Disposition of Excess Real Property Assessment at the Los Alamos National Laboratory Middle DP Road Site

November 2021

Office of Enterprise Assessments
U.S. Department of Energy

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Acronyms

AL	Authorized Limit
Am	Americium
CDNS	NNSA Chief of Defense Nuclear Safety
CFR	Code of Federal Regulations
CM	Chemistry and Metallurgy
DOE	U.S. Department of Energy
EA	Office of Enterprise Assessments
EBSR	Environmental Baseline Survey Report
EIS	Environmental Impact Statement
EM	Office of Environmental Management
EM-LA	EM Los Alamos Field Office
EOSC	Emergency Operations Support Center
EPC	Triad Environmental Protection and Compliance Division
IRWP	Investigation/Remediation Work Plan
LAC	Los Alamos County
LAFD	Los Alamos Fire Department
LANL	Los Alamos National Laboratory
LANS	Los Alamos National Security, LLC
LAPD	Los Alamos Police Department
LASL	Los Alamos Scientific Laboratory
LASO	Los Alamos Site Office
LC&T	Land Conveyance and Transfer
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	Material Disposal Area
MDPR	Middle DP Road
mrem	Millirem
NA-LA	National Nuclear Security Administration Los Alamos Field Office
NEPA	National Environmental Protection Act
NMED	New Mexico Environment Department
NNSA	National Nuclear Security Administration
N3B	Newport News Nuclear BWXT Los Alamos, LLC
ORPS	Occurrence Reporting and Processing System
Pu	Plutonium
QA	Quality Assurance
RAP	Radiological Assistance Program
RCRA	Resource Conservation and Recovery Act
SAL	Screening Action Level
SAP	Sampling and Analysis Plan
SME	Subject Matter Expert
SSL	Soil Screening Level
SWMU	Solid Waste Management Unit
TA	Technical Area
Triad	Triad National Security, LLC
UC	University of California

Disposition of Excess Real Property Assessment
at the Los Alamos National Laboratory
Middle DP Road Site
September 2020 – January 2021

Summary

Scope

This assessment was conducted by the U.S. Department of Energy (DOE) Office of Enterprise Assessments (EA) to evaluate Los Alamos National Laboratory (LANL) site processes and actions for the disposition (conveyance or transfer) of excess real property in response to Public Law 105-119, *Departments of Commerce, Justice, and State, the Judiciary, and Related Agencies Appropriations Act, 1998*. Specifically, this assessment examined the processes used to convey land associated with the 2020 discoveries of buried waste that originated from operations at LANL in the 1940s during the Manhattan Project but was not identified during land characterization activities. The land disposition activities that were evaluated during this assessment occurred over the past 15 years and included multiple Federal organizations and contractors. This assessment was conducted remotely due to COVID-19 travel restrictions and was based on interviews with responsible Federal and contractor managers and staff and examination of program plans, procedures, and related documentation.

This assessment evaluated the adequacy of:

- Legacy characterization practices to properly identify the form, quantity, and location of radiological hazards
- Legacy remediation practices and fulfillment of required end-state conditions to disposition excess real property
- Compliance with governing requirements and the adequacy of implementing procedures and practices
- Response to the discoveries of buried waste at the Middle DP Road (MDPR) site
- Contractor quality assurance (QA) and Federal oversight programs
- Departmental directives (policy, orders, and guidance)

This assessment focused on three tracts of land (A-16-a, A-8-a, and A-8-b as shown in Figure S-1) conveyed over the period 2007 to 2018, and the associated land conveyance and transfer (LC&T) and remediation processes. The assessment scope did not include the disposition of Federal land prior to or not associated with the 1998 Public Law 105-119.

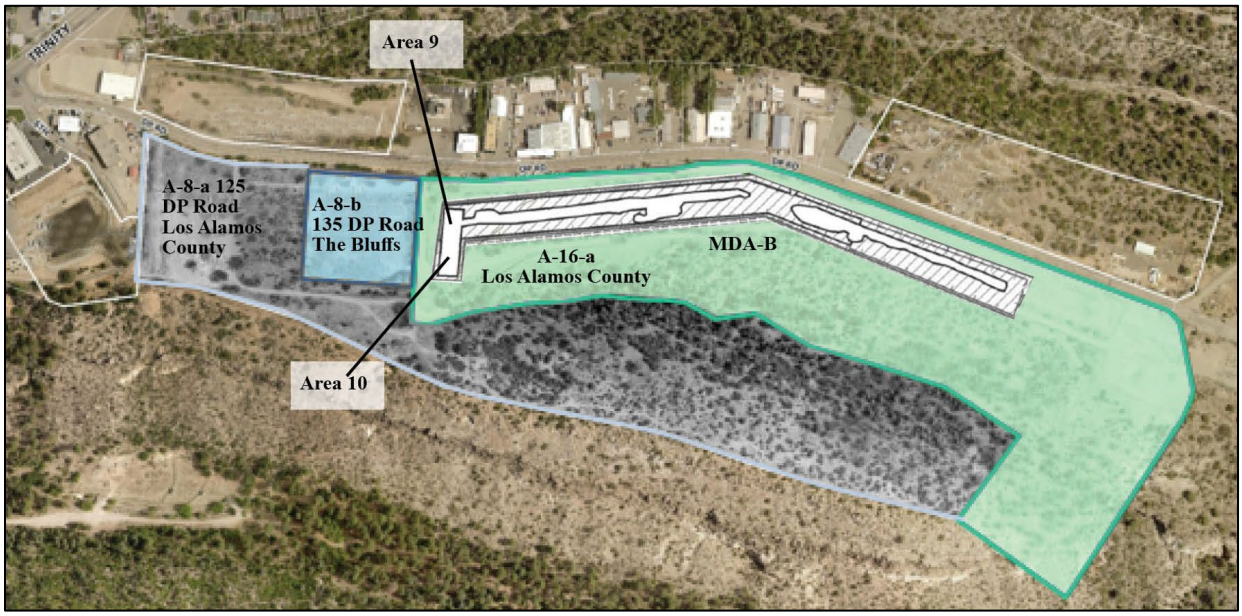
Background

The National Nuclear Security Administration (NNSA) Los Alamos Field Office (NA-LA) oversees the disposition of excess real property managed by its operating contractor, Triad National Security, LLC (Triad). The DOE Office of Environmental Management (EM) Los Alamos Field Office (EM-LA) oversees investigation and remediation, where required, of legacy contamination performed by its contractor Newport News Nuclear BWXT Los Alamos, LLC (N3B). Land conveyance, investigation, and remediation activities were also conducted by previous LANL operating contractors: University of California (UC) and subsequently Los Alamos National Security, LLC (LANS).

On February 14, 2020, a Los Alamos County (LAC) contractor, excavating a utility trench on previously-conveyed land from DOE, uncovered legacy LANL buried waste. Post-discovery radiological surveys and sample analysis of the LAC contractor excavation equipment, and of the responding Los Alamos Police Department (LAPD) and Los Alamos Fire Department (LAFD) facilities and equipment, confirmed no spread of radiological contamination. Subsequent analysis of this buried waste by Triad confirmed the presence of fixed plutonium (Pu) contamination, which is not readily transferred to another object. The excavation work area is currently fenced to restrict access.

After the February 14, 2020, discovery, NA-LA and EM-LA tasked their contractors, Triad and N3B respectively, with monitoring the activities of the LAC excavation contractor and property developer activities. Additional buried waste discoveries were made and removed from work site by Triad while supporting the LAC excavation contractor; buried waste discoveries were made on May 18 (radiologically contaminated), June 22 and 24 (radiologically contaminated), and July 24, 2020 (non-contaminated construction debris). These buried waste discoveries occurred near the intersection of three previously conveyed tracts of land (A-16-a, A-8-a, and A-8-b). LANL organizations now designate the area encompassing the radioactive buried waste discoveries on A-16-a and A-8-a as the MDPR site, which defines the boundary for planned further investigation.

In September 2020, EM-LA requested that EA perform an independent assessment of the LANL site LC&T procedures and practices that contributed to these unexpected discoveries of radiologically contaminated buried waste. Triad is evaluating all tracts of land under the 1998 Public Law 105-119 for the potential risk of further buried radiologically contaminated material.



Significant Results for Key Areas of Interest

The assessment team identified several significant results in the areas of excess real property characterization, investigation and remediation, radiological protection practices associated with LC&T, MDPR site buried waste discoveries and response, organizational integration challenges, contractor QA and Federal oversight, and completeness of DOE directives.

Excess Real Property Characterization

Over the years and throughout many organization and contract changes, the LANL operating contractors identified solid waste management units (SWMUs) primarily by reviewing historical records (e.g., correspondence and reports going back to the Manhattan Project), conducting interviews, and performing limited additional sampling outside the estimated boundary of the known SWMUs. The SWMUs on the tracts of land associated with MDPR were identified using the above-described process.

However, the 2020 discoveries were not located within any previously identified SWMUs. Because of the reliance on historical document reviews without additional or sufficient confirmatory field sampling, the exact location of the earliest LANL Chemistry and Metallurgy (CM) waste disposal areas (the 1944 CM disposal pits) were not adequately reconciled resulting in potentially incomplete characterizations of tracts A-16-a, A-8-a, and A-8-b. Triad has evaluated the potential for similar conditions to exist on other conveyed tracts of land and established a risk ranking; NA-LA is awaiting this assessment report to complete needed corrective actions to address the potential for future discoveries of unexpected legacy contamination. Overall, the discoveries of radiologically contaminated buried waste on two previously-conveyed tracts of land (A-16-a and A-8-a) demonstrate that the original characterization by former LANL management and operating contractors (UC and LANS) was inadequate.

Remediation of Material Disposal Area (MDA)-B and CM Disposal Pits Locations

UC and LANS used the term "Material Disposal Area" to define SWMUs that were the result of planned waste burial activities. During 2010-2011, LANS successfully remediated the identified waste trenches in MDA-B on tract A-16-a to residential standards and obtained a certificate of completion (without controls) from the New Mexico Environment Department in May 2015. LANS assumed at the beginning of the remediation efforts that the 1944 CM disposal pits were located within the boundary of MDA-B at the far western boundary (Areas 9 and 10), based on historical information. Further trenching and sampling in Areas 9 and 10 by LANS did not identify any waste pits, but no investigation was conducted to conclusively identify the actual location of the CM disposal pits. LANS LC&T and remediation personnel missed an opportunity to question the results when remediation activities revealed no evidence of the CM disposal pits within the MDA-B remediation boundaries on tract A-16-a, and the incomplete characterization persisted throughout the LC&T process.

Radiological Protection Practices Associated with LC&T

Radiological documents associated with LC&T, including authorized limits determinations, dose assessment reports, survey and sampling plans, and Environmental Baseline Survey Reports (EBSRs), are generally thorough, informative, and of high quality. However, the LANL site contractors did not perform the required evaluations for institutional controls (i.e., restrictions on land use) to provide a basis for the information presented in the EBSRs and associated deeds. The current Triad LC&T process does not provide sufficient instructions for performing and documenting the evaluation of the need for implementing and maintaining institutional controls for excess real property, as required by DOE Order 458.1, *Radiation Protection of the Public and the Environment*.

MDPR Site Buried Waste Discoveries and Response

In response to the February 14, 2020, buried waste discovery, the LAC excavation contractor contacted the LAFD and LAPD to provide an initial response. However, the initial field response by the DOE Radiological Assistance Program (RAP) occurred six days after the February 14, 2020, buried waste discovery. Complicating factors associated with requesting the RAP assistance include: (1) LAFD did not measure any hazardous levels of radiation emitting from the waste debris, and (2) the event was not on DOE property, thereby requiring the request for RAP assistance to come from LAC. During this time period, LAFD and LAPD were unaware of the actual nature of the radiological contamination hazard and unknowingly handled radiologically contaminated debris and disposed of it in a sanitary waste dumpster. Fortunately, the radiological contamination on the waste debris was fixed, and follow-up radiological

surveys by the RAP did not detect any spread of radiological contamination. NA-LA and EM-LA demonstrated that the current conditions are stable and that none of these MDPR radiologically-contaminated buried waste discovery events adversely affected public safety. NA-LA, EM-LA, Triad, and N3B worked with LAC and the property developer to isolate the MDPR from public access pending further DOE investigation to resolve remaining uncertainties in the characterization of these tracts of land.

The extent of the buried waste remains unknown, but EM-LA and N3B developed a work plan to assess the extent of contaminated subsurface buried waste at MDPR. However, the work plan does not include the east and southeast portions of tract A-8-b, which is adjacent to MDPR. This area is also important, considering: (1) the nearby 2020 discoveries of radioactive buried waste contaminated with early Pu; and (2) a July 5, 1945, letter (Record 9995, Manhattan Project Staff to U.S. Army) with the subject "New Disposal Pit for CM Division" that describes the "now covered 1944 CM disposal pits southeast of the coal storage yard," an area that encompasses the three intersecting tracts A-16-a, A-8-a, and A-8-b.

Organizational Integration Challenges

Two DOE field offices and two main contractors are involved in implementing the LC&T process and associated activities (e.g., investigation and remediation). The Triad LC&T process (historical and current) as described in EPC-ES-TPP-005, *Land Conveyance and Transfer Project* (and predecessor documents) only addresses Triad's responsibilities and does not provide an integrated approach among all four organizations to ensure the appropriate end state for land conveyance. Instead, each organization is focused on its immediate, individual goals and work scope, without adequate consideration of overall LC&T goals.

Contractor Quality Assurance and Federal Oversight

Triad and N3B have established QA programs using a risk-based graded approach, and both contractor organizations improved their programs with feedback from management assessments. However, the N3B and Triad QA organizations have not conducted independent audits and surveillances of field remediation and LC&T activities. Furthermore, Triad does not fully use its issues management system to evaluate issues or track issues and corrective actions to closure to help prevent radiologically-contaminated buried waste from unknowingly remaining on future dispositioned DOE land.

Federal senior managers, including designated EM Headquarters officials, both field office managers, and a designated NA-LA senior advisor supported by a highly experienced and knowledgeable staff, were engaged in monitoring recovery actions at MDPR. NA-LA and EM-LA oversight of recovery actions has been adequate, but the formal oversight of LC&T needs improvement. Correspondingly, assessments conducted by DOE Headquarters (NNSA and EM) have identified longstanding oversight program and performance weaknesses that have not been resolved at the time of this assessment, including an unfilled NA-LA vacancy for a subject matter expert to support oversight of contractor implementation of environmental radiation protection requirements. Furthermore, at the time of the assessment EM-LA had not performed a self-assessment to identify the full scope of its performance issues or developed corrective actions to focus improvement efforts at the time of this assessment. EM-LA completed a self-assessment following data collection for this assessment.

Completeness of DOE Directives

Although DOE directives (policy, orders, and guidance) governing LC&T are generally comprehensive, some problems with DOE Order 458.1 hinder the uniform and consistent disposition of real property and adequate protection of the public from potential radiological hazards. These problems include:

- Definitions of real property and personal property that are insufficient to ensure appropriate application of authorized limits and associated dose constraints

- Not providing a methodology for the formal evaluation and documentation of the need for institutional controls
- Not providing a methodology for investigating potential subsurface contamination
- No clear linkage to DOE Order 430.1, *Real Property Asset Management*

Best Practices
The assessment identified two best practices implemented by EM-LA and Triad that are summarized below and more fully described in Section 3.0 of the report.

- Active engagement of EM-LA with LAC, through attendance at county planning and zoning meetings, promotes DOE monitoring of planned activities on former LANL property and proactively prevents encroachment into legacy SWMUs remaining on conveyed tracts of land.

- Triad's extent-of-condition review provides a risk-ranked list of already-conveyed tracts of land and planned conveyance of future tracts of land based on the potential for discovery of hazardous and radiologically contaminated buried waste. These risk rankings provide the opportunity to expend resources proportional to the assumed risk.

Recommendations
The assessment identified the following seven recommendations for DOE program offices, field elements, and contractors.

DOE Headquarters

- **Recommendation HQ-1.** The DOE Office of the Associate Under Secretary for Environment, Health, Safety and Security should evaluate and revise DOE Order 458.1, as necessary, in the following areas:

    - Definitions of real property and personal property that address radiologically contaminated buried waste
    - Guidance for investigating potential subsurface radioactive contamination (greater than six inches below the surface)
    - Reference DOE Guide 454.1-1G, *Institutional Controls Implementation Guide for Use with DOE P 454.1, Use of Institutional Controls*, or latest applicable guidance (e.g., DOE-HDBK-1240-2021, *Institutional Controls Implementation Handbook for Use with Use of Institutional Controls*) as a DOE approved methodology

    In addition, the DOE Office of Asset Management should revise DOE Order 430.1 to provide a clear linkage to DOE Order 458.1 for radiation protection requirements and institutional controls.

NA-LA

- **Recommendation NA-LA-1.** NA-LA should conduct additional investigation of tract A-8-b for undiscovered disposal pits in two locations not previously sampled: (1) between the previously excavated utility trench and the eastern boundary, and (2) the southeast corner.
- **Recommendation NA-LA-2.** NA-LA, in collaboration with EM-LA, should perform a formal root cause analysis on the MDPR events of 2020. Results of the analysis should be used to develop a

corrective action plan and entered and tracked to resolution via the issues management process. The results should also be shared as lessons learned and operating experience across the DOE complex. The causal analysis should include but not be limited to the following areas, which are identified in this report as potential contributors:

- The initial response to finding buried waste
- The evaluation to locate the 1944 CM disposal pits
- The characterization activities associated with Areas 9 and 10
- The lack of understanding of the characteristics of early Pu
- The lack of an extent-of-condition review when MDA-B remediation identified significantly more waste than anticipated

- **Recommendation NA-LA-3.** NA-LA should provide awareness training to the LAFD on the survey practices for early Pu and verify that the radiological survey equipment used by LAFD is capable of detecting early Pu contamination and/or other alpha, beta, and gamma emitting radionuclides.
- **Recommendation NA-LA-4.** NA-LA, in collaboration with EM-LA, should develop a process to ensure an integrated approach among all four organizations involved in LC&T. This process should include references to organizational responsibilities for all LC&T-related regulatory commitments and DOE requirements documentation.

Triad

- **Recommendation Triad-1.** Triad should incorporate implementing instructions for evaluating the need for institutional controls into its LC&T procedure, and then apply the revised LC&T procedure to all previously dispositioned tracts of land that may contain residual radioactivity. The revised LC&T procedure should be based on the guidance in DOE Guide 454.1-1, *Institutional Controls Implementation Guide for Use with DOE P 454.1*, *Use of Institutional Controls*, or latest applicable guidance.
- **Recommendation Triad-2.** Triad should develop a corrective action plan to address land previously conveyed from LANL that the extent-of-condition report identifies as "potentially elevated risk" and that may need future investigation and remediation. The plan should also address land dispositioned prior to or not associated with Public Law 105-119, *Departments of Commerce, Justice, and State, the Judiciary, and Related Agencies Appropriations Act, 1998.*

Follow-up Actions

EA will monitor LANL's response to this report and evaluate the need for additional assessment activities.

Disposition of Excess Real Property Assessment at the Los Alamos National Laboratory Middle DP Road Site

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Office of Nuclear Engineering and Safety Basis Assessments, within the independent Office of Enterprise Assessments (EA), conducted an assessment of land conveyance and transfer (LC&T) processes at Los Alamos National Laboratory (LANL) used for the disposition of excess real property (land). This assessment was conducted in response to a September 2020 request from the manager of the Environmental Management Los Alamos Field Office (EM-LA), through the DOE Headquarters Office of Environmental Management (EM). EM requested a focus on the LANL LC&T procedures and practices that contributed to legacy radioactive buried waste unknowingly remaining on land, located along DP Road (the origin of the DP acronym is unknown), that was previously conveyed to Los Alamos County (LAC) in 2007 (tract A-8-a) and 2018 (tract A-16-a).

As stated in the assessment plan for the *Disposition of Real Property Assessment at the Los Alamos National Laboratory - Middle DP Road, November 2020*, this assessment evaluated the effectiveness of the Federal offices and associated contractor organizations in managing and performing LC&T activities. Currently, two Federal offices (the National Nuclear Security Administration (NNSA) Los Alamos Field Office (NA-LA) and EM-LA), Triad National Security, LLC (Triad, a NA-LA management and operating contractor), and Newport News Nuclear BWXT Los Alamos, LLC (N3B, an EM-LA contractor) participate in the conveyance of excess real property and the resolution of corrective actions associated with buried waste discoveries.

This assessment evaluated the adequacy of the following elements of LC&T processes and associated activities:

- Legacy characterization practices to properly identify the form, quantity, and location of radiological hazards
- Legacy remediation practices and fulfillment of required end-state conditions to disposition excess real property
- Compliance with governing requirements and the adequacy of implementing procedures and practices
- Response to the discoveries of buried waste at the Middle DP Road (MDPR) site
- Contractor quality assurance (QA) and Federal oversight programs
- Departmental directives (policy, orders, and guidance)

Public Law 105-119, *Departments of Commerce, Justice, and State, the Judiciary, and Related Agencies Appropriations Act, 1998*, directed DOE to identify LANL excess real property that was suitable for conveyance (disposition of land from a Federal agency to a non-Federal entity) or transfer (disposition of land from one Federal agency to another Federal agency). As a result, in 1998, personnel from DOE's Los Alamos Site Office (LASO), the Federal organization that preceded NA-LA and EM-LA, identified 10 tracts of land, which were later divided into 35 smaller tracts of land. Since then, the following land dispositions have occurred, as illustrated in Figure 1-1:

- Three tracts of land were transferred to the U.S. Department of the Interior; LANL organizations determined that these tracts had no history of laboratory operations involving hazardous materials and, therefore, did not require remediation.
- Twenty-four tracts of land were conveyed to LAC, three of which were impacted by the 2020 buried waste discoveries.
- Eight tracts of land remain subject to future disposition.

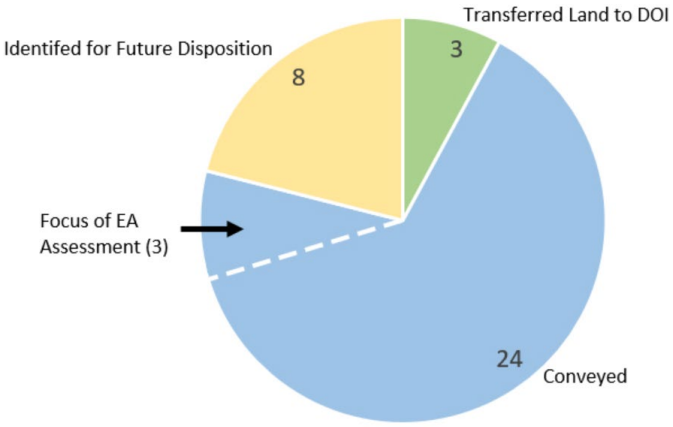
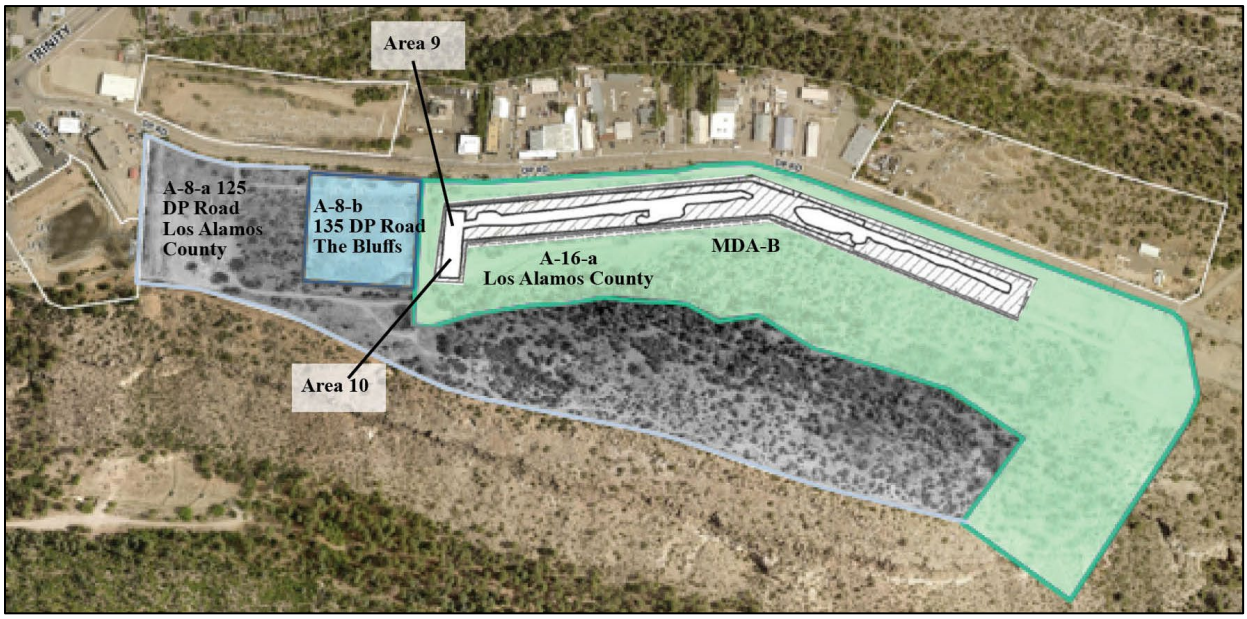


Figure 1-1. Disposition of tracts of land at LANL (1998-2018)

DOE and its predecessor agencies dispositioned additional tracts of land before the 1998 Public Law 105-119. These are not included in the scope of this assessment.

Of the 24 conveyed tracts of land, this assessment focused on the three (A-16-a, A-8-a, and A-8-b; shown in Figure 1-2) that were impacted by the discoveries of buried waste in 2020 as examples to evaluate the LC&T and remediation processes. Tracts A-8-a and A-8-b were conveyed to LAC in 2007 and 2013, respectively, before the EM function separated from NA-LA and the establishment of EM-LA in 2015. In February 2018, tract A-16-a was conveyed to LAC under the new NA-LA/EM-LA Federal site office structure. Although this assessment focused on three tracts of land associated with the 2020 buried waste discoveries, the LC&T and remediation processes that EA evaluated applied to all previously dispositioned tracts of land under the 1998 Public Law 105-119.



The results of the EA assessment are provided in Section 2.0. Best practices are identified in Section 3.0, and recommendations are provided in Section 4.0 to address weaknesses and contributing causes. The

members of the assessment team, the Quality Review Board, and management responsible for this assessment are listed in Appendix A. Appendix B discusses the methodology used to perform this assessment. Appendix C provides a synopsis of the Chemistry and Metallurgy Disposal Pits, Appendix D discusses the LANL LC&T process, and Appendix E discusses the nature of early plutonium and present-day field measurements.

2.0 RESULTS

The results of this assessment are presented in the following six subsections: excess real property characterization (Section 2.1), investigation and remediation (Section 2.2), radiological protection practices associated with LC&T activities (Section 2.3), MDPR buried waste discoveries and response (Section 2.4), contractor QA and Federal oversight (Section 2.5), and completeness of DOE directives (Section 2.6). Furthermore, Sections 2.1 through 2.3 discuss the conditions that contributed to radioactive materials unknowingly remaining in the conveyed tracts of land A-16-a and A-8-a, and Section 2.4 provides the results of the evaluation of the response to the buried waste discoveries. Although the assessment team identified no issues that rose to the level of a finding as defined in DOE Order 227.1A, *Independent Oversight Program*, the assessment team identified specific weaknesses across multiple organizations in several areas.

2.1 Excess Real Property Characterization

The objective of this portion of the assessment was to evaluate the adequacy of previous practices that characterized tracts of land and identified areas requiring evaluation or remediation – i.e., identification of solid waste management units (SWMUs).

LASO began identifying SWMUs in response to the Federal Facility Compliance Act of 1992, an amendment to the Resource Conservation and Recovery Act (RCRA) of 1976. RCRA defines a SWMU as "any discernible unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste." University of California (UC) environmental professionals researched historical documentation to help identify SWMUs resulting from previous and current laboratory operations. UC used this information to develop LA-UR-99-4187, *Environmental Restoration Report to Support Land Conveyance and Transfer Under Public Law 105-119*, in 1999. The report summarized the relationship between the tracts of land proposed for LC&T, and the known or suspected contaminants in identified SWMUs.

The process for investigation and remediation is described in the Compliance Order on Consent (also known as the Consent Order), March 2005 (superseded by the June 2016 Consent Order) between the State of New Mexico Environment Department (NMED) and the DOE LANL, which contains a list of LANL SWMUs grouped by the affected watershed, not by tracts of land. N3B continues to update the SWMU database and the laboratory-wide Geographic Information System with new information from remediation activities.

The original LANL operating contractor, UC (Manhattan Project to 2006) and the subsequent LANL operating contractor, Los Alamos National Security, LLC (LANS) (2006 to 2018) reviewed the historical records but did not identify any SWMUs containing radioactive material requiring remediation for tract A-8-a. A SWMU on tract A-8-a associated with a former septic system (including tanks, drain lines, a leach field, and outfalls) that serviced a former warehouse complex and former residences has received certificates of completion (without controls) from NMED, and did not require remediation. The lack of any identified SWMU with radioactive material on tract A-8-a (based on a review of historical documentation by UC and LANS), not finding the known CM Pits in the general area during the

remediation of MDA-B, and the early 2020 discoveries of radiologically contaminated buried waste near the old sewer lift station (a pumping station that moves sanitary wastewater from a lower elevation to a higher elevation) on tract A-8-a, demonstrates that tract A-8-a was potentially not adequately characterized. Tract A-8-b is discussed in Section 2.4.

Current LC&T documentation identifies eight SWMUs on tract A-16-a as specified in the July 2016 Environmental Baseline Survey Report (EBSR). LANS identified only two of the eight SWMUs as MDAs (MDA-V and MDA-B); UC and LANS used the term "Material Disposal Area," or MDA, to define SWMUs that were the result of planned waste burial activities. MDA-V received a certificate of completion (with controls) from NMED in 2011. The remediation of MDA-B is discussed in Section 2.2 of this report. The remaining six SWMUs required no additional remediation as determined by DOE and approved by NMED. The locations of the 2020 discoveries of radiologically contaminated buried waste on tract A-16-a were all outside of previously identified SWMUs, demonstrating that tract A-16-a was potentially not adequately characterized given the historical records documenting the presence of CM pits in the general area.

Supporting the above discussion on incomplete characterizations is a July 5, 1945, letter (Record 9995, Manhattan Project Staff to U.S. Army), wherein UC requested the construction of a pit for the disposal of contaminated trash "just east of the now covered CM [Chemistry and Metallurgy] disposal pits located southeast of the coal storage yard" (see Figure 2-1). Accordingly, long waste trenches parallel to DP Road (later designated as MDA-B) were initially excavated between July 12 and August 8, 1945. The "now covered CM disposal pits" were used for disposal of contaminated trash in 1944 and early 1945, but were not designated as separate SWMUs. (See Appendix C for additional information on the 1944 CM disposal pits.) Triad has evaluated the potential for similar conditions to exist on other conveyed tracts of land and established a risk ranking; NA-LA is awaiting this assessment report to complete needed corrective actions to address the potential for future discoveries of unexpected legacy contamination. (See Section 2.5.)

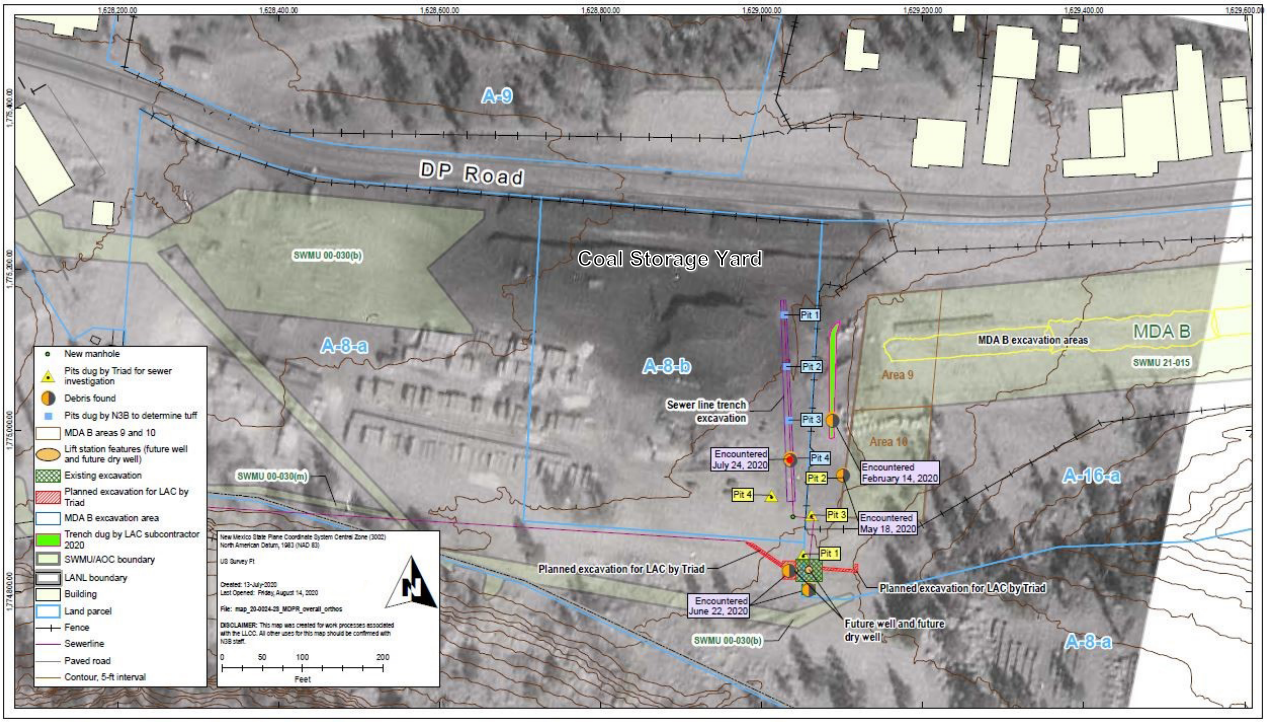


Figure 2-1. Location of the coal storage yard (1946 aerial view) to MDA-B and buried waste discovery locations

Excess Real Property Characterization Conclusions

Over the years, SWMUs have been identified and formally documented. N3B continues to appropriately update the SWMU database with new information from remediation activities. Tracts of land identified as candidates for LC&T contain SWMUs, and this information was appropriately summarized in LA-UR-99-4187. However, the locations of the 2020 discoveries of radiologically contaminated buried waste on tracts A-16-a and A-8-a were all outside of previously identified SWMUs, demonstrating that these tracts of land were not adequately characterized.

2.2 Investigation and Remediation

The objective of this portion of the assessment was to evaluate the planning and execution of investigation and remediation activities to ensure that the NMED-approved objectives established in LA-UR-06-6918, *Investigation/Remediation Work Plan for Material Disposal Area B, Solid Waste Management Unit 21-015, at Technical Area 21, Revision 1*, October 2006, were met.

The NMED-approved 2006 investigation/remediation work plan (IRWP), LA-UR-06-6918, contains the map of MDA-B shown in Figure 2-2. The IRWP asserts that MDA-B received waste in 1944, reinforcing the LANS belief that the CM disposal pits were located within the extreme western side of the MDA-B remediation area depicted in Figure 2-2. However, the IRWP also summarizes the 1998 geophysical survey results (terrain conductivity, high sensitivity metal detection, and ground penetrating radar), stating: "Based on the locations of detected metal objects, the burial area appeared to extend beyond the fence. The survey was continued around the outside of the fence to the south and west, and the results indicated additional buried metal objects."

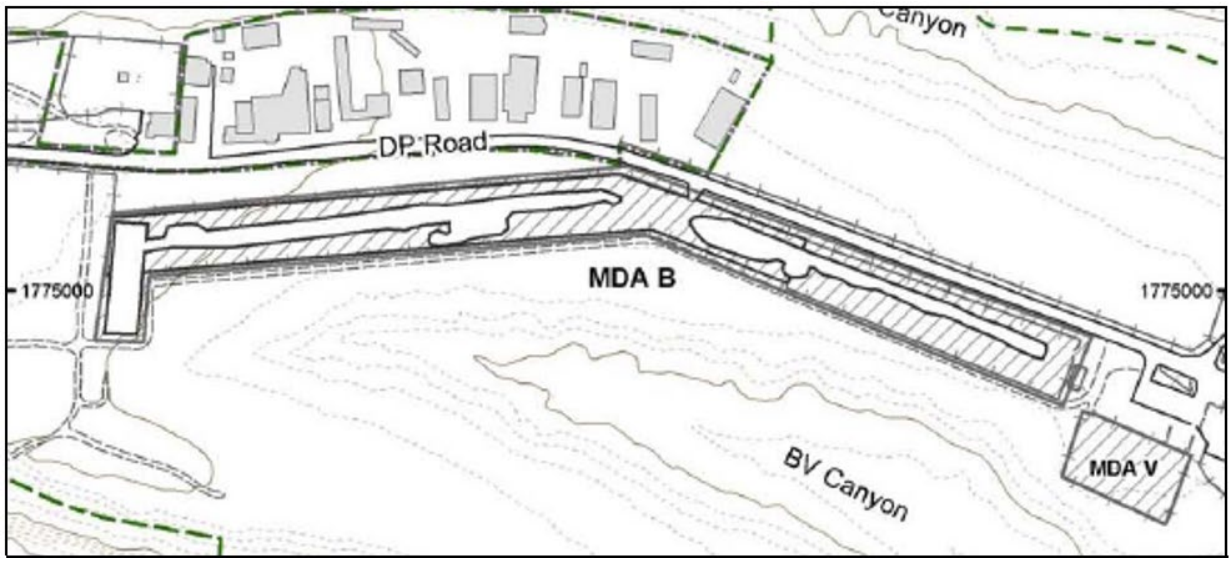


Figure 2-2. MDA-B detail and approximate disposal trench locations from the NMED-approved IRWP (LA-UR-06-6918)

To plan for the remediation of MDA-B, LANS extensively researched the processes used during the Manhattan Project and later at Technical Area (TA)-21 to determine the nature of the wastes produced. The results of that investigation are documented in a 2007 report, LA-UR-07-2379, *Material Disposal Area B: Process Waste Review, 1945-1948*. LA-UR-07-2379 appropriately cautions that both hazardous and radioactive wastes were expected to be present in MDA-B, and that understanding the processes used in the 1940s could inform the remediation workers of expected hazards. The report also states: "Based on

available evidence, the site that is now known as MDA-B was actively used for the disposal of radioactive wastes from April 1944 through June 1948 because it offered sufficient space." Therefore, the report suggests that the 1944 CM disposal pits are included as a portion of MDA-B.

In late 2008, LANS performed additional geophysical measurements within the established boundaries of MDA-B to help identify the extent of the buried waste to support remediation. However, the data from the geophysical measurements on the western boundary was impacted by electronic interference from the nearby metal fencing, halting further investigation to the west without consideration of the 2006 IRWP detection of metal objects beyond the fence. This fence separated the MDA-B western boundary from the areas of land associated with the 2020 buried waste discoveries.

In August 2009, under an NMED-approved sampling and analysis plan (SAP), LANS used direct push technology to obtain soil core samples for radionuclide and hazardous material analysis as a scoping effort to help plan the remediation of MDA-B. Elevated radionuclides were found in the east and west trenches (the long trenches parallel to DP Road) but were not found in Areas 9 and 10 (i.e., the rectangular area within the westernmost portion of MDA-B perpendicular to DP Road). (See Figure 2-3.)

Investigation of Areas 9 and 10

Prior to the remediation of MDA-B, Areas 9 and 10 were investigated to determine the need for remediation. Historical documents described two suspected waste disposal pits in Areas 9 and 10 in the western end of MDA-B that run north to south. The results of direct push technology sampling performed in August 2009 did not delineate waste pit edges indicative of the 1944 CM disposal pits in Areas 9 and 10 as expected. Therefore, additional excavation surveys of Areas 9 and 10 were performed to determine the presence of waste pits. LANS performed the excavation in accordance with TA21-MDAB-PLAN-00012-R.0, *Excavation Control Plan, Areas 9 and 10 - MDA B*, on February 22 and 23, 2010. To increase the likelihood of intersecting these CM disposal pits assumed to be in Areas 9 and 10, LANS excavated nine investigation trenches, all oriented east to west. Three trenches were excavated in Area 10, and six trenches were excavated in Area 9 as depicted in Figure 2-3.

LANS field-screened the excavated material from the trenching activities for radioactive materials and organic vapors, visually observed the material for suspected radioactive waste items, and documented the excavations with photographs. LANS only identified non-radiologically contaminated buried waste and documented that there were no radioactive waste disposal pits in Areas 9 and 10 in LA-UR-10-3301, *Investigation Report for Material Disposal Area B, Areas 9 and 10, Solid Waste Management Unit 21-015 at Technical Area 21*, May 2010.

However, at the time, LANS did not realize that the plutonium (Pu) used in the early 1940s (referred to in this report as "early Pu") did not have the typical gamma signature from the americium (Am)-241 decay product, making detection unlikely with the field-screening instruments and survey techniques LANS used (see Appendix E). Also, LANS did not initiate additional sampling or investigation to determine the true location of the 1944 CM disposal pits described in the historical documents, even though LA-UR-06-6918 specifically noted the presence of subsurface materials within the MDA-B fence line and beyond the fence line to the south and west. Despite this information, the true location of the 1944 CM disposal pits, whether within or outside the MDA-B boundaries, was never conclusively determined or discussed in the final remediation report. (See **Recommendation NA-LA-1**.) The incomplete characterization was propagated through the LC&T process due to missed opportunities to readdress the characterization when unexpected field conditions were encountered.

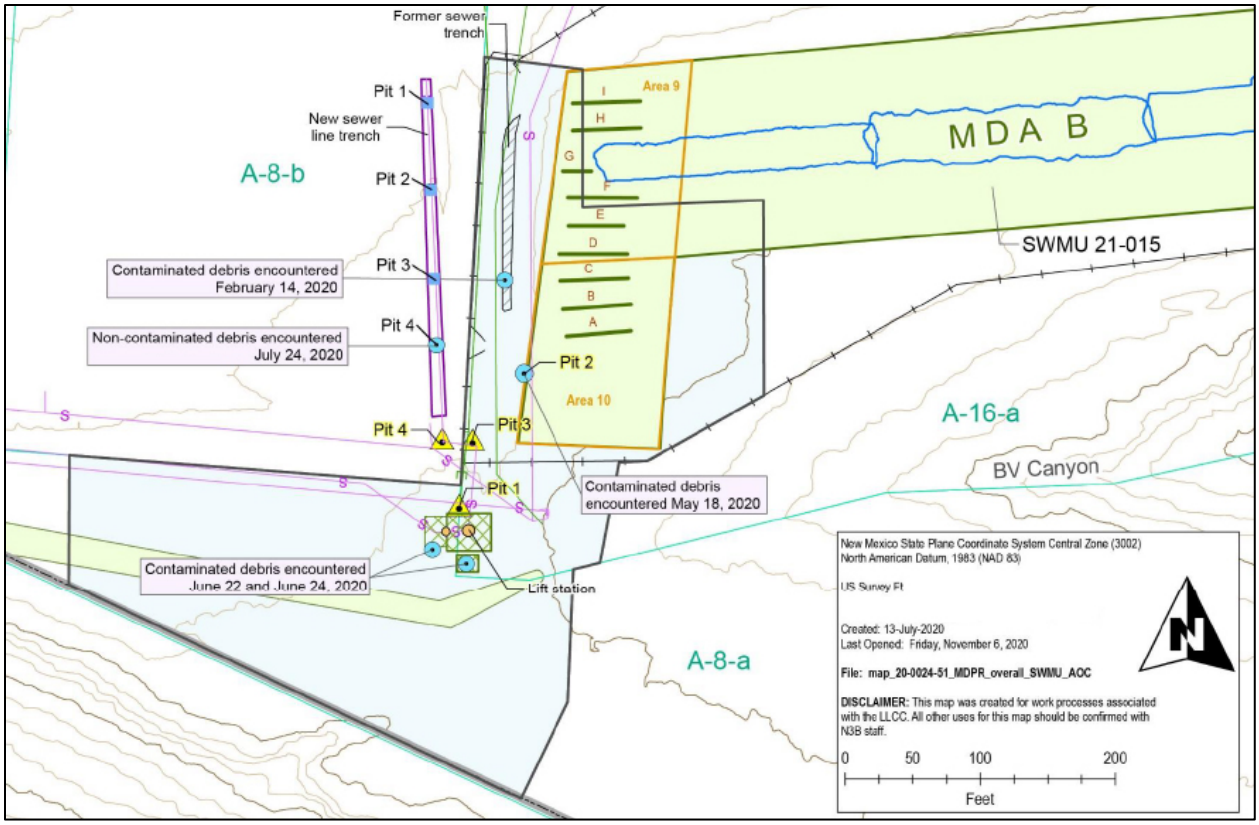


Figure 2-3. Map of MDPR showing locations of buried waste discoveries

Remediation of MDA-B

The January 2010 DOE EM *Los Alamos National Laboratory American Recovery and Reinvestment Act Project - Project Execution Plan* adequately described the approach to MDA-B remediation, including the use of enclosures to minimize public exposure to airborne contamination, air monitoring to record any radioactive emissions, and remotely operated equipment to protect workers. These conservative approaches proved to be prudent because the remediation uncovered significantly more hazardous material than was originally estimated. The plan specified a conservative end state of allowable residual radioactive contamination based on assumed future residential occupancy. Using residential occupancy exposure limits as the basis for the end point was more conservative than the commercial/industrial occupancy exposure limits specified in the Environmental Impact Statement for the conveyance of tract A-16-a (see Appendix D). NMED approved LA-UR-13-24556, *Investigation/Remediation Report for*

Material Disposal Area B, Solid Waste Management Unit 21-015, Revision 2, dated June 27, 2013, and subsequently issued a certificate of completion (without controls) on May 15, 2015.

During the remediation process for MDA-B, LANS encountered and successfully overcame unexpected challenges, including the following:

- An amount of removed waste 75% greater than initially expected
- Generation of 100 cubic yards of transuranic waste, when none was expected
- Remediation of 21 pounds of beryllium, when none was expected
- Trench depths up to twice as deep as initially thought
- Twelve times more radioactive material than originally estimated, increasing the hazard categorization of the facility and leading to a DOE Headquarters-initiated exemption from safety basis requirements of 10 CFR 830, *Nuclear Safety Management*, Subpart B
- Remediation of dozens of unexploded artillery shells

Management systems, such as the Occurrence Reporting and Processing System (ORPS), were appropriately used when the amount of radioactive material exceeded original estimates. However, despite encountering numerous inaccuracies in planning assumptions, the MDA-B remediation project team did not use the LASO or LANS issues management processes to evaluate the extent of condition (see **Recommendation NA-LA-2**.) Using the issues management system to formally evaluate the notable absence of CM disposal pits in the assumed locations of MDA-B Areas 9 and 10 could have resulted in a broader review of the condition, as well as further investigation until the CM disposal pits were located.

Investigation and Remediation of MDA-B Conclusions

The investigation and remediation of MDA-B were based on assumptions that the 1944 CM disposal pits were located in Areas 9 and10, and that the Pu daughter product (Am-241) was the key indicator for the presence of Pu contamination. LANS successfully remediated the identified waste trenches in MDA-B to residential standards and obtained a certificate of completion (without controls) from NMED. However, the remediated areas were not reconciled to the full historical record, so the remediation of the 1944 CM disposal pits may not have been complete, and their exact location in relation to the conveyed tracts of land is still unknown.

2.3 Radiological Protection Practices Associated with Land Conveyance and Transfer

The objective of this portion of the assessment was to evaluate the adequacy of LANL's LC&T activities associated with the release of tracts of land to comply with Public Law 105-119 (A-16-a, A-8-a, and A-8-b). Additionally, the evaluation of LC&T activities for A-16-a and A-8-b included DOE Order 458.1, *Radiation Protection of the Public and the Environment*, since the order requirements were originally promulgated in 2011 and placed in the LANS contracts.

NA-LA appropriately includes DOE Order 458.1 in the current Triad contract, List B. The current Triad Environmental Protection and Compliance Division (EPC) LC&T procedures were approved by NA-LA and appropriately incorporate DOE Order 458.1 requirements for the release and clearance of property.

LANS supporting documents associated with the LC&T of tracts A-8-b and A-16-a, including authorized limit (AL) determinations, dose assessment reports, SAPs, and EBSRs, were generally thorough, informative, and of high quality and demonstrated that the radiological requirements applicable to

property release at the time were met. For example, for the MDA-B remediation work discussed in Section 2.2, a SAP for tract A-16-a was developed using a *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) approach, referenced in DOE Order 458.1, February 2011, for surface sampling, and later implemented after the remediation. The SAP for tract A-16-a also used the statistical principles of MARSSIM to collect subsurface samples. The MARSSIM approach was developed as a surface sampling protocol, but LANS radiological personnel deemed the statistical approach described in MARSSIM to be useful and adequate for determining the number of subsurface samples required to verify that the remediation activities achieved the MDA-B end-state requirements. LANS applied the MARSSIM statistical methodology because DOE has no standard methodology for subsurface sampling (see Section 2.6). As required by DOE Order 458.1, the local Federal office reviewed and approved the subsurface sampling approach. This was also approved by NMED in accordance with the Consent Order.

The results from sampling data demonstrated that the end-state remediation goals and public dose constraints were met, and the results were adequately documented in a formal dose assessment report supporting the tract's suitability for release. An independent contractor to NA-LA concurrently performed the independent verification activities required by DOE Order 458.1 and published its final verification report confirming the suitability for release of tract A-16-a in April 2015. (See Appendix D for additional information on the LANL LC&T process.)

However, neither Triad nor NA-LA were able to provide evidence of formally documented institutional control evaluations in support of LC&T as required by procedure EPC-EF-FSD-004, *Environmental Radiation Protection*. As required by DOE Order 458.1 and the current Triad LC&T procedure, real property under evaluation for clearance from DOE radiological controls must be evaluated against the need for maintaining institutional controls as described in DOE Guide 454.1-1, *Institutional Controls Implementation Guide for Use with DOE P 454.1*, *Use of Institutional Control*. The absence of this evaluation presents a potential future unanalyzed radiological impact to the public. For example, if conveyed or transferred land contains soil with residual radioactivity from laboratory activities at or below the ALs (with a low potential for airborne resuspension under the presumed land use) and is later excavated and used for fill material elsewhere, then the original dose estimate may no longer be valid and the public dose constraint of 25 millirem (mrem) could be exceeded. Additionally, quitclaim deeds (the legal instrument for conveying the MDPR properties) did not contain restrictions on excavation and/or soil removal without reevaluation of the dose assessments.

The current Triad LC&T procedure does not contain sufficient instructions for conducting institutional control evaluations and does not reference the approved DOE process specified in DOE Guide 454.1-1, which provides a suggested process for conducting institutional control evaluations. DOE Guide 454.1-1, states: "This Guide provides information to assist Department of Energy (DOE) program and field offices in understanding what is necessary and acceptable for implementing the provisions of DOE [Policy] 454.1, Use of Institutional Controls" and "identifies issues that need to be addressed when considering the use of institutional controls to support DOE's diverse missions." The Triad LC&T procedure does not demonstrate adequate implementation of the DOE guidance or equivalent methodologies to meet DOE Order 458.1 requirements for institutional controls. (See **Recommendation Triad-1**.)

Radiological Protection Practices Associated with Land Conveyance and Transfer Conclusions

The radiological documentation associated with LC&T, including AL determinations, dose assessment reports, SAPs, and EBSRs, is generally thorough, informative, and of high quality. However, the current and former LC&T processes do not and did not ensure proper evaluation and documentation of the need to implement and maintain institutional controls (as required by DOE Order 458.1) for the tracts of land containing residual radioactivity from laboratory activities that were conveyed to LAC. Moreover, the required evaluations were not performed.

2.4 Middle DP Road Buried Waste Discoveries and Response

The objective of this portion of the assessment was to evaluate both the immediate and follow-on DOE and contractor responses to the discoveries of radioactive buried waste on property that was previously conveyed to LAC. Figure 2-3 above shows the locations of buried waste discoveries that occurred in early to mid-2020, beginning with the initial February 14, 2020, discovery. Figure 2-3 also shows the relative locations of the remediated portion of MDA-B, Areas 9 and 10, the exploratory trenches in Areas 9 and 10, selected utility pits and trenches, the old sewer lift station, and the boundaries of the MDPR investigation.

Initial Discovery and Response

On February 14, 2020, a LAC contractor excavating a utility trench on tract A-16-a, just west of the MDA-B boundary, uncovered buried waste items that appeared to be laboratory buried waste, including one item marked "LASL" (Los Alamos Scientific Laboratory, the former name of LANL). On February 15, 2020, the contractor contacted the LANL Emergency Operations Support Center (EOSC), which advised him to contact the LAC Consolidated Dispatch Center (single-source call center for public safety). The Los Alamos Police Department (LAPD) and Los Alamos Fire Department (LAFD) responded as required, treating the discovery as an unknown hazardous material (HAZMAT) situation. LAFD contacted the EOSC incident response commander, requesting LANL HAZMAT and radiological control technician as consultants. The incident response commander informed LAFD that the DOE radiological assistance program (RAP) team was the appropriate resource, and provided the team's duty pager number. LAFD surveyed the discovered buried waste and determined that the radiological hazard was not an imminent threat to human health based on low-level gamma exposure rate instrument readings; however, this instrument was not suitable for detecting early Pu, which only emits alpha radiation. (See **Recommendation NA-LA-3**.)

Unaware that the samples were radiologically contaminated, LAFD subsequently provided them to LAPD for explosive analysis at LAPD Headquarters. After LAPD determined that the samples did not contain explosives, they discarded the samples in a sanitary waste dumpster. The LAC excavation contractor then retrieved the discarded samples from the waste container and returned them to the jobsite.

On February 20, 2020, six days after the LAC excavation contractor's initial notification to the EOSC, NA-LA requested that the RAP team be activated. Complicating factors associated with requesting the RAP assistance include: (1) LAFD did not measure any hazardous levels of radiation emitting from the waste debris and (2) the event was not on DOE property, thereby requiring the request for RAP assistance to come from LAC. As discussed above, LAFD and LAPD handled buried waste with unknown fixed radioactive contamination (which is not readily transferred to another object) without controls. Upon notification, two RAP teams and a RAP Federal Team Leader responded. (See **Recommendation NA-LA-2**.)

Over the next several days, the teams surveyed the scene, the excavation contractor's equipment, LAFD equipment, other personal property, the sanitary waste dumpster at the police station, and the police vehicle used to transport the samples. Samples were also sent to the LANL Health Physics Analytical Laboratory (HPAL). HPAL interpreted the initial data from sample analysis as indicating uranium contamination. However, in subsequent analyses, HPAL determined that the contaminant was actually Pu (an alpha emitter), without the normal daughter product Am-241 (a gamma emitter). This signature is characteristic of early Manhattan Project material produced in low flux reactors (i.e., early Pu). The absence of easily detected gamma radiation makes detection of this early Pu exceptionally difficult with field instruments (see Appendix E). No spread of contamination was detected.

EM-LA and N3B worked cooperatively with the LAC excavation contractor to retrieve and package the contaminated items from the buried waste discovery, and appropriately moved the containers to a RCRA storage area in TA-21. During this portion of the response, the use of trained, experienced personnel following established procedures ensured both worker and public safety. NA-LA and Triad subsequently arranged for shipment of the suspected mixed (hazardous and radioactive) waste to an appropriate disposal facility.

However, NA-LA did not properly apply the requirements of DOE Order 232.2A, *Occurrence Reporting and Processing of Operations Information*, for the buried waste discovery. Although a draft ORPS report was prepared, NA-LA determined that an ORPS report was not required because the discovery was not related to a DOE facility. This determination does not meet the requirements of DOE Order 232.2A Group 10 #(3), which states: "Any occurrence that may result in a significant concern by affected state, tribal, or local officials, press, or general population; that could damage the credibility of the Department; or that may result in inquiries to Headquarters." Consequently, no information was shared with DOE regarding causes of or lessons learned from the buried waste discoveries.

Subsequent Buried Waste Discoveries

After the February 14, 2020, discovery, NA-LA and EM-LA tasked their contractors with monitoring the actions of the LAC's excavation contractor and property developer. On May 18, 2020, the LAC contractor excavating south of the February discovery on tract A-16-a, with technical assistance from Triad, encountered additional buried waste, composed of wood, glass, and ceramic. Field and laboratory measurements indicated that the buried waste was contaminated with uranium, which was used as a surrogate for plutonium in some early Manhattan Project work.

On June 22, 2020, workers excavating soil for the new sewer lift station (near the old sewer lift station south of the utility excavations on tracts A-16-a and A-8-a) encountered buried waste material including burlap and glass vials, along with discolored soil later determined to be radiologically contaminated with uranium. On June 24, 2020, more uranium-contaminated buried waste was discovered near the new sewer lift station; this excavated area was covered with clean soil to control the potential spread of contamination, and the location was clearly marked in the field for future remediation.

As a conservative measure, EM-LA tasked N3B with locating radiologically contaminated or identifiable laboratory debris. At the recommendation of NA-LA and EM-LA, the LAC property developer agreed to an alternate routing of the utility trench, west of the original route, to reduce the likelihood of encountering additional radioactive buried waste. N3B excavated an alternate utility trench route down to undisturbed native tuff (volcanic rock) along the new western route to ensure that the LAC excavation contractor would not encounter any additional buried waste. On July 24, 2020, N3B encountered buried material, but laboratory analysis determined it to be free of radioactive contamination. The excavated buried material consisted of concrete rubble, pipe, ceramic tile, and glass. Finding no other contaminated buried waste, N3B backfilled and compacted the trench for the LAC excavation contractor's subsequent installation of the sewer line at the correct elevation.

NA-LA and EM-LA demonstrated that the current conditions are stable and that none of these MDPR radiologically contaminated buried waste discoveries adversely affected public safety. DOE, in partnership with the landowners, isolated the MDPR from public access pending further DOE investigation to resolve remaining uncertainties in the characterization of these tracts of land. However, the land remains under non-Federal ownership and control.

Investigation after Buried Waste Discoveries

Because of the 2020 buried waste discoveries, EM-LA directed N3B to investigate most of tract A-8-b for unknown buried waste to supplement the surveys performed for LC&T. Information gained from the trenching along the utility line was also considered. The results are documented in EM2020-0714, *Characterization Closeout Report for Potholing at Land Tract A-8-b*. This closeout report indicates that no potholing (excavation to allow observations at depth) was conducted between the tract A-8-b east boundary and the new sewer trench and the southeastern portion of tract A-8-b. (see the green highlighted area in Figure 2-4).

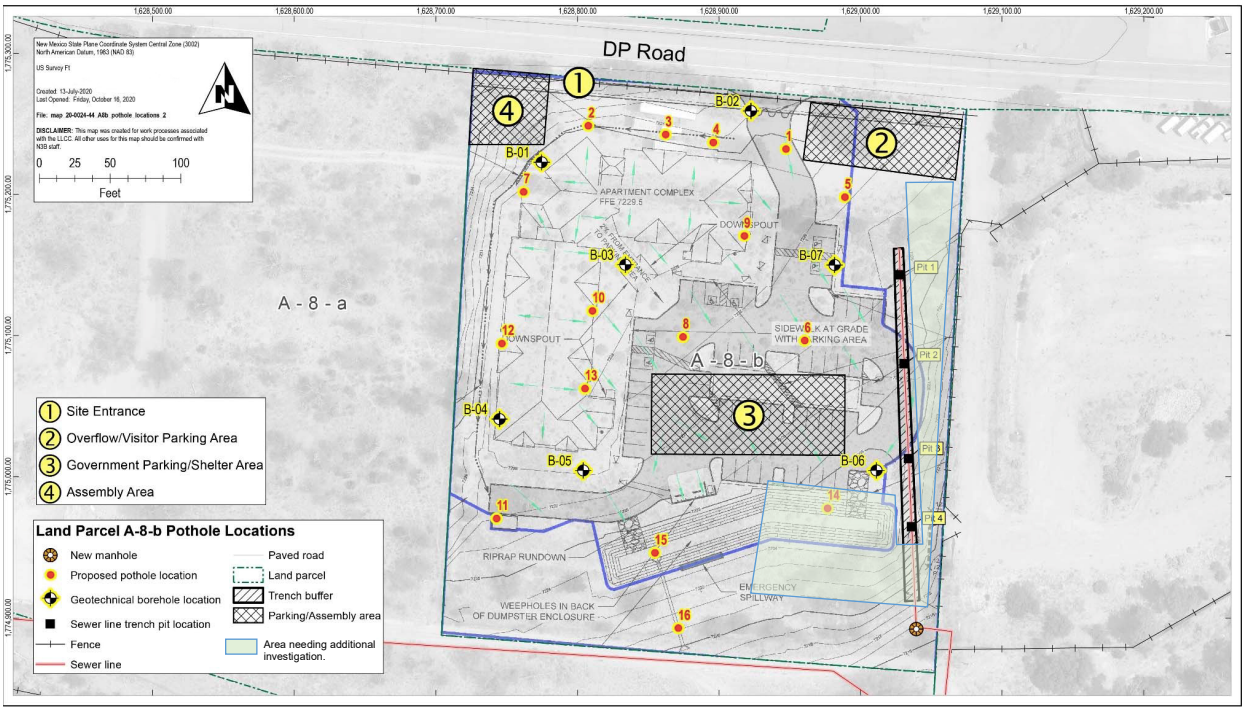


Figure 2-4. Tract A-8-b potholing locations following buried waste discoveries

Further, EM-LA directed N3B to develop EM2020-0498, *Solid Waste Management Unit Assessment Work Plan for Middle DP Road Site* (the blue highlighted area in Figure 2-3), which has been submitted to NMED for approval. However, the work plan does not include actions to ensure that no more undiscovered pits exist in the eastern or southeastern portion of tract A-8-b (see the green highlighted areas in Figure 2-4). These actions are of particular concern because the July 5, 1945, letter cited in Section 2.1 above referenced these areas as potential sites for disposal of contaminated trash. (See **Recommendation NA-LA-1**.)

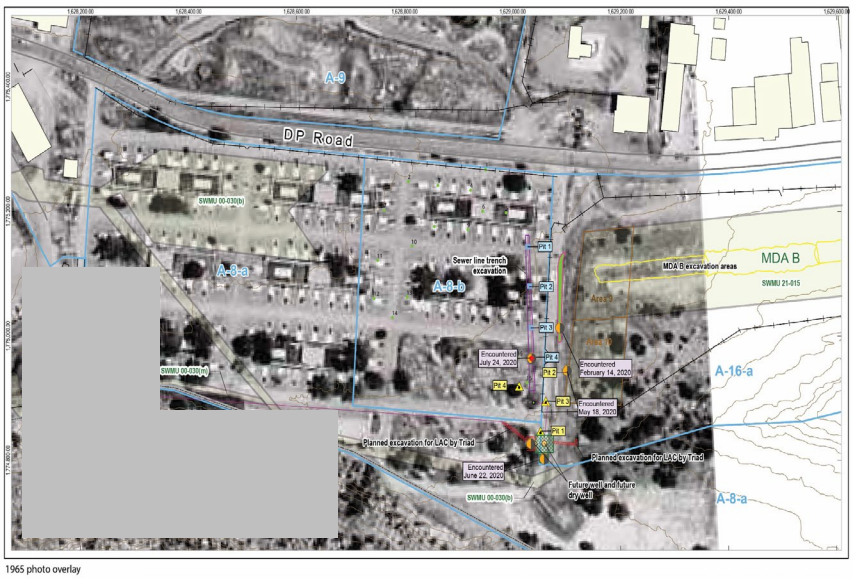


Figure 2-5. Trailer park (circa 1950s) in relation to MDA-B

Former contractors and N3B (with EM-LA concurrence) have assumed that the eastern portion of A-8-b was not a likely location for the CM disposal pits due to the belief that a trailer park (shown in Figure 2-5, an early 1950 aerial photograph) would not have been constructed over a known radioactive waste disposal area. However, based on the assessment team's review of historical documentation of radioactive waste disposal in the 1940s, there is a reasonable possibility that the radioactive and non-radioactive buried waste discoveries on the three tracts of land (A-16-a, A-8-a, and A-8-b) may be from the earliest CM disposal pits. This possibility becomes more compelling when considering that the earliest CM disposal pits were not discovered within the assumed location of Area 9 and 10 during the remediation of MDA-B.

As discussed earlier, in the last six years the organizations operating at LANL have been realigned, resulting in two Federal field offices and two main contractors, each focused on what they understand to be their specific role in the environmental restoration and LC&T process. However, the environmental restoration and LC&T processes do not provide an integrated approach that addresses organizational responsibilities identified in the Compliance Order on Consent; the LC&T Environmental Impact Statement; the Conveyance Agreement; applicable DOE orders; and the implementation, maintenance, and communication of institutional controls. The Triad LC&T process (historical and current) as described in EPC-ES-TPP-005, *Land Conveyance and Transfer Project* (and predecessor documents) does not ensure an integrated LC&T approach among the four organizations. (See **Recommendation NA-LA-4**.) For example:

- EM-LA did not solicit NA-LA comments on the MDPR assessment work plan during document development, although NA-LA is responsible for the LC&T process.
- EM-LA organizes its remediation activities related to a broader area of a watershed, not specific to a tract of land as does NA-LA.
- EM-LA personnel were not informed or aware of a 2017 approval with changes of ALs for soil with residual radioactivity, which was prepared by Triad and approved by NNSA Headquarters, until

December 2020. However, EM-LA is responsible for ensuring that remediated areas meet ALs and accurately communicating information about ALs to public stakeholders.

Middle DP Road Buried Waste Discoveries Conclusions

The initial field response of the DOE/RAP occurred six days after the February 14, 2020, buried waste discovery. Complicating factors associated with requesting the RAP assistance include: (1) LAFD did not measure any hazardous levels of radiation emitting from the waste debris and (2) the event was not on DOE property, thereby requiring the request for RAP assistance to come from LAC. This delay resulted in LAFD and LAPD handling radiologically contaminated buried waste without controls.

After the response to the initial buried waste discovery, NA-LA, EM-LA, Triad, and N3B worked with LAC and the property developer to ensure that workers and the public would not be adversely impacted by the subsequent MDPR buried waste discoveries. The extent of the buried waste remains unknown, but EM-LA and N3B have a work plan to assess the extent at MDPR. However, in light of the July 5, 1945, letter and recent discoveries of unexpected buried waste, the work plan does not provide for sufficient characterization to ensure the absence of any radiologically contaminated buried waste in the east and southeast portions of tract A-8-b. Moreover, the two DOE field offices and two main contractors do not ensure an integrated LC&T process.

2.5 Contractor Quality Assurance and Federal Oversight

The objective of this portion of the assessment was to evaluate the current contractors' implementation of risk-based QA consistent with DOE Order 414.1D, *Quality Assurance*; DOE Order 226.1B, *Implementation of DOE Oversight Policy*; DOE Order 458.1, Section 4.k(9); and NNSA Supplemental Directive 226.1C, *NNSA Site Governance*. The assessment team also evaluated Federal oversight by NA-LA and EM-LA, which is intended to ensure that contractors' current and future remediation and LC&T activities are implemented in a manner that ensures safety of the public.

Contractor Quality Assurance

Triad and N3B have established and implemented written policies and procedures that incorporate the requirements of DOE Order 414.1D, DOE Order 226.1B, and NNSA Supplemental Directive 226.1C (Triad only). Each organization's QA program implements a risk-based graded approach for assessment activities that has been applied to excess real property remediation and LC&T processes.

Both organizations have used the management assessment process effectively to identify weaknesses and implement program improvements associated with remediation and LC&T activities. For example, Triad completed a December 2018 management assessment, *Implementation of the Land Conveyance and Transfer Program*, and a December 2020 management assessment, *Environmental Radiation Protection Program*. These assessments adequately focused attention on program implementation, including LC&T and DOE Order 458.1 implementation. Similarly, N3B appropriately implemented the management assessment process by conducting assessments in areas directly related to remediation, such as issues management, Consent Order compliance, TA-21 work documents, Environmental Restoration Project Preparedness, the Lab Data Steward process, and the DOE consolidated audit program for analytical laboratories. In October 2020, an N3B QA organization management assessment identified that most areas of QA implementation needed improvement; N3B's response to this assessment and the implementation of corrective actions were adequate. In December 2020, N3B submitted a revised QA program description to EM-LA in support of its improvement efforts.

However, at the time of this assessment, neither Triad's nor N3B's QA organization has performed an independent assessment of remediation and LC&T field activities, including oversight of their responses to the MDPR events. Although N3B performed two surveillances and one assessment in 2018 focused on laboratory sample handling, data quality, and data validation, there have been no N3B independent assessments of field remediation planning or work execution activities. In addition, Triad did not plan or conduct independent assessments or surveillances of LC&T. Both QA organizations have identified process gaps in QA program implementation (including use of the issues management system); although the organizations are making improvements, these process gaps could impact LC&T performance.

Triad appropriately implemented work control processes in support of the LAC contractor's excavation activities, encompassing hazards analysis, pre-job briefs, and work performance instructions. Triad documented the February 14, 2020, buried waste discovery in its issues management system and began performing an extent-of-condition review and preparing a causal analysis. The extent-of-condition review was effective in identifying whether similar conditions could exist elsewhere and resulted in Triad drafting a risk ranking of excess real property previously conveyed and real property planned for potential future conveyance. (**Best Practice**) Based on the risk determinations from the extent-of-condition review, NA-LA appropriately paused any further conveyance of land.

EM-LA is proactively monitoring the Los Alamos townsite development activities by attending LAC planning and zoning meetings. EM-LA reported active engagement with LAC that allows for DOE's monitoring of the Los Alamos townsite and private construction permits on previously-conveyed land to alert LAC of any potential legacy subsurface impacts and perform any necessary soil sampling or screening. (**Best Practice**)

However, Triad's issues management documentation of MDPR-related issues remains incomplete and is inconsistent with the process described in Triad procedure P-322-4*, Issues Management*. (See **Recommendations NA-LA-2 and Triad-2**.) For example:

- Triad had no plan to address the previously-conveyed areas that the extent-of-condition review identified as at risk, and there was no action item in the issues management system to develop such a plan.
- The extent-of-condition review and causal analysis focused only on LC&T activities, and at the time of the EA assessment closeout briefing (approximately 11 months after the initial discovery), the analysis remained in draft without a justification for the lengthy development time or a proposed date for completion.
- Issues management entries and analysis activities had not been updated to address additional buried waste discoveries after May 18, 2020, and did not include compensatory actions, such as Triad's support of ongoing public utility construction work, actions to address characterization and cleanup of buried waste, or N3B's implementation of the sampling plan associated with tract A-8-b.
- The Triad extent-of-condition review did not evaluate former Federal property conveyed prior to the 1998 Public Law 105-119.

Upon termination of RAP activities, EM-LA tasked N3B to retrieve discovered buried waste for sampling and packaging for disposal. N3B appropriately implemented work processes and procedures, which included hazards analysis, pre-job briefs, work performance instructions, and QA concurrence, to direct work activities associated with its response to the MDPR event. The N3B integrated project team conducted a virtual work planning meeting that effectively discussed both ongoing and upcoming EM-LA work activities. The meeting was well attended by participants who were prepared to provide the requested status information and followed a set agenda; QA personnel were also represented at the

meeting. Additionally, the N3B Sampling Data Management organization effectively implements quality control of the field sampling analysis process, which incorporates statistical data reviews and third-party independent quality verifications by DOE-approved laboratories. However, procedure N3B-P351, *Project Planning and Regulatory Review*, does not include the QA organization as a reviewer in the project planning process. N3B management stated that the weakness would be resolved through a revision to procedure N3B-P351.

Federal Oversight

Before 2015, LASO conducted Federal oversight of remediation activities. Review of oversight documentation and interviews with field oversight personnel associated with environmental remediation activities during the 2009-2012 timeframe determined that LASO oversight of MDA-B remediation was adequate for the work activities and risk. Qualified Facility Representatives and subject matter experts (SMEs) performed oversight of the remediation work in accordance with approved plans and schedules. This oversight was effective and included LASO shadowing several LANS assessments, including a management self-assessment of the MDA-B excavation in June and July 2010 and an implementation verification review of the MDA-B facility safety plan. Independent assessments of LASO oversight by the NNSA Chief of Defense Nuclear Safety (CDNS) in 2009 and 2012 also concluded that Federal oversight was acceptable.

Since March 2015, when EM-LA began operations independent of NA-LA, Federal oversight of land remediation and LC&T activities has been the separate responsibility of two field offices. The assessment team examined Federal oversight of MDPR recovery actions and LC&T activities. NA-LA and EM-LA oversight of MDPR recovery actions has been adequate despite some restrictions due to the COVID-19 pandemic. The EM-LA Facility Representative has documented operational awareness oversight of tract A-8-b recovery activities. For example, the Facility Representative documented several surveillances including tract A-8-b trenching and potholing work performance. Moreover, the radiation protection SME documented several surveillances including one surveillance of N3B hazardous material shipper qualifications.

Additionally, senior managers, including designated EM Headquarters officials, both field office managers, and a designated NA-LA senior advisor supported by a highly experienced and knowledgeable staff, were engaged in monitoring recovery activities. Also, EM-LA proactively augmented its management oversight by funding the Oak Ridge Institute for Science and Education (ORISE) to conduct an independent review of EM2020-0498 prior to submittal to NMED. The ORISE review provided valuable feedback in the form of recommendations to improve the work plan.

NA-LA conducts oversight of LC&T activities through technical reviews of documentation that provide a basis for meeting the end-state criteria of excess real property; however, sole reliance on technical reviews of documentation does not provide the oversight rigor consistent with the requirements of DOE Order 226.1B, Section 4.b.(1). Additionally, the most recent 2020 CDNS biennial review of NA-LA nuclear safety performance graded the oversight functional area as “needs improvement.” Overall, the CDNS report identified seven oversight findings and two weaknesses, demonstrating that NA-LA continues to have challenging gaps in the adequacy and implementation of oversight procedures, issues management documentation, and qualified staffing. For example, at the time of this assessment, NA-LA had a longstanding unfilled vacancy for an SME to support oversight for the implementation of environmental radiation protection program activities, an important oversight area for LC&T activities. As a compensatory measure, NA-LA assigned those responsibilities to other SME staff members as collateral duties. As a result, oversight activities for environmental radiation protection compete with other equally important oversight areas and are not always accomplished. NA-LA is developing a corrective action plan to improve the oversight functional area.

EM-LA oversight program reviews were performed in October 2020 by the EM Chief of Nuclear Safety and in April 2020 by EA (as documented in "Assessment of Transuranic Radioactive Waste Management at the Los Alamos National Laboratory"). These reviews identified performance gaps, but their scope did not include LC&T. Although EM-LA has acknowledged the results, at the time of this assessment EM-LA had not performed a self-assessment against DOE Order 226.1B oversight requirements to understand the full scope of performance issues. EM-LA completed a self-assessment following data collection for this assessment.

Contractor Quality Assurance and Federal Oversight Conclusions

Triad and N3B have established QA programs using a risk-based graded approach. Both contractors improved their programs using feedback from management assessments and use their work control processes effectively to support the LAC contractor's excavation activities. However, the N3B and Triad QA organizations have not conducted independent audits and surveillances of field remediation and LC&T activities. In addition, Triad does not fully use the issues management system to document valuable information that could prevent future events or provide important information about ongoing activities.

NA-LA and EM-LA oversight of recovery actions has been adequate, but the formal oversight of LC&T needs improvement. In addition, longstanding oversight program and performance weaknesses identified by DOE Headquarters assessors have not been resolved, including at the time of this assessment an unfilled NA-LA vacancy for an environmental radiation protection SME to support oversight of contractor LC&T activities. Furthermore, at the time of this assessment EM-LA has not performed a management self-assessment to identify the full scope of performance issues or developed corrective actions to focus improvement efforts.

2.6 Completeness of DOE Directives

The objective of this portion of the assessment was to evaluate the adequacy of DOE directives related to the release or clearance of property that could contain residual radioactive material. This portion of the assessment examined DOE Policy 454.1, *Use of Institutional Controls*; DOE Guide 454.1-1; DOE Order 458.1; and DOE Order 430.1, *Real Property Asset Management*.

DOE Order 458.1 provides the requirements for the release or clearance of property that could contain residual radioactive material. This directive was issued in 2011 to replace DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. DOE Order 458.1 represented a marked improvement over DOE Order 5400.5, providing additional details and requirements concerning ALs, institutional controls, radiological surveys, and independent verification that were not previously present. However, the following weaknesses in DOE directives were identified (see **Recommendation HQ-1**):

- The DOE Order 458.1 definitions of real property and personal property do not adequately address radiologically-contaminated buried waste. DOE Order 458.1, Section 4.k.(2) provides dose constraints for DOE residual radioactive material based on actual or likely future use of the property: 1 mrem total effective dose equivalent (TED) for personal property and 25 mrem TED for real property. After the buried waste discovery, Triad performed informal calculations to determine the public dose consequence of the known buried waste items should they be unearthed in the future. However, these dose estimates used the real property dose constraint of 25 mrem without considering that the excavated waste items met the definition of personal property and therefore required a dose constraint of 1 mrem. The EA assessment team confirmed with the DOE Office of the Associate Under Secretary for Environment, Health, Safety and Security that the buried waste meets the

definition of personal property, but this position has not been formalized. Discussions and interviews with site personnel revealed significant subjectivity regarding these definitions.

- DOE Order 458.1 requirements associated with institutional controls refer to DOE Policy 454.1 but not DOE Guide 454.1-1, *Institutional Controls Implementation Guide for Use with DOE P 454.1, Use of Institutional Controls*. DOE Guide 454.1-1, states: "This Guide provides information to assist Department of Energy (DOE) program and field offices in understanding what is necessary and acceptable for implementing the provisions of DOE [Policy] 454.1, Use of Institutional Controls" and "identifies issues that need to be addressed when considering the use of institutional controls to support DOE's diverse missions." The guide also specifically includes NNSA guidance and provides assurance that the need for controls, periodic verification, and any changes will be documented and available in the future.
- DOE Order 458.1 requires the use of methodologies sufficient to meet measurement objectives and references MARSSIM (for surface soils) as an acceptable methodology. However, DOE Order 458.1 does not provide a similar referenced methodology for potential subsurface radioactive contamination (greater than six inches below the surface).
- DOE Order 430.1 does not specifically reference DOE Order 458.1. It specifically references 10 CFR 770, *Transfer of Real Property at Defense Nuclear Facilities for Economic Development*, but only generically references "applicable Departmental directives" in Section 4.d.(11) for the transfer of excess real property assets. A direct reference to DOE Order 458.1 would enhance the linkage of these two directives for radiation protection requirements and institutional controls.

Completeness of DOE Directives Conclusions

Although DOE directives (policy, orders, and guidance) related to LC&T are generally comprehensive, some weaknesses were identified. These weaknesses adversely affect uniform and consistent disposition of real property and adequate protection of the public from potential radiological hazards.

3.0 BEST PRACTICES

- Triad's extent-of-condition review provides a risk-ranked list of already-conveyed tracts of land and planned conveyance of future tracts of land based on the potential for discovery of hazardous and radiologically contaminated buried waste. These risk rankings provide the opportunity to expend resources proportional to the assumed risk.
- Active engagement of EM-LA with LAC, through attendance at county planning and zoning meetings, promotes DOE monitoring of planned activities on former LANL property and proactively prevents encroachment into legacy SWMUs remaining on conveyed tracts of land.

4.0 RECOMMENDATIONS

The following recommendations are based on EA's analysis of the results discussed in Section 2.0 of this report. These recommendations are intended to provide insights for potential improvements at LANL and potentially all DOE sites that conduct activities to disposition excess real property. Consequently, DOE organizations and contractors should evaluate the applicability of the following recommendations to their respective facilities and/or organizations and consider them as suggestions for improving the effectiveness of their excess real property management programs.

DOE Headquarters

- **Recommendation HQ-1.** The DOE Office of the Associate Under Secretary for Environment, Health, Safety and Security should evaluate and revise DOE Order 458.1, as necessary, in the following areas:

    - Definitions of real property and personal property that address radiologically contaminated buried waste
    - Guidance for investigating potential subsurface radioactive contamination (greater than six inches below the surface)
    - Reference DOE Guide 454.1-1G, *Institutional Controls Implementation Guide for Use with DOE P 454.1, Use of Institutional Controls*, or latest applicable guidance (e.g., DOE-HDBK-1240-2021, *Institutional Controls Implementation Handbook for Use with Use of Institutional Controls*) as a DOE approved methodology

    In addition, the DOE Office of Asset Management should revise DOE Order 430.1 to provide a clear linkage to DOE Order 458.1 for radiation protection requirements and institutional controls.

NA-LA

- **Recommendation NA-LA-1.** NA-LA should conduct additional investigation of tract A-8-b for undiscovered disposal pits in two locations not previously sampled: (1) between the previously excavated utility trench and the eastern boundary, and (2) the southeast corner.
- **Recommendation NA-LA-2.** NA-LA, in collaboration with EM-LA, should perform a formal root cause analysis on the MDPR events of 2020. Results of the analysis should be used to develop a corrective action plan and entered and tracked to resolution via the issues management process. The results should also be shared as lessons learned and operating experience across the DOE complex. The causal analysis should include but not be limited to the following areas, which are identified in this report as potential contributors:

    - The initial response to finding buried waste
    - The evaluation to locate the 1944 CM disposal pits
    - The characterization activities associated with Areas 9 and 10
    - The lack of understanding of the characteristics of early Pu
    - The lack of an extent-of-condition review when MDA-B remediation identified significantly more waste than anticipated

- **Recommendation NA-LA-3.** NA-LA should provide awareness training to the LAFD on the survey practices for early Pu and verify that the radiological survey equipment used by LAFD is capable of detecting early Pu contamination and/or other alpha, beta, and gamma emitting radionuclides.
- **Recommendation NA-LA-4.** NA-LA, in collaboration with EM-LA, should develop a process to ensure an integrated approach among all four organizations involved in LC&T. This process should include references to organizational responsibilities for all LC&T-related regulatory commitments and DOE requirements documentation.

Triad

- **Recommendation Triad-1.** Triad should incorporate implementing instructions for evaluating the need for institutional controls into its LC&T procedure, and then apply the revised LC&T procedure to all previously dispositioned tracts of land that may contain residual radioactivity. The revised LC&T procedure should be based on the guidance in DOE Guide 454.1-1, *Institutional Controls Implementation Guide for Use with DOE P 454.1*, *Use of Institutional Controls*, or latest applicable guidance.
- **Recommendation Triad-2.** Triad should develop a corrective action plan to address land previously conveyed from LANL that the extent-of-condition report identifies as "potentially elevated risk" and that may need future investigation and remediation. The plan should also address land dispositioned prior to or not associated with Public Law 105-119, *Departments of Commerce, Justice, and State, the Judiciary, and Related Agencies Appropriations Act, 1998.*

Appendix A
Supplemental Information

Dates of Assessment

Remote Assessment Activity Dates:
Initial Data Collection: November 19 to December 18, 2020
Final Data Collection: January 4 to January 14, 2021

Office of Enterprise Assessments (EA) Management

Nathan H. Martin, Director, Office of Enterprise Assessments
John E. Dupuy, Deputy Director, Office of Enterprise Assessments
Kevin G. Kilp, Director, Office of Environment, Safety and Health Assessments
Kevin M. Witt, Director, Office of Nuclear Safety and Environmental Assessments
Charles C. Kreager, Director, Office of Worker Safety and Health Assessments
Jack E. Winston, Director, Office of Emergency Management Assessments
Joseph J. Waring, Director, Office of Nuclear Engineering and Safety Basis Assessments

Quality Review Board

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Team Augmentees

Amanda L. Anderson (Office of Environmental Management)
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Appendix B
Methodology

The U.S. Department of Energy (DOE) independent oversight program is described in and governed by DOE Order 227.1A, *Independent Oversight Program*, which is implemented through a comprehensive set of internal protocols, operating practices, assessment guides, and process guides. This report uses the terms "best practices and recommendations" as defined in DOE Order 227.1A.

As identified in the assessment plan, this assessment considered requirements related to the disposition of excess real property. The assessment team used the criteria from the Office of Enterprise Assessments (EA) criteria and review approach document (CRAD) 34-01, Rev. 0, *Excess Real Property Dispositioning Practices*, to evaluate both the Federal offices' and the associated contractor organizations' implementation of practices and procedures to effectively manage dispositioning activities.

The assessment team examined key documents, such as work packages, procedures, manuals, analyses, policies, and training and qualification records. The assessment team also interviewed key personnel responsible for developing and executing the associated programs focused on land conveyance and transfer (LC&T). EA has not conducted a recent assessment of the LC&T processes; therefore, there were no items for follow-up during this assessment.

Continuous improvement in safety at DOE sites is reinforced with fair, timely, and competent evaluations that are based on both requirements and performance, and are communicated in a balanced report that identifies both sound performance and areas requiring improvement, including needed changes to DOE requirements. To accomplish this goal and effectively evaluate implementation of the Los Alamos National Laboratory (LANL) approach for disposition of excess real property, this assessment was organized into four main areas that described the normal sequence of actions for disposition and response if an event like those at the LANL Middle DP Road (MDPR) occurs. The assessment approach evaluated performance in a given area of the disposition process and evaluated whether the results in one area were successfully used to support the follow-on areas of the disposition process.

Federal oversight and contractor quality assurance were evaluated as applicable to all four main areas. The area of Federal oversight had previously identified deficiencies from DOE Headquarters line management assessments. Therefore, the focus of the EA assessment of Federal oversight was to ensure that the Federal offices have documented corrective actions for the identified weaknesses and are making satisfactory progress toward resolution. The robustness of feedback processes was evaluated as part of the quality assurance area to ensure proper evaluation and identification of corrective actions to reduce the likelihood of future MDPR occurrences. Figure B-1 illustrates the assessment approach.

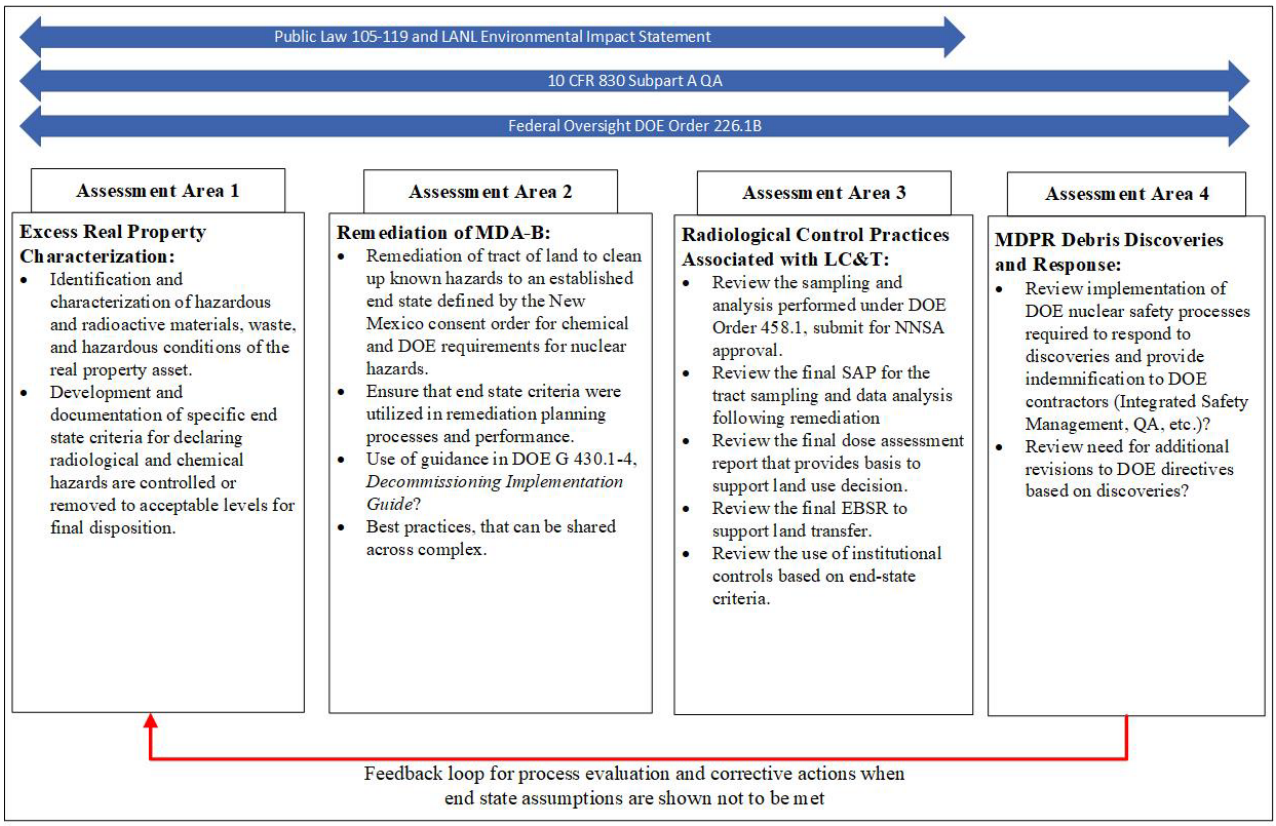

Figure B-1. EA assessment approach for MDPR

Appendix C
Synopsis of the Chemistry and Metallurgy Disposal Pits

In the months following the end of World War II, there was a large turnover of personnel and records at Los Alamos National Laboratory (LANL) as the Army left and contractors were added to provide support functions, such as radioactive waste disposal. Additionally, documentation of radioactive waste disposal from the 1940s is scarce, imprecise, and subject to interpretation. For example:

- In June 1977, over 30 years after the Manhattan Project, LANL issued LA-6848-MS, *History and Environmental Setting of LASL Near-Surface Land Disposal Facilities for Radioactive Wastes (Areas A, B, C, D, E, F, G, and T)*. The report states: "In compiling the information presented in this report, opinions and conclusions as to the accuracy of any particular source material have been avoided. All sources on a given subject are presented, despite apparent contradictions." After publication of the report, memos were sent to the author either disputing or augmenting certain items from the report (see New Mexico Environment Department Hazardous Waste Bureau, Record 12136, as an example).
- LA-6848-MS states: "[Material Disposal Area (MDA)-B] probably was the first common solid waste burial ground for LASL [Los Alamos Scientific Laboratory, the former name of LANL]. It appears on Engineering Drawing ENG-R 4458 as one large pit; no individual pits are shown within the area. However, from old memos dated July 5, 1945 through January 31, 1952, it would appear that Area B is actually a series of pits." In a July 5, 1945, letter (David Dow to Colonel G.R. Tyler), the University of California requested the construction of a new trench "just east of the now covered [Chemistry and Metallurgy (CM)] disposal pits located southeast of the coal storage yard." Accordingly, long waste trenches parallel to DP Road (later designated as MDA-B) were initially excavated between July 12 and August 8, 1945. The location of the coal storage yard is visible on early aerial photographs (see Figure 2-1 in the body of this report).
- To improve the clarity of this report, the Office of Enterprise Assessment distinguishes between the 1944 CM disposal pits and the long trenches parallel to DP Road. LA-6848-MS and many other sources refer to all of these pits and trenches collectively as Area B or MDA-B. As noted in LA-6848-MS, there are disagreements over the number of pits or trenches in MDA-B. The report also states: "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. There was at least one small, shallow trench which was used by CMR-DO safety personnel to dispose of hazardous chemicals." (Written communication, D. D. Meyer, Fall 1974)

After the investigation of Areas 9 and 10 as part of the MDA-B remediation effort, Los Alamos National Security, LLC determined that there were no pits running north and south in that location. However, the true location of the 1944 CM disposal pits has never been conclusively determined.

Appendix D
LANL Land Conveyance and Transfer Process and Implementation

The current Los Alamos National Laboratory (LANL) land conveyance and transfer (LC&T) process that is being implemented was originally developed to support the Laboratory's response to Public Law 105-119, *Departments of Commerce, Justice, and State, the Judiciary, and Related Agencies Appropriations Act, 1998*, which required the U.S. Department of Energy (DOE) to identify, remediate, and transfer available excess real property at LANL to Los Alamos County and the U.S. Department of the Interior within 10 years. As a result, the Los Alamos Area Office and its management and operating contractor, the University of California (UC), identified 10 tracts of land, most of which required various levels of environmental remediation. The original 10 tracts were subdivided into 35 tracts, 27 of which have been conveyed or transferred to date. An extension out to 2022 has been approved for the remaining eight tracts of land to be conveyed.

As required by Public Law 105-119, the Los Alamos Area Office prepared an Environmental Impact Statement (EIS) for LC&T, and a Record of Decision was published in the Federal Register. The EIS documented the required remediation actions and the anticipated future use of the land. Furthermore, in 2002, DOE and Los Alamos County entered into a Conveyance Agreement that also identified future land use. Remediation of land with hazardous wastes is regulated by the State of New Mexico, acting through the New Mexico Environment Department (NMED) Hazardous Waste Bureau. This authority comes from the Resource Conservation and Recovery Act and the U.S. Environmental Protection Agency. In addition, if the excess real property contains radioactive material, the Atomic Energy Act of 1954, as amended, provides the authority to regulate radioactive materials.

In 2005, additional information on the required remediation efforts was documented as part of the settlement negotiations pertaining to alleged violations of the New Mexico Hazardous Waste Act, which prompted NMED, DOE, and UC to sign the Compliance Order on Consent (hereafter referred to as the Consent Order). The 2005 Consent Order (superseded by the June 2016 Consent Order) includes a list of known solid waste management units (SWMUs) that would be candidates for remediation. Understanding the future land use and areas for remediation is important because it is a significant input in determining the amount of remediation and required budget.

When the Conveyance Agreement was signed, the tract of land associated with Technical Area (TA)-21, which included Material Disposal Area (MDA)-B, was withheld by DOE for future use. However, in 2010, TA-21 was re-designated for land transfer, and three tracts of land were subdivided from the western portion of TA-21. Two of the three tracts, A-16-a, which contained MDA-B, and A-8-a, required remediation, while tract A-8-b required no remediation based on the characterization to support the EIS and Conveyance Agreement preparation. As stated above, most tracts required remediation to support conveyance. However, none of the tracts transferred to the U.S. Department of the Interior required remediation because no SWMUs were identified within their tract boundary.

Currently, the Office of Environmental Management Los Alamos Field Office (EM-LA) is responsible for the investigation, remediation, and closure of SWMUs identified in the June 2016 Consent Order. Moreover, EM-LA obtains funding and manages the remediation processes and resources necessary to complete the scope of work, which is to investigate and remediate known SWMUs. Unless specifically tasked and funded, EM-LA does not perform sampling and analysis beyond the known remediation areas. EM-LA does not organize its activities to enable the LC&T process, but rather to fulfill the Consent Order with NMED. Remediation efforts are not connected to a particular tract of land but to a particular watershed on the mesa, which could include multiple tracts of land.

In support of the LC&T process, a final characterization of the excess real property is conducted to fulfill the requirements of DOE Order 458.1, *Radiation Protection of the Public and the Environment*, and to provide a basis for asserting that the end state of the land will meet the documented land use stated in the EIS and Conveyance Agreement. In the case of MDA-B, it was remediated to an end state to support a land use more restrictive than specified by the EIS.

Land is transferred through the State of New Mexico's normal deeding processes, during which institutional controls may be identified to ensure that future land use will not result in increased risk to the public from known hazards remaining on the land. Normally, the goal is to perform remediation to reduce the hazards on the property so unrestricted land use may be approved. The quitclaim deed (the legal instrument for conveying these properties) requires that "any additional remedial action found to be necessary…shall be performed by the United States."

In compliance with the Consent Order, activities to sample and remediate identified known SWMU waste locations at LANL are performed according to written work plans that are approved by NMED. If NMED does not approve a submittal, the reasons for disapproval are documented and transmitted to the LANL DOE and contractor staff so that the work plan can be modified and resubmitted. This process adequately ensures that the desired end state, including specified soil screening levels (SSLs) for hazardous material and screening action levels (SALs) for radioactive material, is clearly identified and agreed upon in advance.

In the case of MDA-B remediation, the DOE and UC staff at LANL submitted LA-UR-06-1933, *Investigation/Remediation Work Plan for Material Disposal Area B, Solid Waste Management Unit 21-015, at Technical Area 21*, to NMED on March 26, 2006. In its August 17, 2006, notice of disapproval, NMED noted, among other items, that "Due to the close proximity of MDA-B to local businesses and the possibility that land close to MDA-B could be used for residences, the Permittees must remove contaminated media (e.g., soil, tuff), both vertically and laterally within the excavation trenches, until residential SSLs/SALs are achieved." Even though the EIS specified that the anticipated future use of the land was commercial/industrial, DOE and its new operating contractor, Los Alamos National Security, LLC, agreed to use residential SSLs/SALs, as directed by NMED, and resubmitted the plan on October 13, 2006, as LA-UR-06-6918, *Investigation/Remediation Work Plan for Material Disposal Area B, Solid Waste Management Unit 21-015, at Technical Area 21*, Revision 1. NMED approved the work plan on January 1, 2007. The plan specified a conservative end state of residential standards for MDA-B. Remediating MDA-B to a residential standard end state significantly simplified the institutional controls required for the conveyance of the entire tract of A-16-a.

Appendix E
The Nature of Early Plutonium and Present-Day Field Measurements

Plutonium exists naturally only in trace amounts; therefore, quantities required for research and development activities in the Manhattan Project required the plutonium material to be produced through manmade processes. Early plutonium was first synthetically produced and isolated in late 1940 and early 1941 by deuteron bombardment of uranium-238 in the cyclotron at the University of California, Berkeley. Producing plutonium by cyclotron supported research activities, but larger quantities were required in a timely manner to fulfill the mission of the Manhattan Project. To meet these mission needs, gram quantities of plutonium were produced by the X-10 Graphite Reactor at Oak Ridge starting in 1944. As documented in *Nuclear Archeology in a Bottle: Evidence of Pre-Trinity U.S. Weapons Activities from a Waste Burial Site*, published in the journal Analytical Chemistry, the plutonium produced at the X-10 Graphite Reactor at that time was very pure isotope Pu-239 and did not contain appreciable amounts of Pu-241, the parent of americium (Am)-241. This type of plutonium is normally referred to as "early plutonium."

Plutonium production was subsequently scaled up from cyclotron production to larger nuclear reactor production with a corresponding higher neutron bombardment. Compared to a cyclotron or the X-10 Graphite Reactor, the larger size and higher neutron bombardment of a production nuclear reactor converts more uranium atoms more quickly. However, due to the increased neutron bombardment, multiple isotopes of plutonium are produced.

Because plutonium emits alpha particles, which are easily shielded by very thin layers of material (e.g., several sheets of notebook paper), conventional field measurements for detecting plutonium contamination rely on detecting the decay products of the isotope Pu-241, which is normally present when the material is produced in nuclear reactors. Pu-241 decays to Am-241, which decays with gamma radiation that can be detected through greater thicknesses of shielding material and at a greater distance from the source of the plutonium contamination, making it easier to detect with modern field instrumentation. However, early plutonium is exceptionally difficult to detect using such field measurements due to its isotopic purity of Pu-239 and the resulting absence of Am-241. Field detection of early plutonium requires the use of an alpha detection survey instrument.

A previous encounter with early plutonium was documented during remediation activities at Los Alamos National Laboratory. The General's Tanks, named after General Leslie Groves, were liquid waste tanks installed on Los Alamos's DP Mesa in the area now known as Technical Area-21. The waste tanks were used during the Manhattan Project to collect radioactive liquids that contained plutonium or uranium, which were not recoverable with the technology of the day. A 2006 white paper, *General's Tanks Radio-Chemical Environment and Associated Hazards*, described samples taken from the General's Tanks in 1981 that contained plutonium with atypically low americium. The white paper hypothesized that the sampled material was "super weapons grade" plutonium (i.e., Pu-239) and noted that "the earliest plutonium production runs were reported to have been of this type." However, this knowledge was not communicated in site contractor remediation planning documents.