DEPARTMENT OF ENERGY
Environmental Management Los Alamos Field Office (EM-LA)
Los Alamos, New Mexico 87544

EMLA-2021-0096-02-001 December 21, 2020

Mr. Kevin Pierard
Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6313

Subject: Submittal of the Solid Waste Management Unit Assessment Work Plan for Middle DP Road Site

Dear Mr. Pierard:

Enclosed please find two hard copies with electronic files of the "Solid Waste Management Unit Assessment Work Plan for Middle DP Road Site."

On February 20, 2020, the U.S. Department of Energy (DOE) made verbal notification to the New Mexico Environment Department (NMED) that on February 14, 2020, a Los Alamos County Public Utilities subcontractor encountered debris during excavation activities for a new sewer utility line designed to serve two new housing complexes and existing facilities along DP Road. On April 7, 2020, NMED requested that DOE submit a preliminary screening plan in accordance with Section X.C of the 2016 Compliance Order on Consent (Consent Order). The objective of this assessment work plan is to evaluate historical information and, based on that evaluation, propose sampling to define the nature and extent of potential contamination associated with the debris encountered at the Middle DP Road site. Based on the results of this screening assessment, a determination will be made if this site should be included in Appendix A of the Consent Order as a newly discovered solid waste management unit or area of concern, or if no further action related to this site will be taken.

Pursuant to Section XXIII.C of the Consent Order, a pre-submission review meeting was held between the DOE Environmental Management Los Alamos Field Office (EM-LA), Newport News Nuclear BWXT-Los Alamos, LLC, and NMED on December 17, 2020. NMED agreed to provide comments to EM-LA by January 31, 2021. In order to meet that date, NMED requested that EM-LA provide the final geophysical survey report and, based on the results of the report, submit revised proposed potholing location maps in early January 2021.

If you have any questions, please contact Duane Parsons at (505) 551-2961 (duane.parsons@em-la.doe.gov) or Cheryl Rodriguez at (505) 414-0450 (cheryl.rodriguez@em.doe.gov).

Sincerely,

Digitally signed by BRIAN HARCEK
Date: 2020.12.18 12:54:30 -07'00'
FOR

Arturo Q. Duran
Compliance and Permitting Manager
Environmental Management
Los Alamos Field Office

Enclosure(s):

1. Two hard copies with electronic files – Solid Waste Management Unit Assessment Work Plan for Middle DP Road Site (EM2020-0498)

CC (letter and enclosure[s] emailed):
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December 2020
EM2020-0498

Solid Waste Management Unit Assessment Work Plan for Middle DP Road Site

N3B Los Alamos

EM2020-0498

Solid Waste Management Unit Assessment Work Plan for Middle DP Road Site

December 2020

Responsible program director:

Michael O. Erickson		Program Director	RCRA Remediation Program	12/16/20
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Responsible N3B representative:

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Responsible DOE EM-LA representative:

Arturo Q. Duran	Digitally signed by BRIAN HARCEK Date: 2020.12.18 12:53:56 -07'00'	Compliance and Permitting Manager	Office of Quality and Regulatory Compliance	
Printed Name	Signature Brian Harcek For	Title	Organization	Date

EXECUTIVE SUMMARY

On February 20, 2020, the U.S. Department of Energy (DOE) made verbal notification to the New Mexico Environment Department (NMED) that on February 14, 2020, a Los Alamos County Public Utilities subcontractor encountered debris during excavation activities for a new sewer utility line designed to serve two new housing complexes and existing facilities along DP Road. The DOE National Nuclear Security Administration and Environmental Management Los Alamos field offices, along with Newport News Nuclear BWXT-Los Alamos, LLC, and Triad National Security, LLC, prepared and submitted details of the event and the initial response to NMED on March 9, 2020, in a joint response to a February 28, 2020, request for information from NMED. The area where the debris was encountered is within the Land Conveyance and Transfer Tract A-16-a and is adjacent to the boundary of Material Disposal Area B and the boundary of Tract A-8-b.

On April 7, 2020, NMED requested that DOE submit a preliminary screening plan in accordance with Section X.C of the 2016 Compliance Order on Consent (the Consent Order). The objective of this assessment work plan is to evaluate historical information and, based on that evaluation, propose sampling to define the nature and extent of potential contamination associated with the debris encountered at the Middle DP Road site. Based on the results of this screening assessment, a determination will be made if this site should be included in Appendix A of the Consent Order as a newly discovered solid waste management unit or area of concern, or if no further action related to this site will be taken.

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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). 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 36 mi^2 of the Pajarito Plateau, which consists of a series of fingerlike mesas that are separated by deep canyons containing perennial and intermittent streams running from west to east. Mesa tops range in elevation from approximately 6200 ft to 7800 ft above mean sea level.

The Laboratory has been part of a national effort by DOE to clean up sites and facilities formerly involved in weapons research and development. The goal of this effort was 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, DOE has investigated sites potentially contaminated by past Laboratory operations. These sites are designated as either solid waste management units (SWMUs) or areas of concern (AOCs).

On February 20, 2020, DOE made verbal notification to the New Mexico Environment Department (NMED) that on February 14, 2020, a Los Alamos County (LAC) Public Utilities subcontractor encountered debris during excavation activities for a new sewer utility line designed to serve two new housing complexes and existing facilities along DP Road. The debris was situated 7 to 8 ft below ground surface (bgs) at the southern end of the sewer trench excavation. The LAC Fire Department and the Hazardous Materials team (HazMat) were deployed to the scene and took preliminary field screening measurements and determined that there was no imminent and immediate threat to human health or the environment. However, the HazMat team determined radiological values were greater than the background threshold. Subsequently, DOE deployed a Radiological Assistance Program (RAP) team to conduct additional assessments of the area and notified NMED that plutonium contamination was confirmed at the site and that access to the site was being controlled with the use of locked fencing. Additional radiological contamination was identified (plutonium and uranium) by the RAP team, but the extent of contamination or presence of hazardous waste constituents had not been identified.

The DOE National Nuclear Security Administration (NNSA) and Environmental Management Los Alamos field offices, along with Newport News Nuclear BWXT-Los Alamos, LLC (N3B) and Triad National Security, LLC (Triad) prepared and submitted details of the event and the initial response to NMED on March 9, 2020, in a joint response to a February 28, 2020, request for information from NMED (DOE 2020, 700839; NMED 2020, 700783). The response included results of isotopic analyses of the debris and summarized initial management of the materials removed from the site . The area where the debris was encountered is within the Land Conveyance and Transfer Tract A-16-a and is adjacent to the boundary of Material Disposal Area (MDA) B and the boundary of Tract A-8-b.

On April 7, 2020, NMED requested that DOE submit a preliminary screening plan (NMED 2020, 700838) in accordance with Section X.C of the 2016 Compliance Order on Consent (the Consent Order). This SWMU assessment work plan details the preliminary screening to be conducted and includes sampling and investigation activities and a schedule for implementing these activities. Based on the results of this screening assessment, a determination will be made if this site should be included in Appendix A of the Consent Order as a newly discovered SWMU or AOC. This determination will be based on whether the site poses a potential unacceptable risk to human health under the residential scenario. This work plan refers to this investigation area as the Middle DP Road (MDPR) site. The location of the MDPR site with respect to surrounding landholdings is shown in Figure 1.0-1.

Four test pits were excavated in the southwest area of Tract A-16-a before the sewer lines and a new sewer lift station were installed. On May 18, 2020, debris that consisted primarily of wood was found in a thin layer at 6-8 ft bgs in Pit 2. Radiological surveys detected residual radioactivity on the debris. This second discovery on Tract A-16-a was approximately 80 feet south of the first discovery at the original sewer line trench. Triad collected samples during excavation and submitted the samples to the Health Physics Analytical Laboratories (HPAL) at LANL for radiological analysis. Results indicated plutonium-239, uranium-235, and uranium-238 were above background values at this location. Both the original trench and test pit debris locations are situated near former MDA B (Figure 1.0-2). Non-contaminated debris was encountered at Pit 1, and no debris or contaminated media was encountered during excavation at Pit 3 and Pit 4 (Figure 1.0-2). On June 22 and June 24, 2020, additional contaminated debris was encountered at 8 ft bgs during excavation for the lift station. The excavated area was located on Tract A-8-a, south of the border with Tract A-16-a and south of the previous locations where contaminated debris was encountered (Figure 1.0-2). The material encountered on June 22 and June 24 contained processed oxidized uranium-234 and uranium-238.

On July 24, 2020, N3B began excavating four test pits on Tract A-8-b before starting the excavation for a new sewer line trench. During excavation of Pit 4, debris consisting of pieces of glass, ceramic plates, clay, and charred wood were encountered at approximately 5 ft bgs. Radiological field screening measurements of the debris indicated activities were below background. The non-contaminated debris was most likely associated with a former residential trailer park (section 2.4.2). No other debris was encountered during excavation of Pits 1–3 and the new sewer line trench (Figure 1.0-2).

The MDPR site is potentially contaminated with hazardous chemicals and radionuclides. 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 458.1, Administrative Change 3, “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.

1.1 Work Plan Overview

This work plan presents the proposed sampling and analyses needed to define the vertical and/or lateral extent of potential contamination associated with the MDPR site. Contaminants to be investigated include inorganic and organic chemicals and radionuclides.

Section 2 presents the background and conceptual site model of the MDPR site. Section 3 summarizes site conditions, and section 4 presents a site description and the scope of proposed activities at the MDPR site. Section 5 describes investigation methods for proposed field activities. Ongoing monitoring and sampling programs within the area are summarized in section 6. Section 7 is an overview of the anticipated schedule of the investigation and reporting activities. The references cited in this work plan and the map data sources are provided in section 8. Appendix A of this work plan includes a list of acronyms and abbreviations, a metric conversion table, and a data qualifier definitions table. Appendix B describes the management of wastes generated during implementation of the work plan. Geophysical surveys proposed for the MDPR site are included in Appendix C.

1.2 Work Plan Objectives

The objective of the investigation activities described in this work plan is to determine the nature and extent of potential contamination associated with the MDPR site. Based on the results of this screening assessment, a determination will be made if this site should be included in Appendix A of the Consent Order as a newly discovered SWMU or AOC or if no further action related to this site will be taken.

To help accomplish this objective, this work plan

- presents historical and background information on this site,
- describes the rationale for proposed data collection activities, and
- identifies and proposes appropriate methods and protocols for collecting, analyzing, and evaluating data to characterize this site.

Contamination is expected to be present as a result of the past burial of debris at the site. Therefore, the investigation approach focuses on identifying areas where debris is located and defining the extent of contamination associated with the debris. During implementation of this plan, if a large area of debris is encountered or a former waste disposal area is identified, an accelerated corrective action plan or similar document will be prepared.

2.0 BACKGROUND

2.1 General Site Information

The MDPR site is located on Delta Prime (DP) Mesa on the northern boundary of the Laboratory and is immediately east-southeast of the Los Alamos townsite (Figure 1.0-1). DP Mesa extends from the mesa top to the stream channels in three adjacent canyons, DP Canyon to the north and BV and Los Alamos Canyons to the south. The MDPR site is located to the west of Technical Area 21 (TA-21) along DP Road. It is situated between the western end of former MDA B and the eastern end of Tract A-8-b. The MDPR site is located within the footprint of Tracts A-8-a and A-16-a (Figure 1.0-2).

2.2 Operational History

During World War II, the Laboratory was established for the research, development, and testing of the first deliverable nuclear weapon. In 1945, the operations for establishing the chemical and metallurgical properties of the nuclear material necessary to achieve and sustain the nuclear fission reaction were transferred from the townsite facilities to newly built facilities at TA-21.

DP West operations began in September 1945, primarily to produce metal and alloys of plutonium from nitrate solution feedstock provided by other production facilities. This procedure involved several acid dissolution and chemical precipitation steps to separate the plutonium and other valuable actinides from the feedstock. A major research objective at DP West was the development of new purification techniques that would increase the efficiency of the separation processes (Christensen and Maraman 1969, 004779). Details of the purification techniques are discussed in the operable unit (OU) work plan for TA-21 (LANL 1991, 007529). Other operations performed at DP West included nuclear fuel reprocessing. In 1977, transfer of work to the new plutonium facility at TA-55 began and much of the DP West complex was vacated.

DP East operations also began in September 1945. These facilities were used to process polonium and actinium and to produce initiators (a nuclear weapons component). From 1952 through 1973 the facilities supported the Rover nuclear propulsion project. In 1964, building 21-209 was built to house research into high-temperature and actinide chemistry. Following the Rover project, the facilities supported fusion research. Building 21-155 housed the Tritium Systems Test Assembly for developing and demonstrating effective technology for handling and processing deuterium and tritium fuels used in fusion reactors. Operations ceased and the DP East facilities were placed in safe shutdown in 2003.

TA-21 includes five MDAs: A, B, T, U, and V. Process wastes, transuranic wastes, and liquid wastes were disposed of at the MDAs from the early 1940s until the late 1970s. The major contributors to waste streams at TA-21 were plutonium-processing activities. However, because plutonium was scarce, waste-stream recycling became a common practice to remove as much plutonium as possible from the waste stream. Numerous other chemicals were used for separation techniques and were present in the waste stream. Airborne effluents were released from some of the buildings at DP West and DP East (LANL 1991, 007529).

All operations at TA-21 have ceased and the majority of the structures at TA-21 have undergone decontamination and decommissioning (D&D) beginning in 2009. Nearly all the buildings have been removed to the foundations, some areas have been remediated, and septic tanks are not receiving any discharges; all sumps and septic tanks are disconnected from their sources, some tanks have been removed, some have been filled and left in place, or some have been emptied and left in place. The MDAs and the main TA-21 area are fenced for controlled access. Currently, TA-21 is under DOE ownership and control and will be transferred to LAC in the future for industrial/commercial use only.

2.3 SWMU and AOC Site Descriptions

The following section describes the SWMUs and AOCs that are located near the MDPR site. The operational history, investigation activities conducted, and current status for each site is discussed.

2.3.1 SWMU 21-015, MDA B

MDA B (SWMU 21-015) is a former 6.03-acre disposal site that was located in TA-21 (Figure 1.0-2). MDA B was the first common disposal area for radioactive waste generated at LANL and operated from 1944 to 1948. The site runs along the fenceline on DP Road and is located about 1600 ft east of the intersection of DP Road and Trinity Drive. The SWMU drains south into BV Canyon, a small tributary of Los Alamos Canyon. The site was thought to contain five or more burial pits (Rogers 1977, 005707). Except for the hazardous-materials pit, which was described as a trench 2 ft wide × 40 ft long × 3 ft deep, pits were believed to be about 300 ft long × 15 ft wide × 12 ft deep. The large pits ran parallel to the DP Road fenceline. The hazardous materials pit was at the easternmost end of MDA B. About 90% of the wastes received at MDA B consisted of radioactively contaminated paper, rags, rubber gloves, glassware, and small metal apparatus contained in cardboard boxes (Meyer 1952, 028154; LANL 1991, 007529; Ferguson et. al. 1998, 058212). The remainder of the waste included hazardous chemicals, waste products from a water boiler, wood from temporary storage cabinets, and a truck contaminated with fission products from the Trinity test. In 1948, a fire in one pit spurred the closure of MDA B, and another disposal site, MDA C (SWMU 50-009), was selected at TA-50 (Rogers 1977, 005708; Rogers 1977, 005707). The practice of filling the depth and width of the pits before covering the waste with fill dirt led to subsidence, which occurred shortly after MDA B closed. Uncontaminated concrete and soil from construction sites were used to abate the subsidence. In 1966, the western two-thirds of MDA B was fenced, compacted, paved, and then leased to LAC for trailer storage. The trailer storage area was used until September 1990.

2.3.1.1 Operational History

From 1944 until it closed in 1948, MDA B received Laboratory wastes that contained both hazardous constituents and radionuclides. Most information about the waste inventory at MDA B comes from reports and memoranda generated by historical Laboratory organizations working at these sites and employee interviews. These sources indicate that the management of materials disposed of at MDA B was largely the responsibility of the waste-generation sites. The only site-specific documentation consisted of waste pickup logbooks that were used beginning in 1947. These logbooks documented the buildings served and the types of materials (e.g., trash, solutions, and chemicals) picked up.

The vast majority of waste disposed of at MDA B was contaminated with residual radioactivity, including routine laboratory waste, glassware, obsolete equipment, wooden laboratory furniture, demolition debris, building materials, clothing, paper, trash, and small amounts of chemicals from laboratory areas. All waste and trash from the Chemistry and Metallurgy Research Division laboratories were considered contaminated by residual radioactivity. Therefore, all waste and trash were to be thrown into the "hot" receptacles that were placed in each laboratory. The largest waste contributors may have been the contaminated laundry and building demolition debris as laboratory structures and equipment were upgraded after the war. Nonroutine waste would have included materials from spills and accidental releases. No process evidence exists that large volumes of chemicals were disposed of at MDA B.

The radionuclides used during the time MDA B was active included plutonium, polonium, uranium, americium, curium, radioactive lanthanum, cesium, and actinium. Short-lived radionuclides, such as radioactive lanthanum, are no longer present because of radioactive decay. Most radioactively contaminated waste consisted of disposed laboratory items such as paper, rags, rubber gloves, glassware, and small experimental assemblies, which were placed in cardboard boxes by the waste originator and sealed with masking tape. Additional large waste items included metal debris such as air ducts and large metal apparatus. The latter type of material was typically placed in wooden boxes or wrapped with paper (Meyer 1952, 028154; LANL 1991, 007529; Ferguson et al. 1998, 058212).

2.3.1.2 Investigation Activities

MDA B was remediated in 2010 and 2011, and the results reported in the Investigation/Remediation Report for Material Disposal Area B, Solid Waste Management Unit 21-015, Revision 2 (LANL 2013, 243675; NMED 2014, 525003). All buried waste and contaminated soil/tuff was removed and the nature and extent of residual contamination from historical waste disposal activities were defined. Because the cleanup objectives were met, the report indicated no further investigation or remediation activities were necessary, and MDA B was appropriate for corrective action complete without controls. Additional sampling was conducted for volatile organic compounds (VOCs), and the results reported to NMED in 2014 (LANL 2014, 600008; NMED 2015, 600192).

2.3.1.3 Site Status

A request for a certificate of completion without controls was submitted in March 2015, and approved by NMED in May 2015 (LANL 2015, 600264; NMED 2015, 600451). MDA B is located within Tract A-16-a, which was transferred to LAC in 2018.

2.3.2 SWMU 00-030(b), Septic Tanks

SWMU 00-030(b) is a septic system that is composed of four tanks that served 6th Street warehouses 1 through 4, an office building, a cold storage plant, and the eastern portion of TA-01 (Figure 1.0-2) (LANL 1996, 054616). The septic system consisted of two diversion boxes, four septic tanks (a north unit consisting of three adjacent tanks with two cells each, and a single south unit with two cells), and associated piping and leach field. The diversion boxes received waste from drains in the buildings and directed the sewage flow to the septic tanks, which then directed the sewage via drainlines to a leach field and an outfall in BV Canyon. The north diversion box, constructed of concrete, directed flow to the two northernmost septic tanks, while the southern diversion box, constructed of brick, directed flow to the southern two septic tanks. The diversion boxes were located adjacent to 6th Street, between the street and warehouse 1. The septic tanks were located approximately 35 ft east of warehouse 1, partially under the 6th Street pavement. The leach field extends eastward from the tanks approximately 500 ft, and the outlet piping extends southeast then east, ending at an outfall in BV Canyon (LANL 1996, 054616). The leach field consisted of a central line running east, with numerous branch, or lateral, lines extending from it toward the northeast and southeast. Each lateral line was approximately 90 to 100 ft long.

2.3.2.1 Operational History

The septic system at SWMU 0-030(b) reportedly served the 6th Street warehouses, an office building, a cold storage plant, and the eastern portion of TA-01 from 1943 until approximately 1950 (LANL 1996, 054616). In the early 1950s the leach field, which is located east of the 6th Street warehouses, was bulldozed and distributed on the mesa top as part of site preparation for a trailer park. Trenches dug in 1995 to locate the leach field components and drainlines found only a few branches of leach field piping, consisting of 2-ft sections of vitrified-clay pipe (VCP) loosely laid end-to-end and underlain by a shallow gravel-filled trench. These were found in the far northwest portion of the leach field area (LANL 1996, 054616). It was clear from comparisons of 1943 engineering drawings to surveyed elevations of points in the field in 1995 that a considerable amount of soil was removed from portions of the field before construction of the trailer park. The 1995 elevations were found to be as much as 5 to 6 ft lower than elevations shown on the engineering drawings. The soil removed from portions of the field was presumably used as fill material to build up the south side of the field near the rim of Los Alamos Canyon. This excavation and recontouring of the field probably accounts for the numerous fragments of VCP found on the surface of the field and for the general absence of intact leach field structures (LANL 1996, 054616). Mobile homes were placed on the site of the former leach field around 1948. The trailer park infrastructure was removed in 1974, and the site has been vacant since that time.

2.3.2.2 Investigation Activities

In 1995, Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) samples were collected from within and below each component of the septic system, and then all four septic tanks were closed in place (LANL 1996, 055203). In 1996, voluntary corrective action (VCA) activities included removing the distribution box and a small volume of contaminated soil associated with the distribution box. In 2002, VCA samples were collected beneath outfall piping and beneath the central leach field drain line and lateral pipes. Overlying soil in the leach field was excavated in an attempt to locate the lateral pipes. Many of the northern laterals were found in place, but the southern laterals were not found (LANL 2003, 087625). The results of the human health risk screening assessment showed that under a residential scenario there is no unacceptable potential risk to human health, and no potential unacceptable adverse ecological effects exist due to residual contamination at this site (LANL 2003, 087625).

2.3.2.3 Site Status

In September 2004, DOE approved the recommendation for no further action (NFA) under NFA Criterion 5: the site has been characterized or remediated in accordance with applicable state and/or federal regulations, and the available data indicate that residual contamination does not pose an unacceptable risk to human health or the environment under current and projected future residential land use. In January 2006, DOE requested a certificate of completion (COC) without controls for SWMU 00-030(b) (LANL 2005, 091617) in accordance with the March 1, 2005, Consent Order. NMED approved the COC without controls on February 23, 2006 (NMED 2006, 091517). This site is located within Tract A-8-a, which was conveyed by NNSA to the Los Alamos School Board in 2007.

2.3.3 SWMU 00-030(m), Former Septic Tank

SWMU 00-030(m) consisted of a 10 ft × 6 ft × 6 ft wood septic tank and 6-in. VCP drainlines that served an incinerator building where residential garbage was burned (Figure 1.0-2). This system also handled sanitary wastes from the incinerator building (LANL 1992, 007667) (LANL 1996, 055203). The outlet line ran east along the edge of the mesa for approximately 400 ft before connecting to the outlet drainline from SWMU 00-030(b), which discharged to BV Canyon.

2.3.3.1 Operational History

The septic tank served an incinerator building where garbage collected from private residences was burned. Before the garbage was incinerated, excess liquids were allowed to drain off and were piped into the septic tank (LANL 1992, 007667; LANL 1996, 055203). The system also handled sanitary wastes from the incinerator building itself. The 1990 SWMU report (LANL 1990, 007511) listed the period of use as beginning in the late 1940s, but no end date was identified.

2.3.3.2 Investigation Activities

In 1995, RFI samples were collected from within and below each component of the septic system (LANL 1996, 055203). Based on the results, VCA activities were conducted to remove the tank, inlet drainline, and surrounding soil/tuff; collect confirmation samples; and backfill and restore the site. In 2002, VCA samples were collected beneath the septic tank outfall pipe. The results of the human health risk screening assessment showed that under a residential scenario there is no unacceptable potential risk to human health, and no potential unacceptable adverse ecological effects exist due to residual contamination at this site (LANL 2003, 087625).

2.3.3.3 Site Status

In September 2004, DOE approved the recommendation for NFA under NFA Criterion 5: the site has been characterized or remediated in accordance with applicable state and/or federal regulations, and the available data indicate that residual contamination does not pose an unacceptable risk to human health or the environment under current and projected future residential land use. In January 2006, DOE requested a COC without controls for SWMU 00-030(m) (LANL 2006, 091617) in accordance with the March 1, 2005, Consent Order. NMED approved the COC without controls on February 23, 2006 (NMED 2006, 091517).

2.3.4 AOC 00-010(a), Surface Disposal Site

AOC 00-010(a) is a surface disposal site located on a small mesa between BV Canyon and Los Alamos Canyon and southwest of the western end of former MDA B (LANL 1990, 007511; LANL 1992, 007667). It was first identified as an AOC based on preliminary review of aerial photographs taken in the mid-1940s that seemed to indicate a drum storage area and several trenches. Photometric analysis of the evidence indicated that the items thought to be drums were in fact rows of stockpiled supplies, not waste awaiting disposal. In addition, an interview with a former Zia Company employee who had worked in the area identified the stored material as canisters of roofing asphalt and roofing coal tar pitch (Francis 1996, 076133). It is believed that the site was used for stockpiling and storage only.

2.3.4.1 Investigation Activities

No investigation activities were conducted at this site because the AOC had been incorrectly identified as a waste disposal storage area.

2.3.4.2 Site Status

The 1992 RFI work plan recommended NFA at this site (LANL 1992, 007667). DOE concurred with the NFA recommendation in October 1995 under Criterion 1 (the site was never used for the management of RCRA solid or hazardous wastes and/or constituents) (DOE 1995, 050023; LANL 1995, 045365). NMED concurred with the NFA determination and issued a COC without controls on December 27, 2005 (NMED 2005, 091387). This site is included in Table K-3, SWMUs and AOCs Corrective Action Complete without Controls, of the Laboratory’s Hazardous Waste Facility Permit.

2.3.5 SWMU 21-021, Soil Contamination from Stack Emissions

SWMU 21-021 consists of surface soil contamination resulting from the deposition of historical airborne releases of radionuclides from stacks previously located throughout TA-21. The estimated potential area of soil contamination is approximately 300,000 m^2 and overlaps current and former sections of TA-21 and portions of DP Canyon north of TA-21. TA-21 was used primarily for plutonium research and metal production and related activities from 1945 to 1978. After the major plutonium research and metal production activities at TA-21 ceased in 1978, subsequent unrelated office and small-scale research activities continued until approximately 2006. Historical airborne releases of radionuclides from stacks at TA-21 were documented from 1951 to 1971 and from 1973 to 1989. A minimum of approximately 2 Ci/yr of plutonium-239/240 was released from all TA-21 stacks in the 1950s. There is no documentation of nonradioactive chemical releases associated with the historical TA-21 stack emissions.

2.3.5.1 Investigation Activities

SWMU 21-021 was investigated during the 1992 and 1993 OU-wide surface soil investigations conducted throughout TA-21 (LANL 1994, 026073). The investigation objectives were to provide data about target analytes and establish a baseline for comparison with published regional background data; investigate area-wide airborne emission deposition; and provide preliminary TA-wide information for a future baseline risk assessment.

During the 1992 RFI conducted throughout TA-21 including SWMU 21-021, a 40 × 40-meter grid was established over TA-21 (LANL 1994, 026073). A total of 453 surface and near-surface samples were collected from 363 locations throughout TA-21 and in Los Alamos and DP Canyon around TA-21, primarily on grid points and some from off-grid points. A total of 155 samples were collected from the 0- to 6-in.

depth interval and 298 samples were collected from the 0- to 1-in. depth interval to evaluate contamination caused by sitewide contamination resulting from airborne stack emissions. Samples were submitted for analysis of target analyte list (TAL) metals, total uranium, americium-241, gamma-emitting radionuclides, isotopic plutonium, strontium-90, and tritium. In addition, numerous samples collected from the 0- to 6-in. depth interval were submitted for analysis of isotopic uranium, semivolatile organic compounds (SVOCs), and isotopic thorium (LANL 1994, 026073).

During the 1993 surface RFI conducted at TA-21 including SWMU 21-021, the north end of the 1992 40 × 40-meter sampling grid was extended to the west up DP Canyon by 15 sample locations (600 m) to coincide with the western edge of the 1992 DP Mesa grid. A total of 15 samples were collected from the 0- to 1-in. depth interval at 15 grid locations, and 8 samples were collected from the 0- to 6-in. depth interval at 8 of the same grid locations. Samples were submitted for analysis of TAL metals, total uranium, americium-241, gamma-emitting radionuclides, isotopic plutonium, strontium-90, and tritium. The 8 samples collected from the 0- to 6-in. depth interval were also submitted for analysis of SVOCs.

Data from the 1992–1993 surface RFI, which are screening level, showed inorganic chemicals detected above background values (BVs); detected polycyclic aromatic hydrocarbons (PAHs) at a few locations primarily west of the former TA-21 operational areas; and radionuclides, primarily americium-241, plutonium-238, and plutonium-239/240, detected above regional BVs/fallout values. Maximum detected inorganic chemical concentrations were below residential soil screening levels (SSLs); maximum detected PAH concentrations were above residential SSLs and below industrial SSLs west of the former TA-21 operational areas and are likely from upgradient sources; and maximum detected radionuclide activities, specifically americium-241 and plutonium isotopes, were above residential screening action levels (SALs) and generally below industrial SALs (LANL 1994, 026073).

An interim action (IA) was conducted in 2002 to characterize the surface and shallow surface soil in the western part of SWMU 21-021 to determine if an unacceptable risk was present to human or ecological health (LANL 2003, 087625). Surface soil samples were collected in an area west of MDA B, within BV Canyon, and on the mesa top south of MDA B. The results of the human health risk screening assessment indicated that under a residential scenario there is no unacceptable potential risk to human health from residual contamination in this area of SWMU 21-021. The ecological risk screening assessment similarly showed that no chemicals of potential ecological concern were retained. The IA concluded no potential unacceptable adverse ecological effects exist due to residual contamination (LANL 2003, 087625).

2.3.5.2 Site Status

SWMU 21-021 is included in Appendixes A and C of the Consent Order as part of the TA-21 D&D and Cleanup Campaign. The areas of SWMU 21-021 within Tracts A-8-a, A-8-b, and A-16-a have been conveyed and no further action is required for this portion of SWMU 21-021. Because SWMU 21-021 overlies all other SWMUs and AOCs within TA-21, evaluation of risk to support a corrective action complete recommendation is not expected to be made until investigation of all other TA-21 SWMUs and AOCs is complete. These TA-21 results will be presented in a future investigation report.

2.4 Historical Documentation Review

An historical documentation review was conducted to identify operational activities that were conducted adjacent to or within the MDPR investigation area. In the 1944 to 1948 timeframe, this area was referred to as South Point or South Mesa. A coal storage yard occupied the DP Road frontage west of MDA B

(Figure 2.4-1). The coal pile storage area provides a reference point for the photographs and some of the period memoranda.

2.4.1 MDA B Pits and Trenches

The 1977 Laboratory report on near-surface land disposal facilities (Rogers report) (1977, 005707; 1977, 005708) provides a review of the number and location of pits and trenches at MDA B. Rogers concluded that the question of how many pits there are and where they are located could not be answered by the available information, but in a memorandum quoted in the Rogers report, Meyer stated, “I am sure that the area contains six pits: two in the west end running north and south making the ‘L’ shape to the fence and four running east and west in the area parallel to DP Road.” (Rogers 1977, 005707; Rogers 1977, 005708).

Tribby (1945, 033817) indicated that in April 1945, a trench of volume 80 ft × 40 ft × 5 ft existed at MDA B and was overfilled with boxes of contaminated items. Kershaw (1945, 001770) reported that the activated refuse material pit that had been provided on South Point, just southeast of the coal storage piles, had been overfilled, and that cardboard boxes lay outside the trench uncovered. Kershaw requested that an area 200-ft × 400-ft adjacent to and just east of the old pit fenceline be reserved (Kershaw 1945, 001770). A 1945 photograph of waste disposal practice at MDA A is shown in Figure 2.4-2 (LANL 2007, 097973). Similar trench conditions and waste disposals are assumed to have existed at MDA B during this time. A similar condition appeared to have existed as early as July 1944, in a request for a new trench to be dug for the burial of corrugated boxes containing contaminated trash, for dirt to cover the boxes, and for a fence to prevent children from breaking into the boxes resulting in possible danger to their lives (Popham 1944, 095503). In July 1945, Dow (1945, 006713) requested that “a trench 15 ft wide by 300 ft long be bulldozed as deep as practical before hard rock is encountered, starting just east of the now covered CM [Division] disposal pits located southeast of the coal storage yard, and running parallel to, and about 40 or 50 ft north of the DP Site power lines.”

Two aerial photographs (Figures 2.4-1 and 2.4-3) show the physical evolution of MDA B from late 1946 to early 1948. These photographs document the presence of a series of long, narrow trenches parallel to DP Road, with new sections being dug to the east because the previous trench segments were filled. A filled trench appears to have extended from the coal piles on the west side of MDA B to the active trench, and the entire eastern portion of MDA B appears undisturbed except for an access road. The December 1946 photograph (Figure 2.4-1) shows a new section of trench either completed or in progress. The new section of trench appears to extend the trend of long trenches on the western leg of MDA B and appears to be about 400 ft long. The photograph taken about December 1947 (Figure 2.4-3) also shows a full photographic view of MDA B from the north. The trees have been cleared on the eastern leg, the active, open portion of the landfill east of the curve on DP Road, and the entire western portion of the area appears filled.

Figure 2.4-4 provides an overlay of a 1946 aerial photograph with current land tracts and MDPR site features. The aerial photograph shows four large linear coal piles running parallel to DP Road, a smaller coal pile to the south, and laydown areas used during the construction of the 6^{th} Street warehouses located to the west. In a memo dated January 31, 1952, Meyer stated “Letters in the CMR-12 files indicate that sometime in 1944 a pit located in the fenced area [Area B] between the Trailer Court and the CMR laundry [Area V] was in use. When this pit was filled, two more were dug in the area now known as the General’s Tank Area [Area A]. When these were filled (1945), three more pits were dug in the area between the Trailer Court and the CMR laundry” (Rogers 1977, 005707; Rogers 1977, 005708). The Rogers report suggested the 1944 pit mentioned by Meyer “located in the fenced area” could well be “the now covered [as of July 5, 1946] CM Disposal pits located southeast of the coal storage yard" described by Dow (1945, 006713).

2.4.2 DP Trailer Park

After MDA B was closed in 1948, a residential trailer park was built to the west of MDA B, on what is now identified as Tracts A-8-a and A-8-b. The trailer park contained a total of 160 spaces for trailers and mobile homes. Each space had hookups for water, electricity, and sewer. Larger spaces in the southeast corner also had natural gas hookups. There were eight service buildings that had natural gas and electric power service. The trailer park operated from 1948 to 1963, after which many of the residents moved to a new trailer park located on East Jemez Road. A site survey for radioactive contamination of the trailer park area was conducted in 1972 and determined there was no radioactivity above background levels (Meyer 1972, 000566). The trailer park, streets, service buildings, space locations, and utilities were decommissioned in late 1973 or early 1974 (Francis 1993, 040770).

Figure 2.4-5 includes an overlay of a 1958 aerial photograph of the trailer park in relationship to MDPR site features and MDA B. SWMUs 00-030(b) and 00-030(m) were located in the eastern part of the former trailer park in current Tract A-8-a. There are no known SWMUs or AOCs located within Tract A-8-b. The debris encountered in February 2020, and debris subsequently identified to the south, were located outside the boundary of the former trailer park. Because the trailer park was constructed after MDA B closed, and the site was used as a residential area from 1948 to 1963, there is no evidence the trailer park was built on top of a former disposal area. In addition, a new sewer line trench was excavated in July 2020 along the eastern side of Tract A-8-b, and no contaminated debris was encountered (Figure 2.4-5).

2.4.3 Manhattan Project Plutonium

The first milligram quantities of plutonium arrived in Los Alamos in January 1944 and gram quantities arrived in March 1944 (Hammel 1998, 701160). A letter from J. Robert Oppenheimer on August 31, 1944, states that 50 g of plutonium was received in August 1944 (Hammel 1998, 701160). The earliest plutonium-239 was produced by relatively small neutron fluxes and therefore contained relatively small amounts of plutonium-241 and americium-241. The process descriptions from the period provide independent evidence that all uranium and plutonium solutions, process equipment, and incidental materials that came into contact with uranium and plutonium were recovered to the extent possible (LANL 2007, 097973). Purification and recovery processes recorded uranium and plutonium at the milligram level. Every effort was made to conserve uranium, plutonium, polonium, and other radioactive source materials (LANL 2007, 097973).

The plutonium found on the debris at the MDPR site was primarily plutonium-239 and had no detectable americium-241. Most plutonium in the environment of Los Alamos has an americium-241 to plutonium-239 activity ratio greater than 0.1, and Manhattan Project plutonium typically has an activity ratio about 0.01 (Ahlquist et al. 1977, 005710). Amercium-241 has not been detected in any of the material uncovered at the MDPR site. According to preliminary screening results, a glass sample collected on May 5, 2020, from "Pit 2" had a plutonium-239 activity of 16,800 pCi/g and an americium-241 activity <0.63 pCi/g, so the activity ratio was less than 4×10^{-5}. Also, a ceramic plate had plutonium-239 activity of 20,100 pCi/g and americium-241 activity <0.21 pCi/g, so the activity ratio was less than 1×10^{-5}. These activities are similar to those of ultra-pure plutonium, which is typical of the earliest plutonium that arrived in Los Alamos during 1944 (Hammel 1998, 701160). Therefore, the debris encountered at the MDPR site is most likely associated with early (1944 era) waste disposal activities.

2.4.4 MDPR Site Boundary

The assessment boundary for the MDPR site was determined based on the historical document review and site investigations conducted previously in the area. The boundary follows the western edge of Tract A-8-b, which was the former location of the residential trailer park. No Consent Order investigation activities are proposed for Tract A-8-b because the location of the trailer park is known, and there is no evidence to indicate the trailer park was built on top of a former disposal area. The boundaries to the north and east were determined by the areas remediated in the western portion of MDA B in 2010 and 2011. The boundary to the south includes the area used as a construction laydown area in the 1940s and extends to the DOE property boundary (Figure 1.0-2). The MDPR site boundary encompasses the area referred to in the 1945 memo by Dow that described a pit located southeast of the coal storage yard (Dow 1945, 006713).

2.5 Conceptual Site Model

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

2.5.1 Potential Contaminant Sources

Releases at the MDPR site may have occurred as a result of waste disposition activities conducted before the known pit boundaries of former MDA B (SWMU 21-015) were established.

2.5.2 Potential Contaminant Transport Mechanisms

Potential transport mechanisms that may lead to exposure include

- disturbance of contaminants in shallow soil and subsurface tuff by construction, D&D, or Laboratory operations,
- continued dissolution and advective/dispersive transport of contaminants contained in subsurface soil and tuff as a result of past operations,
- biotic perturbation and translocation in subsurface contaminated media including shallow soil, and
- disturbance and uptake of contaminants in shallow soil by plants and animals (bioturbation).

2.5.2.1 Surface Processes

Construction activities, disturbance and uptake by plants and animals, surface water runoff, and wind can disturb contaminants present in shallow soils. During summer thunderstorms and spring snowmelt, runoff from the mesa top may flow down the hillsides and into the perennial and ephemeral streams present in BV and Los Alamos Canyons. Surface water runoff and erosion of contaminated surface soil could lead to contamination of bench areas on the hillside and contamination of the surface water off-site. Surface water may also access subsurface contaminants exposed by soil erosion. Soil erosion can vary significantly depending on factors that include soil properties, the amount of vegetative cover, the slope of the contaminated area, and the intensity and frequency of precipitation. Surface transport of contaminants does not represent a dominant transport pathway at the MDPR site. Contaminated debris was encountered at depths below 7 ft bgs. No surface expression of debris has been identified at the MDPR site.

2.5.2.2 Subsurface Processes

Studies have shown that infiltration of natural precipitation is quite low across the mesa tops of the Pajarito Plateau. The average annual potential evapotranspiration rates far exceed precipitation rates. Under these conditions, infiltration events that propagate beneath the root zone are sporadic and occur only when the short-term infiltration rate exceeds the evapotranspiration rate, such as during summer thunderstorms and spring snowmelt. However, these events more commonly produce runoff into neighboring canyons resulting in infiltration rates below the root zone on the order of a few millimeters or less per year for mesa-top sites (Collins et al. 2005, 092028, pp. 2-84−2-88; Kwicklis et al. 2005, 090069).

This slow infiltration rate generally leads to present-day subsurface contaminant migration of only a few meters deep. Geochemical interactions between the contaminants and the rocks generally act to retard migration further. Therefore, groundwater transport of contaminants through the unsaturated zone to the regional aquifer does not represent a dominant pathway for contaminant transport at the MDPR site.

2.5.3 Potential Receptors

Potential receptors include on-site and nearby construction/D&D workers who could potentially be exposed to contaminants in soil, tuff, and sediment by direct contact, ingestion, or inhalation. Ecological receptors, such as plants and animals, may also be exposed to soil and sediment contaminants.

2.5.4 Cleanup Levels

As specified in the Consent Order, SSLs for inorganic and organic chemicals (NMED 2019, 700500; NMED 2019, 700550) are used as soil cleanup levels unless they are determined to be impracticable or values do not exist for the current and reasonably foreseeable future land uses. SALs are used as soil cleanup levels for radionuclides (LANL 2015, 600929). Screening assessments compare chemical of potential concern concentrations for each site with industrial, residential, and construction worker SSLs and SALs. Consistent with the current planned land use, the MDPR site will be cleaned up to meet cleanup goals for the residential and construction worker scenarios.

The cleanup goals specified in Section VIII of the Consent Order are a target risk of 1 x 10^{-5} for carcinogens or a hazard index of 1 for noncarcinogens. For radionuclides, the release requirements in DOE Order 458.1 will be met.

3.0 SITE CONDITIONS

3.1 Surface Conditions

3.1.1 Soil

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

A majority of the natural mesa-top surface soil has been altered by anthropogenic activities. Excavation and fill, paved roads, parking lots, landscaped areas, and buildings have changed the natural soil landscape considerably.

3.1.2 Surface Water

No natural surface water is present on the mesa top at the MDPR site. During summer thunderstorms and spring snowmelt, runoff flows from the mesa top down the hillsides into Los Alamos Canyon to the south. Surface water runoff and sediment transport are among the potential migration pathways by which contaminants might be transported to off-site receptors. Surface water may also access subsurface contaminants exposed by soil erosion. Soil erosion is dependent on several factors, including soil properties, the amount of vegetative cover, slope of the area, exposure, and the intensity and frequency of precipitation.

3.1.3 Land Use

Currently, land use at the MDPR site within the footprint of Tract A-16-a is industrial/commercial and within the footprint of A-8-a is residential. Tract A-16-a is anticipated to remain industrial/commercial and Tract A-8-a residential for the foreseeable future. Public access to the MDPR site is currently prohibited and is controlled through physical controls, including fencing.

3.2 Subsurface Conditions

3.2.1 Stratigraphic Units

The MDPR site is centrally located on the Pajarito Plateau, approximately midway between the flanks of the Jemez Mountains on the west and the Rio Grande to the east. The stratigraphy of the area is summarized in this section.

3.2.1.1 The Tshirege Member of the Bandelier Tuff

The Tshirege Member is the upper member of the Bandelier Tuff and is the most widely exposed bedrock unit of the Pajarito Plateau (Griggs and Hem 1964, 092516; Smith and Bailey 1966, 021584; Bailey et al. 1969, 021498; Smith et al. 1970, 009752). Emplacement of this unit occurred during eruptions of the Valles Caldera approximately 1.2 million years ago (Izett and Obradovich 1994, 048817; Spell et al. 1996, 055542). The Tshirege Member is a multiple-flow ignimbrite sheet that forms the mesa-top exposures at East Site. On a regional basis, the Tshirege Member consists of at least four cooling subunits that display variable physical properties vertically and horizontally (Smith and Bailey 1966, 021584; Crowe et al. 1978, 005720; Broxton et al. 1995, 050121). The welding and crystallization variability in the Tshirege Member produce recognizable vertical variations in its properties, such as density, porosity, hardness, composition, color, and surface-weathering patterns.

Qbt 1g is the lowermost subunit of the thick ignimbrite sheet overlying the Tsankawi Pumice Bed. It consists of porous, nonwelded, and poorly sorted ash-flow tuffs. The “g” in this designation stands for glass because none of the glass in ash shards and pumices shows crystallization by devitrification or vapor-phase crystallization. This unit is poorly indurated but nonetheless forms steep cliffs because of a resistant bench near the top of the unit; the bench forms a harder, protective cap over the softer underlying tuffs. A thin (4 in. to 10 in.), pumice-poor, surge deposit commonly occurs at the base of this unit.

Qbt 1v forms alternating cliff-like and sloping outcrops composed of porous, nonwelded, crystallized tuffs. The “v” stands for vapor-phase crystallization which, together with in situ crystallization devitrification, has converted much of the glass in shards and pumices into microcrystalline aggregates. The base of this unit is a thin, horizontal zone of preferential weathering that marks the abrupt transition from glassy tuffs below (in Unit 1g) to the crystallized tuffs above. This feature forms a widespread marker horizon (locally termed the vapor-phase notch) throughout the Pajarito Plateau, which is readily visible in canyon walls at TA-21. The lower part of Qbt 1v is orange brown, resistant to weathering, and has distinctive columnar (vertical) joints; hence, the term colonnade tuff is appropriate for its description. A distinctive white band of alternating cliff- and slope-forming tuffs overlies the colonnade tuff. The tuffs of Qbt 1v are commonly nonwelded (pumices and shards retain their initial equant shapes) and have an open, porous structure.

Qbt 2 forms a distinctive, medium-brown, vertical cliff that stands out in marked contrast to the slope-forming, lighter-colored tuffs above and below at TA-21. It displays the greatest degree of welding in the Tshirege Member. A series of surge beds commonly marks its base. It is typically nonporous and has low permeability relative to the other units of the Tshirege Member. Vapor-phase crystallization of flattened shards and pumice is extensive in this unit.

Qbt 3 is a nonwelded to partially welded, vapor-phase altered tuff, which forms many of the upper cliffs in the TA-21 area. Its base consists of a purple-gray, unconsolidated, porous, and crystal-rich nonwelded tuff that underlies a broad, gently sloping bench developed on top of Qbt 2. This basal, nonwelded portion forms relatively soft outcrops that weather into low rounded mounds with a white color, which contrast with the cliffs of partially welded tuff in the middle and upper portions of Qbt 3.

The Tsankawi Pumice Bed forms the base of the Tshirege Member. Where exposed, it is commonly 20 in. to 30 in. thick. This pumice-fall deposit contains moderately well-sorted pumice lapilli (diameters reaching about 2.5 in.) in a crystal-rich matrix. Several thin ash beds are interbedded with the pumice-fall deposits.

3.2.2 Hydrogeology

The hydrogeology of the Pajarito Plateau is separable in terms of mesas and canyons forming the plateau. Mesas are generally devoid of water, both on the surface and within the rock forming the mesa. Canyons range from wet to relatively dry; the wettest canyons contain continuous streams and perennial groundwater in the canyon-bottom alluvium. Dry canyons have only occasional stream flow and may lack alluvial groundwater. Intermediate-perched groundwater has been found at certain locations at depths ranging between 100 and 700 ft bgs. The regional aquifer is found at depths of about 600 to 1200 ft bgs.

In the Los Alamos area, groundwater occurs as (1) water in shallow alluvium in some of the larger canyons, (2) an intermediate-perched groundwater body, which lies above a less permeable layer and is separated from the underlying aquifer by an unsaturated zone, and (3) the regional aquifer.

Contamination of the perched water and/or regional groundwater aquifer can occur only by recharge of infiltrating precipitation from contamination at or near the surface to the underlying groundwater. The hydrogeologic conceptual site model for the Laboratory (Collins et al. 2005, 092028) shows that, under natural conditions, relatively small volumes of water move beneath mesa tops because of low rainfall, high evaporation, and efficient water use by vegetation. Atmospheric evaporation may extend into mesas, further inhibiting downward flow.

3.2.2.1 Vadose Zone

The unsaturated zone from the mesa surface to the top of the regional aquifer is referred to as the vadose zone. The source of moisture for the vadose zone is precipitation, but much of it runs off, evaporates, or is absorbed by plants. The subsurface vertical movement of water is influenced by properties and conditions of the materials that make up the vadose zone.

The Bandelier Tuff is generally dry and does not readily transmit moisture. Most of the pore spaces in the tuff are of capillary size and have a strong tendency to hold water against gravity by surface-tension forces. Vegetation is very effective at removing moisture near the surface. During the summer rainy season when rainfall is highest, near-surface moisture content is variable because of higher rates of evaporation and of transpiration by vegetation, which flourishes during this time.

The various units of the Bandelier Tuff tend to have relatively high porosities. Porosity ranges between 30% and 60% by volume, generally decreasing for more highly welded tuff. Permeability varies for each cooling unit of the Bandelier Tuff. The moisture content of tuff beneath the mesa tops is low, generally less than 5% by volume throughout the profile (Kearl et al. 1986, 015368; Purtymun and Stoker 1990, 007508).

Based on the hydrogeologic conceptual model for mesas (Collins et al. 2005, 092028), moisture movement through the vadose zone is expected to be very slow because of low precipitation, the lack of surface water on the mesa top (including artificial water sources such as ponds), and the drying effect of air exchange along mesa edges. Net infiltration beneath dry mesas is low, with rates generally believed to be less than tens of millimeters per year and commonly on the order of 1 mm/yr or less. Transport times to the regional aquifer beneath dry canyons are expected to exceed hundreds of years (Birdsell et al. 2005, 092048).

3.2.2.2 Alluvial Groundwater

Intermittent and ephemeral stream flows in the canyons of the Pajarito Plateau have deposited alluvium as thick as 100 ft. The alluvium in canyons that originate from the Jemez Mountains is generally composed of sands, gravels, pebbles, cobbles, and boulders derived from the Tschicoma Formation and Bandelier Tuff on the flank of the mountains. The alluvium in canyons that originate from the plateau (such as Ancho Canyon) is comparatively more finely grained, consisting of clays, silts, sands, and gravels derived from the Bandelier Tuff (LANL 1998, 059599, p. 2-17).

In contrast to the underlying volcanic tuff and sediment, alluvium is relatively permeable. Ephemeral runoff in some canyons infiltrates the alluvium until downward movement is impeded by the less permeable tuff and sediment, which results in the buildup of a shallow alluvial groundwater body (Collins et al. 2005, 092028, p. 2-90). Depletion by evapotranspiration and movement into the underlying rock limit the horizontal and vertical extent of the alluvial water (Purtymun et al. 1977, 011846). The limited saturated thickness and extent of the alluvial groundwater preclude its use as a viable source of water for municipal and industrial needs. Lateral flow of the alluvial perched groundwater is in an easterly, downcanyon direction (Purtymun et al. 1977, 011846).

There is no alluvial groundwater in the MDPR site. The mesa lacks well-defined drainages and surface-water flow is ephemeral, occurring as overland runoff, primarily following infrequent, intense thunderstorms or during snowmelt.

3.2.2.3 Intermediate-Perched Water

Identification of perched groundwater systems beneath the Pajarito Plateau comes mostly from direct observation of saturation in boreholes, wells, or piezometers or from borehole geophysics. Perched groundwater is widely distributed across the northern and central part of the Pajarito Plateau with depth-to-water ranging from 118 to 894 ft bgs. The principal occurrences of perched groundwater occur in (1) the relatively wet Los Alamos and Pueblo Canyon watersheds, (2) the smaller watersheds of Sandia and Mortandad Canyons that receive significant volumes of treated effluent from Laboratory operations, and (3) the Cañon de Valle area in the southwestern part of the Laboratory. Perched water is most often found in Puye fanglomerates, Cerros del Rio basalt, and in units of Bandelier Tuff. There is no evidence to indicate that perched groundwater is present beneath the MDPR site.

3.2.2.4 Regional Aquifer

The regional aquifer of the Los Alamos area is the only aquifer capable of large-scale municipal water supply (Purtymun 1984, 006513). The surface of the regional aquifer rises westward from the Rio Grande within the Santa Fe Group into the lower part of the Puye Formation beneath the central and western part of the Pajarito Plateau. The depths to groundwater below the mesa tops range between about 1200 ft along the western margin of the plateau and about 600 ft at the eastern margin. The locations of wells and generalized water-level contours on top of the regional aquifer are described in the 2009 General Facility Information report (LANL 2009, 105632). The regional aquifer is typically separated from the alluvial groundwater and intermediate-perched zone groundwater by 350 to 620 ft of tuff, basalt, and sediments (LANL 1993, 023249).

Groundwater in the regional aquifer flows east-southeast toward the Rio Grande. The velocity of groundwater flow ranges from about 20 to 250 ft/yr (LANL 1998, 058841, p. 2-7). Details of depths to the regional aquifer, flow directions and rates, and well locations are presented in various Laboratory documents (Purtymun 1995, 045344; LANL 1997, 055622; LANL 2000, 066802). Groundwater monitoring is conducted under annual updates to the Interim Facility-Wide Groundwater Monitoring Plan (e.g., N3B 2020, 700927). Groundwater monitoring wells in the vicinity of the MDPR site are monitored as part of the TA-21 monitoring group and results are reported in the annual periodic monitoring report for the TA-21 monitoring group (e.g., N3B 2020, 701106).

4.0 SITE DESCRIPTIONS AND PROPOSED INVESTIGATION ACTIVITIES

The following section presents the site descriptions, summaries of previous investigation activities, and proposed sampling activities for each land tract located within the MDPR site.

4.1 Tract A-8-a

4.1.1 Site Description

Tract A-8-a is an approximately 22-acre parcel located on DP Mesa between the eastern edge of the Los Alamos townsite and the western edge of TA-21 (Figure 1.0-1). Tract A-8 was originally one parcel but was divided into Tracts A-8-a and A-8-b in 2005. Tract A-8-a is adjacent to Tract A-11 to the west, Tract A-8-b to the east and north, and Tract A-16-a to the north and includes the finger mesa between BV and LA Canyons (Figure 1.0-2). The area of the MDPR site within Tract A-8-a is approximately 1.3 acres.

4.1.2 Previous Investigations at Tract A-8-a

4.1.2.1 SWMUs and AOCs

Summaries of previous investigations conducted for SWMUs and AOCs located on the western portion of Tract A-8-a are included in section 2.3. SWMU 00-030(b) septic tanks were located on the western and southwestern portion of Tract A-8-a. The outlet drainlines for SWMU 00-030(m) were connected to the outlet drainlines for SWMU 00-030(b), which discharged to BV Canyon. AOC 00-010(a) was incorrectly identified as a waste disposal storage area that was used for stockpiled building supplies. A portion of SWMU 21-021, an operational stack emissions release, is within the project work area because it overlies all of the historical boundary of TA-21. Except for SWMU 21-021, all of these SWMUs have either received NMED certificates of completion without controls, or no-further action determinations (LANL 2006, 091617; NMED 2006, 091517).

4.1.2.2 Land Conveyance and Transfer of Tract A-8-a

In January 2007, an environmental baseline survey report (EBSR) was completed for Tract A-8-a. The EBSR was prepared to support the transfer of ownership of the Tract A-8-a subparcel from DOE to LAC pursuant to Public Law 105-119, Section 632. Despite the presence of trace levels of contamination, Tract A-8-a was determined to be in such condition that DOE/NNSA may issue deeds on the basis that “all remedial action necessary to protect human health and the environment has been taken” (Pope et al. 2007, 701151). A quitclaim deed was signed between Los Alamos School Board and NNSA on January 19, 2007.

4.1.3 Proposed Assessment Activities at Tract A-8-a

The overall assessment approach for Tract A-8-a includes the following activities:

- Excavate areas where anomalies were identified from geophysical surveys to determine if debris or waste disposal areas are present;
- excavate previously identified debris locations to define extent of debris;
- conduct potholing to determine if debris or waste disposal areas are present; and
- conduct sampling to define nature and extent of potential contamination and evaluate risk to human health and ecological receptors.

4.1.3.1 Geophysical Surveys at Tract A-8-a

Geophysical surveys were conducted within the MDPR site boundary at Tract A-8-a to identify potential locations of buried debris or former waste disposal areas. A backhoe will be used to excavate trenches or test pits at locations where anomalies are identified by the geophysical survey. If contaminated debris is encountered, the excavation area will be expanded to define the extent of the debris. The debris will be removed, sampled, and containerized, and confirmation samples will be collected at depths 0–1.0 ft and 3.0–4.0 ft below the bottom of the excavation. Confirmation sampling will also be conducted at step-out locations surrounding the excavation area, from depth intervals of 0–1.0 ft, 4.0–5.0 ft, and 7.0–8.0 ft bgs and at the soil/tuff interface. The step-out distance and locations of confirmation samples to be collected in the bottom of and surrounding the excavation will be determined after the excavation is completed. Confirmation sampling results will be used to define the lateral and vertical extent of potential contamination associated with the debris. If no debris is encountered, the excavation or test pit will be backfilled and samples will not be collected. Details of the type of geophysical surveys to be performed at the MDPR site are described in Appendix C.

4.1.3.2 Known Debris Locations at Tract A-8-a

Excavation activities will be conducted in the area adjacent to the lift station on Tract A-8-a where debris was previously encountered to define the extent of debris (Figure 4.1-1). If additional contaminated debris is encountered, the excavation area will be expanded to define the extent of the debris. The debris will be removed, sampled, and containerized, and confirmation samples will be collected at depths 0–1.0 ft and 3.0–4.0 ft below the bottom of the excavation. Confirmation sampling will also be conducted at step-out locations surrounding the excavation, from depth intervals of 0–1.0 ft, 4.0–5.0 ft, and 7.0–8.0 ft bgs and at the soil/tuff interface. The step-out distance and locations of confirmation samples to be collected in the bottom of and surrounding the excavation will be determined after the excavation is completed. Confirmation sampling results will be used to define the lateral and vertical extent of potential contamination associated with the debris.

4.1.3.3 Potholing at Tract A-8-a

Potholing will be conducted at 53 locations (locations 1–53 in Figure 4.1-1), based on a triangular grid spacing of approximately 35 ft to determine if debris or waste disposal areas are present at Tract A-8-a. The grid spacing is based on a 100% probability of locating a 40-ft × 80-ft waste pit, referenced by Tribby (1945, 033817). This grid spacing also provides a 95% probability of locating a waste pit with an approximate 1000-ft^2 area (17.5-ft radius). The potholes will be excavated down to the top of native tuff at each location. If contaminated debris is encountered, the excavation area will be expanded to define the extent of the debris. The debris will be removed, sampled, and containerized, and confirmation samples will be collected at depths 0–1.0 ft and 3.0–4.0 ft below the bottom of the excavation. Confirmation sampling will also be conducted at step-out locations surrounding the excavation, from depth intervals of 0–1.0 ft, 4.0–5.0 ft, and 7.0–8.0 ft bgs and at the soil/tuff interface. The step-out distance and locations of confirmation samples to be collected in the bottom of and surrounding the excavation will be determined after the excavation is completed. Confirmation sampling results will be used to define the lateral and vertical extent of potential contamination associated with the debris. If no debris is encountered, the pothole will be backfilled and samples will not be collected.

4.1.3.4 Sample Analysis for Tract A-8-a

All samples will be analyzed for TAL metals, nitrate, perchlorate, total cyanide, pH, VOCs, SVOCs, americium-241, gamma-emitting radionuclides, isotopic plutonium, isotopic uranium, strontium-90, and tritium. Twenty percent of the samples will also be analyzed for polychlorinated biphenyls (PCBs), explosive compounds, and dioxins/furans. Table 4.1-1 provides a summary of the proposed sampling locations, depths, and analytical suites.

4.2 Tract A-16-a

4.2.1 Site Description

Tract A-16-a is an approximately 30-acre parcel located on DP Mesa between the eastern edge of the Los Alamos townsite and the western edge of TA-21 (Figure 1.0-1). The tract consists of disturbed and undeveloped mesa top. It is adjacent to Tract A-8-b to the west and Tract A-8-a to the south, DP Road to the north, and TA-21 to the east (Figure 1.0-2). Eight SWMUs and six AOCs are located within Tract A-16-a. The western portion of former MDA B (SWMU 21-015) is located within Tract A-16-a; this is the only SWMU or AOC in Tract A-16-a within the MDPR site boundary. The area of the MDPR site within Tract A-16-a is approximately 1.3 acres.

4.2.2 Previous Investigations at Tract A-16-a

4.2.2.1 Investigation of MDA B Areas 9 and 10

MDA B extended from east to west along DP Road, with the exception of Areas 9 and 10, which were perpendicular to DP Road. Areas 9 and 10 were located along the western boundary of MDA B. Figure 4.2-1 shows the L-shaped portion of MDA B comprising Areas 9 and 10. Historical documents associated with MDA B describe suspected waste disposal pits in Areas 9 and 10 (LANL 2007, 097973, p. 13).

From fall 2008 to spring 2010, investigation activities were conducted at MDA B to delineate the location of disposal trenches and to characterize the nature and extent of waste buried there. Investigation activities included geophysical surveys, direct-push technology (DPT) core sampling, and east-west excavation trenches within Areas 9 and 10. Investigation activities encompassed all of MDA B, with the exception of the excavation trenches, which were conducted only in Areas 9 and 10.

Direct-Push Technology Sampling

DPT core sampling was conducted at MDA B in 2009 for preliminary characterization of the nature of the waste and to provide data to support future characterization and remediation of the site. Data obtained from DPT core sampling was intended to enable safe waste retrieval and sorting, provide an accurate estimate of the quantity and distribution of radioactive material at risk (MAR), and provide an indication of the original trench boundaries. A total of 17 locations were sampled at Areas 9 and 10 using DPT (LANL 2009, 107344; Portage Environmental Inc. 2010, 109160). Results indicated that Areas 9 and 10 did not contain evidence of waste cells and presented an average depth of 5 ft to tuff.

Geophysical Investigations

Historical geophysical surveys were conducted in 1996, 1997, and 1998, to delineate the location of MDA B (Ferguson et al. 1998, 058212; Thavoris 2001, 083862). MDA B Areas 9 and 10 were included in the geophysical surveys conducted in 1998. This geophysical survey showed anomalies scattered randomly throughout Area 10. The survey data showed no evidence of trench boundaries because of excessive interference from fence material but did show a linear anomaly most likely located in Area 8 (east of Area 9) (McQuown 1998, 064146; McQuown 1998, 064147).

In the fall of 2008, another geophysical survey was performed at MDA B to delineate the lateral extent and probable depth of the disposal pits. The objective of the survey was to delineate the approximate MDA B trench boundaries and estimate the depth of disposal pits. Three techniques were used: high-sensitivity metal detection (EM61), terrain conductivity (EM31), and ground-penetrating radar (GPR) (ARM Geophysics 2009, 109161). No anomalies were detected in Areas 9 or 10 during the high-sensitivity metal-detection survey. No subsurface anomalies were detected during the course of the terrain conductivity survey. No buried objects were observed in the radar profile created during the GPR phase of the survey.

Excavation of Trenches

The objective of the excavation activities at MDA B Areas 9 and 10 was to determine the presence or absence of buried waste material by digging exploratory test trenches to the depth of the undisturbed native tuff. Excavation activities were intended to confirm and support the conclusion of the DPT investigation that there was no waste buried in Areas 9 and 10. In February 2010, nine exploratory east-west trenches were excavated in Areas 9 and 10 ranging in depth from 1.5 to 5.5 ft. Excavation began in the southern portion of Area 10 (Trench A) and proceeded northward into Area 9 (Trench I) (Figure 4.2-1). The excavated material was spread out in a manner that allowed visual inspection of the material. The material was surveyed for radioactivity using an alpha/beta scintillation counter and low-energy and high-energy gamma scintillation counters and for VOCs using a photoionization detector. Trenches were excavated until undisturbed native tuff was encountered (Fordham 2010, 109159).

Investigation Results

Results from the investigation in Areas 9 and 10 are included in the "Investigation Report for Material Disposal Area B, Areas 9 and 10, Solid Waste Management Unit 21-015, at Technical Area 21" (LANL 2010, 109526). The investigation report concluded further investigation and remediation was not required in Areas 9 and 10 because no operational waste was found. Surface and near-surface sampling results indicated the soil and fill in Areas 9 and 10 did not contain contaminants that exceed residential screening levels. Because the nine trenches were excavated until undisturbed native tuff was encountered, the report concluded there was no waste buried in the areas excavated in Areas 9 and 10 (LANL 2010, 109526).

During the remediation of MDA B, disposal trenches were excavated until all waste had been removed and all soil/tuff contaminated above cleanup levels had been removed. The extent of the excavations at the western end of MDA B are shown in Figure 4.2-1 and show that the westernmost excavation area extended into Area 9. All wastes were removed from this area and the results from Trenches F, G, and H show there was no additional waste disposal to the west, north, or south of the MDA B excavation area. Because all wastes are known to have been removed from this area, it is excluded from the MDPR site boundary. The proposed combination of geophysical surveys and potholing proposed at Tract A-16-a (section 4.2.3), will be used to confirm previous investigation results that no waste was buried in Areas 9 and 10.

4.2.2.2 Land Conveyance and Transfer of Tract A-16-a

After MDA B was remediated in 2013 (LANL 2013, 243675), soil sampling of Tract A-16-a for dose assessment, as part of the real-property release process, began. The soil sampling process followed DOE, EPA, and Nuclear Regulatory Commission guidance under the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM, https://www.epa.gov/radiation/multi-agency-radiation-survey-and-site-investigation-manual-marssim) as directed under DOE Order 458.1. Hundreds of samples were taken at the soil surface (0–1.0 ft) and at depth (soil directly above the tuff/bedrock layer) where waste disposal trenches were known to exist. These soil samples were analyzed for radionuclide content of eleven different possible LANL-derived radionuclides by an independent laboratory. The main radionuclide found above background concentrations was plutonium-239.

The radionuclide results were statistically analyzed and converted to potential dose using the DOE-approved dose assessment model Residual Radioactivity (RESRAD). These modeled doses were then compared with the dose-based radiological release criteria for both residential and commercial/industrial land use. Based on these soil data, the dose assessments showed that residual radionuclide concentrations of soils within Tract A-16-a converted to potential doses ranged from 0.5 to 3.7 mrem per year. These annual doses were significantly below the property release criteria of 25 mrem/yr, and the dose assessments concluded the site was a candidate for conveyance to the public for construction or future industrial or residential use (LANL 2015, 701143; LANL 2017, 701144; LANL 2017, 701142).

The dose assessment was provided to DOE/NNSA for independent verification (DLE Technical Services 2015, 701150). This independent verification included additional sampling and statistical analysis. The independent verification confirmed the LANL dose assessment conclusions that the site met the release criteria and was a candidate for release to the public. Based on the dose assessment and confirmation of compliance presented in the independent verification, in September 2015, NNSA determined Tract A-16-a meets DOE Order 458.1 requirements for real-property release (DOE 2015, 600908).

Concurrently with the dose assessment, the Laboratory requested a COC without controls for MDA B, which NMED issued in May 2015 (LANL 2015, 600264; NMED 2015, 600451). Also, in July 2016, an EBSR for Tract A-16-a was completed (LANL 2016, 701152). The quitclaim deed was signed between Los Alamos County and NNSA on January 8, 2018.

4.2.3 Proposed Assessment Activities at Tract A-16-a

The overall assessment approach for Tract A-16-a includes the following activities:

- Excavate areas where anomalies were identified from geophysical surveys to determine if debris or waste disposal areas are present;
- excavate previously identified debris locations to define extent of debris;
- conduct potholing to determine if debris or waste disposal areas are present; and
- conduct sampling to define nature and extent of potential contamination and evaluate risk to human health and ecological receptors.

4.2.3.1 Geophysical Surveys at Tract A-16-a

Geophysical surveys were conducted within the MDPR site boundary at Tract A-16-a to identify potential locations of buried debris or former waste disposal areas. A backhoe will be used to excavate trenches or test pits at locations where anomalies are identified by the geophysical survey. If contaminated debris is encountered, the excavation area will be expanded to define the extent of the debris. The debris will be removed, sampled, and containerized, and confirmation samples will be collected at depths 0–1.0 ft and 3.0–4.0 ft below the bottom of the excavation. Confirmation samples will also be collected at step-out locations surrounding the excavation area, from depth intervals of 0–1.0 ft, 4.0–5.0 ft, and 7.0–8.0 ft bgs and at the soil/tuff interface. The step-out distance and locations of confirmation samples to be collected in the bottom of and surrounding the excavation will be determined after the excavation is completed. Confirmation sampling results will be used to define the lateral and vertical extent of potential contamination associated with the debris. If no debris is encountered, the excavation or test pit will be backfilled and samples will not be collected. Details of the type of geophysical surveys to be performed at the MDPR site are described in Appendix C.

4.2.3.2 Known Debris Locations at Tract A-16-a

Excavation activities will be conducted in the former sewer line trench, at Pit 2, and adjacent to the lift station on Tract A-16-a, where debris was previously encountered, to define the extent of debris (Figure 4.2-2). If additional contaminated debris is encountered, the excavation area will be expanded to define the extent of the debris. The debris will be removed, sampled, and containerized, and confirmation samples will be collected at depths 0–1.0 ft and 3.0–4.0 ft below the bottom of the excavation. Confirmation sampling will also be conducted at step-out locations surrounding the excavation, from depth intervals of 0–1.0 ft, 4.0–5.0 ft, and 7.0–8.0 ft bgs and at the soil/tuff interface. The step-out distance and locations of confirmation samples to be collected in the bottom of and surrounding the excavation will be determined after the excavation is completed. Confirmation sampling results will be used to define the lateral and vertical extent of potential contamination associated with the debris.

Sampling will also be conducted at seven locations along the length of the former sewer line trench (locations 54–60 in Figure 4.2-2), to define the lateral and vertical extent of potential contamination associated with the overburden material placed back into the former sewer line trench. At each location, samples will be collected from depth intervals of 0–1.0 ft, 4.0–5.0 ft, and 7.0–8.0 ft bgs and at the soil/tuff interface.

4.2.3.3 Potholing at Tract A-16-a

Potholing will be conducted at 53 locations (locations 1–53 in Figure 4.2-2), based on a triangular grid spacing of approximately 35 ft to determine if debris or waste disposal areas are present at Tract A-16-a. The grid spacing is based on a 100% probability of locating a 40-ft × 80-ft waste pit, referenced by Tribby (1945, 033817). This grid spacing also provides a 95% probability of locating a waste pit with an approximate 1000 ft^2 area (17.5-ft radius). The potholes will be excavated down to the top of native tuff at each location. If contaminated debris is encountered, the excavation area will be expanded to define the extent of the debris. The debris will be removed, sampled, and containerized, and confirmation samples will be collected at depths 0–1.0 ft and 3.0–4.0 ft below the bottom of the excavation. Confirmation sampling will also be conducted at step-out locations surrounding the excavation, from depth intervals of 0–1.0 ft, 4.0–5.0 ft, and 7.0–8.0 ft bgs and at the soil/tuff interface. The step-out distance and locations of confirmation samples to be collected in the bottom of and surrounding the excavation will be determined after the excavation is completed. Confirmation sampling results will be used to define the lateral and vertical extent of potential contamination associated with the debris. If no debris is encountered, the pothole will be backfilled and samples will not be collected.

4.2.3.4 Sample Analysis for Tract A-16-a

All samples will be analyzed for TAL metals, nitrate, perchlorate, total cyanide, pH, VOCs, SVOCs, americium-241, gamma-emitting radionuclides, isotopic plutonium, isotopic uranium, strontium-90, and tritium. Twenty percent of the samples will also be analyzed for PCBs, explosive compounds, and dioxins/furans. Table 4.1-1 provides a summary of the proposed sampling locations, depths, and analytical suites.

5.0 INVESTIGATION METHODS

A summary of investigation methods to be implemented is presented in Table 5.0-1. Summaries of the field investigation methods are provided below.

Chemical analyses will be performed by accredited off-site contract analytical laboratories using the most recent EPA- and industry-accepted extraction and analytical methods for chemical analyses of analytical suites.

5.1 Establishing Sampling Locations

Proposed sampling locations are identified based on engineering drawings, surveyed locations of existing structures, previous sampling locations, and topography or other features identified in the field. The coordinates of proposed locations will be obtained by georeferencing the points from the proposed sampling maps. The coordinates will be used to locate flags or other markers 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 5.2.

5.2 Geodetic Surveys

Geodetic surveys will be conducted to locate and to document field activities such as sampling and excavation locations. The surveyors will use a Trimble GeoXT handheld GPS or equivalent for the surveys. The coordinate values will be expressed in the New Mexico State Plane Coordinate System (transverse Mercator), Central Zone, North American Datum 1983. Elevations will be reported as per the National Geodetic Vertical Datum of 1929.

5.3 Geophysical Surveys

Geophysical surveys were performed during November 2020, to identify anomalies that could indicate the location of debris or former waste disposal areas. Geophysical methods employed included time domain electromagnetic induction, frequency domain electromagnetic induction, vertical gradient magnetometry, GPR, and seismic refraction tomography. Details on geophysical survey instrumentation, sensitivity, and site application are provided in Appendix C. The results of the geophysical surveys were not available or evaluated before submittal of the SWMU assessment work plan.

5.4 Field Screening

As sampling is primarily being conducted to define nature and extent, 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 proposed field-screening approach will include (1) visual examination of samples for evidence of contamination and (2) screening for gross-alpha, -beta, and -gamma radioactivity. Based on site histories and previous Consent Order investigation results, VOC contamination is not expected to be encountered and screening for VOCs will not be performed.

Radiological field screening will also be used to identify contaminated debris or media during potholing and excavation activities. Analytical samples of the debris will be collected only if radiological readings exceed surface contamination values specified in N3B-P121, “Radiation Protection.” Potentially contaminated debris or media will be excavated, characterized, packaged, and disposed of at an appropriate waste disposal facility. A radiological control technician (RCT) will conduct radiological field screening during fieldwork activities. Radiological screening will be performed using calibrated, portable instrumentation in accordance with N3B radiation protection instrument procedures. RCTs will record local environmental background levels of gross-alpha, -beta, and -gamma radioactivity at least once a day.

5.5 Sampling

Soil, fill, 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; and accessibility. Typically, samples will be collected using spade and scoop, hand auger, or drill rig. For all methods, samples for VOC analysis will be immediately transferred from the sampling tool to the sample container to minimize the loss of subsurface VOCs during the sample collection process. Containers for VOC samples will be filled as completely as possible, leaving no or minimal headspace, and sealed with a Teflon-lined cap.

Where practicable, debris will be characterized by direct sampling of the waste (e.g., glassware, metal objects, plastics, concrete, etc.). For debris that is difficult to characterize, acceptable knowledge will be used whenever possible, supplemented by sampling as needed.

5.5.1 Surface Sampling

Surface and shallow subsurface soil and sediment samples will be collected in accordance with N3B-SOP-ER-2001, "Soil, Tuff, and Sediment Sampling." Stainless-steel shovels, spades, scoops, and bowls will be used for ease of decontamination. If the surface location is at bedrock, an axe or hammer and chisel may be used to collect samples.

5.5.2 Subsurface Samples

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

5.5.2.1 Hand Auger

Hand augers or power-assisted augers may be used to drill shallow holes at locations that can be sampled without the use of a drill rig and at locations inaccessible by a drill rig. The hand auger is advanced by turning the auger into the soil or tuff until the barrel is filled. The auger is removed and the sample is placed in a stainless-steel bowl. Hand-auger samples will be collected in accordance with N3B-ER-SOP-2001, "Soil, Tuff, and Sediment Sampling."

5.5.2.2 Hollow-Stem Auger

A drill rig equipped with a hollow-stem auger may be used to drill deeper holes at locations that cannot be sampled using a hand-auger or power-assisted augers. 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 bit 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.

A bottom plug or pilot bit can be fastened onto the bottom of the auger to keep out most of the soil and/or water that tends to clog the bottom of the augers during drilling. Drilling without a center plug is acceptable if the soil plug, formed in the bottom of the auger, is removed before sampling or installing a well casing. The soil plug can be removed by washing out the plug using a side-discharge rotary bit or augering out the plug with a solid-stem auger bit sized to fit inside the hollow-stem auger.

During sampling, the auger will be advanced to just above the desired sampling interval. The sample will be collected by driving a split-spoon sampler into undisturbed soil/tuff to the desired depth. Samples will be collected in accordance with N3B-ER-SOP-2001, “Soil, Tuff, and Sediment Sampling.”

Field documentation will include detailed borehole logs for each borehole drilled using the hollow-stem auger method. 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.

5.5.3 Borehole Abandonment

All hollow-stem auger boreholes will be properly abandoned in accordance with N3B-SOP-ER-6005, “Monitoring Well and Borehole Abandonment.” 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 while the bentonite chips are being added to ensure bridging does not occur.

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

5.6 Excavation

Excavations will be completed using a track excavator or backhoe at selected sites. Excavated soil will be staged a minimum of 3 ft from the edge of the excavation, and excavations deeper than 4 ft bgs will be properly benched to allow access and egress, if necessary. After completion of confirmatory sampling and any necessary overexcavation work, the excavations and/or trenches will be backfilled with clean fill material. If the excavated material is determined to be suitable for reuse (i.e., is not hazardous waste and meets residential SSLs and SALs), it will be used to backfill the excavations.

5.7 Chain of Custody for Samples

The collection, screening, and transport of samples will be documented on standard forms generated by the Sample Management Office (SMO). These include sample collection logs, chain-of-custody forms, and sample container labels. Sample collection logs 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. Chain-of-custody forms will be completed and signed to verify that the samples are not left unattended.

5.8 Quality Assurance/Quality Control Samples

Quality assurance (QA) and quality control (QC) samples will include field duplicate, equipment rinsate, and field trip blank samples. These samples will be collected following the current version of N3B-SOP-SDM-1100, “Sample Containers, Preservation, and Field Quality Control.” Field duplicate, rinsate, and trip blank samples will be collected at an overall frequency of at least 1 for every 10 regular samples as specified in Appendix F, Section I.B.4.f, of the Consent Order.

5.9 Laboratory Analytical Methods

Analytical suites for samples to be collected include TAL metals, nitrate, perchlorate, total cyanide, pH, VOCs, SVOCs, PCBs, explosive compounds, dioxins and furans, americium-241, gamma-emitting radionuclides, isotopic plutonium, isotopic uranium, strontium-90, and tritium. Analytical methods are summarized in Table 5.9-1. Sample collection and analysis will be coordinated with the SMO.

Laboratory analytical data will be validated as outlined in N3B-PLN-SDM-1000, “Sample and Data Management Plan,” N3B-AP-SDM-3000, “General Guidelines for Data Validation,” N3B-AP-SDM-3014, “Examination and Verification of Analytical Laboratory Data,” and additional method-specific analytical data validation guidelines. All procedures have been developed, where applicable, from the EPA QA/G-8 guidance on environmental data verification and data validation, Department of Defense/DOE “Consolidated Quality Systems Manual for Environmental Laboratories”, and the EPA national functional guidelines for data review. N3B-PLN-SDM-1000, “Sample and Data Management Plan,” sets the validation frequency criteria at 100% examination/verification of data and a minimum 10% full validation of data. Data collected at the MDPR site will undergo 100% examination/verification and 25% full validation.

5.10 Health and Safety

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

5.11 Equipment Decontamination

Equipment for drilling and sampling will be decontaminated before and after sampling activities to minimize the potential for cross-contamination. Dry decontamination methods will be used to avoid the generation of liquid waste and to minimize waste generation. Dry decontamination uses disposable paper towels and over-the-counter cleaner, such as Fantastik or equivalent. All sampling and measuring equipment will be decontaminated in accordance with N3B-SOP-ER-2002 “Field Decontamination of Equipment.”

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, drilling/exploration equipment that may come in contact with the borehole will be decontaminated by steam cleaning, by hot water pressure-washing, or by another method before each new borehole is drilled. The equipment will be pressure-washed on a high-density polyethylene liner at a temporary decontamination pad. Cleaning solutions and wash water will be collected and contained for proper disposal. Decontamination solutions will be sampled and analyzed to determine the final disposition of the wastewater and the effectiveness of the decontamination procedures.

5.12 Waste Management

Wastes generated by the proposed investigation and remediation activities may include, but are not limited to, drill cuttings, contact waste such as personal protective equipment, excavated media and structural debris, decontamination fluids, and all other waste that has potentially come into contact with contaminants.

All wastes generated during field investigation and remediation activities will be managed in accordance with N3B-EP-DIR-SOP-10021, “Characterization and Management of Environmental Programs Waste,” applicable EPA and NMED regulations, and DOE orders. Appendix B presents the waste management plan.

5.13 Removal Activities

Removal of the previously encountered contaminated debris is proposed under this assessment work plan. Excavation of contaminated media, waste disposition, and confirmation sampling will be completed during removal activities.

Debris or other material encountered will be excavated and stockpiled next to the excavation. Potentially contaminated soil will be excavated, characterized, packaged, and disposed of at an appropriate waste disposal facility. After the debris has been removed, confirmation samples will be collected from base of the excavation area. Samples will be collected from two depths (0–1.0 ft and 3.0–4,0 ft). Confirmation sampling will also be conducted at step-out locations surrounding the excavation, from depth intervals of 0–1.0 ft, 4.0–5.0 ft, and 7.0–8.0 ft bgs and at the soil/tuff interface. The step-out distance and locations of confirmation samples to be collected in the bottom of and surrounding the excavation will be determined after the excavation is completed. Confirmation sampling results will be used to define the lateral and vertical extent of potential contamination associated with the debris. All samples will be analyzed for TAL metals, nitrate, perchlorate, total cyanide, pH, VOCs, SVOCs, americium-241, gamma-emitting radionuclides, isotopic plutonium, isotopic uranium, strontium-90, and tritium. Additionally, 20% of the samples will be analyzed for PCBs, explosive compounds, and dioxins/furans. After completion of confirmatory sampling and any necessary overexcavation work, the excavations and/or trenches will be backfilled with clean fill material. If the excavated material is determined to be suitable for reuse (i.e., is not hazardous waste and meets residential [SSLs and SALs), it will be used to backfill the excavations.

6.0 MONITORING PROGRAMS

Groundwater monitoring is not performed to specifically monitor potential releases from the MDPR site. Monitoring of perched intermediate and regional groundwater to evaluate potential releases from sites at TA-21 is performed under the 2016 Consent Order as described for the TA-21 monitoring group in the Interim Facility-Wide Groundwater Monitoring Plan (e.g., N3B 2020, 700927). Monitoring results are reported annually to NMED.

Storm water runoff from certain SWMUs and AOCs at the Laboratory is monitored under a National Pollutant Discharge Elimination System (NPDES) Individual Permit (IP). Storm water monitoring under the NPDES IP is not conducted at the MDPR site.

Air monitoring will be conducted during fieldwork activities at the MDPR site. Passive air-monitoring samplers will be set up around the perimeter of the MDPR site as a means to detect and quantify airborne releases during soil disturbance activities. In addition to these site-emission monitoring samplers, there are a variety of ambient air samplers located near the MDPR site. These stations are part of the LANL AIRNET program and continuously measure the ambient air for airborne contamination. Triad will continue to monitor AIRNET monitoring stations located on DP Road to evaluate changes in radiological air emissions during fieldwork.

7.0 SCHEDULE

Following approval of this assessment work plan, the work will be implemented in fiscal year 2021. Fieldwork is expected to take approximately 6 months to complete. The SWMU assessment report will be delivered to NMED approximately 6 months after fieldwork is complete.

8.0 REFERENCES AND MAP DATA SOURCES

8.1 References

The following reference list includes documents cited in this work plan. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. This information is also included in text citations. ERIDs were assigned by the Laboratory's Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above). IDs are used to locate documents in N3B's Records Management System and in the Master Reference Set. The NMED Hazardous Waste Bureau and N3B maintain copies of the Master Reference Set. The set ensures that NMED has the references to review documents. The set is updated when new references are cited in documents.

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8.2 Map Data Sources

LANL Boundary: As published; Triad SDE Spatial Geodatabase: GISPUBPRD1\PUB.Boundaries\PUB.lanlarea; December 2020.

Tech Areas: As published; Triad SDE Spatial Geodatabase: GISPUBPRD1\PUB.Boundaries\PUB.tecareas; December 2020.

Major Road: As published; Q:\16-Projects\16-0033\project_data.gdb\line\major_road; October 2019.

Structures: As published, County of Los Alamos GIS Server: (https://gis.losalamosnm.us/securegis/rest/services/basemaps/basemap/FeatureServer); December 2020.

Drainage: As published, N3B/T2S, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 16-0033; project_data.gdb; line feature dataset; drainage_features; December 2020.

Paved Road: As published; Triad SDE Spatial Geodatabase: GISPUBPRD1\PUB.Infrastructure\PUB.paved_rds_arc; December 2020.

MDPR Site Boundary: As published, N3B/T2S, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 20-0024; project_data.gdb; poly feature dataset; smaller_areas_A8a_A16a_merged; December 2020.

MDA Boundary: As published; Triad SDE Spatial Geodatabase: GISPUBPRD1\PUB.regulatory\PUB.mda_boundary; December 2020.

Sample location: As published, N3B/T2S, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 20-0024; project_data.gdb; point feature dataset; xy_pit_locations_1; December 2020.

Triad environmental air sampler: As published, N3B/T2S, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 20-0024; project_data.gdb; point feature dataset; air_monitoring_station; December 2020.

LA county provided electric,gas,sewer, and water: As published, provided as an email attachment in zipped ESRI shapefile format sent from the County of Los Alamos to the U.S. Department of energy. December 2020.

Lift station features (future well and future dry well): As published, N3B/T2S, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 20-0024; project_data.gdb; poly feature dataset; site_feature_A8b; Site features digitized from Los Alamos County provided engineering drawings; Drawing provided upon request; December 2020.

New Manhole: As published, N3B/T2S, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 20-0024; project_data.gdb; point feature dataset; gps_manhole_location; Information field collected by Dave Frank, summer of 2020; Feature collected using a Leica Zeno 20 hand held GPS unit; June 2020.

MDA B excavation area: As published, N3B/T2S, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 11-0132; Q:\11-Projects\11-0132\ev_MDA_B\shp\all_enclosure_polygons_merge.shp; 2011.

Trench line: As published, N3B/T2S, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 20-0024; project_data.gdb; line feature dataset; trench_lines; features digitized from N3B provided data; All data available upon request; December 2020.

Pits dug by Triad for sewer investigation: As published, N3B/T2S, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 20-0024; project_data.gdb; point feature dataset; triad_data_pit_locations; Information digitized from a Triad IFPROG prepared map; June 2020.

MDA B areas 9 and 10: As published, N3B/T2S, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 20-0024; project_data.gdb; line feature dataset; trench_areas; features digitized from N3B provided data; All data available upon request; December 2020.

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County Boundary: As published, County of Los Alamos GIS Server: (https://gis.losalamosnm.us/securegis/rest/services/basemaps/basemap/FeatureServer); December 2020.

Land Parcel: As published; Triad SDE Spatial Geodatabase: GISPUBPRD1\PUB.Boundaries\PUB.LCT_boundary; December 2020.

Index and Terrain Contours (40- and 5-ft Interval): As published, N3B/T2S, GIS projects folder; \\n3b-fs01\n3b-shares) (Q: GIS DATA) Project: 20-0024; project_data.gdb; line feature dataset; site_contour; All contours generated from the 2014 Bare Earth Elevation Model; N3B/T2S, GIS projects folder; \\n3b-fs01\n3b-shares) Q:\2014\Bare_Earth\BareEarth_DEM_Mosaic.gdb; December 2020.

SWMU or AOC Boundary: As published; Triad SDE Spatial Geodatabase: GISEMPRD1\PUB.regulatory\PUB.prs_all_reg_admin; December 2020.

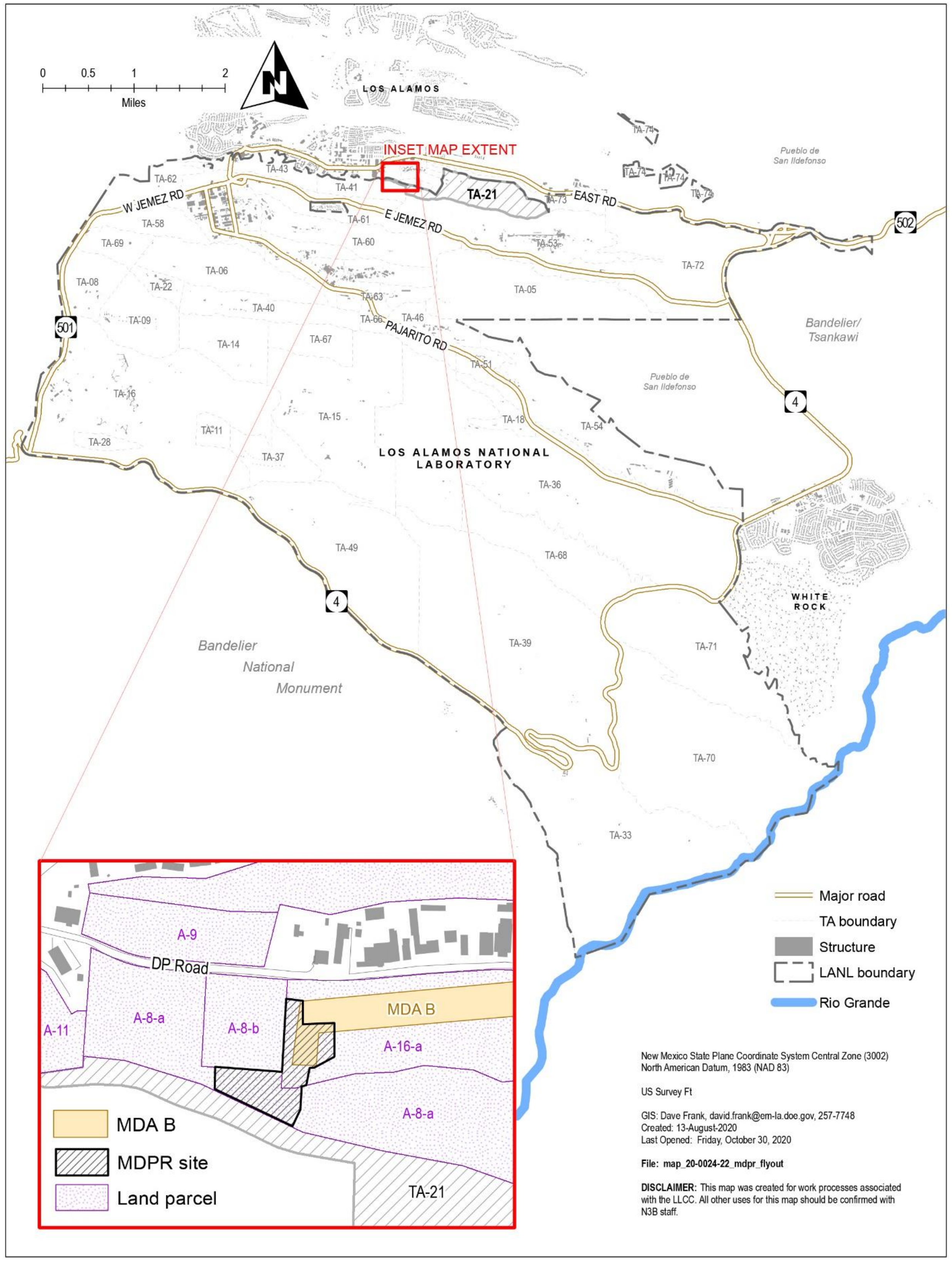

Figure 1.0-1 Location of MDPR site with respect to surrounding landholdings

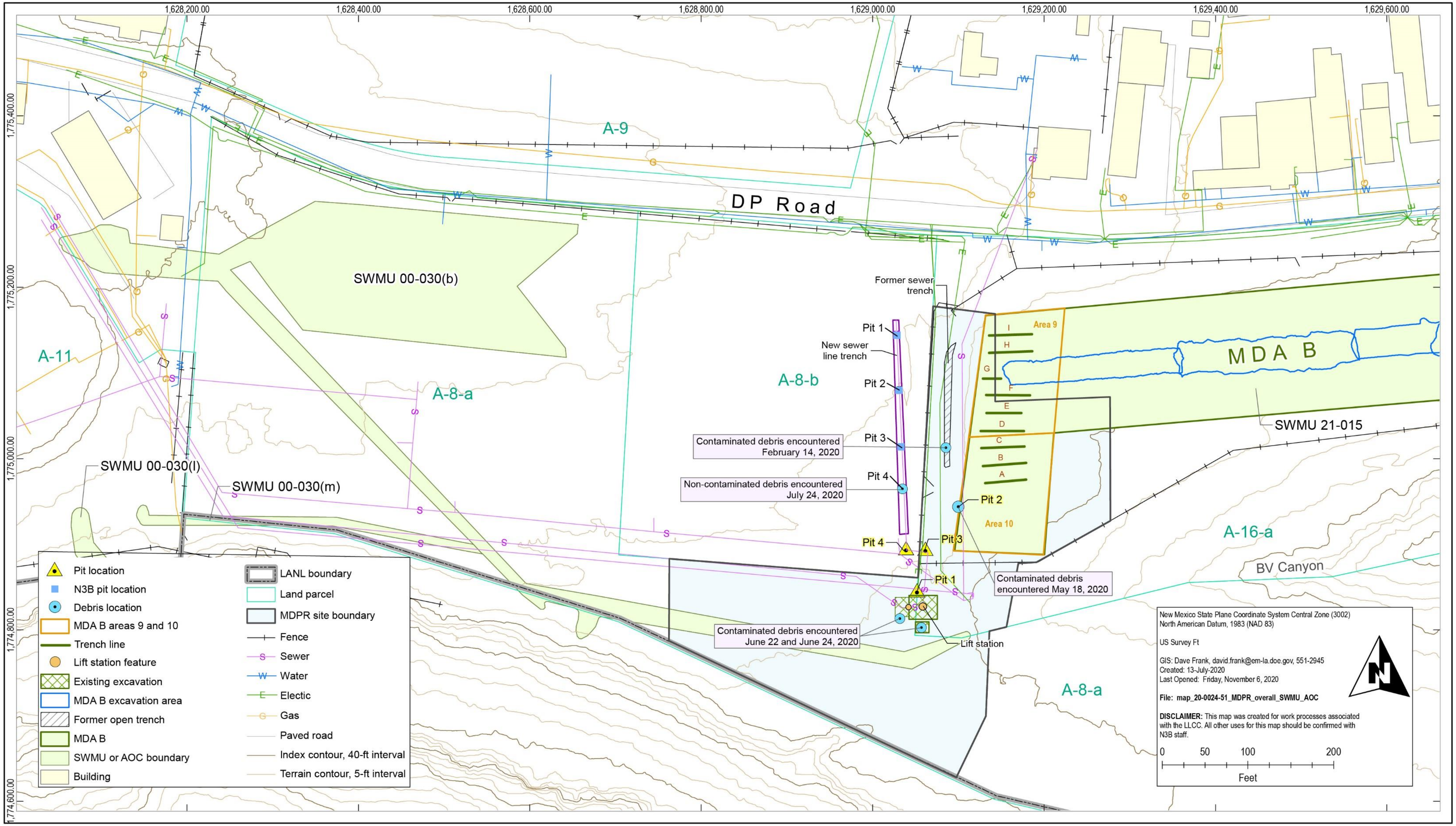

Figure 1.0-2 Site map showing locations of SWMUs, test pits, trenches, and debris encountered in 2020

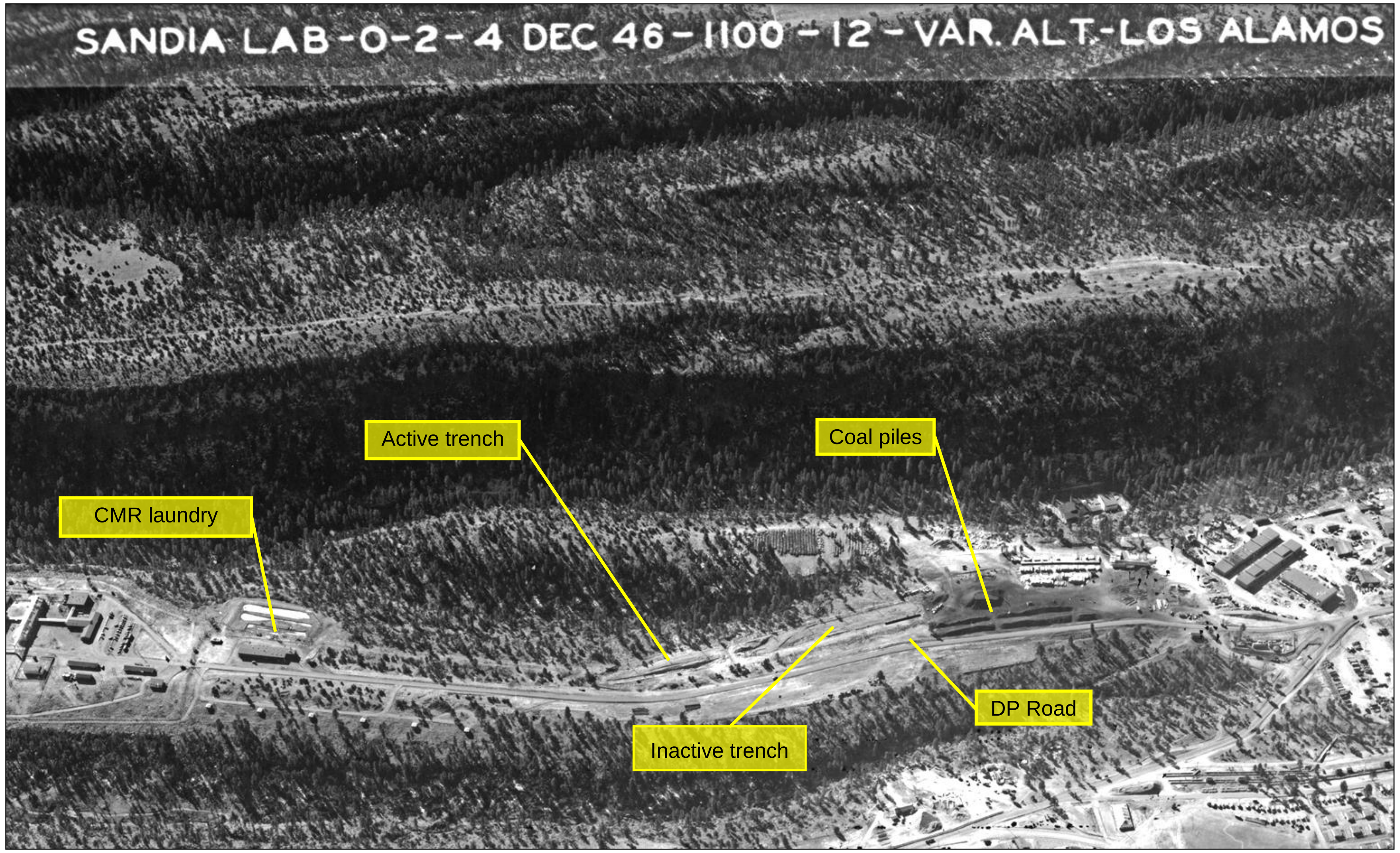

Figure 2.4-1 Aerial photograph of MDA B taken in December 1946, view to the south; the entire length of MDA B is depicted in this enlarged photograph (photographs by Sandia Labs; scanned images courtesy of Los Alamos Historical Museum Photo Archives).

Figure 2.4-2 Waste disposal practices at MDA A circa late 1945; similar trench conditions and waste disposals are assumed to have existed at MDA B during this time period (LANL photograph IM-9: 2284).

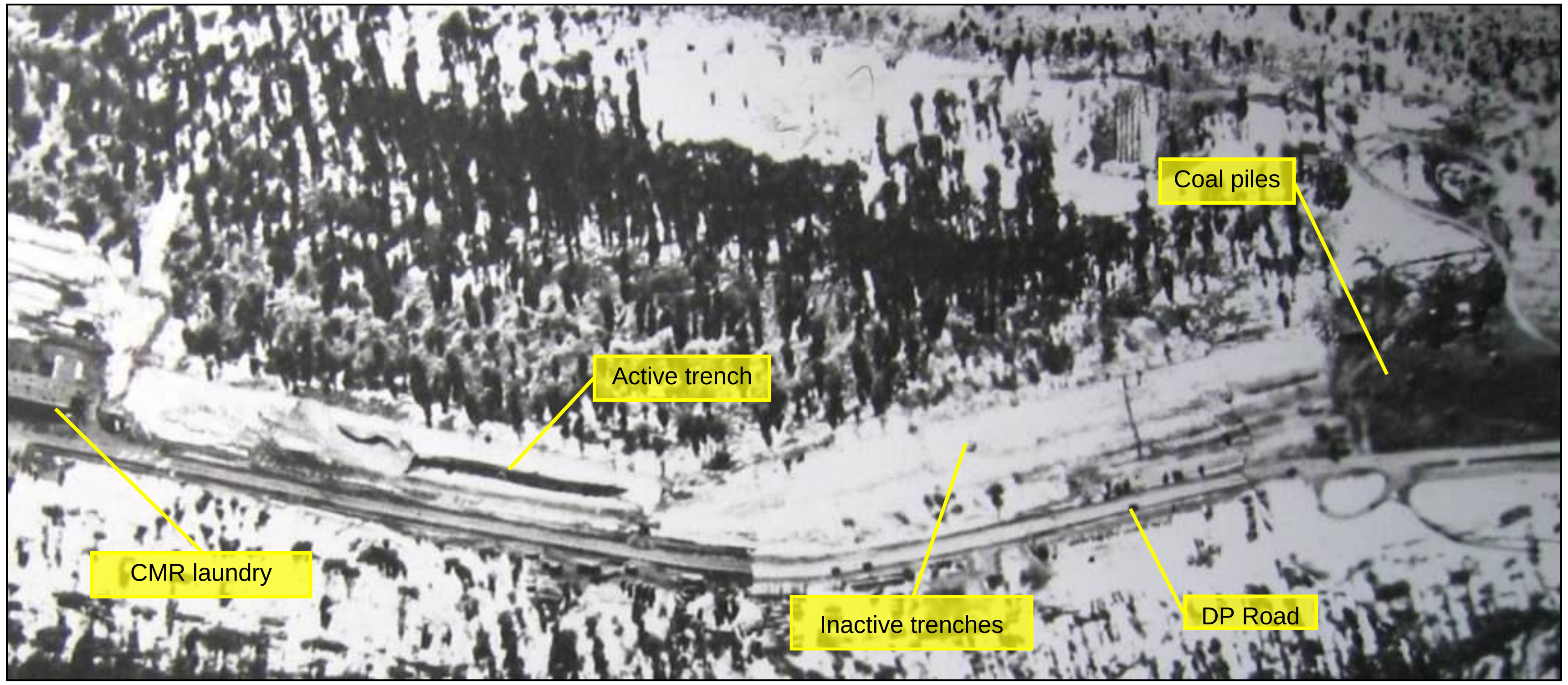

Figure 2.4-3 Aerial photograph of MDA B taken in December 1947, view to south; photograph from MDA B project files (source not identified, but believed to be similar to that of Figure 2.4-1).

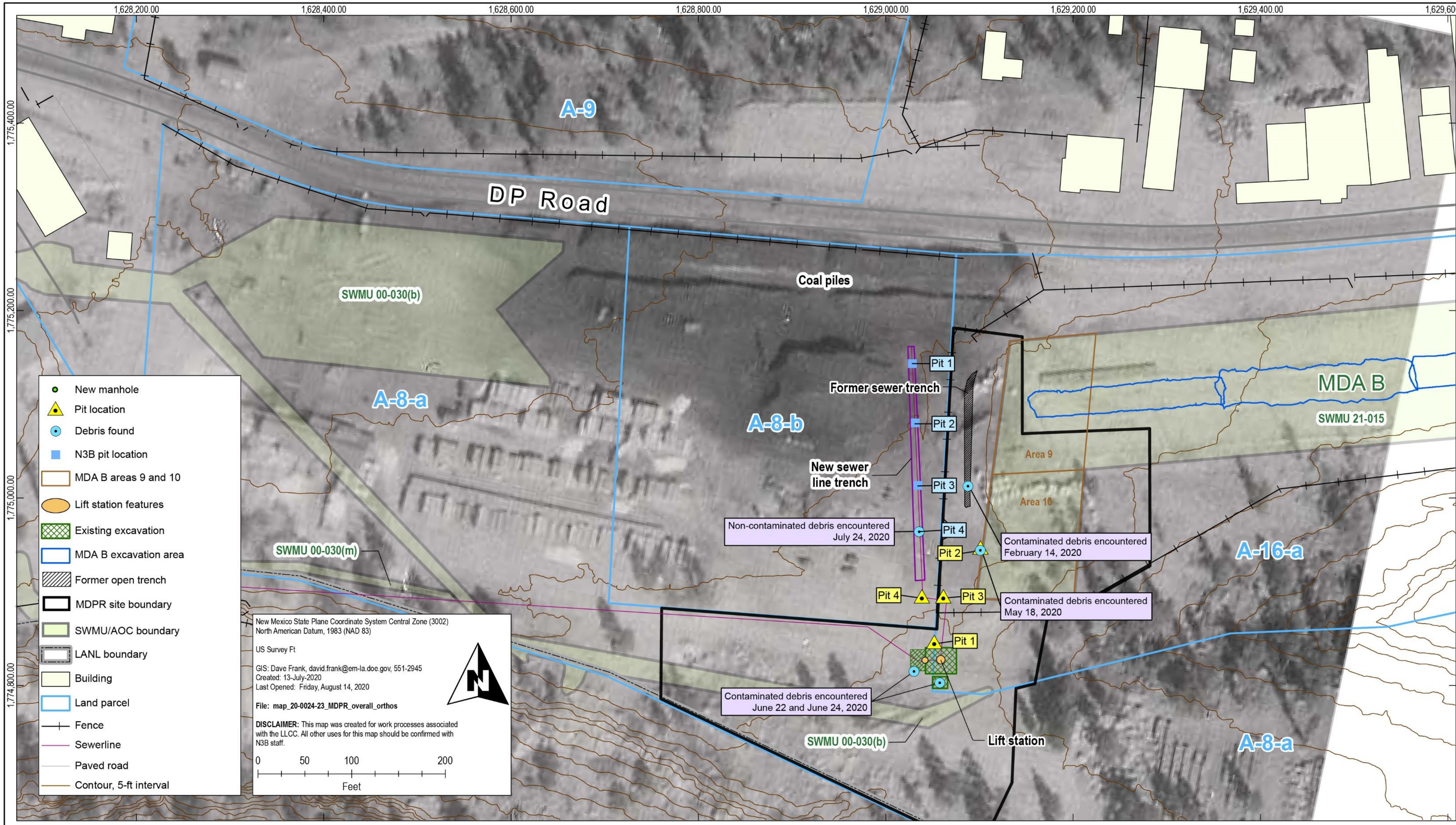

Figure 2.4-4 **Overlay of an aerial photograph taken in December 1946 showing the coal piles in relationship to Tracts A-8-b and A-16-a and MDPR site features**

Figure 2.4-5 Overlay of a 1958 aerial photograph showing the DP Road trailer park in relationship to MDPR site features

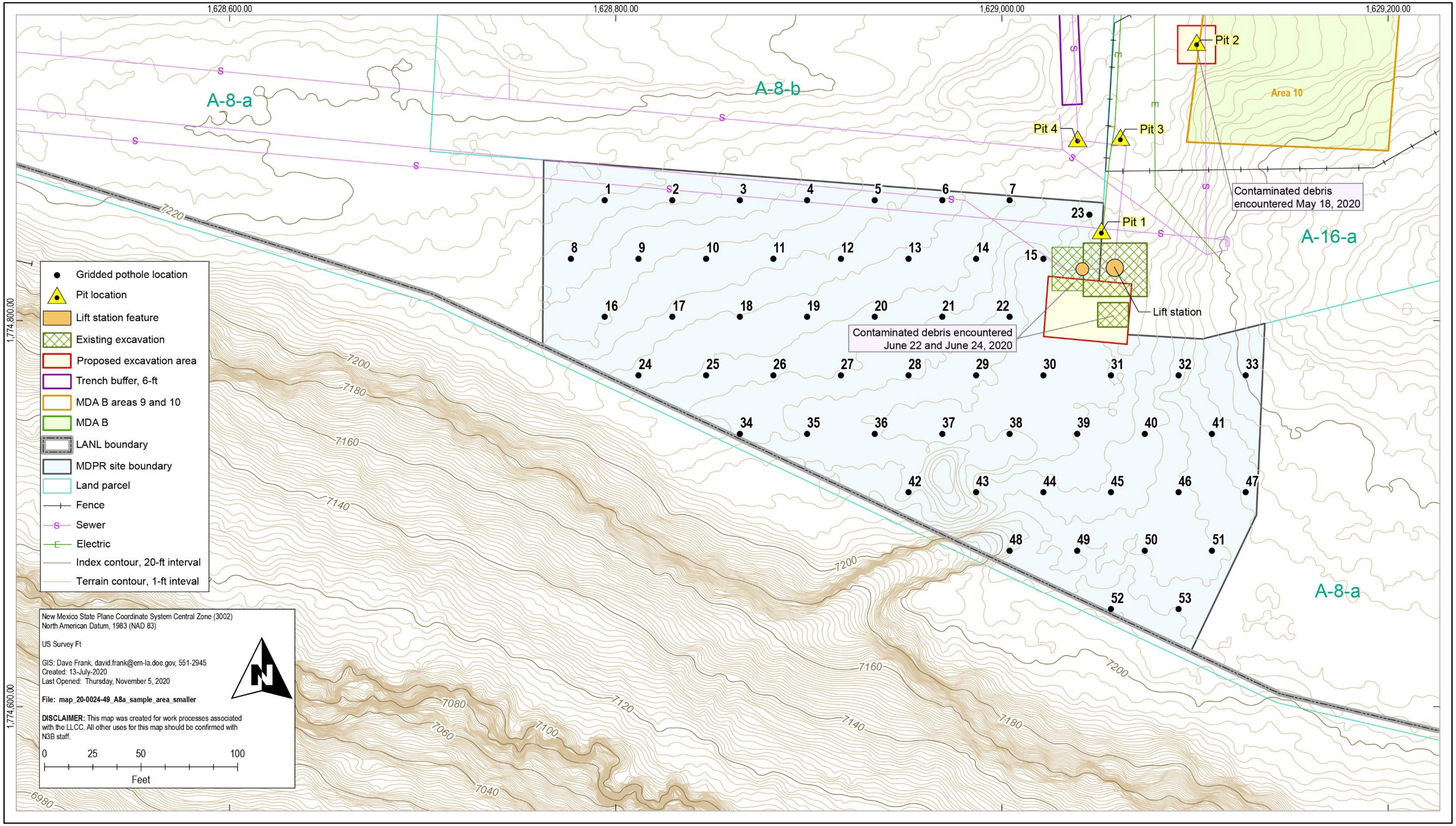

Figure 4.1-1 Proposed potholing locations and excavation areas at Tract A-8-a

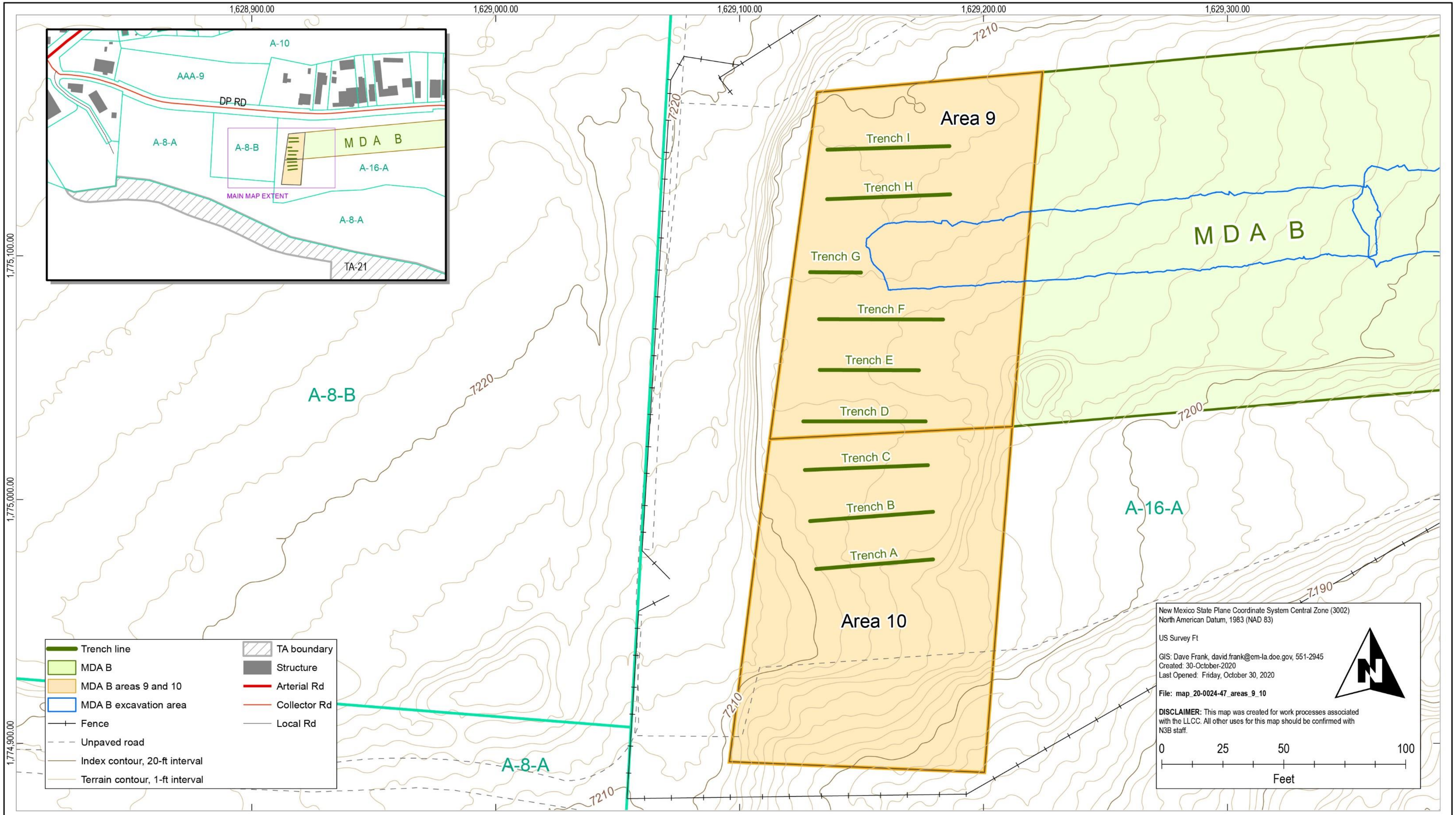

Figure 4.2-1 Locations of trenches excavated in 2010 in Areas 9 and 10 at MDA B

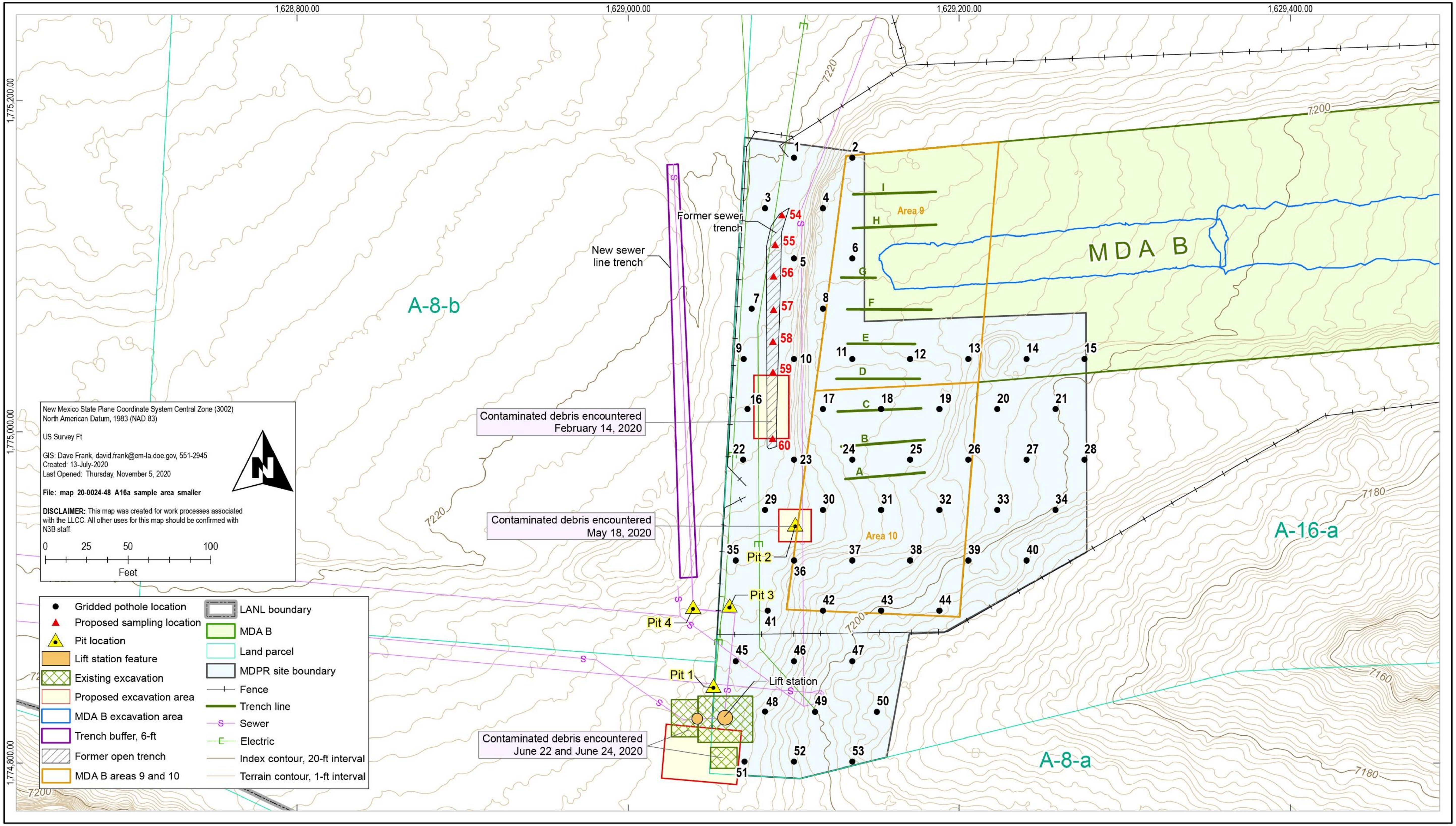

Figure 4.2-2 Proposed potholing locations and excavation areas at Tract A-16-a

Table 4.1-1
Proposed Sampling and Analysis at MDPR Site

Tract	Sampling Justification	Number of Locations and Samples	Sample Interval[a] (ft)	TAL Metals (EPA SW-846:6010C/6020B)	Nitrate (EPA SW-846:9056)	Perchlorate (EPA SW-846:6850)	Total Cyanide (EPA SW-846:9012B)	pH (SW-846:9045C)	VOCs (EPA SW-846:8260B)	SVOCs (EPA SW-846:8270D)	Explosive Compounds (EPA SW-846:8330B)	Dioxins/Furans (EPA SW-846:8290A)	PCBs (EPA SW-846:8082A)	Americium-241 (HASL 300:AM-241)	Gamma-Emitting Radionuclides (EPA 901.1)	Isotopic Plutonium (HASL-300;ISOPU)	Isotopic Uranium (HASL-300:ISOU)	Strontium-90 (EPA 905.0)	Tritium (EPA 906.0)
A-8-a	Collect confirmation samples beneath excavation areas containing contaminated debris identified from results of geophysical surveys.	Locations to be determined, 2 samples at each location	0–1, 3–4[b]	X[c]	X	X	X	X	X	X	X[d]	X[d]	X[d]	X	X	X	X	X	X
	Collect confirmation samples at step-out locations surrounding the excavation areas containing contaminated debris identified from results of geophysical surveys.	Locations to be determined, 4 samples at each location	0–1, 4–5, 7–8, soil/tuff interface[e]	X	X	X	X	X	X	X	X[d]	X[d]	X[d]	X	X	X	X	X	X
	Collect confirmation samples beneath excavation areas containing contaminated debris previously identified or debris encountered during potholing.	Locations to be determined, 2 samples at each location	0–1, 3–4[b]	X	X	X	X	X	X	X	X[d]	X[d]	X[d]	X	X	X	X	X	X
	Collect confirmation samples at step-out locations surrounding the excavation areas containing debris previously identified or debris encountered during potholing.	Locations to be determined, 4 samples at each location	0–1, 4–5, 7–8, soil/tuff interface[e]	X	X	X	X	X	X	X	X[d]	X[d]	X[d]	X	X	X	X	X	X
A-16-a	Collect confirmation samples beneath excavation areas containing contaminated debris identified from results of geophysical surveys.	Locations to be determined, 2 samples at each location	0–1, 3–4[b]	X	X	X	X	X	X	X	X[d]	X[d]	X[d]	X	X	X	X	X	X
	Collect confirmation samples at step-out locations surrounding the excavation areas containing contaminated debris identified from results of geophysical surveys.	Locations to be determined, 4 samples at each location	0–1, 4–5, 7–8, soil/tuff interface[e]	X	X	X	X	X	X	X	X[d]	X[d]	X[d]	X	X	X	X	X	X
	Collect confirmation samples beneath excavation areas containing contaminated debris previously identified or debris encountered during potholing.	Locations to be determined, 2 samples at each location	0–1, 3–4[b]	X	X	X	X	X	X	X	X[d]	X[d]	X[d]	X	X	X	X	X	X
	Collect confirmation samples at step-out locations surrounding the excavation areas containing debris previously identified or debris encountered during potholing.	Locations to be determined, 4 samples at each location	0–1, 4–5, 7–8, soil/tuff interface[e]	X	X	X	X	X	X	X	X[d]	X[d]	X[d]	X	X	X	X	X	X

Table 4.1-1 (continued)

Tract	Sampling Justification	Number of Locations and Samples	Sample Interval[a] (ft)	TAL Metals (EPA SW-846:6010C/6020B)	Nitrate (EPA SW-846:9056)	Perchlorate (EPA SW-846:6850)	Total Cyanide (EPA SW-846:9012B)	pH (SW-846:9045C)	VOCs (EPA SW-846:8260B)	SVOCs (EPA SW-846:8270D)	Explosive Compounds (EPA SW-846:8330B)	Dioxins/Furans (EPA SW-846:8290A)	PCBs (EPA SW-846:8082A)	Americium-241 (HASL 300:AM-241)	Gamma-Emitting Radionuclides (EPA 901.1)	Isotopic Plutonium (HASL-300;ISOPU)	Isotopic Uranium (HASL-300:ISOU)	Strontium-90 (EPA 905.0)	Tritium (EPA 906.0)
A-16-a (cont.)	Collect 28 samples at 7 locations (54–60) to determine nature and extent of potential contamination associated with the overburden material placed back into the former sewer line trench.	7 locations, 28 samples	0–1, 4–5, 7–8, soil/tuff interface[e]	X	X	X	X	X	X	X	X[d]	X[d]	X[d]	X	X	X	X	X	X

[a] Depths are below ground surface, unless indicated otherwise.

[b] Sample depths below bottom of excavation.

[c] X = Analysis proposed.

[d] 20% of samples will be submitted for analysis of PCBs, explosive compounds, and dioxins/furans. Samples will be biased toward areas where field screening indicates the greatest potential contamination.

[e] If depth to tuff is below 8-ft bgs, a soil sample will also be collected at the soil/tuff interface. Sample intervals may be adjusted based on the actual soil/tuff interface depth.

Table 5.0-1
Summary of Investigation Methods

Method	Summary
Spade-and-Scoop Collection of Soil Samples	This method is typically used to collect shallow (e.g., approximately 0–12 in.) soil or sediment samples. The spade-and-scoop method involves digging a hole to the desired depth, as prescribed in the sampling and analysis plan, and collecting a discrete grab sample. The sample for VOC analysis is transferred immediately from the sampler to the sample container to minimize the loss of VOCs during the sample collection process. Containers for VOC samples are filled as completely as possible, leaving no or minimal headspace, and sealed with a Teflon-lined cap. The remaining sample material 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 for VOC analysis is transferred immediately from the sampler to the sample container to minimize the loss of VOCs during the sample collection process. Containers for VOC samples are filled as completely as possible, leaving no or minimal headspace, and sealed with a Teflon-lined cap. The remaining sample material is transferred from the auger bucket to a stainless-steel sampling bowl before the various required sample containers are filled.
Hollow-Stem Auger Drilling Methods	In this method, hollow-stem augers (sections of seamless pipe with auger flights welded to the pipe) act as a screw conveyor to bring cuttings of sediment, soil, and/or rock to the surface. Auger sections are typically 5 ft 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. If samples are to be collected for VOC analysis, the sampler will be lined with brass sleeves. Immediately upon retrieval of the sampler, it will be opened and a sleeve from the desired depth interval will be collected for VOC analysis. The ends of the sleeve will immediately be covered with Teflon film and capped with plastic caps. Tape will then be used to seal the ends of the cap to the sleeve. Material from the remaining sleeves will then be field screened, visually inspected, and placed in a stainless-steel bowl. Samples for the remaining analysis will then be transferred to appropriate sample containers, depending upon the analytical method requirement.
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 chain of custody. 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.

Table 5.0-1 (continued)

Method	Summary
Sample Control and Field Documentation	The collection, screening, and transport of samples are documented on standard forms generated by the SMO. These include sample container labels and combined sample collection log/chain-of-custody forms. Sample collection portions of the combined forms 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. The chain-of-custody portions of the combined forms will be completed and signed to verify the samples are not left unattended. Corresponding labels will be initialed and applied to each sample container, and custody seals will be placed around container lids or openings. Site attributes (e.g., former and proposed soil sampling locations, sediment sampling locations) are located by using a GPS unit. 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. *Trip blanks*: Required for all field events that include the collection of samples for VOC analysis. Trip blanks are containers of certified clean sand that are opened and kept with the other sample containers during the sampling process. Trip blanks are collected at a frequency of one per day when samples are collected for VOC analysis.
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 sample collection logs 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.

Table 5.0-1 (continued)

Method	Summary
Waste Management, Characterization, and Storage	Wastes are 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 wastes will be marked with appropriate signage and labels, as appropriate. Drummed waste will be stored on pallets to prevent the containers from deterioration. Waste 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. Appendix B describes waste management.
Geodetic Surveys	This method describes the procedure for coordinating and evaluating geodetic surveys and establishing QA and QC for geodetic survey data. The procedure covers evaluating geodetic survey requirements, preparing to perform a geodetic survey, performing geodetic survey field activities, preparing geodetic survey data for QA review, performing QA review of geodetic survey data, and submitting geodetic survey data.

Table 5.9-1
Summary of Analytical Methods

Analyte	Analytical Method
TAL metals (aluminum, antimony, arsenic, barium, beryllium, calcium, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, sodium, silver, thallium, vanadium, and zinc)	SW-846:6010C; SW-846:6020B; SW-846:7471A (mercury)
Nitrate	EPA SW-846:9056
Perchlorate	SW-846:6850
Total cyanide	EPA SW-846:9012B
pH	SW-846:9045C
VOCs	SW-846:8260B
SVOCs	SW-846:8270D
Explosive compounds	SW-846:8330B
Dioxins/furans	SW-846:8290A
PCBs	SW-846:8082A
Americium-241	HASL-300:AM-241
Gamma-emitting radionuclides	EPA 901.1
Isotopic plutonium	HASL-300:ISOPU
Isotopic uranium	HASL-300:ISOU
Strontium-90	EPA 905.0
Tritium	EPA 906.0

Appendix A

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

A-1.0 ACRONYMS AND ABBREVIATIONS

2D	2-dimensional
3D	3-dimensional
AK	acceptable knowledge
AOC	area of concern
bgs	below ground surface
BMP	best management practice
BV	background value
COC	certificate of completion
Consent Order	Compliance Order on Consent
D&D	decontamination and decommissioning
DOE	Department of Energy (U.S.)
DP	Delta Prime
DPT	direct-push technology
EBSR	environmental baseline survey report
EM61	Geonics, Limited, EM61-MK2
EMI	electromagnetic induction
EPA	Environmental Protection Agency
GPR	ground-penetrating radar
GPS	global-positioning system
GSSI	Geophysical Survey Systems, Inc.
FDEM	frequency domain electromagnetic (induction)
IA	interim action
IP	Individual Permit
HazMat	Hazardous Materials (team)
LAC	Los Alamos County
LANL	Los Alamos National Laboratory
LASL	Los Alamos Scientific Laboratory (Laboratory's name before January 1, 1981)
LLW	low-level waste
MAR	material at risk
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	Material Disposal Area
MDPR	Middle DP Road
MLLW	mixed low-level waste

N3B	Newport News Nuclear BWXT-Los Alamos, LLC
NFA	no further action
NMED	New Mexico Environment Department
NNSA	National Nuclear Security Administration
NPDES	National Pollutant Discharge Elimination System
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
QA	quality assurance
QC	quality control
RAP	Radiological Assistance Program
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
RESRAD	Residual Radioactivity
RFI	RCRA facility investigation
SAL	screening action level
SMO	Sample Management Office
SOP	standard operating procedure
SRT	seismic refraction tomography
SSL	soil screening level
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TA	technical area
TAL	target analyte list [EPA]
TDEM	time domain electromagnetic (induction)
TFI	total field intensity
Triad	Triad National Security, LLC
TRU	transuranic
VCA	voluntary corrective action
VCP	vitrified-clay pipe
VGM	vertical gradient magnetometry
VOC	volatile organic compound
WAC	waste acceptance criteria
WCSF	waste characterization strategy form

A-2.0 METRIC CONVERSION TABLE

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

A-3.0 DATA QUALIFIER DEFINITIONS

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

Appendix B

Waste Management Plan

B-1.0 INTRODUCTION

This appendix describes how wastes generated during the investigation of the Middle DP Road site will be managed. Wastes may include, but are not limited to, drill cuttings, excavated media, overburden spoils, excavated man-made debris, contact waste, decontamination fluids, and all other waste that has potentially come into contact with contaminants.

B-2.0 WASTE STREAMS

All wastes generated during investigation and remediation activities will be managed in accordance with standard operating procedure (SOP) N3B-EP-DIR-SOP-10021, “Characterization and Management of Environmental Programs Waste.” This SOP incorporates the requirements of all applicable U.S. Environmental Protection Agency (EPA) and New Mexico Environment Department (NMED) regulations and U.S. Department of Energy orders.

A waste characterization strategy form (WCSF) will be prepared and approved per requirements of N3B-EP-SOP-10021. The WCSF will provide detailed information on waste characterization methods, management, containerization, and potential volumes. Waste characterization is completed through review of sampling data and/or documentation or by direct sampling of the waste or the media being investigated (e.g., surface soil, subsurface soil). Waste characterization may include a review of historical information and process knowledge to identify whether listed hazardous waste may be present (i.e., due diligence reviews). If low levels of listed hazardous waste are identified, a “contained in” determination may be submitted for approval to NMED. Data currently available for the sites addressed in this work plan do not identify polychlorinated biphenyl (PCB) concentrations greater than 1 mg/kg. However, if this investigation identifies PCB concentrations of greater than 1 mg/kg, Newport News Nuclear BWXT-Los Alamos, LLC (N3B) may submit a request to EPA (with a copy to NMED) to manage the waste as PCB remediation waste. Radioactive wastes are not expected to contain transuranic (TRU) levels of contamination (i.e., greater than 100 nCi/g). If characterization indicates TRU levels of contamination, work will be stopped, NMED will be notified, and an evaluation of how to proceed will be developed.

Wastes will be containerized and placed in clearly marked and appropriately constructed waste accumulation areas. Waste accumulation area postings, regulated storage duration, and inspection requirements will be based on the type of waste and its classification. Container and storage requirements, as well as transportation and disposal requirements, will be detailed in the WCSF and approved before waste is generated. Table B-2.0-1 summarizes the estimated waste streams, waste types, and other data.

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

B-2.1 Drill Cuttings

Drill cuttings consist of soil and tuff/rock chips generated by the drilling of boreholes for the intent of sampling. Drill cuttings include excess core samples not submitted for analysis and any returned samples sent for analysis. Drill cuttings will be containerized in IP-1 bags, 55-gal. drums, B-12 containers, or other appropriate containers at the point of generation. The initial management of the cuttings will rely on the data from previous investigations and/or process knowledge. Drill cuttings will be managed in secure, designated areas appropriate to the type of the waste. If new analytical data change the expected waste category, the waste will be managed in accumulation areas appropriate to the final waste determination.

This waste stream will be characterized based either on direct sampling of the waste or on the results from core samples collected during drilling. The WCSF will specify the sampling suites for direct sampling of the waste stream. Additional constituents may be analyzed as necessary to meet the waste acceptance criteria (WAC) for a receiving facility or if visual observations indicate that additional contaminants may be present.

Cuttings will be land-applied if they meet the criteria in the NMED-approved Notice of Intent Decision Tree for Land Application of Investigation-Derived Waste Solids from Construction of Wells and Boreholes. N3B expects that cuttings will be land-applied or disposed of in accordance with the approved WCSF. Table B-2.0-1 presents the characterization and management methods and expected disposition of this waste stream.

B-2.2 Excavated Environmental Media

Excavated environmental media consists of contaminated soil and rock removed to meet the proposed cleanup levels where cleanup is recommended. The excavated material will be field-screened and examined for visible evidence of contamination during the excavation process. The excavated material will be placed in appropriate containers in accordance with the approved WCSF. Wastes will be segregated by site or source area if the expected waste classifications are different. A minimum of one direct sample will be collected from each 20 yd^3 or each container of material excavated and will be submitted for laboratory analyses for the analytical suites specified in the WCSF. N3B expects most of the excavated environmental media to be designated as nonhazardous waste, hazardous waste, mixed low-level radioactive waste (MLLW), or low-level radioactive waste (LLW) that will be disposed of in accordance with the approved WCSF. Table B-2.0-1 presents the characterization and management methods and expected disposition of this waste stream.

B-2.3 Overburden Spoils

Overburden spoils consist of soil above or adjacent to areas of known contamination that must be removed to access contaminated media or debris. Overburden spoils are expected to be uncontaminated but will be field-screened and examined for visible evidence of contamination during the excavation process. If radiological contamination is not detected during screening (e.g., does not exceed surface contamination values specified in N3B-P121, “Radiation Protection”), the spoils will be stored either in rolloff bins, other suitable containers, or on the ground surface with appropriate best management practices (BMPs). If field screening indicates the potential for radiological contamination (e.g., exceeds surface contamination values specified in N3B-P121), the spoils will be placed in rolloff bins or other suitable containers. A minimum of one direct sample will be collected from each 20 yd^3, or each container of material excavated, and will be submitted for laboratory analyses for the analytical suites specified in the WCSF. If the spoils are determined to be suitable for reuse (i.e., are not hazardous waste and meet residential soil screening levels [SSLs] and screening action levels [SALs]), N3B will segregate any man-made debris from the soil and will use this soil to backfill the excavations. If the spoils do not meet residential SSLs/SALs or are determined to be hazardous waste, they will be treated/disposed of at an authorized facility appropriate for the waste regulatory classification. N3B expects overburden spoils will be suitable for backfilling excavations. Table B-2.0-1 presents the characterization and management methods and expected disposition of this waste stream.

B-2.4 Pothole Spoils

Pothole spoils are expected to be uncontaminated but will be field-screened and examined for visible evidence of contamination and debris during excavation. If radiological contamination is not detected from field screening (e.g., does not exceed surface contamination values specified in N3B-P121), the spoils will be placed next to the pothole and returned to the excavation after native tuff is encountered. If field screening indicates the potential for radiological contamination (e.g., exceeds surface contamination values specified in N3B-P121) or if debris is encountered in the pothole excavation, the spoils will be placed in rolloff bins or other suitable containers and managed as excavated environmental media as described in section B-2.2.

B-2.5 Excavated Man-Made Debris

Excavated man-made debris may be generated from the evacuation and removal of subsurface debris. Debris will be segregated as it is excavated based on factors such as the type of debris, field screening, process knowledge, and/or staining or odors. Where practicable, this waste stream will be characterized by direct sampling of the waste (e.g., glassware, metal objects, plastics, concrete). Direct samples will be analyzed for the analytical suites specified in the WCSF. For debris that is difficult to characterize, acceptable knowledge (AK) will be used whenever possible, supplemented by sampling as needed. N3B expects most of the excavated man-made debris to be designated as nonhazardous waste, hazardous waste, MLLW, or LLW that will be disposed of in accordance with the approved WCSF.

Waste minimization will be implemented, where practicable, through segregation of waste materials. Nonhazardous materials that can be shown to have no detectable activity for radionuclides, or that can be decontaminated to meet this criterion, will be recycled if practicable.

B-2.6 Contact Waste

The contact waste stream consists of potentially contaminated materials that “contacted” other waste during sampling and excavation. This waste stream consists primarily of, but is not limited to, personal protective equipment such as gloves, decontamination wastes such as paper wipes, and disposable sampling supplies. Contact waste will be stored in containers and characterized in accordance with the approved WCSF.

Characterization of this waste stream will use AK based on data from the media with which it came into contact (e.g., drill cuttings, soil, debris, etc.). N3B expects most of the contact waste to be designated as nonhazardous, nonradioactive waste that will be disposed of in accordance with the approved WCSF. Table B-2.0-1 presents the characterization and management methods and expected disposition of this waste stream.

B-2.7 Decontamination Fluids

The decontamination fluids waste stream will consist of liquid wastes from decontamination activities (i.e., decontamination solutions and rinse waters). Consistent with waste minimization practices, N3B employs dry decontamination methods to the extent possible. If dry decontamination cannot be performed, liquid decontamination wastes will be collected in containers at the point of generation. The decontamination fluids will be characterized through AK of the waste materials, the levels of contamination measured in the environmental media (e.g., the results of the associated drill cuttings), and, if necessary, direct sampling of the containerized waste. If directly sampled, samples will be analyzed for the analytical suites specified in the WCSF. N3B expects most of the decontamination fluids will be nonhazardous waste or LLW and will be treated at a permitted facility for which the waste meets the WAC. Table B-2.0-1 presents the characterization and management methods, and expected disposition of this waste stream.

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

Waste Stream	Expected Waste Type	Characterization Method	On-Site Management	Expected Disposition
Drill Cuttings	Nonhazardous nonradioactive waste or LLW	Analytical results from direct sampling of waste or core samples	Accumulation in 55-gal. drums, IP-1 bags, or other appropriate containers	Land application, or permitted facility for which waste meets acceptance criteria
Excavated Environmental Media	Nonhazardous nonradioactive waste, hazardous waste, MLLW, or LLW	Analytical results from direct sampling of waste	Accumulation in 55-gal. drums, covered rolloff containers, or other appropriate containers	Permitted facility for which waste meets acceptance criteria
Overburden Spoils	Nonhazardous nonradioactive waste	Analytical results from direct sampling of waste	On ground with BMPs, or accumulation in covered rolloff containers or other appropriate containers	Return to excavation or permitted facility for which waste meets acceptance criteria
Excavated Man-Made Debris	Nonhazardous nonradioactive waste, hazardous waste, MLLW, or LLW	Analytical results from direct sampling of waste or AK	Accumulation in covered rolloff containers or other appropriate containers	Permitted facility for which waste meets acceptance criteria
Contact Waste	Nonhazardous nonradioactive waste	AK	Accumulation in 55-gal. drums	Permitted facility for which waste meets acceptance criteria
Decontamination Fluids	Nonhazardous nonradioactive waste or LLW	AK; analytical results from direct sampling of waste	Accumulation in 30-gal. plastic drums	Treatment at permitted facility for which waste meets acceptance criteria

Appendix C

Geophysical Surveys

C-1.0 GEOPHYSICAL SURVEY OVERVIEW

Five geophysical methods were conducted in November 2020 for the subsurface geophysical investigation at the Middle DP Road (MDPR) site. These five methods included

- time domain electromagnetic (TDEM) induction,
- frequency domain electromagnetic (FDEM) induction,
- vertical gradient magnetometry (VGM),
- ground-penetrating radar (GPR), and
- seismic refraction tomography (SRT).

Geophysical data was collected in three phases:

1. Acquire electromagnetic and magnetic data over 100% of the MDPR site.
2. Acquire GPR data over anomalies identified from the electromagnetic and magnetic surveys.
3. Perform multiple two-dimensional (2D) SRT transects across the site.

This combination of geophysical data will help identify where trenches and miscellaneous debris are positioned and located within the site, differentiate the depth of cover and material type (metallic versus non-metallic), and evaluate subsurface soil thickness and bedrock characteristics below the site. Geophysical survey data was acquired in the walking mode using the appropriate line spacing for the instrument type. The geophysical survey type and equipment used for each is described below.

C-1.1 Time Domain Electromagnetic Induction

For TDEM measurements, a primary magnetic field, generated by current supplied to the transmitter coil, induces eddy currents in nearby metallic objects. The induced eddy currents decay with time at a rate dependent on the characteristics of the object, producing a secondary magnetic field with the same rate of decay. The time-decay of the secondary magnetic field generates a signal within each of the two receiver coils, thereby confirming the presence of metal.

A Geonics Limited, EM61-MK2 (EM61) high-sensitivity metal detector was used for the TDEM induction survey. The EM61 is an industry standard instrument for shallow metal detection (e.g., unexploded ordnance surveys, landfill investigations, underground storage tank locates). The EM61 instrument detects ferrous and non-ferrous conductive metals (e.g., copper, aluminum, brass, steel). The effective depth of detection varies with the size (mass and surface area) of the buried metal object. As a general reference range, the EM61 can typically detect a 1-in.-diameter steel pipe 4 in. in length up to a maximum burial depth of about 16 in. A 55-gal. steel drum has a maximum detection burial depth of approximately 6 ft below ground surface (bgs), and a large tank has a detection burial depth up to approximately 10 ft bgs. TDEM induction data was collected over the MDPR site at a nominal line spacing of 3 ft, in an anticipated east-west transect direction, for a total line coverage of 15.5 mi.

C-1.2 Frequency Domain Electromagnetic Induction

The FDEM induction survey was conducted to define changes in terrain conductivity related to buried trench boundaries as well as to evaluate metallic and/or non-metallic materials associated with the trenches and their contents. There are many available FDEM induction instruments, most of which will provide two channels of response for each depth of investigation, termed “in-phase” and “quadrature.”

The in-phase channel provides a measure of magnetic susceptibility and is largely a measure of the presence of metallic objects. The quadrature channel can be represented in terms of electrical conductivity or resistivity, so it responds to changes in soil composition or water content, or targets that vary in their electrical conductivity. Older electromagnetic induction (EMI) instruments, such as the Geonics EM-31-MK2 or EM-34-MK2, provide a single pair of in-phase and quadrature data for each measurement point that represents mean values within a prescribed effective depth range. Because they provide only mean resistivity values commonly referred to as bulk-conductivities, they provide little information about the depth of features they detect. Several FDEM induction instruments have been commercially developed in the past decade that can provide in-phase and quadrature data for multiple depths of investigation with a single (walking) pass.

A GF Instruments CMD Explorer was used for the FDEM induction survey. The CMD Explorer uses a single transmitter coil with three receiver coils at different offsets from the transmitter coil (1.48 m, 2.82 m, and 4.49 m). The three offsets provide three different depths of investigation, with a maximum effective depth of investigation typically equal to the coil spacing (i.e., 4.49-m coil spacing will effectively image to a depth of about 15 ft bgs). The CMD is a bulk measurement instrument such that the measured response for a given point represents the sum of all the response contributions beneath the coil. While this instrument can detect larger ferrous and non-ferrous metallic objects such as metal tanks, culverts, and pipes, it is more specifically designed for identifying changes in soil conditions (e.g., soil composition, water content) making it an effective tool for defining the lateral extent of burial trenches and pits.

Survey lines were aligned with the long axis of the site (east-west) so that they cross perpendicular to the orientation of the anticipated trenches. A nominal line spacing of 8 ft was used for the FDEM measurements for a total line coverage of 5.5 mi. System readings were acquired at 1 Hz (i.e., 1 per second) and had global positioning system (GPS) streaming into the CMD instrument recorder.

Raw survey data was exported in tabular format using CMD Data Transfer, Version 1.6.1, by GF Instruments. Aarhus GeoSoftware Workbench, Version 5.9.3.0, was used to process the data to produce 2D and three-dimensional (3D) visual results. Additional pre-processing steps are required to prepare the data for model inversion. Additional processing, including 2D gridding and 3D voxeling, is performed using Geometrics Geosoft Oasis Montaj, Version 9.6. The terrain conductivity measurements from each coil spacing are exported in x-y-z (2D position and value) to Geosoft, where 2D grids are generated for presentation. Resistivity models from the geophysical inversion are exported in x-y-z-v format (3D position and value) to Geosoft, where a voxel volume (3D grid) is created in order to visualize the EMI resistivity model results beneath the survey area. In general, inversion will produce a more reliable measurement of trench depths if the maximum penetration sufficiently exceeds the trench bottoms.

C-1.3 Vertical Gradient Magnetometry

A magnetic gradient survey was performed in conjunction with electromagnetic surveys to non-invasively characterize the lateral extents and variability of buried waste materials. Magnetic gradient data was acquired by means of VGM, using two Geometrics G-858 magnetic sensors positioned one above the other (about 3 ft apart). Each sensor independently measures the total field intensity (TFI) of the earth’s magnetic field, and the combined measurements of the two sensors provide the vertical gradient of that magnetic field. Depending on data quality and the value of using the gradient measurement, TFI measurements were used to present the best resolution of subsurface features below the site.

A Geometrics G-858 magnetometer was used for the VGM survey. The G-858 magnetometer measures the total magnetic field and will detect magnetic metal objects (e.g., ferrous metals) by measuring the changes in the Earth’s magnetic field caused by the object. The effective depth of investigation of the G-858 is variable as it depends on the cumulative effect of many factors including the size, mass, shape, and orientation of the metal object; the orientation of the remnant magnetic field of the object; and the magnetic properties of the materials surrounding the object. In general, the G-858 is capable of detecting large ferrous metal objects, such as pipelines, drums, and tanks, at significantly greater depths that either the EM61 or CMD, with detection depths to 20 ft or greater for large ferrous metallic masses or buried (vertical) well casings (i.e., plugged and abandoned well casings).

Similarly to the FDEM transects, the magnetometer transects were oriented in the east-west direction and collected using an 8-ft line spacing. Magnetometer data (for each sensor) were acquired at a synchronized sample rate of at least 1 sample per second (i.e., 1 Hz) to maximize detail along the transect. The data were downloaded using the Geometrics MagMap utility and were then transferred for processing to Geosoft Oasis Montaj (Version 9.6). The Montaj software package is the most desirable data processing package for potential fields (e.g., magnetic), with multiple internal routines to analyze each magnetometer sensor TFI independently and the vertical gradient and to perform further processing, including analytic-signal or reduce-to-pole techniques, each of which refine the transect data.

C-1.4 Ground-Penetrating Radar

GPR uses radar pulses to image the subsurface. It is a non-intrusive method of surveying the subsurface to investigate underground utilities such as concrete, asphalt, metals, pipes, cables, or masonry. This nondestructive method uses electromagnetic radiation in the microwave band (ultrahigh frequency/very high frequency) of the radio spectrum and detects the reflected signals from subsurface structures. Reflecting interfaces may be soil horizons, the groundwater surface, soil/rock interfaces, man-made objects, or any other interface possessing a contrast in dielectric properties. The dielectric properties of materials correlate with many of the mechanical and geologic parameters of materials.

The GPR survey was conducted using the most effective GPR frequency selected during testing/evaluation. Both 270-MHz and 400-MHz GPR frequencies were tested to determine which is most appropriate for the site subsurface conditions. The Geophysical Survey Systems Inc. (GSSI) SIR 4000 GPR console was used with the appropriate antenna for acquiring measurements over selected geophysical anomalies identified in the TDEM, FDEM, and VGM surveys. GPR is capable of identifying both metallic and non-metallic buried objects. The effective depth of investigation is strongly affected by the site-specific soil properties such as clay content, water content, and metal content. The manufacturer’s specification for maximum depth of investigation for the 270-MHz antenna is listed as 18 ft; however, this is possible only under ideal/sandy soil conditions above the water table. For typical good soil site conditions, the effective depth of investigation is generally about 8–10 ft (in unsaturated soil settings).

GPR transects were oriented perpendicular to the longitudinal axis of any trench detected, as well as to any transects parallel to the trench long axis. Final position of these transects were based on significant electromagnetic and magnetic geophysical anomalies derived from other geophysical investigations performed at the MDPR site. In addition, a GPR transect was positioned away from known trench locations (and also not coincident with previously identified geophysical anomalies). These data provided information on the suitability of GPR for surveying native ground compared with buried debris and trench materials.

GPR test transects were acquired using two separate frequency GPR antennas, 400 MHz and 270 MHz respectively. Following the acquisition of the GPR test transects, these data were processed on-site and analyzed to determine if GPR, at either of the tested frequency ranges, was suitable for imaging of the buried (trench) materials at the site. If GPR data from either of the two frequencies proved to be useful, the most well-suited frequency antenna (400 MHz or 270 MHz) was selected for completion of a GPR survey. Multiple GPR transects were oriented along the length of the landfill trenches and coincident with all previously identified geophysical anomalies at the site. These lines covered the width of the trenches and anomalies with a nominal line spacing of 10 ft.

C-1.5 Seismic Refraction Tomography

The SRT method uses P- and S-wave energy to map vertical and lateral subsurface changes. A hammer blow generates a shock wave that travels through the ground, which is refracted along material boundaries and is then received at the surface by sensors (geophones). Refraction interfaces correlate with real-world boundaries in the ground, such as soil-to-bedrock boundaries. SRT is performed on soil and rock sites to generate 2D or 3D compression or shear wave velocity profiles. These velocity profiles can be used to estimate vertical and lateral variations in soil properties as well as the depth to, shape of, and physical properties of bedrock.

A Geometrics Geode seismograph and a land streamer receiver array with 24 sensors at 1-m spacing for a total receiver array length of 23 m were used for the SRT survey. SRT can map the depth to top of bedrock and lateral changes in compressibility of overburden soil deposits. The maximum depth of investigation for SRT is a function of the size of the active receiver array (23 m), the seismic source (sledgehammer), and the subsurface velocity structure. The typical maximum depth of investigation using these parameters is about 30-40 ft, depending on surface conditions at the time of the survey (e.g., muddy/soft surface soils versus stiff conditions).

SRT data were collected with a 24-channel seismograph (Geometrics Geode) with 24 gimbaled geophones mounted on a “landstreamer” tow-cable with 1-m spacing (~75.5 ft long); thus a roll-along SRT format was used to cover the line length on the ground.

C-1.6 Global Positioning System

GPS positional measurements were made with a Trimble Geo7X instrument. TDEM, FDEM, VGM, and GPR instrumentation had GPS data streamed into each system at a rate of 1 Hz (1 sample per second). The GPS system had approximately 1-ft horizontal accuracy for these measurements. The GPS was also used to mark the ends, middle, and other important points along the receiver array for data processing to include both topography and lateral stationing.