LA-UR-16-28635

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Title:	2016 Los Alamos National Laboratory Hazardous Waste Minimization Report
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Intended for:	Report
Issued:	2016-12-02 (rev.1)

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November 2016

Title: 2016 Los Alamos National Laboratory Hazardous Waste Minimization Report

Prepared By: Environmental Stewardship Group, Los Alamos National Laboratory

Intended for: New Mexico Environment Department

Los Alamos
NATIONAL LABORATORY
EST. 1943

Document: Hazardous Waste Minimization Report
Date: November 2016

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CONTENTS

List of Acronyms

ADEM	Associate Directorate of Environmental Management
ADESH	Associate Directorate of Environment, Safety, and Health
CFR	Code of Federal Regulations
CMR	Chemistry and Metallurgy Research facility
CRWSSDR	consolidated remote waste storage site disposal request
CWDR	chemical waste disposal request
D&D	decontamination and demolition
DOE	US Department of Energy
EMS	Environmental Management System
EM	Environmental Management Directorate
EPC-ES	Environmental Stewardship Group
ER	Environmental Remediation
EPA	Environmental Protection Agency
FY	fiscal year
GIC	Green is Clean
ISO	International Organization of Standardization
LANL	Los Alamos National Laboratory
LANS	Los Alamos National Security, LLC
LED	light-emitting diode
LLW	low-level waste
MDA	Material Disposal Area
MLLW	mixed low-level waste
MTRU	mixed transuranic waste
NMED	New Mexico Environment Department
NNSA	National Nuclear Security Administration
NPDES	National Pollutant Discharge Elimination System
PCB	polychlorinated biphenyls
P2	Pollution Prevention
R&D	Research and Development
RCA	radiological control area
RCRA	Resource Conservation and Recovery Act
RLUOB	Radiological Laboratory/Utility/Office Building
RLWTF	Radioactive Liquid Waste Treatment Facility
TA	Technical Area
TRU	transuranic (waste)
TWSR	TRU waste storage request
URWSSDR	universal remote waste storage site disposal request
WCATS	Waste Compliance and Tracking System
WIPP	Waste Isolation Pilot Plant
WPF	Waste Profile Form

1.0 Hazardous Waste Minimization Report

1.1 Introduction

Waste minimization and pollution prevention are goals within the operating procedures of Los Alamos National Security, LLC (LANS). The US Department of Energy (DOE), inclusive of the National Nuclear Security Administration (NNSA) and the Office of Environmental Management, and LANS are required to submit an annual hazardous waste minimization report to the New Mexico Environment Department (NMED) in accordance with the Los Alamos National Laboratory (LANL or the Laboratory) Hazardous Waste Facility Permit. The report was prepared pursuant to the requirements of Section 2.9 of the LANL Hazardous Waste Facility Permit. This report describes the hazardous waste minimization program, which is a component of the overall Pollution Prevention (P2) Program, administered by the Environmental Stewardship Group (EPC-ES). This report also supports the waste minimization and P2 goals of the Associate Directorate of Environmental Management (ADEM) organizations that are responsible for implementing remediation activities and describes its programs to incorporate waste reduction practices into remediation activities and procedures. This report includes data for all waste shipped offsite from LANL during fiscal year (FY) 2016 (October 1, 2015 – September 30, 2016).

LANS was active during FY2016 in waste minimization and P2 efforts. Multiple projects were funded that specifically related to reduction of hazardous waste. In FY2016, there was no hazardous, mixed-transuranic (MTRU), or mixed low-level (MLLW) remediation waste shipped offsite from the Laboratory. More non-remediation hazardous waste and MLLW was shipped offsite from the Laboratory in FY2016 compared to FY2015. Non-remediation MTRU waste was not shipped offsite during FY2016. These accomplishments and analysis of the waste streams are discussed in much more detail within this report.

1.2 Background

In 1990, Congress passed the Pollution Prevention Act, which changed the focus of environmental policy from “end-of-pipe” regulation to source reduction and minimizing waste generation. Under the provisions of the Resource Conservation and Recovery Act (RCRA), and in compliance with institutional requirements for treatment, storage, and disposal of wastes, all waste generators must certify that they have a waste minimization program in place.

Specific DOE P2 requirements are delineated in DOE Order 436.1, *Departmental Sustainability*. The Order contains goals for greenhouse gas emission reduction, goals for energy and water conservation, and it places a strong emphasis on P2 and sustainable acquisition. DOE Order 436.1 requirements are executed through the Laboratory’s Environmental Management System (EMS). The Laboratory’s EMS received third-party certification to the International Organization of Standardization (ISO) 14001:2004 standard in April 2006 and was recertified in

March 2015. The EMS is subject to surveillance audits every six months. P2 is a required element of the ISO 14001:2004 standard.

A list of applicable regulatory drivers for the P2 Program is presented below.

Federal Statutes and Executive Orders

- Resource Conservation and Recovery Act
- Executive Order 13693, Planning for Federal Sustainability in the Next Decade

Federal Regulations

- Code of Federal Regulations (CFR), Title 40, Parts 260–280, Hazardous Waste Management

State of New Mexico Statutes

- New Mexico Hazardous Waste Act
- New Mexico Solid Waste Act

State of New Mexico Regulations

- New Mexico Solid Waste Management Regulations, Title 20, Chapter 9, Part 1, New Mexico Administrative Code
- New Mexico Hazardous Waste Management Regulations, Title 20, Chapter 4, Part 1, New Mexico Administrative Code

DOE Orders and Policies

- DOE Order 458.1, "Radiation Protection of the Public and the Environment"
- DOE Order 435.1, "Radioactive Waste Management"
- DOE Order 436.1, "Departmental Sustainability"
- Annual DOE Strategic Sustainability Performance Plan

Directives and Policies

- Laboratory Governing Policy on Environment
- System Description 400, Environmental Management System Description
- Program Description 400, Environmental Protection Program
- Procedure 401, Procedure to Identify, Communicate, and Implement Environmental Requirements
- Procedure 403, Environmental Aspects Identification Requirement
- Procedure 409, Waste Management

- Procedure 412, Environmental Radiation Protection

1.3 Purpose and Scope

The purpose of this report is to describe the waste minimization program that the Laboratory has implemented and maintained to reduce the volume and toxicity of hazardous wastes it generates to minimize the threat to human health and the environment. In most cases, waste minimization activities executed during FY2016 will continue to occur during FY2017 and beyond. The report provides waste minimization information by chapter for hazardous waste, MTRU, and MLLW. This report discusses:

- Methods and activities that are routinely employed to prevent or reduce waste generation
- FY2016 waste quantities shipped offsite in comparison with FY2015 quantities
- Significant waste minimization accomplishments
- Institutional policies, goals, and training activities that address hazardous and mixed waste reduction
- The Laboratory Director's commitment to P2
- Specific elements of the Laboratory's P2 efforts
- Barriers to implementation of further significant reductions
- Waste minimization and P2 activities associated with remediation wastes

1.4 Requirements of the Operating Permit

Section 2.9 of the LANL Hazardous Waste Facility Permit requires that a waste minimization program be in place and that a certified report be submitted annually to NMED. The list of permit requirements in Table 1-1 corresponds with a section of this report that addresses the requirement. Changes from the previous year are noted throughout this report.

Table 1-1. LANL Hazardous Waste Facility Permit Section 2.9.

Permit Requirement	Topic	Report Section
Section 2.9 (1)	Policy Statement	Section 2.1
Section 2.9 (2)	Employee Training and Incentives	Section 2.2
Section 2.9 (3)	Past and Planned Source Reduction and Recycling	Sections 2.4.1, 3.4, 4.4, 5.4, 6.4
Section 2.9 (4)	Itemized Capital Expenditures	Sections 2.4, Appendix A
Section 2.9 (5)	Barriers to Implementation	Sections 3.5, 4.5, 5.5, 6.5
Section 2.9 (6)	Investigation of Additional Waste Minimization Efforts	Sections 2.4, 3.4, 4.4, 5.4, 6.4
Section 2.9 (7)	Waste Stream Flow Charts, Tables, and Analysis	Sections 2.3, 3.1, 3.2, 3.3, 4.1, 4.2, 4.3 5.1, 5.2, 5.3, 6.2, 6.3
Section 2.9 (8)	Justification of Waste Generation	Sections 2.3, 6.1

1.5 Organizational Structure and Staff Responsibilities

The Laboratory Director, the Environmental Senior Management Steering Committee, and the Associate Director for Environment, Safety, and Health have oversight responsibilities and provide an annual review of the LANS' EMS, P2 Program goals, and environmental performance, and DOE is the oversight organization for LANS. The Environmental Protection & Compliance Division has primary responsibility and oversight responsibilities for the P2 Program. The goal of the P2 Program is to support core waste minimization activities and P2 projects. Specific environmental remediation program waste minimization activities are discussed in Section 6.

The EPC-ES group develops and manages the P2 Program and the EMS. The EMS includes directorate-level environmental action plans that may contain P2, waste minimization, and other environmental improvement actions. EPC-ES provides:

- Oversight for P2 Program implementation
- A base of technical knowledge and resources for P2 practices
- Assistance identifying waste generation trends and P2 opportunities
- Recommendations for P2 solutions and applications
- Support in tracking and reporting P2 successes and lessons learned
- Funding for P2 projects
- Assistance identifying and addressing P2 Program implementation barriers

The LANS Waste Management Division provides all waste packaging, transporting, and disposal services at the Laboratory. The Waste Management Division is a key partner with EPC-ES in implementation of waste minimization projects and strategies.

2.0 Waste Minimization Program Elements

2.1 Governing Policy on Environment

The Laboratory Governing Policy on Environment states:

> *"We are committed to act as stewards of our environment to achieve our mission in accordance with all applicable environmental requirements. We set continual improvement objectives and targets, measure and document our progress, and share our results with our workforce, sponsors, and public. We reduce our environmental risk through legacy cleanup, pollution prevention, and long-term sustainability programs."*

2.1.1 FY2016 EMS Institutional Objectives

A required element of the ISO 14001:2004 standard is the establishment of environmental objectives with quantifiable and achievable targets. The Laboratory's Environmental Senior Management Steering Committee established the following objectives and targets as part of the EMS for FY2016:

1. **Clean the Past**
    - Continue to comply with the requirements of the Compliance Order on Consent with the NMED
    - Protect surface water runoff through implementation of the Individual Storm Water Permit with the U.S. Environmental Protection Agency (EPA)
    - Design and commence implementation of remediation activities for the chromium plume in groundwater beneath Sandia and Mortandad canyons
    - Implement the institutional Facility Footprint Reduction Plan
2. **Control the Present**
    - Maintain and improve the LANL environmental compliance program
    - Fully integrate environmental controls with safety controls through integrated work management requirements and standard work processes
    - Identify and perform activities that improve communication about environmental work risks, controls and requirements
    - Implement federal sustainability requirements, including the LANL Site Sustainability Plan, sustainable acquisition, and P2 across all environmental media
    - Implement an enduring waste management program
    - Implement and maintain a site cleanout and workplace stewardship program
    - Implement and maintain a "green" maintenance program

- Implement and maintain integrated site planning and management processes consistent with LANL EMS objectives

3. **Create a Sustainable Future**

    - Plan and implement an integrated, geospatial governance model within a consolidated graphic information system for LANL operations
    - Plan for adaptation to climate change and implement identified controls (e.g. reducing greenhouse gas emissions, et.al.)
    - Implement a new Cultural Resources Management Plan for LANL
    - Develop and deploy new environmentally sustainable technologies
    - Execute the Long-Term Strategy for Environmental Stewardship and Sustainability

P2 is an integral part of the EMS, the annual LANL Site Sustainability Plan, and the Long Term Strategy for Environmental Stewardship and Sustainability.

The FY2016 P2 Program approach focused on:

- Conducting P2 opportunity assessments on key processes
- Meeting with sulfur hexafluoride users to evaluate the potential for reduction in greenhouse gas emissions
- Integrating P2 principles into the project planning process
- Developing and delivering guidance to address waste generation behaviors for staff and subcontractors
- Communicating waste minimization lessons learned to the employees
- Improving chemical use and management
- Sustainable acquisition
- Improving management of materials to reuse materials and equipment to the greatest extent possible before final disposition
- Recycling and reusing materials

2.2 Employee Training and Incentive Programs

Several employee training and incentive programs exist to identify and implement opportunities for recycling and source reduction of various waste types.

Training courses that address waste minimization and P2 requirements include:

- General Employee Training
- Waste Generator Overview
- Radiological Worker II
- Environmental Awareness Training

Waste generators at LANS minimize waste and conduct preventive measure assessments in accordance with waste management guidance documents.

In FY2016, the Integrated Project Review Program provided a series of environmental permits and requirements briefings to several organizations to increase awareness of environmental concerns, including opportunities for waste minimization and prevention. Numerous briefings were provided to several LANS organizations including:

- Construction Safety / Construction Management
- Deployed Environmental Professionals
- Roads & Grounds and Heavy Equipment Operators
- Worker Safety & Security teams throughout LANL

The DOE and the NNSA sponsor annual P2 awards competitions to provide recognition to personnel who implement P2 projects. LANS submits nominations for the DOE and NNSA awards each year. In FY2016, LANL received a DOE P2 award in the sustainable communications category. LANL also received five NNSA awards for P2 projects, including two Best-in-Class awards and three Environmental Stewardship awards. In addition, LANL received a prestigious GreenGov Presidential award in 2015 for implementing comprehensive and proactive strategies to mitigate the long- and short-term effects of climate change.

The P2 Program holds an awards ceremony every year in conjunction with other Earth Day activities. Employees submit descriptions of projects they completed during the past year that reduced waste generation. Each participant is recognized by senior management with an award certificate and a small cash award. During FY2016, the P2 Program gave awards to employees who worked on 41 projects to reduce waste generation, improve efficiency, and conserve resources. These projects have millions of dollars of value through cost savings, waste avoidance, and improved compliance. Benefits from these projects include reuse of ~3,000 pounds of computer hardware, recycling of ~1,000,000 pounds of metal and 500 cubic meters of sediment, and avoidance of multiple gallons of solvent purchases for research.

Each year EPC-ES invites waste generators to submit proposals for P2 project grants. EPC-ES coordinates the peer review of the project proposals and distributes the available funds to the projects. EPC-ES monitors progress on these projects and provides technical assistance as needed.

2.3 Utilization and Justification for the Use of Hazardous Materials

The Laboratory is a research and development (R&D) facility that executes thousands of experiments requiring the use of chemicals or materials that may create hazardous waste. P2 and waste minimization requirements for waste generators include source reduction and material substitution techniques. Best management practices to reduce hazardous waste generation such as the use of micro-scale chemistry, use of nonhazardous cleaners, and other prevention techniques have been adopted. However, customer requirements, project specifications, or the nature of the research may demand the use of particular hazardous chemicals.

To encourage the use of nontoxic or less hazardous substitutes whenever possible, the P2 Program staff will help employees with finding the least toxic chemicals that have the desired characteristics for his or her particular project.

The implementation of DOE Order 436.1 gives procurement representatives opportunities to choose less hazardous or non-hazardous janitorial products, office supplies, and other items that contain recycled materials. LANS held a Sustainability Fair in 2016 to educate employees about sustainable purchasing and green procurement practices, and further expand the practice of sustainable acquisition.

Figure 2-1. Table at the Sustainability Fair.

The janitorial supply catalog that the Laboratory uses offers "green" cleaning supplies, as does the office supply vendor. The computer procurement contract includes the preference for computers that meet the Electronic Product Environmental Assessment Tool certification standard as well. Other procurement requirements address remanufactured printer cartridges and energy efficiency standards for all printers and copiers. Sustainable acquisition requirements for water and energy-efficient equipment and recycled-content construction supplies are in place at the Laboratory.

2.4 Investigation of Additional Waste Minimization and Pollution Prevention Efforts

EPC-ES monitors waste trends and develops improvement projects. Waste reduction projects often come directly from researchers, waste management coordinators, and P2 staff members. P2 staff provide technical support to waste generators in the implementation of these projects.

During FY2016, Directorate organizations participated in the Laboratory's ISO 14001 EMS process by examining their particular impacts on the environment and creating an action plan for addressing their environmental impacts where possible. Although the various action plans do not necessarily have a P2 component, many of these plans contain projects that include a reduction in waste generation, increase recycling, save energy, or otherwise reduce environmental impacts. In FY2016 there were two external ISO 14001 audits and one internal self-assessment.

2.4.1 Funding for Past Projects

Appendix A contains descriptions of P2 projects and capital funding amounts for the past five years. P2 projects address all types of waste and pollutants. However, Appendix A only includes projects that were designed to reduce hazardous waste, MLLW, or MTRU waste. Projects that address other waste types are not described in this report.

3.0 Hazardous Waste

3.1 Introduction

The annual hazardous waste volume that is reported is based on the total amount of waste shipped offsite for disposal as recorded in the Waste Compliance and Tracking System (WCATS) database. This report does not include waste volumes generated prior to any onsite treatment, which is partially why waste volumes do not match with those reported in LANL's biennial report. Additionally, this report includes fiscal year data, and the biennial report includes calendar year data. Data quality assurance for WCATS is managed by the Waste Compliance Group. The WCATS waste data used in this report was collected for FY2016 on October 5, 2016.

In brief, 40 CFR §261.3, as adopted by the NMED as 20.4.1.200 NMAC, defines hazardous waste as any solid waste that

- Is not specifically excluded from the regulations as hazardous waste
- Is listed in the regulations as a hazardous waste
- Exhibits any of the defined characteristics of hazardous waste (i.e., ignitability, corrosiveness, reactivity, or toxicity)
- Is a mixture of solid and hazardous wastes
- Is a used oil having more than 1000 parts per million of total halogens

Hazardous waste commonly generated includes many types of research chemicals, solvents, acids, bases, carcinogens, compressed gases, metals, and other solid waste contaminated with hazardous waste. This waste may include equipment, containers, structures, and other items that are intended for disposal and that are contaminated with hazardous waste (e.g., compressed gas cylinders). Some contaminated wastewaters that cannot be sent to the sanitary wastewater system or the high explosives wastewater treatment plants also qualify as hazardous waste. Recycled wastes include aerosol cans, light bulbs, batteries, mercury, and ferric chloride solution. Figure 3-1 shows the process map for all waste generation at the Laboratory. This diagram comes from Procedure 409, which governs waste disposal at the Laboratory.

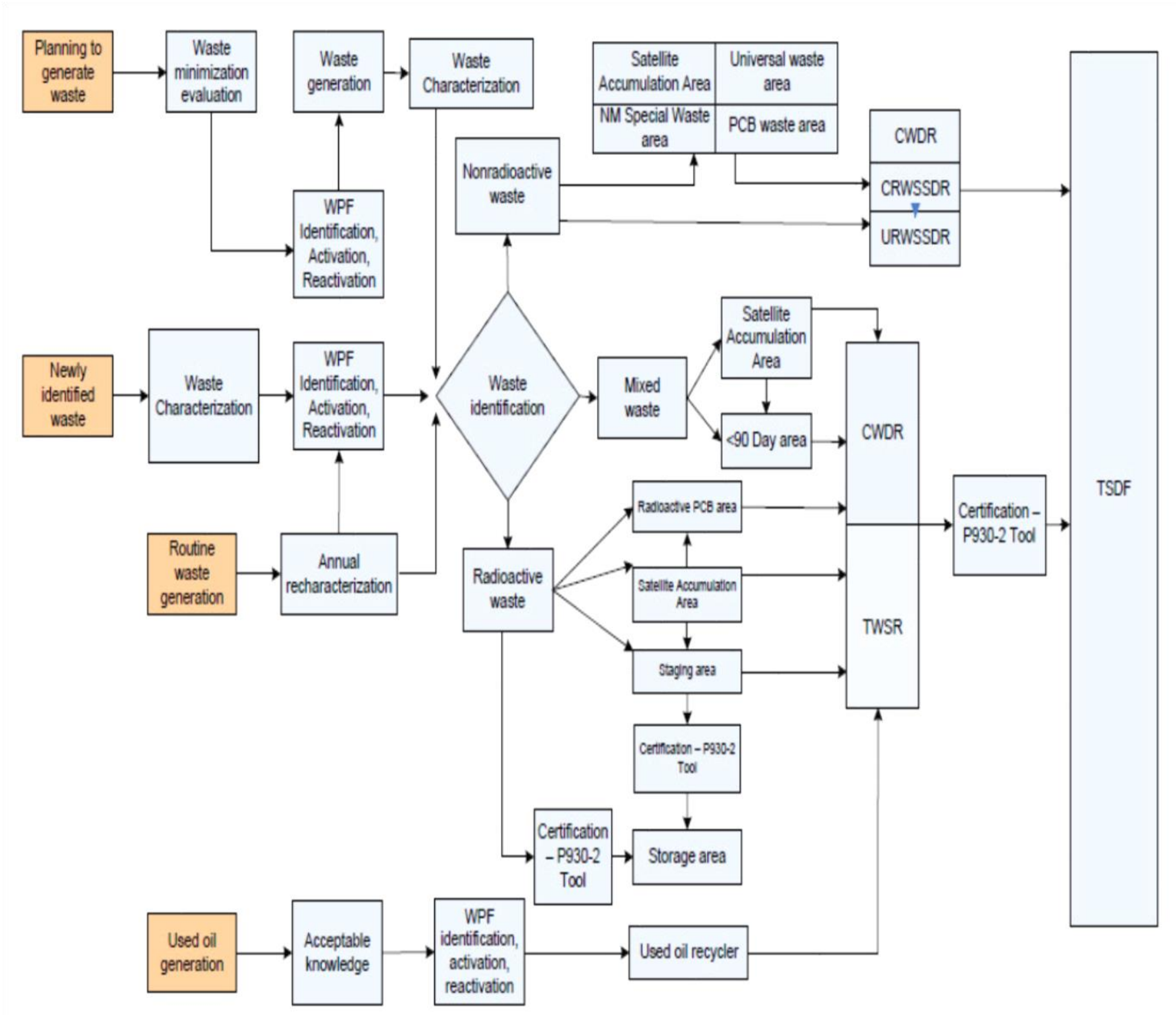

Figure 3-1. Waste Process Flow Map at the Laboratory.

3.2 Hazardous Waste Minimization Performance

The amount of non-remediation hazardous waste shipped from the Laboratory in FY2016 was 28.7 m^3, excluding recycled materials. This amount is slightly more than the 26.5 m^3 of hazardous waste shipped during FY2015. The amount of hazardous waste that was recycled during FY2016 was 37.4 m^3, which was slightly less than the 40.5 m^3 that was recycled during FY2015. During FY2014-2016, no hazardous waste from remediation activities was shipped offsite. All of the non-recycled hazardous waste shipped offsite from the Laboratory in FY2015 and FY2016 is shown in Table 3-1 sorted by the Technical Area (TA) of origin.

Table 3-1. Hazardous Waste by TA Shipped Offsite during FY2015 and FY2016.

TA	FY2015 Hazardous Waste (m^3)	FY2016 Hazardous Waste (m^3)
0 (leased space)	0.1	0
3	6.0	5.5
8	0.02	0.1
9	1.0	0.5
15	0.5	0.05
16	0.2	0.4
22	0.5	3.5
33	0.1	0.2
35	2.7	1.8
36	0.6	0.6
39	0.1	0.02
40	1.0	0.7
43	0.03	0.4
46	3.3	5.9
48	1.8	0.9
50	0.4	0
53	2.5	2.8
54	3.3	1.0
55	1.4	1.8
59	1.0	1.6
60	0.04	0.9

The TAs from which the most hazardous waste was shipped offsite in FY2016 are 3, 22, 35, 46, 53, and 55. Figure 3.2 shows the relative volumes of hazardous waste shipped offsite by TA.

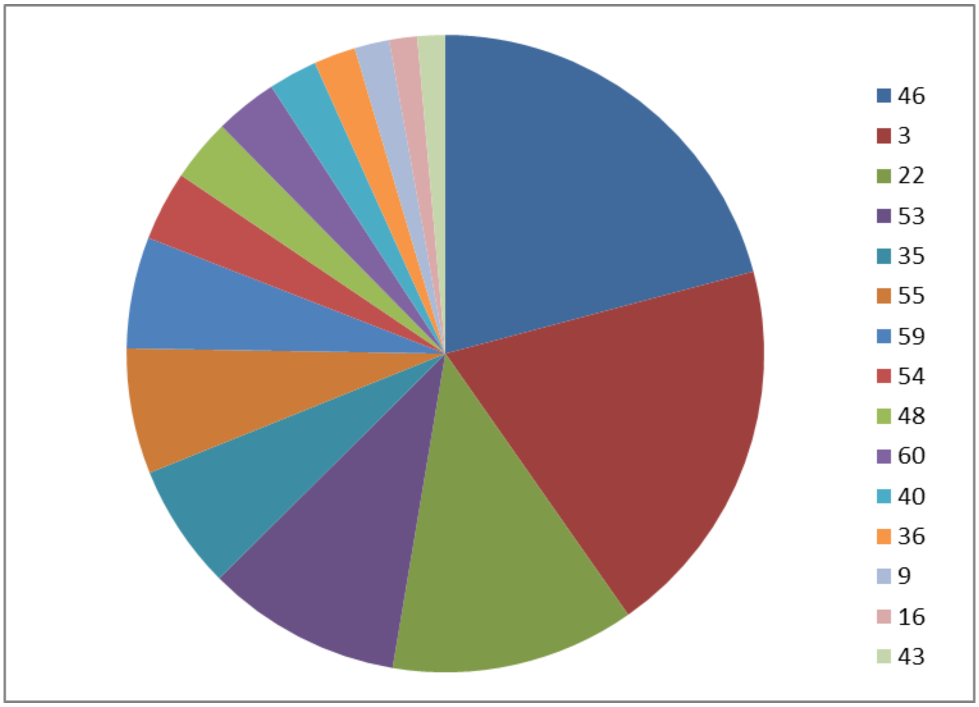

Figure 3-2. Hazardous Waste Shipped Offsite from LANL in FY2016 by TA.

3.3 Waste Stream Analysis

Hazardous waste is derived from hazardous materials and chemicals; hazardous materials disposed of as part of equipment replacement or facility decommissioning; and water contaminated with hazardous materials. After material is declared waste, the hazardous waste is characterized, labeled, and collected in appropriate storage areas. The waste is ultimately shipped to offsite waste facilities for final treatment or disposal.

The largest non-recycled hazardous waste streams for FY2016 are described in this section. High explosives waste and wastewaters are treated onsite, and these are excluded from the analysis. Excess chemicals make up the largest number of individual hazardous waste items. The breakdown of components of hazardous waste for FY2016 is shown in Figure 3-3.

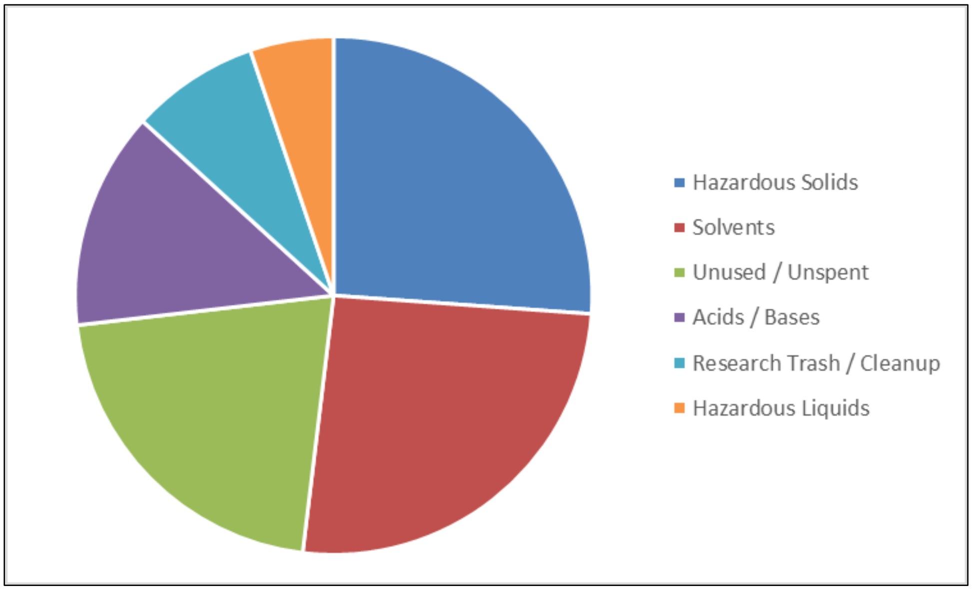

Figure 3-3. FY2016 Hazardous Waste Stream Components, Excluding Recycled Waste.

Table 3-2 shows changes in the composition of the hazardous waste stream from FY2015 to FY2016.

Table 3-2. Hazardous Waste Shipped Offsite in FY2015 and FY2016.

Hazardous Waste Component	FY2015 (m^3)	FY2016 (m^3)
Unused / Unspent	5.7	6.1
Solvent	6.2	7.4
Hazardous Solids	6.1	7.5
Research Trash / Cleanup	2.7	2.3
Acids / Bases	3.1	3.9
Hazardous Liquids	2.7	1.5

Unused/Unspent Chemicals. The volume of unused and unspent chemicals varies each year, but this waste stream comprised the third largest fraction of the hazardous waste in FY2016. Researchers are encouraged not to buy more of any chemical than they are certain to need for several months to avoid having any unused amount. Researchers are also encouraged to share chemicals among multiple users when possible. In FY2016, the volume of unused and unspent chemicals in the hazardous waste stream was slightly higher than in FY2015.

Solvents. EPA-listed and characteristic solvents and solvent-water mixtures are used widely in research, maintenance, and production operations, especially for cleaning and extraction. Nontoxic replacements for solvents are used whenever possible. New procedures are also adopted, where possible, that either require less solvent than before, or eliminate the need for solvent altogether. Solvent distillation equipment has reduced the total amount of solvent used, especially at TA-43. However, solvents are still required for many procedures, and solvents persist as a large component of the hazardous waste stream. Solvents made up the second largest component of LANL’s hazardous waste in FY2016.

Acids and Bases. A variety of strong acids and bases are routinely used in research, testing, and production operations. Over the past decade, the overall volume of hazardous acid and base waste has been reduced mainly by using new procedures that require less acid or base, by recycling acids onsite for internal reuse, and by reusing spent acids and bases as part of established neutralization procedures onsite. Bases made up more than half of this waste stream during FY2016. This was primarily due to the disposal of alkaline water from the TA-22 etching shop holding tank, which is not generated every year.

Hazardous Solids. This waste stream includes inert barium simulants used in high explosives research, electronics, contaminated equipment, broken leaded glass, firing site debris, ash, and various solid chemical residues from experiments. Hazardous solids were the largest waste stream in FY2016, and this was partly due to an increase in research related to nanoparticle synthesis.

Hazardous Liquids. This waste stream is primarily aqueous, neutral liquids that are created from a variety of analytical chemistry procedures. This waste stream also includes aqueous waste from chemical synthesis, spent photochemicals, electroplating solutions, refrigerant oil, and ethylene glycol.

Research Trash and Spill Cleanup. Research trash mostly consists of paper towels, pipettes, personal protective equipment, and disposable supplies. Rags are used for cleaning parts, equipment, and various spills. Equipment improvements have reduced the number of oil spills from heavy equipment, and new cleaning technologies have eliminated some processes where manual cleaning with rags was required in the past.

3.4 Hazardous Waste Minimization and Operational Funding

Fewer bulbs and batteries were recycled during FY2016 than during FY2015. Starting in late FY2011, special recycling operations were established in TA-60-86 at the Laboratory. Spent bulbs, aerosol cans, and batteries are collected from various sites and brought together for empty aerosol cans to be punctured, used bulbs to be packaged together, and batteries to be packaged for recycling. Having all of these recycling operations together at one location is cost effective for packaging and encourages as much recycling as possible. Table 3-3 presents the operational costs to the Laboratory for recycling hazardous waste, based on total weight of the materials, for the past five years.

Table 3-3. Universal Waste Shipped Offsite for Recycling at the Laboratory.

Fiscal Year	Volume of Hazardous Waste Recycled (m^3)	Cost of Recycling Hazardous Waste
FY2012	35	$619,230
FY2013	23	$480,997
FY2014	55	$802,337
FY2015	40.5	$321,711
FY2016	35	$309,463

During the past five years, the volume has varied, and this is mostly due to the intensity of clean out activity that occurred during the year. Decreasing the volume of recyclables means that fewer shipments need to be made, which saves fuel and reduces emissions of carbon dioxide associated with transportation. The costs of recycling these materials are estimated based on the cumulative weight.

Mercury Substitution

Researchers typically replace mercury-containing thermometers as they get broken with non-mercury thermometers. By doing so, the chances of accidentally spilling mercury and creating hazardous waste are reduced. It is especially valuable to have non-mercury thermometers in radiological control areas (RCAs) so that generation of MLLW can be avoided. The elemental mercury in old thermometers and other obsolete mercury-containing equipment is recycled. As less mercury is present at the Laboratory, the volume of spills contaminated with mercury decreases.

Acid Waste Reduction and Recycling

A metal plating shop at LANS uses an acid recycling system to recover nitric and hydrochloric acids for reuse in plating procedures within the shop. The system recovers about 90% of the acid used. There is a nitric acid recycling system at TA-55 so that a significant fraction can be reused multiple times instead of becoming waste.

Solvent Waste Reduction and Recycling

There have been many projects implemented to reduce the use of solvents since solvents have consistently been one of the largest components of the hazardous waste stream. Some of the solvent waste reduction projects are described below.

- Experiments in organic synthesis laboratories generate a large amount of glassware with organic residues. Solvents and oxidizing acids were formerly used to clean this glassware, thus generating hazardous waste. Besides the generation of waste, this process is time consuming and expensive. Two organic synthesis labs purchased Tempyrox Pyroclean ovens to clean the glassware with heat. The ovens eliminate the chemicals and other problems associated with manual cleaning. The organic vapors from this process are destroyed by a catalytic oxidizer system.
- One group reduced the amount of hazardous waste generated and new chemicals procured by installing a planetary mill. The planetary mill can grind solid materials into tiny particles so that reactions can occur with much smaller quantities of chemicals.
- The LANS Material Testing Lab uses a binder oven to test the amount of oil present in samples instead of performing solvent-based extractions. A sample can be weighed, baked in the oven, and then weighed again to determine how much oil was baked off from the sample.
- At TA-43, the solvent formamide was eliminated from the preparation process to sequence strands of DNA. Formamide is a suspect teratogen, and employees proved that a water-based solution called TE worked just as well as formamide for suspending DNA prior to sequencing. Eliminating formamide reduces hazardous waste solvent and research trash.
- A LANS organic synthesis team once performed experimental chemical synthesis activities in 25 mL-2 L reaction vessels. Now researchers use reaction vessels of 5 mL or less, which greatly reduces the volume of solvent used. Typical solvents include toluene, methylene chloride, tetrahydrofuran, and ethanol. Other research teams have also invested in new equipment that requires smaller samples. An added benefit is that often the new equipment can perform more analyses in a shorter time.
- Two laboratories at TA-43 installed solvent recovery systems for acetonitrile in high performance liquid chromatography waste. These systems prevent the generation of about 0.4 m^3 of hazardous waste solvents per week.

- The LANS protective forces subcontractor uses a non-hazardous cleaning solution, “Gunzilla”, for their guns instead of the solvent that was previously used, resulting in a reduction of the amount of hazardous waste generated.

Coolant Waste Reduction and Recycling

Two LANS machine shops implemented coolant recycling systems. Coolant is always used during machining procedures to ensure the quality of the machined pieces and maximize the lifetime of the machine tools. The coolant recycling system eliminated coolant waste from these facilities, and for over ten years only recyclable oil has been generated from these operations.

Lead-Free Ammunition

Lead is a persistent, bio-accumulative toxin in the environment. Historically, the LANS protective forces subcontractor has used traditional lead-containing bullets during training exercises at the small-arms range. All ammunition used for indoor training is lead-free. The bullets used for certification are required by DOE to be the standard lead-containing variety. The protective forces staff uses high-accuracy scopes on their weapons, and this allows them to achieve certification while using many fewer bullets.

3.5 Barriers to Hazardous Waste Minimization

The volume of unused/unspent chemicals was higher in FY2016 than in FY2015, although there were no special clean out events during FY2016. Full or partially used bottles of chemicals are sent for disposal once they have expired or if the chemical is no longer needed. Usable chemicals are sometimes distributed to other researchers in the same building who can use them, although this practice has not been as widely adopted as it could be. Many researchers are reluctant to use bottles of chemicals that were used by other teams since they cannot be sure that no cross-contamination occurred. Through the EMS, some directorates set specific objectives and targets for chemical waste reduction.

4.0 Mixed Transuranic Waste

4.1 Introduction

MTRU waste has the same definition as transuranic (TRU) waste, except that it also contains hazardous waste regulated under RCRA. TRU waste contains >100 nCi of alpha-emitting TRU isotopes per gram of waste, with half-lives greater than 20 years (atomic number greater than 92), except for (1) high-level waste; (2) waste that the DOE has determined, with the concurrence of the Administrator of the EPA, does not need the degree of isolation required by 40 CFR 191; or (3) waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61. MTRU waste is generated during research, development, nuclear weapons production, and spent nuclear fuel reprocessing.

MTRU waste has radioactive elements such as plutonium, neptunium, americium, curium, and californium. These radionuclides generally decay by emitting alpha particles. MTRU waste also contains radionuclides that emit gamma radiation. MTRU waste is disposed of at the Waste Isolation Pilot Plant (WIPP), a geologic repository near Carlsbad, New Mexico.

MTRU waste can be liquids, cemented residues, combustible materials, noncombustible materials, and non-actinide metals. Typically, research production materials and supplies are brought into an RCA and introduced into a glovebox. Waste leaves the glovebox as either solid or liquid. Liquid MTRU is a small percentage of total MTRU, and these wastes are primarily organic liquids. Liquid wastes are sent to the Radioactive Liquid Waste Treatment Facility (RLWTF) for treatment. The radionuclides and other contaminants are removed as a cemented solid waste at the RLWTF and shipped to TA-54 for storage. Treated water is either pumped to the low-level radioactive liquid waste treatment process, or is sent for off-site evaporation and disposal. MTRU solid wastes are accumulated, characterized, and assayed for accountability purposes at the generation site. MTRU solid waste is packaged for disposal in metal 55-gallon drums, standard waste boxes, and oversized containers, and then this waste is shipped to TA-54 for storage. Security and safeguards assay measurements are conducted on the containers for accountability before they are removed for transport, and then the waste is certified for transport and disposal at WIPP. The waste process generation map is shown in Figure 3-1.

During FY2016, no MTRU was shipped offsite from LANL due to the temporary closure of the WIPP facility. Most operations at TA-55 have undergone a work pause until the WIPP facility reopens, and this has reduced the volume of MTRU waste generated. The MTRU drums generated are expected to be stored onsite at LANL until the WIPP facility is accepting waste again.

4.2 MTRU Waste Minimization Performance

The Laboratory shipped no MTRU waste offsite during FY2016 or FY2015 from regular activities or from remediation projects. Excluding remediation projects, MTRU waste has historically been generated at TAs 3, 50, 54, and 55.

4.3 Waste Stream Analysis

During normal operations when WIPP is open, MTRU wastes at LANL are generated within RCAs. These areas also are material balance areas for security and safeguards purposes. The TA-55 Plutonium Facility processes plutonium residues generated throughout the defense complex to create isotopically pure plutonium feedstocks. The manufacturing and research operations performed in the processing and purification of plutonium result in the production of plutonium-contaminated scrap and residues. These residues are processed to recover as much plutonium as possible. These recovery operations, associated maintenance, and plutonium research are the sources of MTRU waste generated at TA-55.

MTRU wastes, process chemicals, equipment, supplies, and some RCRA materials are introduced into the RCAs in support of the programmatic mission. Because of the hazards inherent in the handling, processing, and manufacturing of plutonium materials, all process activities involving plutonium are conducted in gloveboxes. All materials removed from the gloveboxes must be multiple-packaged to prevent external contamination. Currently, all material removed from gloveboxes is initially considered to be TRU or MTRU waste. However, a final analysis is performed to determine if the waste should be classified as MTRU or MLLW. In many cases, the drum contents are found to actually be MLLW. When this occurs, the drum is repackaged and the drum's waste type is reclassified in the WCATS database. Large quantities of waste, primarily solid combustible materials such as plastic bags, cheesecloth, and protective clothing, are generated as a result of contamination avoidance measures taken to protect workers, the facility, and the environment. Operational waste normally generated at TA-55 when there is no work pause includes non–special nuclear material metal, plastic, cheesecloth, protective clothing, glass, filters, graphite, rubber, ceramics, ash, metals, lead-lined gloves, and a small volume of organic chemicals and oil.

Repackaging Waste Standards for waste acceptance at WIPP change periodically, so when this occurs, some drums of MTRU waste are repackaged to conform to new packaging standards. The waste inside the drums is old operational waste that is now packaged to meet the new standards. In many years the majority of the MTRU waste shipped to WIPP comes from repackaging activities.

Operational Waste Operational waste generated at LANL includes non–special nuclear material metal, plastic, cheesecloth, protective clothing, glass, filters, graphite, rubber, ceramics, ash, metals, lead-lined gloves, and a small volume of organic chemicals and oil.

4.4 Mixed Transuranic Waste Minimization

Many process improvements have been identified for implementation within TA-55 and in the processing of MTRU waste after it is produced. Changes in TA-55 processes are made very slowly due to the caution involved with moving new equipment into RCAs and qualifying new processes or changes. Waste minimization projects focus on elimination of RCRA components from products and processes in operations that generate MTRU waste. MTRU waste minimization and avoidance projects are typically funded by the P2 Program. Since shipments of MTRU waste have been halted during the WIPP closure, the P2 Program started making a special effort in FY2016 to assist with minimization of these waste streams.

Routine MTRU waste generated by operational activities has been reduced as a result of past P2 activities. These activities include:

- Replacing lead with a non-hazardous substance whenever possible in items such as gloves and shielding
- Using non-hazardous solvents
- Redesigning processes to minimize chemical use whenever possible
- Using reusable equipment, such as Teflon-coated tubes, instead of disposable equipment
- Using carbon dioxide plasma for cleaning parts instead of trichloroethylene
- Decontaminating equipment to prolong its useful life

In FY2016, there was an intense focus on finding ways to reduce the generation of TRU and MTRU since the WIPP facility was not accepting waste, and this focus will continue in FY2017. LANL does not want to run out of onsite storage space for TRU and MTRU before the WIPP facility reopens. It is expected that during FY2017 several projects will be funded to reduce the generation of TRU and MTRU.

4.5 Barriers to MTRU Minimization

Packaging requirements at WIPP often make minimization efforts difficult. There are dose limits that must not be exceeded, and a very small volume of MTRU could potentially be highly radioactive. All of the containers sent to WIPP are 55 gallons or larger, and often the containers have very small volumes of waste inside with the majority of the internal volume being empty space. The P2 Program is examining the waste packaging process to determine if there are any LANL-imposed rules that might be revised to allow for more efficient packaging of MTRU waste without compromising the ability of the drums to be accepted at WIPP in the future. During the closure, WIPP revised its waste acceptance criteria.

Another issue is that the procedures for using radioactive materials must be carefully followed, and making changes to any procedure, such as a change that could allow for waste reduction, has to be studied in detail and then incorporate into the approved procedures. This process can take multiple years since safety for personnel and efficacy of the revised process must be ensured.

5.0 Mixed Low-Level Waste

5.1 Introduction

For waste to be considered MLLW, it must contain hazardous waste and meet the definition of radioactive LLW. LLW is defined as waste that is radioactive and is not classified as high-level waste, TRU waste, spent nuclear fuel, or by-product materials such as uranium or thorium mill tailings. Test specimens of fissionable material irradiated only for R&D and not for the production of power or plutonium may be classified as LLW, provided that the activity of TRU waste elements is <100 nCi/g of waste.

Most of the routine MLLW comes from stockpile stewardship and from R&D programs. Most of the non-routine waste is generated by off-normal events such as spills in legacy-contaminated areas. Typical MLLW items include contaminated lead-shielding bricks and debris, old glove boxes, excess chemicals, spent solution from analytic chemistry operations, mercury-cleanup waste, electronics, copper solder joints, and used oil. The waste process generation map is shown in Figure 3-1.

5.2 MLLW Waste Minimization Performance

The amount of MLLW shipped from the Laboratory during FY2016 was 59.9 m^3, which is much more than the 16.9 m^3 of MLLW that was shipped offsite during FY2015. There was no MLLW remediation waste shipped offsite during FY2016 or FY2015. Table 5-1 includes all MLLW shipped from the Laboratory by location during FY2016.

Table 5-1. Offsite Shipments of MLLW by TA during FY2015 and FY2016.

TA	FY2015 MLLW (m^3)	FY2016 MLLW (m^3)
3	6.1	0.4
16	0.1	0.02
21	0	0.2
48	0.3	0.8
50	0	3.0
53	0	12.8
54	0.01	12.3
55	10.3	30.4
59	0	0.01

MLLW is generated by routine programmatic work, cleanup activities, and repackaging efforts. The volume of non-routine MLLW from cleanup and repackaging efforts tends to vary significantly and often cannot be substantially minimized, so it is useful to examine the routine fraction of the MLLW waste stream separately to identify good waste minimization opportunities.

5.3 Waste Stream Analysis

Materials and equipment are introduced into an RCA as needed to accomplish specific work activities. In the course of operations, materials may become externally contaminated or become activated, thus becoming MLLW when the item is no longer needed.

MLLW is transferred to a satellite accumulation area after it is generated. Whenever possible, MLLW materials are surveyed to confirm the radiological contamination levels. If decontamination eliminates the radiological or the hazardous component, then materials are decontaminated to prevent them from becoming MLLW.

Waste classified as MLLW is managed in accordance with appropriate waste management and Department of Transportation requirements and is shipped to TA-54. From TA-54, MLLW is sent to commercial and DOE-operated disposal sites.

The largest components of the MLLW stream by volume in FY2016 are lead-containing debris and waste that was reclassified from MTRU to MLLW. Less MLLW generation is anticipated in the future as historical MTRU shipments are completed, as non-toxic materials are substituted for mercury and lead, and as oil-free vacuum pumps replace older pumps. The relative volumes of various waste streams are shown in Figure 5-1.

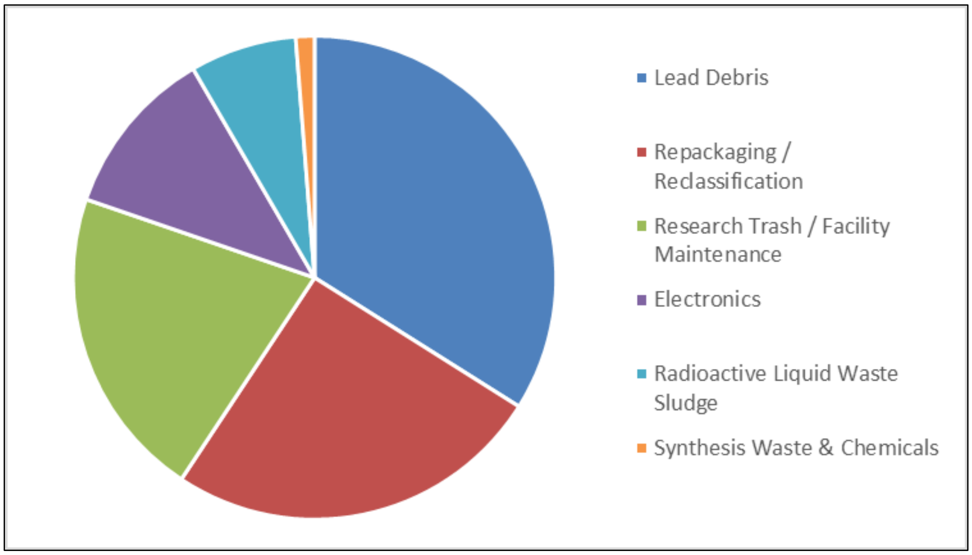

Figure 5-1. Constituents of MLLW in FY2016.

Table 5-2 shows the changes in the composition of the MLLW stream from FY2015 to FY2016.

Table 5-2. MLLW Shipped Offsite in FY2015 and FY2016.

MLLW Component	FY2015 MLLW (m^3)	FY2016 MLLW (m^3)
Reclassification	0	15.2
Electronics	0.4	6.7
Research Trash / Maintenance	7.7	12.5
Synthesis Waste & Chemicals	0.8	0.8
Radioactive Liquid Waste Sludge	0	4.3
Oil	0.02	0.1
Lead Debris	8.0	20.3

Reclassification. This waste was formerly classified as MTRU, but as MTRU standards changed, these wastes were reclassified and disposed of as MLLW instead. Since this waste is already generated, there are not many opportunities for minimization of this component of the MLLW stream. No MTRU waste was reclassified as MLLW in FY2015, but these reclassification efforts began again in FY2016.

Electronics. This waste stream includes various pieces of electronic equipment that were previously located within RCAs. New RCAs are engineered so most or all electronics can remain outside, and smaller electronic equipment will be used inside whenever possible. The Chemistry Division set up a demonstration laboratory using the smallest possible electronic equipment. The volume of electronics shipped in FY2016 was much higher than in FY2015. The volume of electronics MLLW in FY2015 was unusually low because so much electronic waste had been shipped offsite during FY2014 as part of a special electronics roundup effort.

Lead Debris. The lead debris waste stream includes copper pipes with lead solder, lead-contaminated equipment, brass contaminated with lead, bricks, sheets, rags, circuit boards, cathode ray tubes, and personal protective equipment contaminated with lead from maintenance activities. The volume of this waste stream is expected to decrease as lead is used for fewer applications. In FY2016 more than half of the lead debris came from a special project to dismantle a large spectrometer at TA-53.

Sludge from Radioactive Liquid Waste Treatment. Sludge is generated from the treatment of the Laboratory's radioactive liquid waste at the RLWTF, and this sludge is cemented prior to shipping for disposal. No sludge was shipped during FY2015, but shipments of this waste stream resumed in FY2016.

Research Trash and Facility Maintenance. The research trash waste stream is composed of personal protective equipment, dry painting debris, spent light bulbs, and paper towels and rags. This waste stream also included some unwanted equipment that was removed during building upgrades. More research trash and maintenance waste were shipped during FY2016 than during FY2015. A glovebox was removed from service, and this was nearly 80% of the volume of maintenance and research trash waste shipped during FY2016.

Synthesis Waste and Chemicals. In FY2016 this waste stream was composed of precipitated salts, spent solvents, aqueous solutions, unused/unspent chemicals that have become contaminated in RCAs, and analytical chemistry waste. One unusual item from FY2016 was soil that was no longer needed for use in proof-of-concept testing for an isotope separation system.

Oil. Used MLLW oil comes from vacuum pumps that are used within RCAs. A P2 project in FY2014 involved the purchase of oil-free scroll pumps, which decreased the volume of MLLW oil. All of the MLLW oil that was shipped offsite in FY2016 came from vehicle maintenance activities at TA-54.

5.4 Mixed Low-Level Waste Minimization

Efforts to substitute hazardous materials with alternatives and to improve sorting and segregation of these waste streams will reduce MLLW volumes in the coming years. The P2 Program has implemented a number of projects such as lead-free solder, bismuth shielding in RCAs instead of lead, mercury-free thermometers, oil-free vacuum pumps in RCAs, reduction of electronics in RCAs, and elimination of nitric acid bioassay wastes.

One effort involves replacing traditional fluorescent fixtures with LED fixtures in gloveboxes. The LEDs are much smaller and lighter than fluorescents, and the LEDs last longer, use less electricity, create less waste, and generate less heat than fluorescents. From FY2008 through FY2016, groups at TA-55 and TA-48 purchased more LED lights for gloveboxes, and future plans are to expand use of LED lights in radiological areas across the Laboratory. During FY2016, the Laboratory disposed of no fluorescent bulbs as MLLW. During the last four years, the Laboratory shipped no MLLW that was contaminated with mercury.

5.5 Barriers to MLLW Reduction

One barrier to reducing the generation of MLLW was the DOE-imposed suspension of metals recycling from RCAs with particular postings. Prior to the moratorium, any scrap metal could be surveyed for radioactive contamination and released for recycling if no activity was detected.

When the suspension was imposed, scrap metal from RCAs with particular postings had to be handled as waste. Most of the metal affected is scrap steel that would be handled as LLW if not recycled, but a much smaller fraction of the metal would be handled as MLLW. Electronic components often contain lead or other hazardous metals.

In 2000, DOE suspended recycling of clean metals from certain radiological areas. In FY2014, Laboratory staff began work on a proof of principle project to determine if radiation levels in certain recyclable metals are indistinguishable from background and to develop a regulatory process for release of these items to the public. In FY2015, this process was verified by personnel from DOE Headquarters, the Stanford Linear Accelerator, and Sandia National Laboratory. Approximately 1.2 million pounds of metal were recycled through this effort, which exceeded expectations. These metals were not encumbered by the DOE recycling suspension, but provided the technical basis for DOE to consider lifting the suspension. Although none of this metal would have been considered MLLW, lead items could potentially be handled through this process and recycled instead of becoming MLLW in the future.

6.0 Remediation Waste

6.1 Introduction

Section 6.0 of this report represents the P2 Program awareness plan for the corrective actions component of the ADEM. The directorate includes the Environmental Remediation Program (ER) and its associated investigation, cleanup, and site closure projects.

The mission of the ER corrective actions activities is to investigate and remediate potential releases of contaminants as necessary to protect human health and the environment. These activities are implemented to comply with the requirements of a June 2016 Compliance Order on Consent (hereafter, Consent Order) between the NMED and DOE, which supersedes a March 2005 Consent Order between NMED, DOE, and LANS. In completing this mission, activities may generate large volumes of waste, some of which may require special handling, treatment, storage, and disposal. Because the activities involve investigating and, as necessary, conducting corrective actions at historically contaminated sites, source reduction and material substitution are difficult to implement. The corrective action process, therefore, includes the responsibility and the challenge of minimizing the risk posed by contaminated sites while minimizing the amounts of waste that will require subsequent management or disposal. Minimization is desired because of the high cost of waste management, the limited capacity for onsite or offsite waste treatment, storage, or disposal, and the desire to minimize the associated liability.

6.2 Remediation Waste Minimization Performance

No hazardous, MTRU, or MLLW remediation waste was shipped offsite from LANL during FY2016, FY2015, or FY2014. Project activities in FY2016 involved investigations, including soil sampling and removal, storm water and groundwater monitoring, aquifer pump testing, groundwater extraction, and well drilling and abandonment.

In January 2012, DOE and NMED entered into a Framework Agreement for Realignment of Environmental Priorities (Framework Agreement). In accordance with the Framework Agreement, resources for activities by ER have been prioritized on groundwater and surface water protection, which inherently generate less hazardous, MTRU, or MLLW remediation waste than other remediation projects. As a result, there was a significant reduction in the volume of remediation waste generated in FY2012, which continued through FY2016.

6.3 Waste Stream Analysis

This report addresses all RCRA-regulated waste that may be generated by corrective actions during the course of planning and conducting the investigation and remediation of contaminant releases. Wastes generated include “primary” and “secondary” waste streams. Primary waste consists of generated contaminated material or environmental media that was present as a result of past DOE activities, before any containment and restoration activities. It includes contaminated building debris or soil from investigations and remedial activities. Secondary waste streams consist of materials that were used in the investigative or remedial process and may include investigative-derived waste (e.g., personal protective equipment, sampling waste, drill cuttings); treatment residues (e.g., spent resins and activated carbon from groundwater treatment); wastes resulting from storage or handling operations; and additives used to stabilize waste. The corrective actions may potentially generate hazardous waste, MLLW, and MTRU.

The majority of FY2016 waste shipped offsite was the result of investigations and monitoring and focused corrective actions. Investigations, corrective actions, and other activities associated with the Consent Order implemented during FY2016 include the following:

- Investigations and soil remediation for sites within former TA-01 in the Los Alamos town site
- Subsurface vapor monitoring at Material Disposal Area (MDA) C
- Performance of periodic groundwater monitoring for the Chromium Interim Measure and Characterization project, General Surveillance, MDA AB, MDA C, TA-16-260, TA-21, and TA-54 monitoring groups; performance of stormwater monitoring and installation and maintenance of stormwater controls throughout the Laboratory and Los Alamos town site
- Operation of a soil vapor extraction interim measure at MDA L
- Drilling and/or completion of extraction well CrEX-3 and injection wells CrIN-1, CrIN-2, CrIN-3, CrIN-4, and CrIN-5
- Pumping of chromium pilot extraction wells CrEX-1 and CrEX-3

Maps of the former TA-01 and the chromium monitoring wells in Mortandad Canyon are included in Appendix B as Figure 6-1 and Figure 6-2.

6.4 Remediation Waste Minimization

Waste minimization and P2 were integral parts of the FY2016 planning activities and field projects through recycling, reuse, contamination avoidance, risk-based cleanup strategies, and many other practices. Waste reduction benefits are typically difficult to track and quantify because the data to measure the amount of waste reduced (as a direct result of a P2 activity) are often not available and are not easily extrapolated. In addition, many waste minimization practices employed during previous years are now incorporated into standard operating procedures.

The P2 Program techniques used in FY2016 to reduce investigation-related waste streams led to the following accomplishments:

- Dry decontamination techniques continued to be used almost exclusively during field investigations, thereby minimizing generation of liquid decontamination wastes.

- The formal procedure for land application of the groundwater extracted during well drilling, development, sampling, and rehabilitation/reconfiguration developed by the Laboratory's Water Quality team in FY2008 continued to be implemented. Drilling, development, reconfiguration, and purge waters constitute a major potential waste source for ER (i.e., upwards of 100,000 gallons may be produced per well). This procedure, which incorporates a decision tree negotiated with NMED, allows groundwater to be land applied under discharge permit DP-1793 if this will be protective of human health and the environment. Use of this procedure minimizes the amount of purge water that must be managed as wastewater. The volume of land-applied development water and drilling fluids from well drilling and rehabilitation is compiled and reported to NMED on a calendar-year basis. The report for calendar year 2016 will be submitted in March 2017.

- The formal procedure for land application of drill cuttings developed by the Laboratory's RCRA team in FY2008 continued to be implemented in FY2016 after drilling activities resumed in FY2015. Drill cuttings constitute a major potential source of solid wastes generated by ER. This procedure, which incorporates a decision tree negotiated with NMED, allows drill cuttings to be land applied if this will be protective of human health and the environment. These drill cuttings do not have to be managed and disposed of as waste. Additionally, land-applied drill cuttings can be beneficially reused as part of drill site restoration.

- ADEM, ADESH, and DOE began discussions with NMED for development of a procedure for management of sediments removed from sediment retention structures installed under the Consent Order or individual storm water permit. Installation of sediment retention structures is expected to increase in the future and the procedure would employ a risk-based approach for disposition of sediments, similar to that used for drill cuttings. This approach will minimize generation of wastes associated with maintenance of sediment retention structures.

- ADEM stored and treated groundwater extracted during the development and pump tests of chromium plume pilot extraction wells and injection wells and during operation of extraction well CrEX-1. The treated water was land applied in accordance with discharge permit DP-1793 from NMED. On-site treatment and the discharge permit eliminated the need for offsite treatment and disposal of the large volume of water generated by these activities.

- ADEM continued to take actions during FY2016 to improve integration of the EMS into remediation activities and to improve awareness of the EMS by ADEM subcontractors. These actions included flowing down EMS requirements into the environmental requirements in subcontracts and continuing environmental communications through Worker Safety and Security Teams. These activities continue to increase awareness of waste minimization requirements and opportunities by ADEM subcontractors.

6.4.1 Sort, Decontaminate, and Segregate

This task is currently being implemented by ER and is designed to segregate contaminated and non-contaminated soils so that non-contaminated soils can be reused as fill. These practices are implemented at sites where contaminated subsurface soils and structures are overlain by uncontaminated soils. During excavation to remove the contaminated soils and structures, the uncontaminated overburden is segregated and staged apart from contaminated materials. Following removal of the contaminated soils and structures, the overburden is tested to verify that it is nonhazardous and meets residential soil screening levels. If so, this material is used as backfill for the excavation. This practice minimizes the amount of contaminated soil that must be disposed of as waste and also minimizes the amount of backfill that must be imported from off site.

Segregation is also used to allow "contact" waste generated during investigations to be managed through the GIC Program, rather than disposed of as radioactive waste. During FY2016, contact waste from site investigation and groundwater sampling activities continued to be managed through GIC as applicable.

6.4.2 Survey and Release

Past practices have conservatively classified non-indigenous investigation-derived waste (e.g., personal protective equipment, sampling materials) as contaminated, based on association with contaminated areas. New policy allows corrective actions managers and project leaders to develop procedures to survey and release these materials as non-radioactive if the survey finds no radioactivity. This reduces the volume of LLW from corrective actions activities.

6.4.3 Risk Assessment

Risk assessments are routinely conducted for corrective action projects to evaluate the human health and ecological risk associated with a site. The results of the risk assessment may be used by NMED to determine whether corrective measures are needed at a site to protect human health and the environment. The risk assessment may demonstrate that it is adequately protective and appropriate or beneficial to leave waste or contaminated media in place, thus avoiding the generation of waste. Properly designed land-use agreements and risk-based cleanup strategies can provide flexibility to select remedial actions (or other technical activities) that may avoid or reduce the need to excavate or conduct other actions that typically generate high volumes of remediation waste.

As described in more detail in Section 6.5, a risk-based data evaluation procedure is now being used to determine whether extent of contamination is defined at sites being investigated by ER under the Consent Order. This approach will result in protection of human health and the environment while requiring fewer samples and generating less investigation-derived waste.

6.4.4 Equipment and Material Reuse

The reuse of equipment and materials (after proper decontamination to prevent cross contamination) such as plastic gloves, sampling scoops, plastic sheeting, and personal protective equipment produced waste reduction and cost savings. When reusable equipment is decontaminated, it is standard practice to use dry decontamination techniques to minimize the generation of liquid decontamination wastes.

In addition, an equipment-exchange program was initiated, which identifies surplus or inactive equipment available for use. This not only eliminates the cost of purchasing the equipment, but it also prolongs the useful life of the equipment.

6.5 Pollution Prevention Planning

The potential to incorporate P2 practices into future activities is evaluated annually as part of the EMS planning efforts. As has been done in previous years, actions related to P2 are being incorporated into the FY2017 Environmental Action Plan for ADEM developed as part of the EMS. Waste generation, management, and disposition processes are being developed to minimize waste generation and maximize P2. As appropriate, specific actions and approaches that will be incorporated into planned corrective action projects for FY2017 are:

- Segregation and recycle or reuse of uncontaminated materials
- Continued use of land application of drill cuttings and fluids
- Waste avoidance
- Reuse and recycling of equipment and materials
- Increasing use of sustainable acquisition strategies
- Implementation of electronic tablets to replace paper records being used by field inspectors
- Risk-based cleanup strategies

Additionally, pursuant to the January 2012 Framework Agreement, DOE and NMED identified approaches to increase cleanup efficiencies, including reviewing characterization efforts undertaken to date pursuant to the Consent Order to identify those sites where nature and extent of contamination have been adequately characterized. This approach should result in a reduction in sampling activities for future investigations, with a commensurate reduction in investigation-derived waste generation. In FY2013, ER began re-evaluating sites being investigated under the Consent Order that had previously been recommended for additional Phase II sampling to define extent of contamination. Sites were re-evaluated using a risk-based approach. The results of this effort showed that additional sampling was not required at most of these sites and that the remaining sites require fewer samples than originally recommended. As a result, future Phase II investigation activities will result in generation of substantially less waste. These activities continued into FY2016 and will be continued in FY2017.

To help improve the implementation of waste minimization activities, ADEM ensures communication of environmental issues to project participants. Environmental issues are and will continue to be integrated into routine project communications, including the Worker Safety and Security Teams, to increase awareness about waste minimization and promote sharing of lessons learned.

6.6 Barriers to Remediation Waste Minimization

In years when remediation waste is generated, levels of waste minimization achieved fell below potentially achievable levels based on site conditions. Examples follow:

- To allow more options for future use of remediated sites and to eliminate the need for future administrative controls, some sites have been cleaned up to more stringent standards (e.g., residential levels) than needed for current land use. Although the use of the more stringent cleanup levels provides future benefits, it has resulted in generation of a larger volume of waste than if the sites had been cleaned up based on current land use.
- The single largest potential source of waste generated by corrective actions is removal of buried waste or contaminated soil during implementation of corrective measures. Such actions have the potential to generate thousands of cubic meters of waste. In evaluating corrective measure alternatives, corrective action program and project leaders generally give preference to alternatives that would avoid generating large volumes of waste, provided they are protective of human health and the environment. The consideration of other factors by external stakeholders, however, may result in selection of an alternative that generates more waste than the alternative recommended by the Laboratory.
- Cleanup of canyon-side disposal sites in the Los Alamos town site requires use of specialized equipment that is not easily mobilized. In delineating areas to be remediated, a conservative approach has been used to provide a high likelihood that cleanup levels are reached in order to avoid remobilization.

Appendix A – Funding for Past P2 Projects

In FY2012, funds were allocated to the following projects:

- Coolant Longevity Project ($30,000)

  This project implemented coolant filtering at several machines so that the coolant life is extended and less waste is produced. The allocated funds purchased equipment to filter the coolant.

- Waste Reduction Through Dry Cell Battery Recycling ($2,500)

  This project established more extensive recycling of various types of batteries from LANL-owned items such as cell phones and laptop computers.

- LANL Radiological and RCRA Constituents Background Study ($50,000)

  This project updated and expanded the current background report for soil and construction debris. This new report gives remediation and demolition projects one clear set of background values, both for RCRA and radiological constituents.

- Microshield® Non-Destructive Analysis Tool Pilot Project ($50,000)

  This project demonstrated the site wide application of the Microshield® Non-Destructive Analysis software for radiological waste characterization. Using the software is expected to cut analytical costs by 30%.

- ISR-4 Waste Reduction through the Incorporation of Automated Cleaning Systems ($64,000)

  A Trident Automatic De-Fluxing and Cleanliness Testing System and a bench top Ultrasonic Cleaning System were installed, which eliminated use of alcohol and other solvents to clean circuit boards and other electronic components.

- Trichloroethylene replacement study: cleaning effectiveness determination ($100,000)

  This project tested Novec fluids in place of trichloroethylene for ultrasonic cleaning. Novec fluids are more stable than trichloroethylene and are expected to save time for researchers as well as reduce the volume of hazardous or MLLW.

In FY2013, funds were allocated to the following projects:

- Smoke Alarm Recycling ($18,200)

  The funds for this project were used to recycle smoke detectors that contain americium and/or radium. These are smoke detectors that cannot be returned to their manufacturers and would otherwise be handled as MLLW.

- Oil-Free and Cost Efficient Freeze Drying ($6,500)

  A new oil-free pump was installed for synthesizing and preserving peptides. The new pump will not generate any hazardous waste oil and will require less maintenance.

- Replacement of Oil-Based Vacuum Pumps ($81,200)

  Many new oil-free pumps were purchased with these funds for materials science research. Without oil, the new pumps will not generate hazardous waste oil, and there will be no chance of oil spills and related cleanup waste from these pumps.

- Sanitary Effluent Recycling Facility Sludge Makes Carbon Neutral Concrete ($158,000)

  Research was performed on the best method to use for incorporating sludge from the Sanitary Effluent Recycling Facility into concrete. Once the process is optimized, less sludge will need to be disposed of as New Mexico Special Waste because it can be incorporated into useful concrete.

In FY2014, funds were allocated to the following projects:

- Electronics Roundup ($57,000)

  At multiple locations across the Laboratory, old and unwanted electronics were removed from RCAs. Approximately 35m^3 of electronics were collected and disposed as MLLW. The expectation is that this equipment will not be replaced inside the RCAs, or that replacement equipment will be smaller so that much less MLLW will be created by old electronics in the future.

- Lead Brick Recovery ($55,000)

  Personnel collected 25 pallets of lead bricks from TA-33, disinfected them, and shrink-wrapped them. These bricks are valuable since they were manufactured in the nineteenth century before nuclear testing began. Identification and the more protected storage of this material will prevent it from ever becoming waste.

- HS-Pu Filtrate Vessel Design & Replacement ($20,000)

  Process operators were able to significantly reduce TRU waste by designing and implementing a new vessel for the filtrate recovery process. This new vessel has a much longer life span, which will eliminate approximately 1m^3 of contaminated plastics annually.

- Replace Oil-Based Pumps with Scroll Pumps in Radioactive Operations ($40,000)

  This team purchased six scroll pumps to replace traditional pumps lubricated with oil for particular operations that handle radioactive materials. This change prevents any oil from this operation from potentially becoming MLLW or LLW.

In FY2015, funds were allocated to the following projects:

- LED Replacement Plan ($65,000)

  This team purchased six scroll pumps to replace traditional pumps lubricated with oil for particular operations that handle radioactive materials. This change prevents any oil from this operation from potentially becoming MLLW or LLW.

- Reduced Solvent Chemistry ($25,963)

  This team purchased a planetary mill, which allows them to synthesize custom compounds without using solvents, acids, or concentrated peroxides. Not only is hazardous waste avoided, but the reactions are performed more quickly and without the use of a pressure vessel.

- Workplace Stewardship Program ($100,000)

  Funds were provided to some cleanup projects that involved recycling or segregating materials that might otherwise have become waste. Many cubic meters of electronic equipment were tested and segregated to minimize the amount of MLLW generated.

In FY2016, funds were allocated to the following projects:

- Solventless Powder Reduction and Chemistry ($32,169)

  This team has reduced the amount of hazardous waste generated and new chemicals procured through the installation of a planetary mill. The planetary mill can grind solid materials into tiny particles so that reactions can occur with much smaller quantities of chemicals. The mill deposits energy more efficiently into a reaction than standard solution chemistry, so it reduces the reaction times dramatically, and it eliminates solvent usage altogether from many reactions. Many types of reactions can be facilitated in the planetary mill, and since there is no pressure required, it is safer than the previously used methods that required pressurization. The team expects to avoid the use of over one hundred gallons of various solvents annually as well as a few gallons of acutely toxic chemicals. Annual costs avoided from waste disposal and chemical procurement are in excess.

- Small Dry Vacuum Pumps to Replace Centralized Oil-Based Vacuum ($31,275)

  Biological cultures at LANL are grown and manipulated in biosafety cabinets, and in this process biochemists need to aspirate samples and supernatants. This aspiration process was performed using a centrally located oil-based vacuum pump for all high vacuum requirements in the laboratory. This centralized pump ran all the time and required that the oil be changed twice per month. This team used their funding to purchase 45 small oil-free vacuum pumps so that each lab can have its own vacuum source that can be used only as needed. Not only is energy usage reduced and employee time saved, but many gallons of waste oil are no longer generated.

- Dissolving Post-Detonation Debris with Ammonium Bifluoride ($20,000)

  In the field of nuclear forensic study, one of the biggest challenges is dissolving post-detonation debris for analysis. Debris generated after the nuclear detonation is a glassy material that is difficult to dissolve with chemicals. Traditionally, concentrated acids such as nitric acid, hydrofluoric acid, and sulfuric acid are employed during the dissolution. These corrosive acids are not suitable for field sample preparation operations. LANL chemists discovered that a commercially available chemical called ammonium bifluoride, found in many retail products, can be potentially used for debris sample preparation. Due to its less hazardous chemical properties, ammonium bifluoride has been used as a replacement for hydrofluoric acid, an extremely hazardous chemical, in several industrial applications. This team will study the feasibility of using ammonium bifluoride for field analysis of post-detonation debris instead of traditional concentrated acids.

Appendix B – Maps

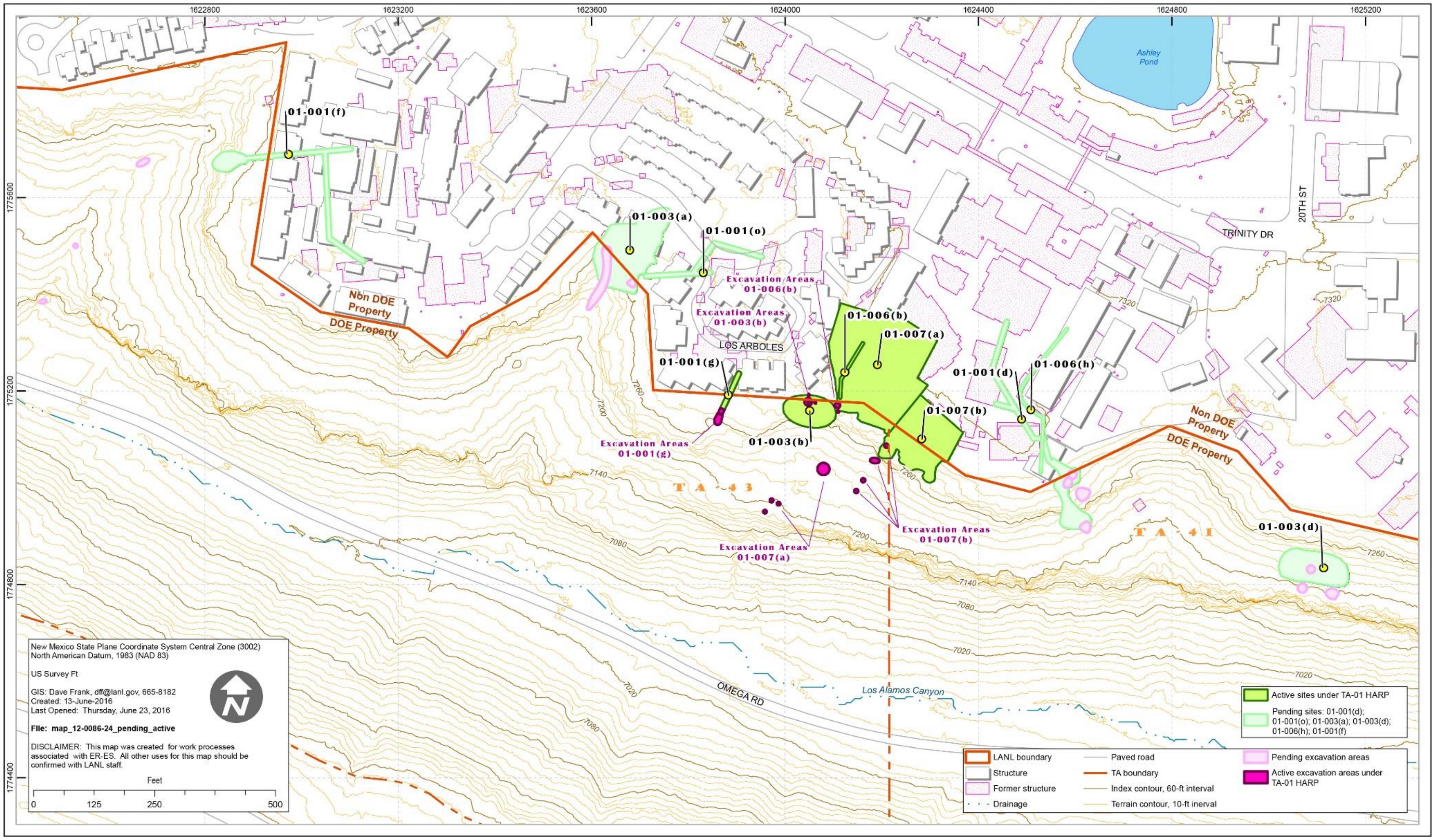

Figure 6-1. Investigations and Soil Remediation for Sites within Former TA-01 in the Los Alamos Town Site.

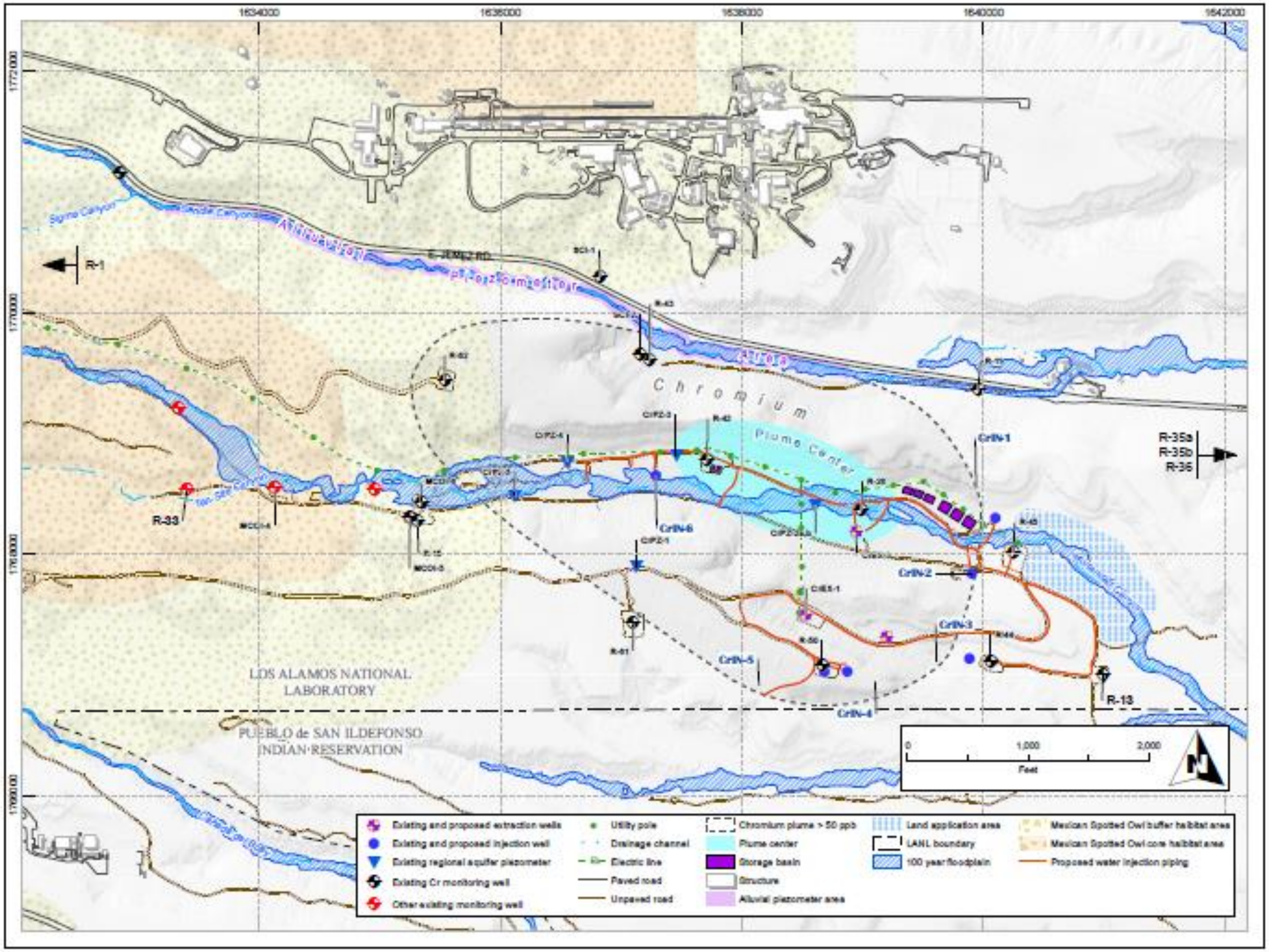

Figure 6-2. Locations of Current Chromium Extraction and Injection Wells in Mortandad Canyon.