, and the deeper results are above the EQL. Concentrations are below EQLs or decrease laterally at all locations except 49-610494, where there is no sampling location to the south. Lateral extent of perchlorate is not defined to the south of location 49-610494.

Sampling locations and results for inorganic chemicals detected above BVs and radionuclides detected or detected above BVs/FVs are shown on Plates 9 and 10, respectively.

2.6.3 Proposed Activities at AOC 49-008(c)

Subsurface samples will be collected from previously sampled locations 49-610492 and 49-610494, extending the depth at each sampling location to define the vertical extent of perchlorate. Samples will be collected from 12 to 13 ft and 15 to 16 ft bgs (2 and 5 ft below the deepest 2010 sample depth) and analyzed for perchlorate.

One new borehole (location 8c-1) will be drilled south of location 49-610494 to define the lateral extent of perchlorate. Samples will be collected from the same depth intervals as the 2010 samples (0 to 2 ft and 8 to 10 ft bgs). Additionally, one sample will be collected from 15 to 16 ft bgs at new borehole location 8c-1 to correspond to the deeper vertical extent sample to be collected at location 49-610494. All samples will be analyzed for perchlorate.

Four new step-out boreholes (locations 8c-2, 8c-3, 8c-4, and 8c-5) will be drilled north, east, south, and west of the former small-scale containment experiment area to define the lateral extent of tritium. At step-out locations 8c-2, 8c-3, 8c-4, and 8c-5 samples will be collected from the same depth intervals (33 to 35 ft and 63 to 65 ft bgs) where tritium was detected in samples at locations 49-610489 and 49-610490. All samples will be analyzed for tritium.

Vertical extent of tritium at location 49-610493 will be defined by samples to be collected at nearby borehole 49-610496 (section 2.5.3).

Proposed sampling locations at AOC 49-008(c) are shown in Figure 2.5-2. Table 2.6-1 summarizes proposed sampling locations, depths, and analyses.

2.7 AOC 49-008(d), Bottle House and Cable Pull Test Facility

2.7.1 Site Description and Operational History

AOC 49-008(d) is an area consisting of potential soil contamination located within Area 12 in the northeast corner of the MDA AB NES boundary (Figure 2.7-1). Area 12 was used in 1960 and 1961 to conduct confinement experiments related to the hydronuclear experiments conducted at MDA AB. These experiments involved HE detonations in sealed metal bottles. The bottles measured up to 5 ft in diameter by 16 ft long and were placed in a 10-ft-diameter × 30-ft-deep underground shaft during the experiments. Former building 49-23, constructed over the shaft, was known as the Bottle House. Approximately 26 confinement experiments were conducted at Area 12 (LANL 1992, 007670, p. 6.6-3). After the confinement experiments at Area 12 ceased, Area 12 was used to conduct tests to determine the strength of cables used in other experiments. The CPTF, former building 49-121, was constructed approximately 60 ft south of former building 49-23 in the early or mid-1960s to perform these tests (LANL 1992, 007670, p. 3-9). The shaft in former building 49-23 was backfilled with crushed tuff, and a hydraulic system was installed in the building. Underground hydraulic lines were run to former building 49-121. The total fluid capacity of the hydraulic system was estimated to have been less than 10 gal. (LANL 2007, 098492). The Bottle House and CPTF were removed in February 2006 (Beguin 2007, 098607); neither polychlorinated biphenyls nor radioactivity above background levels were detected in any of the waste streams generated during decontamination and decommissioning activities (Beguin 2007, 098607). The site is currently used occasionally to support microwave experiments that involve portable equipment (LANL 2007, 098492).

2.7.2 Nature and Extent of Contamination

The approved investigation report (LANL 2010, 110656.17; NMED 2010, 111226) concluded that nature and extent had been defined for all chemicals and radionuclides detected at AOC 49-008(d), except for the following:

- Vertical extent of antimony and plutonium-239/240 at location 49-609903
- Lateral and vertical extent of thallium at locations 49-609909 (lateral extent not defined to the south and east of this location) and 49-609913 (lateral extent not defined to the north and east of this location)

Although the investigation report concludes that lateral and vertical extent of tritium are defined, results from pore-gas sampling showed tritium detected at 20,140 pCi/L in the deepest pore-gas sample at location 49-610481. This result, which is from a sample collected from 82 ft to 84 ft bgs, slightly exceeds the 20,000-pCi/L maximum contaminant level for pore-gas monitoring specified in the investigation work plan (LANL 2008, 102691, p. 46), and the investigation report recommended additional pore-gas monitoring at this sampling location. Based on further review of the data, however, this result is not consistent with the result from a sample collected 1 d later in the same borehole at 77 ft to 79 ft bgs. Tritium was detected at an activity of 9662 pCi/L in the latter sample. Given the short vertical distance between these samples, much closer results would be expected. Therefore, additional sampling at this location is needed to ascertain whether pore-gas monitoring is necessary.

Sampling locations and results for inorganic chemicals detected above BVs and radionuclides detected or detected above BVs/FVs are shown on Plates 11 and 12, respectively.

2.7.3 Proposed Activities at AOC 49-008(d)

Subsurface samples will be collected from previously sampled locations 49-609903, 49-609909, and 49-609913, extending the depth at each sampling location to define the vertical extent of antimony, thallium, and/or plutonium-239/240. Samples will be collected from 3 to 4 ft and 6 to 7 ft bgs (1.5 and 4.5 ft below the deepest 2010 sampling depth). Samples will be analyzed as follows:

- Samples collected from location 49-609903 will be analyzed for antimony and plutonium-239/240.
- Samples collected from locations 49-609909 and 49-609913 will be analyzed for thallium.

Four new step-out boreholes (locations 8d-1, 8d-2, 8d-3, and 8d-4) will be drilled to define the lateral extent of thallium. Borehole locations 8d-1 and 8d-2 will be drilled east and south of location 49-609909; borehole locations 8d-3 and 8d-4 will be drilled north and east of location 49-609913. Samples will be collected from 0 to 1 ft, 3 to 4 ft, and 6 to 7 ft bgs. All samples will be analyzed for thallium.

Borehole location 49-610481 will be resampled for tritium in pore gas. This borehole was originally advanced to a depth of 120 ft bgs for collection of core samples. Because of sloughing after the augers were removed, the borehole depth at the time of pore-gas sampling was 84 ft bgs. Pore-gas samples were collected at depth intervals of 29 to 31 ft, 77 to 79 ft, and 82 to 84 ft bgs, corresponding to the depth of the Bottle House shaft, the base of unit Qbt 4, and the bottom of the borehole (Plate 12). To define the vertical distribution of tritium at this location, the borehole will be redrilled to a depth of 120 ft bgs, and a pore-gas sample will be collected at the 118 to 120 ft bgs interval before the augers are withdrawn. Pore-gas samples will also be collected at the previously sampled depth intervals (29 to 31 ft, 77 to 79 ft, and 82 to 84 ft bgs).

Proposed sampling locations at AOC 49-008(d) are shown on Plate 13. Table 2.7-1 summarizes proposed sampling locations, depths, and analyses.

3.0 VERTICAL EXTENT IN SHALLOW QBT 4 SAMPLES

The results of the 2009–2010 investigation showed numerous cases, especially at Area 3 [SWMU 49-001(e)], where concentrations of inorganic chemicals were above BVs in shallow (0.5 to 1.5 ft bgs) Qbt 4 samples, but not in overlying soil samples. The investigation report indicated that the background concentrations of inorganic chemicals in Qbt 4 were likely higher than the Qbt 2, 3, 4 BVs, which are based on pooled data from tuff units Qbt 2, 3, and 4 (LANL 1998, 059730). The report concluded many of the Qbt 4 values were not elevated compared with background based on the results of scatter-plot analyses, and vertical extent was defined. The report recommended that a Qbt 4 background study be performed to establish BVs specifically for Qbt 4. A work plan for performing this study was prepared and has been approved by NMED (LANL 2010, 111504; NMED 2011, 111680).

Evaluation of existing, historical Qbt 4 data during preparation of the background study work plan indicated that the background concentrations of many inorganic chemicals in Qbt 4 appear to be higher than the Qbt 2, 3, 4 BVs, but not high enough to explain many of the results observed during the 2010 investigation. As a result, shallow holes were excavated at several locations where elevated Qbt 4 results were reported. Following the examination of the material excavated by a geologist, it appears that the material identified in sample collection logs (SCLs) as Qbt 4 may have been highly weathered tuff whose chemical characteristics are more similar to soil than tuff. The 2010 samples were collected from hand-auger cuttings, and this distinction may have been difficult to make at the time of sampling. Because the new Qbt 4 BVs may not totally explain the results of the 2010 investigation, undisturbed core samples will be collected from 0 to 3 ft bgs at 10 locations where inorganic chemicals were detected in shallow Qbt 4 samples above the Qbt 2, 3, 4 BVs but scatter-plot analyses indicated results were not elevated compared with background (LANL 2010, 110656.17). The core will be examined by a geologist to determine whether the material sampled should have been classified as soil and compared with soil BVs. The locations for collection of these core samples are presented in Table 3.0-1 and are shown on Plates 2, 5, and 6.

4.0 INVESTIGATION METHODS

A summary of the investigation methods to be implemented is presented in Table 4.0-1. The standard operating procedures (SOPs) used to implement these methods are available at http://www.lanl.gov/environment/all/qa.shtml. Summaries of the field-investigation methods are provided below. Additional procedures may be added as necessary to describe and document quality-affecting activities.

Sample analyses will be performed in accordance with the analytical statement of work (LANL 2008, 109962). Accredited contract analytical laboratories will use the most recent EPA- and industry-accepted extraction and analytical methods for analysis of the samples.

4.1 Establishing Sampling Locations

Proposed sampling locations are identified for each site based on engineering drawings, surveyed locations of existing structures (from the geographic information system database), previous sampling locations, and topography or other features identified in the field (e.g., drainage channels, sediment accumulation areas, etc.). The coordinates of proposed new sampling locations will be obtained by georeferencing the points from the proposed sampling maps. These coordinates will be located and flagged or otherwise marked in the field using a differential global positioning system (GPS) unit. If any proposed sampling locations are moved because of field conditions, utilities, or other unexpected reasons, the new locations will be surveyed immediately following sample collection as described in section 4.2.

4.2 Geodetic Surveys

Geodetic surveys will be conducted by a land surveyor in accordance with the latest version of SOP-5028, Coordinating and Evaluating Geodetic Surveys, to locate historical structures and to document field activities, such as sampling. The surveyors will use a Trimble GeoXT hand-held GPS or equivalent for the surveys. The coordinate values will be expressed in the New Mexico State Plane Coordinate System (transverse mercator), Central Zone, North American Datum 1983. Elevations will be reported per the National Geodetic Vertical Datum of 1929. All GPS equipment used will meet the accuracy requirements specified in SOP-5028.

4.3 Field Screening

Because sampling is primarily being conducted to define extent based on previous investigations, field screening will be conducted mainly for health and safety purposes. However, if elevated field-screening levels are observed for the deepest sample collected from a specific sampling location, sample collection will continue until field-screening results show no elevated readings. The Laboratory's proposed field-screening approach will be to (1) visually examine all samples for evidence of contamination, (2) screen for organic vapors, and (3) screen for radioactivity. The field-screening methods are discussed below.

4.3.1 Organic Vapors

Based on 2009–2010 site investigation results, substantial volatile organic compound contamination is not expected to be encountered, and organic vapor screening will be conducted primarily for health and safety purposes.

Screening will be conducted using a photoionization detector (PID) capable of measuring quantities as low as 1 ppm. Vapor screening of soil, sediment, and subsurface core for organic vapors will be conducted using a PID equipped with an 11.7-electron volt lamp. All samples will be screened for organic vapors in headspace gas in accordance with SOP-06.33, Headspace Vapor Screening with a Photo Ionization Detector. Field-screening results for organic vapors will be recorded on SCLs.

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

4.3.2 Radioactivity

Field screening for radioactivity will be conducted primarily for health and safety purposes. Radiological screening will target gross-alpha, -beta, and -gamma radiation. Field screening for alpha, beta, and gamma radiation will be conducted within 6 in. from the core material and will be performed using appropriate field instruments calibrated in accordance with the Laboratory's Health Physics Operations Group procedures. All instrument calibration activities will be documented daily in the field logbooks in accordance with SOP-5181, Notebook and Logbook Documentation for Environmental Directorate Technical and Field Activities. Field-screening results for radioactivity will be recorded on SCLs.

4.4 Sample Collection

Soil and tuff samples will be collected by the most efficient and least invasive method practicable. The methods will be determined by the field team based on site conditions such as topography, the nature of the material to be sampled, the depth intervals required, accessibility, and the level of disruption to Laboratory activities. Typically, samples will be collected using spade-and-scoop, hand-auger, or drill-rig methods.

Samples will be placed in appropriate containers in accordance with SOP-5056, Sample Containers and Preservation. Quality assurance/quality control (QA/QC) samples will include field duplicate and equipment rinsate samples. Field duplicate and rinsate samples will be collected at an overall frequency of at least 1 for every 10 regular samples as directed by the current version of SOP-5059, Field Quality Control Samples. QA/QC samples are used to monitor the validity of the sample collection procedures.

4.4.1 Surface Sampling

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

4.5 Subsurface Sampling

Subsurface samples will be collected using hand- or hollow-stem auger or direct-push methods, depending on the depth of the samples and the material being sampled. Brief descriptions of these methods are provided below.

4.5.1 Hand Auger

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

4.5.2 Direct Push

Direct push is a subsurface sampling method that pushes a tool string into the ground using the weight of a truck in combination with a hydraulic ram or hammer. Various tool strings can be used to collect discrete samples, continuous samples, both discrete and continuous samples, and groundwater samples. The direct-push core samples collected for this investigation will be continuous. The inside of the continuous sampler is exposed to the subsurface environment as it is advanced to the sampling interval. This is a dual-tube sampler, so named because it uses two sets of rods to collect soil cores. The outer rods receive the driving force from the hydraulic pushing method and provide a sealed hole from which soil samples may be recovered without cross-contamination or cave-in. The inner set of rods is placed within the outer rods and holds a sampler in place as the outer rods are driven to the sampling interval. The inner rods are then retracted to retrieve the soil core. The direct-push methods will follow the American Society of Testing and Materials (ASTM) D18 Subcommittee on Direct Push Sampling (D18.21.01) (ASTM 1997, 057511).

4.5.3 Hollow-Stem Auger

Hollow-stem augers are used to collect subsurface samples where hand-augering is impractical because of the depth or the material being sampled. The hollow-stem auger consists of a hollow-steel shaft with a continuous-spiraled-steel flight welded onto the exterior of the stem. The stem is connected to an auger bit; when the auger is rotated, it transports cuttings to the surface. The hollow stem of the auger allows insertion of drill rods, split-spoon core barrels, Shelby tubes, and other samplers through the center of the auger so samples may be retrieved during drilling operations.

During sampling, the auger is advanced to just above the desired sampling interval. The sample is collected by driving a split-spoon sampler into undisturbed soil/tuff to the desired depth in accordance with SOP-06.26, Core Barrel Sampling for Subsurface Earth Materials. All borehole cuttings will be managed as IDW, as described in Appendix B.

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

Borehole Abandonment

All hollow-stem auger boreholes will be abandoned in accordance with SOP-5034, Monitor Well and RFI Borehole Abandonment, by one of the following methods:

- Shallow boreholes, with a total depth of 20 ft or less, will be abandoned by filling the borehole with bentonite chips and then hydrating the chips in 1- to 2-ft lifts. The borehole will be visually inspected as the bentonite chips are being added to ensure 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 grout will be documented in a field logbook with respect to volumes (calculated and actual), intervals of placement, and additives used to enhance backfilling. All borehole abandonment information will be presented in the Phase II investigation report.

4.6 Quality Assurance/Quality Control Samples

QA/QC samples will include field duplicate and equipment rinsate samples. Field duplicate and rinsate samples will be collected at an overall frequency of at least 1 for every 10 regular samples as directed by the current version of SOP-5059, Field Quality Control Samples.

4.7 Chain of Custody for Samples

The collection, screening, and transport of samples will be documented on standard forms generated by the Laboratory's Sample Management Office (SMO). These include SCLs, chain-of-custody (COC) forms, and sample container labels. The SCLs will be completed at the time of sample collection and signed by the sampler and a reviewer who will verify the logs for completeness and accuracy. Corresponding labels will be initialed and applied to each sample container, and custody seals will be placed around container lids or openings. COC forms will be completed and signed to verify that the samples are not left unattended.

4.8 Laboratory Analytical Methods

The analytical laboratory methods are summarized in Table 4.8-1. All analytical methods are presented in the statement of work for analytical laboratories (LANL 2008, 109962). Sample collection and analysis will be coordinated with the SMO.

4.9 Health and Safety

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

4.10 Equipment Decontamination

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

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

4.11 Investigation-Derived Waste

The IDW generated during field-investigation activities may include, but is not limited to, drill cuttings; 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 field-investigation activities will be managed in accordance with applicable SOPs that incorporate the requirements of all applicable EPA and NMED regulations, DOE orders, and Laboratory implementation requirements. Appendix B presents the IDW management plan.

5.0 MONITORING PROGRAMS

5.1 Groundwater

Groundwater-monitoring activities in the Ancho Canyon watershed are performed in accordance with the Laboratory's Interim Facility-Wide Groundwater Monitoring Plan, which is updated annually. This includes semiannual monitoring near or downstream from areas of past Laboratory activities. Monitoring locations in the Ancho Canyon watershed include six regional wells (DT-5A, DT-9, DT-10, R-29, R-30, and R-31) (LANL 2010, 110654.16).

5.2 Stormwater

SWMU 49-001(g) and AOC 49-008(c) are the only sites addressed in this Phase II investigation work plan subject to the stormwater monitoring requirements of the Laboratory's National Pollutant Discharge Elimination System individual permit (IP) for stormwater discharges from SWMUs and AOCs. Monitoring under the IP is performed using site-monitoring areas (SMAs) that monitor stormwater runoff from individual SWMUs and AOCs or groups of SWMUs and AOCs. The SMA monitored under the IP at SWMU 49-001(g) is W-SMA-12.05, and the SMA at AOC 49-008(c) is W-SMA-11.7. Monitoring results are reported to EPA on an annual basis.

6.0 SCHEDULE

Preparation for investigation activities is anticipated to begin in early fiscal year (FY) 2012. To integrate field activities with the Qbt 4 background study and the investigation of TA-49 sites outside the NES boundary, fieldwork is expected to be completed in mid-FY2012. A submittal date of no later than September 30, 2012, is proposed for the Phase II investigation report.

7.0 REFERENCES AND MAP DATA SOURCES

7.1 References

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

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

ASTM (American Society for Testing and Materials), June 1997. "D6001 Standard Guide for Direct-Push Water Sampling for Geoenvironmental Investigations," in *Annual Book of ASTM Standards*, Vol. 04.09 Soil and Rock (II), ASTM, West Conshohocken, Pennsylvania. (ASTM 1997, 057511)

Beguin, K., October 15, 2007. "TA-49 Area 12 Bottle House and CPTF Building Removal," Apogen Technologies memorandum to file from K. Beguin, Los Alamos, New Mexico. (Beguin 2007, 098607)

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)

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), 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), 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)

LANL (Los Alamos National Laboratory), January 2008. "Investigation Work Plan for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary, Revision 1," Los Alamos National Laboratory document LA-UR-08-0447, Los Alamos, New Mexico. (LANL 2008, 102691)

LANL (Los Alamos National Laboratory), January 2008. "Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1," Los Alamos National Laboratory document LA-UR-08-0449, Los Alamos, New Mexico. (LANL 2008, 102215)

LANL (Los Alamos National Laboratory), June 30, 2008. “Exhibit "D" Scope of Work and Technical Specifications, Analytical Laboratory Services for General Inorganic, Organic, Radiochemical, Asbestos, Low-Level Tritium, Particle Analysis, Bioassay, Dissolved Organic Carbon Fractionation, and PCB Congeners,” Los Alamos National Laboratory document RFP No. 63639-RFP-08, Los Alamos, New Mexico. (LANL 2008, 109962)

LANL (Los Alamos National Laboratory), December 2009. “Radionuclide Screening Action Levels (SALs) from RESRAD, Version 6.5,” Los Alamos National Laboratory document LA-UR-09-8111, Los Alamos, New Mexico. (LANL 2009, 107655)

LANL (Los Alamos National Laboratory), September 2010. “Investigation Report for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary, Revision 1,” Los Alamos National Laboratory document LA-UR-10-6032, Los Alamos, New Mexico. (LANL 2010, 110656.17)

LANL (Los Alamos National Laboratory), September 2010. “Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1,” Los Alamos National Laboratory document LA-UR-10-6033, Los Alamos, New Mexico. (LANL 2010, 110654.16)

LANL (Los Alamos National Laboratory), December 2010. “Work Plan for Determining Background Concentrations of Inorganic Chemicals in Unit 4 of the Bandelier Tuff,” Los Alamos National Laboratory document LA-UR-10-8111, Los Alamos, New Mexico. (LANL 2010, 111504)

NMED (New Mexico Environment Department), February 14, 2008. “Approval with Modifications for the Investigation Work Plan for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary,” New Mexico Environment Department letter to D. Gregory (DOE-LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2008, 100464)

NMED (New Mexico Environment Department), December 2009. “Technical Background Document for Development of Soil Screening Levels, Revision 5.0,” with revised Table A-1, New Mexico Environment Department, Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program, Santa Fe, New Mexico. (NMED 2009, 108070)

NMED (New Mexico Environment Department), September 22, 2010. “Approval with Modifications, Investigation Report for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1,” New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2010, 110859)

NMED (New Mexico Environment Department), November 12, 2010. “Approval with Modifications, Investigation Report for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary, Revision 1,” New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2010, 111226)

NMED (New Mexico Environment Department), January 12, 2011. “Notice of Approval, Work Plan to Determine Background Concentrations in Unit 4 of the Bandelier Tuff,” New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2011, 111680)

7.2 Map Data Sources

Data sources used in original figures and/or plates created for this report are described below and identified by legend title.

LANL Technical Areas - Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; September 2007; as published 04 December 2008.

NES and Facility boundaries at TA-49 - Revised boundary shape files: TA49_NES_20090812_arc and TA49_FACILITY_20090812_arc, provided by LANL Site Technical Representative, dated 12 August 2009.

Paved roads - Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Dirt roads - Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Drainages - WQH Drainage_arc; Los Alamos National Laboratory, ENV Water Quality and Hydrology Group; 1:24,000 Scale Data; 03 June 2003.

LANL structures - Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

LANL fence lines - Security and Industrial Fences and Gates; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Former/other existing TA-49 structures - Description of: Geospatial Data Created for Maps Appearing in TA-49 HIRS and IWPS, K. Crowell, ERID-098702, October 2007

TA-49 2009/10 sample locations - TPMC field survey data, now found in: Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Waste and Environmental Services Division, 12 April 2010.

LANL historical sample locations - Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Waste and Environmental Services Division, 21 January 2010.

Contours - Hypsography, 10, 20, and 100 Foot Contour Interval; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; 1991.

Former TA-49 structures - Description of: Geospatial Data Created for Maps Appearing in TA-49 HIRS and IWPS, K. Crowell, ERID-098702, October 2007

Experimental shaft /pipe dump hole locations - Description of: Geospatial Data Created for Maps Appearing in TA-49 HIRS and IWPS, K. Crowell, ERID-098702, October 2007

Landfills, regraded areas, and former asphalt pad location - Description of: Geospatial Data Created for Maps Appearing in TA-49 HIRS and IWPS, K. Crowell, ERID-098702, October 2007

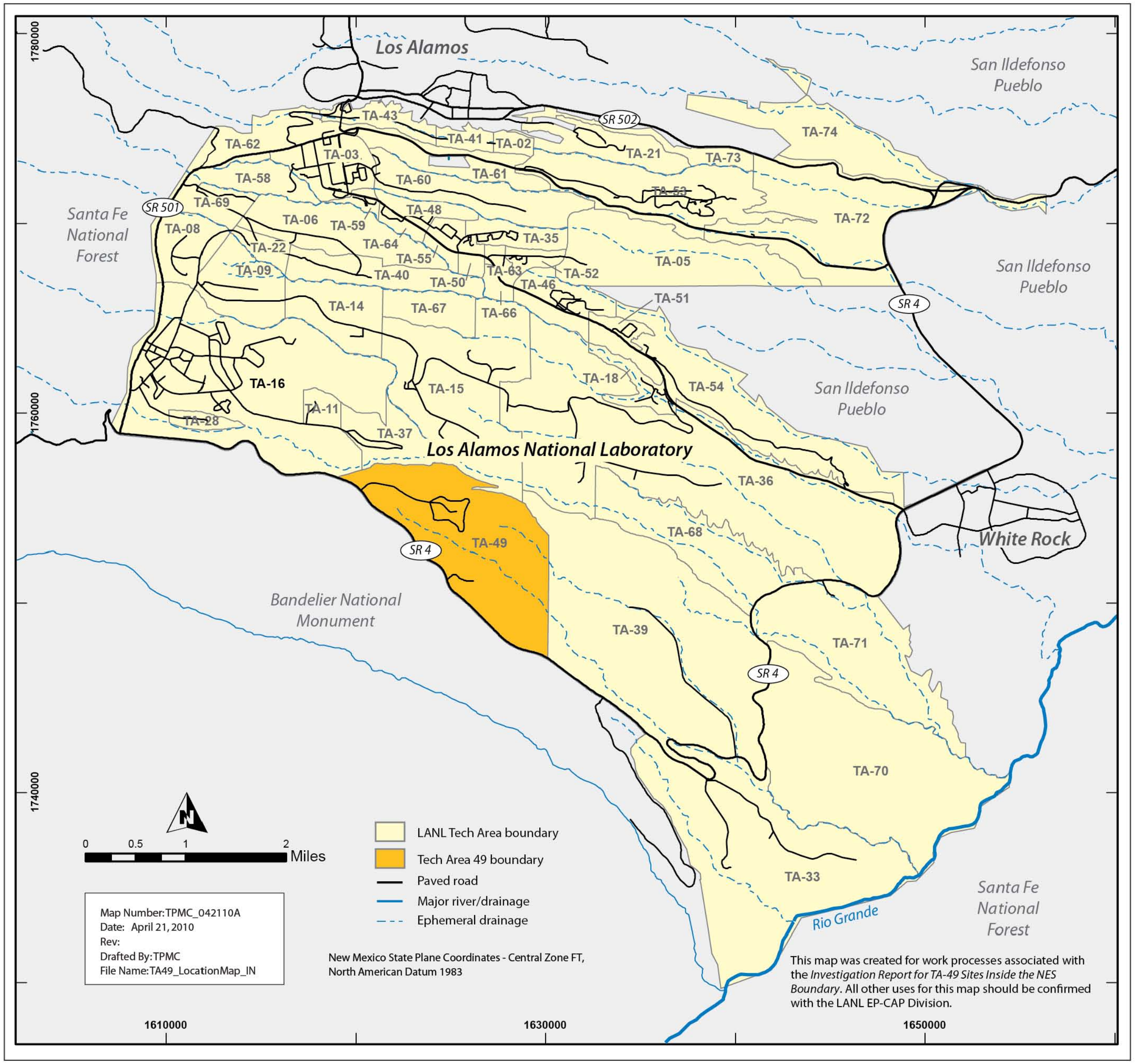

Figure 1.1-1 Location of TA-49 with respect to Laboratory technical areas and surrounding landholdings

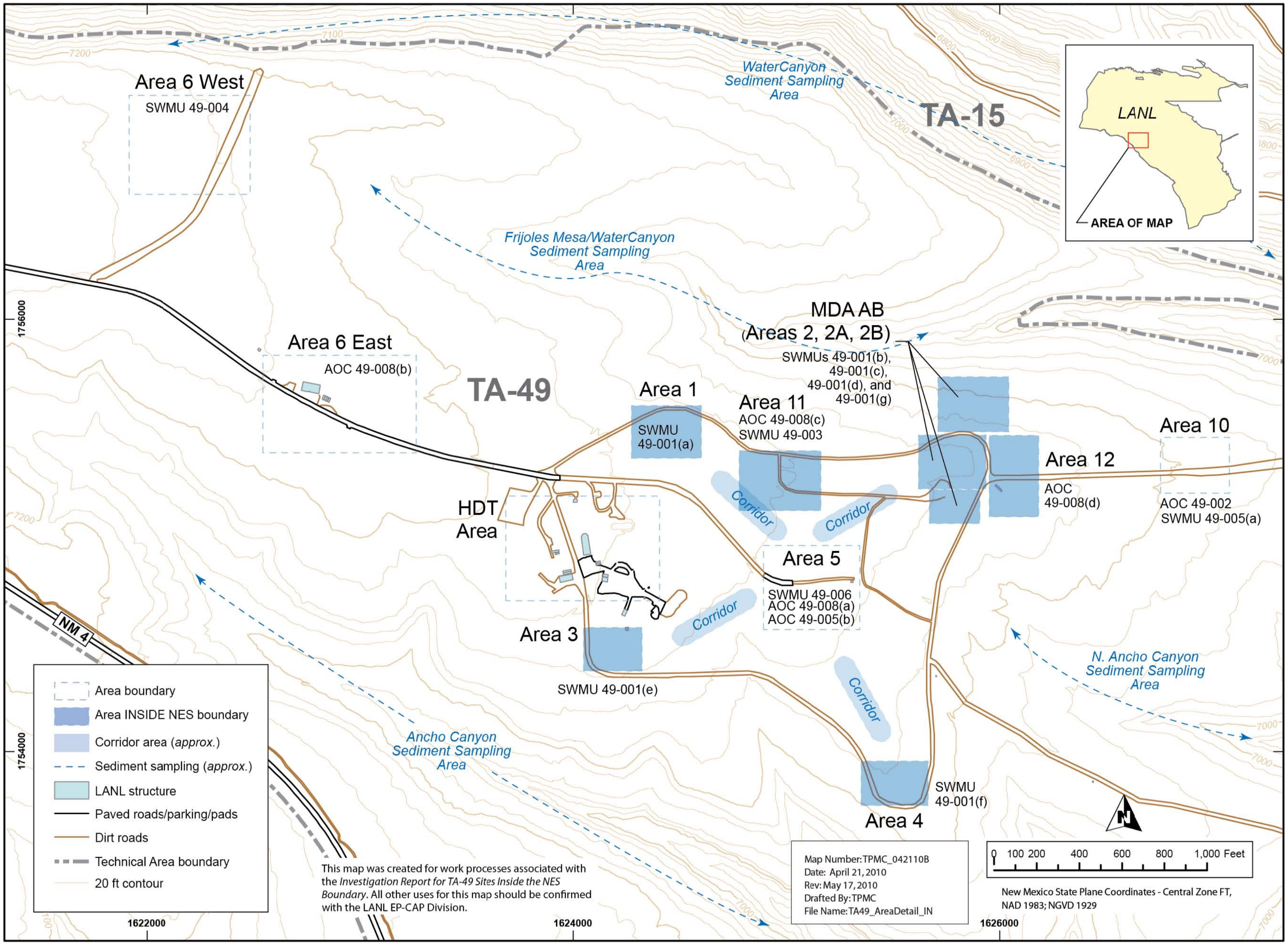

Figure 1.1-2 Locations of TA-49 SWMUs, AOCs, and associated overland corridors

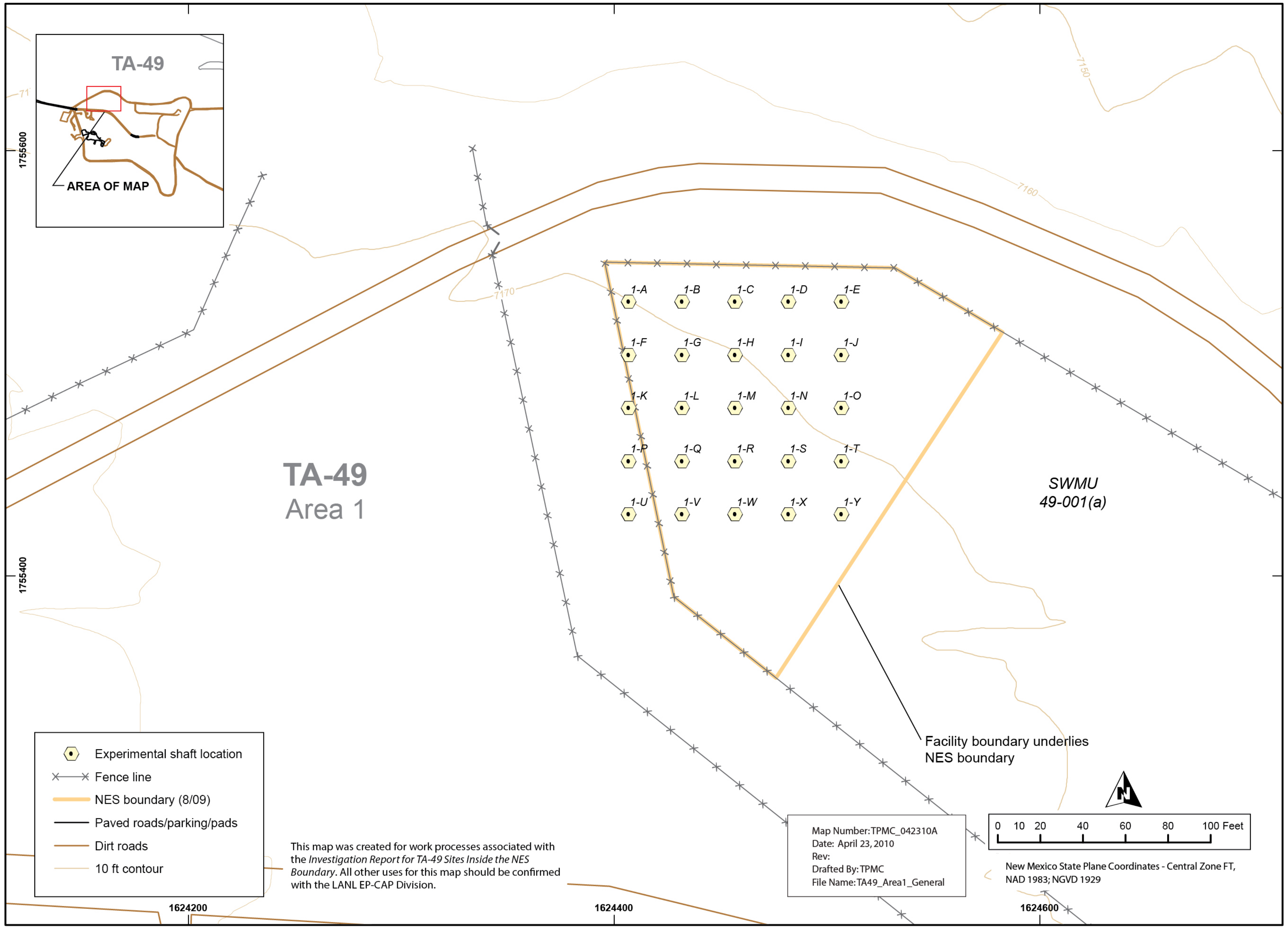

Figure 2.1-1 General site layout of Area 1, SWMU 49-001(a)

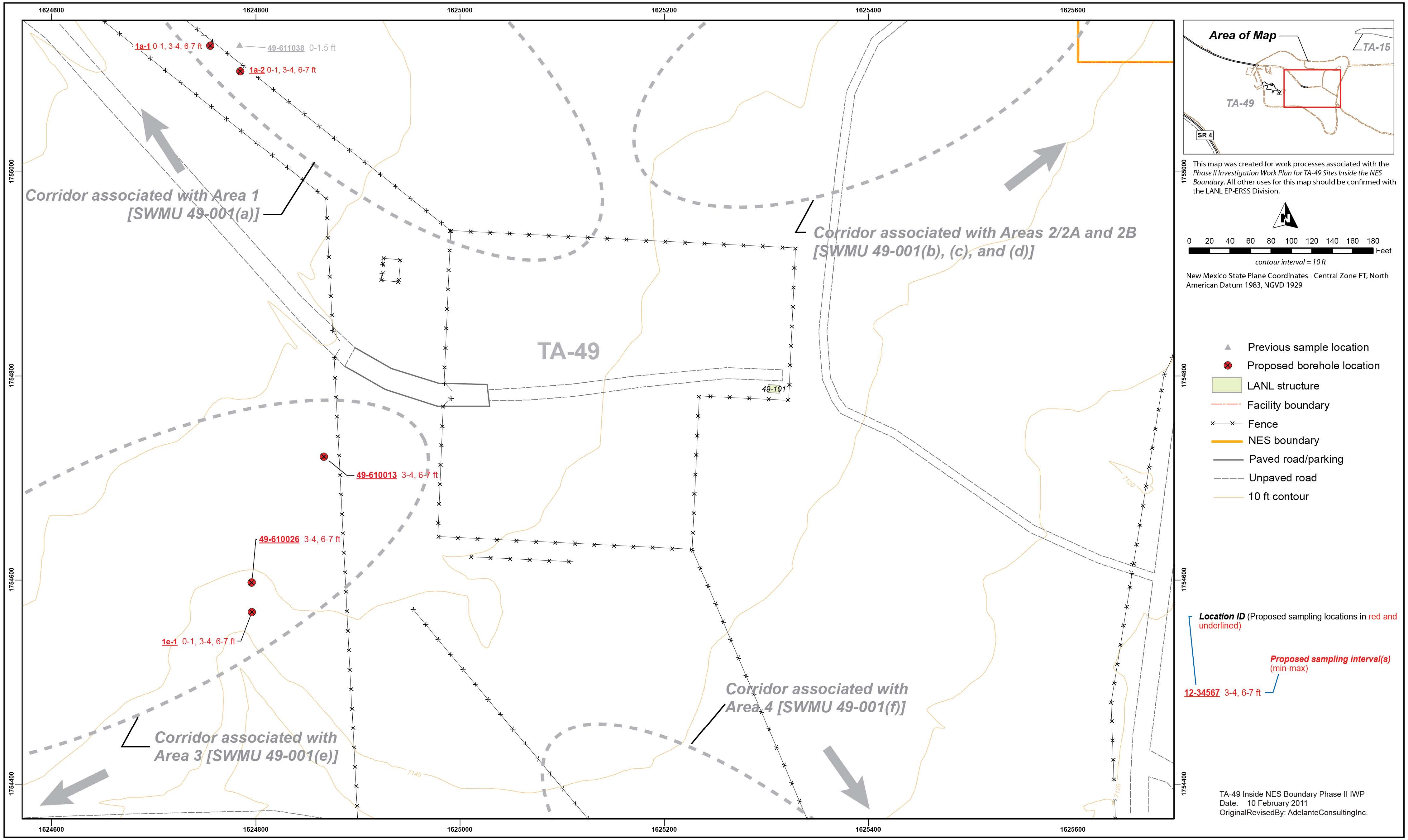

Figure 2.1-2 Proposed sampling locations at overland corridors

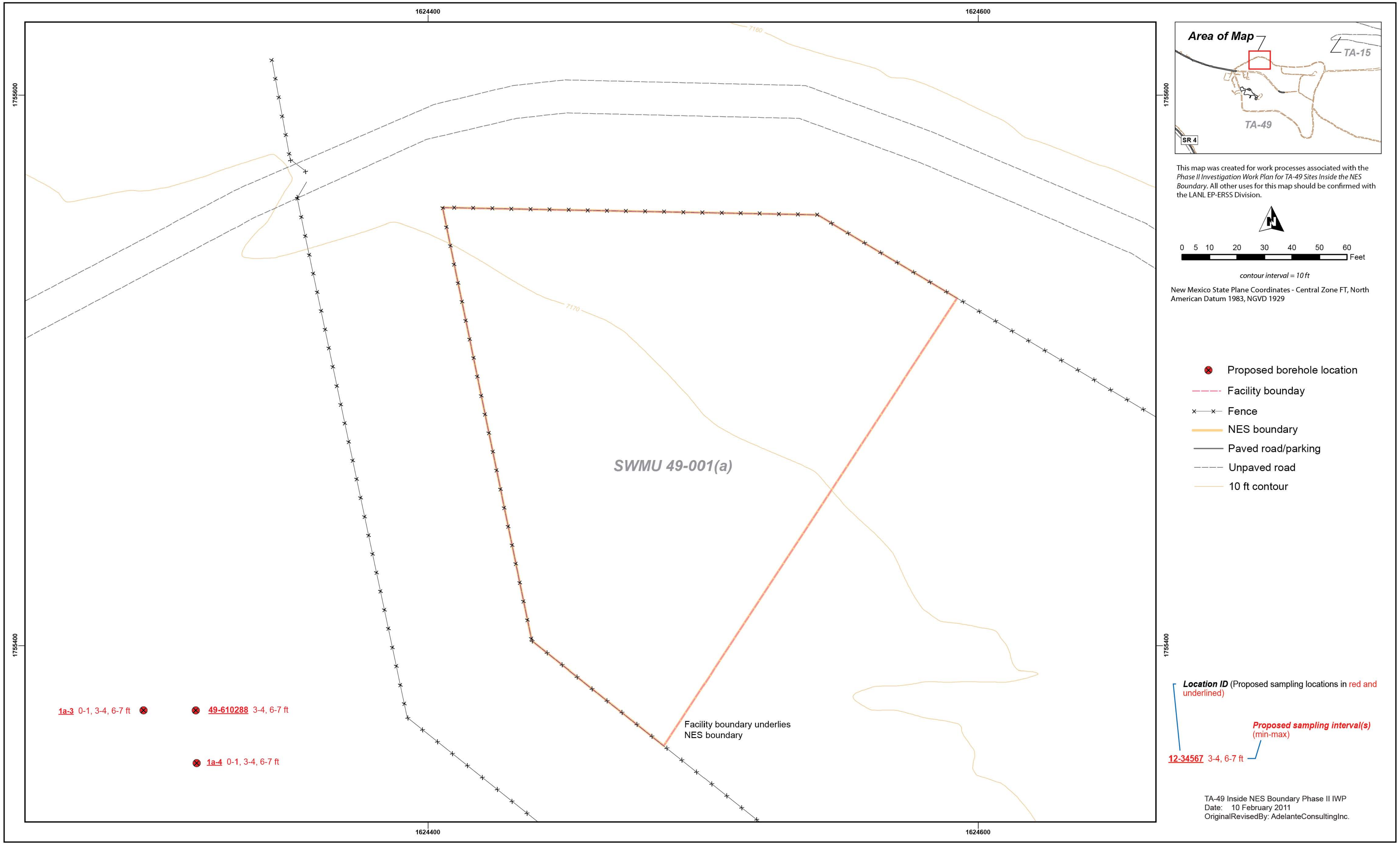

Figure 2.1-3 Proposed sampling locations at Area 1, SWMU 49-001(a)

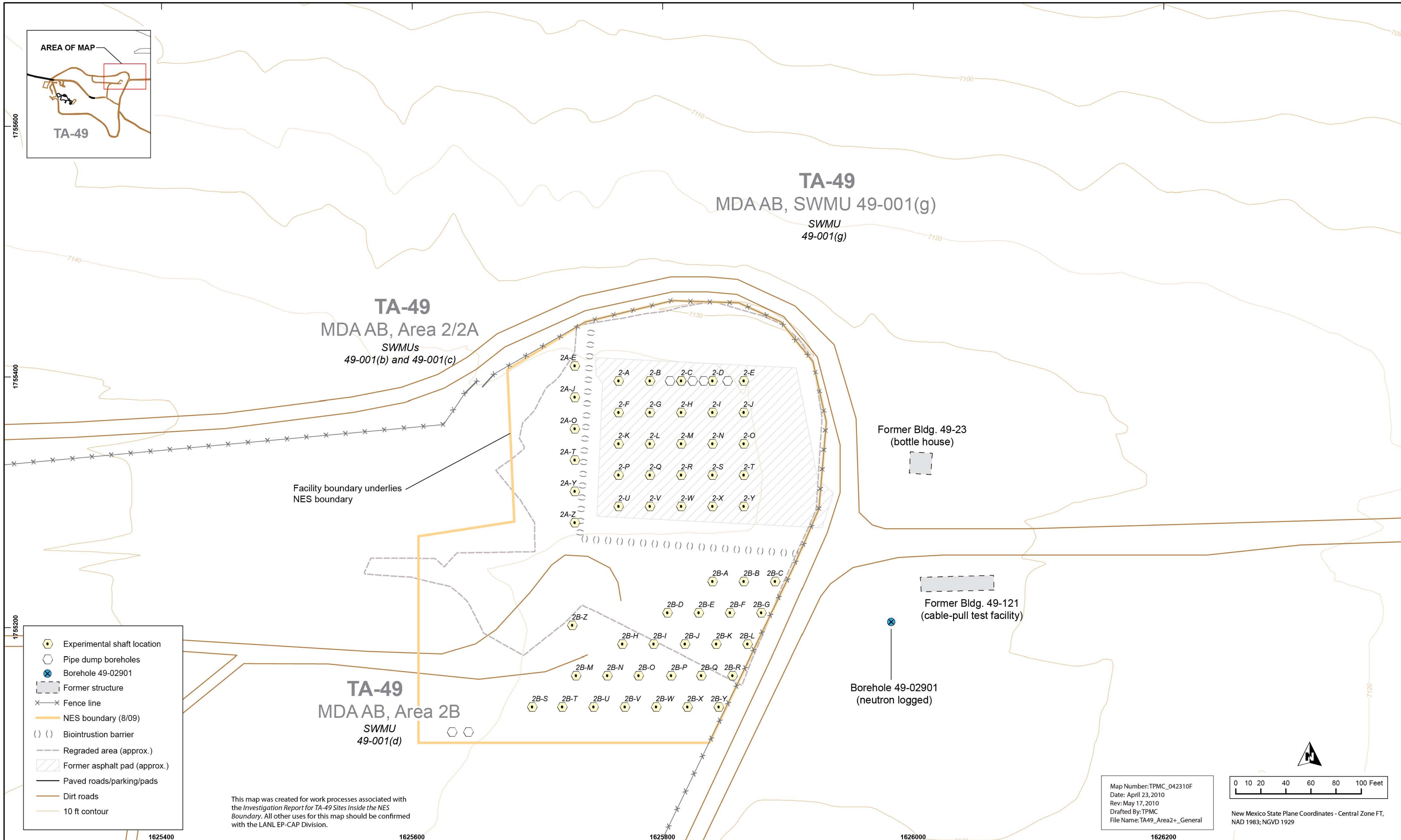

Figure 2.2-1 General site layout of MDA AB [SWMUs 49-001(b, c, d, g)]

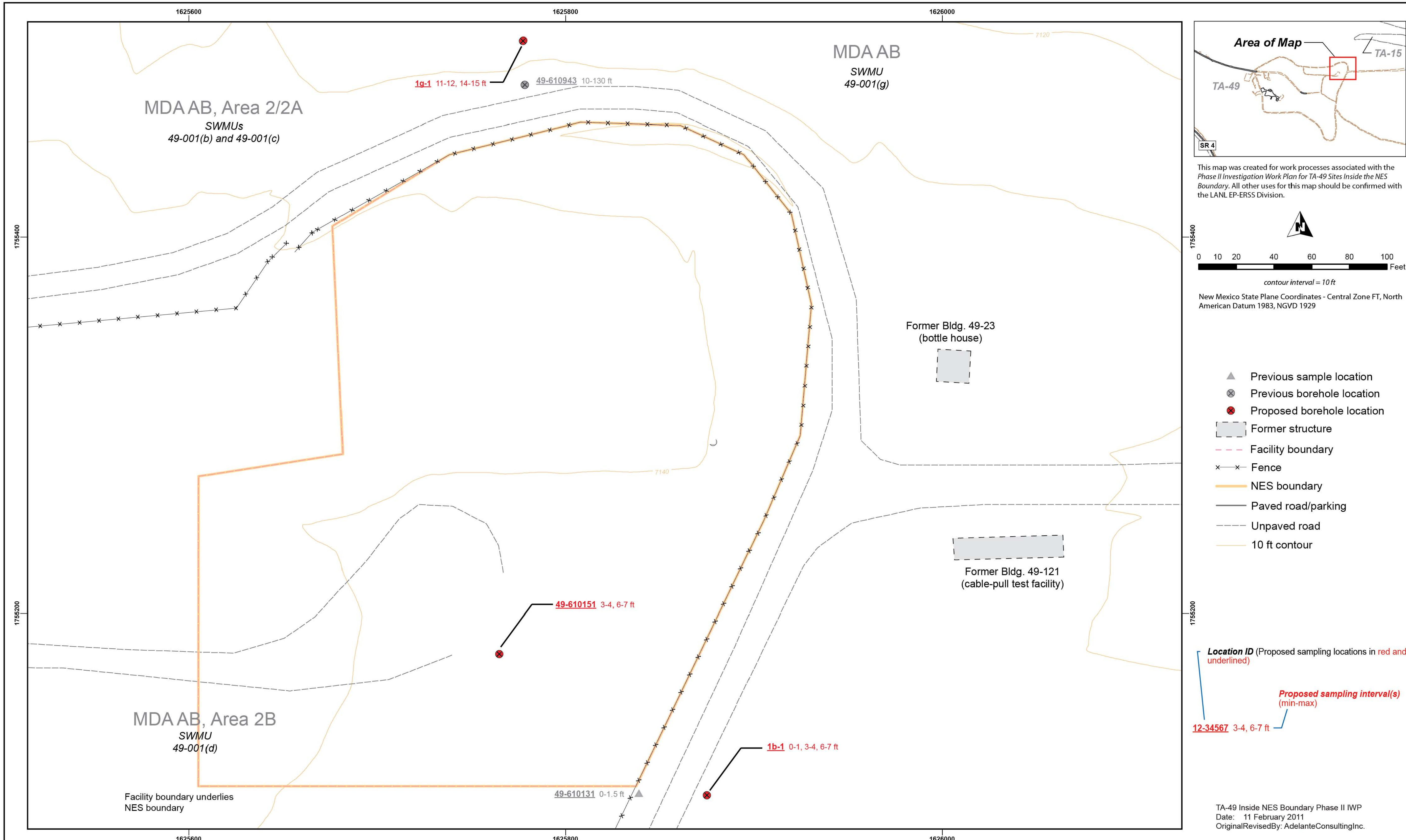

Figure 2.2-2 Proposed sampling locations at MDA AB [SWMUs 49-001(b, c, d, g)]

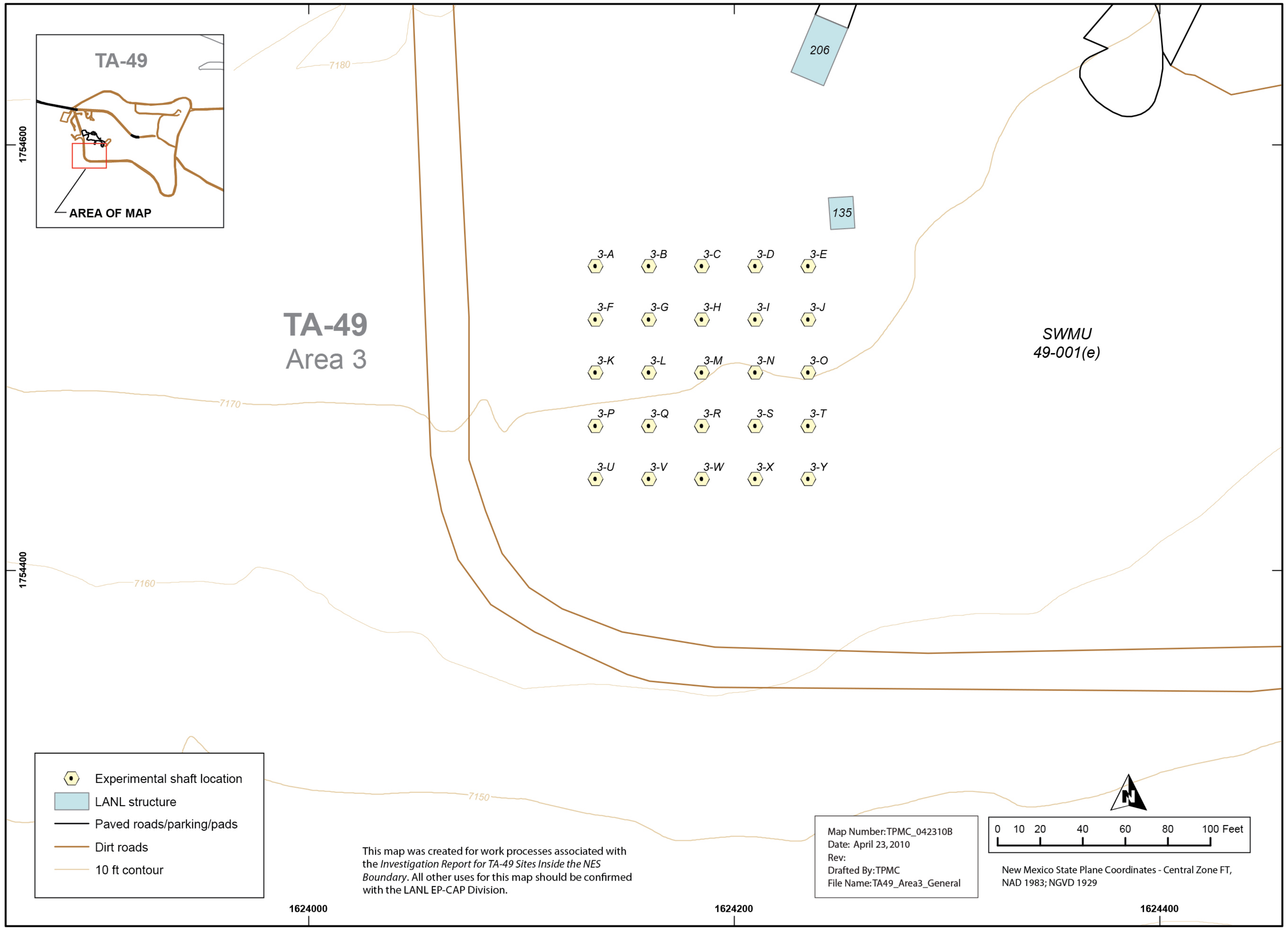

Figure 2.3-1 General site layout of Area 3, SWMU 49-001(e)

Figure 2.3-2 Proposed sampling locations at Area 3, SWMU 49-001(e)

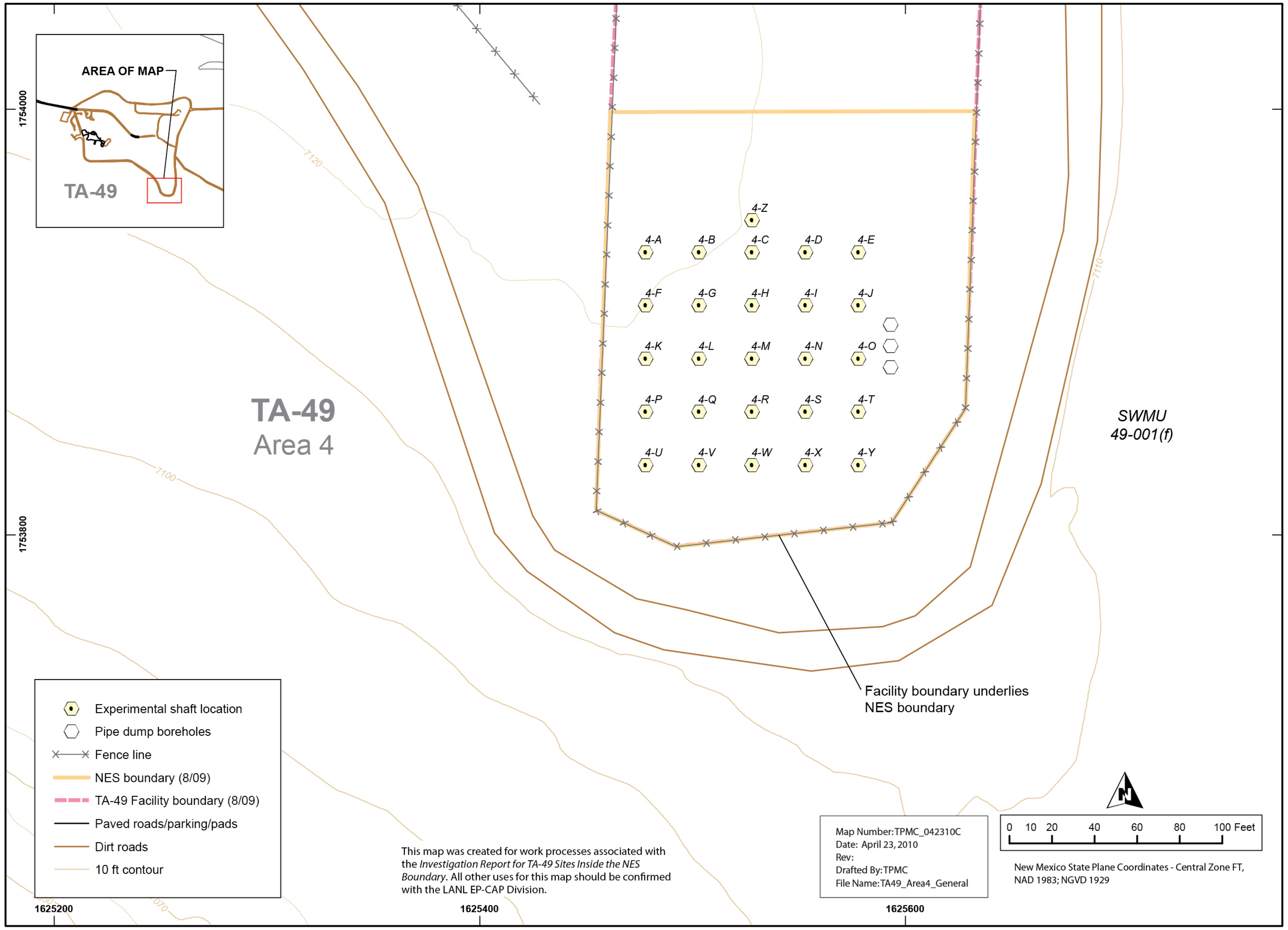

Figure 2.4-1 General site layout of Area 4, SWMU 49-001(f)

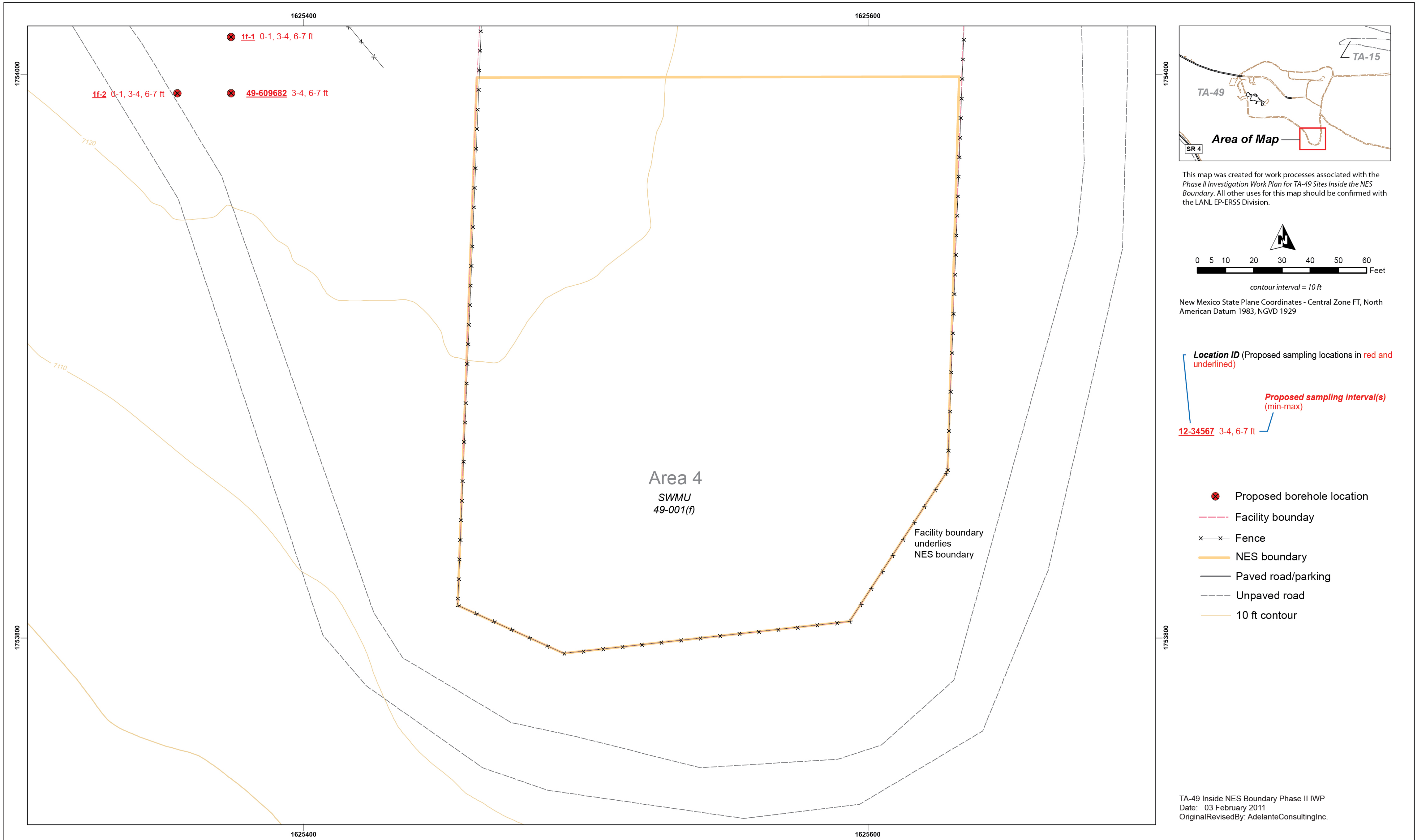

Figure 2.4-2 Proposed sampling locations at Area 4, SWMU 49-001(f)

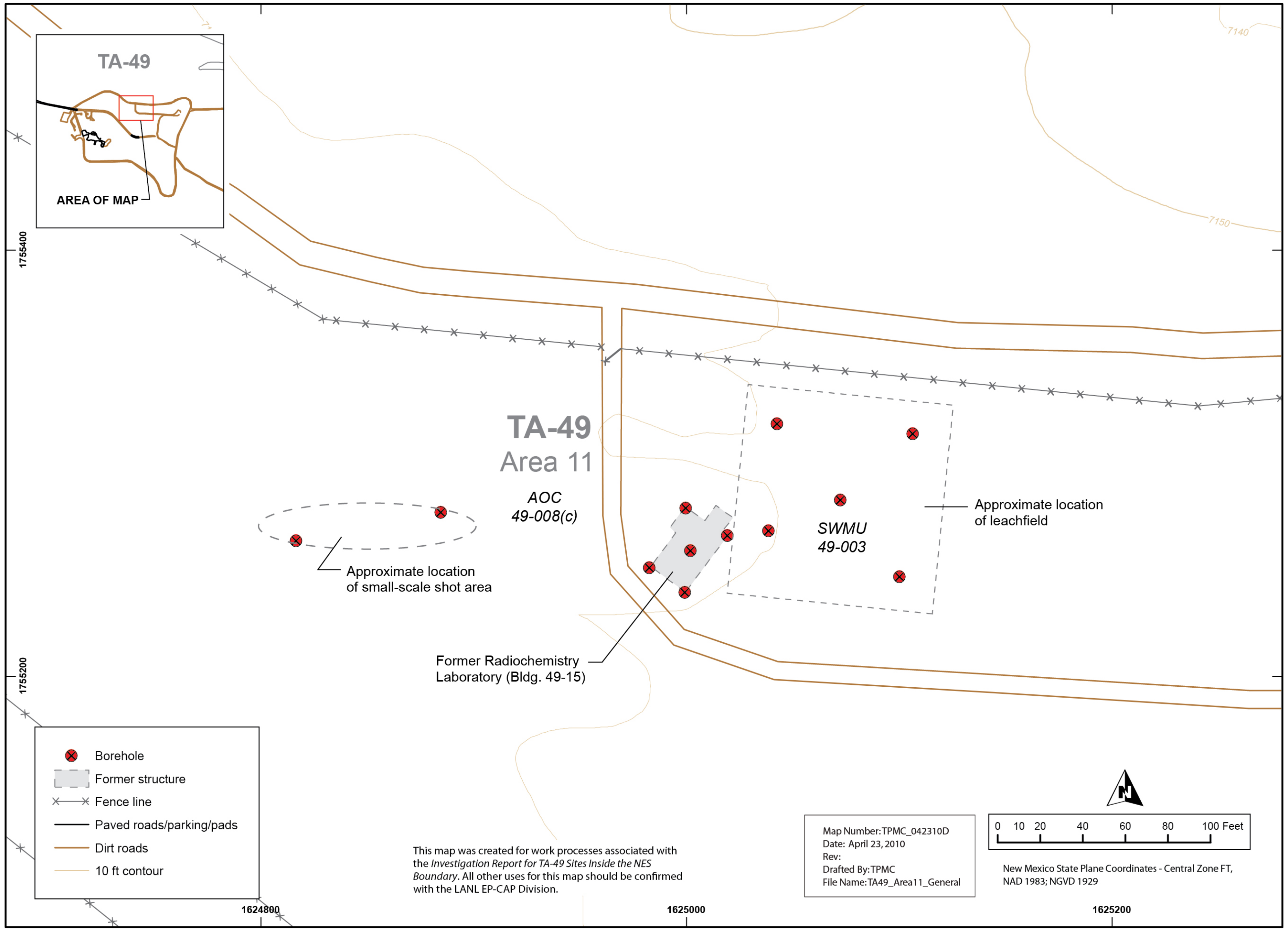

Figure 2.5-1 General site layout of Area 11, SWMU 49-003 and AOC 49-008(c)

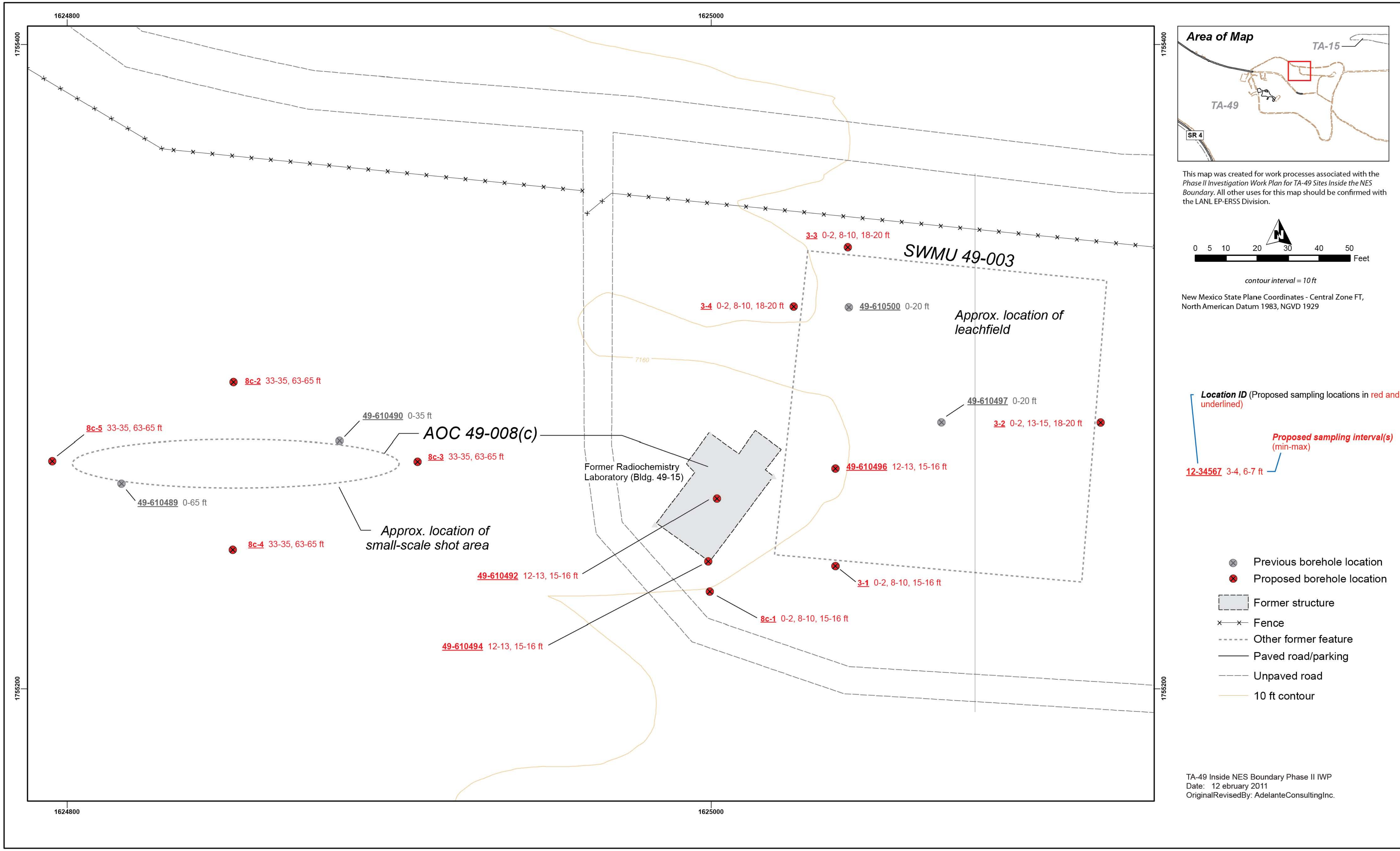

Figure 2.5-2 Proposed sampling locations at Area 11, SWMU 49-003 and AOC 49-008(c)

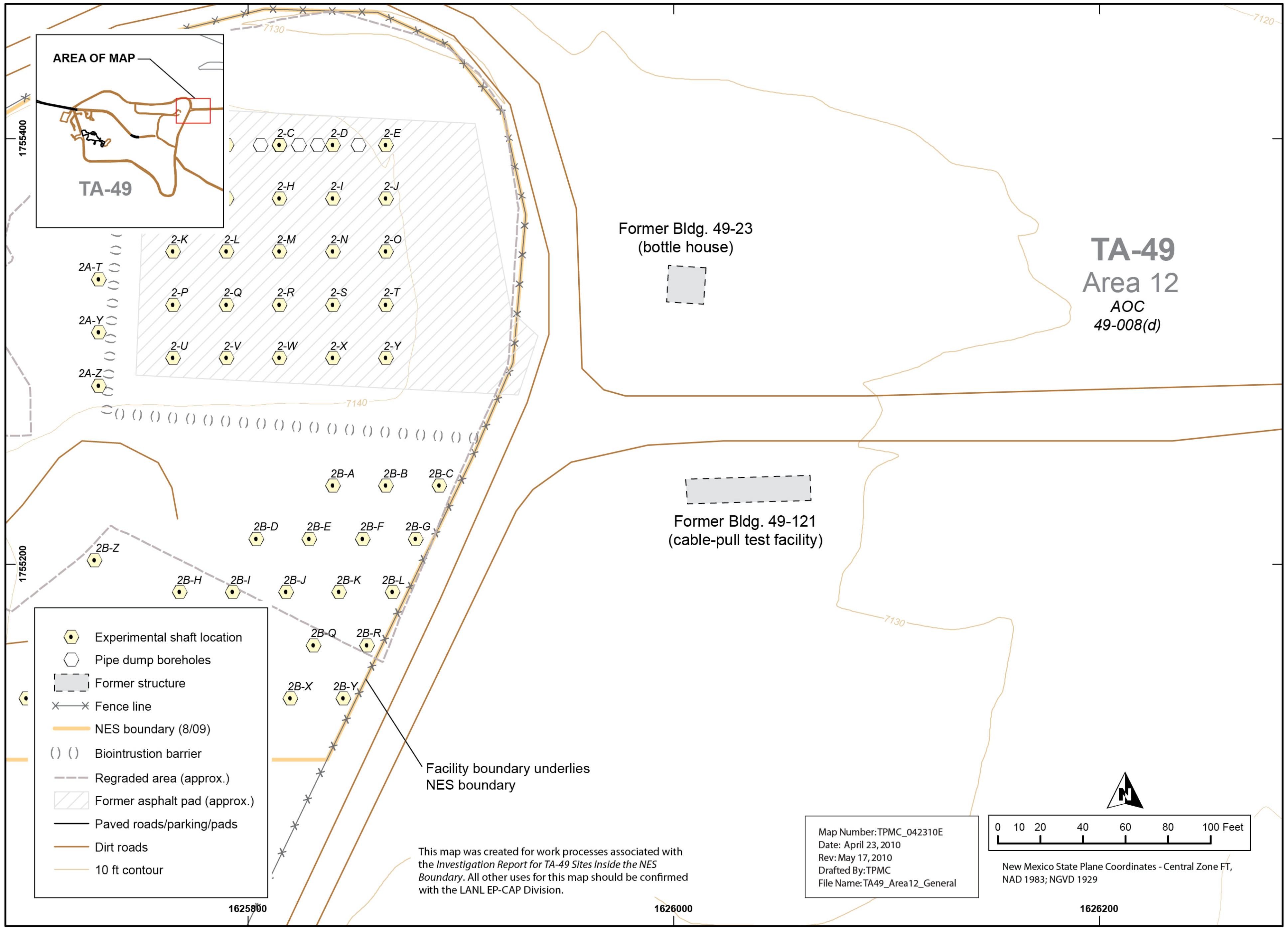

Figure 2.7-1 General site layout of Area 12, AOC 49-008(d)

Table 1.1-1
Investigation Status of SWMUs and AOCs Located Inside the NES Boundary at TA-49

Area	Site ID	Brief Description	2010 Investigation Results	Phase II Proposed Activities
1	SWMU 49-001(a)	Experimental shafts	Extent not defined: lateral extent of plutonium 238 and lateral and vertical extent of cesium 134	Additional sampling for extent
2, 2A, 2B (MDA AB)	SWMU 49-001(b, c, d, g)	Experimental shafts	Extent not defined: lateral extent of lead, vertical extent of americium-241 and plutonium-238, and lateral and vertical extent of plutonium-239/240	Additional sampling for extent
3	SWMU 49-001(e)	Experimental shafts	Extent not defined: vertical extent of arsenic and cesium-137 and lateral and vertical extent of copper, lead, and cesium-134	Additional sampling for extent
4	SWMU 49-001(f)	Experimental shafts	Extent not defined: vertical and lateral extent of chromium	Additional sampling for extent
11	SWMU 49-003	Inactive drain field and associated drainlines	Extent not defined: lateral and vertical extent of perchlorate and tritium	Additional sampling for extent
	AOC 49-008(c)	Area of potential soil contamination	Extent not defined: lateral and vertical extent of perchlorate and tritium	Additional sampling for extent
12	AOC 49-008(d)	Bottle House and CPTF	Extent not defined: vertical extent of antimony and plutonium-239/240 and lateral and vertical extent of thallium	Additional sampling for extent
	AOC 49-009*	Above ground tank	None. No further action approved 01/21/05 (EPA 2005, 088464)	None

* Shading denotes no further action approved.

Table 2.1-1
Summary of Proposed Sampling at Area 1, SWMU 49-001(a)

Site	Sampling Extent Objective	Location	Depth (ft)	Media	Gamma Spectroscopy (EPA 901.1 M)	Isotopic Plutonium (HASL-300)
SWMU 49-001(a)	Define vertical extent of contamination for cesium-134	Location 49-610288	3–4, 6–7	Tuff	X[a] (cesium-134)	—[b]
	Define lateral extent of contamination for cesium-134 and plutonium-238	2 new boreholes (locations 1a-1 and 1a-2) west and south of overland corridor location 49-611038	0–1, 3–4, 6–7	Tuff	—	X (plutonium-238)
		2 new boreholes (locations 1a-3 and 1a-4) west and south of location 49-610288	0–1, 3–4, 6–7	Tuff	X (cesium-134)	—

[a] X = Analysis proposed.
[b] — = Analysis will not be performed.

Table 2.2-1
Summary of Proposed Sampling at MDA AB [SWMUs 49-001 (b, c, d, g)]

Site	Sampling Extent Objective	Location	Depth (ft)	Media	Target Analyte List Metals (EPA SW-846:6010B/6020)	Americium-241 (HASL-300:AM-241)	Isotopic Plutonium (HASL-300:ISOPU)
MDA AB [SWMUs 49-001 (b, c, d, g)]	Define vertical extent of contamination for americium-241, plutonium-238, and plutonium-239/240	Location 49-610151	3–4, 6–7	Tuff	—[a]	X[b]	X (plutonium-238, plutonium-239/240)
	Define lateral extent of contamination for lead and plutonium-239/240	1 new borehole (location 1g-1) north of location 49-610943	11–12, 14–15	Tuff	X (lead)	—	—
		1 new borehole (location 1b-1) east of location 49-610131	0–1, 3–4, 6–7	Tuff	—	—	X (plutonium-239/240)

[a] — = Analysis will not be performed.
[b] X = Analysis proposed.

Table 2.3-1
Summary of Proposed Sampling at Area 3, SWMU 49-001(e)

Site	Sampling Extent Objective	Location	Depth (ft)	Media	Target Analyte List Metals (EPA SW-846:6010B/6020)	Gamma Spectroscopy (EPA:901.1M)
SWMU 49-001(e)	Define vertical extent of contamination for arsenic, copper, lead, cesium-134, and cesium-137	Location 49-609317	3–4, 6–7	Tuff	X[a] (arsenic, lead)	—[b]
		Location 49-609329	3–4, 6–7	Tuff	X (lead)	—
		Location 49-610026 (overland corridor)	3–4, 6–7	Tuff	X (copper)	—
		Location 49-609336	3–4, 6–7	Tuff	—	X (cesium-134)
		Locations 49-609324, 49-609328, 49-609330, and 49-610013 (overland corridor location)	3–4, 6–7	Tuff	—	X (cesium-137)
	Define lateral extent of contamination for copper, lead, and cesium-134	1 new borehole (location 1e-1) south of location 49-610026 (overland corridor)	0–1, 3–4, 6–7	Tuff	X (copper)	—
		2 new boreholes (locations 1e-2 and 1e-3) south and west of location 49-609329	0–1, 3–4, 6–7	Tuff	X (lead)	—
		2 new locations (locations 1e-3 and 1e-4) north and east of location 49-609336	0–1, 3–4, 6–7	Tuff	—	X (cesium-134)

[a] X = Analysis proposed.

[b] — = Analysis will not be performed.

Table 2.4-1
Summary of Proposed Sampling at Area 4, SWMU 49-001(f)

Site	Sampling Extent Objective	Location	Depth (ft)	Media	Target Analyte List Metals (EPA SW-846:6010B/6020)
SWMU 49-001(f)	Define vertical extent of contamination for chromium	Location 49-609682	3–4, 6–7	Tuff	X* (chromium)
	Define lateral extent of contamination for chromium	Two new boreholes (locations 1f-1 and 1f-2) north and west of location 49-609682	0–1, 3–4, 6–7	Tuff	X (chromium)

* X = Analysis proposed.

Table 2.5-1
Summary of Proposed Sampling at Area 11, SWMU 49-003

Site	Sampling Extent Objective	Location	Depth (ft)	Media	Perchlorate (EPA SW-846:6850)	Tritium (EPA:906.0)
SWMU 49-003	Define vertical extent of contamination for perchlorate and tritium	Location 49-610496	12–13, 15–16	Tuff	X[a]	X
	Define lateral extent of contamination for perchlorate and tritium	One new borehole (location 3-1) south of location 49-610496	0–2, 8–10, 15–16	Tuff	X	X
		One new borehole (location 3-2) east of location 49-610497	0–2, 13–15, 18–20	Tuff	X	—[b]
		Two new boreholes (locations 3-3 and 3-4) north and west of location 49-610500	0–2, 8–10, 18–20	Tuff	X	—

[a] X = Analysis proposed.
[b] — = Analysis will not be performed.

Table 2.6-1
Summary of Proposed Sampling at Area 11, AOC 49-008(c)

Site	Sampling Extent Objective	Location	Depth (ft)	Media	Perchlorate (EPA SW-846:6850)	Tritium (EPA:906.0)
AOC 49-008(c)	Define vertical extent of contamination for perchlorate	Locations 49-610492 and 49-610494	12–13, 15–16	Tuff	X[a]	—[b]
	Define lateral extent of contamination for perchlorate and tritium	One new borehole (location 8c-1) south of location 49-610494	0–2, 8–10, 15–16	Tuff	X	—
		Four new boreholes (locations 8c-2, 8c-3, 8c-4, and 8c-5) north, east, south, and west of the small-scale containment experiment area	33–35, 63–65	Tuff	—	X

[a] X = Analysis proposed.
[b] — = Analysis will not be performed.

Table 2.7-1
Summary of Proposed Sampling at Area 12, AOC 49-008(d)

Site	Sampling Extent Objective	Location	Depth (ft)	Media	Target Analyte List Metals (EPA SW-846:6010B/6020)	Tritium (EPA:906.0)	Isotopic Plutonium (HASL-300:ISOPU)
AOC 49-008(d)	Define vertical extent of contamination for antimony, thallium, and plutonium-239/240	Location 49-609903	3–4, 6–7	Tuff	X[a] (antimony)	—[b]	X (plutonium-239/240)
		Locations 49-609909 and 49-609913	3–4, 6–7	Tuff	X (thallium)	—	—
	Determine concentrations of tritium in pore gas	Overdrill borehole location 49-610481 and sample for tritium in pore gas	29–31, 77–79, 82–84, 118–120	Pore gas	—	X	—
	Define lateral extent of contamination for thallium	Two new boreholes (locations 8d-1 and 8d-2) east and south of location 49-609909	0–1, 3–4, 6–7	Tuff	X (thallium)	—	—
		Two new boreholes (locations 8d-3 and 8d-4) north and east of location 49-609913	0–1, 3–4, 6–7	Tuff	X (thallium)	—	—

[a] X = Analysis proposed.

[b] — = Analysis will not be performed.

Table 3.0-1
Locations for Collection of Core Samples

Site	Location ID
SWMU 49-001(a)	49-610224
SWMU 49-001(a)	49-610232
SWMU 49-001(e)	49-609311
SWMU 49-001(e)	49-609313
SWMU 49-001(e)	49-609321
SWMU 49-001(e)	49-609326
SWMU 49-001(e) Corridor	49-610017
SWMU 49-001(e) Corridor	49-610021
SWMU 49-001(e) Corridor	49-610025
SWMU 49-001(f) Corridor	49-610042

Table 4.0-1
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 work 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. inside diameter), creating a vertical hole that can be advanced to the desired sampling depth. When the desired depth is reached, the auger is decontaminated before the hole is advanced to the sampling depth. The sample material is transferred from the auger bucket to a stainless-steel sampling bowl before the various required sample containers are filled. Carbon-steel auger buckets may be used, particularly in cases where chromium and nickel are the primary constituents of interest and cross-contamination from stainless-steel equipment is a concern.
Handling, Packaging, and Shipping of Samples	Field team members 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 either to the SMO or to an SMO-approved radiation screening laboratory under COC. The SMO arranges to ship samples to the 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.
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 min. 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 electron volts or higher.
Sample Control and Field Documentation	The collection, screening, and transport of samples are documented on standard forms generated by the SMO. These forms include SCLs, COC 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. COC 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 Sample Management Database.
Field QC Samples	Field QC samples are collected as follows. Field duplicate: At a frequency of 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.

Table 4.0-1 (continued)

Method	Summary
Field Decontamination of Drilling and Sampling Equipment	Dry decontamination is the preferred method to minimize generating liquid waste. Dry decontamination may include using a wire brush or other tool to remove soil or other material adhering to the sampling equipment, followed by using 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 QA. Specific requirements for each sample are printed on the SCLs provided by the SMO (size and type of container [glass, amber glass, polyethylene, preservative, etc.]). All samples are preserved by placing them 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 complies 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 will be established before waste is generated. Waste storage areas located in controlled areas of the Laboratory will be controlled as needed to prevent inadvertent addition or management of wastes by unauthorized personnel. Each container of waste generated will 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 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.
Hollow-Stem Auger Drilling Methods	In this method, a hollow-stem auger (a section of seamless pipe with auger flights welded to the pipe) acts as a screw conveyor to bring cuttings of sediment, soil, and/or rock to the surface. Auger sections are typically 5 ft in length 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. Hollow-stem augers are used as temporary casings when setting wells to prevent cave-ins of the borehole walls.

Table 4.0-1 (continued)

Method	Summary
Direct-Push Sampling Methods	In this method, a tool string is pushed into the ground using the weight of a truck in combination with a hydraulic ram or hammer. Various tool strings can be used for obtaining discrete samples, continuous samples, both discrete and continuous samples, and groundwater samples. The direct-push core samples collected for this investigation will be continuous. The inside of the continuous sampler is exposed to the subsurface environment while it is advanced to the sampling interval. This is a dual-tube sampler, so named because it uses two sets of rods to collect soil cores. The outer rods receive the driving force from the hydraulic pushing method and provide a sealed hole from which soil samples may be recovered without the threat of cross-contamination or cave-in. The inner set of rods is placed within the outer rods and holds a sampler in place as the outer rods are driven to the sampling interval. The inner rods are then retracted to retrieve the soil core.

Table 4.8-1
Summary of Analytical Methods

Analyte	Analytical Method
Target analyte list metals	SW-846:6010B; SW-846:6020
Perchlorate	SW-846:6850
Americium-241	HASL-300:AM-241
Gamma spectroscopy	EPA:901.1M
Isotopic plutonium	HASL-300:ISOPU
Tritium	EPA:906.0

Appendix A

Acronyms and Abbreviations,
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
ASTM	American Society for Testing and Materials
bgs	below ground surface
BV	background value
COC	chain of custody
Consent Order	Compliance Order on Consent
CPTF	Cable Pull Test Facility
DOE	Department of Energy (U.S.)
DOT	Department of Transportation (U.S)
EPA	Environmental Protection Agency (U.S.)
EQL	estimated quantitation limit
FV	fallout value
FY	fiscal year
GPS	global positioning system
HE	high explosives
IDW	investigation-derived waste
IP	individual permit
LANL	Los Alamos National Laboratory
LLW	low-level waste
MDA	material disposal area
MLLW	mixed low-level waste
NES	nuclear environmental site
NMED	New Mexico Environment Department
NOI	notice of intent
PID	photoionization detector
PPE	personal protective equipment
QA	quality assurance
QC	quality control
RPF	Records Processing Facility
SCL	sample collection log

SMA	site-monitoring area
SMO	Sample Management Office
SOP	standard operating procedure
SSL	soil screening level
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TA	technical area
TCLP	toxicity characteristic leaching procedure
TPH	total petroleum hydrocarbons
VOC	volatile organic compound
WAC	waste acceptance criteria
WCSF	waste characterization strategy form

A-2.0 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-3.0 DATA QUALIFIER DEFINITIONS

Data Qualifier	Definition
U	The analyte was analyzed for but not detected.
J	The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.
J+	The analyte was positively identified, and the result is likely to be biased high.
J-	The analyte was positively identified, and the result is likely to be biased low.
UJ	The analyte was not positively identified in the sample, and the associated value is an estimate of the sample-specific detection or quantitation limit.
R	The data are rejected as a result of major problems with quality assurance/quality control parameters.

Appendix B

Management Plan for Investigation-Derived Waste

B-1.0 INTRODUCTION

This appendix describes how investigation-derived waste (IDW) generated during the Phase II investigation of sites at Technical Area 49 inside the nuclear environmental site boundary at Los Alamos National Laboratory (the Laboratory) will be managed. The IDW may include, but is not limited to, drill cuttings, contact waste, decontamination fluids, and all other waste that has potentially come into contact with contamination.

B-2.0 INVESTIGATION-DERIVED WASTE

All IDW generated during investigation activities will be managed in accordance with the current version of Standard Operating Procedure (SOP) 5238, Characterization and Management of Environmental Program Waste. This SOP incorporates the requirements of applicable U.S. Environmental Protection Agency and New Mexico Environment Department (NMED) regulations, U.S. Department of Energy (DOE) orders, and Laboratory requirements.

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

A waste characterization strategy form (WCSF) will be prepared and approved according to the requirements of SOP-5238. The WCSF will provide detailed information on IDW characterization methods, management, containerization, and potential volumes. IDW characterization is completed through review of investigation data and/or documentation or by direct sampling. Waste characterization may include a review of historical information and process knowledge to identify whether listed hazardous waste may be present (i.e., due diligence reviews). If low levels of listed hazardous waste are identified, a "contained in" determination may be submitted for approval to NMED.

Wastes will be containerized and placed in clearly marked and appropriately constructed waste accumulation areas. The initial management of the waste will rely on the data from previous investigations and/or process knowledge. If new analytical data change the expected waste category, the waste will be managed in accumulation areas appropriate to the final waste determination. Waste accumulation area postings, 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 WCSF and approved before the waste is generated. The waste streams anticipated to be generated during work plan implementation are described below.

B-2.1 Drill Cuttings

This waste stream consists of soil and rock generated by the drilling of boreholes with the intent to sample. Drill cuttings include excess core samples not submitted for analysis and any returned samples sent for analysis. Drill cuttings will be containerized in 20-yd^3 rolloff containers, 55-gal. drums, B-12 containers, or other appropriate containers at the point of generation.

Cuttings will be land-applied if they are nonhazardous and meet residential soil screening levels and the criteria in the NMED-approved NOI Decision Tree for Land Application of IDW Solids from Construction of Wells and Boreholes. This waste stream will be characterized based either on direct sampling of the waste or on the results from core samples collected during drilling. If directly sampled, the following analyses will be performed: volatile organic compounds (VOCs); semivolatile organic compounds (SVOCs); cyanide, nitrate, explosive compounds, and perchlorate (if screening and/or process knowledge indicates the presence of explosives); radionuclides as identified for each site in the work plan; total metals; and, if needed, toxicity characteristic leaching procedure (TCLP) metals. If process knowledge, odors, or staining indicates the cuttings may be contaminated with petroleum products, the materials will also be analyzed for total petroleum hydrocarbons (TPH) and polychlorinated biphenyls. Other constituents may be analyzed as necessary to meet the waste acceptance criteria (WAC) for a receiving facility. The Laboratory expects most cuttings will be land-applied or disposed of as low-level waste (LLW). However, the waste may also be classified as hazardous or mixed low-level waste (MLLW). All drill cuttings will be treated/disposed of at an authorized on-site or off-site facility appropriate for the waste classification.

B-2.2 Contact Waste

The contact waste stream consists of potentially contaminated materials that “contacted” waste during sampling and excavation. This waste stream consists primarily of, but is not limited to, personal protective equipment (PPE) such as gloves, decontamination wastes such as paper wipes, and disposable sampling supplies. Characterization of this waste stream will use acceptable knowledge (AK) of the waste materials, the methods of generation, the extent of contamination, and analysis of the material contacted (e.g., drill cuttings and soil). The waste will be containerized (e.g., in 55-gal. drums) and managed in accordance with applicable Laboratory waste management requirements based on the waste characterization results. The Laboratory expects most of the contact waste to be designated as industrial waste. However, the waste may also be classified as hazardous, MLLW, or LLW. All contact waste will be treated/disposed of at an authorized off-site facility appropriate for the waste classification.

B-2.3 Decontamination Fluids

This waste stream will consist of liquid wastes from decontamination activities if dry decontamination cannot be performed. Consistent with waste minimization practices, the Laboratory uses dry equipment decontamination methods to the extent possible. If dry decontamination cannot be performed, liquid decontamination wastes will be collected in containers at the point of generation. The fluids from decontaminating drilling or sampling equipment will be characterized through AK of the waste materials, the levels of contamination measured in the environmental media (e.g., the results of the associated drill cuttings), and, if necessary, direct sampling of the containerized waste. If directly sampled, the following analyses will be performed: VOCs, SVOCs, radionuclides (as identified for each site in the work plan), total metals, and, if needed, TCLP metals and other analyses required by the receiving facility (e.g., total suspended solids, Microtox, chemical oxygen demand, oil and grease, pH, nitrates). The Laboratory expects any decontamination liquid waste to be nonhazardous liquid waste that will be sent to one of the Laboratory’s wastewater treatment facilities or to an authorized off-site facility where the WAC allows the waste to be received.

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, and expected disposition 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-5238. The WCSF will provide detailed information about IDW characterization, management, containerization, and potential volume generation for each site.

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).

Most 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 U.S. Department of Transportation (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.

Table B-3.0-1
Summary of Estimated IDW Generation and Management

Waste Stream	Expected Waste Type	Expected Disposition
Drill cuttings	Industrial Hazardous LLW MLLW	Land application or treatment/disposal at an authorized on-site or off-site facility
Contact waste	Industrial Hazardous LLW MLLW	Disposal at an approved off-site facility
Decontamination fluids	Industrial	Treatment at an on-site wastewater treatment facility or treatment/disposal at an authorized off-site facility