Los Alamos National Laboratory

Environmental Stewardship Office
Environmental Science and Waste Technology Division
P.O. Box 1663, Mail Stop J591
Los Alamos, New Mexico 87545
(505) 667-4348/ FAX: (505) 665-8118

Date: January 8, 2001
Refer to: E/ES 01-003

SUBJECT: 2000 ENVIRONMENTAL STEWARDSHIP ROADMAP, LOS ALAMOS NATIONAL LABORATORY

Enclosed is the Laboratory's 2000 Environmental Stewardship Roadmap. This is the third annual roadmap. It summarizes a systems description of Laboratory processes that could impact the environment. It also describes measures that greatly reduce the possibility of impacting the environment. Many of these measures are now being implemented.

This roadmap, in conjunction with the Site Pollution Prevention Plan (published in 1997) and the Environmental Restoration Waste Minimization Plan satisfies the waste minimization program requirement of RCRA/HWA SECTION 40CFR264.73(b)(9) (RCRA).

Please contact me (505-667-6639 or tps@lanl.gov) if you would like further information.

Sincerely,

Thomas P. Starke, Program Manager
Environmental Stewardship Office
Los Alamos National Laboratory

TPS/bjb

Enclosure: a/s

Distribution:
John Arthur, DOE/AL
Arnold Eldeman, DOE/SC
Corey Cruz, DOE/AL
Sara Galpin, CAB
Joel Grimm, DOE/AL
David Gurule, LAAO
Howard Hatayama, UC
Charlie. Henn, DOE/AL
Chris Houston, DOE/AL
John Marchetti, DOE/DP-45
Kylene Molly, Sandia
Ricardo Notini, UC
James Orban, DOE/AL
Michael Sweitzer, DOE/AL
Al Villa, Sandia
R. Thorpe, DP-133
Joe Vozella, LAAO
Bernard. Whitaker, DOE/AL
Lee Wynn, NMEO

Cy: M. Baker, E-DO, J591
J. Balkey, NMT-DO, E500
M. Barr, JCNNM-JMGR, A199
J. Bartlit, ESH-DO, A117
C. Blackwell, ESH-IEP, K491
K. Braithwaite, GR, A103
M. Brown, JCNNM-HSEO, A199
J. Browne, DIR, A100
D. Burick, DLDOPS, A100
J. Canepa, E-ER, M992
R. Day, DX-DO, P915
T. Doerr, ESH-20, M887
B. Erdal, E-DO, J591
D. Erickson, ESH-DO, K491
T. Eshleman, E-ER, M992
R. Ferenbaugh,ESH-IEP, K491
C. Frostenson, AA-2, G783
D. Garvey, ESH-EIS, M889
S. Gibbs, NW-MM, A102
T. George, NMT-DO, E500
T. Gunderson, DLDOPS, A100
R. Hahn, SWO/FWO, J595
E. Hanson, ESA-DO, P945
K. Hargis, E-WMOSR, J591
T. Hayes, NMT-7, E501
D. Hjeresen, E-DIV, J591
J. Holt, NW-IFC, F627
R. Huchton, NMT-7, G745
A. Jackson, ESH-19, K490
A. Johnston, BUS-DO, P119
R. Lemons, MST-DO, G754
J. Loud, AA-2, G783
E. Louderbough, LC-GL, A187
B. Martin, E-WMOSR, J591
L. McAtee, ESH-DO, K491
D. McInroy, E-ER, M992
A. Montoya, NMT-7, E501

S. Moore, JCNNM-HENV, A199
W. Myers, E-DO, J591
D. Nylander, CST-DO, G747
D. Padilla, FWO-UI, K718
R. Parks, NW-IFC, F627
M. Pickrell, E-ET, E517
A. Pratt, EES-13, M992
E. Racinez, FWO-UI, K718
S. Rae, ESH-18, K497
B. Ramsey, FWO-DO, K492
J. Ruminer, ESA-DO, P945
A. Sattelberger, CST-DO, J515
M. Shepherd, JCNNM-MGPM, A199
T. Stanford, FWO-DO, K492
J. Stanton, JSNNM-HENV, A199
D. Stavert, ESH-17, J978
P. Thullen, DLDOPS, A100
P. Wardwell, LC-GL, A187
R. Wieneke, NMT-7, G744
D. Wilburn, E-DIV, J591
J. Williams, NW-MM, G747
D. Woitte, LC-GL, A187
S. Younger, ALDNW, A105
C. Zerkle, NW-IFC, F627
E/ESO Staff

General

LA-UR-00-5601

DEC. 2000

Placement

LOS ALAMOS NATIONAL LABORATORY
2000 ENVIRONMENTAL STEWARDSHIP ROADMAP

by

Thomas P. Starke, C. D'Ann Bretzke, Bryan J. Carlson, Eleanor Chapman, Robert Dodge, Brian Thompson, Patricia Vardaro-Charles, Janet Watson, and James H. Scott

Environmental Stewardship Office
Los Alamos National Laboratory

Original published
December 1, 2000
LA-UR-00-5601

This Roadmap is certified, along with the 1997 Site Pollution Prevention Plan (LA-UR-97-1726), to satisfy the requirements of 40CFR264.73(b)(9) (RCRA).

Thomas P. Starke

Thomas P. Starke
E Division, Environmental Stewardship Office
Los Alamos National Laboratory

CONTENTS

Page

ACRONYM AND ABBREVIATION LIST xi

ACKNOWLEDGMENTS xv

EXECUTIVE SUMMARY xvii

ABSTRACT 1-1

1.0. INTRODUCTION 1-1
- 1.1. Site Description 1-1
- 1.2. Laboratory Mission 1-2
- 1.3. Environmental Stewardship Mission Statement 1-3

2.0. DESCRIPTION OF THE ENVIRONMENTAL STEWARDSHIP PROGRAM....2-1
- 2.1. Methodology 2-1
- 2.2. Summary of Regulatory Drivers 2-2
- 2.3. Relevant Documents and Links 2-2

3.0. ASSUMPTIONS USED IN ENVIRONMENTAL STEWARDSHIP PLANNING .3-1
- 3.1. Operational Assumptions 3-1
  - 3.1.1. Laboratory Operations 3-1
  - 3.1.2. Waste Generation 3-1
  - 3.1.3. Environmental Management 3-1
- 3.2. Budget Assumptions 3-2
- 3.3. Organizational Descriptions and Commitments 3-2

4.0. TRANSURANIC WASTE (TRU) 4-1
- 4.1. Introduction 4-1
- 4.2. TRU Waste Performance 4-4
- 4.3. Waste Stream Analysis 4-5
- 4.4. Aspect Analysis 4-9
- 4.5. Improvement Projects 4-12
  - 4.5.1. Completed TRU Waste Minimization Projects 4-12
  - 4.5.2. Ongoing TRU Waste Minimization Projects (Partial List) 4-13
  - 4.5.3. Unfunded Projects 4-14

5.0. LOW-LEVEL WASTE 5-1
- 5.1. Introduction 5-1
- 5.2. LLW Performance 5-3
- 5.3. Waste Stream Analysis 5-5

CONTENTS (cont)

Page

5.3.1. Combustible Waste Streams....5-7
5.3.2. Noncombustible Waste Streams....5-8
5.3.3. Scrap Metal Waste Stream....5-8
5.4. Aspect Analysis....5-8
5.5. Improvement Projects....5-11
5.5.1. Completed Projects....5-12
5.5.1.1. Green Is Clean....5-12
5.5.1.2. Metal Recycling....5-12
5.5.1.3. Launderable Product Substitution....5-12
5.5.1.4. D&D Metal Decontamination....5-12
5.5.1.5. DU Machining Turning and Chip Recycling....5-12
5.5.1.6. RCA Source Elimination....5-12
5.5.1.7. Real-Time Surface Contamination Monitor....5-13
5.5.1.8. PPE Reuse as Rags....5-13
5.5.1.9. Crush Demolition Waste Concrete....5-13
5.5.2. Ongoing Projects....5-13
5.5.2.1. ESO Base Program....5-13
5.5.2.2. RLWTF Influent Minimization Project....5-13
5.5.3. Unfunded Projects....5-14

6.0. MIXED LOW-LEVEL WASTE....6-1
6.1. Introduction....6-1
6.2. MLLW Minimization Performance....6-2
6.3. Waste Stream Analysis....6-4
6.4. Aspect Analysis....6-8
6.5. Improvement Projects....6-12
6.5.1. Completed Projects....6-13
6.5.1.1. Aerosol Can Recycling....6-13
6.5.1.2. Sorting, Segregation, and Recycle, and Reuse of Miscellaneous Electronic Equipment....6-13
6.5.1.3. Reuse of Equipment from RCAs....6-13
6.5.1.4. Elimination of Mercury Thermometers and Other Devices in RCAs....6-13
6.5.1.5. Lead Removal from Gloveboxes....6-13
6.5.1.6. Lead Decontamination....6-13
6.5.1.7. Substitution of Lead Shielding Materials....6-13

CONTENTS (cont)

Page

66.5.1.8. Sorting, Segregation, Reuse, and Recycling of Miscellaneous Equipment from RCAs....6-13
.5.1.9. Nitric Acid Waste Reduction....6-14
6.5.1.10. Size Reduction of Inorganic Waste Analyses....6-14
6.5.1.11. Microconcentric Nebulizer....6-14
6.5.1.12. Conversion to Nonhazardous Fluorescent Lights....6-14
6.5.1.13. Semivolatile Extraction Project....6-14
6.5.1.14. Mediated Electrochemical Oxidation....6-14
6.5.2. Ongoing Projects....6-14
6.5.2.1. ESO Base Program....6-14
6.5.2.2. MLLW Cask Reuse and Recycling....6-15
6.5.2.3. Oil-Free Vacuum Pumps....6-15
6.5.3. Unfunded Projects....6-15
6.5.3.1. Use of Flat Screen Monitors for RCAs (see Appendix B)....6-15
6.5.3.2. New Mercury Cleanup Protocol (see Appendix B)....6-15
6.5.3.3. Nitrate Bio-Assay Diversion Projects (see Appendix B)....6-15
6.5.3.4. Hot-Water Extraction for the Characterization of Hazardous Compounds (see Appendix B)....6-15
6.5.3.5. Mixed Oil Solidification....6-16

7.0. HAZARDOUS WASTE....7-1
7.1. Introduction....7-1
7.2. Hazardous Waste Minimization Performance....7-2
7.3. Hazardous Waste Analysis....7-2
7.4. Environmental Aspect Analysis....7-7
7.4.1. Potential Mitigating Actions....7-10
7.5. Improvement Projects....7-10
7.5.1. Completed Projects....7-10
7.5.2. Ongoing Projects....7-11
7.5.3. Unfunded Projects....7-12

8.0. SOLID SANITARY WASTE....8-1
8.1. Introduction....8-1
8.2. Sanitary Waste Minimization Performance Compared with DOE Goals....8-2
8.3. Waste Stream Analysis....8-3
8.3.1. Construction/Demolition Waste....8-4
8.3.2 Procured Equipment and Supplies....8-4

CONTENTS (cont)

Page

8.3.3. Paper Products 8-5
8.3.4. Office Supplies/Equipment 8-5
8.3.5. Mail 8-5
8.3.6. Cardboard 8-6
8.3.7. Plastics 8-6
8.3.8. Glass 8-6
8.3.9. Food and Food-Contaminated Materials 8-6
8.4. Aspect Analysis 8-6
8.5. Improvement Projects 8-9
8.5.1. Completed Projects 8-10
8.5.2. Ongoing Projects 8-11
8.5.3. Unfunded Projects 8-12
8.6. FY01 Project Summaries 8-12

9.0. CONSTRUCTION 9-1
9.1. Introduction 9-1
9.2. Construction Waste Minimization Performance Compared with DOE Goals 9-3
9.3. Waste Stream Analysis 9-3
9.4. Construction Waste Streams 9-3
9.5. Aspect Analysis 9-5
9.6. Potential Improvement Projects 9-6
9.6.1. Completed Projects 9-6
9.6.2. Ongoing Projects 9-6
9.6.3. Unfunded Projects 9-8

10.0. WATER USE AND CONSERVATION 10-1
10.1. Introduction 10-1
10.2. Water Conservation Performance 10-4
10.3. Waste Stream Analysis 10-5
10.4. Aspect Analysis 10-5
10.4.1. Water Consumption 10-8
10.4.2. Potential Mitigating Actions 10-8
10.5. Improvement Projects 10-8
10.5.1. Completed Projects 10-9
10.5.2. Ongoing Projects 10-9
10.5.3. Unfunded Projects 10-10
10.6. Project Summaries 10-11

CONTENTS (cont)

Page

11.0. ENERGY USE AND CONSERVATION 11-1
11.1. Introduction 11-1
11.2. Energy Conservation Performance 11-4
11.3. Waste Stream Analysis 11-6
11.4. Aspect Analysis 11-6
11.4.1. Potential Mitigating Actions 11-8
11.5. Improvement Projects 11-8
11.5.1. Completed Projects 11-8
11.5.2. Ongoing Projects 11-8
11.5.3. Unfunded Projects 11-9

A.1. POLLUTION PREVENTION GOALS A-1

A.2. RESOURCES A-1

A.3. ENVIRONMENTAL MANAGEMENT IN ISM A-2

A.4. SUSTAINABILITY A-2

A.5. PERFORMANCE MEASURES AND GOALS A-2

B.1. TRU WASTE B-1

B.2. LOW-LEVEL WASTE B-8

B.3. MIXED LOW-LEVEL WASTE B-15

B.4. HAZARDOUS WASTE B-24

B.5. SANITARY WASTE B-29

C.1. SUMMARY C-1

C.2. POLLUTION PREVENTION AWARENESS SYSTEM DESCRIPTION C-1

C.3. PROJECTS C-3
C.3.1. Develop a Lab-Wide Communication Program Plan C-3
C.3.2. Expand Pollution Prevention in Formal Training C-3
C.3.3. Expand Awards Program C-3
C.3.4. Direct Communications to All Employees C-4
C.3.5. Implement Public Communication C-4
C.3.6. Stewardship Brochures C-4
C.3.7. Assistance C-5

CONTENTS (cont)

Page

D.1. CONSTRUCTION PROCESS D-1

D.2. PRECONCEPTUAL AND CONCEPTUAL PHASES D-2

D.3. EXECUTION PHASE D-2

D.4. OPERATIONS PHASE D-4

D.5. SHUTDOWN PHASE D-6

FIGURES

Page

Fig. 1-1. Laboratory process map........ 1-2
Fig. 3-1. Appendix F process (18-month continuous cycle)........ 3-3
Fig. 4-1. Top-level TRU waste process map and waste streams. 4-2
Fig. 4-2. Generation rates for TRU waste at LANL........ 4-3
Fig. 4-3. TRU and MTRU waste generating organizations........ 4-4
Fig. 4-4. TRU waste generation by year........ 4-5
Fig. 4-5. The proportion of LANL-generated mixed TRU waste........ 4-6
Fig. 4-6. Composition of TRU waste from NMT Division, FY98 through FY00........ 4-7
Fig. 5-1. Top-level LLW process map and waste stream chart. 5-1
Fig. 5-2. LLW generation by division. 5-2
Fig. 5-3. Routine waste generation by division........ 5-2
Fig. 5-4. LANL's routine and nonroutine waste generation rates........ 5-4
Fig. 5-5. Chart demonstrating that LANL has exceeded the 2005 goal. 5-4
Fig. 5-6. LLW streams........ 5-5
Fig. 6-1. Top-level MLLW process map. 6-1
Fig. 6-2. MLLW generation and projected generation........ 6-2
Fig. 6-3. Routine MLLW generation by division........ 6-3
Fig. 6-4. Routine and nonroutine waste generation........ 6-3
Fig. 6-5. Routine MLLW generation vs DOE goal........ 6-4
Fig. 6-6. Waste stream constituents........ 6-8
Fig. 7-1. Routine hazardous waste generation compared with the DOE 2005 goal. 7-3
Fig. 7-2. Hazardous waste process map........ 7-4
Fig. 7-3. FY00 hazardous waste by type. 7-4
Fig. 7-4. Hazardous waste generation FY 97–00........ 7-5
Fig. 7-5. Hazardous waste by division, excluding ER waste........ 7-5

FIGURES (cont)

Page

Fig. 7-6. Hazardous waste streams, excluding ER waste. 7-6
Fig. 8-1. Top-level sanitary waste process map and waste streams. 8-1
Fig. 8-2. Routine sanitary waste sent to landfill 8-2
Fig. 8-3. Laboratory routine sanitary waste recycling rate. 8-3
Fig. 9-1. Project management construction phases. 9-4
Fig. 10-1. LANL water system. 10-2
Fig. 10-3. Monthly water consumption. 10-3
Fig. 10-4. Water usage by year. 10-4
Fig. 10-5. Water discharge and losses. 10-6
Fig. 10-6. Water consumption with and without the efficiency project. 10-10
Fig. 11-1. Energy process map for LANL. 11-2
Fig. 11-2. LANL energy usage. 11-3
Fig. 11-3. LANL energy usage without LANSCE. 11-4
Fig. 11-4. LANL electrical usage. 11-5
Fig. 11-5. Natural gas consumption at LANL. 11-5
Fig. D-1. Project management construction phases D-1
Fig. D-2. Construction project execution phase D-3
Fig. D-3. Anticipated waste streams for preparing a site for construction. D-3
Fig. D-4. Anticipated waste streams for construction of a new facility. D-4
Fig. D-5. Construction project operations phase. D-5
Fig. D-6. Anticipated waste streams for the operation of a facility D-5
Fig. D-7. Construction project facility shutdown phase. D-6
Fig. D-8. Anticipated waste streams for the shutdown of a facility. D-7

TABLES

Page

Table 2-1. Regulatory Drivers for Environmental Action 2-3
Table 2-2. Required Reports 2-3
Table 4-1. Transuranic Waste Aspect Scores 4-11
Table 6-1. Approximate Costs for MLLW Streams[6-1] 6-6
Table 7-1. Identification of the waste streams, their activities, and their score 7-9
Table 11-1. Electrical Energy Usage at LANL 11-3
Table A-1. LANL Pollution Prevention Goals A-1
Table A-2. Pollution Prevention and Waste Minimization Activities Resources A-2

ACRONYM AND ABBREVIATION LIST

A/E	Architect/Engineer
AF	Acre-Feet
AFY	Acre Feet per Year
AHF	Advanced Hydrotest Facility
BRC	Below Regulatory Concern
BUS	Business Operations Division
CCF	Central Computing Facility
CFR	Code of Federal Regulations
CMIP	Capability Maintenance and Improvement Project
CMR	Chemistry and Metallurgy Research (Facility)
CNMIP	Colorado/New Mexico Intertie Project
County	Los Alamos County
County Landfill	The DOE-Owned, Los-Alamos-County-Operated Landfill
CRT	Cathode Ray Tube
CST	Chemical Science and Technology (Division)
CY	Calendar Year
D&D	Decontamination and Decommissioning
DAHRT	Dual Axis Hydrodynamic Test
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
DOE/DP	Department of Energy/Defense Programs
DOE/EM	Department of Energy/Environmental Management
DP	Defense Programs
DSSI	Diversified Scientific Services, Inc.
DU	Depleted Uranium
DX	Dynamic Experimentation (Division)
E	Environmental Science and Waste Technology Division
E-ET	Environmental Technologies Group of the Environmental Science and Waste Technologies Division
EM	Environmental Management
EMS	Environmental Management System

ACRONYM AND ABBREVIATION LIST (cont)

EO	Executive Order
EPA	Environmental Protection Agency
ER	Environmental Restoration
ER/D&D	Environmental Remediation/Decontamination and Decommissioning
ESH	Environment, Safety, and Health (documents, programs, etc.)
ESA	Engineering Sciences and Applications (Division)
ESH	Environment, Safety, and Health (Division)
ESO	Environmental Stewardship Office
FFCO/STP	Federal Facility Compliance Order/Site Treatment Plan
FWO	Facility and Waste Operations
FWO/UI	Facility and Waste Operations Utilities and Infrastructure Group
FY	Fiscal Year
GDMS	Gas Discharge Mass Spectrometer
GET	General Employee Training
GIC	Green Is Clean
GPMS	Glove Procurement Management System
GPP	General Plant Project
GSAF	Generator Set-Aside Fee
GWCP	Generator Waste Certification Program
HE	High Explosives
HEPA	High-Efficiency Particulate Air Filter
HLW	High-Level Waste
ICP	Inductively Coupled Plasma
IM	Information Management (Division)
INEEL	Idaho National Energy and Environmental Laboratory
ISM	Integrated Safety Management
ISM-E	Environmental Component of ISM
ISO	International Standards Organization
JCNNM	Johnson Controls Northern New Mexico
Laboratory	Los Alamos National Laboratory
Landfill	The DOE-Owned, Los-Alamos-County-Operated Landfill

ACRONYM AND ABBREVIATION LIST (cont)

LANL	Los Alamos National Laboratory
LANSCE	Los Alamos Neutron Science Center Experiment
LAPP	Los Alamos Power Pool
LDCC	Laboratory Data Communications Center
LEDA	Low-Energy Demonstration Accelerator
LEED™	Leadership in Energy and Environmental Design
LINAC	Linear Accelerator
LIR	Laboratory Implementation Requirement
LLNL	Lawrence Livermore National Laboratory
LLW	Low-Level (Radioactive) Waste
LPR	Laboratory Performance Requirement
LRS	Laramie River Station
MBA	Material Balance Area
MDA	Materials Disposition Area
MEO	Mediated Electrochemical Oxidation
MLLW	Mixed Low-Level Waste
MRF	Material Recycle Facility
MT	Metric Ton
MTRU	Mixed Transuranic
MW	Megawatt
NARS	Nitric Acid Recovery System
NDA	Nondestructive Assay
NMED	New Mexico Environment Department
NMSWMR	New Mexico Solid Waste Management Regulations
NMT	Nuclear Materials Technology (Division)
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
PCB	Polychlorinated Biphenyl
PEP	Project Execution Plan
PNM	Public Service Company of New Mexico
PNMGS	Public Service Company of New Mexico Gas Services

ACRONYM AND ABBREVIATION LIST (cont)

PNNL	Pacific Northwest National Laboratory
PPE	Personnel Protective Equipment
PTLA	Protection Technologies Los Alamos
PVA	Polyvinyl Alcohol
PVC	Polyvinyl Chloride
R&D	Research and Development
RANT	Radioassay and Nondestructive Testing
RCA	Radiological Control Area
RCRA	Resource Conservation and Recovery Act
RFP	Request for Proposal
RLWTF	Radioactive Liquid Waste Treatment Facility
SCC	Strategic Computing Complex
SD	Sustainable Design
SNM	Special Nuclear Material
STL	Safeguards Termination Limit
SWB	Standard Waste Box
SWEIS	Site-Wide Environmental Impact Statement
SWO	Solid Waste Operation
SWSC	Sanitary Wastewater System Consolidation
TA	Technical Area
TBD	To Be Determined
TCE	Trichloroethylene
TCLP	Toxic Characteristic Leaching Procedure
TFCH	Treated Formerly Characteristic Hazardous (Waste)
TRU	Transuranic
TSCA	Toxic Substances Control Act
TSDF	Treatment, Storage, and Disposal Facility
UC	University of California
VOC	Volatile Organic Carbon
WAC	Waste Acceptance Criteria
WAPA	Western Area Power Administration
WCRRF	Waste Compaction, Reduction, and Repackaging Facility
WFM	Waste Facilities Management
WIPP	Waste Isolation Pilot Plant
WM	Waste Management
WMC	Waste Management Coordinators

ACKNOWLEDGMENTS

We wish to thank the many Laboratory and subcontractor personnel who made significant contributions to this roadmap. Furthermore, we especially wish to thank Lisa Rothrock, IM-1/TSA-10; Mary Timmers, TSA-11; and Ann Mascareñas, TSA-10, who edited and produced this document.

EXECUTIVE SUMMARY

Los Alamos National Laboratory's goal is to experience zero environmental incidents. The Environmental Stewardship Office, which manages the Laboratory's Pollution Prevention Program, coordinates efforts to eliminate the sources of environmental incidents. Good stewardship eliminates these sources through waste minimization, pollution prevention, and conservation improvements. In fact, good stewardship moves the Laboratory beyond compliance-based goals toward zero waste produced, zero pollutants released, zero natural resources wasted, and zero natural resources damaged. It helps the Laboratory operate in such a way that future employees will have equal or better natural resources and quality of environment as current employees.

Environmental stewardship and pollution prevention not only protect the environment, but also pay for themselves by reducing costs and creating a safer workplace. Furthermore, they minimize both waste- and pollution-related work tasks, enabling staff to devote more time to mission activities. In effect, they increase productivity. Practicing good environmental stewardship and reducing the sources of environmental incidents are the responsibility of every person working on the site.

This roadmap documents the Laboratory's Environmental Stewardship Program and the process used to define and implement environmental improvements. It describes current operations, improvements that will eliminate the sources of environmental incidents, and the end state that is the Laboratory's goal. Over the next 18 months, the Laboratory will move from an environmental management approach that emphasizes compliance requirements to an Environmental Management System (EMS) that embodies the concepts of ISO 14001. The Laboratory currently has implemented environmental protection as part of Integrated Safety Management (ISM) implementation. The initial implementation focuses on ensuring that Laboratory operations comply with applicable laws and regulations. The ISM Program requires continuous improvement of the ISM System. An ISM environmental upgrade enhancing the "E in ISM" is now being planned. The format of the 2000 roadmap anticipates this upgrade.

This 2000 version of the roadmap meets the requirements for Department of Energy Order 5400.1, *Site Pollution Prevention Plan—Triennial Update,* and it is certified also to satisfy the waste minimization program documentation requirements of 40 CFR 264.73(b)(9) (Resource Conservation and Recovery Act).

LOS ALAMOS NATIONAL LABORATORY
2000 ENVIRONMENTAL STEWARDSHIP ROADMAP

ABSTRACT

The Environmental Stewardship Program supports Los Alamos National Laboratory's goal of zero environmental incidents. The Stewardship Program has taken a systems approach to eliminating the waste, pollution, natural resources wastage, and natural resources impact that are the source of incidents and violations. The systems approach is summarized in this Stewardship Roadmap document. In the near future, the Laboratory will upgrade its ISM-E system based on the principles embodied in ISO 14001. The roadmap identifies recent waste minimization, pollution prevention, and conservation successes, as well as improvement initiatives now being implemented or being proposed for implementation. It also identifies performance measures that will track the impact of the initiatives. Implementation of the Stewardship Program described here should result in Laboratory operations that significantly reduce waste generation and environmental impact.

1.0. INTRODUCTION

1.1. Site Description

Los Alamos National Laboratory (LANL) is located within the county of Los Alamos ~35 miles northwest of Santa Fe and occupies 43 square miles of land in northern New Mexico. The Laboratory is divided into 50 technical areas (TAs), with locations and spacing that reflect historical development patterns, topography, and functional relationships. Owned by the Department of Energy (DOE), LANL has been managed by the University of California (UC) since 1943.

Los Alamos is located in a temperate mountain climate at an elevation of ~7400 ft. In July, the warmest month of the year, the temperature ranges from an average daily high of 27.2°C (81°F) to an average daily low of 12.8°C (55°F). In January, the coldest month, the temperature ranges from an average daily high of 4.4°C (40°F) to a low of -8.3°C (17°F). The large range in daily temperatures results from the relatively dry, clear atmosphere, which allows strong solar heating during the day and rapid radiative cooling at night. The average annual precipitation (rainfall plus the water equivalent of frozen precipitation) is 18.7 in.

1.2. Laboratory Mission

The central mission of the Laboratory is to enhance the security of nuclear weapons and nuclear materials worldwide. Its statutory responsibility is the stewardship and management of the nuclear stockpile. This requires a solid foundation in science and state-of-the-art technology. The Laboratory has approximately 6800 UC employees plus approximately 2800 contractor personnel. Partnering with universities and industry is critical to Laboratory success. Carefully selected civilian research and development programs complement the Laboratory Mission.

As in any other activity, waste and pollution are generated in executing the Laboratory Mission. Environmental management at LANL provides for the reduction and elimination of this waste and pollution and for remediation of sites impacted by previous operations. Figure 1-1 shows the Laboratory process map, which is a view of the Laboratory from the local environmental perspective. Not shown, but also important, is the regional environmental impact related to Laboratory operations.

The Laboratory receives funding and mission assignments from the DOE. Through the DOE, it also performs work for other government sponsors and private industry. To accomplish these assignments, the Laboratory procures services, materials, equipment, new facilities, and commodities (electricity and natural gas). The Laboratory also takes in water from the regional aquifer and air from the surrounding atmosphere. Figure 1-1 also shows the substance and energy inflows to the Laboratory. When in the Laboratory, the inflows are used in the six types of operations listed the figure.

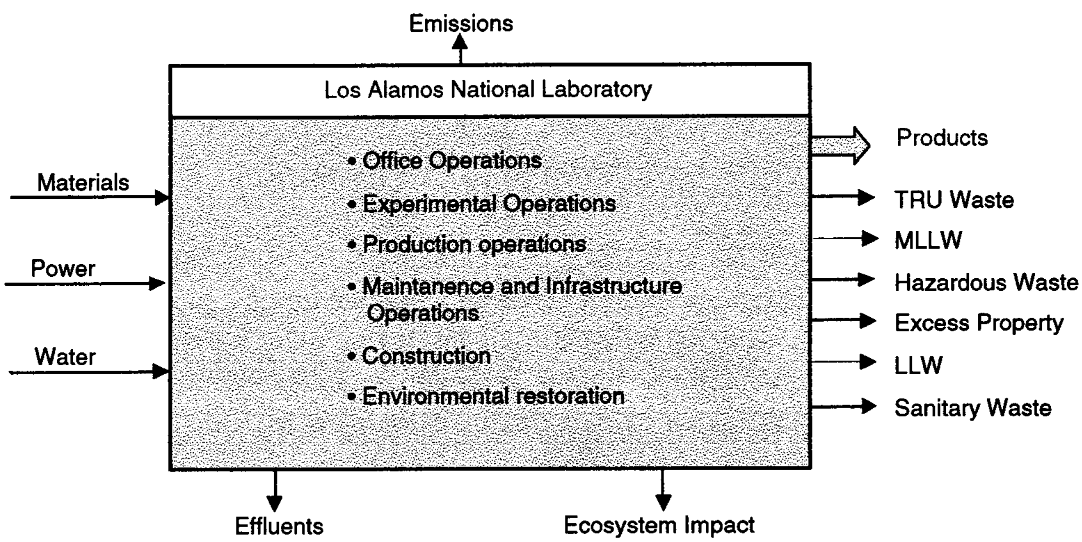


Fig. 1-1. Laboratory process map.

1. Most UC and subcontractor person-hours are spent conducting office operations.

2. Experimental operation includes bench-scale research, experiments at the Los Alamos Neutron Science Center (LANSCE), criticality experiments at TA-18, explosive tests at Dynamic Experimentation (DX) Division firing sites, and fabrication of the experimental hardware used in experiments.

3. Production operations include Nuclear Materials Technology (NMT) Division plutonium processing and production operations. They also include NMT analytic chemistry operations at the Chemistry and Metallurgy Research (CMR) Facility.

4. Maintenance and infrastructure operations include all Johnson Controls Northern New Mexico (JCNNM) maintenance activities, Facility Management Unit maintenance activities, and site-wide infrastructure systems such as the solid waste operation (SWO) (TA-54), Radioactive Liquid Waste Treatment Facility (RLWTF) (TA-50) power plant, Sanitary Wastewater Systems Consolidation (SWSC) waste-water plant, water influent system, and highway system.

5. Construction includes both smaller construction projects performed by JCNNM and major construction projects conducted by competitively selected contractors.

6. Environmental Restoration (ER) includes all DOE/Environmental Management (EM)-funded facility Decontamination and Decommissioning (D&D) and contaminated-site remediation.

Because the Laboratory's products are mostly information, most material inflows become byproduct or waste outflows. Consequently, both consumption and waste generation reflect the Laboratory's inefficiency. Outflows are divided into transuranic (TRU) waste, mixed low-level (radioactive) waste (MLLW), low-level (radioactive) waste (LLW), hazardous waste, and solid sanitary waste and are well defined and discussed in detail later in this document. Excess property includes all items processed through the Business Operations Division (BUS)-6/JCNNM salvage system. Effluents include all of the waste water released from the site into the canyons. Two-thirds of the water brought on site is discharged through outfalls.

1.3. Environmental Stewardship Mission Statement

LANL's primary environmental-excellence goal is zero environmental incidents. The strategy for achieving this goal has two primary elements. First, the Laboratory will comply with all applicable environmental laws, regulations, DOE orders, and consensus standards identified through the Laboratory's Integrated Safety Management (ISM) Work Smart Standards process and listed in Appendix E to the UC contract. Compliance is managed through the ISM System.

The Environment, Safety, and Health (ESH) Division assists Laboratory divisions in planning and maintaining compliant operations. Second, the Laboratory will continue to execute its prevention-based Environmental Stewardship Program that seeks to eliminate the potential for environmental incidents. The Stewardship Program is a fundamental part of ISM at the Laboratory. Both compliance and stewardship are managed through the ISM process.

The Laboratory's Environmental Stewardship Mission is to reduce waste and other environmental releases and impacts to zero or as near zero as possible. The Laboratory's prevention-based program to achieve zero waste is called the Environmental Stewardship Program. The Laboratory chose the "Stewardship" title because pollution prevention traditionally has implied waste minimization and prevention of environmental releases, whereas stewardship implies an equal emphasis on engaging all adverse environmental impacts and stressing energy conservation, water conservation, ecosystem protection, etc. The DOE programs that have these same goals are called Pollution Prevention Programs.

The control and reduction of waste generated by the Laboratory must take place within certain constraints. Pollution prevention and waste minimization activities must not compromise safety or increase worker exposure to radioactive or hazardous materials. For that reason, pollution prevention is an integral part of ISM. To help accomplish its stewardship mission, LANL will begin implementing an Environmental Management System (EMS) in fiscal year (FY) 2001 (FY01). This system will be integrated fully with the ISM System and will help LANL move beyond compliance toward its stated zero-incidents goals. The EMS will be based on the principles of International Standards Organization (ISO) 14001.

The environmental component of ISM (ISM-E) can identify all of the Laboratory's environmental aspects (activities, products, and services that can interact with the environment), evaluate each aspect with regard to its magnitude and severity, and prioritize the aspects accordingly. Options and business cases can be developed to mitigate the highest-priority aspects. In this way, the environmental aspects of Laboratory operation can be managed efficiently and cost effectively to protect the environment. Pollution prevention and waste management also should not compromise either productivity or product quality. Indeed, successful implementation of good pollution prevention practices should increase both productivity and quality because waste is a manifestation of lost productivity.

2.0. DESCRIPTION OF THE ENVIRONMENTAL STEWARDSHIP PROGRAM

The Stewardship Program is managed by the Environmental Stewardship Office (ESO) of the Environmental Science and Waste Technology Division (E Division). However, environmental stewardship is the responsibility of every person working at the Laboratory. The Stewardship Program is based on a systems understanding of Laboratory operations and is summarized through an environmental stewardship roadmap, of which this document is the 2000 version. The Environmental Stewardship Program is responsible for pollution prevention and waste minimization on site.

The Laboratory will upgrade environmental protection in the ISM System. The resulting management system will satisfy the requirements of Executive Order (EO) 13148.

The ISM-E upgrade, using ISO 14001 as a benchmark, will result in sensible intermediate steps being taken toward the zero-incident goals, such as more effective pollution prevention, recycling, reuse, and waste processing. These intermediate steps will reduce the Laboratory's environmental footprint significantly. Implementation of the EMS will allow LANL to go beyond compliance and invest in environmental excellence wherever that investment cost-effectively eliminates the source of environmental impacts.

2.1. Methodology

Currently, the environmental stewardship goals are being met by two complementary actions. First, individuals across the Laboratory are evaluating their operations and making process improvements that reduce the possibility of environmental impacts. A significant fraction of the Laboratory's recent waste minimization success is the result of many small improvements instituted by individuals "doing the right thing." Second, the stewardship goals are being met through an organized, Laboratory-wide Environmental Stewardship Program. This program identifies site-wide opportunities for reducing waste and pollution, organizes metrics for environmental aspects and impacts, analyzes Laboratory operations as a system, identifies the most cost-effective opportunities, and implements these processes. Both the actions of individuals and the Laboratory-wide program are necessary to achieve the stewardship goals.

In the future, the Laboratory-wide environmental goals will be established and met through the active application of ISM-E. This approach is expected to allow a more systematic identification and evaluation of opportunities to reduce environmental impacts cost effectively.

This FY00 roadmap focuses on the most significant stewardship opportunities as identified through systematic process analysis. Implementing these opportunities will not take the

Laboratory to zero waste, but it will lead to significant reductions. As these most significant opportunities are addressed, future versions of the roadmap will address the next most-significant opportunities.

2.2. Summary of Regulatory Drivers

The Environmental Stewardship Program and the stewardship goals are not only good practice and good business, they satisfy several requirements and regulations for pollution prevention and waste minimization programs and plans as well. These requirements and regulations, which govern the operation of the Laboratory, are included in Appendices F and G of the DOE-UC contract. These environmental regulations arise from law, agency directives, EOs, and Laboratory policy. The regulatory drivers are summarized in Table 2-1.

The Laboratory reports (1) the status of its pollution prevention and waste management activities and (2) the progress toward established environmental goals to several regulatory agencies. The periodic reports required from the Laboratory are listed in Table 2-2.

2.3. Relevant Documents and Links

Documents relevant to environmental stewardship at LANL include the following.

1. *Los Alamos National Laboratory; 1998, Environmental Stewardship Roadmap*; LA-UR-99-6321, available at http://emeso.lanl.gov/emeso.lanl.gov_info/publications/publications.html.
2. *Los Alamos National Laboratory; 1999, Environmental Stewardship Roadmap*; LA-UR-99-6321; available at http://emeso.lanl.gov/.
3. *Site Pollution Prevention Plan for Los Alamos National Laboratory*; LA-UR-97-1726; available at http://emeso.lanl.gov/.
4. *Los Alamos Strategic Overview 1996–2015*, available at http://www.lanl.gov:80/labview/org/planning/docs.html.
5. *Tactical Plan*, available at http://lib-www.lanl.gov/la-pubs.
6. *Institutional Plan 1999–2004*, available at http://lib-www.lanl.gov/la-pubs/00460118.pdf.
7. UC Performance Measure Quarterly Reports; available at http://emeso.lanl.gov/useful_info/publications/publications.html.

Table 2-1. Regulatory Drivers for Environmental Action

Driver Type	Driver Code	Driver Title
Law	CAA	Clean Air Act
Law	CWA	Clean Water Act
Regulation	29 CFR 1910	Hazardous Waste Operations
Order	DOE 5400.1	General Environmental Protection Program
Order	DOE 5820.2A	Radioactive Waste Management
Order	DOE 231.1	Environmental Safety and Health Reporting
Order	DOE 5400.5	Radiation Protection of the Public and the Environment
Order	DOE 5480.19	Conduct of Operations Requirements for DOE Facilities
Order	EO 131XX	Greening the Government through Leadership in Environmental Management
Order	EO 1310	Affirmative Procurement
Policy	DOE 450.1	Pollution Prevention in Integrated Safety Management
Policy	LANL SWEIS	LANL Site-Wide Environmental Impact Statement
Policy	LANL ISMPDD	Integrated Safety Management Program Description Document
Policy	LANL AM 703	Health, Safety, and Environment
Guidance	DOE	Pollution Prevention Planning Guidance
Guidance	DOE	EO 13148 Implementation Direction
Guidance	DOE	Environmental and Energy Efficiency Leadership Goals for FY00 and Beyond

Table 2-2. Required Reports

Report	Frequency
DOE Site Pollution Prevention Plan	Triennially
DOE Affirmative Procurement Report	Annually
DOE Annual Waste Generation Report	Annually
Certified RCRA Waste Minimization Plan	Annually
Appendix F: Performance Measure Self Assessments	Quarterly
Government Performance Results Act	Quarterly
DOE Pollution Prevention Program Report	Quarterly

8. *The Site Wide Environmental Impact Statement for the Continued Operation of Los Alamos National Laboratory*, DOE/EIS-0238 (January 1999).

9. *Los Alamos National Laboratory Options Study Report on Action Plan for Upgrading Electrical Power System Reliability and Import Capability*, Los Alamos National Laboratory report LA-UR-99-3788 (July 1999).

Other documents of interest may be found on the ESO homepage at http://emeso.lanl.gov/useful_info/publications/publications.html or the ESH Division homepage at http://drambuie.lanl.gov:80/.

Other Laboratory Web sites relevant to Environmental Stewardship include the following.

- Affirmative Procurement: http://emeso.lanl.gov/projects/affirmproc/default.htm.
- Recycling: http://emeso.lanl.gov/recycling.htm.
- Equipment available for reuse: http://datawarehouse.lanl.gov.

3.0. ASSUMPTIONS USED IN ENVIRONMENTAL STEWARDSHIP PLANNING

3.1. Operational Assumptions

In compliance with the DOE Pollution Prevention Plan Guidance, the Environmental Stewardship Program defines the following assumptions for the Los Alamos site.

3.1.1. Laboratory Operations

- The Laboratory will be the primary DOE facility for plutonium research and development and for plutonium processing.
- The Laboratory will execute the following major activities:
  - research and development;
  - stockpile stewardship and management, including remanufacturing of weapons components and stockpile surveillance;
  - stabilization of weapons production residues in response to Defense Nuclear Facility Safety Board Recommendation 94-1 (DNFSB 94-1);
  - workoff of legacy wastes;
  - environmental restoration of historically contaminated areas;
  - decontamination and decommissioning of obsolete facilities; and
  - disposal of legacy wastes.
- An increasing fraction of Laboratory waste-producing activities will be subcontracted.

3.1.2. Waste Generation

- Growth of Laboratory operations will continue and will tend to increase waste generation and resource consumption.
- DOE and UC goals and performance measures will require reductions in waste generation and resource consumption.
- Funding will be adequate to meet the goals and performance measures.

3.1.3. Environmental Management

- A strong corporate pollution prevention effort will remain a Laboratory and DOE priority.
- The DOE will increase its emphasis on site-specific pollution prevention performance measures.

- The Generator Set-Aside Fee (GSAF) Program will continue.
- Implementation of EO 13148 will require that the Laboratory upgrade environmental protection in the ISM System.
- Adequate funding will be made available for environmental stewardship at the Laboratory.

3.2. Budget Assumptions

Approval of the budget request for FY01–02 Environmental Stewardship Programs (including pollution prevention) is assumed. Environmental stewardship funding will be adequate to meet the institution's goals and to meet the pollution prevention and waste minimization performance measures. This includes funding for Return on Investment projects.

3.3. Organizational Descriptions and Commitments

The Laboratory Director has delegated responsibility for leading pollution prevention and environmental stewardship efforts for the Laboratory to the Director of the Environmental Science and Waste (E) Technology Division. E Division has established an ESO to lead the Laboratory's pollution prevention effort. The ESO disseminates data on the generation of waste and pollution, establishes incentives for pollution prevention, and brokers pollution prevention investment projects. The ESO also reports Laboratory pollution prevention performance and plans to the DOE. Each major waste- or pollution-generating division is responsible for organizing its own pollution prevention plan, process, and implementation.

LANL has developed, and uses as a guiding blueprint, a strategic plan for the next 5 yr. The current LANL strategic plan sets out major programmatic objectives and strategies. It also identifies environmental objectives related to most LANL major goals. In addition, a major objective of demonstrating operational excellence in all activities specifically calls out the following strategies.

- Achieve measurable improvements in safety and environmental stewardship through full implementation of the ISM Program throughout the Laboratory.
- Manage wastes and hazardous legacy materials effectively and accept the challenge of minimizing the generation of hazardous wastes in the future, with a long-term direction toward zero emissions.

Each year LANL also produces an Institutional Plan, a 5-yr perspective on Laboratory operations. This document identifies strategic requirements for LANL organizational units;

summarizes strategic, tactical, and programmatic plans; and helps ensure the integration of LANL activities and DOE priorities.

In partnership with the DOE, UC has developed specific overall performance goals for LANL, which are contained in Appendix F of the operating contract, that emphasize the results most important to the DOE on an annual basis (see Fig. 3-1). Each year, LANL renegotiates this set of specific performance measures in 10 administrative and operational functional areas, one of which is environmental restoration and waste management, with the DOE and UC.

The performance measures found in Appendix F of UC's operating contract provide clear expectations, increase accountability, and improve customer relations by addressing performance issues that concern the DOE. Appendix F contains approximately 100 specific performance measures and associated goals. Over 24 of those measures fall within the functional area of environmental restoration and waste minimization. Many more measures directly related to environmental excellence fall within the functional area of ESH. The negotiation steps for these measures, the process to set priorities, the improvement steps, and the resulting evaluations all help focus resources on key business processes, improve operational quality, and reduce external oversight by sharing performance results with key customers.

Appendix F requires an annual self-assessment and evaluation by both the DOE and UC, but LANL senior managers also meet quarterly with UC and DOE representatives to discuss current

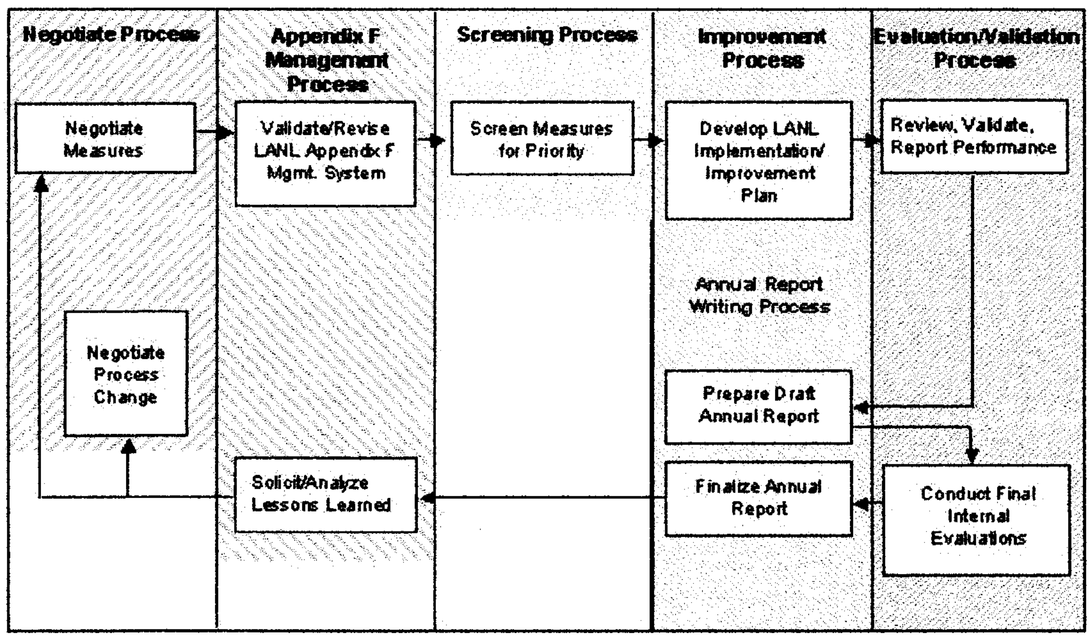


Fig. 3-1. Appendix F process (18-month continuous cycle).

progress against goals and to identify any issues. This regular and frequent interaction helps prevent surprises; mitigate problems; and create a cooperative, rather than an adversarial, atmosphere.

The Appendix F process is a key performance indicator of our contractual requirements and also is a measure of customer satisfaction. Managers monitor progress related to project and performance goals and use that information to develop and/or modify operational plans and to identify areas for improvement. Specific performance measures and progress in meeting these measures will be detailed as a part of each waste type description later in this document.

LANL's E Division maintains extensive databases related to environmental information for the Laboratory as an institution and for individual divisions and groups. These data include measurement of progress toward goals for waste minimization for various waste types.

To ensure an adequate safety envelope and compliance with laws and regulations, facilities at the Laboratory must produce several operations plans, including the following.

- Facility management plans
- Configuration management plans
- Facility safety plans
- Quality assurance plans
- Emergency action plans
- Training program descriptions and job analyses
- Maintenance implementation plans

All of the above plans represent a process that is integral to ensuring that high-quality work is accomplished with minimal risk to the worker, the worker's peers, the surrounding communities, and the environment.

The Laboratory implemented environmental protection as part of the initial ISM implementation. This initial implementation focuses on ensuring that Laboratory operations comply with applicable laws and regulations. The ISM Program requires continuous improvement of the ISM System. Over the next 18 months, the ISM System will be upgraded so that it satisfies the EMS requirements stated in EO 13148 and the DOE guidance implementing that order. The EMS will be the environmental component of ISM. The most significant element of the upgrade is broadening the scope of environmental protection to address the full range of environmental impacts from Laboratory operations. The ISM-E that will be implemented as a result of this upgrade will be derived from the ISO requirements. ISO 14001 is the most mature, validated EMS available.

4.0. TRANSURANIC WASTE

4.1. Introduction

Transuranic (TRU) waste is waste containing more than 100 nCi of alpha-emitting TRU isotopes per gram of waste, with half-lives greater than 20 yr (atomic number greater than 92), except for (1) high-level waste (HLW); (2) waste that the DOE has determined, with the concurrence of the Administrator of the Environmental Protection Agency (EPA), does not need the degree of isolation required by 40 CFR 191; or (3) waste that the US Nuclear Regulatory Commission (NRC) has approved for disposal on a case-by-case basis in accordance with 10 CFR 61. TRU waste is generated during research, development, nuclear weapons production, and spent nuclear fuel reprocessing.

TRU waste has radioactive elements such as plutonium, with lesser amounts of neptunium, americium, curium, and californium. These radionuclides generally decay by emitting alpha particles. TRU waste also contains radionuclides that emit gamma radiation, requiring it to be managed as either contact handled or remote handled. Approximately half of the TRU waste analyzed is mixed TRU (MTRU) waste, containing both radioactive elements and hazardous chemicals regulated under the Resource Conservation and Recovery Act (RCRA).

The DOE has ~68,000 m^3 of stored TRU waste that can be retrieved and expects to generate ~64,000 m^3 over the next 20 yr (excluding TRU waste that could be generated as a result of environmental restoration activities), for a total of ~132,000 m^3. TRU waste is disposed of at a geologic repository called the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico.

TRU waste at the Laboratory can be classified as either legacy waste or newly generated waste. Legacy waste is that waste generated before September 30, 1998. DOE Environmental Management (DOE/EM) is responsible for disposing of this waste at WIPP and for all associated costs. Newly generated waste is defined as waste generated after September 30, 1998; DOE/Defense Programs (DOE/DP) is responsible for disposing of this waste at WIPP. This roadmap focuses only on the newly generated wastes. Within this broad category, newly generated wastes are subdivided further into solid and liquid wastes, as well as routine and nonroutine wastes. Solid wastes include cemented residues, combustible materials, noncombustible materials, and nonactinide metals. Liquid wastes comprise effluent solutions associated with the nitric acid and hydrochloric acid plutonium-processing streams. Because of the final pH of these streams, they are also referred to, and are reported as, the acid and caustic waste streams, respectively. Routine waste is defined as waste produced from any type of production operation, analytical and/or research and development (R&D) laboratory operations; treatment, storage, and disposition facility operations; "work for others"; or any other periodic and recurring work that is considered ongoing in nature.

Nonroutine is defined as one-time operations waste: wastes produced from environmental restoration program activities, including primary and secondary wastes associated with retrieval and remediation operations; legacy wastes; and D&D/transition operations. TRU and MTRU wastes are reported separately because of the differing characterization requirements applied to them. These requirements are detailed in the RCRA and the Federal Facilities Compliance Order/Site Treatment Plan (FFCO/STP). The top-level process map for TRU waste is shown in Fig. 4-1.

The total volume of TRU waste generated by the Laboratory is shown in Fig. 4-2 and identified as routine, nonroutine, and environmental remediation waste. The Environmental Remediation/Decontamination and Decommissioning (ER/D&D) Program has produced TRU

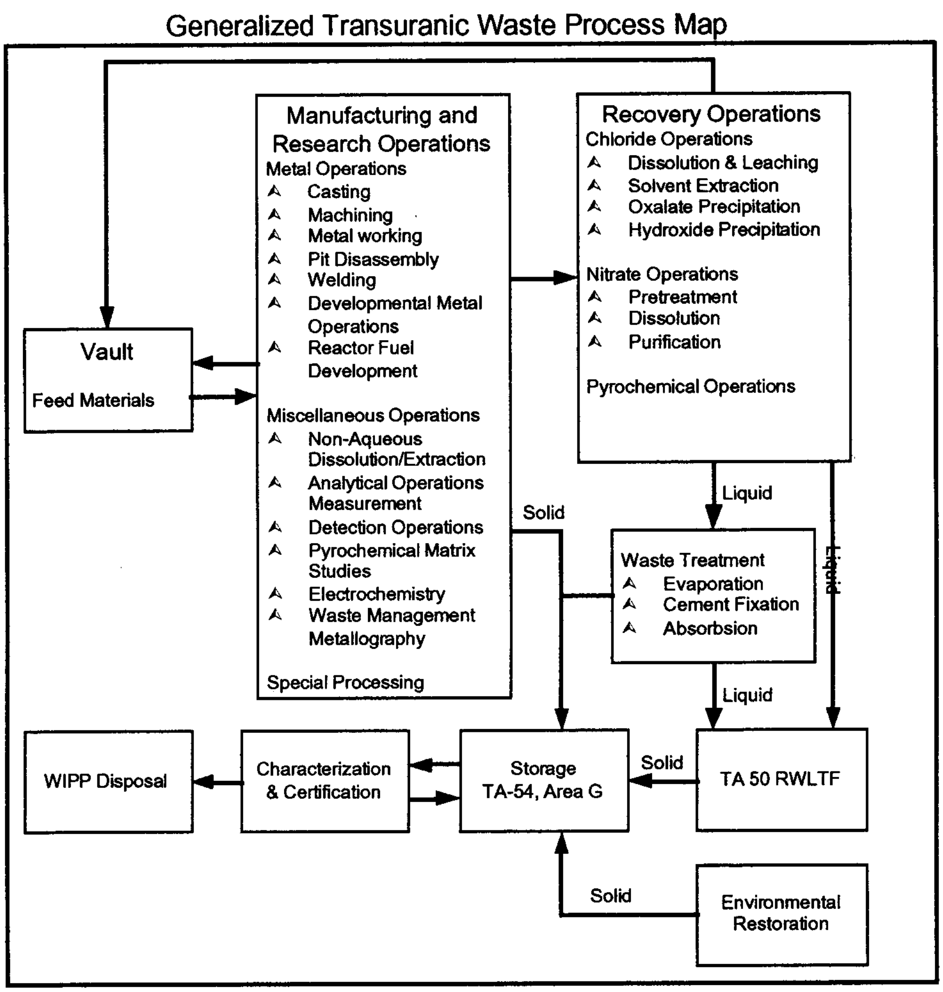


Fig. 4-1. Top-level TRU waste process map and waste streams.

waste intermittently, related directly to the area or facility being remediated or decommissioned. In FY97, significant quantities were generated because of the D&D of TA-21, which was the old uranium and plutonium-processing site. No TRU waste has been produced by ER/D&D since then. On March 16, 2000, a radiological release of ^{238}Pu occurred near a glovebox in LANL's Plutonium Processing and Handling Facility (TA-55). As a result of the subsequent Type A Accident Investigation and the response to that investigation, work within TA-55 was curtailed for the remainder of FY00. The curtailment of operations resulted in an artificially low TRU waste generation rate for FY00.

The majority of the TRU wastes generated at the Laboratory are associated with the Stockpile Stewardship and Management Program, the MilliWatt Heat Source Program, and nuclear materials R&D. NMT Division is the principal waste generator responsible for these programs, which are conducted at the Plutonium Facility (TA-55-PF4) and the CMR Facility (TA-3, Building SM-29). The MilliWatt Heat Source Program is the sole producer of ^{238}Pu-contaminated TRU waste. A small quantity of TRU waste is produced from waste characterization activities required for waste disposal at WIPP. The Environmental Technologies (ET) group of the Environmental Science and Waste Technologies (E) Division (called E-ET) performs these characterization activities.

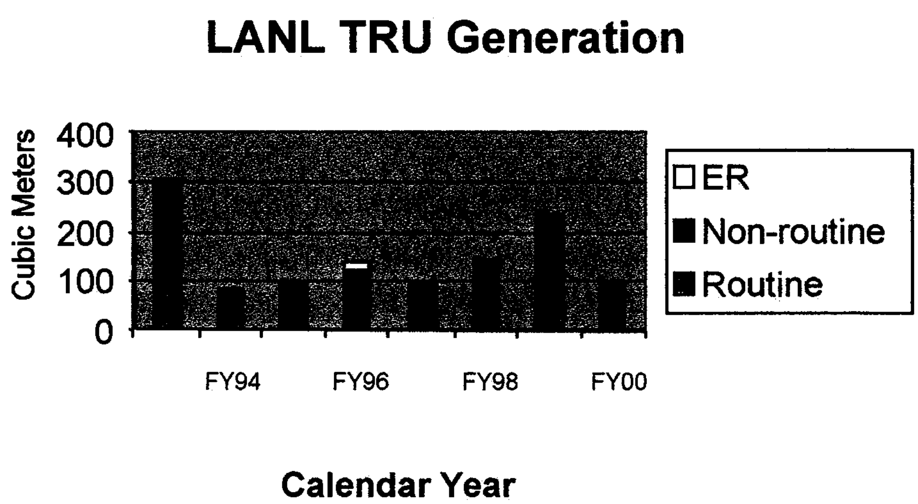


Fig. 4-2. Generation rates for TRU waste at LANL.

*All data are for calendar years (CYs) because the annual report (until 2000) was based on the CY.

*1993–1995 data obtained from EM/ES: 96-350 letter of baseline corrections submitted to the DOE in December 1996.

*1996–1999 data obtained from previous reports to the DOE on waste generation, stored in the "twilight.saic" database.

*2000 data obtained from SWO database "swoon" and will be reported to the DOE this year in the waste generation report.

Figure 4-3 shows total routine and nonroutine TRU and MTRU waste-generating organizations by relative volume of waste generated. All of the E-ET TRU waste is nonroutine, and the Facility and Waste Operations Division (FWO) waste is solid waste generated from the treatment at the RLWTF of the NMT Division acid and caustic waste streams.

4.2. TRU Waste Performance

The DOE 2005 Pollution Prevention goals require that the DOE complex reduce "routine" TRU/MTRU waste generation by 80% to <141 m^3 by 2005. LANL's allocation of that 141 m^3 has not been determined. However, LANL must reduce its present generation rate if the DOE is to achieve that goal. Between 1993 and 1998, the amount of TRU waste generated by LANL increased from 76.7 to 121.7 m^3 (58%). The volume of routine TRU waste produced by LANL has been increasing recently as a result of increased TRU waste processing. To help achieve the DOE complex-wide goal, LANL set an FY01 performance measure that includes submittal of an integrated TRU Waste Minimization Management Plan and no increase in routine TRU waste generation over a 1999 baseline of 122.3 m^3. The integrated TRU Waste Minimization Management Plan will include project descriptions, required technologies, cost, cost savings, waste reduction estimates, and implementation issues for a comprehensive set of routine waste avoidance/minimization activities at LANL TRU waste generating facilities. This plan will show how LANL can meet DOE goals in the reduction of TRU waste and impact readiness in technical base and facilities, campaign/construction, and directed stockpile work positively.

The recent trend in TRU/MTRU waste generation is shown in Fig. 4-4. The goal shown is the 80% reduction from the CY93 baseline. It is clear that LANL will have to take aggressive pollution prevention and waste minimization measures to meet the goal.

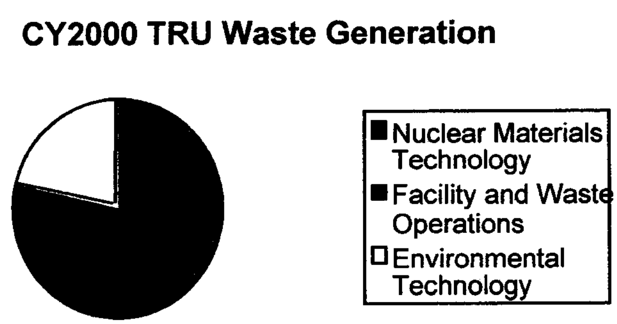


Fig. 4-3. TRU and MTRU waste generating organizations.

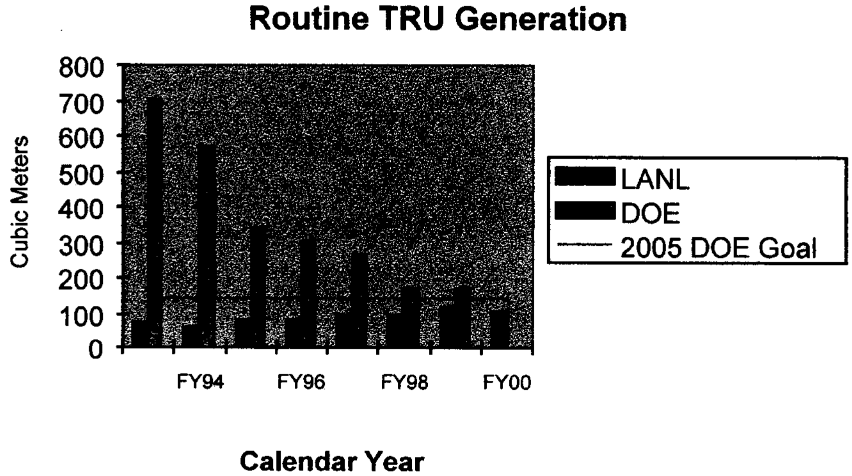


Fig. 4-4. TRU waste generation by CY.

*The DOE 2000 total volume is not yet available. The CY00 volume for LANL is partial-year (8-month) data.

4.3. Waste Stream Analysis

TRU wastes are generated within radiological control areas (RCAs). These areas also are material balance areas (MBAs) for security and safeguards purposes to prevent the potential diversion of special nuclear material (SNM). TRU and MTRU wastes are reported separately because of the different characterization requirements for the wastes. These requirements are detailed in the RCRA and the FFCO/STP—New Mexico Environment Department (NMED), which stipulates treatment requirements for MTRU wastes. In CY99, WIPP received a "No Mitigation Variance," which allows it to accept MTRU waste for disposal without treatment. However, the characterization requirements for MTRU waste remain. MTRU waste can be shipped to WIPP without treatment, except as needed to meet storage and transportation requirements. In the following sections, TRU/MTRU wastes will be discussed as one waste type because the waste minimization strategy for both waste types is the same. When this document was prepared, the final MTRU waste volume for CY00 was not available; however, as shown in Fig. 4-5, the MTRU waste stream in CY99 was 24% of the routine TRU waste and 53% of the nonroutine TRU waste. The MTRU waste generated in CY00 is expected to follow this trend.

The TA-55 Plutonium Facility processes ^{239}Pu from residues generated throughout the defense complex into pure plutonium feedstock. The manufacturing and research operations performed at TA-55 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 is practical. These recovery operations, as well as associated maintenance operations, and TA-55 plutonium research are the sources of TRU waste generated at TA-55.

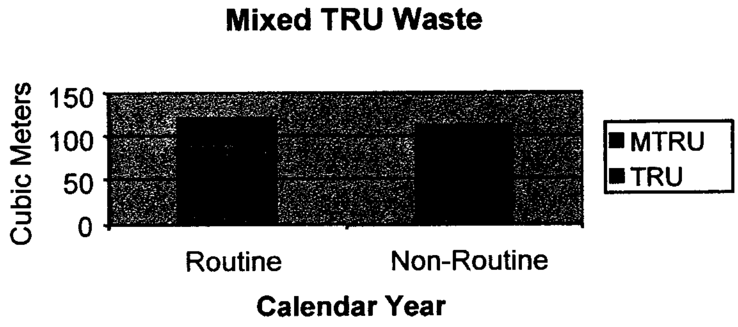


Fig. 4-5. The proportion of LANL-generated mixed TRU waste.

TRU waste materials, process chemicals, equipment, supplies, and some RCRA materials are introduced into the RCAs in support of the programmatic mission. All SNM introduced into Building PF-4, TA-55 is stored in the vault in the PF-4 basement until needed for processing. Because of the hazards inherent in the handling, processing, and manufacturing of plutonium materials, all process activities involving plutonium are conducted in gloveboxes. High levels of plutonium contamination can build up on the inside surfaces of gloveboxes and process equipment as a result of the process or because of leaking process equipment. All materials being removed from the gloveboxes must be multiple-packaged to prevent the spread of contamination outside the glovebox. Currently, all material removed from gloveboxes is considered to be TRU waste. 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.

Process residues with plutonium contamination less than the Safeguards Termination Limits (STLs) and cemented evaporator bottoms are other solid TRU wastes generated during operations. Process residues exceeding the STL values are returned to the vault for storage and future reprocessing. During FY98 through FY00, ~59,087 kg of solid TRU waste was generated by NMT Division. The percentage breakdown of that waste is shown in Fig. 4-6.

The TRU waste stream is the result of Laboratory missions focused on the Stockpile Stewardship and Management Program, MilliWatt Heat Source Program, and nuclear materials R&D. NMT Division is the predominant generator of TRU wastes. In their efforts to reduce plutonium-contaminated waste generation and to minimize the total quantity of plutonium discarded annually, NMT Division has committed to a path forward, and the NMT Division philosophy and expectations for environmentally conscious plutonium processing are presented in the NMT Division Waste Management Program Plan. The goals of this plan are to reduce liquid waste by 90% and to essentially eliminate the combustible waste stream by CY03. Both plans made

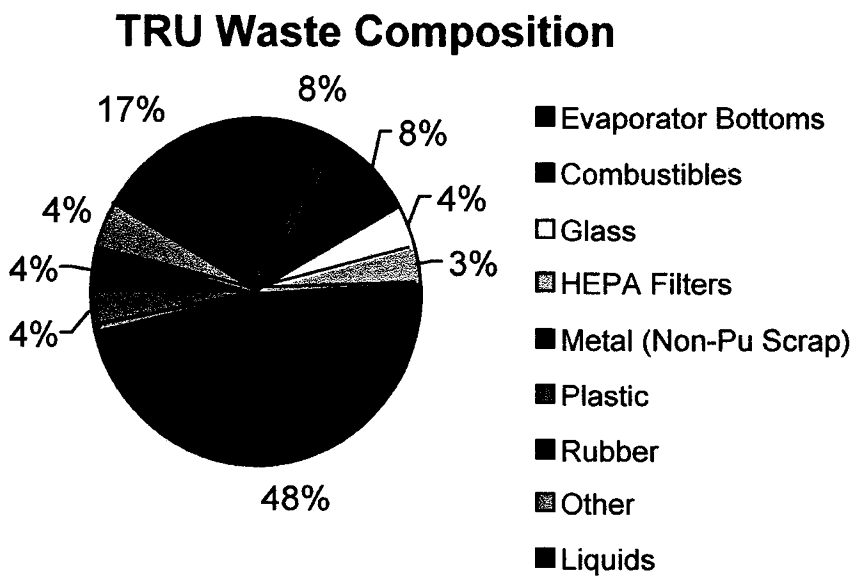


Fig. 4-6. Composition of TRU waste from NMT Division, FY98 through FY00.

assumptions regarding annual funding levels and programmatic priorities and thus must be updated periodically. In FY01, NMT Division has committed to the preparation of an integrated TRU Waste Minimization Management Plan that will include project descriptions, required technologies, cost, cost savings, waste reduction estimates, and implementation issues for a comprehensive set of waste avoidance/minimization activities specific to NMT Division operations.

NMT Division, E-ET, and FWO Waste Facilities Management Group (WFM) all generate TRU waste. Effective waste minimization must begin at TA-55 because the TRU waste produced at the TA-50 RLWTF is a direct result of treating TA-55 caustic and acid waste streams and because the E-ET TRU waste results from characterizing and certifying NMT-Division-produced waste (both legacy and newly generated).

Combustible Wastes: Combustible wastes comprise ~10% of the solid TRU waste generated at the Laboratory. For the MilliWatt Heat Source Program, combustible solids account for almost 90% of the TRU wastes contaminated with ^{238}Pu, for which there is currently no disposal pathway. In all instances, combustible waste comprises mostly plastic bags, plastic reagent bottles, plastic-sheet goods used for contamination barriers, organic chemicals and oils, cheesecloth, gloves, and protective clothing worn by workers.

Noncombustible TRU Waste: Noncombustible TRU wastes comprise materials that prohibit thermal decomposition treatment because they are mixed metallic, glass, graphite, or other noncombustible materials.

Nonactinide Metals: Nonactinide metals are any metallic waste constituents that may be contaminated with, but are not fabricated out of, actinide metals. Metallic wastes typically include tools, process equipment, glovebox structures, facility piping, and ventilation ducting. Significant volumes of metallic waste are generated under the following conditions: (1) when gloveboxes have reached the end of their useful life; (2) when processes within the facility and glovebox are changed; (3) when routine and nonroutine maintenance activities are completed; and (4) as facility construction projects are implemented to meet new programmatic missions.

Cemented Wastes: Cemented wastes are those acidic and caustic processing sludges and oxalate precipitation residues that contain levels of plutonium exceeding the STLs but containing less than the values requiring reprocessing. Before being discarded, the residues must be immobilized to minimize their potential attractiveness for diversion. Cementation meets this immobilization requirement. The high concentrations of actinides in this sludge frequently exceed the thermal wattage limit for WIPP disposal and require dilution by as much as a factor of five to meet certification requirements. NMT Division has been pursuing several alternatives to resolve this issue.

Caustic Liquid Waste: Caustic liquid waste results from the final hydroxide precipitation step in the aqueous chloride process. Feedstocks for this process typically are anode heels, chloride salt residues, and other materials having a relatively high chloride content. Efforts are underway to upgrade the throughput capabilities of the aqueous chloride process to handle the increased quantities of chloride residues that will result from workoff under the 94-1 Residue Stabilization Program. Over the next 3 to 5 yr, throughput quantities are expected to double. Caustic process liquids are transferred to the TA-50 RLWTF for final processing via the caustic waste line.

Acidic Liquid Waste: Acidic liquid waste is derived from processing plutonium feedstock with nitric acid for matrix dissolution. Following oxalate precipitation, the effluent is sent to the evaporator, where the overheads are removed and sent to the acid waste line for further processing. Evaporator bottom sludge is cemented into 55-gal. drums for disposal.

TRU solid wastes are accumulated, initially assayed, and characterized at the generation site. TRU solid waste is packaged for disposal in metal 55-gal. drums, 4-x-4-x-6-ft standard waste boxes (SWBs), and oversized containers. Security and safeguards assay measurements are conducted on the containers for accountability before they are removed from PF-4. The 55-gal. drums are stored in an auxiliary building at TA-55. The SWBs and oversized containers are staged on an asphalt pad behind PF-4 to await shipment to the waste characterization areas at TA-54 or TA-50. Detailed characterization of TRU wastes occurs at TA-54 Building 34, the Radioassay and Nondestructive Testing (RANT) facility, and at TA-50 Building 69, the Waste Compaction, Reduction, and Repackaging Facility (WCRRF). Samples from drums are sent to the CMR building for characterization in some cases. TRU waste is stored at TA-54, Area G, until it is shipped to WIPP for final disposal. Certification of the waste for transport and disposal at WIPP is the responsibility of the Environmental Science and Waste Technology Group of E Division. Waste shipments to WIPP began on March 25, 1999.

Liquid TRU wastes from the nitric acid (acidic) and hydrochloric acid (caustic) aqueous processes are transferred from TA-55 to the TA-50 RLWTF via separate, doubly encased transfer lines for processing and further removal of plutonium by flocculent precipitation. The precipitate is cemented into 55-gal. drums and transported to TA-54 for storage and ultimate disposal at WIPP as TRU solid waste. In FY00, ~11,660 L of liquid TRU waste was processed at the TA-50 RLWTF. Of this volume, 76% came from the acid waste stream and the remaining 24% from the caustic waste stream.

Costs for handling, storage, and disposal of TRU waste have been estimated at ~\$58,000/m^3 in FY00; these costs are expected to rise in the future because of increased costs of characterization, storage, and disposal.

4.4. Aspect Analysis

To evaluate the TRU waste aspects for the Laboratory, the following scoring system was developed for environmental aspects. The scoring system ranks aspects based on damage to the environment, quantity, and probability of occurrence.

Based on this scoring system, the TRU waste aspects were evaluated for the various waste streams produced by NMT Division and E-ET. The aspect analysis presented here must be regarded as preliminary. The Laboratory will be developing a final aspect analysis and scoring system over the next several months. Once developed, the system will be used to score the Laboratory environmental aspects systematically. That analysis will supercede the analysis presented below. The results of the current evaluation are depicted in the Table 4-1.

Aspect Definition: Waste

General Information

This aspect definition sheet was developed for the TRU, LLW, MLLW, Sanitary, Hazardous, and Liquid LLW Streams at LANL.

Location of Activity Impact

Location of Impact	Description	Scenarios Considered	Type
Global	Beyond the United States (US)	1. None	N/A
Regional	Beyond LANL but within the US	1. Release to the Environment or No Path Forward	Normal/Abnormal
		2. Disposition to a Landfill	Normal
		3. Treatment to BRC or Elimination of the Hazard	Normal
		4. Destruction	Normal
		5. Reuse or Recycle	Normal
Local	At LANL	1. On-Site Release	Abnormal

Magnitude of Activity		Probability of Occurence	
Normal Scenario		*Abnormal Scenario*	
Toxicity*(Volume or Mass) Toxicity: Sanitary =1, LLW = 100, MLLW & Haz = 100–1000, TRU = 1000 Volume or Mass: cubic meters or metric tons			
High	Product >100,000	**High**	Occurs at least once per yr
Medium/High	Product 50,00–100,000	**Medium/High**	Occurs once every 1–10 yr
Medium	Product 10,000–50,0000	**Medium**	Occurs once every 10–100 yr
Medium/Low	Product 1,000–10,000	**Medium/Low**	Occurs once every 100–1000 yr
Low	Product <1,000	**Low**	Occurs only >1000 yr

Scale of Impact Definitions and Examples		High	Med./ High	Med.	Med./ Low	Low
1. Permanent:	Discharge of sufficient volume, duration, and toxicity to cause irreversible damage to the environment • Release to the Environment or No-Path-Forward Waste	1000	100	10	1	0.1
2. Significant:	Discharge of sufficient volume, duration, and toxicity to cause reversible damage to the environment • Disposal at a Regulated Landfill	100	10	1	0.1	0.01
3. Moderate:	Causes a change to the environment that requires long-term controls or corrective action • Treatment Below Regulatory Concern (BRC) or Elimination of the Hazard	10	1	0.1	0.01	0.001
4. Minimal:	Discharges of materials that are below the lowest regulatory threshold or, if not regulated by permit, have no known effect on the environment • Destruction	1	0.1	0.01	0.001	0.001
5. No Impact:	Negligible or no release to the environment • Reuse or Recycle	0.1	0.01	0.001	0.001	0.001

Table 4-1. TRU Waste Aspect Scores

Waste Stream	Activity	Magnitude Probability	Impact (Normal/ Abnormal)	Score (Normal/ Abnormal)
Liquid TRU waste	Weapons Production	Medium/Low Medium/Low	2 2	0.1 1
Metal (Non-Pu Scrap)	Weapons Production	Medium Medium/High	2 2	1 10
^{238}Pu Waste	Heat Source Production	Low Medium/High	1 1	0.1 100
Combustibles	Weapons Production	Low Medium/High	2 1	0.01 100
Cemented Waste	Weapons Production	Low Medium/High	2 3	0.01 10
Solidified Waste	RLWTF Solidification of NMT Liquid TRU waste	Medium Medium/High	2 2	1 10
Glass	Weapons Production	Low Medium/High	2 2	0.01 10
HEPA Filters	Weapons Production	Low Medium/High	2 1	0.01 100
Plastic	Weapons Production	Low Medium/High	2 1	0.01 100
Rubber	Weapons Production	Low Medium/High	2 1	0.01 100
Other Waste Streams	Weapons Production	Medium/Low Medium/High	2 2	0.1 10

Abnormal Aspect Analysis: The accident scenarios and probabilities that are documented in the Site-Wide Environmental Impact Statement (SWEIS) were used as the basis of the abnormal event scoring. The accident scenarios were screened to find those that both applied to TRU waste and had a high frequency of occurrence along with an offsite consequence. Those accidents would give the highest aspect scores for TRU waste. Many of the accidents involving TRU waste that were analyzed in the SWEIS had very low frequencies of occurrence. Two scenarios had frequencies of occurrence greater than once every 10 yr: the "Site-04" and "RAD-09." Site-04 is a wildfire scenario with a frequency of once every 10 yr. The plume created by the fire is the primary path for the offsite deposition of radioactive materials. Those waste types that are combustible were given an impact score of 1 because the radionuclides they contain could be transported off site in the plume and cause irreversible damage to the environment. Those that are considered noncombustible were given an impact score of 2 because the radionuclides they contain would probably remain within Area G and could be remediated.

The liquid effluent from TA-55 that is processed by TA-50 was assumed to be affected by accident scenario "SITE-01," which is the lowest level, site-wide earthquake analyzed across LANL. Although scenarios SITE-02, SITE-03, and SITE-04 have greater consequences because of the higher ground movement, the frequencies of those events are much lower and would result in a lower aspect score. SITE-01 has a frequency of once every 1000 yr and received a Probability of Occurrence Score of Medium/Low and a Scale of Impact of 1. The abnormal score for this scenario is 1 for the liquid waste.

The RAD-09 scenario is a failure or puncture of a drum of TRU waste at TA-54, Area G. The scenario includes an incident involving a drum of high-activity waste, which occurs once every 250 yr, and a drum of typical-activity TRU waste, which occurs once every 2.5 yr. The incident with the typical-activity TRU-waste drum has a negligible consequence and was not included in the aspect analysis. Because the frequency of the scenario with the high-activity waste drum is once every 250 yr, it has a probability of occurrence of medium/low. Although the consequence of that container extends beyond the facility boundary, it does not cause irreversible harm to the environment and received a scale of impact of 2. The abnormal score for this scenario is 1 for all waste streams except the liquid waste. Because this score is lower than that for the SITE-04 scenario, the SITE-04 score was used in all cases except the liquid waste.

Based on this scoring system, projects and activities that minimize the amount of TRU waste produced by NMT Division will be given priority in FY01. Minimizing the waste produced by NMT Division will minimize the downstream characterization and treatment activities performed by E-ET and WFM.

4.5. Improvement Projects

Many process improvements have been identified for implementation within TA-55 and in the processing of TRU waste after it is produced. Priorities for new waste minimization projects and activities within TA-55 will be detailed in the integrated TRU Waste Minimization Management Plan being prepared by NMT Division in FY01. Completed, ongoing, and unfunded projects are detailed in Sections 4.5.1, 4.5.2, and 4.5.3, respectively.

4.5.1. Completed TRU Waste Minimization Projects

1. TA-21 Ductwork Decontamination
2. Hydride-Dehydride Process for Plutonium Recovery
3. Salt Distillation for Plutonium Recovery
4. Dry Machining of Plutonium Parts

5. Fractional Distillation for HNO_3 Concentration
6. Advanced Disassembly Lathe (Bi-Sector)
7. Advanced Welding
8. Advanced Casting
9. Ion Exchange Resin for HNO_3 Line
10. Segregation of LLW, TRU, and Compacting TRU Waste
11. Mobile Nondestructive Assay (NDA) for Nonroutine Items
12. RCA Source Elimination
13. CMR Glovebox Decontamination
14. Aliquot Mold and Blending and Reduction of Plutonium Scrap in Alloying/Casting Operations
15. Scintillating Inline Alpha Counter
16. Advanced Technology Reduced Mass Casting Mold
17. CMR Ductwork Sprayhead Decontamination

4.5.2. Ongoing TRU Waste Minimization Projects (Partial List)

1. Vitrification System. The ESO Pollution Prevention Program is funding the fabrication, testing, and installation of a vitrification process for the TRU waste that currently is solidified with cement. The project provides the fabrication and installation of gloveboxes to house the vitrification equipment, the fabrication and operational testing of the vitrification system, and installation of the equipment within the gloveboxes in TA-55 PF-4. The Vitrification System will produce waste drums certifiable to WIPP waste acceptance criteria (WAC) and is expected to reduce the generation of TRU/MTRU cemented waste at a rate of 20 to 30 drums per year.

2. Gas Discharge Mass Spectrometer (GDMS). An in-line GDMS is currently under development, with funding through the GSAF program. This analytical instrument allows real-time analyses of metal feeds and castings. It not only enhances the process efficiency in the plutonium foundry but also reduces the amount of samples sent off site for analyses, the waste generated, and the reprocessing cost. The use of an inline GDMS will reduce operational costs and drastically reduce the TRU waste that would be produced in the wet chemistry analysis of these samples.

3. Plutonium Oxidation State Diagnostic for Chloride Line. This project is funded through the GSAF program and will implement a real-time, in-line capability to rapidly determine the plutonium oxidation state while a batch is in process by monitoring the visible light absorption spectrum of plutonium in solution. This diagnostic will use off-the-shelf, compact, reliable spectrometers. By providing a continuous knowledge of the plutonium oxidation state, this diagnostic will enable operators to adjust process conditions immediately if the oxidation state drifts. This process will eliminate most of the unacceptable batches, reducing operation costs and process waste generation by 5% to 10%. It also will reduce the consumption of reagents for oxidation state adjustment, which are commonly overused to compensate for uncertainty about the oxidation state. The primary waste stream that will be affected consists of 15,000 L/yr of neutralized TRU liquid waste (4.3 mCi/L average) that normally is piped to TA-50 for precipitation and solid waste disposal as TRU waste. A 5% reduction in the number of batches would eliminate 750 L (3.2 Ci) of this stream per year.

4. PF-4 Trichloroethylene (TCE) Upgrade. The processes for cleaning plutonium parts at TA-55 are undergoing a series of upgrades designed to reduce the amount of waste generated, reduce the exposure levels of the operator to both radiation and solvent, and aid in removing any inconsistencies in the level of cleaning. Central to these upgrades is the replacement of the ultrasonic bath currently in use with a mechanical spray washer developed by NMT-5. A second development designed to reduce the amount of waste generated further is the installation of a distillation recycle unit in conjunction with a fluorometer and pH meter to monitor the organic contaminant loading and TCE breakdown. Combined, these process modifications will reduce the annual volume of TCE waste by >95%. This project is funded through the GSAF program.

4.5.3. Unfunded Projects

1. Electrolytic Decontamination. The goal of the project is to continue the decontamination of gloveboxes being removed from service within TA-55 PF-4. Electrolytic decontamination reduces the level of contamination within the glovebox to allow the box to be reused either within PF-4 or by other organizations and facilities or to allow for disposal as LLW. Revised safety and operational documentation is required for the continued use of electrolytic decontamination.

2. Glove Improvement Project. Glovebox gloves protect workers from radiological contamination while they are working with nuclear materials. At LANL, about 50 gloves fail and about 490 are replaced each year. The typical failure results in facility contamination, worker exposure/contamination, waste generation, and work stoppage. This will result in a 50% reduction in glove failures. As part of this project, a common glove

procurement specification and glove testing protocol will be developed and implemented. A lead-free glove will be procured, tested, and implemented. A self-monitoring glove will be procured, tested, and implemented. A second glove source or vendor and a vendor quality assistance program will be established.

3. Radiolytically Induced Recombination of H_2 and O_2. Weapons-related activities at TA-55 produce TRU wastes that contain ^{238}Pu, ^{239}Pu, and ^{241}Am. High-wattage cemented TRU waste is more likely to generate hydrogen gas in concentrations that exceed the 5% lower-flammability limit for H_2 imposed by the DOT and the NRC. Drums are only partially filled so as not to exceed the prescribed wattage limit; this results in the shipment of a greater number of waste drums. This proposal will establish a feasible means of maintaining a low percentage of hydrogen in the headspace of TRU waste drums by effective use of the alpha-particle radioactivity in the waste. By selecting the proper geometric dimensions of a waste container, it may be possible to eliminate the hydrogen generation hazard. Successful use of the proposed packaging scheme for enhancing recombination of H_2 and O_2 will reduce the number of drums loaded for shipment to the WIPP significantly. This project will fabricate three reaction chambers that will contain plutonium/americium-cemented waste forms or configurations to determine the effectiveness of recombination with and without headspace.

4. Hot-Water Extraction for Characterization of Hazardous Compounds. The established methods for extraction and characterization of organic compounds were developed for nonradioactive wastes. When applied to TRU waste, those same methods were environmentally unfriendly, yielded poor analytical results, were expensive, exposed the analyst to radiological hazards, and produced an MTRU waste that currently has no path to disposal. The processes involving RCRA solvents will generate ~800 L of MTRU waste per year. This project will purchase off-the-shelf instrumentation to demonstrate the effectiveness of hot-water extraction (250°F water at a pressure of 1000 psi) for characterization of hazardous compounds. Successful implementation of this project will (1) eliminate a source of MTRU waste, (2) reduce characterization time and improve quality, (3) greatly enhance worker safety, and (4) reduce operational costs.

5. Dissolution Chemistry. The TA-55 Plutonium Facility processes ^{239}Pu from residues generated throughout the defense complex into pure plutonium feedstock. The manufacturing and research operations performed at TA-55 in the processing and purification of plutonium result in the production of plutonium-contaminated scrap and residues. The residues are processed to recover as much plutonium as practical, and the process step with the highest nuclear material loss is dissolution. Although the materials that are not completely dissolved are not lost, they are effectively trapped in a residue matrix that cannot be recovered or discarded and thus must be stored indefinitely. Dissolution chemistry

has been examined in the past without identifying successful techniques or new technologies that would successfully integrate into the nitrate-based process. This project would develop techniques to effectively dissolve contaminated materials to enhance recovery of plutonium.

6. Solid Surface Leaching Testing. This project would develop and implement sonication-aided surface leaching for decontamination of plutonium-contaminated materials. In addition to obtaining a better general understanding of dissolution chemistry, better solid surface leaching is needed, whether electrolytic (surface electrolytic decontamination or in baths), or sonic (sonication-aided leaching using proprietary surface penetration and wetting agents). This project includes conducting proof-of-principle experiments with a sonication system and the procurement and installation of sonication system equipment if the proof-of-principle activities are successful.

7. Polymer Filtration Equipment. This project would engineer and implement polymer filtration on the caustic waste stream from TA-55. Although the effluent and filtrate losses in the caustic and acid waste streams are generally of low concentration, the large volumes involved result in a significant loss. Demonstrated technologies are available but still require engineering development to be deployed successfully. Polymer filtration for the caustic stream is one such technology. Reducing the concentration and volume of the caustic liquid waste stream will reduce the processing required at the RLWTF and the amount of TRU waste produced by the RLWTF.

8. Development of Extraction Chromatography. This project would develop extraction chromatography for the nitric acid waste stream from TA-55. Although the effluent and filtrate losses in the caustic and acid waste streams are generally of low concentration, the large volumes involved result in a significant loss of nuclear material. Demonstrated technologies are available but still require engineering and development to deploy successfully. One such technology is the use of extraction chromatography for acid solutions. Reducing the concentration and volume of the caustic and acid waste streams reduces the processing required at the RLWTF and the amount of TRU waste produced by the RLWTF.

9. Development and Certification of Destructive Chemical Analysis. This project would implement advances in analytical chemistry and NDA to improve process control and material accountability. To maintain good process control, a significant and integrated level of analytical chemistry is required. Because of the lack of radiation signature from some of the materials, NMT Division must rely on destructive chemical analysis using estimates of the isotopic composition for routine process control and material accountability. Advances in analytical chemistry and NDA make elemental destructive assay available (no reliance on

isotopic input), as well as possible nondestructive solution assay advances that would be applicable to the material's isotopic makeup. Improvements in process controls will reduce the radioactive waste streams by reducing the amount of material requiring disposal and the concentration on radionuclides within the waste.

10. Pyrolysis of Plastics. This project will develop and demonstrate the pyrolysis of contaminated plastic materials to aid in the recovery of plutonium. For the most recent recovery campaigns, the host matrix containing the most material was plastic. Surface leaching techniques have not been successful, and sonication-aided leaching may not be amenable. Pyrolysis (high-temperature decomposition in the absence of oxygen) would be developed, demonstrated, and deployed to create an ash from the plastic that then would be processed by more aggressive dissolution techniques. Although pyrolysis has been developed and deployed for cellulose, it has not been modified for treating the wide variety of plastics generated in glovebox operations.

11. Casting Improvements. This project would develop and implement improved casting technologies to reduce the amount of feed material required. Improved efficiencies in the casting and manufacturing areas also could be important in reducing losses from those processing areas. In particular, near-net-shape casting would reduce the amount for feed material required for an experiment, and the development and deployment of a reusable casting mold would reduce waste and minimize the amount of residues requiring processing for material recovery. Reducing the amount of feed material required for an experiment will reduce the volume of LLW and TRU waste generated.

12. Improved Sorting and Segregation. Sorting and segregating of radioactive waste currently is performed at TA-55. This project would implement improved sort and segregation of glovebox waste at TA-55. This project is tied to the preliminary proposal for the installation of state-of-the-art NDA instrumentation. Improved sorting and segregation of waste at the generating facility will reduce the amount of TRU waste generated by ~6 m^3/yr.

13. CMR Assay and Compaction. This project would implement an assay and compaction process for glovebox waste at CMR. That improvement would reduce the generation of TRU/MTRU waste solid by up to 3 m^3/yr.

14. Hydrothermal Processing of Organic Chemicals. This project would complete the upgrade and installation of a Hydrothermal Processing System used to destroy organic chemicals. Use of the Hydrothermal Processing System will reduce the generation of TRU/MTRU waste organic compounds by ~0.4 m^3/yr.

15. State-of-the-Art NDA Instrumentation. This project would purchase and install state-of-the-art NDA instrumentation for the characterization of radioactive waste at TA-55. NDA is used to determine the radiological characteristics of TRU waste as part of the characterization process. Because of background radiation levels, the current instrumentation is not sensitive enough to distinguish clearly between LLW and TRU waste concentrations. This requires that the LLW be categorized as TRU waste until further characterization is performed at another facility. Those low-level radioactive wastes that previously were categorized as TRU waste are separated and removed from the TRU waste stream at this point in the characterization process. Proper characterization and separation of TRU waste materials from LLW will reduce the amount of TRU waste generated and resolve issues related to differences in data generated during the characterization of the waste and that data generated during the Safeguards and Security Assay at TA-55.

16. Lauderable Personal Protective Equipment (PPE) Pilot. This project would pilot the use of launderable PPE and plastic sheet goods used for contamination control. If successful, the launderable materials would replace their disposable counterparts. Use of launderable PPE will reduce the volume of radioactive waste produced.

17. Nonhalogenated Plastic Materials. This project would pilot the replacement of polyvinyl chloride (PVC)-based plastic goods with nonhalogenated plastics and polyvinyl alcohol (PVA) counterparts to reduce the corrosive off-gas produced during thermal decomposition. Use of PVA will allow the exploration of dissolution of the PVA PPE using commercially available technology at a throughput rate large enough to decompose much of the low-level combustible waste stream in addition to the TRU/MTRU waste volumes. If successful, replacement of the PVC materials will reduce the generation of combustible LLW, TRU, and MTRU waste.

18. NDA. To maintain good process control, a significant and integrated level of analytical chemistry is required. Because of the lack of radiation signature from some material, LANL must rely on destructive chemical analysis using estimates of the isotopic composition for routine process control and material accountability. Advances in analytical chemistry and NDA have made elemental destructive assay available (no reliance on providing isotopic input), as well as possible nondestructive solution assay advances that would be applicable to this unique material's isotopic makeup. This project will implement advances in NDA to improve process control and material accountability and includes equipment procurement and fabrication and software modification. Better process control will reduce the amount of material that must be processed as radioactive waste.

19. Crawler Technology. Cleanout of DYNEX containers is labor intensive, time consuming, and inefficient. Several initiatives are being considered to effect a more efficient and timely cleanout. A magnetic robotic crawler fixed with an air-driven wire brush as the scouring fixture is being evaluated. A small camera monitors the process, and the robot is controlled by telemanipulation. Removed particulate materials are collected with a compact vacuum cleaner. If successful, several enhancements are possible with this technology, including programming the robot's cleaning sequence to eliminate operator involvement different cleaning fixtures, including laser ablation and dry-ice blasting. This project would pursue improvements to the present system. This project will be especially important if larger containers are envisioned for future experiments. Improved clean-out techniques will reduce worker exposure and the amount of radioactive TRU waste generated.

5.0. LOW-LEVEL WASTE

5.1. Introduction

LLW is defined as waste that is radioactive and is not classified as HLW, TRU waste, spent nuclear fuel, or II(e)2 by-product materials (e.g., uranium or thorium mill tailings). Test specimens of fissionable material irradiated only for research and development 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.

Disposal of LLW is governed at the Laboratory by the LANL WAC, which also drives LLW reporting requirements. These criteria place limits on the physical, chemical, and radiological characteristics of acceptable LLW and are developed from DOE Orders, federal and state laws and requirements, and site characteristics. Laboratory Implementation Requirement (LIR) 404-00-05.1, *Managing Radioactive Waste,* provides guidance specific to LLW; and LIR 404-0002.2, *General Waste Management Requirements,* contains waste minimization requirements.

Figure 5-1 depicts the process map for LLW generation at the Laboratory and a pie chart showing the percent of the total LLW stream comprising each category (combustible waste, noncombustible waste, and scrap metal).

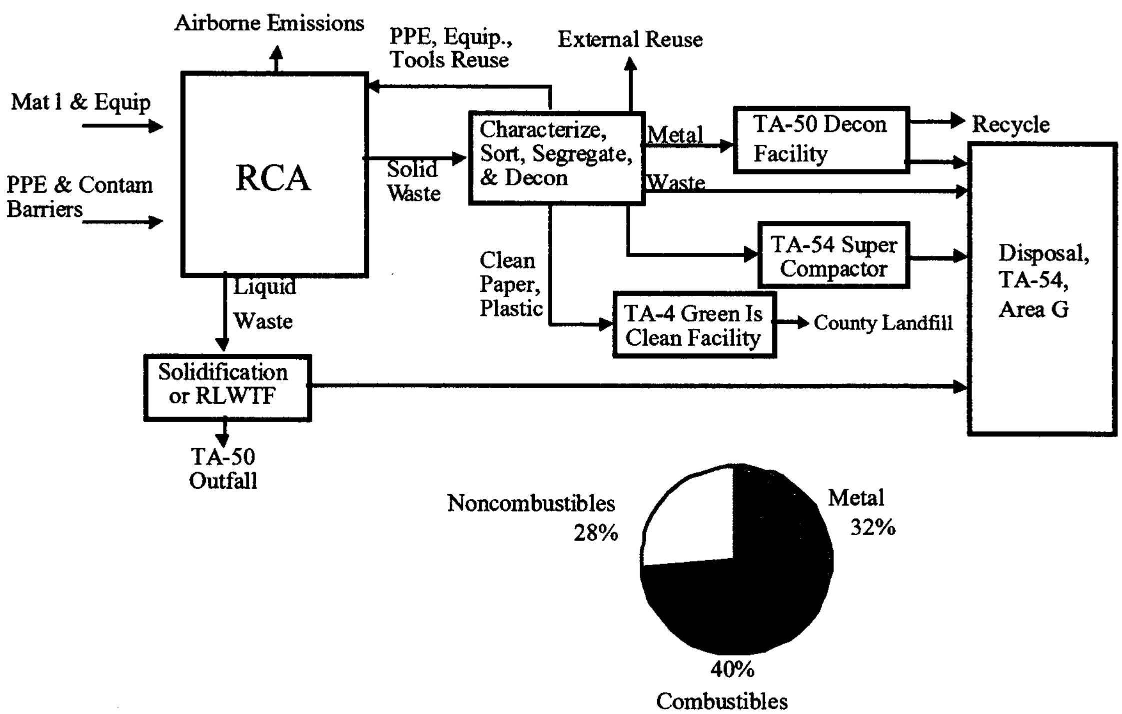


Fig. 5-1. Top-level LLW process map and waste stream chart.

LLW generation by division is depicted in the pie chart in Fig. 5-2.

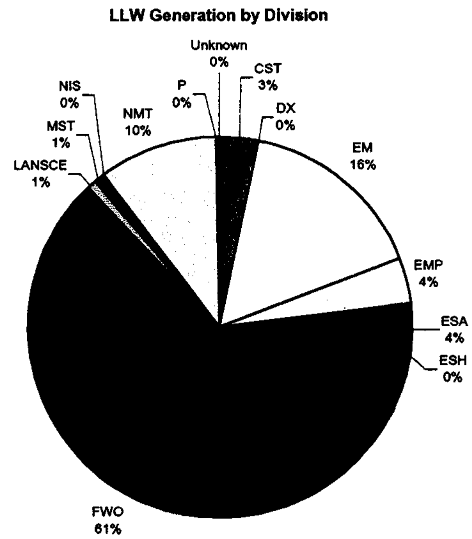


Fig. 5-2. LLW generation by division.

EM and FWO Divisions were by far the largest LLW generators in FY00. These large percentages were a result of the fire recovery efforts caused by the Cerro Grande fire in early May. A more accurate depiction of waste generation can be obtained by looking at routine LLW generation by division, as depicted in Fig. 5-3.

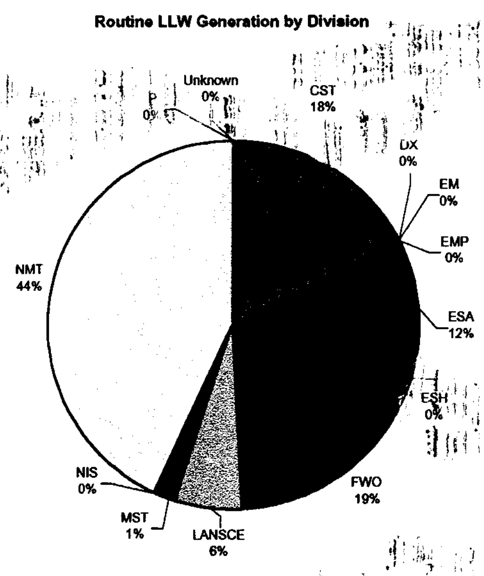


Fig. 5-3. Routine waste generation by division.

This figure clearly shows that NMT, Chemical Science and Technology (CST), FWO, and Engineering Sciences and Applications (ESA) Divisions are the largest waste generators under normal operating conditions.

The solid LLW generation values for each division are listed below.

Division	Routine (m^3)	Nonroutine (m^3)	Total (m^3)
CST	111.2	28	139.2
DX	0.025	0	0.025
EM	0	637.6	637.6
EMP	0	157.9	157.9
ESA	77.56	102.33	179.89
ESH	1.36	0.0001	1.3601
FWO	122.5	2313.45	2435.95
LANSCE	36.27	0	36.27
MST	9.36	19.98	29.34
NIS	3.02	0	3.02
NMT	273	131.02	404.02
P	0	4.79	4.79
Unknown	0.224	5.3	5.524

5.2. LLW Performance

The DOE has implemented goals for waste minimization. The DOE environmental leadership program will go beyond compliance requirements and be based on continuous and cost-effective improvements. To achieve these goals, the Laboratory will use an EMS to evaluate environmental aspects and define the highest-priority aspects and the most cost-effective solutions to reduce the environmental impacts from these aspects.

The LLW reduction goal for FY05 is to reduce waste from routine operations by 80% by 2005, which will be calculated using CY93 as the baseline, as required by the DOE. Figure 5-4 shows the Laboratory's routine and nonroutine waste generation rates. Figure 5-5 shows the Laboratory's success in achieving this goal. Figure 5-5 clearly illustrates that the Laboratory has exceeded the 2005 goal. In Figs. 5-4 and 5-5, the FY00 value for the volume of routine waste includes compaction. In previous years, the values did not include compaction.

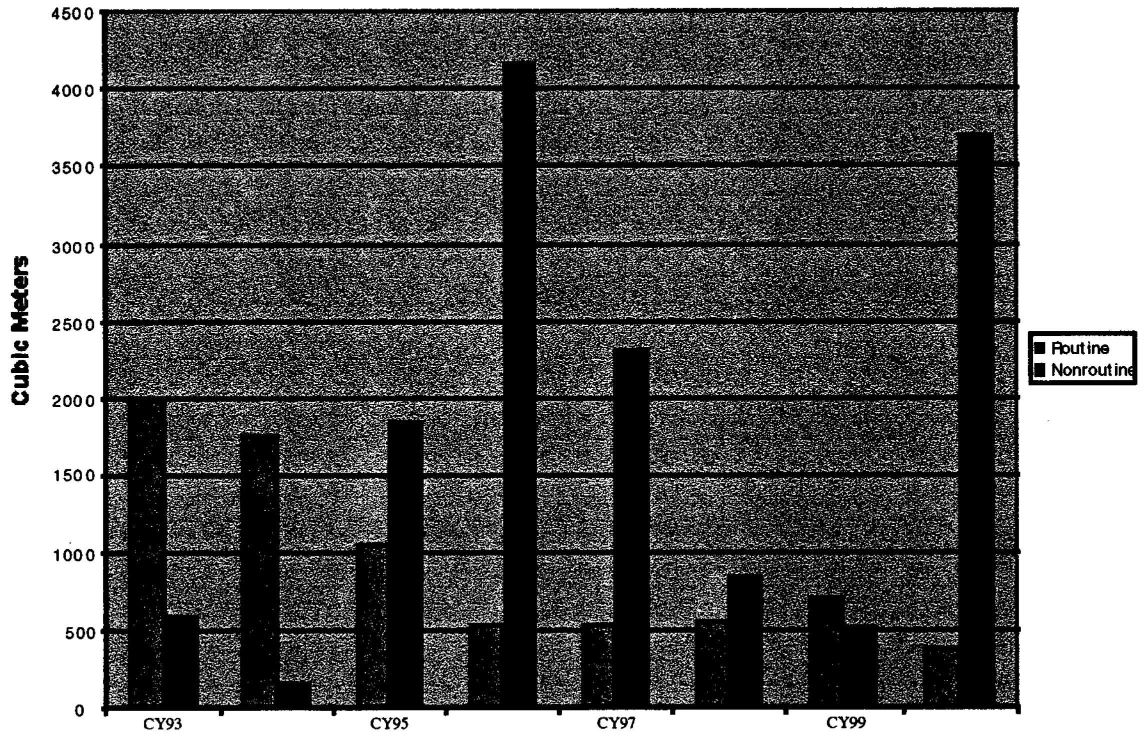


Fig. 5-4. LANL's routine and nonroutine waste generation rates.

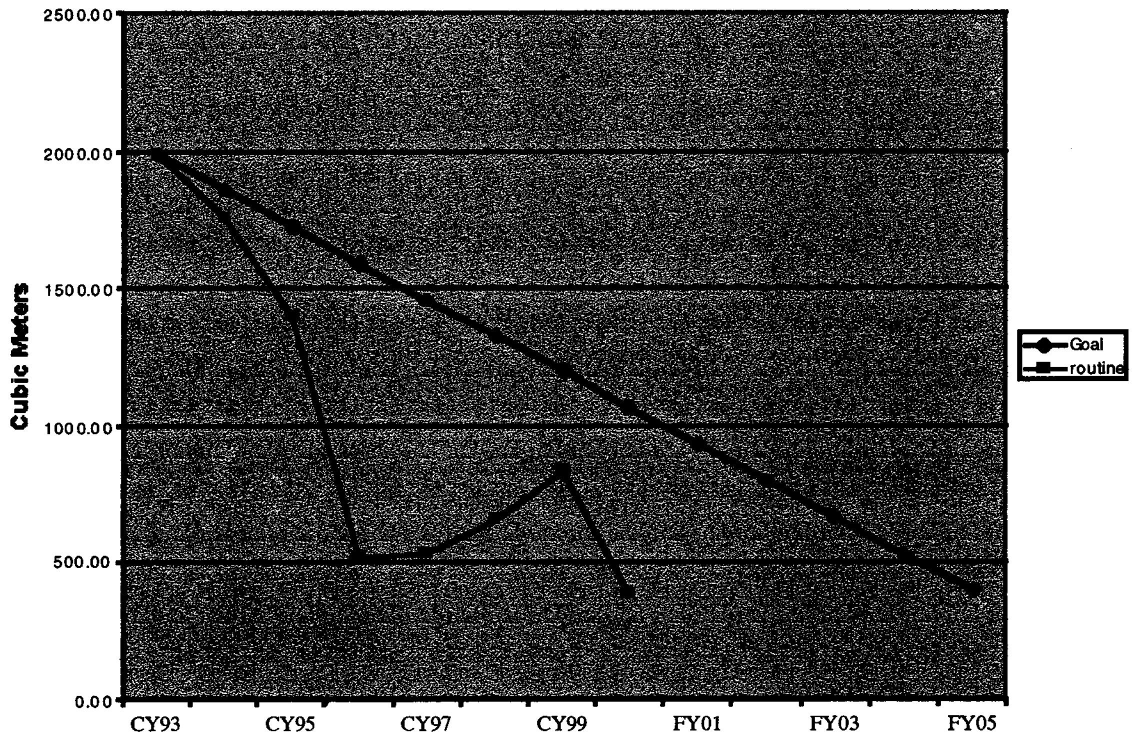


Fig. 5-5. Chart demonstrating that LANL has exceeded the 2005 goal.

5.3. Waste Stream Analysis

Materials, hardware, equipment, PPE, and contamination barriers (paper and plastic) are used in RCAs. After these items are no longer needed, they leave the RCA after being sorted, segregated, and, if possible, decontaminated. Some PPE, equipment, and tools are reused at the Laboratory, whereas some other equipment is sent offsite for reuse. Compactable waste is sent to the TA-54, Area G, compactor for volume reduction before disposal. Much of the waste leaving RCAs is not radiologically contaminated and can be surveyed to determine if the waste meets the radiological release criteria. If so, it is recycled or disposed of as sanitary waste. Low-density waste is sent to the Green is Clean (GIC) Facility at TA-54, Area G, for verification that it meets the radiological release criteria. It then is sent to the County Landfill for disposal. Scrap metal items for verification are sent to the TA-50 Decontamination Facility, where the items are assayed to ensure that they meet radiological release criteria, are decontaminated if required, and then are recycled. The LLW streams are broken down by percent in Fig. 5-6.

Solid LLW generated by the Laboratory's operating divisions is characterized and packaged for disposal at the on-site LLW disposal facility at TA-54, Area G. LLW minimization strategies are intended to reduce the environmental impact associated with LLW operations and waste disposal

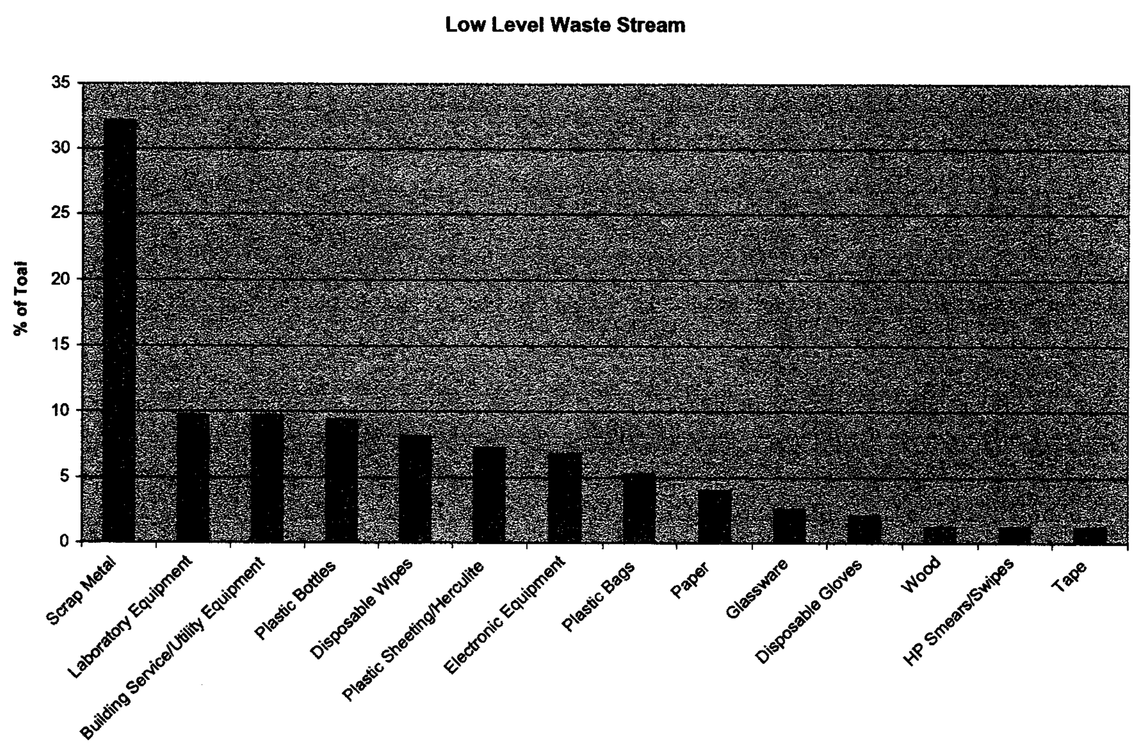


Fig. 5-6. LLW streams.

by reducing the amount of LLW generated and/or minimizing the volume of LLW that will require storage or disposal on site. LLW minimization is driven by the finite capacity of the on-site disposal facility and by the requirements of DOE Order 435.1 and other federal regulations and DOE Orders.

A 1998 analysis of the LLW landfill at TA-54, Area G, indicated that at previously planned rates of disposal, the LLW landfill's disposal capacity would be exhausted in a few years. Reduction in LLW generation has extended this time to ~5 yr; however, potentially large volumes of waste from planned construction upgrades could fill the remaining available landfill rapidly. Because the SWEIS (through a DOE Record of Decision in the fourth quarter of 1999) has received regulatory approval, construction of additional disposal sites now is allowed. Additional sites for LLW disposal at Area G would provide on-site disposal for an additional 50 to 100 yr. However, cost considerations and public acceptance issues may delay construction of additional disposal sites.

Liquid LLW typically is generated at the same facilities that generate solid LLW. It is transferred through a system of pipes and by tanker trucks to the RLWTF at TA-50, Building 1. The radioactive components are removed and disposed of as solid LLW. The remaining liquid is discharged to a permitted outfall.

Unlike the other waste, waste produced from decommissioning and ER projects will be disposed of either at the Envirocare site in Utah or *in situ* and is not addressed in this LLW section.

Solid LLW comprises various waste streams that are categorized as combustible LLW, noncombustible LLW, and scrap metal LLW. LLW is generated when materials, equipment, air, and water brought into RCAs to assist in performing work are radiologically contaminated and then are removed from the facility in the form of air emissions, solid LLW, or aqueous LLW.

The LLW streams at the Laboratory arise from processes at various Laboratory sites and are interrelated in some cases. For example, significant quantities of Laboratory equipment (e.g., computers) contain circuit boards that must be disposed of as MLLW. The goal for the TRU program is to lower the radiation levels of gloveboxes from TRU to LLW levels through decontamination; the goal for the LLW program is to use all means possible to release the maximum materials for recycle, reuse, or sanitary waste disposal. LLW streams are categorized below as combustible, noncombustible, or scrap metal. The categorized waste streams and their definitions follow.

5.3.1. Combustible Waste Streams

Materials from combustible waste streams used to accomplish programmatic work in RCAs are processed as LLW when they are removed. Combustible materials make up ~40% of the total LLW produced at the Laboratory annually. Combustible LLW streams and their definitions follow in descending order by volume.

- **Plastic Bottles:** Plastic bottles are used to contain aqueous samples and move aqueous material from one RCA to another.
- **Disposable Wipes:** Disposable wipes consist of any absorbent product (paper towels, wipes, cheese cloth, etc.) used as a cleaning aid or to absorb aqueous materials. The majority of these wipes either are used as laboratory aids or are contaminated during cleanup activities.
- **Plastic Sheeting/Herculite:** Plastic sheeting is used for contamination barriers. It typically is placed on the floor areas or used to build containment structures around equipment to prevent the spread of radioactive contamination and to ease cleanup activities.
- **Plastic Bags:** Plastic bags are used to package waste for disposal and to transport materials from one RCA to another.
- **Paper:** Office paper is used for recording data, working procedures, etc. Other forms of paper, such as brown paper wrapping material, are used as temporary contamination barriers to prevent the spread of contamination and to ease cleanup activities.
- **Disposable Gloves:** Disposable gloves are an essential PPE requirement when working in RCAs. Disposable gloves offer a high level of dexterity. If more protection is required, a heavier, more launderable pair of gloves is worn over the disposable gloves.
- **Wood:** Wood is used as a construction material to erect temporary containment structures. It is introduced into RCAs in the form of wooden pallets, scaffolding planks, and ladders. Wood also is used to support heavy objects being packaged for disposal to ensure that the objects do not shift in their packaging container during transport.
- **Tape:** Tape is used for a variety of purposes within RCAs, such as to seal PPE. It is also used to fix plastic and paper contamination barriers in place.
- **HP Smears/Swipes:** This material consists of filter paper material and large "masslin" swipes used to monitor removable contamination levels within RCAs.

5.3.2. Noncombustible Waste Streams

Noncombustible materials make up ~28% of the total LLW produced at the Laboratory annually. Noncombustible LLW streams are defined in the following list.

- **Laboratory Equipment:** This waste stream consists of a variety of laboratory equipment that is either outdated, no longer functional, or for which a use cannot be found. This waste stream consists of hot plates, furnaces, centrifuges, computers, and a variety of miscellaneous analytical instrumentation.
- **Building Service/Utility Equipment and Tools:** This waste stream consists of a variety of work tools, as well as equipment used to provide basic facility services, such as pumps, ventilation units, and compressors. This equipment generally is removed during facility maintenance or upgrade activities.
- **Electronic Equipment:** This waste stream consists of a variety of equipment, including computer equipment and miscellaneous laboratory and building services and utilities electronic equipment. This equipment is expensive to dispose of because it is difficult to characterize and because many of the components are classified as hazardous waste; therefore, this equipment either must be disposed of as MLLW or be recycled.
- **Glassware:** This waste stream consists of laboratory glassware that no longer can be used because it cannot be cleaned well enough to prevent the cross-contamination of samples.

5.3.3. Scrap Metal Waste Stream

- **Scrap Metal (380 m^3):** This waste stream consists of a large variety of items, including structural steel, piping, sheet metal objects, laboratory furniture, gloveboxes, and other scrap metal items. Typically, the majority of this material is produced during facility upgrade activities.

5.4. Aspect Analysis

To evaluate the LLW aspects for the Laboratory, the following scoring system was developed for the LLW streams. The scoring system ranks aspects based on damage to the environment, quantity, and probability of occurrence. The following table depicts the scoring system used to evaluate the LLW aspects.

Aspect Definition: Waste								
General Information								
This aspect definition sheet was developed for the TRU, LLW, MLLW, Sanitary, Hazardous, and Liquid LLW Streams at LANL.								

Location of Activity Impact

Location of Impact	Description	Scenarios Considered	Type
Global	Beyond the US	1. None	N/A
Regional	Beyond LANL but within the US	1. Release to the Environment or No Path Forward	Normal/Abnormal
		2. Disposition to a Landfill	Normal
		3. Treatment to BRC or Elimination of the Hazard	Normal
		4. Destruction	Normal
		5. Reuse or Recycle	Normal
Local	At LANL	1. On-Site Release	Abnormal

Magnitude of Activity		Probability of Occurrence	
Normal Scenario		*Abnormal Scenario*	
Toxicity*(Volume or Mass) Toxicity: Sanitary =1, LLW = 100, MLLW & Haz = 100–1000, TRU = 1000 Volume or Mass: cubic meters or metric tons			
High	Product >100,000	**High**	Occurs at least once per yr
Medium/High	Product 50,00–100,000	**Medium/High**	Occurs once every 1–10 yr
Medium	Product 10,000–50,0000	**Medium**	Occurs once every 10–100 yr
Medium/Low	Product 1,000–10,000	**Medium/Low**	Occurs once every 100–1000 yr
Low	Product <1,000	**Low**	Occurs only >1000 yr

Scale of Impact Definitions and Examples		High	Med./ High	Med.	Med./ Low	Low
1. Permanent:	Discharge of sufficient volume, duration, and toxicity to cause irreversible damage to the environment • Release to the Environment or No-Path-Forward Waste	1000	100	10	1	0.1
2. Significant:	Discharge of sufficient volume, duration, and toxicity to cause reversible damage to the environment • Disposal at a Regulated Landfill	100	10	1	0.1	0.01
3. Moderate:	Causes a change to the environment that requires long-term controls or corrective action • Treatment BRC or Elimination of the Hazard	10	1	0.1	0.01	0.001
4. Minimal:	Discharges of materials that are below the lowest regulatory threshold or, if not regulated by permit, have no known effect on the environment • Destruction		0.1	0.01	0.001	0.001
5. No Impact:	Negligible or no release to the environment • Reuse or Recycle	0.1	0.01	0.001	0.001	0.001

The amount of liquid LLW produced by the various divisions was estimated to score the aspects. A range of liquid LLW generation was estimated, and the higher value was used for scoring purposes. The estimated liquid LLW generation rates are listed below.

Division	Liquid LLW (Liters)	Liquid LLW (Metric Tons)
NMT	11,400,000	11,400
CST	2,400,000	2,400
ESA	1,400,000	1,400
ESH	600,000	600
MST	1,800,000	1,800
LANSCE	600,000	600
FWO	1,400,000	1,400

Based on this scoring system, the LLW aspects were evaluated for the various divisions at the Laboratory. The results of this evaluation are listed in the following table.

Division	Waste Stream	Activity	Magnitude Probability	Impact (Normal/ Abnormal)	Score (Normal/ Abnormal)
NMT	Solid LLW	Weapons Production	Medium Medium/High	2 2	1 1
	Liquid LLW	Weapons Production	High Medium/High	3 1	10 100
CST	Solid LLW	Laboratory	Medium Medium/High	2 2	1 1
	Liquid LLW	Laboratory	High Medium/High	3 1	10 100
ESA	Solid LLW	Machining	Medium/Low Medium/High	2 2	0.1 1
	Liquid LLW	Machining	High Medium/High	3 1	10 100
ESH	Solid LLW	Laboratory	Low Medium/High	2 2	0.01 1
	Liquid LLW	Laboratory	Medium/High Medium/High	3 1	1 100
MST	Solid LLW	Material Science	Low Medium/High	2 2	0.01 1
	Liquid LLW	Material Science	High Medium/High	3 1	10 100
LANSCE	Solid LLW	Accelerator	Medium/Low Medium/High	2 2	0.1 1
	Liquid LLW	Accelerator	Medium/High Medium	3 1	1 100
FWO	Solid LLW	TSDF	Medium Medium/High	2 2	1 1
	Liquid LLW	TSDF	High Medium/High	3 1	10 100

Aspects scoring 10 or more are significant aspects. Solid waste was scored at an impact level of 3 for the abnormal case because it was felt that any release to the environment could be mitigated readily with simple corrective actions. Aspect scoring by division did not yield a significant difference in scoring because the abnormal case for solid and liquid LLW controlled the scoring process. Therefore, the aspects will be addressed as solid and liquid LLW instead of by division. These aspects are discussed in further detail here. Projects addressing these aspects also are identified in this section and are described in more detail in the following sections.

Solid LLW: This waste stream consists of scrap metal, combustible, and noncombustible waste (see Section 5.3). It is estimated that 50% of this waste stream is not contaminated and could be disposed of as sanitary waste or recycled. A large portion of the paper and plastic waste could be replaced with launderable products, and porous construction materials could be replaced with nonporous materials that could be decontaminated and reused. The following projects have been identified to address this waste stream.

- Scrap Metal Recycling
- Sorting, Segregation, Reuse, and Recycling of Equipment
- Green Is Clean
- Launderable Product Substitution
- Porous Material Standard for RCA Construction
- RCA Source Elimination
- Real Time Surface Contamination Detector
- Depleted Uranium (DU) Machining Turning and Chip Recycling
- D&D Metal Decontamination
- Crush Demolition Waste Concrete
- PPE Reuse As Rags

Liquid LLW: This waste is generated by all of the major laboratory and production facilities at LANL. The following projects have been identified to address this waste stream.

- RLWTF Influent Minimization Study
- Dust Suppression
- Liquid Scintillation Cocktail Solidification

5.5. Improvement Projects

The following projects were identified as potential corrective measures for the LLW aspects scoring 10. These projects will affect all of the LLW regardless of scoring. However, these projects were selected for their applicability to the high-scoring aspects.

5.5.1. Completed Projects

5.5.1.1. Green Is Clean. It is estimated that 50% of the LLW stream is not contaminated. Through the use of acceptable knowledge and segregation techniques, a large portion of this waste stream can be eliminated. A verification facility with sophisticated counting instrumentation was established at TA-54 to perform verification surveys on waste segregated based on acceptable knowledge before it is disposed of as sanitary waste. In addition, site-wide implementation procedures were developed. The ESO still supports this project as part of its base program activities. Support consists of working with generators to better define acceptable knowledge and segregation techniques.

5.5.1.2. Metal Recycling. This project consisted of setting up the infrastructure at LANL to enable large-scale surveying and release of scrap metal leaving radiological areas at LANL. Since implementation, ~600 m^3/yr of scrap metal has been recycled. The ESO still provides technical assistance to generators to encourage and assist in this effort.

5.5.1.3. Launderable Product Substitution. This project increased the use of launderable PPE at the Laboratory to eliminate disposable PPE. The ESO office still is supporting this project as part of its base program to encourage the use of launderable wipes, mops, bags, and contamination barriers to eliminate further the use of disposable products.

5.5.1.4. D&D Metal Decontamination. Sponge jet decontamination equipment was set up to decontaminate and recycle ~120 m^3 of contaminated scrap metal from D&D operations.

5.5.1.5. DU Machining Turning and Chip Recycling. The ESA machine shops segregate DU machining operations from nonradioactive machining operations. After a DU machining operation is completed, the machining equipment is cleaned before nonradioactive machining operations begin. However, even with these precautions, discreet chips of DU periodically contaminate the clean machining chips and turnings, preventing their recycling as scrap metal. This project consisted of constructing specialized survey equipment for monitoring this material and segregating any discreet chips of DU from the chips and turnings so that they can be recycled as scrap metal.

5.5.1.6. RCA Source Elimination. This project consisted of reducing or eliminating the number and size of RCAs at the Laboratory. By eliminating many of these areas and by reducing the size of others, it is estimated that the Laboratory has decreased the LLW generation from these areas by 340 m^3/yr.

5.5.1.7. Real-Time Surface Contamination Monitor. Much waste is produced when monitoring for tritium contamination at tritium facilities. Potentially contaminated surfaces are smeared with small, specialized cloth swabs. The swaps then are placed in 25-ml vials with scintillation cocktail for analysis. Thousands of these samples are processed annually. This project developed an instrument that will provide a direct reading of the surface contamination without the need to take samples for processing in the Laboratory. Successful implementation of this device essentially will eliminate this waste stream.

5.5.1.8. PPE Reuse as Rags. Worn and torn PPE typically has been disposed of in the past. This project cut the material into usable rags. The use of this material for rags essentially eliminated this waste stream.

5.5.1.9. Crush Demolition Waste Concrete. D&D operations generate large volumes of concrete rubble. This rubble can be crushed and used as fill at the D&D site, eliminating the need to dispose of this material as LLW. This project funded a concrete crushing operation to eliminate the disposal of large volumes of concrete rubble.

5.5.2. Ongoing Projects

5.5.2.1. ESO Base Program. A variety of ongoing activities are funded as part of the ESO base program. The ESO provides ongoing support for the following activities.

- GIC
- Metal recycling
- LLW sorting/segregation/reuse and recycling
- Liquid scintillation cocktail solidification
- Launderable product substitution

In addition, the ESO provides technical assistance to waste generators to develop and implement waste minimization/pollution prevention projects.

5.5.2.2. RLWTF Influent Minimization Project (see Appendix B for more details).
It is estimated that at least 20% of the liquid LLW currently being discharged to the RLWTF could be eliminated. This project will identify sources of waste that can be eliminated and will recommend actions to eliminate these streams.

5.5.3. Unfunded Projects

1. **Porous Material Standard for RCA Construction (see Appendix B).**
   This project would set a standard for the use of nonporous materials during construction activities in an RCA. By using plastic lumber, metal ladders, and other nonporous construction materials and equipment, this material can be decontaminated and reused, thus eliminating the need to dispose of this equipment and material as LLW.

2. **Dust Suppression (see Appendix B).**
   This project would eliminate the liquid effluent from the RLWTF by using it for dust suppression at TA-54. If dust suppression is not appropriate, other elimination methods will be investigated to eliminate this liquid effluent stream.

3. **Decontamination Park—Electronics Sort and Segregate.**
   Electronics excessed from radiation control areas are suspect LLW and MLLW. By dismantling and surveying them, most can be declared nonradioactive under DOE Order 5400.5 and recycled as scrap metal. The Laboratory's electronics sort and segregate capability has been displaced by modifications to the RLWTF (TA-50). This project will provide funding to complete the move of sort and segregate capabilities to TA-54, provide new infrastructure, and integrate the sort and segregate activity with the other decontamination activities that will exist at TA-54.

4. **Decontamination Park—Large Metal Objects.**
   The Laboratory has lost its capability to decontaminate large pieces of equipment. This proposal would reestablish this capability at TA-54; it would be part of a decontamination park with broad segregation and decontamination capabilities. Without decontamination capabilities up to 80 m^3, equipment must be disposed of as LLW each year. When decontaminated, much of this equipment can be returned to service. This waste minimization project will install the Environmental Restoration Project's decontamination skid at the TA-54 decontamination park. Installation will include testing and the preparation of all operating procedures.

6.0. MIXED LOW-LEVEL WASTE

6.1. Introduction

For mixed waste to be considered MLLW, it first must meet the definition of low-level radioactive waste. Mixed waste is any waste containing both hazardous and source materials, SNM, or by-product materials. Therefore, MLLW contains both radioactive and RCRA waste. Because MLLW contains radioactive components, it is regulated by DOE Order 435.1. Because it contains RCRA waste components, MLLW also is regulated by the State of New Mexico through the Laboratory's operating permit, FFCO/STP (NMED) and the EPA. Materials in use that will be RCRA waste upon disposal are defined as hazardous materials.

Most of the Laboratory's routine MLLW results from stockpile stewardship and management and from R&D programs. Most of the nonroutine waste is generated by off-normal events such as spills. Environmental restoration and waste management legacy operations, which also produce MLLW, are not included for the purposes of this roadmap. Typical MLLW items include contaminated lead shielding bricks, R&D chemicals, spent solution from analytic chemistry operations, mercury cleanup-kit waste from broken fluorescent bulbs and mercury thermometers, circuit boards from electronic equipment removed from a TRU waste radiation area, discarded lead-lined gloveboxes, and some contaminated water removed from sumps.

Figure 6-1 shows the process map for MLLW generation at the Laboratory.

MLLW generation by division is shown in the pie chart in Fig. 6-2.

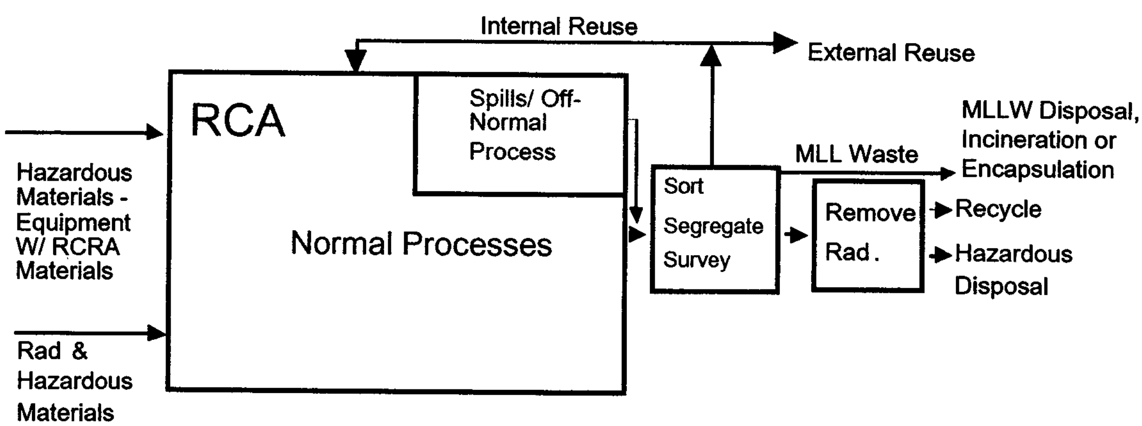


Fig. 6-1. Top-level MLLW process map.

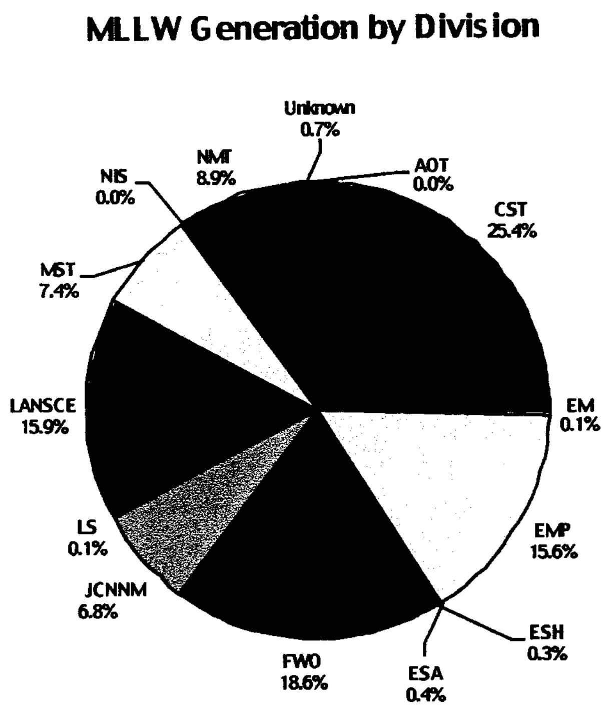


Fig. 6-2. MLLW generation and projected generation.

CST and FWO Divisions and the Manual Lujan Neutron Scattering Center (MLNSC) were the largest MLLW producers in FY00. The biggest contributor to CST Division's waste volume was electronics from their sort and segregation activities (now performed by E-ET). The largest contributor to FWO waste volumes was grouted sludge and paint debris. Mercury-contaminated debris from the drain system was the largest contributor to LANSCE volumes.

Routine MLLW generation by division is shown in Fig. 6-3. CST and NMT Divisions and JCNNM were the largest routine MLLW generators in FY00. Spent nitrate liquid waste solutions from laboratories were the largest contributor to CST's total volume. Previously, this waste stream was processed through the RLWTF. Used oil and lead-contaminated debris were the largest contributors to NMT's total volume. Paint debris was the largest contributor to the total volume of MLLW produced by JCNNM.

6.2. MLLW Minimization Performance

DOE has implemented goals for waste minimization. The mixed low-level radioactive waste goal is to reduce waste from routine operations by 80% by 2005 using CY93 as the baseline. Figure 6-4 shows the Laboratory routine and nonroutine waste generation rates. Figure 6-5 shows the Laboratory's success toward achieving this goal. DOE's environmental leadership program will go beyond compliance requirements and be based on continuous and cost-effective

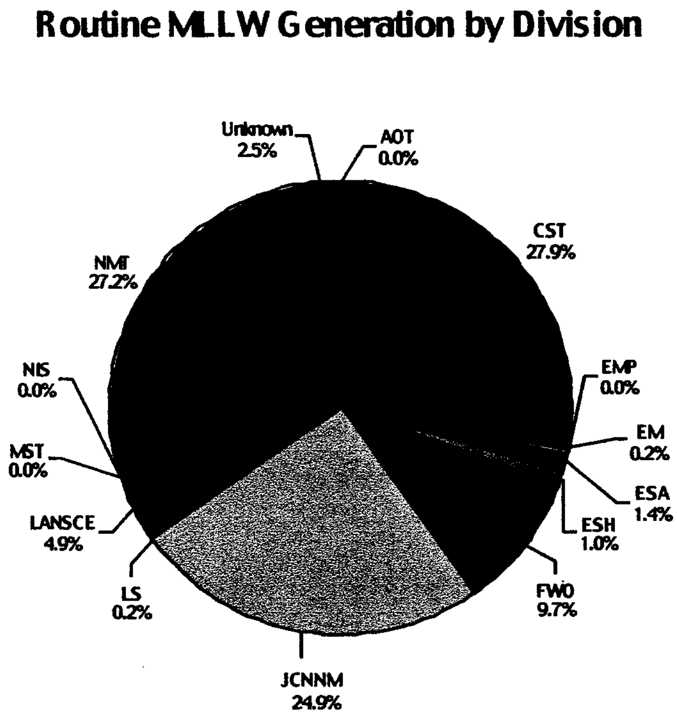


Fig. 6-3. Routine MLLW generation by division.

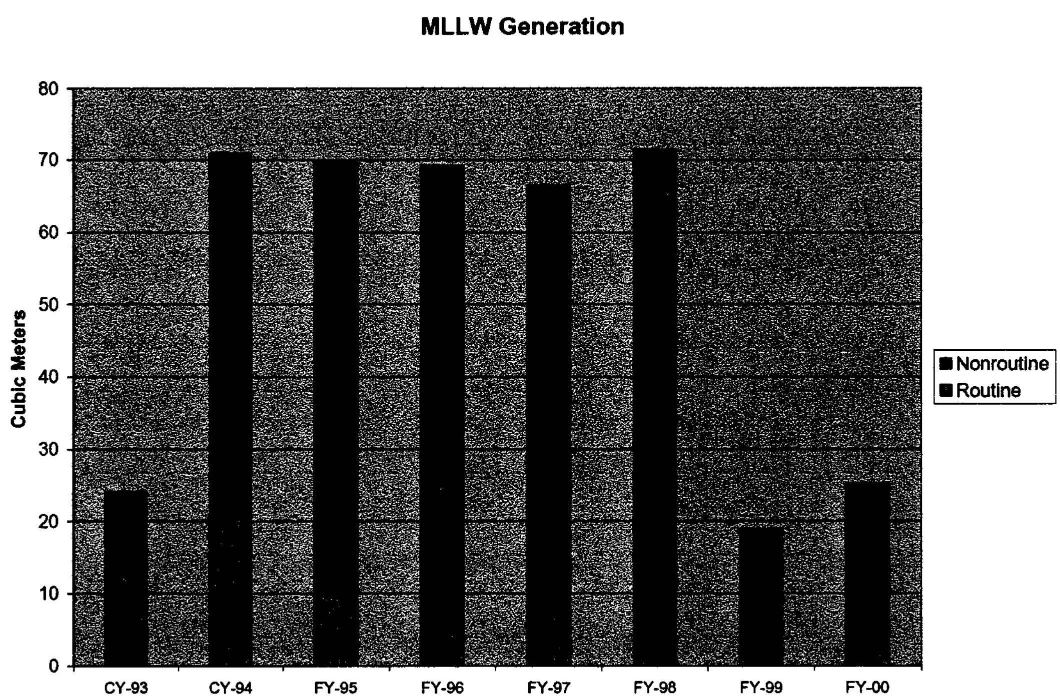


Fig. 6-4. Routine and nonroutine waste generation.

improvements. To achieve these goals, the Laboratory must use pollution prevention processes that lead to minimal waste generation and life-cycle costs.

6.3. Waste Stream Analysis

MLLW is generated in RCAs. Hazardous materials and equipment containing RCRA materials, as well as MLLW materials, are introduced into the RCA as needed to accomplish specific activities. In the course of operations, hazardous materials become contaminated with LLW or become activated, becoming MLLW when the item is designated as waste.

Typically, MLLW is transferred to a satellite storage area after it is generated. Whenever possible, MLLW materials are surveyed to confirm the radiological contamination levels, and if decontamination will eliminate either the radiological or the hazardous component, materials are decontaminated and removed from the MLLW category.

Waste classified as MLLW is managed in accordance with appropriate waste management and Department of Transportation requirements and shipped to TA-54.

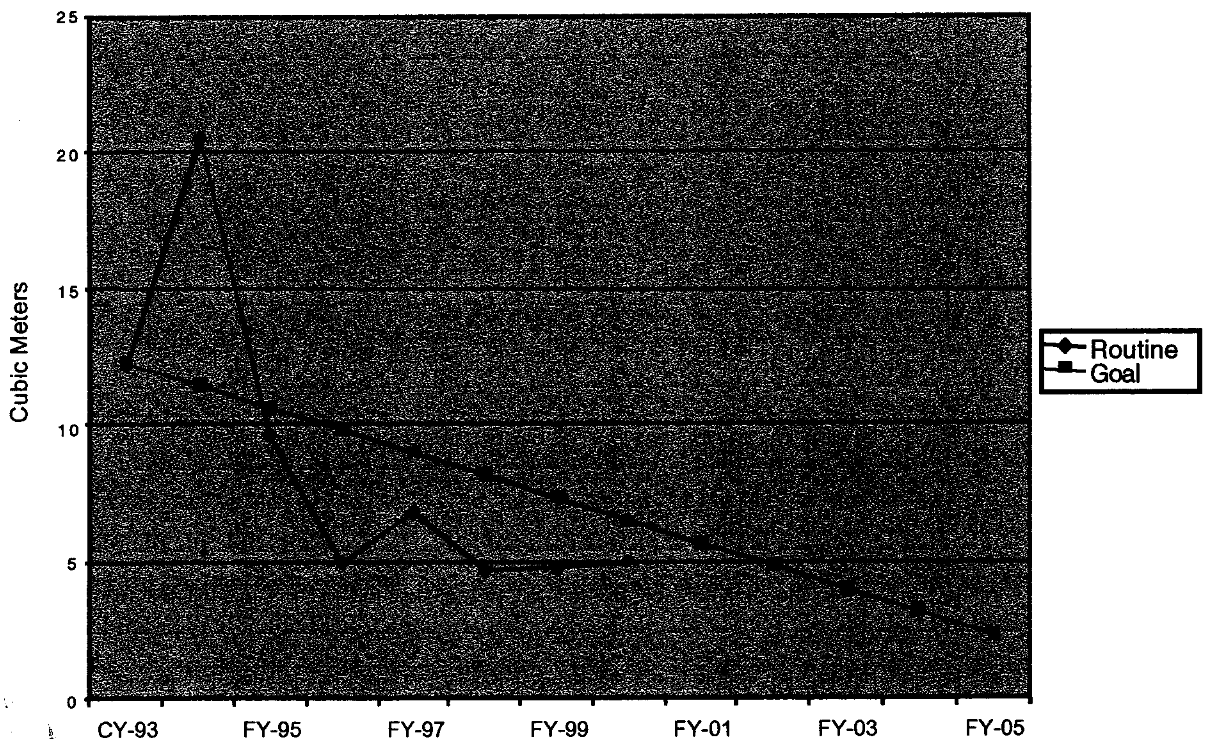


Fig. 6-5. Routine MLLW generation vs DOE goal.

From TA-54, MLLW is sent to commercial and DOE treatment and disposal facilities. The waste is treated/disposed of by various processes (e.g., segregation of hazardous components, macroencapsulation, or incineration).

In some cases, the Laboratory procures spent MLLW materials from other DOE/commercial sites to avoid creating new MLLW. For example, LANSCE is designing several new beam stops and shutters from lead. Rather than fabricating these from uncontaminated lead, LANSCE can receive these parts at no expense from GTS Duratek (formerly SEG), a company that processes contaminated lead from naval nuclear reactor shielding. Duratek fabricates parts at no cost to the Laboratory because their fabrication costs are much less than those of MLLW lead disposal.

The largest waste streams are generated from spills, debris, and PPE. These waste streams constitute ~50% of the MLLW waste type and are the primary targets for elimination. The waste streams were determined from 1995 through 1998 waste generation. The individual waste streams are listed below and are defined later in this section.

- Miscellaneous (decontamination solutions, contaminated soil, etc.)
- Electronic equipment
- Mercury and mercury debris
- Lead and lead debris
- Paint debris
- Nitrate waste
- High-efficiency particulate air (HEPA) filters
- Oil
- Fluorescent light bulbs
- R&D chemicals

MLLW cost an average of $88,305/m^3 to characterize, treat, and dispose of in FY99. SWO spent a total of $5,684,000 managing newly generated MLLW in FY99. Table 6-1 summarizes the Laboratory's typical unit costs for MLLW disposal. Waste is disposed of either by incineration or by macroencapsulation and land disposal. Macroencapsulation involves potting the waste (typically solid parts) in a suitable plastic and creating a barrier around the waste.

Table 6-1. Approximate Costs for MLLW Streams[6-1]

Waste Type	Treatment Method	Treatment and Disposal Cost	Transportation Cost
Activated or inseparable lead	Macroencapsulation	$15,000/m^3$	$5000 per shipment
Surface-contaminated lead (amenable to onsite decontamination)	Decontamination at TA-50	Treatment—$4000/ m^3	Nominal
Surface-contaminated lead (for offsite recycling)	Standard decontamination methods (bead blasting, acid dip, etc.) followed by recycling	$8000/m^3$	$5000 per shipment
RCRA waste-regulated solvents with radioactive components	Fuel recycling at Diversified Scientific Services, Inc. (DSSI)-permitted boiler	$19,815–52,840/ m^3 Actual costs depend on levels of radionuclides, metal content, percent water, and halogen content	$5000 per shipment
Activated RCRA waste components	Macroencapsulation	$15,000/ m^3	$5000 per shipment
Fluorescent tubes with mercury	Amalgamation followed by landfill disposal	$105,900/ m^3	$5000 per shipment
Printed circuit boards	Macroencapsulation	$15,000/ m^3	$5000 per shipment

MLLW waste streams arise from processes at various Laboratory sites and are interrelated with other waste streams in some cases. For example, contaminated PPE and other contaminated equipment are generated in many processes. These streams also are captured in other process maps. Figure 6-6, which is presented after the MLLW waste streams listed and defined below, shows the percentage of the total volume of MLLW that each division contributes to Laboratory MLLW.

- **Miscellaneous (6.40 m^3).** This consists of contaminated water, decontamination fluids, unused commercial products, and other miscellaneous materials.

- **Electronic Equipment (3.54 m^3).** This waste stream comprises circuit boards and other materials removed from electronic equipment containing lead.

- **Mercury and Mercury-Contaminated Debris (2.93 m^3).**

- **Lead and Lead-Contaminated Debris (2.14 m^3).** This waste stream comprises activated or surface-contaminated lead shielding, contaminated lead paint, and lead components. Lead normally is sent to Envirocare, Inc. for encapsulation and land disposal, but surface-contaminated lead parts are decontaminated and recycled. Lead debris is contaminated copper pipe with lead solder joints, contaminated plastic sheets, duct tape, hoses, and used pump housings.

- **Paint and Painting Waste (1.85 m^3).** This waste stream consists of rags, brushes, and other materials contaminated with hazardous paints or paint-stripping materials.

- **Nitrate Waste (1.18 m^3).** This waste stream consists of nitric acid used in Laboratory processes that is neutralized and disposed of. Previously, this waste stream was disposed of at the RLWTF. To meet new nitrate regulatory limits, the nitrate waste is being collected in carboys for offsite disposal.

- **Oil (1.04 m^3).** This waste stream consists of oil removed from laboratory and facility machinery. Typically, the oil is contaminated with heavy metals from the bearings and other materials in the equipment. Laboratory vacuum pump oil also is typically contaminated with various laboratory solvents.

- **HEPA Filters (1.01 m^3).** This waste stream consists of HEPA filters removed from laboratory ventilation systems. These filters periodically become contaminated with perchlorates, heavy metals, and other hazardous constituents

- **Fluorescent Lights (0.26 m^3).** Lights that become activated in an RCA must be disposed of as MLLW. This type of activation typically occurs only at LANSCE (in the Proton Storage Ring). (This stream was eliminated in FY98.)

- **R&D Chemicals (0.07 m^3).** Spent chemicals from research projects and production operations are generated in milliliter to several-liter quantities and are consolidated into 30-gal. volumes before being sent offsite for disposal (typically incineration).

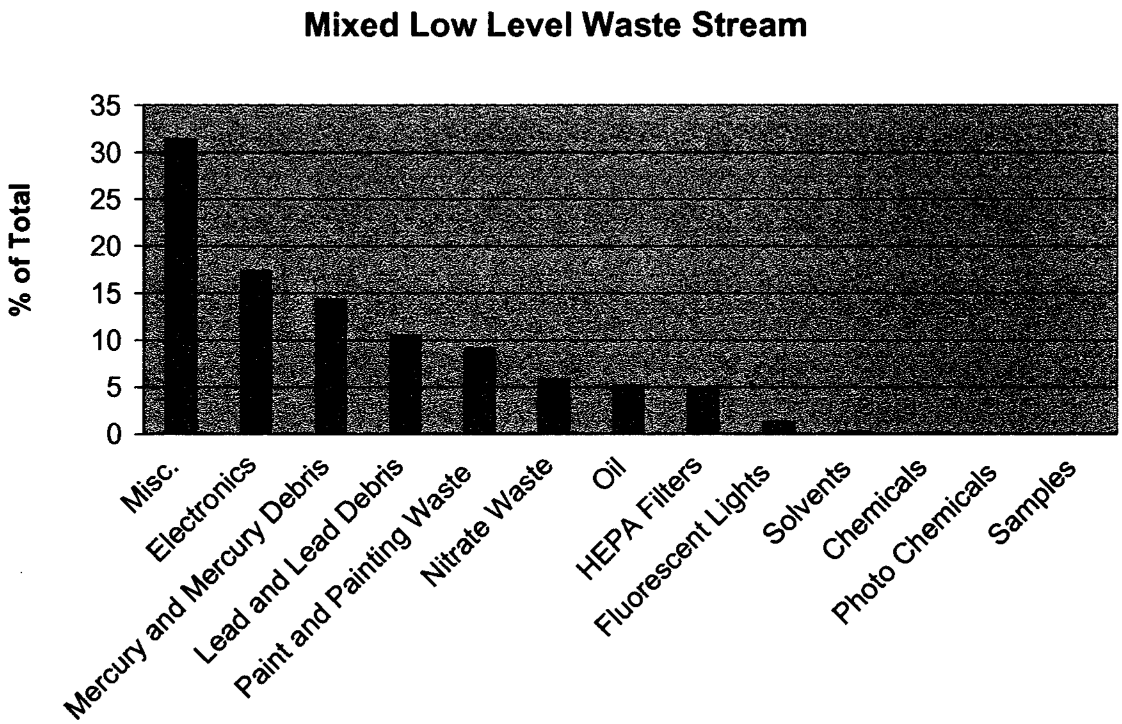


Fig. 6-6. Waste stream constituents.

6.4. Aspect Analysis

To evaluate the MLLW aspects for the Laboratory, the following scoring system was developed for the MLLW streams. The scoring system ranks aspects based on damage to the environment, quantity, and probability of occurrence. The following table depicts the scoring system used to evaluate MLLW aspects.

Aspect Definition: Waste

General Information

This aspect definition sheet was developed for the TRU, LLW, MLLW, Sanitary, Hazardous, and Liquid LLW Streams at LANL.

Location of Activity Impact

Location of Impact	Description	Scenarios Considered	Type
Global	Beyond the US	1. None	N/A
Regional	Beyond LANL but within the US	1. Release to the Environment or No Path Forward	Normal/Abnormal
		2. Disposition to a Landfill	Normal
		3. Treatment to BRC or Elimination of the Hazard	Normal
		4. Destruction	Normal
		5. Reuse or Recycle	Normal
Local	At LANL	1. On-Site Release	Abnormal

Magnitude of Activity		Probability of Occurrence	
Normal Scenario		*Abnormal Scenario*	
Toxicity*(Volume or Mass) Toxicity: Sanitary =1, LLW = 100, MLLW & Haz = 100–1000, TRU = 1000 Volume or Mass: cubic meters or metric tons			
High	Product >100,000	**High**	Occurs at least once per year
Medium/High	Product 50,00–100,000	**Medium/High**	Occurs once every 1 and 10 yr
Medium	Product 10,000–50,0000	**Medium**	Occurs once every 10–100 yr
Medium/Low	Product 1,000–10,000	**Medium/Low**	Occurs once every 100–1000 yr
Low	Product <1,000	**Low**	Occurs only >1000 yr

Scale of Impact Definitions and Examples		High	Med./ High	Med.	Med./ Low	Low
1. Permanent:	Discharge of sufficient volume, duration, and toxicity to cause irreversible damage to the environment • Release to the Environment or No-Path-Forward Waste	1000	100	10	1	0.1
2. Significant:	Discharge of sufficient volume, duration, and toxicity to cause reversible damage to the environment • Disposal at a Regulated Landfill	100	10	1	0.1	0.01
3. Moderate:	Causes a change to the environment that requires long-term controls or corrective action • Treatment Below Regulatory Concern (BRC) or Elimination of the Hazard	10	1	0.1	0.01	0.001
4. Minimal:	Discharges of materials that are below the lowest regulatory threshold or, if not regulated by permit, have no known effect on the environment • Destruction	1	0.1	0.01	0.001	0.001
5. No Impact:	Negligible or no release to the environment • Reuse or Recycle	0.1	0.01	0.001	0.001	0.001

The MLLW aspects were evaluated for the various MLLW streams at the Laboratory based on this scoring system. The results of this evaluation are listed below.

Waste Stream	Division	Activity	Magnitude Probability	Impact (Normal/ Abnormal)	Score (Normal/ Abnormal)
Miscellaneous	EMER, NMT, CST,FWO	All	Medium/Low Medium/High	2 3	0.1 1
Electronics	NMT, CST, MST	All	Medium/Low Medium/High	2 3	0.1 1
Mercury and Mercury-Contaminated Debris	MLNSC, NMT,CST	Laboratory Operations, LANSCE Maintenance	Medium/Low Medium/High	1 3	1 1
Lead and Lead-Contaminated Debris	MST, NMT	Construction	Medium/Low Medium/High	2 3	0.1 1
Paint and Painting Waste	NMT, FWO	Construction	Low Medium/High	2 3	0.01 1
Nitrate Waste	CST	Bioassay Analysis	Low Medium/High	2 3	0.01 1
Oil	NMT	Laboratory Operations	Medium/Low Medium/High	2 3	0.1 1
HEPA Filters	CST,NMT,EMER	Maintenance	Low Medium/High	2 3	0.01 1
Fluorescent Tubes	MLNSC	Maintenance	Low Medium/High	2 3	0.01 1
R&D Chemicals	CST, NMT	Laboratory Operations	Low Medium/High	2 3	0.01 1

Aspects scoring 1 or more are significant aspects. Aspect scoring by waste stream did not yield a significant difference in scoring because the abnormal case for each of the waste types controlled the scoring process. An impact level of 3 was used for the abnormal case. Because of the small volumes, any abnormal scenario involving a release to the environment could be mitigated with a simple corrective action measure. A toxicity level of a 1000 was assigned to mercury, oil, and R&D chemical wastes. A toxicity level of 250 was assigned to nitrate wastes, and a level of 100 was assigned to HEPA filter wastes. A toxicity level of 500 was assigned to the remaining waste streams. These aspects are discussed in further detail in the following text.

Miscellaneous: This waste stream consists of a large variety of items that cannot be classified easily into a specific category. The majority of items in this waste stream consist of spent consumer products, particularly materials in aerosol cans. The following projects have been identified to address this waste stream.

- Aerosol Can Recycling.

Electronics: Electronics contain solder, cathode ray tubes (CRTs), and other components that contain heavy metals (e.g., lead). If these materials cannot be recycled, they must be disposed of as MLLW. These items can be recycled after they have been surveyed and determined not to be radioactive. The following projects have been identified to address this waste stream.

- Sorting, Segregation, Reuse, and Recycling of Miscellaneous Electronic Equipment
- Use of Flat Screen Monitors for RCAs
- Reuse of Equipment from RCAs

Mercury and Mercury-Contaminated Debris: This waste stream results from the use of mercury and mercury-containing devices in RCAs. When a mercury spill occurs, the cleanup of mercury generates this waste stream. The following projects have been identified to address this waste stream.

- New Mercury Cleanup Protocol for RCAs
- Elimination of Mercury Thermometers and Other Devices from RCAs

Lead and Lead-Contaminated Debris: This waste stream results from the use of lead shielding materials, lead solder on copper pipe joints, and lead wool and tape. The following projects have been identified to address this waste stream.

- Lead Removal from Gloveboxes
- Lead Decontamination
- Sorting Segregation, Reuse, and Recycling of Miscellaneous Equipment from RCAs
- Substitution of Lead Shielding Materials
- MLLW Cask Reuse and Recycling

Painting and Painting Waste: This waste stream results from the use of paint, paint thinners, and paint-stripping materials containing hazardous materials.

Nitrate Waste: This waste stream results from the use of nitric acid in various laboratory processes. This waste stream can be reduced significantly by improving sample digestion methods, reducing sample size requirements, and improving labware cleaning techniques. The following projects have been identified to address this waste stream.

- Nitrate Bio-Assay Diversion Projects
- Nitric Acid Waste Reduction
- Size Reduction of Inorganic Analysis
- Microconcentric Nebulizer

Oil: This waste stream results from the use of lubricating oils in a variety of laboratory and facility equipment. The oil in vacuum pumps and other equipment becomes contaminated with hazardous materials (heavy metals) and must be disposed of as MLLW. The following projects have been identified to address this waste stream.

- Oil-Free Vacuum Pumps
- Mixed Oil Solidification

HEPA: This waste stream results from the airborne hazardous materials entering facility ventilation systems. The following projects have been identified to address this waste stream.

- None

Fluorescent Lights: This waste stream results from the use of fluorescent lights in RCAs containing levels of mercury that result in classification of the lights as MLLW. The following projects have been identified to address this waste stream.

- Conversion to Nonhazardous Fluorescent Lights

R&D Chemicals: This waste stream results from the use of a variety of hazardous laboratory chemicals. Improved laboratory methods can reduce the amount of these materials generated significantly. The following projects have been identified to address this waste stream.

- Semivolatile Extraction Project
- Hot-Water Extraction for Characterization of Hazardous Compounds
- Mediated Electrochemical Oxidation

6.5. Improvement Projects

The following projects were identified as potential corrective measures for the MLLW aspects. These projects were selected for their applicability to high-scoring aspects.

6.5.1. Completed Projects

6.5.1.1. Aerosol Can Recycling. The use of consumer products in RCAs results in the generation of aerosol cans that are classified as MLLW. This project punctures these cans to render them nonhazardous. Metals cans that can be released as nonradioactive are recycled. Cans that cannot be released are disposed of as LLW.

6.5.1.2. Sorting, Segregation, and Recycle, and Reuse of Miscellaneous Electronic Equipment. Miscellaneous electronic equipment leaving RCAs is disassembled, and the individual components are surveyed. Those components that are nonradioactive are recycled. The ESO continues to support this project as part of its base program activities.

6.5.1.3. Reuse of Equipment from RCAs. Much of the equipment leaving RCAs containing hazardous materials is still operable and can be reused. Because this equipment was used in an RCA without disassembly, it is not possible to determine positively if the equipment is nonradioactive. To reuse this equipment, it must be transferred to another nuclear facility. This project resulted in the transfer of 10 m^3 of equipment to Russian nuclear facilities for reuse. The ESO continues to support this project as part of its base program activities.

6.5.1.4. Elimination of Mercury Thermometers and Other Devices in RCAs. This project funded the purchase of nonmercury thermometers and other devices to eliminate mercury from RCAs.

6.5.1.5. Lead Removal from Gloveboxes. Gloveboxes decontaminated to LLW levels are classified as MLLW because of the lead shielding present. This project funded the development of techniques to remove the lead and recycle the lead shielding. The lead from several gloveboxes was recycled as part of this project. The ESO continues to support this project as part of its base program activities.

6.5.1.6. Lead Decontamination. A lead decontamination facility to decontaminate lead was set up and operated. The lead is recycled after decontamination. The ESO continues to support this project as part of its base program.

6.5.1.7. Substitution of Lead Shielding Materials. Tin, bismuth, tungsten, and other materials can be used as effective shielding materials. This project identified potential substitute materials and piloted their use.

6.5.1.8. Sorting, Segregation, Reuse, and Recycling of Miscellaneous Equipment from RCAs. Equipment or materials (copper pipe with lead solder joints) are disassembled and surveyed. Materials that can be determined as nonradioactive are recycled. The ESO continues to support this project as part of its base program activities.

6.5.1.9. Nitric Acid Waste Reduction. Glassware cleaning at the bioassay laboratory generates several hundred liters of concentrated nitric acid waste annually. This project funded improvements to the cleaning methods and reduced the nitric acid usage by 75 to 200 L annually.

6.5.1.10. Size Reduction of Inorganic Waste Analyses. This project funded the development of improved sample digestion methods to reduce the generation of nitric acid wastes.

6.5.1.11. Microconcentric Nebulizer. The use of improved nebulization techniques for introducing samples into inductively coupled plasma (ICP) emission spectroscopy devices can reduce the sample size requirements dramatically. Reducing the sample size requirements reduces the amount of nitric acid waste generated. This project resulted in the development of improved nebulization techniques.

6.5.1.12. Conversion to Nonhazardous Fluorescent Lights. This project resulted in blocking the purchase of hazardous fluorescent lights in the Laboratory procurement system. The ESO continues to support the effort to eliminate all hazardous fluorescent lights from RCAs as part of its base program activities.

6.5.1.13. Semivolatile Extraction Project. Methylene chloride is a solvent used in the analysis of materials to determine if they contain regulated semivolatile organic compounds. This project funded an effort to identify and purchase new equipment that significantly reduced the size of this waste stream.

6.5.1.14. Mediated Electrochemical Oxidation. A method for destroying organic waste was developed. This method may be implemented, depending on the results of several other competing technologies.

6.5.2. Ongoing Projects

6.5.2.1. ESO Base Program. A variety of activities is funded as part of the ESO base program. The ESO provides ongoing support for the following activities.

- Sorting, Segregation, and Recycle, and Reuse of Miscellaneous Electronic Equipment
- Reuse of Equipment from RCAs
- Lead Removal from Gloveboxes

- Lead Decontamination
- Sorting, Segregation, Reuse, and Recycling of Miscellaneous Equipment from RCAs
- Conversion to Nonhazardous Fluorescent Lights

In addition, the ESO provides technical assistance to waste generators to develop and implement waste minimization/pollution prevention projects.

6.5.2.2. MLLW Cask Reuse and Recycling. Shielded containers (casks) must be either disposed of as MLLW, decontaminated and recycled, or used for the disposal of highly radioactive materials. This project is funding an effort to decontaminate these casks for recycling or to use these casks for the disposal of highly radioactive materials.

6.5.2.3. Oil-Free Vacuum Pumps. This project is funding the replacement of oil-filled vacuum pumps used in RCAs. Oil-free replacement pumps are being purchased. The use of these pumps will eliminate a significant amount of the MLLW oil produced at the Laboratory.

6.5.3. Unfunded Projects

6.5.3.1. Use of Flat Screen Monitors for RCAs (see Appendix B). Computer monitors contain CRTs that are classified as a hazardous material. The ESO believes that replacement of these monitors with flat-screen monitors using light-emitting-diode technology will eliminate this MLLW stream. This project will test flat-screen monitors to ensure that they are not classified as hazardous. If the monitors pass these tests, this project will fund the replacement of several monitors containing CRTs.

6.5.3.2. New Mercury Cleanup Protocol (see Appendix B). When a mercury spill occurs in an RCA, significant amounts of mercury-contaminated debris are generated during the remediation of the spill. The ESO believes that information learned during a mercury waste treatability study performed at the Laboratory could be used to develop improved spill cleanup protocols, dramatically reducing the size of this waste stream. This project would fund the development of new cleanup protocols.

6.5.3.3. Nitrate Bio-Assay Diversion Projects (see Appendix B). Nitric acid waste currently generated by the bioassay laboratories must be disposed of as MLLW. This project would investigate the potential of sending this waste to the sanitary waste water treatment facility or would develop other treatment options to eliminate this waste stream.

6.5.3.4. Hot-Water Extraction for the Characterization of Hazardous Compounds (see Appendix B). Methylene chloride and other solvents currently are used to extract hazardous compounds from materials for analysis. This project would develop a hot-water extraction process that would eliminate the need for these solvents, thus eliminating this waste stream.

6.5.3.5. Mixed Oil Solidification. Oil from various process and laboratory equipment in RCAs must be disposed of as MLLW. Heavy-metal contamination is the predominant reason for classifying the oil as an RCRA waste. An oil solidification process (NoChar) developed at Mound is simple and appears to be effective at eliminating the RCRA classification because of toxicity. This project would complete the testing necessary to implement this process at the Laboratory. If successful, this project essentially should eliminate this MLLW stream.

REFERENCES

6-1. John Kelly, Los Alamos National Laboratory, personal communication, November 2, 2000.

7.0. HAZARDOUS WASTE

7.1. Introduction

Hazardous waste is divided into three waste types: RCRA waste, Toxic Substances Control Act (TSCA) waste, and state special solid waste. In addition to waste, considerable material would be disposed of as waste if it were not recycled. Finally, for purposes of reporting the waste minimization UC Contract, Appendix F, performance measure, the Laboratory distinguishes between routine and nonroutine waste generation. Routine generation results from production, analytical, and/or other R&D laboratory operations; treatment, storage, and disposal operations; and "work for others" or any other periodic and recurring work that is considered ongoing. Nonroutine waste is cleanup stabilization waste and relates mostly to the legacy from previous site operations.

The RCRA and 40 Code of Federal Regulations (CFR) 261.3, as adopted by NMED, define hazardous waste as any solid waste that

1. is generally hazardous if not specifically excluded from regulation as a hazardous waste;
2. is listed in the regulations as a hazardous waste;
3. exhibits any of the defined characteristics of hazardous waste (i.e., ignitability, corrosivity, reactivity, or toxicity); or
4. is a mixture of solid and hazardous waste.

Hazardous waste also includes substances regulated under the TSCA, such as polychlorinated biphenyls (PCBs) and asbestos.

Finally, a material is hazardous if it is regulated as a special waste by the State of New Mexico as required by the New Mexico Solid Waste Act of 1990 (State of New Mexico) and defined by the most recent New Mexico Solid Waste Management Regulations, 20NMAC 9.1 (NMED) or current revisions. This includes the following types of solid wastes that have unique handling, transportation, or disposal requirements to ensure protection of the environment and the public health, welfare, and safety:

- treated formerly characteristic hazardous (TFCH) wastes;
- packing house and killing plant offal;
- asbestos waste;
- ash;
- infectious waste;
- sludge (except compost, which meets the provisions of 40 CFR 503);

- industrial solid waste;
- spill of a chemical substance or commercial product;
- dry chemicals that, when wetted, become characteristically hazardous; and
- petroleum-contaminated soils.

Hazardous wastes are disposed of through Waste Management Federal Services, a Laboratory subcontractor. They send waste to permitted treatment, storage, or disposal facilities (TSDFs), recyclers, energy recovery facilities for fuel blending or burning for British thermal unit recovery, or other licensed vendors (as in the case of mercury recovery). The treatment and disposal fees are charged back to the Laboratory at commercial rates specific to the treatment and disposal circumstance. The actual cost varies with the circumstances; however, the average cost for onsite waste handling by SWO and offsite disposal is $11.75/kg. (Note: This rate and the rate structure for hazardous waste will change in FY01.)

Additional information on hazardous waste, Laboratory procedures for managing hazardous waste, and historical waste generation can be found in Refs. 7-1 to 7-5.

7.2. Hazardous Waste Minimization Performance

The DOE hazardous waste minimization goal is to reduce waste from routine operations by 90% by 2005, using CY93 as the baseline. Figure 7-1 shows this trend.

The Laboratory has achieved its portion of the DOE's 2005 goal as of the end of FY00. A significant fraction of the Laboratory's FY00 waste reduction can be attributed to FWO/SWO's policy of directing waste to recyclers rather than disposal companies. In the FY01 hazardous waste minimization performance measure, the Laboratory states that it is committed to maintaining hazardous waste generation at or below the FY00 generation rate.

7.3. Hazardous Waste Analysis

Hazardous waste commonly generated at the Laboratory includes many types of laboratory research chemicals, solvents, acids, bases, carcinogens, compressed gases, metals, and other solid waste contaminated with hazardous waste. This may include equipment, containers, structures, and other items intended for disposal and contaminated with hazardous waste (e.g., compressed gas cylinders). Also included are asbestos waste from the abatement program, wastes from removal of polychlorinated biphenyl (PCB) components, contaminated soils, and contaminated waste waters that cannot be sent to the SWSC or high-explosives (HE) waste water treatment plants.

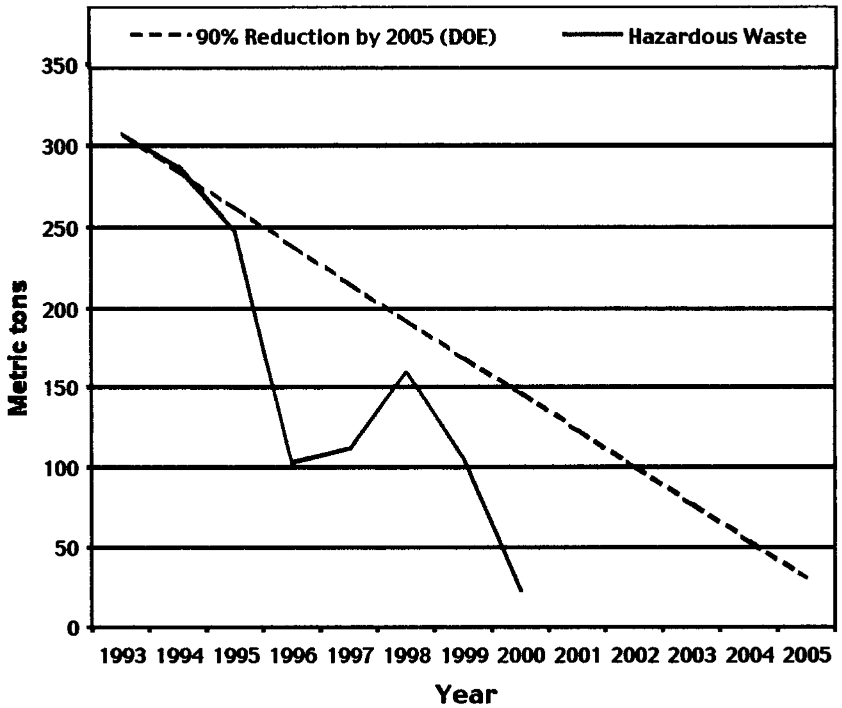


Fig. 7-1. Routine hazardous waste generation compared with the DOE 2005 goal.

Hazardous waste is derived from hazardous materials/chemicals purchased, used, and disposed of; hazardous materials already resident at the Laboratory that are disposed of as part of equipment replacement, facility replacement, or facility decommissioning; and water contaminated with hazardous materials. Once declared waste, hazardous waste is described (assayed if necessary), labeled, and collected at less-than-90-day storage areas. This waste then is either directly shipped to off-site TSDFs or transshipped to Area L, TA-54, from which it will be subsequently shipped to an off-site TSD. ER project waste typically is shipped directly from ER sites to commercial TSD facilities. Spent research chemicals make up the largest number of hazardous waste items; however, they account for only a small fraction of total hazardous waste volume (<1%). The ER project is the largest hazardous waste generator on site, accounting for over 95% of all hazardous waste. The Laboratory spent a total of $6,500,000 managing newly generated hazardous waste in FY00.

The top-level process map for hazardous waste is shown in Fig. 7-2.

As described in the introduction, the Laboratory produces three types of hazardous waste: RCRA, TSCA, and State Special. The quantity of each type of waste and the quantity of recycled waste are shown in Fig. 7-3. The waste shown in the figure is routine waste and excludes ER-generated waste.

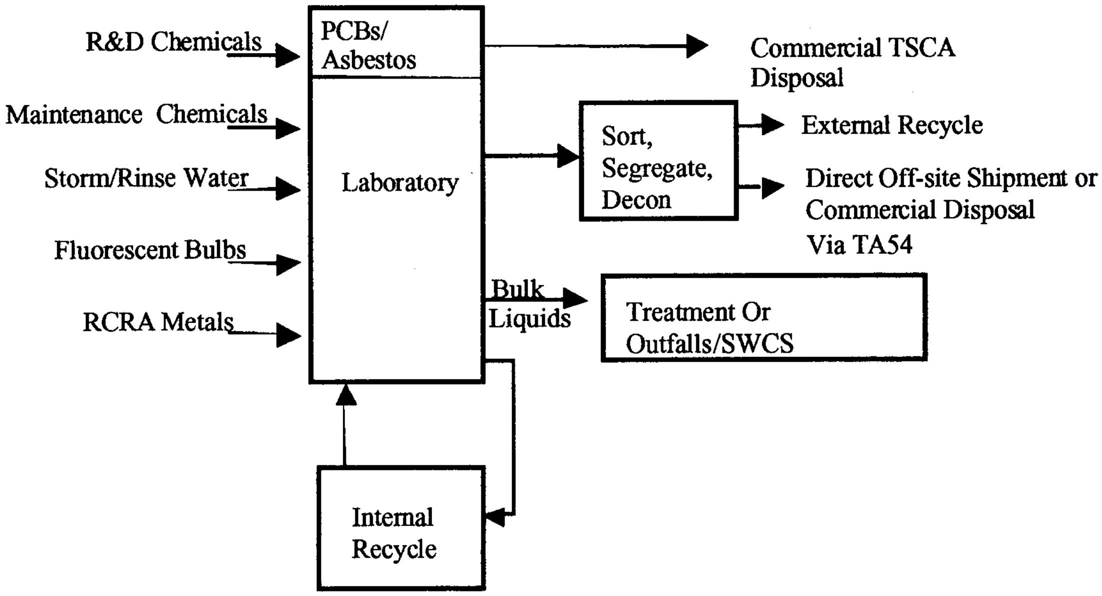


Fig. 7-2. Hazardous waste process map.

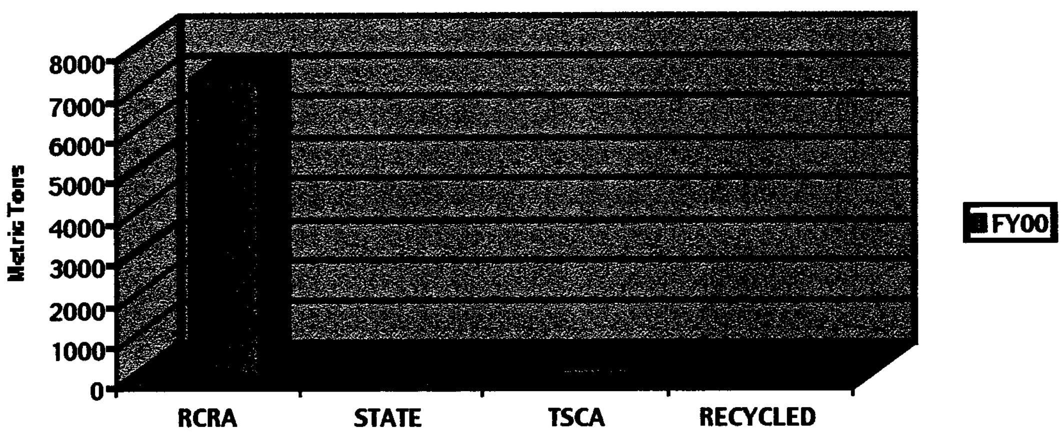


Fig. 7-3. FY00 hazardous waste by type.

The total quantity of hazardous waste generated at the Laboratory during the past four FYs is shown in Fig. 7-4. The waste quantities shown include routine, nonroutine, and ER-generated waste.

The large increase in FY00 hazardous waste results from remediation of Materials Disposition Area-P (MDA-P), an HE/barium-contaminated site from which large amounts of soil were removed. Routine hazardous waste generation is so small that it does not register on the chart. Nonroutine hazardous waste decreased abruptly from FY99 to FY00 because the Laboratory began excluding recycled hazardous waste from the hazardous waste total (see Fig. 7-5). Recycling of hazardous waste by SWO vendors has been increasing for the past several years. However, FY00 is the first year that the Laboratory has removed the recycled materials from the hazardous waste total.

FWO division generated the most hazardous waste, followed by DX Division and JCNNM, the Laboratory's crafts support contractor. The most significant waste streams are identified in Fig. 7-6 and described below.

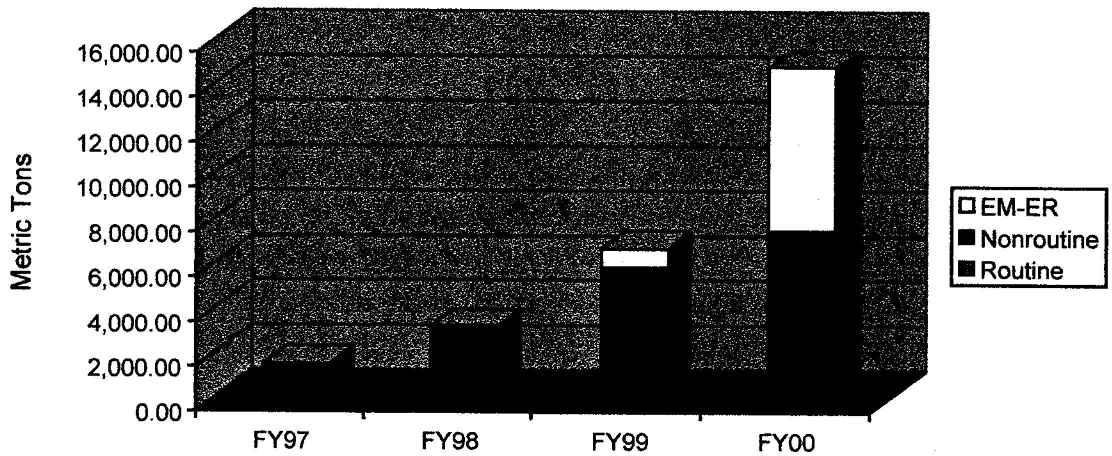


Fig. 7-4. Hazardous waste generation FY 97–00.

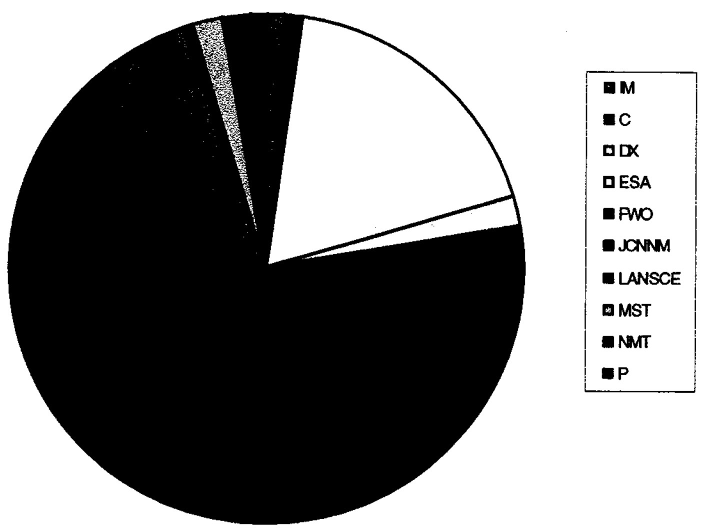


Fig. 7-5. Hazardous waste by division, excluding ER waste.

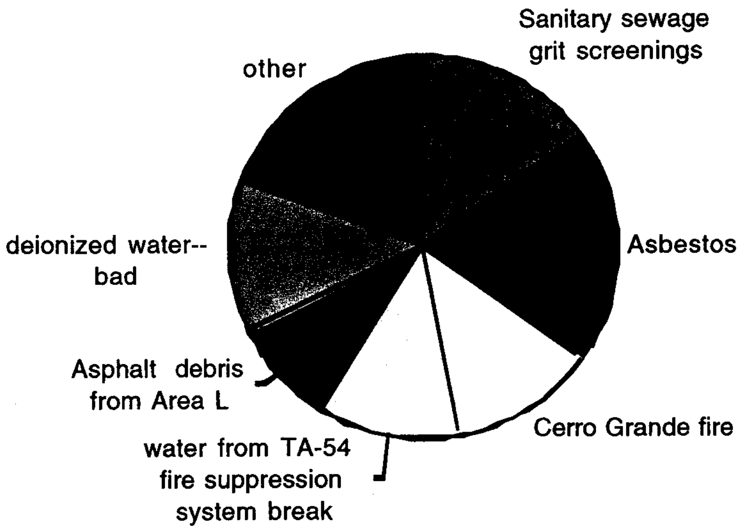


Fig. 7-6. Hazardous waste streams, excluding ER waste.

- **Sanitary sewage grit screenings.** In CY95, LANL grit screenings contained one sample that exceeded the regulatory limit for PCBs. Since then, sanitary sewage sludge has been disposed of as TSCA waste. The largest single constituent of the TSCA hazardous waste type is the PCB-contaminated sanitary sludge. This sludge becomes contaminated because the sanitary sewer lines upstream of the waste water plant are contaminated with PCBs. As a result, the sludge produced by treatment of the sanitary waste is contaminated with PCBs and therefore is TSCA waste. This sludge is sent off site for thermal destruction. In FY00 the Laboratory cleaned the PCB-contaminated drains, and because the Laboratory has not had another high-PCB event in the sanitary sludge, it requested EPA approval to no longer treat the sludge as a TSCA waste. When this request is approved, the sanitary sludge will be sent to a state-approved, special-waste landfill.

- **Asbestos.** Many Laboratory facilities contain asbestos insulation. Also, many safes at the Laboratory purchased from the 1940s through the 1970s contain asbestos fireproofing. These safes are being removed as part of the Laboratory's asbestos abatement program. This waste stream should continue for several years.

- **Cerro Grande fire debris.** Forty-eight metric tons of debris waste were generated by the Cerro Grande fire cleanup activities. This waste is not expected in FY01 or future years.

- **Water from the TA-54 fire suppression system break.** TA-54 domes have been plagued with fire suppression system water breaks—mostly because of freeze/thaw action. The system has been upgraded to address this problem. In addition, TA-54 is not building any more domes; future buildings will be heated.

- **Asphalt construction debris from Area L.** Area L is a hazardous waste disposal area. Past waste disposal practices created an organic vapor plume under the site. Previous management of asphalt contaminated with these volatile organic compounds as nonhazardous waste has been a point of contention between NMED and LANL. Because this waste stream did not meet the definition of hazardous waste, future generation of this type of material will not be managed as hazardous pursuant to ESH policy.

- **DX deionized water.** Deionized water stored in DX division for HE and printed-circuit-board processing had become contaminated during storage. Storage and inspection procedures have been improved to prevent this waste in the future.

- **Other.** The Laboratory produces an additional 80 MT of hazardous waste. Twenty metric tons of this waste result from small-quantity waste generation (<100 kg), which includes spent and unused chemicals, which constitute the largest number of waste items but only ~10 MT of waste. Also included in this category are photographic waste, flashpad ash, oil-contaminated soil, cooling-tower-basin residue, cooling-tower and chiller cleaner, large shipments of unused and spent chemicals, and spent machine coolant.

7.4. Environmental Aspect Analysis

An environmental aspects analysis was developed for those waste streams that are expected to continue in the future. This analysis is based on the ISO 14001 definitions of aspects, impacts, and activities. It analyzes the potential of hazardous waste to impact the environment in both normal operations and as a result of abnormal operational events. This analysis also links the waste stream to the activities that generate the waste. The next section describes options for minimizing the aspect by minimizing or eliminating the waste stream. Waste is one of the Laboratory's top-level aspects, and hazardous waste is a subaspect of waste. Hazardous waste is analyzed according to waste streams through an aspect scoring process, which is summarized in the following table.

The aspect analysis presented here must be regarded as preliminary. The Laboratory will be developing a final aspect analysis and scoring system over the next several months. Once developed, the system will be used to score the Laboratory environmental aspects systematically. That analysis will supercede the analysis presented below.

Aspect Definition: Waste

General Information

This aspect definition sheet was developed for the TRU, LLW, MLLW, Sanitary, Hazardous, and Liquid LLW Streams at LANL.

Location of Activity Impact

Location of Impact	Description	Scenarios Considered	Type
Global	Beyond the US	1. None	N/A
Regional	Beyond LANL but within the US	1. Release to the Environment or No Path Forward	Normal/Abnormal
		2. Disposition to a Landfill	Normal
		3. Treatment to BRC or Elimination of the Hazard	Normal
		4. Destruction	Normal
		5. Reuse or Recycle	Normal
Local	At LANL	1. On-Site Release	Abnormal

Magnitude of Activity		Probability of Occurence	
Normal Scenario		*Abnormal Scenario*	
Toxicity*(Volume or Mass) Toxicity: Sanitary =1, LLW = 100, MLLW & Haz = 100–1000, TRU = 1000 Volume or Mass: cubic meters or metric tons			
High	Product >100,000	**High**	Occurs at least once per year
Medium/High	Product 50,00–100,000	**Medium/High**	Occurs once every 1–10 yr
Medium	Product 10,000–50,0000	**Medium**	Occurs once every 10–100 yr
Medium/Low	Product 1,000–10,000	**Medium/Low**	Occurs once every 100–1000 yr
Low	Product <1,000	**Low**	Occurs only >1000 yr

Scale of Impact Definitions and Examples		High	Med./ High	Med.	Med./ Low	Low
1. Permanent:	Discharge of sufficient volume, duration, and toxicity to cause irreversible damage to the environment • Release to the Environment or No-Path-Forward Waste	1000	100	10	1	0.1
2. Significant:	Discharge of sufficient volume, duration, and toxicity to cause reversible damage to the environment • Disposal at a Regulated Landfill	100	10	1	0.1	0.01
3. Moderate:	Causes a change to the environment that requires long-term controls or corrective action • Treatment BRC or Elimination of the Hazard	10	1	0.1	0.01	0.001
4. Minimal:	Discharges of materials that are below the lowest regulatory threshold or, if not regulated by permit, have no known effect on the environment • Destruction	1	0.1	0.01	0.001	0.001
5. No Impact:	Negligible or no release to the environment • Reuse or Recycle	0.1	0.01	0.001	0.001	0.001

In the normal scenario, hazardous waste most often falls to moderate levels because this waste is regulated and must be disposed of in prescribed pathways using long-term monitoring requirements. From a magnitude-of-activity perspective, hazardous waste that is landfilled has the greatest impact on the environment, waste that is treated to be nonhazardous has less impact, and hazardous waste that is recycled into other products has the least impact. In the abnormal scenario, hazardous waste spills dominate the analyses. Table 7-1 identifies the waste streams, their activities, and their score.

Table 7-1. Identification of the Waste Streams, Their Activities, and Their Score

Division	Waste Stream	Activity	Magnitude Probability	Impact (Normal/ Abnormal)	Score (Normal/ Abnormal)
DX	Methyl-ethyl ketone in water	HE production	Medium Medium/Low	2 2	1 0.1
DX	HE Waste water	HE production	Medium/Low Low	1	1 0.01
FWO/SWO	Area L debris	Waste operations in a Material Disposal Area	Medium	3	0.1
Several	Research chemicals	Chemistry research	Medium Medium/low	2 1	1 1
Several	Unused chemical	Chemistry research and production operations	Medium/Low Medium/Low	2 1	0.1 1
ESA	Burn ground ash	HE burning	Medium/Low	2	0.1
IM, DX, ESA, B	Photochemistry waste	Wet photography	Medium/Low Medium/Low	3 3	0.01 0.01
DX	Contaminated rainwater	Exposed containment sumps	Medium	3	0.1
FWO/UI	Sanitary sewage grit screenings	Contaminated sewer system operation—PCBs	Medium Medium/High	2 1	10 100
Several	Chiller cleaner	Chiller maintenance	Medium Medium/High	3 3	0.1 1
ESA, NMT, DX	Machine coolants	Machining operations	Medium Medium	3 3	0.1 0.1
JCNNM	Contaminated soils	Hydraulic/other oil spills, small chemical spills, firing range activity	Medium/High Medium	2 2	10 1

Aspects scoring 10 or more are significant and are discussed in more detail below. Projects addressing these aspects are identified below and described in more detail in the next section.

Contaminated sanitary sewer system operation. The PCB-contaminated sludges have resulted from PCB contamination in the sewer drains and piping. Several PCB sources have been identified and cleaned to EPA-specified standards. Thus, PCB contamination should not appear again in the sewage sludge. However, contamination in the sewer system remains a significant aspect. Because of the age of the sewer system and knowledge of past operational procedures, it is very likely that the sewer system contains significant residual contamination. For example, mercury from broken thermometers often is found in sewer systems from installations of laboratories as old as LANL. Livermore has slip-lined all of their sewage pipes. This method ensures that past contamination is not released into the sewage treatment system. It also ensures that the drain pipe contents do not leak to the surrounding environment. The Laboratory's sewage system could be a continuing source of hazardous waste concerns. Currently, there is no recommended remedial action to address the hazardous waste potential of the sewage system.

Petroleum spills. Several times during the year, oil or other hazardous liquids are spilled onto the soil during Laboratory operations. Several actions are underway to minimize this aspect. JCNNM conducted a Green Zia analysis of hydraulic oil spills and found that switching to bio-based hydraulic oils would mitigate the hazard because these oils are sanitary waste. Soils also are contaminated as a result of firing range activity and small spills.

7.4.1. Potential Mitigating Actions

The potential mitigating actions for the high-scoring aspects are listed below.

Hazardous Waste Subaspect	Potential Mitigating Action
Sanitary Sewage Government Screenings	TSCA Sludge Mitigated; Drain System—TBD
Contaminated Soils	Switch to Bio-Based Hydraulic Fluids, Green Ammunition

7.5. Improvement Projects

The projects intended to mitigate the effects of hazardous waste are described in this section. These projects are classified as completed, ongoing, and unfunded.

7.5.1. Completed Projects

The following projects have been completed, but in some cases, there are follow-on activities. The projects are aggregated in three groups: projects addressing high-scoring aspects, projects addressing other aspects, and projects for which an aspect no longer exists.

- Projects for High-Scoring Aspects
  - Sanitary sewage grit screenings. PCB-contaminated drains in the Sigma facility were cleaned to regulatorily prescribed levels as a corrective action for PCB contamination found in the SWSC plan screening grit. A letter has been sent to the EPA notifying them of acceptable PCB levels in the SWSC sludge and requesting authority to dispose of SWSC sludge as State-Regulated Special solid waste rather than TSCA waste (which is 50 times more expensive to dispose of).

- Projects for Which an Aspect No Longer Exists
  - Fluorescent bulbs. The Laboratory has begun purchasing low-mercury, nonhazardous fluorescent bulbs for the ~30% of Laboratory lighting fixtures with 34-W ballasts. Low-mercury bulbs are not available for fixtures with the more common, older, 40-W ballasts.
  - MST-6 Sigma plating shop water recycle. Waste water from a plating shop is F 006-listed RCRA waste. In 1998, DOE/EM funded installation of an evaporative water recycling unit (1.5 million gal./yr) to eliminate plating shop waste water from plating and rinsing operations.
  - Thinner recycle. The JCNNM paint shop installed an evaporative recycle device for paint thinner.
  - Machine coolant recycle. The MST-6 and ESA main machine shops have installed coolant filtration and management systems that achieve a 10–100X increase in coolant lifetime.
  - HE waste water reduction. DX-2 replaced handwashing of glassware with industrial dishwashers that use less water.
  - Lead recycle. The Laboratory has contracted with Ace Metals, Inc., of Albuquerque to recycle excess or waste Laboratory lead.
  - Nitric acid recycle. MST-7 has installed a nitric acid recycling unit to recycle the nitric acid used to dissolve copper electroforms.
  - Nonhazardous ink plotter. JCNNM replaced a plotter using hazardous inks with a dry ink model.
  - Biowaste autoclaving. B Division routinely autoclaves all biomedical waste so that it can be disposed of at the sanitary landfill.
  - Administration building chiller replacement. This building chiller was replaced with a newer model with abrasive scrubber balls that circulate in the working fluid. This eliminates the need for chiller cleaning with hazardous chemicals.

7.5.2. Ongoing Projects

These funded projects are currently active. They are categorized as in the previous subsection.

- **Projects for High-Scoring Aspects**

  For contaminated soils:

  - Green ammunition. Protection Technologies Los Alamos (PTLA) is testing lead-free bullets. If acceptable, these bullets will replace the lead bullets used in livefire training at the PTLA firing range. This will stop deposition of an RCRA hazardous material into the environment and avoid future remediation costs.

  - Bio-based hydraulic oil. JCNNM is converting Laboratory heavy equipment to use bio-based hydraulic oils. These are not regulated as hazardous waste; consequently, oil spills and spill cleanup become sanitary waste.
  - Hydraulic systems improvements. JCNNM is redesigning hydraulic couplings on backhoes to reduce the likelihood of coupling failure and the resulting oil spills. JCNNM is replacing the oldest Pakmaster (trash compacting truck), which has had frequent hydraulic line failures.

- **Projects for Other Aspects**
  - Aerosol-can recycle. JCNNM and several other Laboratory organizations are installing 55-gal.-drum mounted aerosol-can puncture units. Once punctured, the cans are no longer RCRA waste and can be recycled by Ace Metals.
  - Non-RCRA waste water pretreatment. The JCNNM-managed SWSC plant is configuring a waste water pretreatment trailer that can process waste waters that do not meet the SWSC plant WAC so that those waters can be disposed of to SWSC. Floor stripper (for removing wax) and mop water from some floor cleaning operations could be processed with this unit.

7.5.3. Unfunded Projects

These proposed projects, where an environmental aspect exists, currently are unfunded.

- **Projects for Other Aspects**
  - Sump elimination. DX-2 proposes filling sumps and open trenches that connect to the HE waste water collection system. This will avoid rain-water infiltration.
  - Chemical exchange system. The new chemical management system is proposed to be upgraded to facilitate exchange and reuse of new, unopened chemicals.
  - Perchlorate minimization. Elimination of perchlorate as a reagent in production chemical assay processes is proposed.
  - Digital photography. Replacement of film-based wet photography with direct digital recording photography is proposed, both for optical and x-ray photography.

- Chiller replacement. As Laboratory chillers using ozone-depleting substances are replaced, it is proposed that they be replaced with models using self-cleaning sponge balls that continuously circulate with the chiller refrigerant.

REFERENCES

7-1. United States Department of Energy, "Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory," United States Department of Energy document DOE/EIS-0238 (January 1999).

7-2. United States Department of Energy, "Mitigation Action Plan for the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory," United States Department of Energy document DOE/EIS-0238 (September 1999).

7-3. "General Waste Management Laboratory Implementing Requirement (LIR)," Laboratory Implementation Requirement LIR404-00-02.2 (Issue Date: November 1, 1998, Revised Date: October 6, 1999).

7-4. "Hazardous Waste Management LIR—Laboratory Implementation Requirements," LIR404-00-03.0 (Effective Date: December 16, 1996).

7-5. Los Alamos National Laboratory Hazardous Waste Permit NM0890010515-1 (1989).

8.0. SOLID SANITARY WASTE

8.1. Introduction

Most material brought into the Laboratory will leave as solid sanitary waste if it cannot be sold for reuse, salvage, or recycle. Sanitary waste is excess material that is neither radioactive nor hazardous and that can be disposed of in the DOE-owned, Los-Alamos-County-operated landfill (County landfill, or landfill) according to the WAC of that landfill and the State of New Mexico Solid Waste Act and regulations. Solid sanitary waste includes paper, cardboard, office supplies and furniture, food waste, wood, brush, and construction/demolition waste. Figure 8-1 is the process map for sanitary waste generation at the Laboratory; the major constituents and sub-elements of the sanitary waste stream are shown in the pie charts.

The Laboratory generates more than 9500 tons of sanitary waste per year. Of this total, ~5000 tons is construction debris, which is disposed of as sanitary waste; 2500 tons of material is recycled; and 2000 tons of discarded material is disposed of in the landfill each year. The exact size of the waste streams and the year-to-year variations are difficult to assess because sanitary waste is not traced by generator or in detail by waste stream.

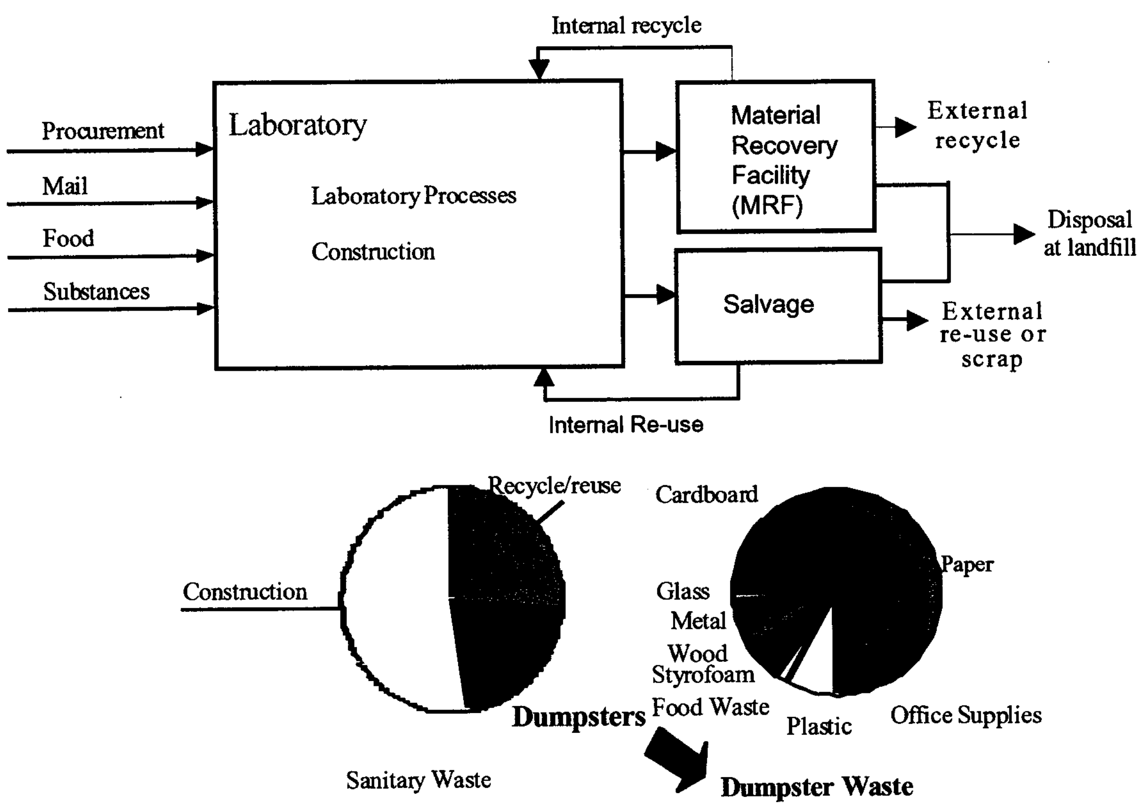


Fig. 8-1. Top-level sanitary waste process map and waste streams.

8.2. Sanitary Waste Minimization Performance Compared with DOE Goals

The DOE has implemented goals for waste minimization. The DOE environmental leadership program will go beyond compliance requirements and will be based on continuous and cost-effective improvements. To achieve these goals, the Laboratory will use an EMS to evaluate environmental aspects and define the most cost-effective solutions to reduce the environmental impacts from these aspects.

The DOE requires that solid sanitary waste generated from routine operations be reduced by 75% by 2005 and 80% by 2010, using CY93 as the baseline. Routine waste is defined as waste generated by any type of production, analytical, and/or R&D laboratory operations; work for others; and any periodic and recurring or ongoing work. The Laboratory's performance toward this goal is shown in Fig. 8-2. (Total yearly waste generation is calculated as the sum of disposed waste and recycled volumes—only the yearly amount disposed of is represented in the graph.)

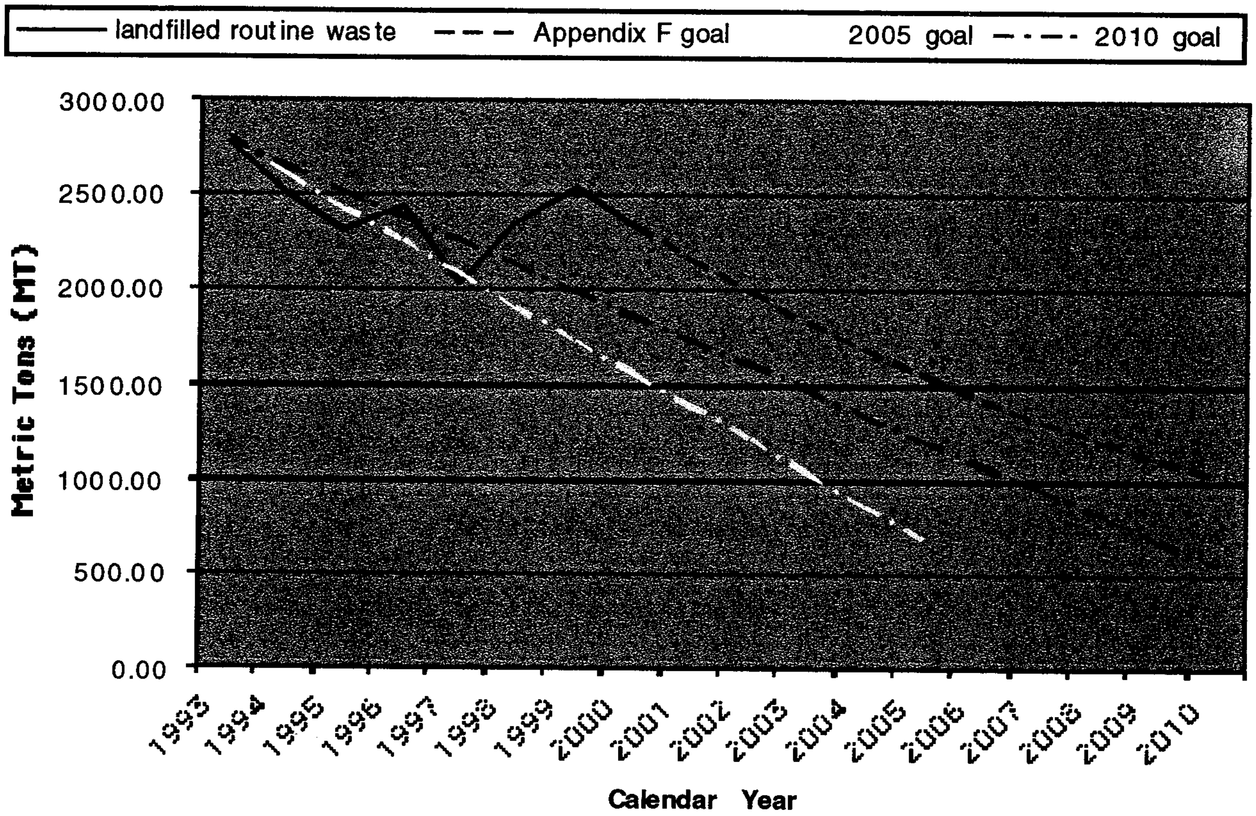


Fig. 8-2. Routine sanitary waste sent to landfill.

The DOE also requires that 45% of the sanitary waste from all operations (both routine and nonroutine) be recycled by 2005 and that 50% be recycled by 2010. The recycling rate is calculated as

$$\frac{\text{amount recycled}}{(\text{amount recycled}) + (\text{amount disposed of})} = \text{overall recycling rate.}$$

The Laboratory's performance toward this goal for sanitary waste is shown in Fig. 8-3.

The recycle of total (routine + nonroutine) sanitary waste currently stands at 16%; the Appendix F goal for 2001 specifies a 2% increase.

8.3. Waste Stream Analysis

Nonhazardous, nonradioactive materials enter the Laboratory as procured items, mail, food, and various other substances, such as glass, brush, and construction materials. These items are used by the Laboratory and are recycled, reused, salvaged, or disposed of in the County landfill. Materials disposed of include construction waste, food and food-contaminated wastes, paper products, glass, and Styrofoam.

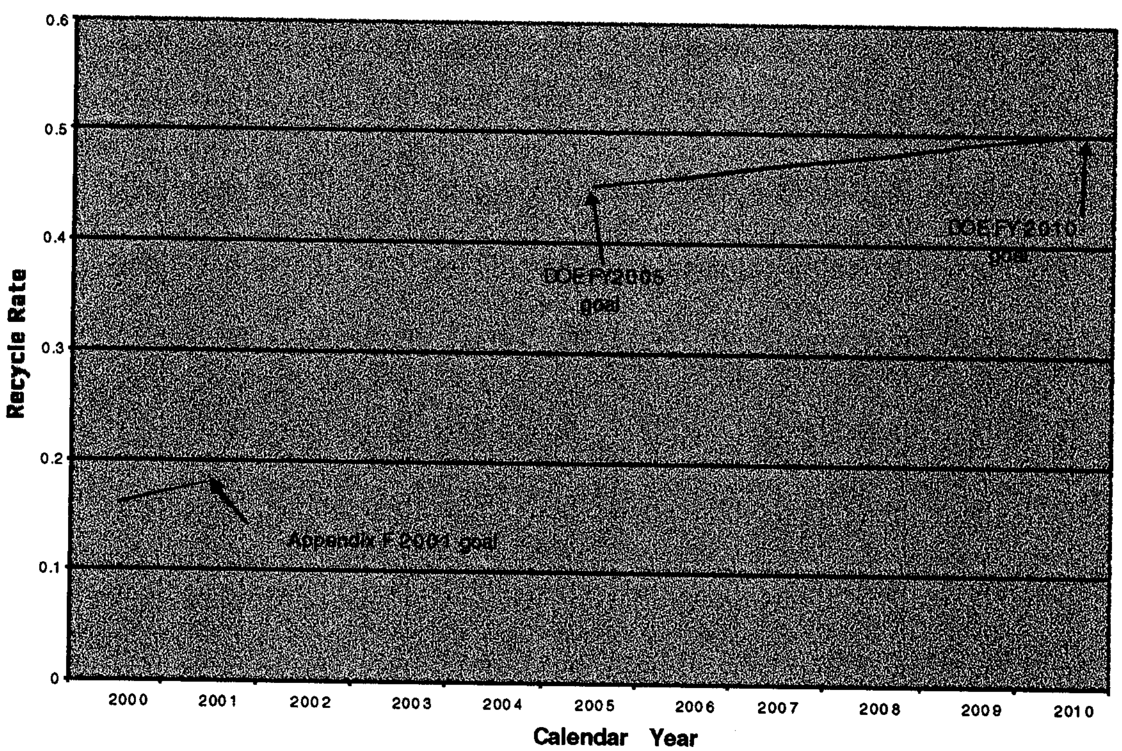


Fig. 8-3. Laboratory routine sanitary waste recycling rate.

The nine predominant sanitary waste streams listed below are described in more detail in the following sections.

1. Construction/demolition waste
2. Procured equipment and supplies
3. Paper products
4. Office supplies and equipment
5. Mail
6. Cardboard
7. Plastics
8. Glass
9. Food and food-contaminated materials

8.3.1. Construction/Demolition Waste

The largest sanitary waste stream is the construction/demolition waste stream. Construction/demolition waste is generated during the Laboratory's projects to build new facilities, upgrade existing facilities, or demolish facilities that are no longer needed. Construction/demolition projects require that raw materials and equipment be brought onto the site, along with utilities, especially water. The waste generated by these projects is varied and consists primarily of dirt, concrete, asphalt, some wood items, and various metal objects; the three largest components of this waste are used asphalt, concrete rubble, and dirt. This waste stream is growing and will continue to do so as planned new construction and renovation projects begin. Before May 1998, these materials were reused as fill to construct a land bridge between two areas of the Laboratory; however, that activity was halted because of environmental and regulatory issues. Currently, much of this waste goes directly to the landfill; however, there are several other options for the reuse of construction/ demolition debris.

8.3.2 Procured Equipment and Supplies

Every year the Laboratory procures equipment and supplies to enable it to fulfill its mission. The procured material ranges from computers, office supplies, and office furniture to scientific instruments and vehicles. Items that are valuable enough to be assigned a property number must be salvaged when they are no longer needed. Items that have some useful life left can be reused within the Laboratory or sold to individuals, organizations, or off-site vendors for reuse or recycle. The Laboratory currently disposes of ~2500 tons of used equipment and supplies per year through the Property Disposal operations. There are three major components to the procured materials stream; however, because supplies and equipment are handled in virtually identical ways at the Laboratory, they have been aggregated into a single waste stream in the following discussion. The handling of paper products is very different and much more complex and therefore is treated as a separate waste stream.

8.3.3. Paper Products

The Laboratory purchases ~500 tons of paper products each year. These products are used in a variety of ways, but mostly in offices for printing, copying, faxing, and other office support uses. Paper is used to produce unclassified, classified, and sensitive documents, and each type has a different path to disposal. Unclassified paper products normally are disposed of in either green desk-side bins, which are taken directly to recycle, or in trash bins. Some unclassified materials are sent to storage or to archiving. This material is held in storage for varying periods before it is disposed of. Some unclassified material may be distributed to RCAs, where it is subject to radioactive contamination and disposal as LLW. Uncontaminated paper from RCAs may be disposed of in "Green Is Clean" bins and sent to be characterized and recycled.

Sensitive materials are shredded. Although strip-shredded sensitive material is sent to recycle, cross-cut shredded material (e.g., classified material) currently cannot be recycled and is disposed of.

8.3.4. Office Supplies/Equipment

The Laboratory purchases a variety of office supplies and equipment, including furniture, partitions, computers, fax machines, printers, and desk accessories. Equipment with assigned property numbers is excessed or salvaged at the end of its use. Items that have been replaced or are no longer needed but have some useful life left can be reused, either within the Laboratory or when sold to individuals, organizations, or vendors off site. Items that have no other intrinsic value can be sold as scrap for recycling. Items that cannot be recycled, salvaged, or otherwise reused are disposed of at the landfill.

8.3.5. Mail

Every year the Laboratory receives and distributes over 700 MT of mail. This mail includes junk and business mail, catalogs, phone directories, and various documents.

The Laboratory distributes mail, including internally generated mail. Most of this material can be recycled after use. Publications such as catalogs and directories that are bound with glue must have the bindings sheared off before the paper is recycled; the bindings then are sent to the landfill for disposal. Classified material may not be disposed of unless it has been security (cross-cut) shredded. Strip-shredded material can be recycled, but cross-cut shredded material currently goes to the landfill.

8.3.6. Cardboard

Cardboard enters the Laboratory in one of two ways: as packaging materials or as newly purchased moving boxes. Some of the cardboard, particularly cardboard moving boxes, is recycled for reuse routinely. Other cardboard is discarded to either the dedicated cardboard collection roll-offs or the trash dumpsters. Dumpster trash is taken to the Material Recovery Facility (MRF) and sorted, where recyclable cardboard is recovered. Wet or food-contaminated cardboard is sent to the landfill for disposal.

8.3.7. Plastics

Plastics and foam are used for many purposes at the Laboratory and constitute the third largest component of dumpster waste. The waste stream consists primarily of food/beverage containers, shrink-wrap, plastic bags, and packaging materials. A plastics recovery/recycle program that will capture a variety of mixed plastics was initiated recently at the Laboratory. Packaging material, e.g., Styrofoam, will continue to be disposed of at the landfill.

8.3.8. Glass

Glass products enter the Laboratory either as purchased items (e.g., beakers, flasks, and pipettes) or as containers. Although many chemicals are purchased in glass bottles, the largest source of glass is beverage containers, either purchased through the food services on site or brought in from outside the Laboratory and disposed of on site. Limited opportunities exist for recycling this waste stream because of a lack of market demand and high transportation costs. Glass currently is disposed of at the landfill.

8.3.9. Food and Food-Contaminated Materials

Food products enter the Laboratory waste streams either through food service from one of the three cafeterias or from food brought into the Laboratory from off site. Based on FY98 data, the total waste stream is estimated to exceed 500 tons per year and equates to more than 25% of the sanitary waste stream. A minimum of 400 tons (or 20%) of the sanitary waste is generated from this stream. All of the food and food-contaminated wastes generated at the Laboratory currently are sent to the landfill. This waste stream is particularly intractable because there are few realistic options for reducing it.

8.4. Aspect Analysis

An environmental aspects analysis was developed for those waste streams that are expected to continue in the future. This analysis is based on ISO 14001 definitions of aspects, impacts, and activities. It analyzes the potential of sanitary waste to impact the environment, both in normal operations and as a result of abnormal operational events. The analysis links the waste stream to the activities that generate the waste. The scoring system ranks aspects based on damage to the environment, quantity, and probability of occurrence. The following subaspects have been identified for solid sanitary waste.

1. Solid sanitary waste disposed of at the Los Alamos County landfill
2. Off-site recycling
3. Off-site reuse

The aspect analysis presented here must be regarded as preliminary. The Laboratory will be developing a final aspects analysis and scoring system over the next several months. Once developed, the system will be used to score the Laboratory environmental aspects systematically. That analysis will supercede the analysis presented in the following table.

Aspect Definition: Waste

General Information

This aspect definition sheet was developed for the TRU, LLW, MLLW, Sanitary, Hazardous, and Liquid LLW Streams at LANL

Location of Activity Impact

Location of Impact	Description	Scenarios Considered	Type
Global	Beyond the US	1. None	N/A
Regional	Beyond LANL but within the US	1. Release to the Environment or No Path Forward	Normal/Abnormal
		2. Disposition to a Landfill	Normal
		3. Treatment to BRC or Elimination of the Hazard	Normal
		4. Destruction	Normal
		5. Reuse or Recycle	Normal
Local	At LANL	1. On-Site Release	Abnormal

Magnitude of Activity		Probability of Occurence	
Normal Scenario		*Abnormal Scenario*	
Toxicity*(Volume or Mass) Toxicity: Sanitary = 1, LLW = 100, MLLW & Haz = 100-1000, TRU = 1000 Volume or Mass: cubic meters or metric tons			
		High:	Occurs at least once per year
High:	Product >100,000	**Medium/High:**	Occurs once every 1 and 10 yr
Medium/High:	Product 50,000–100,000		
Medium:	Product 10,000–50,0000	**Medium:**	Occurs once every 10–100 yr
Medium/Low:	Product 1,000–10,000	**Medium/Low:**	Occurs once every 100–1000 yr
Low:	Product <1,000	**Low:**	Occurs only >1000 yr

Scale of Impact Definitions and Examples		High	Med./High	Med.	Med./Low	Low
1. Permanent:	Discharge of sufficient volume, duration, and toxicity to cause irreversible damage to the environment • Release to the Environment or No-Path-Forward Waste	1000	100	10	1	0.1
2. Significant:	Discharge of sufficient volume, duration, and toxicity to cause reversible damage to the environment • Disposal at a Regulated Landfill	100	10	1	0.1	0.01
3. Moderate:	Causes a change to the environment that requires long-term controls or corrective action • Treatment BRC or Elimination of the Hazard	10	1	0.1	0.01	0.001
4. Minimal:	Discharges of materials that are below the lowest regulatory threshold or, if not regulated by permit, have no known effect on the environment • Destruction	1	0.1	0.01	0.001	0.001
5. No Impact:	Negligible or no release to the environment • Reuse or Recycle	0.1	0.01	0.001	0.001	0.001

In the normal scenario, sanitary waste most often falls in the significant impact category because solid sanitary waste is regulated and must be disposed of in a prescribed manner. From a magnitude-of-activity perspective, sanitary waste that is landfilled has the greatest impact on the environment, sanitary waste that is recycled into other products has less impact, and items that are salvaged and reused have the least impact. In the abnormal scenario, sanitary waste contamination dominates the analyses. The waste streams, their activities, and their score are listed below.

Waste Stream	Activity	Magnitude Probability	Impact (Normal/ Abnormal)	Score (Normal/ Abnormal)
Construction Debris	Off-site recycle	Medium/low Medium	3 2	0.01 1
	Disposal	Medium/low Medium/high	2 2	0.1 10
Dumpster Waste	Off-site recycle	Low Low	5 3	0.001 0.001
	Disposal	Medium/low Medium/high	2 2	0.1 10
Equipment Recycle and Reuse	Off-site recycle	Low Medium/high	5 3	0.001 1
	Off-site reuse	Low Medium/high	5 3	0.001 1

Aspects scoring 10 or more are significant. The abnormal scenarios dominate the significant aspects for solid sanitary waste. This is to be expected because this waste form has neither the volume nor the toxicity to affect the environment significantly under normal circumstances. The abnormal scenarios address the inadvertent disposal or recycle of contaminated sanitary waste or disposal of items that are not now considered a threat to the environment but may be regulated in the future. These scenarios either require corrective action or cause reversible damage to the environment. Materials that are candidates for recycle normally are surveyed for contamination, and thus, recycle decreases the probability of inadvertently disposing of contaminated items.

8.5. Improvement Projects

The projects intended to mitigate the affects of sanitary waste on the environment are described in this section and are shown below. The projects are classified as completed, ongoing, and unfunded.

Sanitary Waste Aspect	Potential Mitigating Action
Dumpster Waste Disposal—Abnormal Scenario	Recycle Programs
Construction Debris Disposal—Abnormal Scenario	Recycle Programs

8.5.1. Completed Projects

The following projects have been completed; however, in some cases, there are follow-on activities.

1. MRF. The Laboratory completed construction of and began initial operation of an MRF to recover recyclable items from trash dumpsters. Dumpsters are emptied and their contents sorted at the MRF. This operation results in the recovery of ~100,000 lb of cardboard, 20,000 lb of metal, 24,000 lb of wood, and 4500 lb of other recyclables per year. Purchase of a baler has greatly increased the efficiency of the MRF operation.

2. Cardboard Recycle. For several years, the Laboratory has been expanding its cardboard recycle program. Beginning in FY97, LANL began purchasing roll-offs for facilities across the site. This action has greatly increased the volume of cardboard going to recycle. In addition, the Laboratory began recovering cardboard at the MRF and compacting it in FY00, which increases the ease of recycle.

3. Paper and Document Recycle. The Laboratory recycles paper, mail, and publications through three programs.

   - Green Recycle. Most unclassified white paper can be deposited in green desk-side bins for recycle. Sensitive materials are shredded before being recycled as unclassified waste. Strip-shredded paper can be recycled, but cross-cut shredded material cannot.

   - MS A1000. Junk mail, books, transparencies, newsprint (newspapers), magazines, flyers, brochures, catalogs, binders, colored paper, and folders are recycled at the Laboratory by sending unwanted materials to MS A1000. Phone books are recycled annually at MS A1000. This program won a White House Closing the Circle Award in FY00.

   - MS J568—"Stop Mail." MS A1000 provides a mechanism for recycling unwanted paper or documents, but the "Stop Mail" Program provides a mechanism for stopping unwanted mail from ever entering the mail system. Employees receiving unwanted mail at the Laboratory may send that mail to MS J568 to be removed from mailing lists.

4. Asphalt Recycle. JCNNM provides asphalt grinding, when needed, for all projects for which they are responsible. Other organizations that generate asphalt waste at the Laboratory are responsible for contracting to have that waste ground. Ground asphalt waste is stored at sites determined by FWO until it can be reused or recycled.

8.5.2. Ongoing Projects

These projects are funded projects that are currently active. They are categorized as in the previous section.

1. Concrete Crushing. The Laboratory has obtained a concrete crusher for use in recycling or reusing concrete waste. The crusher currently is being deployed before acceptance testing and should be operational in FY01. Noncontaminated concrete waste then will be crushed and stored for reuse.

2. Construction Debris Inspection/Recycle. A program has been initiated to inspect all construction debris for recyclable content. Sorting and segregation of reusable items occur at the construction site before the debris is loaded. Trucks containing construction debris then are dispatched to the salvage yard for inspection. If the trucks are found to contain recyclable or reusable items, those items are removed.

3. Salvage and Reuse. Items that have been replaced or are no longer needed but have some useful life left can be recycled. These items can be reused within the Laboratory through the Laboratory salvage program or sold to individuals, organizations, or vendors off site for recycling.

4. Metal Recycle. Metals and scrap wire are recycled through JCNNM. If large amounts of metal or wire are expected to be generated at a site, the generator may arrange for a scrap metal collection bin (roll-off or dumpster) to be placed at its site. All metal must be clean and suitable for public release (i.e., no radioactive or chemical contamination). This program currently is undergoing modification.

5. Lead Recycle. Lead is recycled through JCNNM. All lead must be checked for radioactive contamination. All metal must be clean and suitable for public release (i.e., no radioactive or chemical contamination). Currently, there is a moratorium on decontamination and recycle of contaminated lead for public use.

6. Glass Recycle. The Laboratory is participating in a glass recycling program initiated by JCNNM. Glass collected for recycle is shipped to Nambe Pueblo in northern New

Mexico, where it is ground and marketed commercially. Potential uses include decorative materials and aggregate substitution in concrete.

8.5.3. Unfunded Projects

These are projects for which an environmental aspect exists but that currently are unfunded.

1. Site-Wide Excess Cleanup. The Laboratory has ~10,000 tons of mostly unusable excess equipment stored outdoors. Because this material is exposed to rain and snow, it is significant storm-water polluted. In addition, some of the material is flammable and represents a fire hazard if stored near structures or other combustible materials such as grass or trees. The excess material also may serve as shelter for mice, rats, and other small mammals. An effort to reduce or eliminate this material could reduce the pollution potential dramatically, as well as reduce the fire and health risks.

2. Sanitary Waste Composting. The 400 MT of the Laboratory's annual solid sanitary waste stream consists of food-related waste. The waste is generated from three primary sources: (1) cafeterias, (2) catering services, and (3) containers from food brought on site by employees. This waste is amenable to composting, which produces a useful soil amendment. In addition to the ~400 MT of food waste generated each year, 33 MT of shredded paper also could be composted. Composting will be implemented in partnership with a local organization that will own and operate the composting system after it has been tested and is operational.

8.6. FY01 Project Summaries

Summaries of many of the major Solid Sanitary Waste Projects can be found in Appendix B, "Return on Investment Analyses."

9.0. CONSTRUCTION

9.1. Introduction

LANL plans significant new construction and facility upgrades in the next 10 yr. The Laboratory's aging facilities/infrastructure and new missions have caused construction activities to become a priority. Although sustainability is a new concept to the Laboratory, sustainable design (SD) principles are becoming more and more important as available natural resources are threatened and DOE funding is reduced. The Laboratory realizes that SD will reduce life-cycle costs and generation, improve energy efficiency, increase resource conservation, reduce regulatory concerns, improve public perception, and improve the health and safety of facility occupants.

In accordance with DOE Order 5400.1 and EO 13123, pollution prevention/waste minimization and sustainability considerations must be incorporated into the design and operating plans of new facilities.

The construction roadmap will define waste streams generated in construction processes, explain SD, and provide an approach to implement SD into construction processes and thus reduce waste generation and natural resource consumption throughout the life of the facility. The impacts of Laboratory construction include waste generation, liquid effluents, air emissions, energy usage, water usage, and materials procured.

The following definitions are used throughout this chapter in relation to sustainability.

1. Sustainability. The ability of a society, ecosystem, or any such ongoing system to continue functioning into the indefinite future without being forced into decline through the exhaustion of key resources and without having a significant detrimental effect on the environment. Overuse or nonrenewable use of resources eventually will decrease future productivity, thereby lowering sustainable yields. Even if the resources are abundant, systems that rely on certain resources may not be sustainable if this resource consumption results in major environmental impacts.

2. SD. The systematic consideration during design of an activity, project, or product's life cycle impacts on the sustainable use of environmental and energy resources. The main thrust of sustainable design is to use resources efficiently and within their renewable limits. SD (1) recognizes that products and processes are interdependent with the environmental, economic, and social systems surrounding them; (2) follows design principles that respect these connections; and (3) implements measures to prevent an unsustainable compromise to these systems.

3. SD Principles

- Increase energy and water conservation and efficiency
- Increase use of renewable energy resources
- Reduce or eliminate toxic and hazardous substances in facilities, processes, and their surrounding environments
- Improve indoor air quality and interior/exterior environments, which leads to increased human productivity and performance and to better human health
- Use resources and material efficiently
- Select materials and products that would minimize safety hazards and life-cycle environmental impacts
- Increase the use of materials and products with recycled content and of environmentally preferred products
- Recycle and salvage construction waste and building materials during construction and demolition
- Generate less-harmful products during construction, operation, and decommissioning/ demolition
- Implement maintenance and operational practices that reduce or eliminate harmful effects on people and the natural environment

4. Sustainable Design Practices

- Passive solar design
- Optimum use of daylighting
- Optimum use of natural ventilation
- Water-efficient design features
- Energy-efficient design features
- Sustainable construction features
- Maximum use of recycled materials
- Sustainable landscaping design
- Aesthetically and ergonomically appealing work areas
- Indoor environmental quality attributes
- Alternative (sustainable) construction materials

9.2. Construction Waste Minimization Performance Compared with DOE Goals

The DOE has not set quantitative goals for the reduction of construction waste. However, construction waste is covered in DOE Order 5400.1, *Appendix A, Cleanup and Stabilization*, by including in that category "any wastes that are generated on a one-time basis such as construction wastes." Further, 5400.1 requires that sites fully incorporate sustainable design principles to achieve lowest life-cycle cost and minimize generation of wastes and pollutants in site planning for construction of new facilities or modification of existing facilities. In addition, the Project Management LIR requires construction projects to develop a waste minimization plan. These requirements set the parameters for pollution prevention and waste minimization for construction activities. To meet these requirements and satisfy Appendix F performance measures, two pollution prevention opportunity assessments were performed using Green Zia analysis tools. These analyses were done for the Laboratory's two Title One construction projects, as described in Refs. 9-1 and 9-2.

9.3. Waste Stream Analysis

The Laboratory currently does not track the quantities of construction waste being produced either by type or by generator, except for rubble waste being sent to the County Landfill. Approximately 5000 tons of construction debris is disposed of as sanitary waste each year (see Section 8, Solid Sanitary Waste). Because the relevant data are not currently available, a waste analysis by type and generator cannot be produced for this waste type.

9.4. Construction Waste Streams

To understand construction waste streams and opportunities for minimizing them, it is necessary to understand the construction process. The nature of waste minimization activities and of the waste streams themselves depends on the phase of the construction activities. The Laboratory's construction and upgrading activities are organized into five phases: Preconceptual, Conceptual, Execution, Operations, and Facility Shutdown, which are shown in Fig. 9-1. Although construction at the Laboratory encompasses a wide variety of projects, including nuclear and nonnuclear facility construction and upgrades, all projects will follow the five basic construction phases.

The Preconceptual Phase is the initial planning stage. All of the preliminary work to get a project started is accomplished in this stage, including assigning the project leader, selecting the project team, defining the scope of the project, and deciding whether the project is feasible.

Fig. 9-1. Project management construction phases.

In the Conceptual Phase, the design for the project is established. In this stage, the design plan is prepared and a preliminary budget and project schedule are developed.

In the Execution Phase, the design is implemented and the facility is constructed. The Project Execution Plan (PEP) is developed, the Architect Engineer (A/E) contractor is established, and project-specific plans are generated. Special studies/value engineering requirements are performed. The ESH regulatory requirements are defined, and plans and procedures are developed. The cost and project schedule are updated. Periodic inspections of the construction site occur to ensure that safety and other project concerns are met.

In the Operations Phase, project management closes out its authority over the project and turns over the completed facility to the operating group. During the project management closeout, all final documentation is completed, including the operations procedures, maintenance procedures, and the cost/schedule review.

Project management will step back into the system when operations at the facility are complete and shutdown is planned. At this point, the cycle will start again with the initiation of the Preconceptual Stage and moving through the Conceptual and Execution Phases. Environmental D&D performs facility decommissioning at the Laboratory. Activities performed by Environmental D&D are outside the scope of this roadmap.

The objectives of the preconceptual and conceptual design phases are to develop a project scope, ensure project feasibility and attainable performance levels, identify project risks, and develop a cost estimate and schedule. This is a critical time to begin incorporating SD principles into the design project because nearly all of the general construction and operational design elements are defined during these design phases. High-level SD principles can be incorporated into the Conceptual Design Report. By documenting the SD opportunities in the Conceptual Phases, the project will have a strong driver to promote detailed SD during the later phases of the project. LANL conducts a cost life-cycle analysis and generates a waste minimization plan for construction projects during the Preconceptual Stage. This life-cycle analysis is a cost analysis of alternatives and includes the cost of D&D of the facility. The waste minimization plan identifies the wastes that are anticipated during the construction phases and develops methods of reducing or eliminating these wastes before design and construction.

Another opportunity to integrate SD principles in or immediately after the conceptual design phases is when hiring the A/E and construction subcontractors. The project should include SD requirements in the design and construction bid request documentation to ensure that the subcontractors implement SD principles that have been identified during the conceptual design phases. The Laboratory can request offerers to maximize efficient energy use, minimize water use, use recycled content construction materials, and consider compliance with existing Laboratory engineering codes/standards to be only the minimum standard. LANL can consider allowing the offerers to score higher based on their incorporation of SD elements.

A variety of wastes is generated during the Execution, Operation, and Shutdown phases. These wastes generally can be organized into the following waste streams: air emissions, liquid waste, and solid waste. The specific makeup of each of these waste streams varies with the particular phase of construction, but generally, the waste streams have the following characteristics.

1. Air emissions include any wastes that can volatilize, evaporate, aerosolize, or otherwise be transported by air. These waste substances include dust, vehicle and equipment exhausts, solvents, and volatile organic compounds.

2. Liquid wastes are fluids that can enter the environment by several pathways, such as water, storm water, or soil. These substances include waste oils and coolants, process water, rinse water, cleaning solvents, and sanitary waste.

3. Solid wastes are solid materials used or generated during the construction process that are excess to the needs of the project. Solid waste materials may include excavation spoils, cardboard and other packing materials, mixed rubble, wood, construction forms, and scrap metals.

It is evident that the specific materials in each waste stream depend strongly on the phase of the construction. For a more detailed analysis of the construction waste streams, refer to Appendix D, "Construction Waste Streams."

9.5. Aspect Analysis

Although waste is generated during construction processes, this roadmap does not discuss the waste generation aspect analysis. The entire volume of waste generated by construction activities is assigned either to other waste streams or to aspects other than waste, such as water and air. The quantity and ranking of waste generated during construction processes are captured in the Sanitary, Transuranic, Low-Level, and Mixed Low-Level Waste sections of this roadmap. This construction section of the roadmap recognizes the necessity of minimizing waste at the point of generation and identifies processes to improve sustainability and reduce waste generation.

9.6. Potential Improvement Projects

Several measures could be implemented to reduce the quantities of construction waste generated, improve the life-cycle cost of new construction and renovation, and reduce resource consumption. The following are actions designed to accomplish these goals and to comply with DOE Order 5400.1 and EO 13123.

9.6.1. Completed Projects

1. SD Workshop. The Laboratory hosted a Sustainable Design Brainstorming Workshop to present ideas for sustainability for future facilities that LANL is designing. The workshop was attended by over 30 people representing LANL, Sandia National Laboratories, National Renewable Energy Laboratory, the city of Austin, Lockheed Martin Energy Systems, DOE-AL Waste Management Division, Battelle Pacific Northwest National Laboratory, and the National Park Service.

2. Green Zia Analysis of Construction Projects. In FY00, Green Zia pollution prevention and waste minimization opportunity assessments were completed, along with waste minimization implementation plans for the Central Physics Calibration Facility construction and the Nuclear Materials Security and Safeguards Upgrade Project.

9.6.2. Ongoing Projects

1. Incorporate SD into LANL Engineering Standards. The Laboratory must continually assess, and upgrade where deficient, existing Facility Engineering Manuals and Construction Specifications to address, incorporate, and require the use of SD principles for Laboratory projects. All Laboratory infrastructure project phases, including initial design, construction, remodeling, renovation, and construction waste management, can incorporate and should consider SD principles. It has been determined by an initial assessment that 13 "sustainable practices" are included within the standards and specifications. It was found that the electrical and structural standards contained the majority of these identified SD practices, whereas the architectural and mechanical standards were determined to be deficient in sustainable practices. It became apparent during this review that revisions should be made to the standards and specifications to include more sustainable practices. Last year, the Laboratory identified 48 SD improvements and recommended these for implementation into the specific sections of the Engineering Manuals and Construction Specifications. These standards will be adopted as Laboratory standards in FY01.

2. SD Contract Language. The Laboratory must review the existing construction contract language for new requests for proposals (RFPs) and the boilerplate language in existing engineering and design contracts to include SD performance metrics. LANL will be building several new office buildings in the short term as a result of losing offices to the Cerro Grande Fire. The RFPs for the design/build should include an evaluation criterion for sustainability. The Laboratory needs to evaluate the offerers' ability to provide more SD than our present Engineering and Construction Standards requires. The Laboratory needs to evaluate the existing boilerplate contract language for the existing Basic Order Agreements and Task Order contracts to include criteria to meet SD criteria during all task reviews.

3. Reuse Construction Debris. Several construction excess commodities can be reused on site, including used asphalt, concrete, and other construction materials. Debris uses include fill for new roads, road base, and land caps for ER. Because construction waste is the largest sanitary waste stream, reuse of construction/demolition debris will have a significant effect on the waste volume. Reuse of noncontaminated asphalt is currently possible if the asphalt can be segregated from the other debris and crushed during removal. Dirt for fill use also would reduce the volume of debris going to the landfill but may require storage for some period before use. Similarly, concrete rubble could be crushed for use as an aggregate or base course. There are several options for the reuse of construction/demolition debris. In the highway industry, pavement recycling is becoming widely accepted. Recycled asphalt pavement competes not only with the application of new bituminous pavement but also with "glasphalt," which contains crushed recycled glass as a portion of its aggregate, and with asphalt material with recycled rubber tire content.

4. Use Environmental Landscaping. Environmentally beneficial and economical landscaping can be implemented throughout the Laboratory. Drought-resistant plants require ~1.8 acre-feet per year (AFY) of water, whereas traditional landscaping, such as grass, requires more than 6 AFY of water. Every acre that is planted with environmentally beneficial plants will save 4.2 AFY of water.

5. Recycle. It is anticipated that recycling of the two major categories of dumpster waste, paper and cardboard, could be increased dramatically. The Laboratory currently recycles both paper and cardboard. Because construction is subcontracted, the waste paper and cardboard from construction projects may not be put in the Laboratory recycle systems. The Laboratory should require subcontractors to recycle construction debris when practical.

6. Salvage. Salvage at the Laboratory can be used to order equipment as well as to dispose of equipment that is still usable. To facilitate the use of salvage, users should give advance

notice. This allows salvage to find a new use, thus reducing the amount of equipment disposed of as waste.

7. Waste Segregation. By far, the most accessible market for source-separated demolition debris is the construction project underway at the site itself. Many of the items, such as paper and cardboard, could be recycled if they were segregated from the rest of the waste. Many of the nonrecyclable items, such as plastic and Styrofoam, could be compacted and baled to minimize the landfill volume. Even demolition wood that may be contaminated with metals (e.g., fasteners) or paints may still be salable. Scrap metal, including ferrous and nonferrous metals such as aluminum (from window wall demolition), brass, and copper (from old roofs, roof flashing, electrical and plumbing fixtures, and decorative uses), can be separated and reused.

8. Pollution Prevention Assessments. Pollution prevention and waste minimization opportunity assessments are prepared for all Title I and II construction activities as required by Laboratory's Project Management LIR. In most cases, the construction contractor is required to produce the subsequent waste minimization and pollution prevention plans as part of the contract. Language is being included in some of the more recent contracts that requires that these plans be submitted at the bid stage so that the contractors' waste minimization plan can be evaluated before the contract is let. This activity is ongoing.

9.6.3. Unfunded Projects

1. Sustainable Facilities Design Guide. LANL should prepare a facilities design guide for the site that takes maximum advantage of SD practices. Architects, engineers, and designers for new construction and remodel projects would use the guide. The guide would serve as a companion to the Laboratory's "Site and Architectural Design Guidelines."[9-3] The combined use of these documents during project design would allow the systematic consideration of the project's life-cycle impacts on the sustainable use of environmental and energy resources. The guide would explore building systems from an integrated approach showing the necessary system interactions and compatibility requirements embodied in SD practices. This approach contrasts (and at the same time complements) the current design practices, where systems are differentiated by discipline-based engineering manuals.

2. SD Pilot. LANL has several office buildings scheduled for design/build in the near term. One of these office buildings should be targeted as an SD pilot and would incorporate the sustainable practices. As an SD pilot, this model facility design would explore the availability and benefits of the sustainable practices for the Los Alamos area. The facility would be a showplace for others to experience and understand sustainability. This pilot

would allow the Laboratory to go through a learning process for sustainable facilities and to implement sustainability in the new TA-3.

3. SD Training. Using environmental evaluation techniques such as Energy-10 and Leadership in Energy and Environmental Design (LEED)™ to identify potential waste streams anticipated during construction, operation, and eventual closure/demolition of the facility and to identify pollution prevention opportunities. The process analyses also investigate available pollution prevention design options for mitigating the waste streams and impacts identified. The process analysis will evaluate the economic and technical feasibility of pollution prevention design opportunities and will make recommendations for implementation considerations. The design engineers and the Laboratory's A/E and construction subcontractors need training on sustainable design opportunities and software tools.

REFERENCES

9-1. J. H. Scott and B. Davis, "Pollution Prevention and Waste Minimization Green Zia Analysis of the Central Health Physics Calibration Facility Project" letter report (September 28, 2000).

9-2. J. H. Scott and L. Garcia, "Pollution Prevention and Waste Minimization Green Zia Analysis of the Nuclear Materials Safeguard and Security Upgrades Project Phase I" letter report (September 28, 2000).

9-3. J. Stanford and C. D. Higgins, "Site and Architectural Design Guidelines," Los Alamos National Laboratory report LA-UR-99-0879 (1999).

10.0. WATER USE AND CONSERVATION

10.1. Introduction

With water conservation projects now being implemented, LANL has sufficient water resources to operate current and planned facilities. If the Laboratory significantly increases operation of present facilities or constructs additional ones, its historical water usage could be exceeded. Although Los Alamos County, which supplies water to the Laboratory, has some unused water rights, a significant increase in Laboratory or County water usage could exceed current water resources. Consequently, it is in the Laboratory's and the County's interest to pursue an aggressive, cost-effective, water-conservation and gray-water-reuse program. It is also in their joint interest to develop additional water resources to accommodate future growth. Water use and planning is the responsibility of the Utilities and Intrastructure group in the Facilities and Waste Operations Division (FWO/UI). Although the Laboratory has no formal water conservation program, this group tracks water use and manages improvements and repairs that reduce water usage at the Laboratory.

The Laboratory used ~1368 acre-feet (AF) of water in FY99 and 1325 AF in FY00. The source of this water is a series of deep wells that draw water from the Rio Grande aquifer. Approximately 60% of Laboratory water flows into cooling towers. Without the cooling-tower-water efficiency upgrades, this flow may increase to as much as 70% by 2005 because of new facilities being built. About half of this water is evaporated; the remainder is released into the surrounding canyons through National Pollutant Discharge Elimination System (NPDES)-permitted outfalls, exacerbating existing ecological problems by influencing the migration of past contaminant releases toward the Rio Grande. The cooling-tower conservation project, funded by the Nuclear Weapons/Facilities and Infrastructures group, will reduce the total amount of water used in cooling towers even as the new Strategic Computing Complex (SCC) comes on line in 2002. Other conservation and gray-water-reuse projects described in this roadmap could reduce water usage further and ensure that future LANL initiatives are not limited by water availability.

Water is consumed at LANL for a variety of purposes, including cooling tower uses, domestic use, landscaping, and temperature control. The water eventually is discharged in the form of sanitary water effluent, outfalls, and evaporation or leakage losses. The water supply system and water balance for the Laboratory are shown in Fig. 10-1.

The Laboratory's use of water is regulated largely by the Clean Water Act, which requires an NPDES permit for waste water released to waterways. Laboratory operations are designed to produce waste waters that remain within the limits specified by the NPDES permit. Most of the

Laboratory's water ends up as NPDES-regulated effluent or is evaporated. Non-NPDES uses include construction water and landscaping.

The estimated consumption of water by individual use at the laboratory is shown in Fig. 10-2.

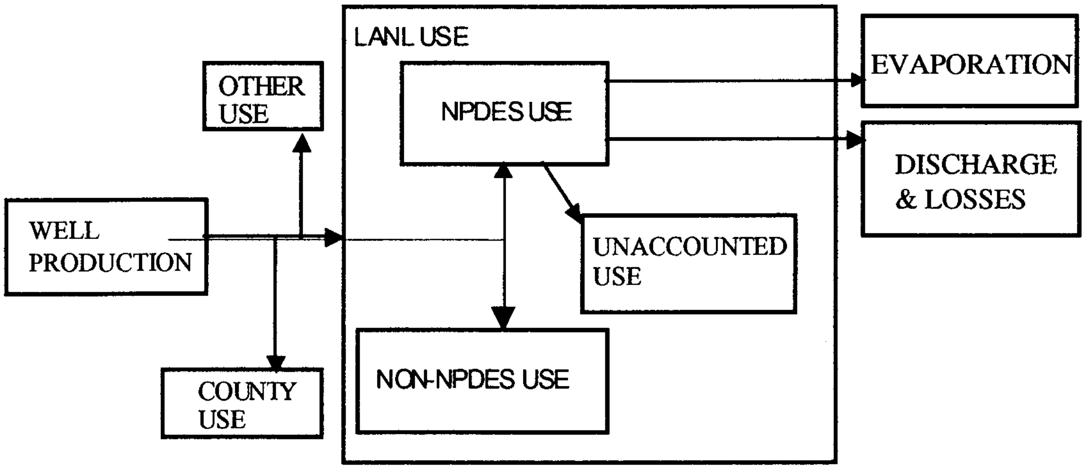


Fig. 10-1. LANL water system.

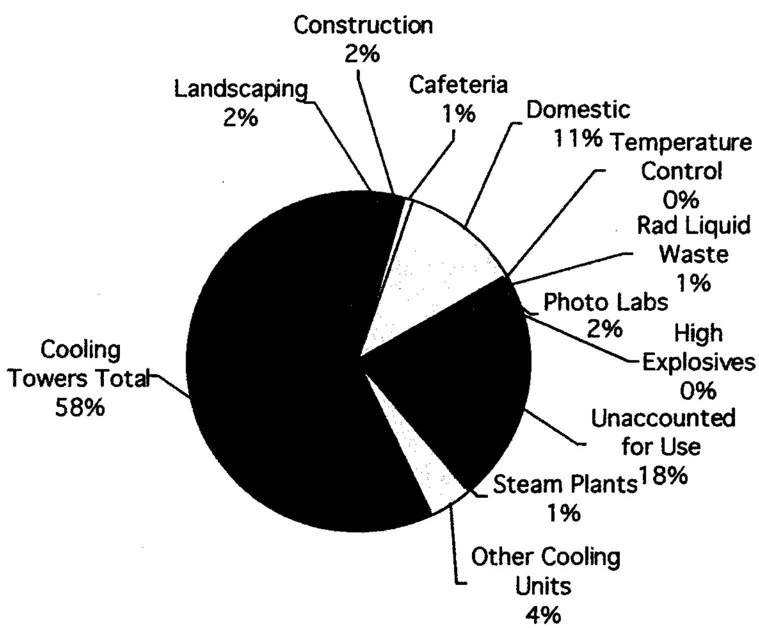


Fig. 10-2. FY97 Laboratory water usage.

By far the largest use of water at the Laboratory is for cooling. The various cooling towers that operate at the Lab consume 58% of the total water usage. The largest cooling towers, by volume of water consumed, are the LANSCE towers at TA-53 and the TA-3 towers associated with the large computer facilities, the Central Computing Facility (CCF), and the Laboratory Data Communications Center (LDCC). The major constraints on cooling-towers' water efficiency are silica and arsenic concentrations in the cooling water. The concentration of silica in the local groundwater is ~88 ppm. Because silica will begin to precipitate and foul heat-exchanger surfaces at ~200 ppm, the concentration must be controlled below that level. Currently, the silica concentration is controlled by operating the towers at 1.5 to 2.0 cycles of concentration. However, the Cooling Tower Efficiency Project is addressing this problem and will deploy a water treatment technology or technologies that will allow cooling-tower operation at higher cycles of concentration. The effluent water from the cooling towers is discharged through NPDES-permitted outfalls. However, as cooling water use becomes more efficient and sanitary waste-water use is increased, the quantities of water being discharged to outfalls will decrease dramatically.

The overall consumption of water at the Laboratory in FY99 and FY00 is shown by month in Fig. 10-3. The trend in consumption of water is weakly seasonal, with the largest volumes being consumed in summer. This is the period of hottest weather and frequently has the highest electrical demand. Water usage at the Laboratory is correlated to electrical demand because water is required to remove waste heat generated by electrical consumption.

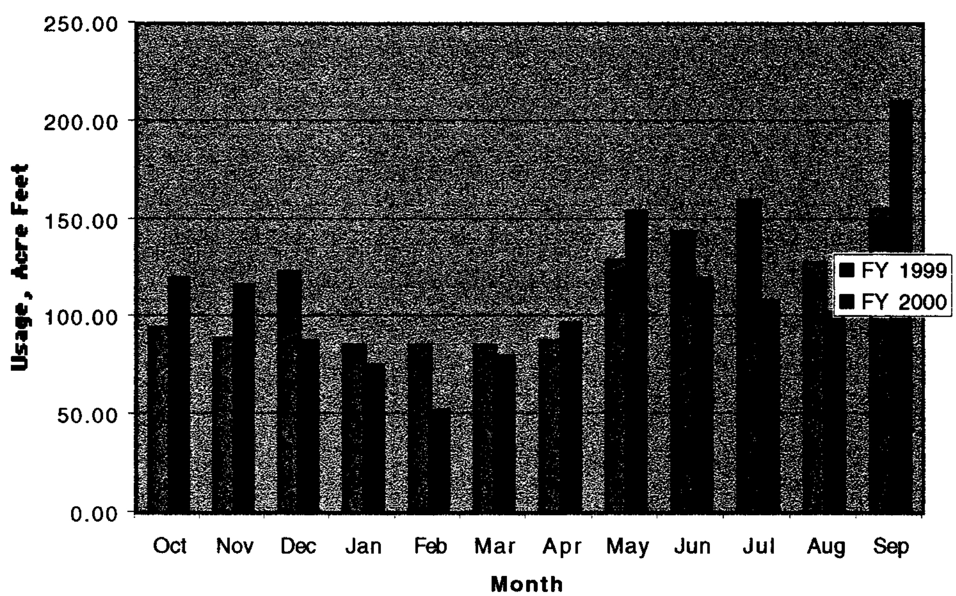


Fig. 10-3. Monthly water consumption.

10.2. Water Conservation Performance

The Laboratory has no established water conservation performance goals. However, EO 13123, "Greening the Government through Energy Efficiency Management," mandates the development of such water goals. In advance of these goals, the Laboratory has committed to an aggressive water conservation program. The consumption of water at the Laboratory by year for recent years is shown in Fig. 10-4.

The data for years before 1999 are approximate because of many factors, including incomplete metering at the Laboratory, unknown system losses, and uncertainty in distribution. There are no reliable data for FY98 because in that year, the operation of the Los Alamos water supply and distribution system was transferred from the DOE to Los Alamos County. The different techniques for measuring and estimating water used at these two entities lead to greater-than-normal uncertainty in the estimate of water use. There is no strong trend in water use at the Laboratory. A pronounced reduction occurred in the mid-1990s, but consumption has since risen again. Consumption has decreased over the last 2 yr, in part because of an aggressive leak repair program.

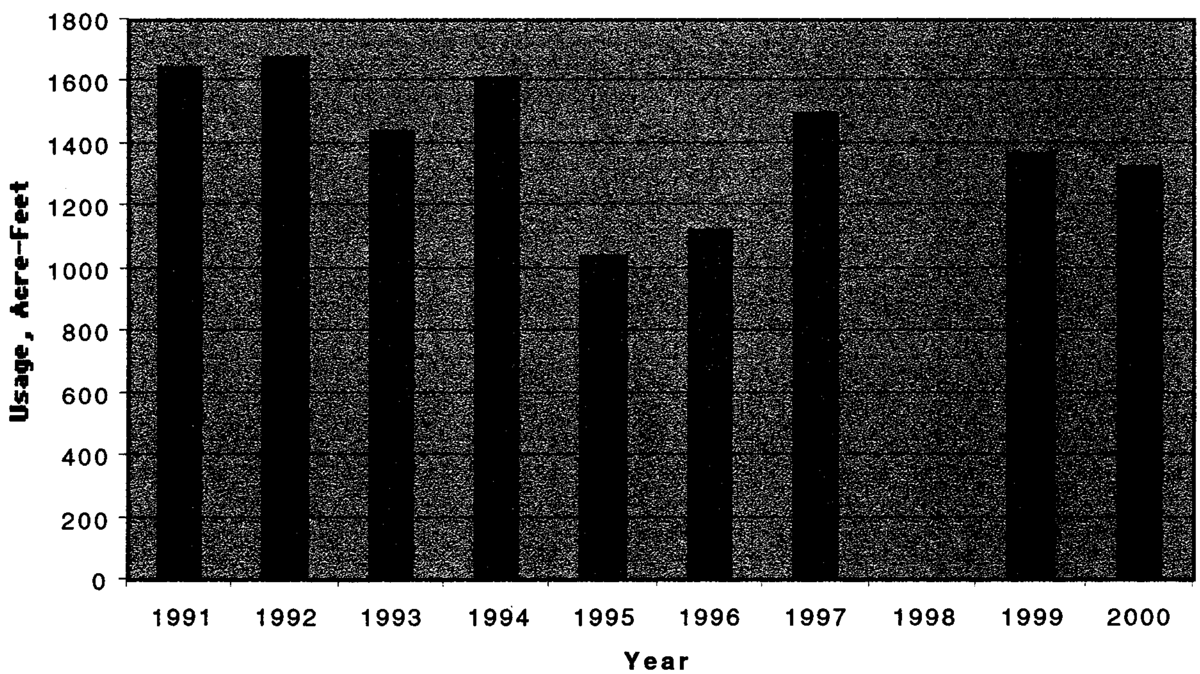


Fig. 10-4. Water usage by year.

10.3. Waste Stream Analysis

Aqueous waste streams are generated by both natural processes and consumptive use of water. Natural processes include storm-water drainage, and snow melt. Natural processes are not included in this roadmap. Consumptive use of water leads to evaporation or discharge following use. At the Laboratory, NPDES permits control most discharge of waste water. Approximately 88% of the water used by the Laboratory is used for purposes regulated by NPDES permits. Slightly less than half of the NPDES-regulated water evaporates before it is discharged. About 850 AFY of water is discharged through NPDES-permitted outfalls. Figure 10-5 shows the distribution of water discharge and loss at the Laboratory.

The following waste water streams are associated with water use at the Laboratory.

- NPDES Regulated Discharges—These are discharges from cooling towers, cafeterias, domestic use, research activities, laboratories, steam plants, etc. Much of this water is treated before discharge either in the SWSC plant or in a specialized treatment plant such as the High Explosives Waste Water Treatment Plant.
- Non-NPDES Regulated Discharges—These discharges are from those activities exempted from the NPDES. They include discharges from landscaping and construction and constitute ~12% of the waste water discharged on site.
- Unaccounted Use—This waste stream is water that does not show up in the water balance. The quantity of water drawn from wells is reasonably well known, and the water usage at the Laboratory can be estimated. Usually ~10% to 15% of the water drawn from the water supply cannot be accounted for. The sources of this apparent loss could be inaccuracies in the use estimates, leaks in the distribution system, activities such as well flushing (which are not included in the balance), or a combination of these and other uncertainties. With the current metering system, it is not possible to estimate the size of this stream reliably or to find the source of the losses.

10.4. Aspect Analysis

The two components of the environmental aspects associated with water use at LANL are resource consumption and waste-water discharge. This roadmap is concerned only with consumption. Waste-water discharge will be addressed in the systematic aspect analysis associated with the upgrade of the environmental component of ISM.

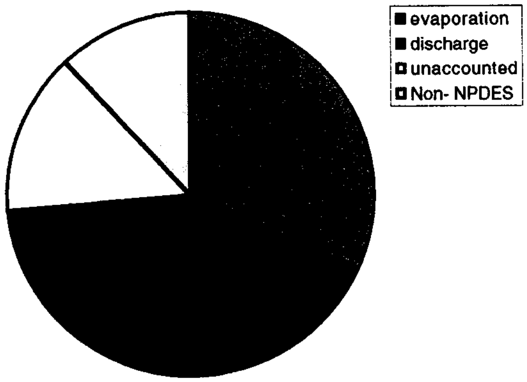


Fig. 10-5. Water discharge and losses.

The aspect analysis presented here must be regarded as preliminary. The Laboratory will be developing a final aspect analysis and scoring system over the next several months. Once developed, the system will be used to score the Laboratory environmental aspects systematically. That analysis will supercede the analysis presented below.

Aspect Definition: Resource Use

General Information

Los Alamos is in a semi-arid, high-desert biome with little surface water and limited rainfall. Water is drawn from a series of deep wells into the Rio Grande Aquifer, which is recharged at an unknown rate, by the Rio Grande and tributary rivers. The water level in the aquifer has been falling regionally for many years, and growing populations threaten to accelerate this depletion.

Location of Activity Impact

Location of Impact	Description	Scenarios Considered	Type
Global	Beyond the US	None	N/A
Regional	Use of resources outside the LANL site	Depletion of aquifer water	Normal
Local	On LANL site	None	N/A

Magnitude of Activity		Probability of Occurence	
Normal Scenario		*Abnormal Scenario*	
High	Volume -- >10% of water use	**High**	Occurs at least once per yr
Medium	Volume -- 1–10% of water use	**Medium**	Occurs once every 1–10 yr
Low	Volume -- < 1% of water use	**Low**	Occurs only >10 yr

Scale of Impact Definitions and Examples		High	Med.	Low
1. Permanent:	Use of water in sufficient quantity to irreversibly deplete the resource in less than 100 yr	1000	100	10
2. Significant:	Use of water in sufficient quantity to deplete the resource in 100 to 500 yr	100	10	1
3. Moderate:	Consumption of water in volumes sufficient to require regulatory controls	10	1	0.1
4. Minimal:	Consumption of water at a rate that does not have measurable impact on the environment	1	0.1	0.01
5. No Impact:	Negligible or no impact on the environment	0.1	0.01	0.001

Based on this scoring system, the resource consumption aspect was evaluated for the Laboratory. The results of this evaluation are listed below.

Resource Use Aspect						
Resource	**Division**	**Activity**	**Magnitude**	**Impact**	**Normal**	**Abnormal**
Water consumption	All	Various	High	2	100	100

Aspects scoring 10 or more are significant and are discussed in more detail below. Projects addressing these aspects are identified below and described in more detail in the next section.

10.4.1. Water Consumption

Resource use is the highest-scoring aspect in water use and conservation. The Laboratory's water usage has a regional impact and, even though the aquifer recharges, contributes to depletion of this resource. The quantities of water consumed are not large by most standards, but the region is semi-arid and the water is drawn from an aquifer that recharges at an unknown rate. It is prudent to investigate ways to lower consumption. Lowering consumption also means that volumes of waste water being discharged to the environment after use will be reduced.

10.4.2. Potential Mitigating Actions

The potential mitigating actions for the high-scoring aspects are presented in the following table.

Hazardous Waste Aspect	Potential Mitigating Action
Water consumption	Water conservation projects Efficiency projects

10.5. Improvement Projects

Several measures could be implemented to reduce the quantities of water used, improve the life of the aquifer, and reduce environmental impact from water use. The projects are intended to reduce water consumption and increase efficiency of use. The projects are classified as completed, ongoing, and unfunded. All of the projects are for the high-scoring aspect: water consumption.

10.5.1. Completed Projects

1. **Water System Leak Survey and Repair.**

   A survey of leaks in the main water distribution system has been conducted, and repairs have been completed. Based on measurements made at the time of repair, ~140 AFY of water will be saved.

10.5.2. Ongoing Projects

1. **Cooling Tower Water Efficiency Project.**

   A cooling tower water conservation project has been initiated that will seek the best commercial technologies for improving cooling-tower-water use. The Laboratory issued an RFP to industry to pilot water conservation technologies on large-scale cooling towers with both potable and treated sanitary waste water. The pilot phase is complete, and the results are being evaluated. The Laboratory will now procure a treatment plant(s) based on one or more of these technologies. The plant is expected to be on line in FY02; assuming that at least 75% cooling-tower efficiency will be realized from the project, the following savings in water use is expected.

	FY02 without Efficiency Project (in AFY)	FY02 with Efficiency Project (in AFY)
LANSCE	340	227
LEDA	64	43
CCF & LDCC	85	57
SCC	156	104
Power Plant	250	167
Sanitary Water Reuse	(340)	(340)
General Usage	974	974
Total	1529	1232

Note that these projections assume increased reuse of sanitary waste water. The water savings expected is ~600 AFY.

A water savings of this magnitude means that outfalls can be eliminated or reduced dramatically. The effect of the Cooling Tower Efficiency Project can be seen in Fig. 10-6, which compares water consumption with and without the project in force.

These estimates are slightly different than those provided by the LANL SWEIS. They are based on the most recent operating experience, but it should be understood that the estimates provided in the SWEIS are the official projections.

2. **Use of Environmentally Beneficial Plantings.**
   Environmentally beneficial and economical landscaping is required, where appropriate, by EO 13123. The Laboratory currently has no plans to replace existing plantings, but all new construction will have environmentally beneficial landscaping. There is no fixed schedule for this initiative, but it will take place as new construction and renovation occurs.

10.5.3. Unfunded Projects

1. **Import Los Alamos County Waste Water.**
   The TA-46 SWSC plant is operating so far below design capacity that the digester microbes are vulnerable to starvation during holidays and to die-off from small quantities of toxic influents. Mildly toxic substances such as wax stripper in mop water and mop water detergent currently cannot be sent to the SWSC plant because of the microbes' vulnerability. Larger volumes of sanitary waste would reduce the vulnerabilities of the SWSC plant. The Los Alamos County waste-water treatment plant is running at >80% capacity and is in danger of reaching full capacity in the near future. The transfer of Los Alamos County Western-Area residential waste water to the Laboratory's waste water plant would reduce that plant's

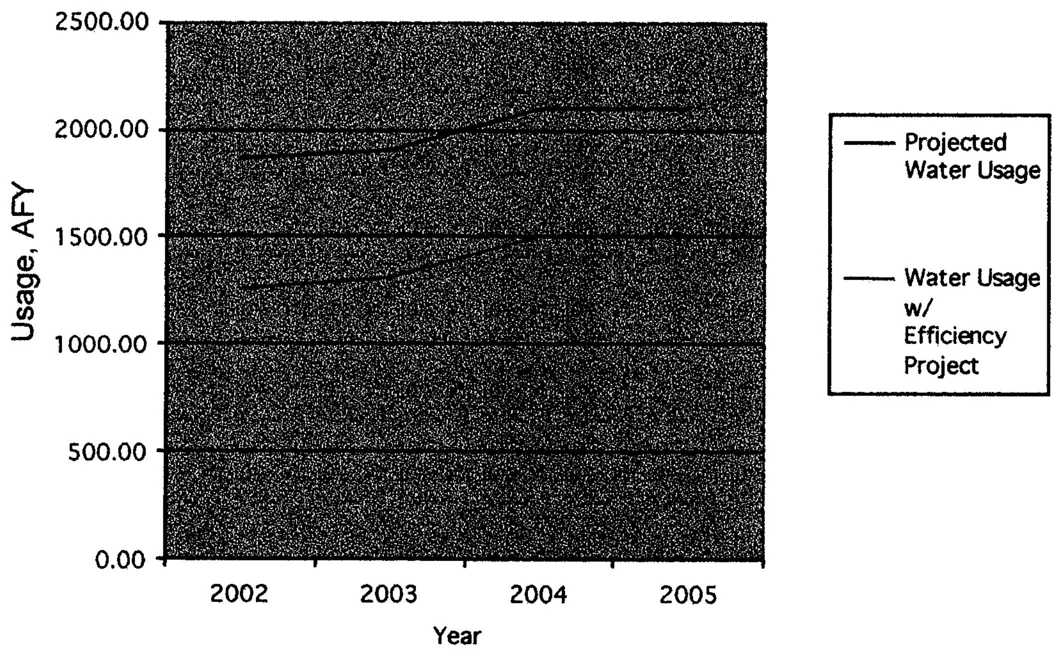


Fig. 10-6. Water consumption with and without the efficiency project.

vulnerability and provide an additional 200 AFY of SWSC effluent for reuse in LANL cooling towers. Because this project would replace ~200,000 gal. of purchased potable water per day, the yearly savings is substantial. This project benefits both the county and the Laboratory.

2. **Survey and Repair Leaks in the Piping in the LANL Water Drainage System.**
   The Laboratory has conducted camera inspections of the 50 miles of sewer lines and has concluded that as much as 25% of the lines may be subject to leakage. There have been no measurements to date of the losses to leakage from the sewer system.

10.6. Project Summaries

Summaries of many of the major Hazardous Waste Projects can be found in Appendix B, "Return on Investment Analyses."

REFERENCES

10-1. Thomas P. Starke et al., "Los Alamos National Laboratory 1999 Environmental Stewardship Roadmap," Los Alamos National Laboratory report LA-UR-00-282 (January 7, 2000).

10-2. "The Site Wide Environmental Impact Statement for the Continued Operation of Los Alamos National Laboratory," Department of Energy report DOE/EIS-0238 (January 1999).

11.0. ENERGY USE AND CONSERVATION

11.1. Introduction

The continued growth of the Laboratory has required and will continue to require increased energy consumption. The addition of various facilities at the Laboratory, such as the SCC and the Dual Axis Radiographic Hydrodynamic Test (DARHT) second axis, has increased demand significantly. Future projects such as the Advanced Hydrodynamic Facility (AHF) will dramatically increase the demand for electrical energy and for increased load-following capability.[11-1] Access to adequate, reliable power supplies is critical to the continued growth of the Laboratory and particularly to the ability to develop large experimental programs and computing facilities. The consumption of energy at the Laboratory clearly has reached the point where careful planning for the future will be required if growth is to be sustained. Group FWO/UI is responsible for energy planning and managing energy use at the Laboratory. This group also is the responsible for the Laboratory's energy conservation program.

Current power demand challenges the existing system capacity so that any future growth of the Laboratory depends on finding practical and cost-efficient solutions to the electrical supply and usage problems. Two avenues for improving the energy supply are conservation and increases in power import or generation capability. Of these two options, conservation is the easiest to implement, will have more immediate results, and will minimize the impact of energy usage on the environment; however, increasing the supply will have a much larger effect on energy availability, as well as the environment. The Laboratory has been addressing these problems for some time and has taken significant actions, including studying options to increase the power supply and implementation of Laboratory-wide conservation programs. This section investigates the trends in energy usage over time, examines the constraints on such usage, defines problem areas, and explores issues and options for improved performance.

The Laboratory power supply problems are exacerbated by the regional and national situation. Regionally, the northern New Mexico power grid is operating near capacity. If demand increases much beyond current levels, some load shedding may be required across the entire grid. This means that Los Alamos could be required to shed its load by curtailing electrical use and shutting down operation in one or more facilities. Nationally, available generating capacity has not kept pace with demand, which, coupled with deregulation, has led to dramatic increases in electrical energy costs. Costs on the open market have risen from about $55/MWh to a capped cost of $250/MWh. If it persists, this increase in the cost of electrical energy could alter the strategy for ensuring future energy supplies. At the higher costs, a premium is placed on conservation and on-site generation.

The utility system (water and electricity supply) at the Laboratory is driven by demand for electrical energy. As energy requirements go up, the demand for cooling water and the volume of effluent discharged at outfalls increase. Most of the Laboratory's consumption of electrical energy manifests itself as heat that must be removed and dissipated. In fact, ~60% of the Laboratory's water is used in cooling towers. Although the electrical supply can be increased by implementing one or more options, the critical component of the energy/water cycle (i.e., the availability of water) cannot easily be increased (see Section 10, Water Use and Conservation). In fact, the parameter most likely to absolutely limit Laboratory growth is the availability of water. Although the Laboratory currently is far from that limit, additional electrical demand brings the limit closer. Projected increased reliance on the power plant for load following will have a pronounced effect on water use at the Laboratory. The TA-3 power plant most often is used as a power-peaking facility. The facility is aging and is not very efficient by modern standards; therefore, its water consumption is large relative to the energy it produces.

The system diagram for the Laboratory consumption of energy and water is shown in Fig. 11-1.

Operation of the Laboratory requires the consumption of water, natural gas, and electricity. Air emissions and effluent discharges result from this consumption. Use of energy and water at the Laboratory is closely coupled. The electrical supply system at the Laboratory will be analyzed in this section.

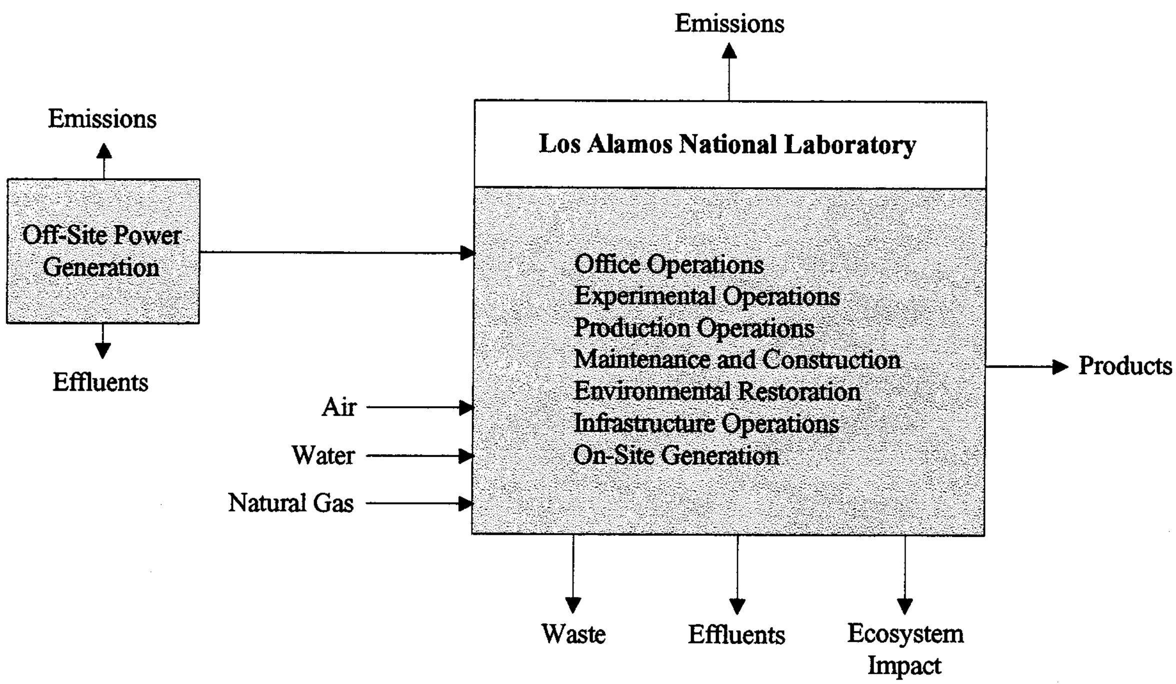


Fig. 11-1. Energy process map for LANL.

The largest users of electrical energy at the Laboratory are shown in Table 11-1. The top four consumers account for up to 51 MW at coincidental peaks.

Table 11-1. Electrical Energy Usage at LANL

Facility	Electrical Energy Usage (MW)	Duration
LANSCE—peak demand	25–32	24 h/d during operation
LANSCE—base load	5–7	24 h/d
Computing (CCF & LDCC)	4–5	24 h/d
TA-3[a]	10	5 d/week
TA-55	2–3	24 h/d

[a]The above total for TA-3 **does not** include the 5 MW for LDCC/CCF. Computing at TA-3 is separate. A 10-MW Laboratory-wide peak load swing occurs during weekends and holidays.

The consumption of electricity at the Laboratory is shown in Fig. 11-2. The datum for September was not available at the time of publication, and thus, the FY00 data set is incomplete.

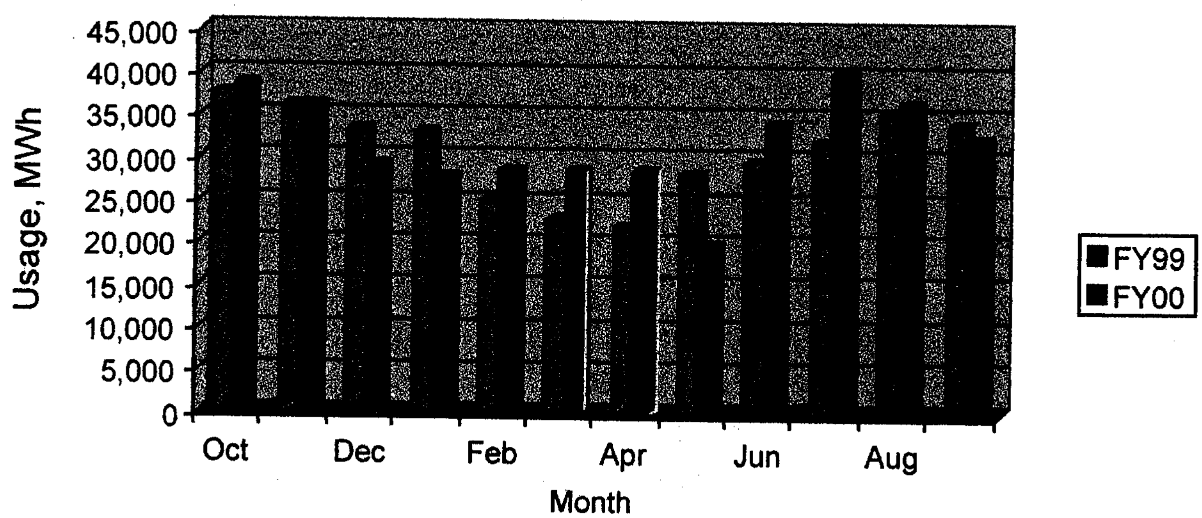


Fig. 11-2. LANL energy usage.

These data include the LANSCE usage. The Laboratory usage without LANSCE is shown in Fig. 11-3.

11.2. Energy Conservation Performance

Energy usage is not regulated, but the government has established guidelines for government facilities in the *Energy Policy Act of 1992* and in EO 12902, *Energy Efficiency and Water Conservation at Federal Facilities* (March 8, 1994). EO 12902 mandates a 30% reduction in energy use for agencies by FY05 as compared with FY85. The Laboratory has a performance measure in the UC/DOE contract that specifically addresses this reduction. Utility loads associated with the operations of LANSCE (defined as experimental processes) are excluded from this measure. The measure is based on a reduction in energy usage from FY85 levels in British thermal units per gross square feet of building, expressed as a percentage of FY85 energy usage. Total-energy British thermal units includes electricity, natural gas, and liquefied petroleum gas. The performance measure calls for a reduction in FY00 of 25.5% to achieve an outstanding rating. The Laboratory achieved a 42% reduction from the baseline in total energy in FY99.

Laboratory electrical consumption is shown by year in Fig. 11-4.

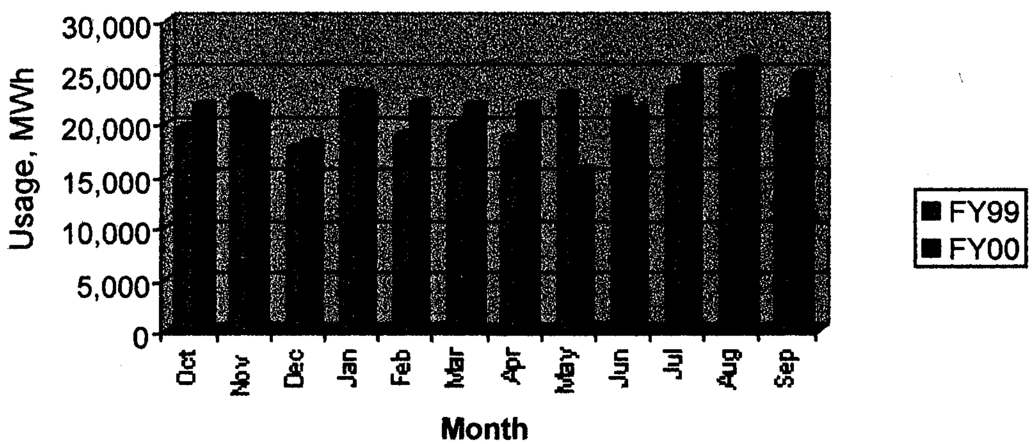


Fig. 11-3. LANL energy usage without LANSCE.

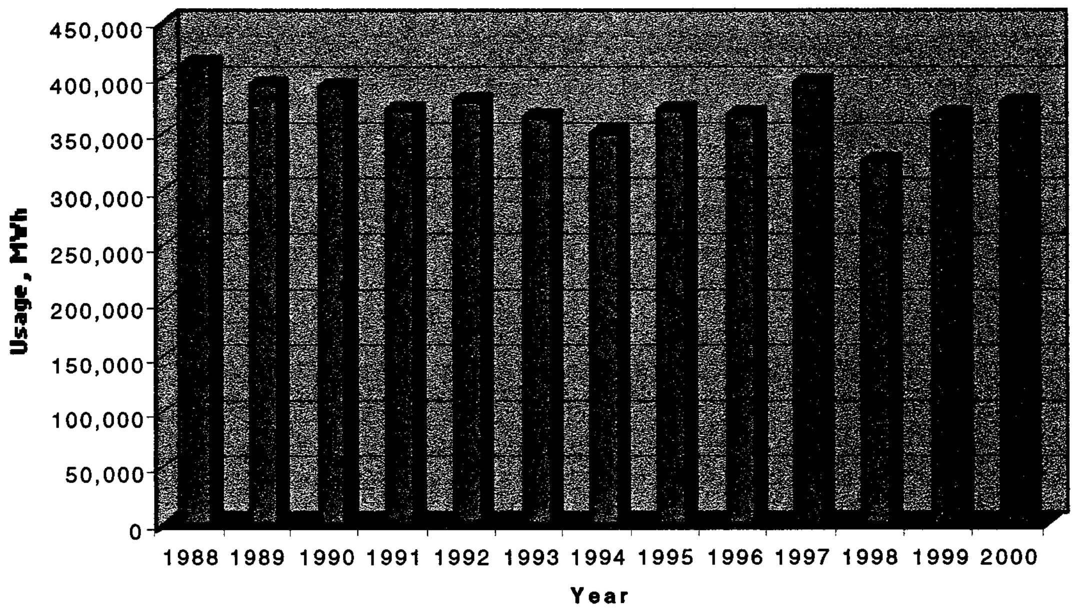


Fig. 11-4. LANL electrical usage.

Because of the Cerro Grande fire, electrical consumption in May was less than normal. Without the effect of the fire, the FY00 usage clearly would have been greater.

The Laboratory's use of natural gas is limited and tends to be seasonal. The principal use of natural gas is for space heating, although some natural gas is burned by the power plant. Natural gas usage is shown for the last two FYs in Fig. 11-5.

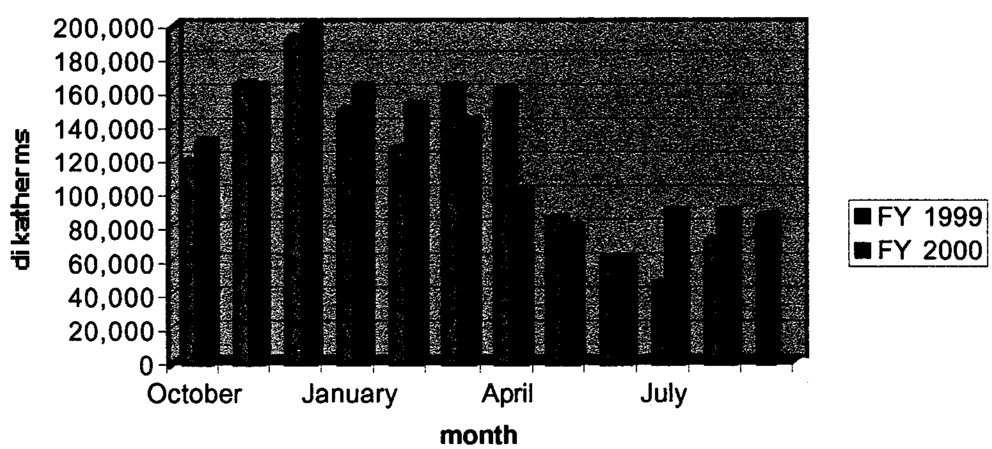


Fig. 11-5. Natural gas consumption at LANL.

11.3. Waste Stream Analysis

Electricity is imported into the Laboratory from off-site sources; however, because peak coincidental demand can exceed the import capacity, it is sometimes necessary to generate power at TA-3 by burning fuel oil or natural gas. Natural gas also is burned to produce steam and hot water for space heating and process support.

The waste streams associated with use of energy at the Laboratory are emissions in the form of industrial gases and waste-water effluent from various cooling towers. Emissions occur on site when the TA-3 power plant is operating and as the result of Laboratory consumption of electricity imported from off site. Emergency power generation and portable generators also produce emissions. The process map element for energy use is shown in Fig. 11-6.

With the exception of water usage for on-site generation, the size of the waste streams associated with Laboratory electrical usage is not known; however, some emissions can be estimated. The use of water by the power-plant cooling tower is a function of power generation. Below 8 MW, the cooling tower operates on sanitary waste water; beyond 8 MW, the sanitary waste water must be supplemented by potable water.

11.4. Aspect Analysis

Two components of the environmental aspects are associated with water use at the Laboratory: resource consumption and waste-water discharge. This roadmap is concerned only with consumption. Waste-water discharge will be addressed in the systematic aspect analysis associated with the upgrade of the environmental component of ISM.

The aspects analysis presented here must be regarded as preliminary. The Laboratory will be developing a final aspects analysis and scoring system over the next several months. After it is developed, the system will be used to score the Laboratory environmental aspects systematically. That analysis will supercede the analysis presented below.

Aspect Definition: Resource Use			
General Information			
The Los Alamos Power Pool (LAPP) owns generating capacity in the form of hydroelectric and coal-burning plants. The Laboratory has an aging power plant that is used as a peaking facility. Transmission resources to LAPP are owned by the Public Service Company of New Mexico.			
Location of Activity Impact			
Location of Impact	**Description**	**Scenarios Considered**	**Type**
Global	Beyond the US	1. None	N/A
Regional	Use of resources outside the LANL site	1. Depletion of aquifer water	Normal
Local	At LANL	1. None	N/A

Magnitude of Activity		Probability of Occurrence	
Normal Scenario		*Abnormal Scenario*	
High:	Volume -- >10% of Resource/energy use	**High:**	Occurs at least once per year
Medium:	Volume – 1%–10% of Resource/energy use	**Medium:**	Occurs once every 1–10 years
Low:	Volume -- < 1% of Resource/energy use	**Low:**	Occurs only >10 years

Scale of Impact Definitions and Examples		High	Med	Low
1. Permanent:	Consumption at levels sufficient to deplete a naturally occurring resource in 100 years.	1000	100	10
2. Significant:	Consumption at levels sufficient to deplete a naturally occurring resource in 100 to 500 years.	100	10	1
3. Moderate:	Consumption of energy at levels that require regulatory or supplier control (conservation, Executive Orders, etc.)	10	1	0.1
4. Minimal:	Usage of energy at a rate that has no measurable impact on the environment	1	0.1	0.01
5. No Impact:	Negligible or no impact on the environment	0.1	0.01	0.001

Based on this scoring system, the resource consumption aspect was evaluated for the Laboratory. The results of this evaluation are listed below.

Resource Use Aspect						
Resource	**Division**	**Activity**	**Magnitude**	**Impact**	**Normal**	**Abnormal**
Electrical Usage	All	Various	High	2	100	NA
Natural Gas consumption	All	Various	low	3	0.1	NA

There is less than a 500-yr supply of coal in the Four Corners region of New Mexico and Arizona. The Laboratory's use of electricity generated at the San Juan Power Station contributes to the depletion of the nonrenewable coal resource. Aspects scoring 10 or more are significant and are discussed in more detail here. Projects addressing these aspects are identified below and described in more detail in the next section.

Electrical Consumption. The impact of the electricity usage by the Laboratory is at least regional and arguably global. Regional coal and water resources are affected by the necessity to generate power for the Laboratory, and emissions from this generation of power, which although small in an absolute sense, nevertheless contribute to pollution of the global atmosphere. The Laboratory cannot function with a significant reduction in electrical usage; in fact, it is probable that the Laboratory will require more electrical power in the future. The increased usage of power directly impacts not only the waste streams associated with power generation, but also water consumption and waste-water discharge. Usage of electricity is a complex system at the Laboratory and is strongly coupled to the consumption of water and emission of pollutants.

11.4.1. Potential Mitigating Actions

The potential mitigating actions for the high-scoring aspects are presented below.

Hazardous Waste Aspect	Potential Mitigating Action
Electrical usage	Electrical energy conservation projects Purchase of electricity from renewable sources

11.5. Improvement Projects

11.5.1. Completed Projects

No completed projects mitigate the effect of electrical energy usage at LANL.

11.5.2. Ongoing Projects

1. **On-Site Power Generation Study**

   The Laboratory is conducting a study to determine the feasibility and costs of replacing or supplementing the TA-3 power plant for the on-site generation of electricity. The study will determine the required size and operating parameters of the potential alternate generator. From an energy conservation point of view, a modern plant is much more desirable because of its increased efficiency. The impact of on-site generation on water consumption could be lessened dramatically with a more efficient modern generating plant. A plant with a heat recovery cycle would be particularly desirable because it could be used to supply space heating to TA-3 in lieu of the current power plant. At the conclusion of the study, a decision will be made regarding the extent and timing of the power plant replacement or augmentation.

2. **Chiller Replacement**
   Another increase in efficiency will be realized when the older chillers around the Laboratory are replaced with modern and more efficient chillers. Some of the chillers at TA-3 already have been replaced, and the program will continue in the future. A site-wide chiller upgrade will save up to 1.5 MW of power.

3. **Conservation**
   There is an operational incentive to conserve electricity. As much as 3–5 MW of usage could be avoided by implementing simple conservation measures such as "Energy Star" computing. For that reason, the Laboratory has had a conservation program in place for some time.[11-2] Significant savings have been realized as a result of this program, but the program must be expanded in the Laboratory. Further savings will be realized, without additional cost, through projects already planned, such as chiller upgrades. The proposed LANSCE 201-MHz upgrade will result in a savings of ~1 MW. Although conservation can never solve the peak-demand problem, these measures may be a very effective, short-term remedy. A reduction in demand through conservation will mean that near-term growth will not challenge the firm-load serving capability of off-site import and will reduce the frequency of TA-3 power plant operation. The power plant is a particularly inefficient power producer, and its use has been increasing in response to the growth of peak coincidental demand. It may be possible to conserve as much as 10 MW through combined conservation efforts.

11.5.3. Unfunded Projects

1. **Continued Chiller Replacement**
   Chiller replacement is underway for a significant number of chillers at the Laboratory. However, although many sites are candidates for replacement, no funding is available. Replacement of the chillers at LANSCE would have a significant effect on electrical usage, as would replacement of chillers at TA-48 and the balance of TA-3. Funding has not been identified for these projects. Modern chillers are twice as efficient as the older chillers, and thus, the use of modern chillers represents a significant savings.

REFERENCES

11-1. M. Hinrichs and J. Lundberg, "Approaches for Upgrading Electrical Power System Reliability and Import Capability," Los Alamos National Laboratory report LA-UR-96-3882 (August 1997).

11-2. E. Racinez, "Energy Management Plan for Los Alamos National Laboratory, Los Alamos, New Mexico," Rogers and Associates report (December 27, 1996).

APPENDIX A
SITE ENVIRONMENTAL GOALS, RESOURCES, AND PROGRAMS

A.1. POLLUTION PREVENTION GOALS

The Laboratory has adopted the DOE pollution prevention goals for FY05 to FY10 (with adjustments); progress toward meeting these goals is discussed for each waste type in the body of this report. In some cases, analysis of waste streams by waste type reveals the presence of site-specific waste streams. Waste streams, including site-specific streams, and major program activities to mitigate their effect are identified in the specific waste type chapters. Table A-1 lists information on the Laboratory's pollution prevention goals.

A.2. RESOURCES

The resources available to pollution prevention and waste minimization activities are presented by fiscal year in Table A-2.

Table A-1. LANL Pollution Prevention Goals

	1993 Baseline	2000 Actual	2001 App. F Goal	2005 Goal	2010 Goal
GOAL	Quantity	Quantity (%)	Quantity (%)	Quantity (%)	Quantity (%)
Reduction of routine waste					
1. Hazardous	307 MT	22 (7)	22 (7)	22 (7)	-
2. Mixed Low Level	12.3 m^3	5 (41)	5 (41)	5 (41)	-
3. Low Level	1988 m^3	389 (20)	389 (20)	389 (20)	-
4. TRU/Mixed TRU	NA*	104	102 (98)	TBD	-
5. Sanitary	2858 MT	2369 (83)	3000 (67)	2179 (76)	TBD
Waste from cleanup/ stabilization and decommissioning	NA				
Recycle of sanitary waste		16	18	45	50

*The TRU goal is baselined on production in the last 6 months of FY99 or 244.6 m^3.

Table A-2. Pollution Prevention and Waste Minimization Activities Resources

Funding Source	FY00 Congressional ($k)	FY01 Congressional ($k)	FY02 Planned ($k)
Defense Programs	2000	1500	1500
Environmental Management	594	260	100
Office of Science	-	-	-
Other PSOs	-	-	-
Other Sources	-	-	-
National Pollution Prevention Program	-	-	-
TOTAL	2594	1760	1600

A.3. ENVIRONMENTAL MANAGEMENT IN ISM

To help accomplish its stewardship mission, the Laboratory will begin upgrading Environmental Protection in ISM in FY01. This upgrade will be based on the principles of ISO 14001.

A.4. SUSTAINABILITY

Sustainability and SD are discussed in Section 9, Construction.

A.5. PERFORMANCE MEASURES AND GOALS

The Laboratory performance measures are included in Appendix F of the UC contract. The environmental performance measures are summarized below.

The Laboratory has met the DOE Pollution Prevention 2005 goals in LLW and hazardous waste as of the end of FY00 through aggressive pollution prevention activities. The goal of this measure is to maintain this level of success and continuously improve on successes in a cost-effective manner. The Laboratory will decrease or maintain routine, solid MLLW, hazardous waste, and LLW generation at the FY00 routine waste generation amounts. Increased waste generation volumes over FY00 numbers will require management assessment to determine actions needed to maintain generation rates below the 2005 goals. The Laboratory will reduce routine sanitary waste generation by 8% as compared with an FY00 baseline. The Laboratory also will recycle at least 18% of the total solid sanitary waste generated. The Laboratory will purchase those EPA-designated items having recovered content, except when they are not available competitively at a reasonable price or when recycled-content items do not meet performance standards in accordance with EO 13101. Electricity, water, and natural gas usage will be reported, trended, and compared with the usage numbers for the last 3 yr. A project management plan to meet the Secretary of the Department of Energy's goals will be developed. Estimated fleet vehicle efficiency, ozone-depleting substance inventory, and greenhouse gas emissions will be reported for the second half of FY01. A system to trend the data and a project management plan to meet the Secretary's goals will be developed. The Laboratory will apply the Green Zia tools (or equivalent) to identify pollution prevention opportunities.

APPENDIX B
FY01 PROJECT SUMMARIES

B.1. TRU Waste

Crate Counter

Glove Improvement

Electro-Decontamination

P2/Waste Minimization Project

WBS Number:

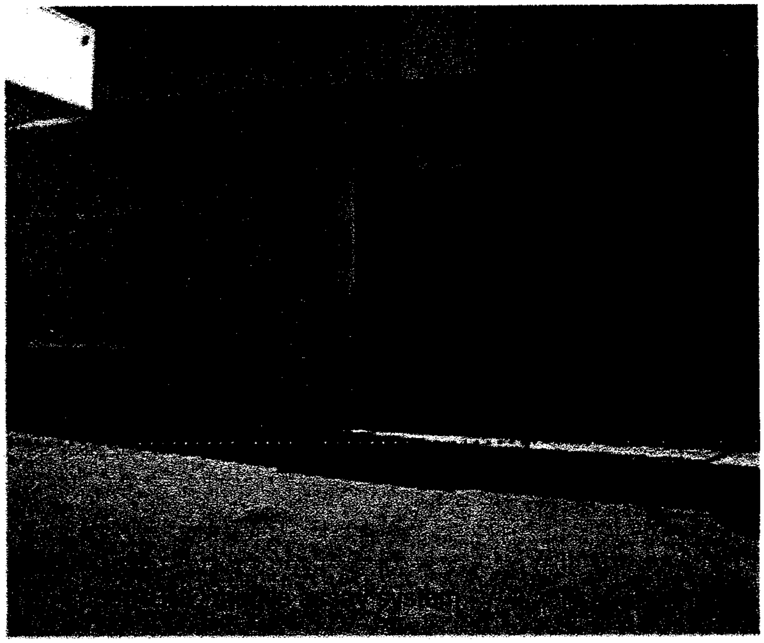
Procurement of a SuperHENC* Standard Waste Box (SWB) Assay System

Goal: The goal of this project is to reduce the cost of Transuranic (TRU) waste volume expansion required for shipment to the Waste Isolation Pilot Plant (WIPP).

Summary:

Over 25% of LANL s 27,000 legacy TRU waste drums exceed the wattage limit for shipment to WIPP by a factor of four. Drums generating too much heat must be repackaged into several drums to meet the allowed limits. The typical volume expansion after the required repackaging is four to one. The cost of repackaging TRU waste for shipment is quite high. There are two reasons for the high costs: (1) the repackaging process is done entirely manually and (2) each of the repackaged drums must be fully recharacterized.

This project proposes to combine the contents of high-wattage drums with the contents of lower-wattage drums in an SWB before characterizing the waste. This process will allow the SWB container to meet the requirements for transportation to WIPP. Special assay equipment is required to assay the SWBs before transportation. This project will procure a commercially available SuperHENC SWB assay system for that purpose.



Value Analysis

Project Cost	**$2,200K**
Project Implementation Time	**1 - 2 Years**
Project Lifecycle Duration	**10 Years**
Lifecycle Savings	**$20,000K**

ROI - 101% (Medium, score = 2)
Compliance (Supportive, score = 2)
Safety (Supportive, score = 2)
UC Contract (Supportive, score = 2)
Composite Score: 8
Notes: * HENC = High Efficiency Neutron Counter.

Contacts

Contact:
Mark Pickrell, LANL, E/ET
(505) 665-2640
mpickrell@lanl.gov

ESO Contact:
Robert Dodge, LANL, E/ESO
(505) 665 0493
rdodge@lanl.gov

P2/Waste Minimization Project

WBS Number:

Procurement of a SuperHENC Standard Waste Box (SWB) Assay System

Schedule: Some tasks may occur concurrently

- Commercialization of SuperHENC — 6 months
- Procure equipment — 1 year (after commercialization)

Issues:

Cost Basis:

There are ~7000 waste drums in the inventory that exceed the thermal wattage limit for shipment to WIPP. On average, each of these drums will have to be repackaged into eight drums to meet the thermal limit. The base cost of characterizing and preparing a drum for shipment to WIPP is $27K/drum. By repackaging 4 drums into one standard waste box instead of 32 new drums, the cost of repackaging and characterization is reduced by about $3.5K (see reference, page 30). The approximate total savings over the life of the project is then 7000* $3500 = $24.5M or $2.45M/yr.

Budget:

1999	2000	2001	2002	2003
$K	$K	$1000K	$1200K	$K

References: Presentation to DOE/AL on 8/15/00, TRU Waste Optimization, Mark M. Pickrell

P2/Waste Minimization Project

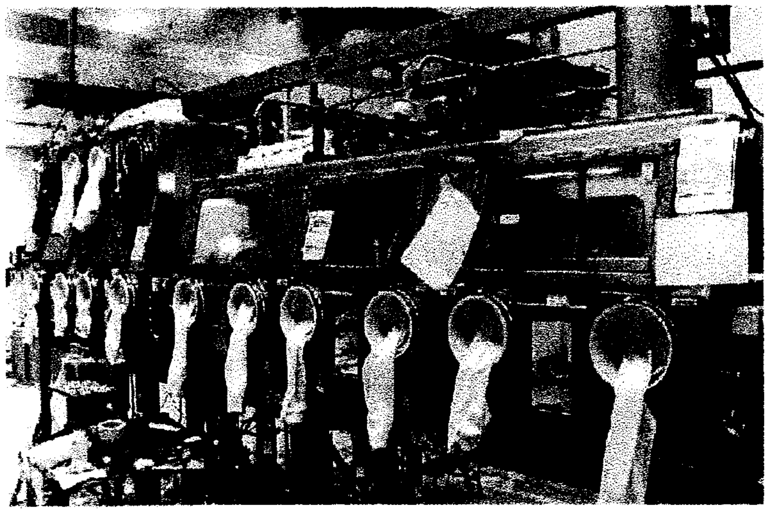
WBS Number:

Glovebox Glove Improvement

Goal: This project is aimed at reducing glove life-cycle cost by 50% in 3 years.

Summary:
Glovebox gloves protect workers from radiological contamination while working with nuclear materials. At LANL, about 50 gloves fail and about 490 are replaced each year. Glove manufacture is based on technology developed before 1958. The typical failure results in facility contamination, worker exposure/contamination, waste generation, and work stoppage. When a glove fails, the room containing the glovebox with the failed glove is usually shut down until it is cleaned up and recertified for operation. At LANL, there are 40 rooms containing gloveboxes susceptible to glove failure, and each room operates an average of 48 weeks each year. In a typical year, about 60 room—weeks of production are lost due to glove failure, resulting in $3.8M of downtime costs annually. The total cost attributable to glove failure at LANL is $5.3M annually.

A glovebox glove improvement project will result in a 50% reduction in glove failures. As part of this project, a common glove procurement specification and glove testing protocol will be developed and implemented. A lead-free glove will be procured, tested, and implemented. A self-monitoring glove will be procured, tested, and implemented. A second glove source or vendor will be established. A vendor quality assistance program will be established.



Value Analysis

Project Cost	**$3990K**
Project Implementation Time	**3 Years**
Project Lifecycle Duration	**20Years**
Lifecycle Savings	**$52,000K**

ROI — 62% (Low, score = 1)
Compliance (Supportive, score = 2)
Safety (Essential, score = 3)
UC Contract (Supportive, score = 2)
Composite Score: 8
Notes:

Contacts

Contact:
John MacDonald, LANL, NMT/NMT-2
(505) 667 7889
jmac@lanl.gov

ESO Contact:
Robert Dodge, LANL, E/ESO
(505) 667 2442
rdodge@lanl.gov

P2/Waste Minimization Project

Glovebox Glove Improvement

WBS Number:

Schedule (2001): Many of he activities in FY01 are ongoing activities throughout the year that will serve to define and guide the specific tasks in later years. They include

- Standards and specs for current gloves — December 2000
- Delivery of second vendor molds — March 2001
- Delivery of second vendor gloves — begin evaluation — September 2001
- Pilot recordkeeping database — January 2001
- Migrate current database to new system — June 2001
- Initial evaluation and testing of lead replacement materials — January 2002

Issues:

- New software, training and application development could impact the Glove Procurement Management System (GPMS) system.
- Effects of gamma radiation on some components, particularly transponders, are unknown at this time.

Cost Basis:

- The three year average (1997 — 1999) for glove failures resulting in a radiological Incident is 46
- and that is the basis of this estimate. Waste generation costs are based on RIR data ($741K)
- Cleanup Materials Costs are based on the actual purchase cost of the items ($36K)
- Cleanup Labor Cost is estimated by the hours required to clean up a contamination event
- ($576K)
- Cost of gloves is included because not all glove failures result in Radiological Incident Reports
- ($61K)
- Loss of productivity costs assume glove failure resulting in a RIR shuts down the entire room the
- glovebox is in, but only that particular room. Normal or periodic glove changes are assumed not
- to shut down an entire room, but only that particular glovebox ($3,807K)

Budget:

1999	2000	2001	2002	2003
$K	$K	$1050K	$1400K	$1540K

References:

P2/Waste Minimization Project

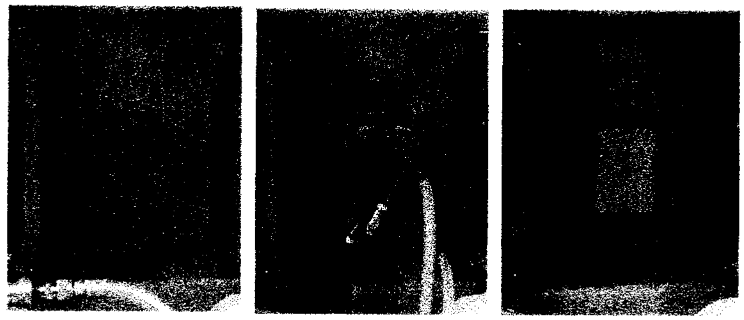
WBS Number:

Glovebox Electrolytic Decontamination

Goal: Increase reuse of gloveboxes and tools through electrolytic decontamination

Summary:
The Plutonium Processing facility at LANL, TA-55, PF-4, contains hundreds of gloveboxes that are used to provide containment for process equipment and work areas. Many gloveboxes contain lead shielding for personnel exposure reduction, which also constitutes a mixed waste. When taken out of service, gloveboxes are large volume waste items and, because they are typically categorized as transuranic/mixed-transuranic (TRU/MTRU) waste, they are packaged in oversized containers that are not certified for disposal at the Waste Isolation Pilot Plant (WIPP). These oversize containers will require costly size reduction and repackaging to meet certification requirements before disposal at WIPP.

Over 40 gloveboxes from TA-55 and CMR are scheduled for removal and disposal as TRU waste. Many of these gloveboxes can be decontaminated and reused or disposed as low-level waste LLW, saving several million dollars in TRU waste costs. This technique can also be used to decontaminate small tools and equipment. The project provides for demonstration and deployment of the technology. This is the last year of P2 program support for this activity. Beginning in FY02, waste generators and groups will decontaminate gloveboxes as part of standard operations.



Electrolytic Decon - before, during and after

Value Analysis	
Project Cost	**$400K**
Project Implementation Time	**1 Year**
Project Lifecycle Duration	**10 Years**
Lifecycle Savings	**$841K/yr.**

ROI: 200% (High, score = 3)
Compliance (Essential, score = 3)
Safety (Supportive, score = 2)
UC Contract (Supportive, score = 2)
Composite Score: 10
Notes: The cost benefits of electrolytic decontamination will increase as the process becomes a standard operational practice. Electrolytic decontamination is an important part of LANL s overall commitment to reducing the generation of TRU waste.

Contacts

Contact:
Douglas Wedman, LANL, NMT/NMT-15
(505) 665 7140
dwedman@lanl.gov

ESO Contact:
Robert Dodge, LANL, E/ESO
(505) 665 0493
rdodge@lanl.gov

P2/Waste
Minimization Project

Glovebox Electrolytic Decontamination

WBS Number:

Schedule:

- Safety Analysis of electrolytic decontamination — 3 months
- Criteria for selecting glovebox and location for decontamination
- Decontamination of gloveboxes - continuous

Issues:

On March 16, 2000, a radiological release of plutonium-238 occurred near a glovebox in the Plutonium Processing and Handling Facility (TA-55) of Los Alamos National Laboratory. As a result, the decontamination of gloveboxes has been temporarily suspended until the potential hazards associated with the glovebox decontamination process are further assessed. Criteria for determining when gloveboxes will be decontaminated within PF-4, decontaminated at another location, or not decontaminated are being developed.

Cost Basis: The estimated cost of disposal for 1 M^3 of TRU/MTRU waste is $58,000. Each glovebox produces several M^3 of TRU waste. Some of the decontaminated gloveboxes can be re-used within the facility eliminating the need to purchase and install new gloveboxes. This saves approximately $150,000 for each glovebox reused. Additionally, the electrolytic decontamination solutions can be processed for recovery of the plutonium, which further reduces the quantity of secondary wastes generated. Conservative estimates of the cost savings for FY01 include elimination of 8 M^3 of TRU/MTRU waste ($464,000) and eliminating the need to purchase one new glovebox ($150,000) for a total of $614,000.

Budget:

1999	2000	2001	2002	2003
$K	$200K	$200K	$K	$K

References:
FY 2000 Closing the Circle P2 Award Nomination

B.2. Low-Level Waste

Dust Suppression

Porous Materials

Radioactive Liquid Wastewater Treatment Facility

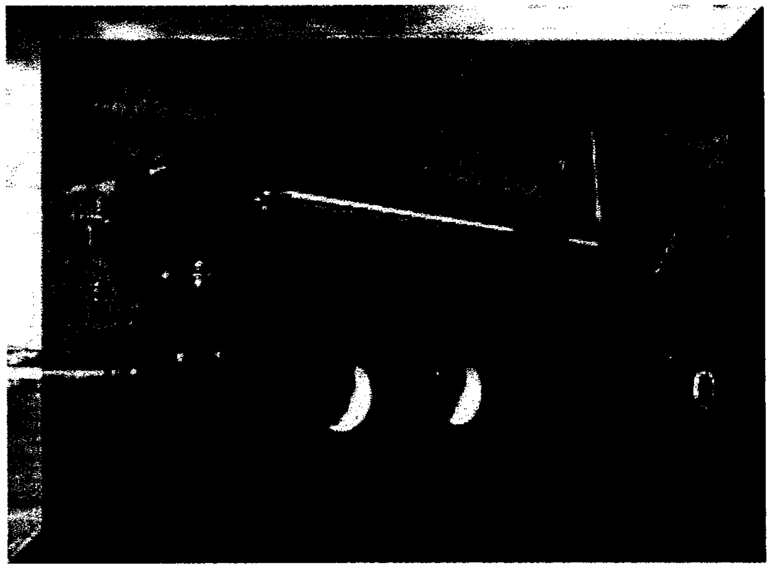
P2/Waste Minimization Project

WBS Number:

Dust Suppression

Goal: Reuse radioactive Liquid Waste Treatment Facility (RLWTF) effluent for dust suppression at TA-54.

Summary:
TA-54 sprays 7 million gallons of water per year on the radioactive waste disposal site (Area G) to control dust on the haul roads. The RLWTF releases 5 million gallons of water per year into Mortandad canyon. Elimination of the RLWTF discharge into Mortendad canyon would reduce LANL s regulatory risk and reduce a migration pathway. The discharge from the TA-50 RLWTF is permitted and must meet the DOE Derived Concentration Guidelines, as well as other permit requirements. Consumptive use of the discharge water will eliminate an outfall and the monitoring and reporting requirements associated with it. The TA-54 tanker would fill up at the RLWTF instead of using freshwater at TA-54. In addition, when the effluent supply from RLWTF is exhausted, graywater from the sanitary wastewater system consolidation plant could be used. This project provides a NEPA determination and an environmental analysis to determine if the RLWTF water can be used at TA-54 and for the increased costs associated with transporting water from RLWTF to TA-54. Should the analysis determine that the wastewater cannot be used, the project will be terminated at that phase.



Value Analysis	
Project Cost	**$200K**
Project Implementation Time	**1 Year**
Project Lifecycle Duration	**10 Years**
Lifecycle Savings	**$261K/yr.**

ROI - 84% (Neutral, score = 1)
Compliance (Essential, score = 3)
Safety (Neutral, score = 1)
UC Contract (Neutral, score = 1)
Composite Score: 6
Notes: Although the cost benefit of this project is obvious, the greatest benefit would be the elimination of a permitted outfall and its associated sampling, analysis, and reporting requirements.

Contacts

Facility Contact:
Dennis McLain, FWO-WFM
505-665- 5099
dmclain@lanl.gov

ESO Contact:
Patricia Vardaro-Charles
505-665-4644
vardaro@lanl.gov

P2/Waste Minimization Project

Dust Suppression

WBS Number:

Schedule: Tasks can run concurrently.
Review and analysis of NEPA documentation for TA-54 — 2 Months

Review and analysis of TA-54 Stormwater Pollution Prevention Plan — 1 Months

Update of data and modeling used in Area G Radiological Performance Assessment — 3 Months

Issues: The radioactive waste disposal site at Area G in TA-54 has a comprehensive environmental monitoring system that monitors dust, runoff, and sediment. The dust, water, and sediments are collected and analyzed for radionuclide content. The use of effluent from the Radioactive Liquid Waste Treatment Facility for dust suppression must be evaluated to ensure that the very low concentrations of radionuclides in the effluent do not accumulate in the new surface environment of TA-54.

Cost Basis:
Although 7000 gallons of water is used annually for dust suppression at TA-54, 5000 gallons was used in estimate because that is all that is available. The actual cost per gallon for potable water was used. The number of trips to transport the water was calculated using a truck capacity of 4000 gallons. The round trip cost for hauling the water to TA-54 was estimated from actual data from the cooling tower water treatment project. That cost was $10,000 for sixty 4,000 gallons truckloads or $167/trip. Because the distance is shorter, $150/trip was used for the TA-54 estimate. The cost savings due to eliminating the sampling and reporting associated with the outfall at TA-50 we estimated to be $31,000.

Budget:

1999	2000	2001	2002	2003
$K	$K	$200K	$K	$K

References:

P2/Waste Minimization Project

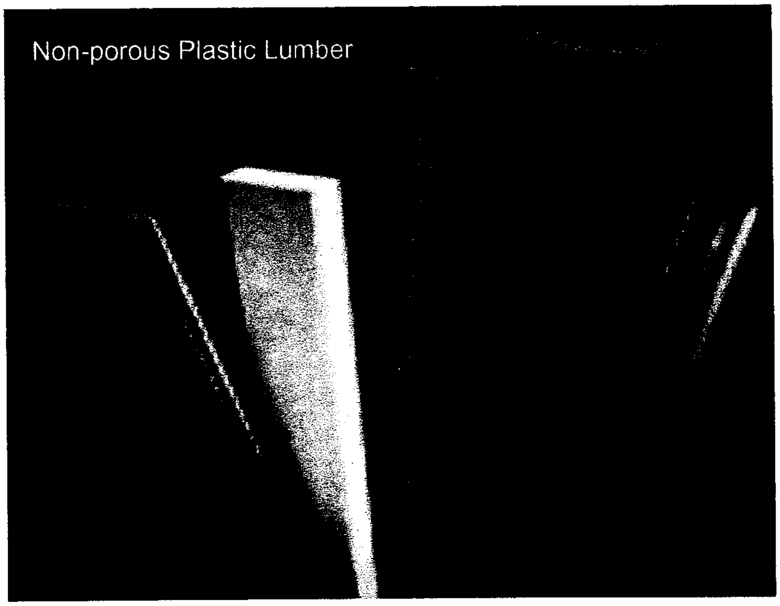
WBS Number:

Porous Material Standard for Radiation Control Area (RCA) Construction

Goal: Increase detectability and the ease of decontamination for radiation contaminated items in RCAs

Summary:

Many porous materials (wood, fabric, etc.) are routinely used in RCAs. Radiological contaminants can absorb into these materials and make them volume contaminated . Although surface contaminated materials (metal, plastic, etc.) can be surface-surveyed and released for recycle under DOE Order 5400.5, there is no authority for releasing volume-contaminated materials. Unless there is acceptable knowledge that they have never been contaminated, suspect volume-contaminated materials are always disposed as low-level waste (LLW). In most cases, porous materials removed from RCAs are not contaminated. In most applications, nonporous materials such as metals could replace porous materials, thus reducing the LLW stream by as much as 50 M^3/year. Metal scaffolding, ladders, pallets, and other construction materials are more easily surveyed and much more easily decontaminated for reuse or recycle. Under this project, guidelines for use of nonporous materials in RCAs will be developed and adopted. This project will establish a working group, draft the guidelines, and provide training to RCA personnel.



Value Analysis	
Project Cost	**$95K**
Project Implementation Time	**6 Months**
Project Lifecycle Duration	**10 Years**
Lifecycle Savings	**$130K/yr.**

ROI: 126% (Medium, score = 2)
Compliance (Supportive, score=2)
Safety (Neutral, score =1)
UC Contract (Essential, score = 3)
Composite Score: 8
Notes:

Contacts

Contact:
Bryan Carlson, LANL E/ESO
(505) 665-6772
bjc@lanl.gov

ESO Contact:
Bryan Carlson, LANL E/ESO
(505) 665-6772
bjc@lanl.gov

P2/Waste Minimization Project

Porous Material Standard for RCA Construction

WBS Number:

Schedule:
- Establish a working group to evaluate nonporous substitutes for use in RCAs — 1 month
- Develop a procedure for the use of nonporous materials — 2 months
- Develop a training program for the use of nonporous materials — 1 month
- Conduct training — 2 months

Issues:
- DOE is considering a moratorium on release of materials under DOE Order 5400.5 until NRC issues national release regulations.
- Health and safety issues related to switching from porous to nonporous materials must be evaluated.

Cost Basis:
Estimated to save >50 m^3/yr in LLW generation = $130K at FY00 waste recharge rates.

Budget:

1999	2000	2001	2002	2003
$K	$K	$95K	$K	$K

References:

P2/Waste Minimization Project

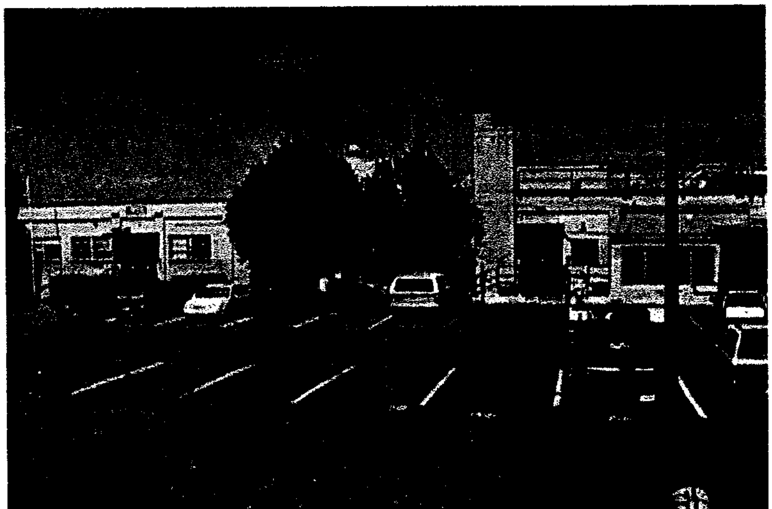
WBS Number:

Radioactive Liquid Waste Treatment Facility (RLWTF) Influent Minimization Study

Goal: Eliminate/reduce the non-radioactive water being discharged to the radioactive water treatment system.

Summary:
The TA-50 Radioactive Liquid Waste Treatment Facility (RLWTF) treats the radioactive liquid wastes from LANL facilities. Up to 10,000 gallons per day of nonradioactive water flows into the RLWTF on a continuous basis resulting in unnecessary operational cost, personnel risk, and waste. The RLWTF must be operated continuously, even in emergency conditions such as the Cerro Grande fire, to assure regulatory compliance. This requirement poses a serious safety risk to crews.

This project will review those activities that discharge effluent into radioactive waste drains and identifies the activities that discharge non-radioactive effluent. Once identified, a list of recommended actions to eliminate the unnecessary discharges will be prepared. The individual facilities will be responsible for implementing the recommended actions or similar actions to provide the intended results.



Technical Area 50 - RLWTF

Value Analysis	
Project Cost	$100K
Project Implementation Time	180 Days
Project Lifecycle Duration	10 Years
Lifecycle Savings	$858K/yr.

ROI - 212% (High, score = 3)
Compliance (Supportive, score = 2)
Safety (Essential, score = 3)
UC Contract (Supportive, score = 2)
Composite Score: 10
Notes: The project costs are $100K. The cost to implement changes based on the project findings are not known but are estimated, for purposes of the ROI calculation, to be less than $300K.

Contacts

Contact:
Rick Alexander, LANL, FWO/WFM
(505) 665- 7020
raa@lanl.gov

ESO Contact:
Bryan Carlson, LANL E/ESO
(505) 665-6772
bjc@lanl.gov

P2/Waste Minimization Project

Facility (RLWTF) Influent Minimization Study

WBS Number:

Schedule:

- Review of activities discharging into liquid radioactive waste system — 4 months.
- Develop recommendations for elimination of non-radioactive waste discharges — 2 months.

Issues:

- There are over 1300 drains connected to the liquid radioactive waste system.
- New activities must be engineered to prevent future unnecessary discharges into the liquid radioactive waste system.

Cost Basis:

- RLWTF treats 5 million gallons per year for an estimated cost of $12 M.
- This project is expected to eliminate at least 1 million gallons of influent water.
- Total cost is estimated at less than $300,000.
- Reducing 1 million gallons of influent water may decrease the number of evaporator bottom shipments by 6 per year at a savings of $858,000.

Budget:

1999	2000	2001	2002	2003
$K	$K	$100K	$K	$K

References:

B.3. Mixed Low-Level Waste

Mercury Cleanup Protocol

Hot Water Extraction

Nitrate Bio-Diversion

Flat Screen

P2/Waste Minimization Project

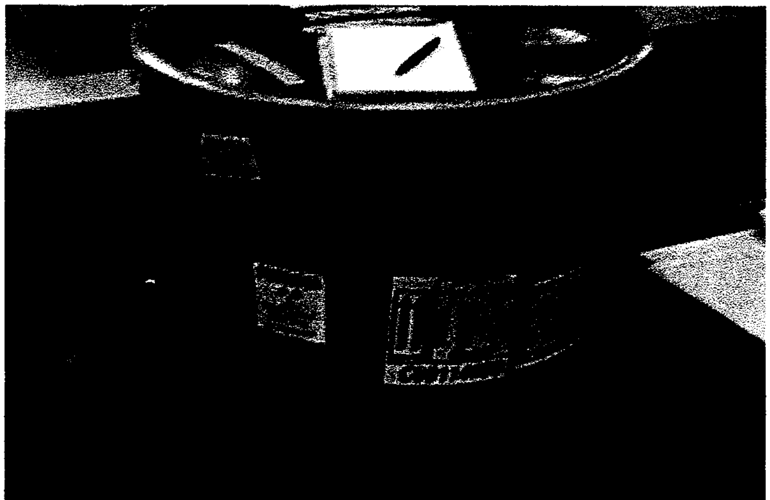
WBS Number:

New Hg Cleanup Protocol for Radiation Control Areas (RCA)

Goal: Implement an established mercury spill cleanup technology that generates almost no spill clean-up waste.

Summary:
Mercury spilled in a Radiation Controlled Area (RCA) results in mixed low level waste that doesn t have a disposal path. Breaking a thermometer in an RCA generates a few cubic feet of MLLW. A new mercury spill cleanup technology exists that generates almost no spill cleanup waste. Use of this new procedure will result in a reduced volume of mercury-contaminated mixed waste and avoids accumulation of mercury MLLW at TA-54. The protocol therefore reduces personnel exposures to mercury, reduces the potential for Resource Conservation and Control Act (RCRA) violations, and reduces the volume of waste generated.

This project will adopt the new mercury spill cleanup protocol to LANL requirements and implement it sitewide.



Barrel containing Hg contaminated waste

Value Analysis	
Project Cost	$50K
Project Implementation Time	6 Months
Project Lifecycle Duration	10 Years
Lifecycle Savings	$175K/yr.

ROI - 340% (High, score = 3)
Compliance (Supportive, score = 2)
Safety (Supportive, score = 2)
UC Contract (Essential, score = 3)
Composite Score: 10
Notes: Lifecycle savings and ROI based on avoided waste. Mercury spill cleanup generates an average of $1.75m^3$/yr of MLLW.

Contacts

Contact:
Barbara Smith, LANL, CST/CST-12
(505)667 2391
bfsmith@lanl.gov

ESO Contact:
Bryan Carlson, LANL E/ESO
(505) 665-6772
bjc@lanl.gov

P2/Waste Minimization Project

New Hg Cleanup Protocol for RCAs

WBS Number:

Schedule:

- Develop new mercury spill cleanup protocol — 3 months
- Prepare a site wide mercury spill cleanup procedure — 3 months

---

Issues:

- ESH-19 will have to validate the new mercury spill protocol and ensure that TCLP limits are met.
- The protocol will have to be adopted lab-wide to realize the full savings.

Cost Basis:

Eliminate the generation of 1.75 m^3/yr of MLLW = savings of $175K/yr.

Budget:

1999	2000	2001	2002	2003
$K	$K	$50K	$K	$K

References:

P2/Waste Minimization Project

WBS Number:

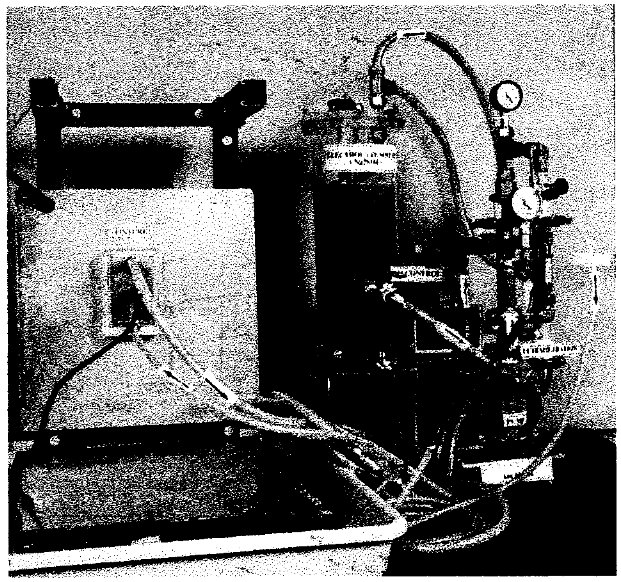
Hot Water Extraction for Characterization of Hazardous Compounds

Goal: Increase worker safety, increase productivity and reduce the cost of extracting hazardous materials for characterization

Summary:
The established methods for extraction and characterization of organic compounds were developed for nonradioactive wastes. When applied to transuranic (TRU) waste, those same methods are environmentally unfriendly, yield poor analytical results, are expensive, expose the analyst to radiological hazards, and produce a mixed-TRU (MTRU) waste that currently has no path to disposal.

The processes involving Resource Conservation and Recovery (RCRA) solvents will generate ~800 L of MTRU per year. Successful implementation of this project will (1) eliminate a source of mixed TRU waste, (2) reduce characterization time and improve quality, (3) greatly enhance worker safety and (4) reduce operational costs.
The proposal is for the purchase of off-the-shelf instrumentation to demonstrate the effectiveness of hot-water extraction (250¡F water at a pressure of 1000 psi) for characterization of hazardous compounds.

Hazardous compound extraction



Value Analysis

Project Cost	**$100K**
Project Implementation Time	**1 Year**
Project Lifecycle Duration	**10 Years**
Lifecycle Savings	**$500K/yr**

ROI - 400% (High, score = 3)
Compliance (Essential, score = 3)
Safety (Supportive, score = 2)
UC Contract (Neutral, score = 1)
Composite Score: 9

Notes:
Compliance is rated highly because the established method for extracting hazardous compounds produces a TRU contaminated solvent with no path to disposal.
The ROI calculation includes productivity savings (see cost basis).

Contacts

Contact:
Craig Taylor, LANL,c-12
(505) 665 3545
eggus_taylor@lanl.gov

ESO Contact:
Robert Dodge, LANL, E/ESO
(505) 665 0493
rdodge@lanl.gov

P2/Waste Minimization Project

WBS Number:

Hot Water Extraction for Characterization of Hazardous Compounds

Schedule:

- Procurement of equipment - 3 months
- Setup and testing — 4 months
- Pilot implementation — 2 months
- Full Implementation — 1 month

Issues:

- If funded the probability of technical success is good based on preliminary studies.
- EPA must grant SW-846 certification for hot water extraction procedure - not included in the schedule. Preliminary talks with the EPA are encouraging.

Cost Basis:

- The productivity savings come from reducing the manpower required from three analysts to one (a $300K savings).
- The major cost savings come from eliminating waste costs.

Budget:

1999	2000	2001	2002	2003
$K	$K	$100K	$K	$K

References:

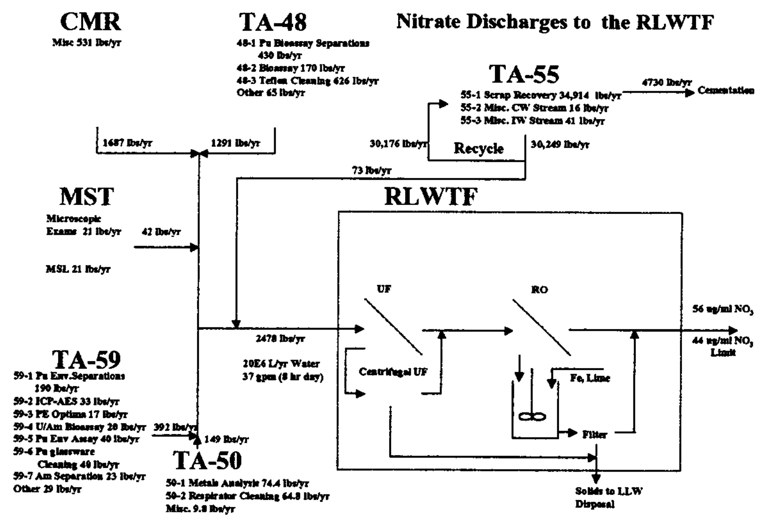
P2/Waste Minimization Project

WBS Number:

Nitrate Bio-Assay Diversion Project

Goal: Divert all bio-assay nitrate streams from the Radioactive Liquid Waste Treatment Facility (RLWTF) to the Sanitary Wastewater System Consolidation (SWSC) facility.

Summary:
When the Nitric Acid Recovery System (NARS) is placed in service at TA-55 an estimated 2478 lb of nitrate waste will still be sent to the RLWTF. Unless these discharges can be reduced, the RLWTF will have to install expensive process equipment to destroy nitrates to keep their discharges below the 44 mg/L nitrate discharge limit. Source reduction efforts have reduced the nitrate discharges to ~2000 lb per year or ~45 mg/L. Another 1000 lb per year of reductions is possible by sending bio-assay analysis waste to the SWSC facility. This waste stream meets the radioactive drinking water limits. However, the current SWSC waste acceptance criteria does not allow discharge of materials with any added radioactivity. This project will develop a new SWSC WAC, which will allow discharge of this Bio-Assay waste. Elimination of this waste from the RLWTF will reduce their nitrate discharge average to 23 mg/L, which is well within their discharge limit.



Value Analysis	
Project Cost	**$50K**
Project Implementation Time	**6 Months**
Project Lifecycle Duration	**10 Years**
Lifecycle Savings	**$1570K**

ROI - 304% (High, score = 3)
Compliance (Supportive, score = 2)
Safety (Neutral, score = 1)
UC Contract (Neutral, score = 1)
Composite Score: 7
Notes:

Contacts

Contact:
Bryan Carlson, LANL E/ESO
(505) 665-6772
bjc@lanl.gov

ESO Contact:
Bryan Carlson, LANL E/ESO
(505) 665-6772
bjc@lanl.gov

P2/Waste Minimization Project

WBS Number:

Nitrate Bio-Assay Diversion Project

Schedule:

- Rewrite the existing SWSC Waste Acceptance Criteria— 3 months.
- Review and approve the new SWSC WAC — 2 months
- Implement discharge to the SWSC plant — 1month

Issues:

There may be institutional issues related to residual radioactive content to overcome before approval to release to the SWSC plant.

Cost Basis:

Eliminate discharge of 1,000 lbs/yr of Nitrate to the RLWTF = $157K/yr in operating costs.

Budget:

1999	2000	2001	2002	2003
$K	$K	$50K	$K	$K

References:

P2/Waste Minimization Project

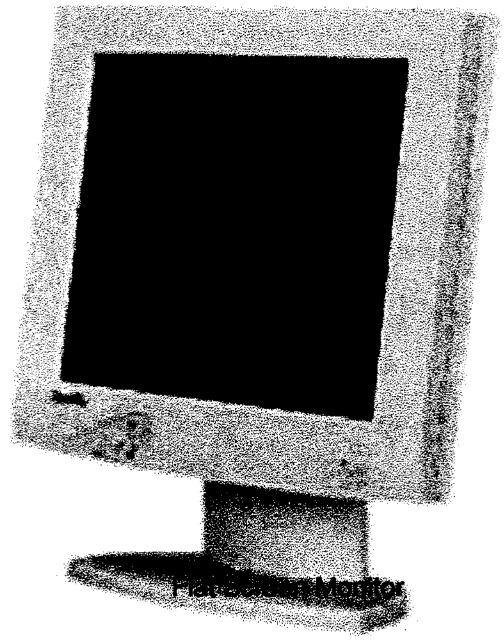
WBS Number:

Flat Screen Monitors for Radiation Control Areas (RCA)

Goal: Reduce the volume of low-level and mixed low level waste by replacing cathode ray tubes CRTs in RCAs with flat screen monitors.

Summary:
Standard cathode ray tube (CRT) displays contain hazardous materials that, when contaminated in radiological controlled areas (RCA), become MLLW. About 100 CRT displays are removed from RCAs each year, and ~10% of these constitute ~3 m^3 of suspect MLLW. The balance is LLW. Flat screen displays do not contain as much hazardous material, such as lead, as CRTs. This replacement would eliminate one of the largest sources of contaminated electronics in the MLLW stream. In addition, the volume of a flat screen monitor is about one-quarter the volume of a CRT, so the volume of non-MLLW generated will be reduced.

In this project, we propose initial implementation on a pilot basis and evaluation of results from the pilot, followed by a Lab policy mandating that only flat screen monitors be used in RCAs.



Value Analysis	
Project Cost	**$30K**
Project Implementation Time	**6 Months**
Project Lifecycle Duration	**5 Years**
Lifecycle Savings	**$1320K**

ROI: 420% (High, score = 3)
Compliance (Supportive, score = 2)
Safety (Supportive, score = 2)
UC Contract (Essential, score = 3)
Composite Score: 10
Notes: The savings associated with reduced hazardous and LLW volume was not included in the ROI calculation.

Contacts

Contact:
Bryan Carlson, LANL E/ESO
(505) 665-6772
bjc@lanl.gov

ESO Contact:
Bryan Carlson, LANL E/ESO
(505) 665-6772
bjc@lanl.gov

P2/Waste Minimization Project

Flat Screen Monitors for RCAs

WBS Number:

Schedule:
- Procure one monitor and perform a toxicity characteristic leach procedure TCLP analysis — 3months
- If TCLP indicates non-RCRA waste, procure and deploy 20 replacement monitors for NMT Division — 2 months
- Evaluate performance and issue site ban on the procurement of new CRTs — 1 month

Issues:
- Full implementation of this project will require a lab-wide procurement ban on CRTs for use in RCAs

Cost Basis:
- About 100 CRTs are removed from RCAs each year, and 10 of these are suspect MLLW
- Replacing the CRTs with flat screen monitors will reduce MLLW generation by 3 m^3/yr = $264K/yr.
- Flat screen monitors requires 75% less table-top space compared to CRT monitors the reduced use of RCA space isn t included in the ROI calculation.

Budget:

1999	2000	2001	2002	2003
$K	$K	$30K	$K	$K

References:

B.4. Hazardous Waste

DX-2 Sump

Green Roadstripes

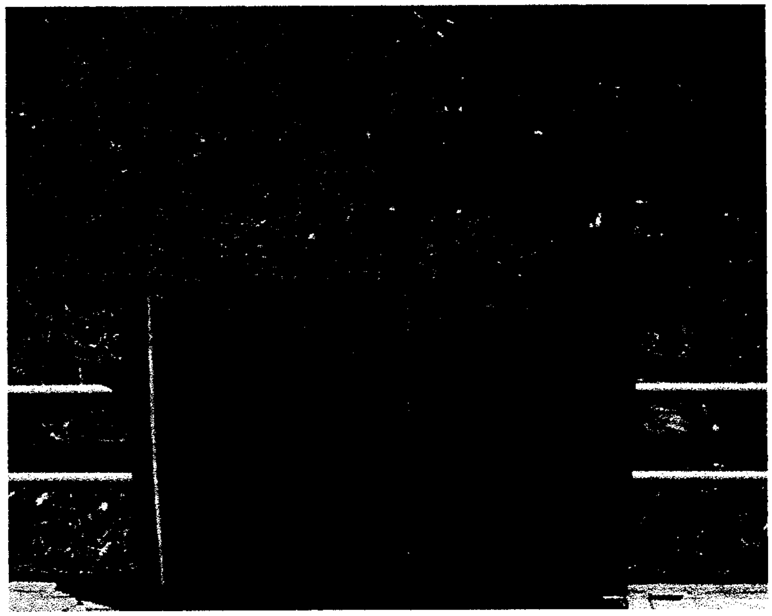
P2/Waste Minimization Project

WBS Number:

Filling Non-operational Sumps

Goal: Fill and cap eight non-operational sumps

Summary:
DX-2 has eight nonoperational sumps collecting water from rainfall and snow melt. The sumps collect no water from operations within their associated buildings. Each sump requires from 15 to 20 pumpouts each year. In the past, these sumps were contaminated with high-explosives residue, so the 40,000 gallons of water pumped from them annually was considered hazardous waste and had to be tested and treated before disposal. Because the sumps currently serve no purpose, this project proposes to fill the eight sumps and the connecting trenches with sand and cap the final 6 in. of both trenches and sumps with concrete.



Value Analysis

Project Cost	**$80K**
Project Implementation Time	**3 Months**
Project Lifecycle Duration	**10 Years**
Lifecycle Savings	**$100K/yr.**

ROI - 112% (Medium, score = 2)

Compliance (Supportive, score = 2)

Safety (Neutral, score = 1)

UC Contract (Supportive, score = 2)

Composite Score: 7

Notes:

Contacts

Contact:
Gordon Jio, LANL, DX/DX-2
(505) 667-4325
jio@lanl.gov

ESO Contact:
Tom Starke, LANL, E/ESO
(505) 667 6639
tps@lanl.gov

P2/Waste Minimization Project

Filling Non-operational Sumps

WBS Number:

Schedule: Tasks are performed sequentially
- Disconnect electrical service, remove conduit and remove all lids — 4 weeks
- Backfill with sand, compact and reinforce — 6 weeks
- Pour 6" concrete slab over backfilled area and clean up job site — 2 weeks

Issues:
There are no issues with this project

Cost Basis:
- Project costs are based on JCNNM estimate
- Savings include: analytical costs of $27,000/yr, pumpout and treatment costs of $10,000/yr and a hazardous waste minimization tax of $60,000/yr

Budget:

1999	2000	2001	2002	2003
$K	$K	$80K	$K	$K

References:
Filling Non-Operational Sumps, Environmental Stewardship GSAF proposal - FY 2000

P2/Waste Minimization Project

WBS Number:

Green Roadstriping Pilot

Goal: The entire waste stream created by mixing, cleanup, spill containment and application of paint is avoided by using thermoplastic stripes and the useful life of the stripe is much longer.

Summary:
The paints used in roadstriping have typically been either oil based or water based. Oil based paints contain volatile organic compounds that require oil based thinners and active mixing. The application of oil-based stripping paints generates spray and a large volume of rags, mixers, and used containers. This waste must be disposed as hazardous waste. The use of water-based paints eliminates most of the hazardous waste but generates about the same volume of solid sanitary waste, which must be disposed in landfills.
Precut thermoplastic stripes are an alternative to paint for roadstriping, and they generate neither hazardous nor solid sanitary waste. The initial costs for thermoplastics are higher, but because the lifetime is eight times longer, the lifecycle costs are much better than paint. The state of Idaho uses 3M thermoplastic stripes exclusively on I-84 because of the 4-year life and excellent performance under adverse weather, sanding, and heavy traffic conditions.
This project will provide funding for a pilot study to evaluate the cost and performance of thermoplastic road stripes at Los Alamos.

Truck Mounted Thermoplastic Roadstripe Applicator

Value Analysis

Project Cost	**$100K**
Project Implementation Time	**1 Year**
Project Lifecycle Duration	**4 Years**
Lifecycle Savings	**$594K**

ROI - 150% (Medium, score = 2)
Compliance (Supportive, score = 2)
Safety (Essential, score = 3)
UC Contract (Supportive, score = 2)
Composite Score: 9

Notes:
The ROI is calculated based on assumed full implementation following a successful pilot. The project cost is for the pilot only.
There are no savings in the first year using thermoplastics: the thermoplastics replace two paintings but costs twice as much. In the subsequent 3 years before reapplication of the thermoplastic, six paintings at $99,000 each are avoided.

Contacts

Contact:
James Stanton, JCNNM/HENV
667-0104
jks@lanl.gov

ESO Contact:
Tom Starke, LANL,E/ESO
667-6639
tps@lanl.gov

P2/Waste Minimization Project

Green Roadstriping Pilot

WBS Number:

Schedule:
- Plan pilot — 3 months
- Procure materials and equipment — 3 months
- Apply materials — 2 months
- Initial evaluation — 4 months
- Further evaluations at one year intervals

Issues:
The primary issue with this project is the lifecycle costs of the thermoplastic striping in the Los Alamos environment. Based on the experience of others, it is thought to be much lower than the life cycle costs for paint, but that has not been demonstrated.

Visibility and reflectivity of 3M thermoplastic stripes are demonstrably greater than painted stripes.

Cost Basis:
- The Laboratory paints 145 miles of stripes (50 miles highway, 95 miles parking lots) twice a year at a cost of $99,000 per application.
- Cost comparison based on the following elements: materials cost, pavement preparation, sprayer efficiency, labor, waste disposal and overhead or indirect costs (such as ES&H support). Except for waste disposal costs oil and water based paints are equivalent.
- Thermoplastic stripes cost twice as much to procure and apply ($198,000 per application).
- Thermoplastic stripes last eight times as long as paint (four year life).
- Savings over the four year life of the thermoplastic material is $594,000.
  Cost of the pilot includes materials, equipment rental, planning, and labor.

Budget:

1999	2000	2001	2002	2003
$K	$K	$100K	$K	$K

References:
1) Green Zia Application; Pollution Prevention at LANL
Reducing Pollution from Road Stripping Operations; Dianne Wilburn, et al.;
2) State of Idaho; www2.state.id.us/itd/press/97press/102297.htm
3) 3M web site: www.3m.com/product

B.5. Sanitary Waste

Site Excess Cleanup

Sanitary Compost

Dirt, Rubble and Asphalt

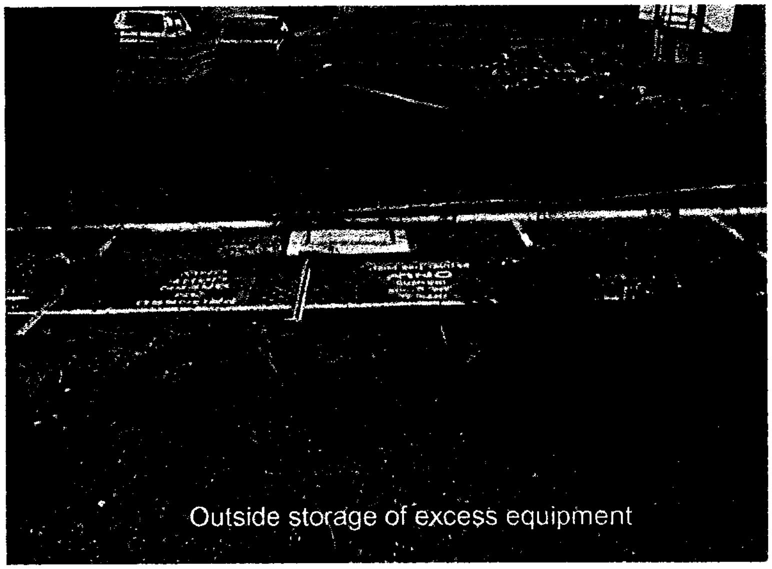
P2/Waste Minimization Project

WBS Number:

Excess Material Cleanup

Goal: Reduce the possibility of contaminating storm water and reduce other hazards associated with outside storage of excess materials.

Summary:
The Lab has ~10,000 tons of mostly unusable excess equipment stored outdoors. Because this material is exposed to rain and snow, it has a significant storm-water pollution. In addition, some of the material is flammable and represents a fire hazard if stored near structures or other combustible materials, such as grass or trees. The excess material may also serve as shelter for mice, rats, and other small mammals.
An effort to reduce or eliminate this material could reduce the pollution potential dramatically, as well as reduce the fire and health risks.



Outside storage of excess equipment

Value Analysis

Project Cost	**$200K**
Project Implementation Time	**3 Years**
Project Lifecycle Duration	**5 Years**
Lifecycle Savings	**$600K**

ROI: 66% (Low, score = 1)
Compliance (Supportive, score = 2)
Safety (Supportive, score = 2)
UC Contract (Supportive, score = 2)
Composite Score: 7
Notes: In the ROI calculation, it is assumed that cleanups will be required at 5-year intervals. (Subsequent cleanups should cost only $100K and take less than one year. The ROI over a 10-year, two-cleanup cycle would then be near 100%)

Contacts

Contact:
Mike Shepherd, JCNNM-MGPN
(505) 667-6225
shepherd_michael_j@lanl.gov

ESO Contact:
Tom Starke, LANL,E-ESO
(505) 667-6639
tps@lanl.gov

P2/Waste Minimization Project

Excess Material Cleanup

WBS Number:

Schedule:
- Inspect Laboratory areas and determine priority of clean-up activities — 3 months
- Prepare work orders to begin site cleanup activities at each of the technical areas — 6 months
- Complete cleanup of all Laboratory Technical Areas — 24 months

Issues:
- A better cost estimate will be available after the technical areas have been inspected.
- Revenue from the sale of scrap metal materials may completely offset the project cost, depending on type and quantity of metal available.
- Removal of excess materials will also improve safety aspects of Laboratory operations; e.g., reduction of tripping/slipping hazards, as well as removal of rodent and vermin nesting areas.

Cost Basis:
- Initial costs of inspection and project development are estimated based on similar projects.
- Project costs expected to be offset by revenue derived from scrap metal sales.

Budget:

1999	2000	2001	2002	2003
$K	$K	$100K	$50K	$50K

References:

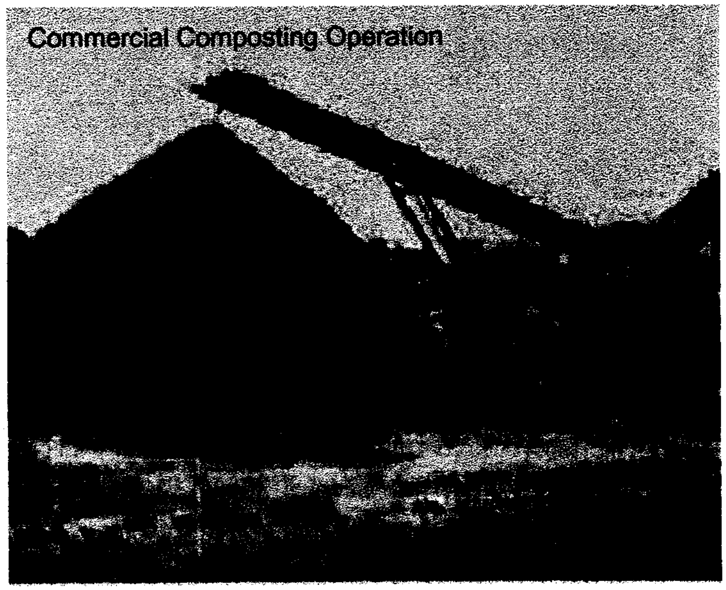
P2/Waste Minimization Project

WBS Number:

Composting System Implementation

Goal: Compost food and paper waste

Summary:
400 MT of the Laboratory s annual solid sanitary waste stream consists of food related waste. The waste is generated from three primary sources: (1) the cafeterias; (2) catering services; and (3) containers from food brought on-site by employees. This waste is amenable to composting which produces a useful soil amendment. In addition to the ~400 MT of food waste generated each year, 33 MT of shredded paper could also be composted. The funding will provide for contacting vendors, purchasing equipment, developing procedures for segregation of compostable items, and developing a market for compost. Composting will be implemented in partnership with a local organization that will own and operate the composting system once it has been tested and is operational. If economically feasible, the resultant soil amendment will be applied to Laboratory land.



Value Analysis	
Project Cost	**$150K**
Project Implementation Time	**1 Year**
Project Lifecycle Duration	**10 Years**
Lifecycle Savings	**Up to$-50K/yr.**

ROI - This project has no ROI

Compliance (Supportive, score = 2)

Safety (Neutral, score = 1)

UC Contract (Essential, score = 3)

Composite Score: 6

Notes: It is not likely that the Laboratory can realize a return on investment for this project and it may cost up to $50K/yr. to operate it. The driver for this project is the Appendix F performance measure. See Cost Basis.

Contacts

Contact:
Michael J Shepherd, JCNNM, MGPM
(505) 667 2665
shepherd_michael_j@lanl.gov

ESO Contact:
Tom Starke, LANL,E-ESO
(505) 667-6639
tps@lanl.gov

P2/Waste Minimization Project

Composting System Implementation

WBS Number:

Schedule: Some tasks can proceed concurrently

- Plan composting operation - 2 months
- Prepare site and purchase equipment - 3 months
- Install and check out equipment - 4 months
- Develop users for compost products - 3 months
- Begin initial operation - 1 month

Issues:

- Without composting the food and shredded paper waste stream the Laboratory will not achieve a rating of good on the Appendix F performance measure for recycling sanitary waste.
- For efficient composting it will be necessary to change the way food waste is handled at the Laboratory.

Cost Basis:

The Laboratory pays $134/MT to collect and dispose of solid sanitary waste ($126/MT collection cost plus an $8MT landfill tipping fee). By composting instead of disposing of the 400MT of food related waste the Laboratory would save only the tipping fee or about $3200/yr. The cost of operating the composting project is much greater than the savings if the system is operated by the Laboratory. If the waste is transported off-site to a partner who owns and operates the composting operation, the collection and transportation costs increase and will more than offset the savings. There is no plausible scenario in which the Laboratory could realize an ROI for this project.

Budget:

1999	2000	2001	2002	2003
$K	$K	$150K	$K	$K

References:

P2/Waste Minimization Project

WBS Number:

Dirt, Rubble, and Asphalt Reuse

Goal: Reduce the volume of dirt, rubble, and asphalt going to the landfill by re-using the material

Summary:
The Lab is currently disposing (at the Los Alamos County landfill) in excess of 1000 metric tons of dirt and concrete per month. This amount is expected to increase as the revitalization of TA-3 proceeds. Using this material as fill would reduce construction costs and provide a means of recycling this rubble, rather than disposing of it at a cost to the Laboratory. Operating costs on the order of $50K-$60K per year will be required to reuse the rubble vs $120K to dispose of same. The funding will provide for an engineering study, contracting with regional users of fill, and initial operating costs.

Rubble recycle operation

Value Analysis	
Project Cost	**$75K**
Project Implementation Time	**1 Year**
Project Lifecycle Duration	**10 Years**
Lifecycle Savings	**$600K**

ROI - 83% (Low, score = 1)
Compliance (Supportive, score = 2)
Safety (Neutral, score = 1)
UC Contract (Essential, score = 3)
Composite Score: 7
Notes: Without some improvement in this category of sanitary waste it is unlikely that the Lab will be able to meet the Appendix F performance measures for sanitary waste in the UC contract.

Contacts

Contact:
Michael J Shepherd, JCNNM, MGPM
(505) 667 2665
shepherd_michael_j@lanl.gov

ESO Contact:
Tom Starke, LANL,E-ESO
(505) 667-6639
tps@lanl.gov

P2/Waste Minimization Project

Dirt, Rubble, and Asphalt Reuse

WBS Number:

Schedule:

- Perform engineering study — 4 months
- Contract with regional users — 3 months
- Develop release criteria/documentation form — 2 months
- Contract for transportation (of rubble) to end user — 4 months

Issues:

- Meeting the performance measures will depend on at least some reduction in this waste stream.
- Regional users of fill will have to be identified.
- Fill material will likely be used for erosion control on public and/or tribal lands. Fill material may also be used as topsoil.

Cost Basis:

- Disposal cost based on average tipping fees of $10/ton — this figure does not include infrastructure costs, such as pickup and transport of materials to the landfill itself.
- Transportation to end-users at off-site locations will be required. Cost of loading and transporting debris to end-users will average $4 - $5K per month.

Budget:

1999	2000	2001	2002	2003
$K	$K	$75K	$K	$K

References:

APPENDIX C
EMPLOYEE POLLUTION PREVENTION AWARENESS

C.1. SUMMARY

Environmental stewardship is the responsibility of every person working at the Laboratory. The purpose of the pollution prevention awareness program is to inform Laboratory personnel of pollution prevention and waste minimization requirements and of tools and systems that can assist them in protecting the environment. The awareness element of the Environmental Stewardship Program continues to be developed. This roadmap describes the activities and initiatives of this developing program.

C.2. POLLUTION PREVENTION AWARENESS SYSTEM DESCRIPTION

The official requirement for waste minimization and pollution prevention is published in the Laboratory's ISM System Laboratory Performance Requirement (LPR) for Environmental Protection (LPR 404-00-00.0), Appendix 4, "Waste Minimization and Pollution Prevention."

The awareness system performs four functions: it (1) communicates LPR waste minimization and pollution prevention requirements, (2) motivates environmentally responsible behavior, (3) announces and explains pollution prevention and waste minimization tools and systems, and (4) informs staff about environmental protection progress. The Environmental Stewardship Program continuously improves awareness, both to meet new requirements, such as upgrading environmental protection in ISM, and to improve pollution prevention awareness.

The pollution prevention awareness system includes several elements.

- Annual Pollution Prevention Awards Program. Cash awards are given to individuals who have taken extraordinary action to prevent pollution, minimize waste, or conserve natural resources on Earth Day. For the past few years, Peter Maggiore, Secretary of the New Mexico Environment Department, has been the keynote speaker. The awards ceremony also is attended by senior DOE Albuquerque and Los Alamos Area Operations Office managers and senior Laboratory and subcontractor managers. The ceremony is well attended, both in the presentation auditorium and via the LABNET TV system. The LANL web page that contains additional information on this program may be accessed at the following URL: http://emeso/lanl.gov/ projects/p2awards.

- GSAF. A small fee equivalent to 1% to 5% of waste disposal cost is assessed to each item of waste generated. This fee is accumulated into the GSAF fund, which is used to fund waste minimization projects. Typically, $500,000 is awarded to 10 to 15 projects each year.

- Newsbulletin articles and ALL-LANL E-mails. At least one pollution prevention or waste minimization message is published for the Laboratory each week.

- Environmental and other training. All of the environmental training courses (Hazwoper, Radworker, Waste Generator Overview, etc.) include modules on waste minimization. In addition, General Employee Training (GET) also includes a pollution prevention/waste minimization module. Facilities and divisions with significant waste generation, such as TA-55 and NMT Division, have specialized waste minimization training.

- Green Zia Environmental Excellence Award Program. The process of developing award-winning environmental protection programs in groups and divisions seeking the Green Zia award communicates useful information and provides hands-on experience for Laboratory staff in the areas of pollution prevention/waste minimization requirements, methods, and measurements.

- External training and conferences. The Laboratory brings DOE and other site-sponsored training modules to the site. These include environmentally preferable products training as an example. The Laboratory also encourages groups and divisions to send their staff to national pollution prevention workshops (such as that offered by DOE Defense Programs), the DOE national pollution prevention conference, and special-topic pollution prevention meetings.

- ESO brochure. The ESO has developed a brochure summarizing important pollution prevention/waste minimization requirements, points of contact, and other useful information.

- Waste Management Coordinator training. The ESO develops and presents pollution prevention/waste minimization training for the Laboratory's Waste Management Coordinators on a quarterly basis.

- Environmental Stewardship Web page. ESO maintains an extensive Web page to assist staff with waste minimization. Detailed data on waste generation, down to individual waste packages, is available and can be downloaded into a spreadsheet for further manipulation. Detailed instructions for recycling different items, such as batteries and paper, are also available. There is a direct link from the Laboratory's main Web page to the Stewardship page through a recycle icon.

Pollution prevention awareness also is communicated through the actions and example set by the ESO personnel.

C.3. PROJECTS

Currently, the focus of the ESO pollution prevention communication program is on the individual employee. In the future, this focus will be enlarged to include several internal audience groups, as well as the public and sponsors. The communications vehicles for reaching these target audiences are listed below.

C.3.1. Develop a Lab-Wide Communication Program Plan

- Create a formality of communication that will include an ESO logo for name recognition and ease of identification of LANL environmental ethics. In addition, this logo and format will be used by all ESO personnel on ESO letterheads, Web pages, reports, signature lines of E-mails, business cards, and any other appropriate items to further the ESO mission. The object is to have all LANL personnel recognize the ESO posters/communications. All communications will be unified by a common symbol.

C.3.2. Expand Pollution Prevention in Formal Training

- All Laboratory personnel must undergo general as well as specific training when warranted. The training requirements offer unique opportunities for the ESO to explain its services and provide information to all employees. Because the majority of the current training modules does not address pollution prevention concepts adequately, the existing training material will be reviewed and revised as necessary to provide information to employees that will enable them to incorporate pollution prevention techniques into their activities. Three modules have been identified as representing the most effective cross-section of Laboratory employees: GET; Waste Generator Overview training, which focuses on specific waste generators; and Waste Management Coordinators (WMC) training.

C.3.3. Expand Awards Program

- Increase annual pollution prevention awards funding from $10,000 to $20,000.

C.3.4. Direct Communications to All Employees

- The DOE and UC performance measures require that LANL effectively reduce its waste streams. The Laboratory has effectively reduced some of its most significant waste streams. However, LANL also needs to tackle the smaller waste streams (electricity and sanitary waste) because it will help the Laboratory achieve the DOE and UC Contract waste minimization and recycling goals. In 2000, the ESO developed a brief presentation communicating how LANL staff can help the Laboratory conserve electricity and reduce sanitary waste. During 2001, additional protect-the-environment presentations will be developed and presented to Laboratory personnel.

- This plan should include two or more invited guest speakers each year. Speakers also could be invited to workshops held by ESO or E Division. In the Laboratory culture, the environmental stewardship goal is to educate, assist, and promote environmental excellence. Of the approximately 7000 UC employees, 3400 are Technical Staff Members. A large majority of these people are scientists involved in various research and technical development areas. To that end, the ESO would like to offer seminars, such as the Director's Colloquium, with renowned speakers in the areas of environmental ethics and pollution prevention to attract the attention and attendance of scientists at the Laboratory.

C.3.5. Implement Public Communication

- ESO will release news items within the Laboratory's news release policy that will provide pollution prevention success stories to public news media in Northern New Mexico. A release will occur in the first calendar quarter, followed by two releases for the next three calendar quarters. The subject will be determined by the ESO team.

C.3.6. Stewardship Brochures

- Individuals and groups inside and outside of the Laboratory need to learn about the resources that ESO has available for stewardship/pollution prevention. Two marketing brochures will be created to provide this information. One of the brochures will contain general information about the ESO mission, key ongoing ESO programs and projects, and ESO general contact information. The second brochure will be in the form of a folder that can be customized for specific audiences/ individuals with a core of basic information about ESO and the addition of appropriate fact sheets related to individual programs and projects.

C.3.7. Assistance

- The ESO provides assistance to waste generators to (1) identify pollution prevention/waste minimization opportunities, (2) solve pollution prevention/waste minimization problems, (3) obtain funding, and (4) solve infrastructure problems. By integrating these activities into more of a team structure, the level of assistance can be improved. By informing waste generators of ESO expertise, the number of calls for assistance should increase dramatically.

APPENDIX D
CONSTRUCTION WASTE STREAMS

D.1. CONSTRUCTION PROCESS

The Laboratory's construction and upgrading activities are organized into five phases: Preconceptual, Conceptual, Execution, Operations, and Facility Shutdown, as shown in Fig. D-1. Although construction at the Laboratory encompasses a wide variety of projects, including nuclear and nonnuclear facility construction and upgrades, all projects will follow the five basic construction phases.

The Preconceptual phase is the initial planning stage. All of the preliminary work for a project is accomplished in this phase, including assigning the project leader, selecting the project team, defining the scope of the project, and determining whether the project is feasible.

The Conceptual phase establishes the design for the project. In this phase, the design plan is prepared and a preliminary budget and project schedule are developed.

In the Execution phase, the design is implemented and the facility is constructed. The Project Execution Plan (PEP) is developed, the A/E contractor is determined, and project-specific plans are generated. Special studies/value engineering requirements are performed. The ES&H regulatory requirements are defined, and plans and procedures are developed. The cost and project schedule are updated. The construction site is inspected periodically to ensure that safety and other project concerns are met.

In the Operations phase, project management closes out its authority over the project and turns the completed facility over to the operating group. During the project management closeout, all final documentation is completed, including the operations procedures, maintenance procedures, and cost/schedule review.

Fig. D-1. Project management construction phases.

Project management will step back into the system when operations at the facility are completed and shutdown of the facility is planned. At this point, the cycle will start again, with the facility decommissioning is performed by the LANL FWO Division's D&D group. The activities performed by the D&D group are outside of the scope of this roadmap.

D.2. PRECONCEPTUAL AND CONCEPTUAL PHASES

The Preconceptual and Conceptual design phases develop a project scope, ensure project feasibility and attainable performance levels, identify project risks, and develop a cost estimate and schedule. This is a critical time to begin incorporating SD principles into the design project because nearly all of the general construction and operational design elements are defined during these design phases. High-level SD principles can be incorporated into the Conceptual Design Report. By documenting the SD opportunities in the Conceptual phase, the project will have a strong driver to promote detailed SD during the later phases of the project.

Another SD opportunity during or immediately after the Conceptual design phases is when hiring the A/E and construction subcontractors. The project should include SD requirements in the design and construction bid request documentation to ensure that the subcontractors implement SD principles that have been identified during the Conceptual design phases. LANL should request that offerers maximize efficient energy use, minimize water use, use recycled-content construction materials, and consider compliance with existing LANL engineering codes/standards to be only the minimum standard. LANL can consider allowing the offerers to score higher based on their incorporation of SD elements.

D.3. EXECUTION PHASE

The Execution phase consists of several subphases, as shown in Fig. D-2. No waste actually is generated during the Preliminary Design, Design, and Engineering and Inspection subphases. All of the waste generated during the Execution phase is generated during the Construction subphase, which includes preconstruction and construction activities.

Preconstruction activities are concerned primarily with preparing the site for construction of the new facility. Preparation could include clearing trees and brush and excavating and leveling of the ground. The process diagram for preconstruction (Fig. D-3) shows the possible inputs and outputs. Both energy and water are used during the preconstruction process. Waste streams produced by this process include air emissions of excessive dust and equipment exhaust and leaks, aqueous losses of waste oils and coolants from the equipment, spills and storm water runoff, and solid waste consisting of metals, mixed rubble, wood, glass, plastics, and soil.

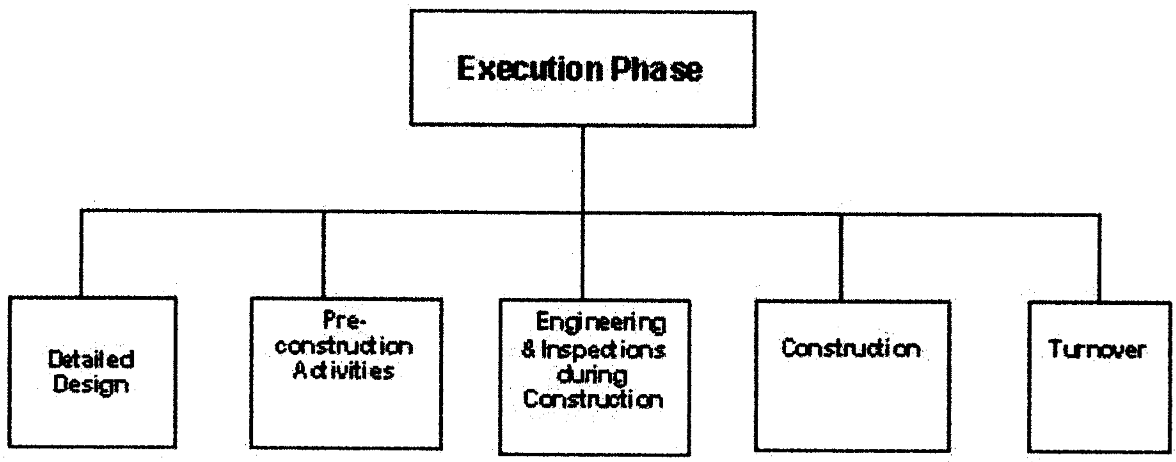


Fig. D-2. Construction project execution phase.

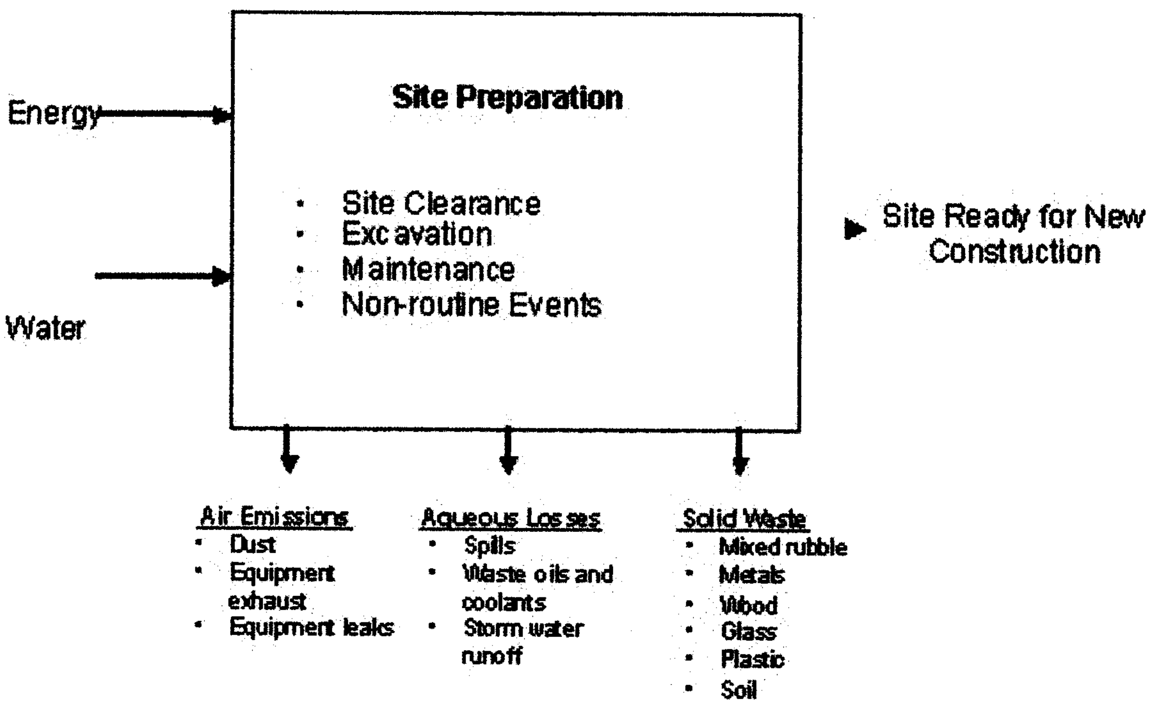


Fig. D-3. Anticipated waste streams for preparing a site for construction.

After preconstruction activities are completed, construction of the new facility can begin. Figure D-4 shows the anticipated waste streams for construction of a new facility. Inputs to the system include water, energy, and building materials. Depending on the type of facility, the amounts and types of inputs can vary.

Many of the wastes produced are similar to the site preparation wastes, with some variations. Air emissions will include not only fugitive dust emissions and equipment exhaust and leaks, but also the possibility of volatile organic carbon (VOC) emissions from painting operations. Aqueous losses will consist of used waste solvents, process water, waste oils and coolants from the equipment, spills, and storm-water runoff. Solid wastes generated will include many of the same wastes as the preconstruction phase, including metals, wood, glass, and plastic. Cardboard waste and excess masonry materials also will be generated during the construction process. After the construction of the facility has been completed, project management will turn the facility over to the operating group.

D.4. OPERATIONS PHASE

The operations phase of a facility (Fig. D-5) includes both startup and the continued operation throughout the facility's lifetime.

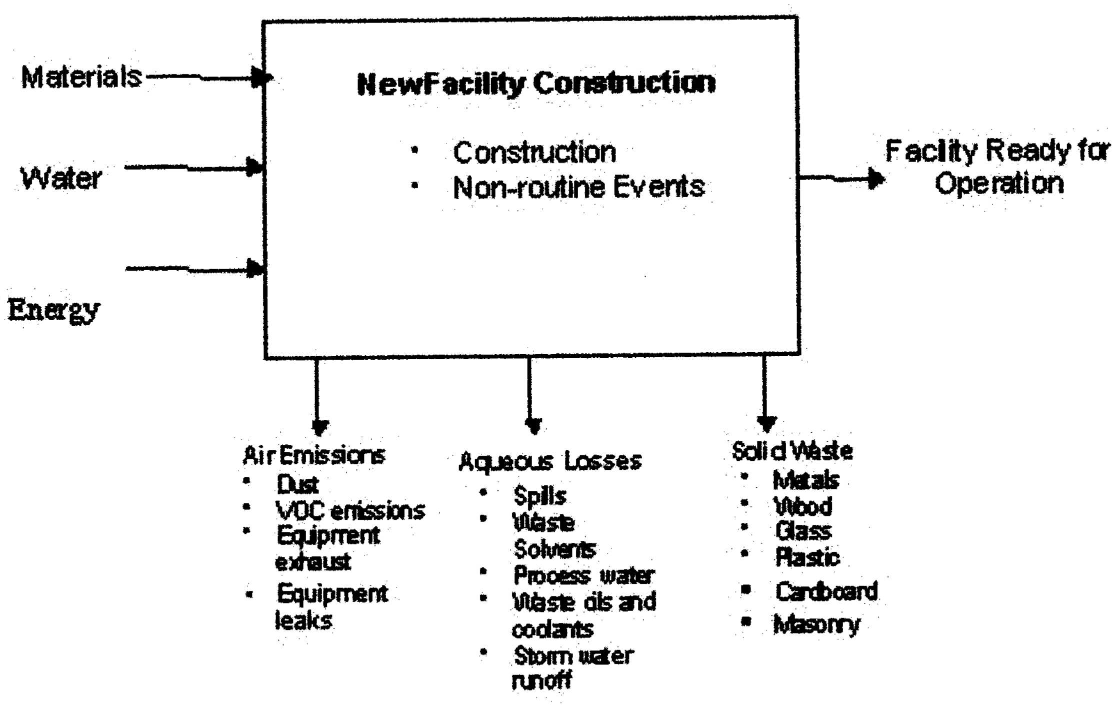


Fig. D-4. Anticipated waste streams for construction of a new facility.

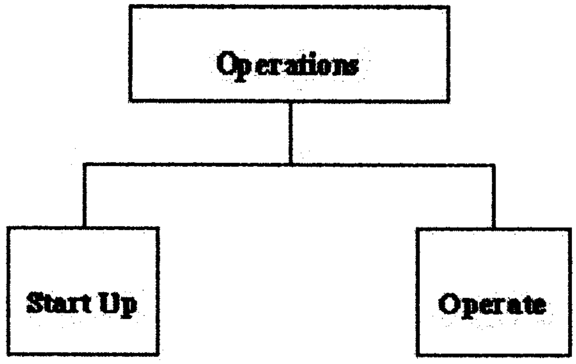


Fig. D-5. Construction project operations phase.

Operation of the facility includes facility maintenance and repair, utilities, and janitorial support. Figure D-6 shows the anticipated waste streams for the operation of a facility. All facilities will consume both water and energy. Depending on the facility, the amount and types of materials consumed will vary.

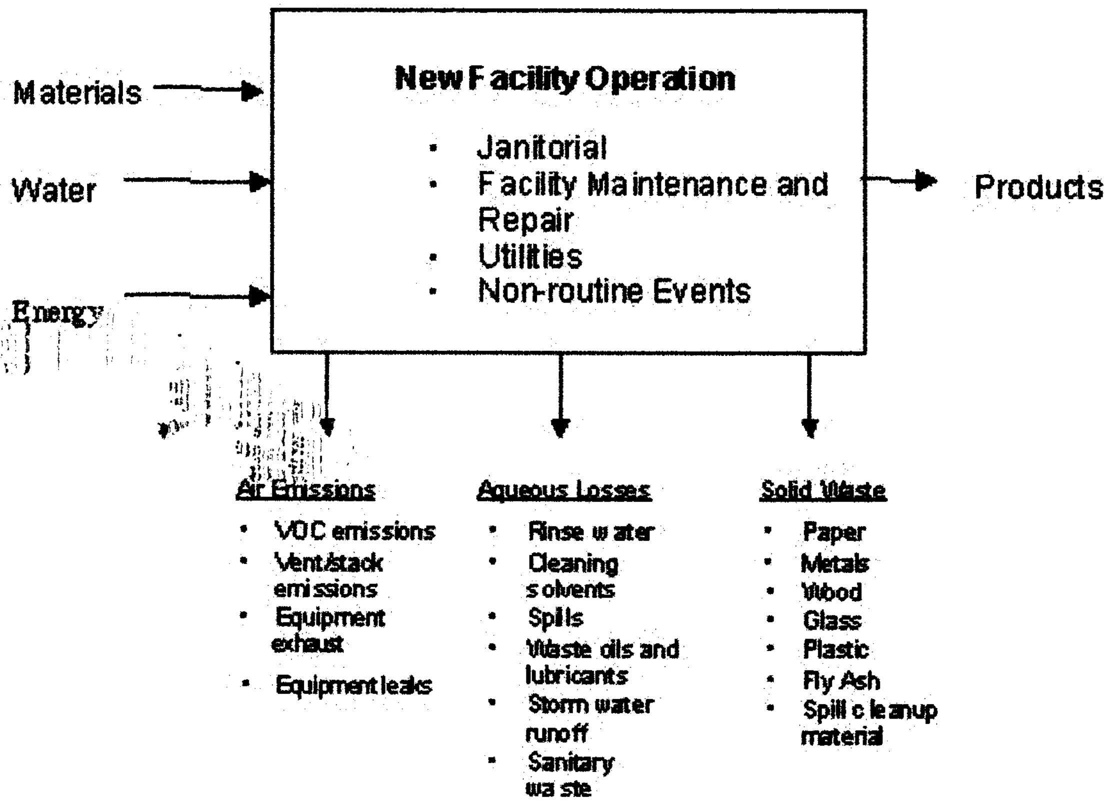


Fig. D-6. Anticipated waste streams for the operation of a facility.

Air emissions are highly dependent on the type of facility but can include VOC emissions, vent or stack emissions, and equipment exhaust and leaks. Aqueous losses are less dependent on the type of facility but can still vary. All facilities will have a sanitary waste stream and used cleaning solvents. Depending on the facility, the rinse-water, waste-oils, waste-lubricants, and storm-water runoff streams can vary greatly in quantity and sources. Unlike the Execution phase, in which a large amount of solid waste is generated in a short period of time (depending on the facility), the amount of solid waste generated during the facility's lifetime will vary greatly. Usually the largest waste stream in an operating facility is paper waste. Other waste streams can include metals, wood glass, plastic, fly ash from exhaust stacks, and spill cleanup material.

D.5. SHUTDOWN PHASE

At the end of the facility's lifetime, the facility can be either upgraded to meet future needs or decommissioned. In either case, the shutdown of the facility will include the Preconceptual, Conceptual, and Execution subphases, as shown in Fig. D-7. During the Preconceptual and Conceptual subphases, the design plan for the upgrade/decommissioning is established; the plan is executed during the Execution subphase.

A significant amount of waste can be generated during the Facility Shutdown/Upgrade stage. The anticipated waste streams from the shutdown of a facility are shown in Fig. D-8. The facility shutdown can include dismantlement of equipment, site clearance, utilities, and maintenance during the shutdown. The waste streams generated are very similar to those for site preparation. Air emissions include fugitive dust emissions and equipment exhaust and leaks. Aqueous losses will include waste oils and lubricants, spills, and storm-water runoff. Solid waste generated will be the major contributor by volume to the total amount of waste generated. Solid waste streams include paper, mixed rubble, metals, wood, glass, plastic, and spill cleanup material.

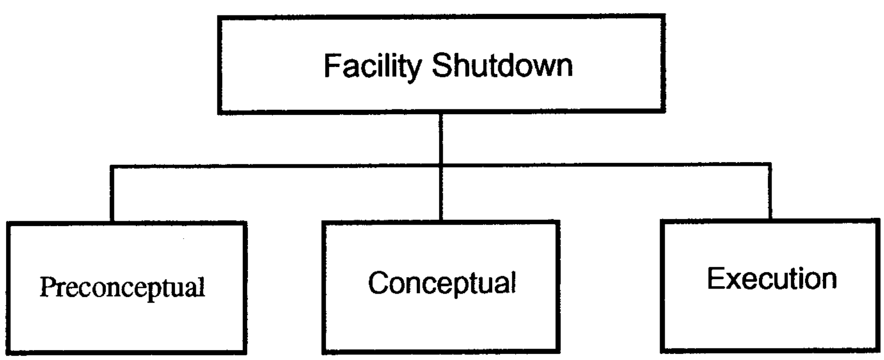


Fig. D-7. Construction project facility shutdown phase.

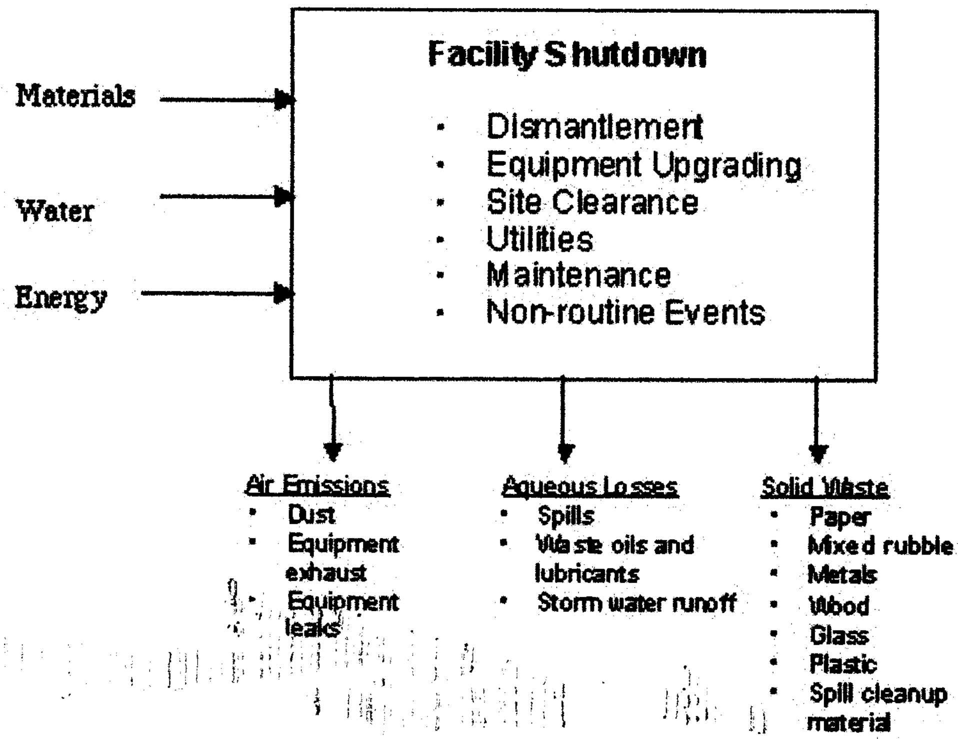


Fig. D-8. Anticipated waste streams for the shutdown of a facility.

All five phases in the Laboratory's construction project management system affect the waste generation, effluents, air emissions, energy usage, water usage, and materials procured over the lifetime of a facility. The preconceptual and conceptual phases are the most critical phases to implement sustainable design principles. These phases of construction allow for maximum SD, pollution protection, and waste minimization to be incorporated into the facility for life-cycle benefits. After the preconceptual and conceptual design phases are complete, recycle, reuse, and substitution are the primary opportunities for waste minimization and pollution prevention.