DOE/EIS-0380
May 2008

Final Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico

Volume 2 • Book 1

Appendices A through H

U.S. Department of Energy

National Nuclear Security Administration

Los Alamos Site Office

AVAILABILITY OF
THE FINAL SITE-WIDE ENVIRONMENTAL IMPACT
STATEMENT FOR CONTINUED OPERATION OF
LOS ALAMOS NATIONAL LABORATORY,
LOS ALAMOS, NEW MEXICO

To submit general questions regarding this EIS, or to request a copy, please contact:

Elizabeth Withers, EIS Document Manager
NNSA Service Center - Albuquerque
National Nuclear Security Administration
U.S. Department of Energy
P. O. Box 5400
KAFB East, SC-1
Albuquerque, NM 87185-5400
Telephone: 505-845-4984

♻ *Printed with soy ink on recycled paper*

COVER SHEET

Responsible Agency: U.S. Department of Energy (DOE)
National Nuclear Security Administration (NNSA)

Title: *Final Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (SWEIS) (DOE/EIS-0380)

Location: Los Alamos, New Mexico

For additional information or for copies of the SWEIS, contact:

Elizabeth Withers, EIS Document Manager
NNSA Service Center - Albuquerque
National Nuclear Security Administration
U.S. Department of Energy
P. O. Box 5400
KAFB East, SC-1
Albuquerque, NM 87185-5400
Telephone: 505-845-4984

For general information on the DOE National Environmental Policy Act (NEPA) process, contact:

Carol M. Borgstrom, Director
Office of NEPA Policy and Compliance
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
Telephone: 202-586-4600, or leave a message at 1-800-472-2756

This document is available on the DOE NEPA website (www.eh.doe.gov/nepa) and the NNSA Los Alamos Site Office website (www.doeal.gov/laso/NEPASWEIS.aspx) for viewing and downloading.

Abstract: NNSA proposes to continue operating Los Alamos National Laboratory (LANL), which is located in Los Alamos County in north-central New Mexico. NNSA has identified and assessed three alternatives for continued operation of LANL: (1) No Action, (2) Reduced Operations, and (3) Expanded Operations. Under the No Action Alternative, NNSA would continue the historical mission support activities conducted at LANL at currently approved operational levels. Under the Reduced Operations Alternative, NNSA would eliminate some activities and limit the operations of other activities. Under the Expanded Operations Alternative, NNSA would operate LANL at the highest levels of activity currently foreseeable, including full implementation of mission assignments. Expanded Operations is NNSA's Preferred Alternative. NNSA intends to implement actions necessary to comply with the March 2005 Compliance Order on Consent (Consent Order) to address the investigation and remediation of environmental contamination at LANL, regardless of decisions it makes on other actions analyzed in the SWEIS. Under all of the alternatives, the affected environment is primarily within 50 miles (80 kilometers) of LANL. Analyses indicate little difference in the environmental impacts of the alternatives on many resource areas. The primary discriminators are public risk due to radiation exposure, collective worker risk due to radiation exposure, socioeconomic effects due to LANL employment changes, electrical power and water demand, waste management, and transportation. A classified appendix assesses the potential impacts of terrorist acts.

Public Comments: In preparing the Final SWEIS, NNSA considered comments received during the scoping period (January 19 to February 17, 2005) and during the public comment period on the Draft SWEIS (July 7 to September 20, 2006). Public hearings on the Draft SWEIS were held in Los Alamos, Española, and Santa Fe, New Mexico. Comments on the Draft SWEIS were requested during a period of 75 days following publication of the U.S. Environmental Protection Agency's (EPA's) Notice of Availability in the *Federal Register*. All comments, including any late comments, were considered during preparation of the Final SWEIS.

The Final SWEIS contains revisions and new information based in part on comments received on the Draft SWEIS. Vertical change bars in the margins indicate the locations of these revisions and new information. Volume 3 contains the comments received during the public comment period on the Draft SWEIS and NNSA's responses to the comments. NNSA will use the analysis presented in this Final SWEIS, as well as other information, in preparing the Record(s) of Decision (RODs) regarding the level of continued operations at LANL. NNSA will issue ROD(s) no sooner than 30 days after the EPA publishes a Notice of Availability of this Final SWEIS in the *Federal Register*.

TABLE OF CONTENTS
VOLUME 2

TABLE OF CONTENTS
VOLUME 2

VOLUME 1 – CHAPTERS 1 THROUGH 11
VOLUME 2 BOOK 1 – APPENDICES A THROUGH H
VOLUME 2 BOOK 2 – APPENDICES I THROUGH M
VOLUME 3 BOOK 1 – COMMENT RESPONSE DOCUMENT
SECTIONS 1, 2, AND 3 (PAGES 3-1 THROUGH 3-561)
VOLUME 3 BOOK 2 – COMMENT RESPONSE DOCUMENT
SECTION 3 (PAGES 3-562 THROUGH 3-1089) AND SECTION 4

Appendix A
Federal Register Notices

Appendix B
Nonradiological Air Quality

Appendix C
Evaluation of Human Health Impacts from Normal Operations

Appendix D
Evaluation of Human Health Impacts from Facility Accidents

Appendix E
Current Understanding of the Groundwater Regime at Los Alamos National Laboratory

Appendix F
Environmental Sample Data

Appendix G
Impacts Analyses of Projects to Maintain Existing Los Alamos National Laboratory Operations and Capabilities

Appendix H
Impacts Analyses of Closure and Remediation Actions

Appendix I
Major Material Disposal Area Remediation, Canyon Cleanups, and Other Consent Order Actions

Appendix J
Impacts Analyses of Projects Associated with New Infrastructure or Levels of Operation

Appendix K
Evaluation of Human Health Effects From Transportation

Appendix L
Categorical Exclusion Summary

Appendix M
Contractor Disclosure Statement

LIST OF FIGURES

Appendix C

Appendix D

Appendix E

Appendix F

Appendix G

Appendix H

Appendix I

Appendix J

Appendix K

LIST OF TABLES

Appendix B

Appendix C

Appendix D

Appendix E

Appendix F

Appendix G

Appendix H

Appendix I

Appendix J

Appendix K

ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

ALARA	as low as reasonably achievable
AOC	area of concern
BEIR	Biological Effects of Ionizing Radiation
CAP-88	Clean Air Act Assessment Package – 1988
CASA	Critical Assembly Storage Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CH	contact-handled
CME	corrective measure evaluation
CMR	Chemistry and Metallurgy Research (Building)
CMRR	Chemistry and Metallurgy Research Building Replacement Project
CO	carbon monoxide
CO_2	carbon dioxide
CSU	container storage unit
DARHT	Dual Axis Radiographic Hydrodynamic Test (Facility)
dB	decibel
dBA	decibel A-weighted
D&D	decontamination and decommissioning
DD&D	decontamination, decommissioning, and demolition
DIF	Definitive Identification Facility
DNA	deoxyribonucleic acid
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DVRS	Decontamination and Volume Reduction System
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guideline
FONSI	Finding of No Significant Impact
FR	*Federal Register*
FY	fiscal year
GIS	geographical information system
HDPE	high-density polyethylene
HE	high explosive
HEPA	high-efficiency particulate air (filter)
HSWA	Hazardous and Solid Waste Amendments
HTO	tritiated water
ISCORS	Interagency Steering Committee on Radiation Standards
ISCST3	Industrial Source Complex Air Quality Dispersion Model

LANL	Los Alamos National Laboratory
LANL SWEIS	*Site-Wide Environmental Impact Statement for the Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico*
LANSCE	Los Alamos Neutron Science Center
LSA	low specific activity (waste)
LASL	Los Alamos Scientific Laboratory (now LANL)
LCF	latent cancer fatality
LEED	Leadership in Energy and Environmental Design
LLNL	Lawrence Livermore National Laboratory
LLW	low-level radioactive waste
LOC	level-of-concern
MAR	material at risk
MDA	material disposal area
MEI	maximally exposed individual
MET	meteorological
MLLW	mixed low-level radioactive waste
NEPA	National Environmental Policy Act of 1969
NESHAP	National Emission Standards for Hazardous Air Pollutants
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NNSA	National Nuclear Security Administration
NO_x	nitrogen oxide
NOEL	No Observed Effect Level
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NTS	Nevada Test Site
PC	performance category
PCB	polychlorinated biphenyl
PEL	permissible exposure limit
petaflops	one quadrillion floating point operations per second
PHERMEX	Pulsed High Energy Radiographic Machine Emitting X Rays
PIDAS	Perimeter Intrusion Detection and Assessment System
ppm	parts per million
PM_n	particulate matter less than or equal to n microns in aerodynamic diameter
PRS	potential release site
PSVE	passive soil vapor extraction
PuO_2	plutonium dioxide
rad	radiation absorbed dose

RANT	Radioassay and Nondestructive Testing Facility
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man
RFI	RCRA facility investigation
RH	remote-handled
RLWTF	Radioactive Liquid Waste Treatment Facility
ROD	Record of Decision
SA	supplement analysis
SAL	Screening Action Level
SHEBA	Solution High-Energy Burst Assembly
SLEV/Q	screening level emission value by the estimated emission rate
SNM	special nuclear material
SO_x	sulfur oxide
SRS	Savannah River Site
SST	safe secure transport
SVE	soil vapor extraction
SWEIS	Site-Wide Environmental Impact Statement
SWMU	solid waste management unit
TA	technical area
TCLP	toxicity characteristic leaching procedure
TEDE	total effective dose equivalent
TEELs	Temporary Emergency Exposure Limits
teraflops	one trillion floating point operations per second
TNT	trinitrotoluene
TRAGIS	Transportation Routing Analysis Geographic Information System
TRU	transuranic
TSCA	Toxic Substances Control Act
TSD	treatment, storage, and disposal
TWCF	Transuranic Waste Consolidation Facility
U-233	uranium-233
UCL	upper confidence limit
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey
VOC	volatile organic compound
WCRR	Waste Characterization, Reduction, and Repackaging Facility
WIPP	Waste Isolation Pilot Plant
Y-12	Y-12 Complex in Oak Ridge
°C	degrees Celsius
°F	degrees Fahrenheit
µg/g	micrograms per gram
mg/m^3	milligrams per cubic meter

CONVERSIONS

METRIC TO ENGLISH			ENGLISH TO METRIC		
Multiply	**by**	**To get**	**Multiply**	**by**	**To get**
Area					
Square meters	10.764	Square feet	Square feet	0.092903	Square meters
Square kilometers	247.1	Acres	Acres	0.0040469	Square kilometers
Square kilometers	0.3861	Square miles	Square miles	2.59	Square kilometers
Hectares	2.471	Acres	Acres	0.40469	Hectares
Concentration					
Kilograms/square meter	0.16667	Tons/acre	Tons/acre	0.5999	Kilograms/square meter
Milligrams/liter	1 [a]	Parts/million	Parts/million	1 [a]	Milligrams/liter
Micrograms/liter	1 [a]	Parts/billion	Parts/billion	1 [a]	Micrograms/liter
Micrograms/cubic meter	1 [a]	Parts/trillion	Parts/trillion	1 [a]	Micrograms/cubic meter
Density					
Grams/cubic centimeter	62.428	Pounds/cubic feet	Pounds/cubic feet	0.016018	Grams/cubic centimeter
Grams/cubic meter	0.0000624	Pounds/cubic feet	Pounds/cubic feet	16,025.6	Grams/cubic meter
Length					
Centimeters	0.3937	Inches	Inches	2.54	Centimeters
Meters	3.2808	Feet	Feet	0.3048	Meters
Kilometers	0.62137	Miles	Miles	1.6093	Kilometers
Temperature					
Absolute					
Degrees C + 17.78	1.8	Degrees F	Degrees F - 32	0.55556	Degrees C
Relative					
Degrees C	1.8	Degrees F	Degrees F	0.55556	Degrees C
Velocity/Rate					
Cubic meters/second	2118.9	Cubic feet/minute	Cubic feet/minute	0.00047195	Cubic meters/second
Grams/second	7.9366	Pounds/hour	Pounds/hour	0.126	Grams/second
Meters/second	2.237	Miles/hour	Miles/hour	0.44704	Meters/second
Volume					
Liters	0.26418	Gallons	Gallons	3.78533	Liters
Liters	0.035316	Cubic feet	Cubic feet	28.316	Liters
Liters	0.001308	Cubic yards	Cubic yards	764.54	Liters
Cubic meters	264.17	Gallons	Gallons	0.0037854	Cubic meters
Cubic meters	35.314	Cubic feet	Cubic feet	0.028317	Cubic meters
Cubic meters	1.3079	Cubic yards	Cubic yards	0.76456	Cubic meters
Cubic meters	0.0008107	Acre-feet	Acre-feet	1233.49	Cubic meters
Weight/Mass					
Grams	0.035274	Ounces	Ounces	28.35	Grams
Kilograms	2.2046	Pounds	Pounds	0.45359	Kilograms
Kilograms	0.0011023	Tons (short)	Tons (short)	907.18	Kilograms
Metric tons	1.1023	Tons (short)	Tons (short)	0.90718	Metric tons
ENGLISH TO ENGLISH					
Acre-feet	325,850.7	Gallons	Gallons	0.000003046	Acre-feet
Acres	43,560	Square feet	Square feet	0.000022957	Acres
Square miles	640	Acres	Acres	0.0015625	Square miles

a. This conversion is only valid for concentrations of contaminants (or other materials) in water.

METRIC PREFIXES

Prefix	Symbol	Multiplication factor
exa-	E	1,000,000,000,000,000,000 = 10^{18}
peta-	P	1,000,000,000,000,000 = 10^{15}
tera-	T	1,000,000,000,000 = 10^{12}
giga-	G	1,000,000,000 = 10^{9}
mega-	M	1,000,000 = 10^{6}
kilo-	k	1,000 = 10^{3}
deca-	D	10 = 10^{1}
deci-	d	0.1 = 10^{-1}
centi-	c	0.01 = 10^{-2}
milli-	m	0.001 = 10^{-3}
micro-	μ	0.000 001 = 10^{-6}
nano-	n	0.000 000 001 = 10^{-9}
pico-	p	0.000 000 000 001 = 10^{-12}

APPENDIX A
FEDERAL REGISTER NOTICES

DEPARTMENT OF ENERGY

Record of Decision: Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory in the State of New Mexico

AGENCY: Department of Energy.

ACTION: Record of decision.

SUMMARY: The Department of Energy (DOE) is issuing this Record of Decision on the continued operation of the Los Alamos National Laboratory (LANL) in the State of New Mexico. This Record of Decision is based on the information and analysis contained in the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, DOE/EIS–0238 (including the classified supplement), and other factors, including the mission responsibilities of the Department, and comments received on the final Site-Wide Environmental Impact Statement. DOE has decided to implement the Preferred Alternative, which, with certain limitations, is the Expanded Operations Alternative. This alternative would expand operations at LANL, as the need arises, to increase the level of existing operations to the highest reasonably foreseeable levels, and to fully implement the mission elements assigned to LANL.

FOR FURTHER INFORMATION CONTACT: For further information on the Site-Wide Environmental Impact Statement or to receive a copy of the Site-Wide Environmental Impact Statement or other information related to this Record of Decision, contact: Corey Cruz, Document Manager, U.S. Department of Energy, Albuquerque Operations Office, P.O. Box 5400, Albuquerque, NM 87185, (505) 845–4282.

For information on the DOE National Environmental Policy Act (NEPA) process, contact: Carol M. Borgstrom, Director, Office of NEPA Policy and Assistance (EH–42), U.S. Department of Energy, 1000 Independence Avenue, SW, Washington, DC 20585, (202) 586–4600, or leave a message at (800) 472–2756.

SUPPLEMENTARY INFORMATION:

Background

DOE prepared this Record of Decision pursuant to the regulations of the Council on Environmental Quality for implementing NEPA (40 CFR Parts 1500–1508) and DOE's NEPA Implementing Procedures (10 CFR Part 1021). This Record of Decision is based, in part, on DOE's Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, (DOE/EIS–0238). LANL is located in north-central New Mexico, 60 miles (96 kilometers) north-northeast of Albuquerque, 25 miles (40 kilometers) northwest of Santa Fe, and 20 miles (32 kilometers) southwest of Española. LANL occupies an area of approximately 27,832 acres (11,272 hectares), or approximately 43 square miles (111 square kilometers), of which 86 percent lies within Los Alamos County and 14 percent within Santa Fe County. The Fenton Hill site (Technical Area [TA]–57), a remote site 20 miles (32 kilometers) west of LANL, occupies 15 acres (6 hectares) in Sandoval County on land leased from the U.S. Forest Service. LANL is divided into 49 separate Technical Areas. LANL is a multi-disciplinary, multipurpose national laboratory engaged in theoretical and experimental research and development. DOE has assigned elements of each of its four principal missions (National Security, Energy Resources, Environmental Quality, and Science) to LANL, and has established and maintains several capabilities in support of these mission elements, including applications of science and technology to the nuclear weapons program. These capabilities also support applications for other Federal agencies and other organizations in accordance with national priorities and policies.

DOE is currently engaged in other NEPA reviews that include LANL as an alternate location for the action under consideration. These other NEPA reviews include programmatic and project Environmental Impact Statements for Waste Management and Surplus Plutonium Disposition. Since these other Environmental Impact Statements identify potential new or expanded activities for LANL, the impacts of these activities are described under the Preferred Alternative in the Site-Wide Environmental Impact Statement. The nature of the decisions in this Record of Decision with regard to the Waste Management programmatic and project proposals is simply to reserve infrastructure at LANL pending completion of these programmatic and project reviews and the corresponding decision document. With regard to the Surplus Plutonium Disposition program, the nature of the decision in this Record of Decision is to maintain the competency and capability to fabricate the Lead Assemblies as evaluated in the Surplus Plutonium Disposition Environmental Impact Statement (SPD EIS). However, the availability and capacity of facilities to perform such work may be limited because of competing priorities from the weapons program. DOE's resolution of any such competing priorities will be reflected in the Record of Decision for the SPD EIS.

DOE was directed by Congress (Pub. L. 105–119) to convey or transfer parcels of DOE land in the vicinity of LANL to the Incorporated County of Los Alamos, New Mexico, and the Secretary of the Interior, in trust for the San Ildefonso Pueblo. Such parcels, or tracts of land, must not be required to meet the national security mission of LANL and must also meet other criteria established by the Act. DOE has issued a Draft Environmental Impact Statement to examine the potential environmental impacts associated with the conveyance or transfer of 10 specific parcels. EPA published a Notice of Availability for the Draft Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico, in the Federal Register on February 26, 1999.

The Site-Wide Environmental Impact Statement considers the environmental impacts of ongoing and proposed activities at LANL. DOE expects that it will continue to suggest new programs, projects, and facilities for LANL (or consider LANL as an alternative site for such facilities or activities). These new proposals will be analyzed in programmatic or project-specific NEPA reviews, as they become ripe for decision. Subsequent NEPA reviews will make reference to, and be tiered from, the Site-wide Environmental Impact Statement; and subsequent DOE decisions on these proposals may amend this Record of Decision.

Alternatives Considered

DOE analyzed four broad alternative levels of operation at the Los Alamos National Laboratory. The four alternatives are as follows:

Alternative 1—No Action

The No Action Alternative reflects the levels of operation at LANL that are currently planned. This includes operations that provide for continued support of DOE's four primary missions, but would not include an increase in the existing pit manufacturing capacity (beyond the current capacity of 14 pits per year) nor expansion of the low-level waste disposal facility at Technical Area–54 (the remaining space in the existing Area G footprint would be used, but some low-level waste would be shipped off-site for disposal). This alternative includes the maintenance of existing capabilities, continued support/infrastructure activities, and implementation of several facility construction or modification projects throughout LANL that have previous NEPA reviews.

Alternative 2—Expanded Operations (DOE's Preferred Alternative Except for Pit Manufacturing)

The Expanded Operations Alternative would expand operations at LANL, as the need arises, to increase the level of existing operations to the highest reasonably foreseeable levels, and to fully implement the mission elements assigned to LANL. This includes the impacts of the full implementation of pit manufacturing up to a capacity of 50 pits per year under single-shift operations (80 pits per year using multiple shifts). This alternative includes the expansion of the low-level waste disposal site at Technical Area–54, including receipt of off-site wastes. In addition, this alternative includes the continued maintenance of existing and expanded capabilities, continued support/infrastructure activities, and implementation of several facility construction or modification projects at Technical Area–53 (i.e., the Long-Pulse Spallation Source, the 5-Megawatt Target/Blanket Experimental Area, the Dynamic Experiment Laboratory, and the Isotope Production Facility).

Alternative 3—Reduced Operations

The Reduced Operations Alternative reflects the minimum levels of operation at LANL considered necessary to maintain the capabilities to support DOE missions over the near-term (through the year 2007). While the capabilities are maintained under this alternative, this may not constitute full support of the mission elements currently assigned to LANL. This alternative reflects pit manufacturing at a level below the existing capacity (at 6 to 12 pits per year) and reflects shipment of much of the low-level waste generated at LANL for off-site disposal (on-site disposal would be limited to those waste types for which LANL has a unique capability at Area G). This alternative includes the maintenance of existing capabilities, continued support/infrastructure activities, and implementation of several facility construction or modification projects throughout LANL that have previous NEPA reviews; some of the projects previously reviewed under NEPA would be reduced in scope or eliminated (e.g., the Low-Energy Demonstration Accelerator would only be operated at the lower end of its energy range).

Alternative 4—''Greener''

The ''Greener'' Alternative reflects increased levels of operation at LANL in support of nonproliferation, basic science, and materials recovery/stabilization mission elements, and reduced levels of operation in support of defense and nuclear weapons mission elements. All LANL capabilities are maintained for the short term under this alternative; however, this may not constitute full support of the nuclear weapons mission elements currently assigned to LANL. This alternative reflects pit manufacturing at a level below the existing capacity (at 6 to 12 pits per year) and reflects shipment of much of the low-level waste generated at LANL for off-site disposal (on-site disposal would be limited to those waste types for which LANL has a unique capability at Area G). This alternative includes the maintenance of existing capabilities, continued support/infrastructure activities, and implementation of several facility construction or modification projects at Technical Area–53 (i.e., the Long-Pulse Spallation Source, the 5-Megawatt Target/Blanket Experimental Area, the Dynamic Experiment Laboratory, and the Isotope Production Facility.) The name and general description for this alternative were provided by interested public stakeholders as a result of the scoping process.

Preferred Alternative

In the draft Site-Wide Environmental Impact Statement, the Preferred Alternative was the Expanded Operations Alternative. In the final Site-Wide Environmental Impact Statement, the Expanded Operations Alternative is the Preferred Alternative with one modification, which involves the level at which pit manufacturing would be implemented at LANL. Under the Expanded Operations Alternative, DOE would expand operations at LANL, as the need arises, to increase the level of existing operations to the highest reasonably foreseeable levels. This expansion of operations would apply broadly to the essential science and technology activities across LANL, and would apply to the level of activity for those operations (e.g., increased throughput or increased numbers of experiments). The Expanded Operations alternative includes expansion to fully implement pit manufacturing up to the capacity of 50 pits per year under single-shift operations (80 pits per year using multiple shifts) assigned to LANL in the Record of Decision for the Stockpile Stewardship and Management Programmatic Environmental Impact Statement.

However, as a result of delays in the implementation of the Capability Maintenance and Improvement Project and recent additional controls and operational constraints applied to work conducted in the Chemistry and Metallurgy Research (CMR) Building, DOE has determined, as a matter of policy, to postpone any decision to expand pit manufacturing beyond a level of a nominal 20 pits per year in the near future (through the year 2007), and to study further methods for implementing the 50 pits per year production capacity. The revised Preferred Alternative reflects implementing pit manufacturing at the 20-pit-per-year level. This postponement does not modify the long-term goal announced in the Record of Decision for the Stockpile Stewardship and Management Programmatic Environmental Impact Statement of 50 pits per year (up to 80 pits per year using multiple shifts).

The Preferred Alternative includes the expansion of the low-level waste disposal site at Technical Area–54. The Preferred Alternative also includes the continued maintenance of existing and expanded capabilities, continued support/infrastructure activities, and implementation of several facility construction or modification projects at Technical Area–53 (i.e., the Long-Pulse Spallation Source, the 5-Megawatt Target/Blanket Experimental Area, the Dynamic Experiment Laboratory, and the Isotope Production Facility).

Environmentally Preferable Alternative

The Council on Environmental Quality, in its ''Forty Most Asked Questions Concerning CEQ's NEPA Regulations'' (46 FR 18026, 2/23/81), with regard to 40 CFR 1505.2, defined the ''environmentally preferable alternative'' as the alternative ''that will promote the national environmental policy as expressed in NEPA's Section 101. Ordinarily, this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources.''

After considering impacts to each resource area by alternative, DOE has identified Alternative 3, Reduced Operations, as the environmentally preferable alternative. Alternative 3 was identified as having the fewest direct impacts to the physical environment and to worker and public health and safety because all operations would be at the lowest levels. However, the analyses indicate that there would be very little difference in the environmental impacts among the alternatives analyzed. The major discriminators among alternatives are collective worker risks due to radiation exposure, socioeconomic effects due to LANL employment changes, and electrical power demand. Therefore, Reduced Operations would have the fewest impacts and Expanded Operations would have the most.

Environmental Impacts of Alternatives

DOE weighed environmental impacts as one factor in its decision making. DOE analyzed the potential impacts that might occur to land resources; geology, geological conditions, and soils; water resources, air quality; ecological and biological resources, human health, environmental justice, cultural resources; and socioeconomic, infrastructure, and waste management for the four alternatives. DOE considered the impacts that might occur from use of special nuclear materials, facility accidents, and the transportation of radioactive and other materials associated with LANL operations. DOE considered the impacts of projects and activities associated with each alternative, the irreversible or irretrievable commitments of resources, and the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity.

The highest resource impacts under any of the alternatives will be to the electrical power infrastructure. Peak electrical demand under the Reduced Operations Alternative exceeds supply during the winter months and may result in periodic brownouts. Peak electrical demand under the No Action, Expanded Operations, and Greener Alternatives exceeds the power supply in both winter and summer, when this may result in periodic brownouts. (Power supply to the Los Alamos area has been a concern for a number of years, and DOE continues to work with other users in the area and power suppliers to increase supply and reduce use.)

Nonradioactive hazardous air pollutants would not be expected to degrade air quality or affect human health under any of the alternatives. The differences in activities among the alternatives do not result in large differences in chemical usage. The activities at LANL are such that large amounts of chemicals are not typically used in any industrial process at LANL (compared to what may be used in commercial manufacturing facilities); but research and development activities involving many users dispersed throughout the site are the norm. Air emissions are, therefore, not expected to change by a magnitude that would, for example, trigger more stringent regulatory requirements or warrant continuous monitoring. Radioactive air emissions change slightly, but are within a narrow range due to the controls placed on these types of emissions and the need to assure compliance with regulatory standards. The collective population radiation doses from these emissions range from about 11 person-rem per year to 33 person-rem per year across the alternatives, and the radiation dose to the maximally exposed individual ranges from 1.9 millirem per year to 5.4 millirem per year across the alternatives. These doses were considered in the human health impact analysis.

The total radiological doses from normal operations over the next 10 years to the public under any of the alternatives are relatively small and are not expected to result in any excess latent cancer fatalities (LCFs) to members of the public. Additionally, exposure to chemicals due to LANL operations under any of the alternatives is not expected to result in significant effects to either workers or the public. Exposure pathways associated with the traditional practices of communities in LANL area (special pathways) would not be expected to result in human health effects under any of the alternatives. The annual collective radiation dose to workers at LANL ranges from 170 person-rem per year to 833 person-rem per year across the alternatives. These dose levels would be expected to result in from 0.07 to 0.33 excess LCFs per year of operation, respectively, among the exposed workforce. These impacts, in terms of excess LCFs per year of operation, reflect the numbers of excess fatal cancers estimated to occur among the exposed members of the work force over their lifetimes per year of LANL operations. These impacts form an upper bound, and the actual consequences could be less, but probably would not be worse.

Worker exposures to physical safety hazards are expected to result in a range of 417 (Reduced Operations) to 507 (Expanded Operations) reportable cases each year; typically, such cases would result in minor or short-term effects to workers, but some of these incidents could result in long-term health effects or even death.

LANL employment (including the University of California employees and those of the two subcontractors with the largest employment among LANL subcontractors) ranges from 9,347 (Reduced Operations) to 11,351 (Expanded Operations) full-time equivalents across the alternatives, as compared to 9,375 LANL full-time equivalents in 1996. These changes in employment would result in changes in regional population, employment, personal income, and other socioeconomic measures. Under any of the alternatives, these secondary effects would change existing conditions in the region by less than 5 percent.

Water demand for LANL ranges from 602 million gallons (2,279 million liters) per year to 759 million gallons (2,873 million liters) per year across the alternatives; the total water demand (including LANL and the residences and other businesses and agencies in the area) is within the existing DOE Rights to Water, and would result in average drops of 10 to 15 feet (3.1 to 4.6 meters) in the water levels in DOE well fields over the next 10 years. Usage, therefore, will remain within a fairly tight range among the alternatives. The related aspect of wastewater discharges is also within a narrow range for that reason. Outfall flows range from 218 to 278 million gallons (825 to 1,052 million liters) per year across the alternatives, and these flows are not expected to result in substantial changes to existing surface or groundwater quantities. Outfall flows are not expected to result in substantial surface contaminant transport under any of the alternatives. However, since mechanisms for recharge to groundwater are highly uncertain, it is possible that discharges under any of the alternatives could result in contaminant transport in groundwater and off the site, particularly beneath Los Alamos Canyon and Sandia Canyon, which have increased outfall flows. The outfall flows associated with the Expanded Operations and Greener Alternatives reflect the largest potential for such contaminant transport, and the flows associated with the Reduced Operations Alternative have the least potential for such transport.

There is little difference in the impacts to geology, geological conditions, and soils across the alternatives. Wastewater discharge volumes with associated contaminants do change across the alternatives, but not to a degree noticeable in terms of impacts (such as causing soil erosion, for example). Under all of the alternatives, small quantities (as compared to existing conditions) of contaminants would be deposited in soils due to continued LANL operations, and the Environmental Restoration Project would continue to remove existing contaminants at sites to be remediated. Geological mapping and fault trenching studies at LANL are currently under way or recently completed to better define the rates of fault movements, specifically of the Pajarito Fault, and the location and possible southern termination of the Rendija Canyon Fault. Ongoing and recently completed seismic hazard studies indicate that slip rates (recurrence intervals for earthquakes) are within the parameters assumed in the 1995 seismic hazards study at LANL.

There is little difference in the impacts to land resources between the No Action, Reduced Operations, and the Greener Alternatives. Differences among the alternatives are primarily associated with operations in existing facilities, and very little new development is planned. Therefore, these impacts are essentially the same as currently experienced. The Expanded Operations Alternative has very similar land resources impacts to those of the other three alternatives, with the principal differences being attributable to the visual impacts of lighting along the proposed transportation corridor between the Plutonium Facility and the Chemistry and Metallurgy Research Building (this corridor will not be built under the Preferred Alternative) and the noise and vibration associated with increased frequency of high explosives testing (as compared to the other three alternatives).

No significant adverse impact to ecological and biological resources is projected under any of the alternatives. The separate analyses of impacts to air and water resources constitute some of the source information for analysis of impacts in this area; as can be seen from the above discussion, the variation across the alternatives is not of a sufficient magnitude to cause large differences in effects. The impacts of the Expanded Operations Alternative differ from those of the other alternatives in that there is some projected loss of habitat; however, this habitat loss is small (due to limited new construction) compared to available similar habitat in the immediate vicinity.

DOE expects no environmental justice impacts from the operation of LANL under any of the alternatives, i.e., projected impacts are not disproportionately high for minority or low-income populations in the area. DOE also analyzed human health impacts from exposure through special pathways, including ingestion of game animals, fish, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of plant materials. The special pathways have the potential to be important to the environmental justice analysis because some of these pathways may be more important or viable for the traditional or cultural practices of minority populations in the area. However, human health impacts associated with these special pathways also will not present disproportionately high and adverse impacts to minority or low-income populations.

Under all of the Site-Wide Environmental Impact Statement alternatives, there is a negligible to low potential for impacts to archaeological and historic resources due to shrapnel and vibration caused by explosives testing and contamination from emissions. Potential impacts will vary in intensity in accordance with the frequency of explosives tests and the operational levels that generate emissions (e.g., Reduced Operations would reflect the lowest potential, and Expanded Operations would reflect the highest potential). Recent assessments of prehistoric resources indicate a low potential compared to the effects of natural conditions (wind, rain, etc.). In addition to these potential impacts, the Expanded Operations Alternative includes the expansion of the low-level waste disposal site at Technical Area-54, which contains several National Register of Historic Places sites; if any significant cultural resources will be adversely effected by the undertaking, DOE will consult with the New Mexico State Historic Preservation Office and other consulting parties to resolve the adverse effect.

The potential impacts to specific traditional cultural properties would depend on their number, characteristics, and location. Such resources could be adversely affected by changes in water quality and quantity, erosion, shrapnel from explosives testing, noise and vibration from explosives testing, and contamination from ongoing operations. Such impacts would vary in intensity in accordance with the frequency of explosive tests and the operational levels that generate emissions. The current practice of consultation would continue to be used to provide opportunities to avoid or minimize adverse impacts to any traditional cultural properties located at LANL.

LANL chemical waste generation ranges from 3,173 to 3,582 tons (2,878,000 to 3,249,300 kilograms) per year across the alternatives. LANL low-level waste generation, including low-level mixed waste, ranges from 338,210 to 456,530 cubic feet (9,581 to 12,837 cubic meters) per year across the alternatives. LANL transuranic (TRU) waste generation, including mixed TRU waste, ranges from 6,710 to 19,270 cubic feet (190 to 547 cubic meters) across the alternatives. Disposal of these wastes at on-site or off-site locations is projected to constitute a relatively small portion of the existing capacity for disposal sites; disposal of all LANL low-level waste on the site would require expansion of the low-level waste disposal capacity beyond the existing footprint of Technical Area-54 Area G under all alternatives (although this is only included in the analysis of the Expanded Operations Alternative).

Radioactively contaminated space in LANL facilities would increase by about 63,000 square feet (5,853 square meters) under the No Action, Reduced Operations, and Greener Alternatives (due primarily to actions previously reviewed under NEPA but not fully implemented at the time the existing contaminated space estimate was established [May 1996]). The Expanded Operations Alternative would increase contaminated space in LANL facilities by about 73,000 square feet (6,782 square meters). The creation of new contaminated space causes a clean-up burden in the future, including the generation of radioactive waste for treatment and disposal; the actual impacts of such clean-up actions are highly uncertain because they are dependent on the actual characteristics of the facilities, the technologies available, and the applicable requirements at the time of the cleanup.

Incident-free transportation associated with LANL activities over the next 10 years would be conservatively expected to cause radiation doses that would result in about one excess latent cancer fatality to a member of the public and two excess latent cancer fatalities to members of LANL workforce over their lifetimes under each of the Site-Wide Environmental Impact Statement alternatives. There is little variation in impacts because effects are small, and the increased transport of radioactive materials is not enough to make a significant change in those small effects.

Transportation accidents without an associated cargo release over the next 10 years of LANL operations are conservatively projected to result in from 33 to 76 injuries and 3 to 8 fatalities (including workers and the public) across the alternatives. The bounding off-site and on-site transportation accidents over the next 10 years involving a release of cargo would not be expected to result in any injuries or fatalities to members of the public for any of the alternatives. Accidents were analyzed by type of material, and the maximum quantities were selected for analysis. These parameters do not change across the alternatives. Total risk also does not change appreciably across the alternatives because the frequency of shipments does not vary enough to substantially influence the result.

The accident analyses (other than transportation and worker physical safety incidents/accidents) considered a variety of initiators (including natural and manmade phenomena), the range of activities at LANL, and the range of radioactive and other hazardous materials at LANL. Transportation accidents and the relatively frequent worker physical safety incidents/accidents were considered separately. The accidents discussed below are those that bound the accident risks at LANL (other than transportation and physical safety incidents/accidents).

The operational accident analysis included four scenarios that would result in multiple source releases of hazardous materials: three due to a site-wide earthquake and one due to a wildfire, resulting in three different degrees of consequences and one wildfire scenario. These four scenarios dominate the radiological risk due to accidents at LANL because they involve radiological releases at multiple facilities and are considered credible (that is, they would be expected to occur more often than once in a million years), with the wildfire considered likely.

Another earthquake-initiated accident, labeled RAD–12, is facility-specific (to Building Technical Area–16–411) and is dominated by the site-wide earthquake accidents due to its very low frequency (about 1.5×10^{-6} per year). It is noteworthy that the consequences of such earthquakes are dependent on the frequency of the earthquake event, the facility design, and the amount of material that could be released due to the earthquake; such features do not change across the alternatives, so the impacts of these accidents are the same for all four alternatives. The risks were estimated conservatively in terms of both the frequency of the events and the consequences of such events. (In particular, it is noteworthy that the analysis assumes that any building that would sustain structural or systems damage in an earthquake scenario does so in a manner that creates a path for release of material outside of the building.) The total risk of an accident is the product of the accident frequency and the consequences to the total population within 50 miles (80 kilometers). This risk ranges from 0.046 (SITE–01, i.e., seismic event) and 0.034 (SITE–04, i.e., wildfire event) excess latent cancer fatalities per year of operation, to extremely small numbers for most of the radiological accidents. The risk for release of chemicals, such as chlorine, is calculated similarly as the product of the frequency and numbers of people exposed to greater than the selected guideline concentration, Emergency Response Planning Guideline (ERPG)–2. (ERPG–2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without irreversible or serious health effects or symptoms that could impair their abilities to take protective action). Under all alternatives, the risks for chemical releases range from 6.4 (SITE–01) people exposed per year of operation to extremely small numbers for some chemical releases. In general, such earthquakes would be expected to cause fatalities due to falling structures or equipment; this also would be true for LANL facilities. Thus, worker fatalities due to the direct effects of the earthquakes would be expected. Worker injuries or fatalities due to the release of radioactive or other hazardous materials would be expected to be small or modest increments to the injuries and fatalities due to the direct effects of the earthquakes.

Comments on the Final Site-Wide Environmental Impact Statement

DOE distributed approximately 500 copies of the final Site-Wide Environmental Impact Statement to Congressional members and committees, the State of New Mexico, various American Indian Tribal governments and organizations, local governments, other Federal agencies, and the general public. Comments were received from the U.S. Department of the Interior (DOI) and Chestnut Law Offices, representing San Ildefonso Pueblo. The U.S. Environmental Protection Agency (EPA) did not provide comments on the final Site-Wide Environmental Impact Statement stating in the **Federal Register** (64 FR 18901) that ''Review of the FEIS was not deemed necessary. No formal comment letter was sent to the preparing agency.''

DOI identified two areas of concern with the final Site-Wide Environmental Impact Statement. The first concern is that the Site-Wide Environmental Impact Statement does not adequately assess the direct, indirect, and cumulative effects of programs and activities associated with the continued operation of LANL either on or off the site. DOI maintains that the existing impacts from the environmental baseline should be quantified and not restricted to the evaluation of only two site-specific projects. DOI further states that while programs and activities that are proposed or under way may help to reduce adverse impacts, these programs and activities were not adequately evaluated in the Site-Wide Environmental Impact Statement.

Chapter 4 (Volume I) of the Site-Wide Environmental Impact Statement presents the environmental setting and existing conditions associated with LANL operations. The information presented in Chapter 4 forms a baseline for use in evaluating the environmental impacts of the four Site-Wide alternatives. For all alternatives, assessment of significance was accomplished both quantitatively where data and analysis were available, and qualitatively. The assessment of the potential effects, both positive and adverse, of the Expanded Operations, Reduced Operations, Greener, and No Action Alternatives was based on the degree of change from baseline conditions and was presented in Chapter 5 (Volume I) of the Site-Wide Environmental Impact Statement. DOE integrated many programs and activities, including the Natural Resources Management Plan (see Mitigation Measures), that would reduce adverse impacts in its analysis of environmental impacts.

DOI's second concern is threatened and endangered species protection at LANL. DOI does not concur with DOE's determination that implementation of the Expanded Operation Alternative may affect but would not likely adversely affect four listed species at LANL. The DOI believes that measures necessary to reduce impacts to threatened and endangered species that are identified through the consultation process should be incorporated into the Site-Wide Environmental Impact Statement as required measures.

On April 29, 1999, subsequent to DOI's submittal of comments on the final Site-Wide Environmental Impact Statement, DOE initiated formal section 7 consultation between the DOI and DOE for DOE's proposal to expand existing operations at LANL. DOE sees this consultation process as an opportunity to further the stewardship of listed species provided by the recently implemented Threatened and Endangered Species Management Plan for LANL. Based on communications with the U.S. Fish and Wildlife Service, DOE anticipates that the Service will issue a Biological Opinion in the near future. Upon its receipt DOE will continue to coordinate with the Service the integration into the operation of LANL of any needed measures recommended in the Biological Opinion that will contribute to the welfare of listed species. DOE believes that this process should proceed on a separate, parallel track from that of the Site-Wide Environmental Impact Statement process.

The Chestnut Law Offices, representing San Ildefonso Pueblo, identified three issues of concern with the final Site-Wide Environmental Impact Statement. First, Chestnut Law Offices states that the environmental justice analysis is flawed because it divides San Ildefonso Pueblo into several different segments thereby not indicating any adverse impacts to the Pueblo. Chestnut Law Offices states that most environmental risk is at the perimeter of the laboratory directly affecting San Ildefonso Pueblo, and that the Site-Wide Environmental Impact Statement determines there is no greater impact on the Pueblo than on other disadvantaged communities. Chestnut Law Offices states that this approach in environmental justice analysis does not comply with Federal law and is inadequate.

DOE prepared the environmental justice analysis in accordance with guidance from the Council on Environmental Quality and Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. The segments referred to in the comments were used to identify and highlight the locations of low-income and/or minority populations for the impact analyses. Using this tool, the San Ildefonso Pueblo was identified as housing minority and/or low-income populations for consideration in the Environmental Justice analysis. DOE has not identified any disproportionately high and adverse human health or environmental impacts on minority or low-income populations under any of the alternatives analyzed in the Site-Wide Environmental Impact Statement. To the extent that there is a potential for adverse impacts, DOE analysis has shown that most of the impact would affect all populations equally. In the cases of air emissions and on-site transportation, the residential populations nearest to LANL, which have a relatively low percentage of minority and low-income populations, would be affected to a greater extent than other populations within the 50-mile radius.

The impacts addressed in the environmental justice analysis in the Site-Wide Environmental Impact Statement include land resources, geology, soils, water resources, ecological resources, air quality, human health, waste management, socioeconomic, and transportation. This analysis includes the projected impacts due to contamination in the area from past LANL activities. As part of its human health impact analysis, DOE looked at potential exposure through special pathways, including ingestion of game animals, fish, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of plant materials. For LANL, the special pathways influence the environmental justice analysis because some of these pathways are more important or viable to the traditional or cultural practices of minority populations in the area. Even considering these special pathways, DOE did not find disproportionately high and adverse health impacts to minority or low-income populations.

The Chestnut Law Offices' second concern is groundwater contamination due to LANL activities. The Chestnut Law Offices states that the final Site-Wide Environmental Impact Statement does not address the recent groundwater contamination but downplays it, and that this section of the Site-Wide Environmental Impact Statement should be re-evaluated.

DOE believes that drinking water quality in the Los Alamos area continues to meet all Federal and New Mexico chemical and radiological standards. In February 1999 DOE discovered, as part of implementing the Hydrogeologic Workplan (the multi-year effort to characterize the flow and extent of contamination of the main aquifer), high explosives contamination while drilling a well (R–25) in the western part of the Laboratory. Based on current knowledge, DOE believes it will take at least 50 years for these contaminants to reach the drinking water production wells approximately three and a half miles to the East of R–25. DOE has and will continue to sample the drinking water to ensure it is safe. Groundwater monitoring data from implementation of the Hydrogeologic Workplan is still under review and evaluation. As new information becomes available, the LANL Environmental Surveillance and Compliance Program will be revised to incorporate the additional data.

Chestnut Law Offices' third concern is that the Site-Wide Environmental Impact Statement does not consider the shutdown of the low-level waste disposal area, Area G, a reasonable alternative. The commentor states the alternatives in the Site-Wide Environmental Impact Statement are based on the assumption that LANL will be a regional low-level waste disposal site. The commentor believes the Site-Wide Environmental Impact Statement does not analyze the possibility that another site may be chosen as the regional low-level waste disposal site, thereby providing the opportunity for the waste to be removed from Area G. The commentor states this is a serious flaw since it does not anticipate a clearly reasonable alternative in light of existing planning documents.

The shutdown of the low-level waste disposal area, Area G, was not considered a reasonable alternative for analysis in the Site-Wide Environmental Impact Statement because Area G has a unique capability for the disposal of certain wastes generated by LANL. Such wastes include classified wastes and other wastes that would be difficult to transport to other sites. The Expanded Operations Alternative was the only alternative that analyzed the impacts of LANL being chosen as a regional low-level waste disposal site.

Under the Waste Management Programmatic Environmental Impact Statement, which evaluated locations for treatment and disposal of low-level radioactive waste and mixed low-level radioactive waste, these wastes would be treated on the site at LANL and disposed of at a regional site to be determined after consultation with stakeholders. One of the potential regional disposal sites for low-level waste is LANL. Therefore, in the Expanded Operations Alternative, the Site-Wide Environmental Impact

Statement addressed treatment and disposal of LANL-generated low-level waste, as well as disposal of off-site generated low-level waste. The Expanded Operations Alternative analyzes the environmental impacts and the footprint needed at Area G to allow for the implementation of this alternative.

If LANL is not selected as a regional disposal site, some low-level waste could be sent off-site for disposal, as reflected in the No Action, Reduced, and Greener Alternatives. The current low-level waste capacity available at Area G is limited. If LANL were selected as a regional disposal site, the expansion of Area G would occur at the fastest rate. If LANL continues to dispose of its own wastes, the expansion would still occur, but at a slower rate. Currently LANL generates some low-level waste that, primarily because of its size and shape, does not meet the acceptance criteria for disposal at other DOE sites, such as the Nevada Test Site. However, the decision as to the ultimate treatment and disposal of low-level waste and mixed low-level waste will be made in a Record of Decision for the Waste Management Programmatic Environmental Impact Statement.

It should also be noted that the EPA, State of New Mexico, and representatives of the Pueblos (four Accord Pueblos) near LANL were invited to review and comment on the Classified Supplement for the Draft Site-Wide Environmental Impact Statement (EPA declined the invitation). Comments from that review were received shortly after the final Site-Wide Environmental Impact Statement was issued. This final Classified Supplement and all comments provided were considered in reaching the decisions in this Record of Decision.

Other Decision Factors

As noted in the final Site-Wide Environmental Impact Statement, LANL houses unique facilities and expertise that have been developed over the past 50 years. These have served several National Security and other national needs in the past. It is expected that, for the foreseeable future, the U.S. will maintain a nuclear weapons stockpile and require ‘‘cutting edge’’ science and manufacturing capabilities to address issues of national importance for the maintenance of that stockpile and for other purposes, including assuring the safety and reliability of that stockpile. The unique facilities and expertise at LANL are needed to assist in finding solutions to these issues. As noted in the final Site-Wide Environmental Impact Statement, LANL's role in supporting DOE's missions has expanded as the DOE nuclear weapons complex has been downsized over the last decade. Additionally, it is expected that there will be continued emphasis on applying the unique capabilities at LANL to support DOE's basic science mission and to apply technologies developed in DOE laboratories to improve the U.S. technological position and competitiveness. These factors were also considered (in addition to the human health and environmental impact information discussed above) in reaching this Record of Decision.

Decisions

DOE has decided to continue to operate LANL for the foreseeable future and to expand the scope and level of its operations at LANL. DOE is implementing the Preferred Alternative, that is Alternative 2, Expanded Operations, but with pit production limited to a capacity that can be accommodated within the limited space currently set aside for this activity in the plutonium facility (estimated at nominally 20 pits per year). This alternative reflects a broad expansion of science and technology research, and applications of this research to a variety of issues of national importance; this alternative also includes the continued maintenance of existing and expanded capabilities, and continued support/infrastructure activities. The following discussion describes the major actions to be taken, with an emphasis on those areas that have had the most extensive programmatic or public interest.

It should be noted that the decisions in this Record of Decision will be reflected in DOE budget requests and management practices. However, the actual implementation of these decisions is dependent on DOE funding levels and allocations of DOE budget across competing priorities.

Pit Production and Other Plutonium Operations

DOE remains committed to meeting pit production requirements to support the enduring nuclear weapons stockpile. As part of its implementation of the Preferred Alternative, DOE will establish, over time, a pit production capability at LANL with a capacity of nominally 20 pits per year; this decision reflects an intent to establish a pit production capability at LANL within the existing floor space set aside for this operation (about 11,400 ft^2 [1060 m^2]). This will eliminate the need to transfer several Technical Area-55 plutonium operations (to ‘‘make room’’ for pit production activities in Technical Area-55) either to the CMR Building, or to newly constructed nuclear space, as contemplated in the Site-Wide Environmental Impact Statement. Thus, the Preferred Alternative for Pit Production can be implemented without an expansion of the plutonium operations floor space at LANL. The exact production capacity of this floor space is not known with certainty (pending process optimization studies), but has been characterized as nominally 20 pits per year. This level provides adequate capacity to meet the near-term pit production requirements to maintain the enduring stockpile (about 20 pits per year), as expressed in the Record of Decision for the Stockpile Stewardship and Management Programmatic Environmental Impact Statement. While this does not change the 50-pit-per-year mission assignment made in the Stockpile Stewardship and Management Programmatic Environmental Impact Statement Record of Decision, it does suspend full implementation of that decision until an undetermined time in the future.

Implementation of the pit production mission at LANL will be phased. The first pit for delivery to the U.S. nuclear weapons stockpile will be made in 2001. It is expected that, through equipment installation in existing facilities, the limited production capacity of nominally 20 pits per year will be achieved in 2007. At these levels of production, there is no need to move plutonium operations from the Plutonium Facility, Technical Area-55, to the CMR Building, and there is no need to construct a corridor between Technical Area-55 and Technical Area-3. Thus, DOE has decided not to move these operations or construct the road at this time.

Chemistry and Metallurgy Research Building—As the Site-Wide Environmental Impact Statement was being prepared, DOE was working on two sets of information associated with CMR operations: (1) Establishment of a modern authorization basis for these operations (referred to as the CMR Basis for Interim Operations, or BIO); and, (2) studies of the seismicity of the Technical Area-55 and Technical Area-3 areas. Both sets of information are included in the impact analyses in the Site-Wide Environmental Impact Statement (where details were not known, the analyses in the Site-Wide Environmental Impact Statement were, in fact, bounding of the details determined through these efforts). Through this effort, it became apparent that the subprojects included in the CMR Upgrades Construction Project should be reprioritized and oriented to provide for the continued safe operation of the CMR Building through about 2010. The single most substantive change in this project was to replace the proposed seismic upgrades with a combination of material containerization, a reduction in the amount of Material at Risk (or MAR, which is the amount of in-process material that would be subject to release if there were a catastrophic accident), and a substantial reduction in the amount of combustible material allowed in the CMR Building. With these controls in place, the worst-case plausible accidents involving the CMR Building would have minimal effects on public health (effects would be within applicable guidelines intended to protect human health).

The 1996 Stockpile Stewardship and Management Programmatic Environmental Impact Statement analyzed the environmental impacts of locating a pit manufacturing capability at either LANL or the Savannah River Site. In December 1996, DOE issued a Record of Decision reestablishing the pit manufacturing mission at LANL. In August 1998, the U.S. District Court for the District of Columbia, while ruling in DOE's favor in litigation challenging the adequacy of the Stockpile Stewardship and Management Programmatic Environmental Impact Statement, directed DOE to take another look at certain new studies regarding seismic hazards at LANL, and to provide a factual report and technical analysis of the plausibility of a building-wide fire at LANL's plutonium facility (PF–4 at Technical Area-55). The Court directed that DOE prepare a Supplement Analysis, pursuant to DOE's NEPA regulations (10 CFR 1021.314(c)), to help determine whether a supplemental Stockpile Stewardship and Management Programmatic Environmental Impact Statement should be issued to address these studies. These seismic studies have been released to the public and are examined in more detail in the draft Supplement Analysis released for public review and comment on July 1, 1999. On September 2, 1999, DOE issued a final Supplement Analysis and determined that none of the issues analyzed in the Supplement Analysis represents substantial changes to the actions considered in the Stockpile Stewardship and Management Programmatic Environmental Impact Statement, nor do those issues provide significant new information relevant to the environmental concerns discussed in that Programmatic Environmental Impact Statement. Therefore no supplement to that Programmatic Environmental Statement is required.

Secondaries

While LANL was considered as a production site for secondaries (components of a nuclear weapon that contains elements needed to initiate the fusion reaction in a thermonuclear reaction) in the Stockpile Stewardship and Management Programmatic Environmental Impact Statement, this mission was assigned to the Y–12 plant at Oak Ridge, Tennessee. However, DOE expects LANL to maintain an understanding of secondary production technologies, as well as the characteristics of War Reserve secondaries in the stockpile.

Tritium

LANL will continue to support both research and development and production activities involving tritium (neutron tube target loading for nuclear weapons stockpile components). These will include development of new reservoirs and reservoir fill operations, surveillance and performance testing on tritium components, tritium recovery and purification technologies, and production operations associated with neutron generator production for the stockpile. The expansion of these activities results in: (1) tritium throughputs on an annual basis increase by a factor of up to 2.5; and (2) the on-site inventory of tritium increases by a factor of 10.

High Explosives Processing and Testing

Operations in this area will increase such that annual explosives throughput will increase to about 82,700 pounds, and the annual mock explosives throughput will increase to about 2,910. These quantities include continued research, development, and fabrication of high-power detonators, including support of up to 40 major product lines per year in support of the Stockpile Stewardship and Management program. In addition, the number of hydrodynamic tests will increase to about 100 per year; the annual amount of depleted uranium will increase to about 6,900 pounds.

Accelerator Operations

DOE will implement several facility construction or modification projects at Technical Area–53: the Long-Pulse Spallation Source, the 5-Megawatt Target/Blanket Experimental Area, the Dynamic Experiment Laboratory, and the Isotope Production Facility.

Expansion of Technical Area–54/Area G Low-Level Waste Disposal Area

As part of the implementation of the Preferred Alternative, DOE will continue the on-site disposal of LANL generated low-level waste using the existing footprint at Area G low-level waste disposal area and will expand disposal capacity into Zones 4 and 6 at Area G (this expansion would cover up to 72 acres [29 hectares]). DOE will develop both Zones 4 and 6 in a step-wise fashion, expanding these areas as demand requires.

Mitigation Measures

The Site-Wide Environmental Impact Statement included a discussion of existing programs and plans and controls built into the operations at LANL, including operating within applicable regulations, DOE Orders, contractual requirements and approved policies and procedures. The following discussion outlines the mitigation measures that DOE will undertake to reduce the impacts of continuing to operate LANL at the levels outlined in this Record of Decision.

Electrical Power

The Site-Wide Environmental Impact Statement recognizes the need for an increase in electrical power supply and reliability under the Preferred Alternative as well as other alternatives analyzed. The impact analyses emphasize the severity of these issues and consequences if they are not resolved, e.g., brownouts. Solutions to power supply issues are essential to mitigate the effects of power demand under all alternatives. An operating plan for improved load monitoring, equipment upgrades, and optimization of some available power sources was discussed. Additional measures under consideration by DOE include: (1) Limiting operation of large users of electricity to periods of low demand, and contractual mechanisms to bring additional electric power to the region and some form of on-site cogeneration as an incremental resource. DOE and other users of electrical power in the area have been working with suppliers to resolve these foreseeable power and reliability issues. One solution under consideration for improved reliability is the provision of a third power line from the existing Public Service Company of New Mexico Norton substation to the existing LANL substations. This solution could include a new LANL substation. In any case, DOE is committed to manage electric power demands to prevent periods of brownouts by adjusting to the limitations of available power until a solution for a long-term increase in power is in place. DOE is also committed to approve and begin implementing a Utility Procurement Plan by November 1999.

Water Supply and Demand

Prior to September 8, 1998, DOE supplied all potable water for LANL, Bandelier National Monument, and Los Alamos County, including the towns of Los Alamos and White Rock. This water was derived from DOE's groundwater right to withdraw 5,541.3 acre-feet or about 1,806 million gallons of water per year from the main aquifer. On this date, DOE leased these rights to the County of Los Alamos. This lease also included DOE's contracted annual right obtained in 1976 to 1,200 acre-feet of San Juan-Chama Transmountain Diversion Project water. This lease agreement is effective for three years, at which point DOE expects to convey 70 percent of the water right to the County of Los Alamos and lease the remaining 30 percent to them. The San Juan-Chama rights will be transferred in their entirety to the County. On several occasions since 1986 through 1998, LANL operations have exceeded 30 percent of the total DOE annual water right. The agreement between DOE and the County does not preclude provision of additional waters in excess of the 30 percent agreement, if available. However, the agreement also states that should the County be unable to provide water to its customers, the County shall be entitled to reduce water services to DOE in an amount equal to the water rights deficit.

DOE is committed to managing water demand to prevent exceedances of DOE water rights. LANL will develop and implement by June 2000 procedures to assure that all new projects will implement water conservation design and techniques. LANL will also develop water conservation goals and begin implementing them by October 2001.

Waste Management

DOE is committed to the proper management and minimization of all wastes. LANL will integrate waste minimization into Integrated Safety Management by October 2000. By June 2000 LANL will develop and implement procedures to assure that all new projects will implement waste minimization for TRU and mixed TRU waste streams. In addition LANL will reduce by December 2005 waste from routine operations by 80% using 1993 as a baseline for hazardous, low-level radioactive, and mixed low-level radioactive wastes. Also, LANL will recycle 40% of sanitary waste from routine operations by December 2005.

LANL will also purchase EPA-designated items with recycled content according to the conditions of Executive Order 12873. A LANL Implementing Requirement for waste minimization activities is currently in draft.

Wildfire

The final Site-Wide Environmental Impact Statement included an accident scenario from a wildfire that was initiated on land adjacent to LANL and spread to the LANL site. The analysis concluded that a major fire is not only credible but also likely. The current and future risks of wildfires at LANL can only be mitigated through purposeful environmental intervention and active land management. LANL will develop by December 1999 a preliminary program plan for comprehensive wildfire mitigation, including construction and maintenance of strategic fire roads and fire breaks, creation of defensible space surrounding key facilities, and active forest management to reduce fuel loadings. LANL will prepare and begin implementation of a long-term strategy for wildfire mitigation actions before the start of the 2000 fire season.

Cultural Resources

DOE is committed through ongoing consultation processes with affected Native American tribes to ensure protection of cultural resources and sites of cultural, historic, or religious importance to the tribes. With input from the tribes participating in the Los Alamos Pueblos Project (LAPP), DOE will develop a strategy to increase the understanding of traditional cultural properties at LANL, to determine strategies for the long-term management of identified traditional cultural properties and sacred sites and to determine appropriate mitigation measures for specific traditional cultural properties. The strategies could include the development of access agreements to traditional cultural properties and sacred sites. In the past, attempts to identify specific traditional cultural properties at LANL have encountered concerns from traditional groups because of the potential for increased risk to these resources if they are individually identified; thus, DOE will explore the potential benefits and risks of such a study, and options to such a study, with the LAPP tribes. This approach is intended to ensure appropriate respect and consideration regarding cultural concerns, while attempting to provide the information and ability to mitigate or avoid potential impacts to traditional cultural properties (which are currently not specifically known, to a large extent). The goal of the consultation and coordination would be an agreement with the relevant Native American tribes for the management of these resources.

DOE will complete an Integrated Cultural Resource Management Plan (ICRMP) by April 2002. The ICRMP will detail how LANL will manage, preserve, and protect cultural resources within the scope of Federal and State laws, regulations, Executive Orders, standards, as well as to the extent practicable, follow Tribal criteria and guidelines. The ICRMP will provide a basis for a unified approach to address the multiplicity of cultural resources located on LANL lands. The plan will serve to streamline many of the administrative steps required by Federal and State laws and regulations. The scope of activities for the ICRMP would include development of the plan, completion of surveys of archeological resources and historic buildings, and implementation of long-term monitoring.

Natural Resources

DOE will develop and begin implementation of an integrated Natural Resources Management Plan (NRMP) by October 2002, which will integrate the principles of ecosystem management into the critical missions of LANL to conserve ecosystem processes and biodiversity. The NRMP will support DOE's policy to manage all of its land and facilities as valuable national resources. This stewardship will integrate LANL's mission and operations with its biological, water, soil, and air resources in a comprehensive plan that will guide land and facility use decisions. The plan will consider the site's larger regional context and be developed in consultation with regional land managing agencies and owners (particularly Bandelier National Monument, Santa Fe National Forest, and Native American Pueblos), State agencies, and the U.S. Fish and Wildlife Service. This cooperative effort will ensure a consistent, integrated, and structured approach to regional natural resource management.

The NRMP is viewed as a sequenced planning document that will include specific tasks and studies as part of the process of development. It will include new initiatives as well as integrating ongoing programs, plans, and activities at LANL, some of which may be reassessed to ensure their contribution to the goals and objectives of integrated ecosystem management.

Mitigation Action Plan

In accordance with 10 CFR 1021.331, DOE is preparing a Mitigation Action Plan that will identify specific actions needed to implement these mitigation measures and provide schedules for completion. These mitigation measures represent all practicable means to avoid or minimize harm from the alternative selected.

Conclusion

DOE has considered environmental impacts, stakeholder concerns, and National policy in its decisions regarding the management and use of LANL. The analysis contained in the Site-Wide Environmental Impact Statement is both programmatic and site specific in detail. It is programmatic from the broad multi-use facility management perspective and site specific in the detailed project and program activity analysis. The impacts identified in the Site-Wide Environmental Impact Statement were based on conservative estimates and assumptions. In this regard, the analyses bound the impacts of the alternatives evaluated in the Site-Wide Environmental Impact Statement. The Expanded Operations Alternative was defined to include activities to implement the programmatic decisions made or that may be made as a result of other DOE Environmental Impact Statements (some of which are currently in progress). This Site-Wide Environmental Impact Statement and the analyses it contains can be used to support these future programmatic or project decisions.

In accordance with the provisions of NEPA, its implementing procedures and regulations, and DOE's NEPA regulations, I have considered the information contained within the Site-Wide Environmental Impact Statement, including the classified supplement and public comments received in response to the final Site-Wide Environmental Impact Statement. Being fully apprised of the environmental consequences of the alternatives and other decision factors described above, I have decided to continue and expand the use of LANL and its resources as described. This will enhance DOE's ability to meet its primary National security mission responsibility and create an environment that fosters technological innovation in both the public and private sectors.

Issued at Washington, DC, September 13, 1999.

Thomas F. Gioconda,

Brigadier General, USAF, Acting Assistant Secretary for Defense Programs.

[FR Doc. 99–24456 Filed 9–17–99; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

National Nuclear Security Administration

Notice of Intent to Prepare a Supplemental Environmental Impact Statement to the Final Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory

AGENCY: U.S. Department of Energy, National Nuclear Security Administration.

ACTION: Notice of Intent.

SUMMARY: Pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321 *et seq.*), the Council on Environmental Quality's (CEQ) and the U.S. Department of Energy's (DOE) regulations implementing NEPA (40 CFR parts 1500–1508 and 10 CFR part 1021, respectively), the National Nuclear Security Administration (NNSA), an agency within the DOE, announces its intent to prepare a supplemental site-wide environmental statement (S–SWEIS) to update the analyses presented in the Final Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory (SWEIS) (DOE/EIS–0238; January 1999). The purpose of this notice is to invite individuals, organizations, and government agencies and entities to participate in developing the scope of the S–SWEIS.

In its September 1999 Record of Decision (ROD) based on the SWEIS, DOE announced its decision to implement the Expanded Operations Alternative analyzed in the SWEIS, with modifications to weapons related production work (the Preferred Alternative), at Los Alamos National Laboratory (LANL). That decision is being implemented at LANL. Pursuant to 40 CFR 1502.20, the S–SWEIS will rely on and expand on the analysis in the original SWEIS. The No Action Alternative for the S–SWEIS is the continued implementation of the SWEIS ROD, together with other actions described and analyzed in subsequent NEPA reviews. The Proposed Action in the S–SWEIS will include changes since the SWEIS 1999 ROD.

DATES: NNSA invites comments on the scope of this S-SWEIS through February 27, 2005. NNSA will hold a public scoping meeting in Pojoaque, New Mexico, at the Pablo Roybal Elementary School on January 19, 2005, from 6 to 8 pm. Scoping comments received after February 27, 2005, will be considered to the extent practicable.

ADDRESSES: To submit comments on the scope of the S-SWEIS, questions about the document or scoping meeting, or requests to be placed on the document distribution list, please write or call: Ms. Elizabeth Withers (e-mail address: *lanl_sweis@doeal.gov;* mailing address: NNSA Los Alamos Site Office, NEPA Compliance Officer, 528 35th Street, Los Alamos, New Mexico, 87544; (toll free) telephone 1–877–491–4957; or Facsimile 505–667–9998).

FOR FURTHER INFORMATION CONTACT: For general information about the DOE NEPA process, please contact: Ms. Carol Borgstrom, Director, Office of NEPA Policy and Compliance (EH–42), U.S. Department of Energy, 1000 Independence Avenue, SW, Washington, DC 20585, 202–586–4600, or leave a message at 1–800–472–2756.

SUPPLEMENTARY INFORMATION: LANL is located in north-central New Mexico, 60 miles north-northeast of Albuquerque, 25 miles northwest of Santa Fe, and 20 miles southwest of Española in Los Alamos and Santa Fe Counties. It is located between the Jemez Mountains to the west and the Sangre de Cristo Mountains and Rio Grande to the east. LANL occupies about 40 square miles (104 square kilometers) and is operated for NNSA under contract, by the University of California. (The contract for LANL's management and operation is undergoing a competitive bid process; however, the selection of the LANL management and operations contractor in the future will not affect the nature of the NNSA and DOE work performed at LANL.)

LANL is a multidisciplinary, multipurpose institution primarily engaged in theoretical and experimental research and development. LANL has been assigned science, research and development, and production mission support activities that are critical to the accomplishment of the national security objectives (as reflected in the ROD for the September 1996 Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management (DOE/EIS–0236)). Specific LANL assignments will continue for the foreseeable future include production of War-Reserve products, assessment and certification of the stockpile, surveillance of the War-Reserve components and weapon systems, ensuring safe and secure storage of strategic materials, and management of excess plutonium inventories. LANL's main role in the fulfillment of DOE mission objectives includes a wide range of scientific and technological capabilities that support nuclear materials handling, processing and fabrication; stockpile management; materials and manufacturing technologies; nonproliferation programs; and waste management activities.

The Final LANL SWEIS, issued in January 1999, considered the operation of LANL at various levels for about a 10-year period of time. Alternatives considered in that document were: No Action Alternative, the Expanded Operations Alternative, the Reduced Operations Alternative, and the Greener Alternative. In addition to providing an overview of the LANL site and its activities and operations, the SWEIS identified 15 LANL "Key Facilities" for the purposes of NEPA analysis. "Key

---

[1] Protection from public disclosure involving this kind of specific information is based upon 18 CFR 4.32(b)(3)(ii) of the Commission's regulations implementing the Federal Power Act.

Facilities'' are those facilities that house operations with the potential to cause significant environmental impacts; are of most interest or concern to the public based on scoping comments; or are facilities that would be the most subject to change due to potential programmatic decisions. The operations of these ''Key Facilities'' were described in the SWEIS and, together with other non-key facility functions, formed the basis of the description of LANL facilities and operations analyzed for their potential impacts. The Preferred Alternative was the Expanded Operations Alternative with certain reductions in weapons-related manufacturing capabilities. This alternative was chosen for implementation in the ROD issued in September 1999.

In mid-2004, NNSA undertook the preparation of a Supplement Analysis for the SWEIS pursuant to DOE's regulatory requirement to evaluate site-wide NEPA documents at least every 5 years (10 CFR 1021.330) and determine whether the existing EIS remains adequate, to prepare a new site-wide EIS, or prepare a supplement to the existing EIS. During the development of this Supplement Analysis, NNSA decided to proceed immediately with a supplement to the existing SWIES in order to expedite the NEPA process and to save time and money. DOE NEPA regulations (10 CFR 1021.314) require the preparation of a Supplemental EIS if there are substantial changes to a proposal or significant new circumstances or information relevant to environmental concerns. Substantial changes to the level of LANL operations may result from proposed, modified or enhanced activities and operations within LANL facilities (discussed later in subsequent paragraphs of this Notice), and new circumstances and information with regard to effects from the Cerro Grande Fire (which burned a part of LANL), a reduction in the size of the LANL reservation due to recent land conveyance and transfers, and contaminant migration have come to light over the past five years that could be deemed significant under 10 CFR 1021.314.

Since the issuance of the Final SWEIS in 1999, DOE and NNSA have finalized several environmental impact statements, environmental assessments (EA), and a special environmental analysis dealing with LANL operations and actions taken immediately after the 2000 Cerro Grande Fire. The activities analyzed in these NEPA documents and developing changes to the LANL environmental setting led NNSA to conclude it would be prudent and efficient to begin updating the SWEIS now by preparing a supplemental SWEIS. NNSA will use the S–SWEIS to consider the potential impacts of proposed modifications to LANL activities, as well as the cumulative impacts associated with on-going activities at LANL, on the changed LANL environment.

The S–SWEIS will provide a review of the impacts resulting from implementing the SWEIS ROD over the past 5 years at LANL and compare these impacts to the impacts projected in the SWEIS analyses for that alternative to provide an understanding of the SWEIS's ability to identify potential impacts. The S–SWEIS analyses will focus primarily on aspects of the existing environment that could be impacted by newly proposed changes to LANL operations at certain facilities and by environmental cleanup actions that could occur over the next 5 to 6 years in response to a consent order from the State of New Mexico. The S–SWEIS Proposed Action will analyze projected impacts anticipated from operating LANL at the 1999 ROD level for at least the next 5 years, with some modified work now being proposed at certain facilities. NNSA is considering proposed operational changes within at least two new ''Key Facilities'' at LANL:

- The Nicholas C. Metropolis Center for Modeling and Simulation (formerly called the Strategic Computing Complex), and
- The Nonproliferation and International Security Center (NISC).

The construction and operation of the Nicholas C. Metropolis Center for Modeling and Simulation were analyzed in a December 1998 EA and a finding of no significant impact (FONSI) for that proposed action was issued based on the impact analyses for operating the computational facility up to a 50–TeraOp platform (a TeraOp is a trillion floating point operations per second). The Center has been constructed and is currently operating below the operations level analyzed in the 1998 EA; however, NNSA proposes to increase the facility's operational capacity up to 100 TeraOps before 2009 with corresponding increases to the facility's consumption of water and electrical power resources. This proposed increase in the operating platform from 50 TeraOps up to 100 TeraOps will be analyzed in the S–SWEIS.

The NISC's construction and operation were analyzed in a July 1999 EA and a FONSI was issued for that proposed action based on the impact analyses for consolidating activities and operating the facility as it was envisioned at that time. The facility is currently operating as evaluated in the 1999 EA; however, NNSA is now proposing to move certain operations from the Technical Area 18 (TA–18) Pajarito Site (another of LANL's ''Key Facilities,'' which is also discussed in the following paragraph) into the NISC. This would change the amount of nuclear material stored in the facility, with corresponding potential increases to worker exposures in the case of a site accident. The proposed changes to operations and material stored in NISC will be analyzed in the S–SWEIS.

NNSA will also eliminate one former LANL ''Key Facility'' identified in the 1999 SWEIS—the TA–18 Pajarito Site. In its 2002 EIS (the TA–18 Relocation Final EIS (DOE/EIS–319)) and ROD, the NNSA decided to relocate TA–18 security category I and II operations and associated nuclear material to the Nevada Test Site. Implementation of the relocation decision began in 2004 and will continue over the next 5 years. After relocation of operations and materials, this facility will no longer be a LANL ''Key Facility'' within the meaning of the SWEIS, and therefore will not be listed as such a facility. There are certain proposals related to the relocation of the TA–18 security category III and IV operations and the disposition of the TA–18 facilities that were not analyzed in the 2002 EIS; these proposed actions and their projected impacts will be evaluated in the S–SWEIS impact analyses.

Certain aspects of operational changes, construction and activities that have occurred or are being proposed for LANL over the next 5 years that were not analyzed in the 1999 SWEIS will also be considered and analyzed in the S–SWEIS. Changes that have been made to existing LANL operations that will also be considered further in the S–SWEIS include some permanent modifications to on-going operations that have recently been made as a result of decreases in specific work and projects performed at some LANL facilities, and changes to the locations of various types of materials at risk (MAR) at LANL facilities or off-site locations. Examples of newly proposed actions at LANL include the remediation of 10 major material disposal areas (MDAs) at LANL; the operation of a Biosafety Level-3 (BSL–3) Facility (this facility will become part of an existing ''Key Facility'' at LANL, the former Health Research Laboratory (HRL) now known as the Bioscience Facilities); the construction and operation of a new solid waste transfer station, an office and light laboratory complex, a consolidated warehouse and truck inspection station, and a new radiography facility; and recently proposed increases in the types and quantities of sealed sources accepted for waste management at LANL. Some of these newly proposed actions may be analyzed explicitly in the S–SWEIS in project specific analyses, while others may be analyzed in separate EAs to be prepared over the next several months, such as the new BSL–3 Facility EA. The potential impacts of the BSL–3 Facility will be included in the S–SWEIS evaluation of cumulative impacts, as will the impacts of all of the newly proposed actions. A comparison of the newly projected operational impacts will also be made to the projected impacts identified in the SWEIS.

The NEPA compliance process for the BSL–3 Facility at LANL has spanned several years. In early 2002, the NNSA issued an EA and FONSI for the construction and operation of the facility at LANL. Due to the need to consider new circumstances and information relevant to the actual construction of the BSL–3 Facility and its future operation, the NNSA withdrew the 2002 FONSI for operating this facility and determined that a new EA should be prepared that re-evaluates the proposed operations of the facility as it has been constructed. The new EA is currently being prepared and a draft EA will be issued for public review and comment in early 2005. The EA will be used by NNSA in making a decision about whether to issue a FONSI for operation of the BSL–3 Facility. If a FONSI cannot be issued, the analyses for the operation of the BSL–3 Facility will be included in the S–SWEIS Proposed Action.

In accordance with applicable DOE and CEQ NEPA regulations, the No Action Alternative will also be analyzed in the S–SWEIS. In this case, the No Action Alternative will be the continued implementation of the 1999 ROD at LANL over the next 5 years as this alternative was originally analyzed in the SWEIS, and will also include the implementation of other actions selected in DOE and NNSA RODs supported by separate NEPA reviews (specifically, actions analyzed since the issuance of the final SWEIS in the Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico (DOE/EIS–293), the Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at Los Alamos National Laboratory (DOE/EIS–319), the Final Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico (DOE/EIS–0350), and in about 20 various EAs and their associated FONSIs, as well as actions categorically excluded from the need for preparation of either an EA or an EIS). The Los Alamos Site Office has posted a list of EAs and their associated FONSIs that pertain to LANL operations dating from the completion of the 1999 SWEIS on their Web site at: *http://www.doeal.gov/LASO/nepa.* The full text of most of these EAs is also available through links provided at that Web site; copies of all of the documents may be obtained by contacting Ms. Withers at any of the addresses provided previously in this Notice.

Changes or new information have also surfaced regarding the environmental setting at LANL over the past 5 years that may affect future LANL operations, such as changes to LANL watersheds as the result of the Cerro Grande Fire, new information and changes resulting from thinning the forests around LANL, and the long-term effects from the regional drought. Additionally, there have been changes to both the number of LANL workers and to the surrounding population that have occurred or are being projected that are different from those on which the SWEIS socioeconomic and other impact analyses were based. To the extent that changes to or new information about the existing LANL environment may significantly affect natural and cultural resource areas originally considered in the 1999 SWEIS, projected impacts associated with implementing the Proposed Action over the next 5 years at LANL will be analyzed in the S–SWEIS.

Direct, indirect, and unavoidable impacts to the various natural and cultural resources present at LANL, together with irreversible and irretrievable commitments and mitigations, will also be analyzed in the S–SWEIS. Further, operational and site differences require a re-evaluation of LANL operational accident analyses and a new assessment and understanding of cumulative impacts of LANL operations will also be addressed.

Public Scoping Process: The scoping process is an opportunity for the public to assist the NNSA in determining the issues for impact analysis, and at least one public scoping meeting is held. The purpose of the scoping meeting is to provide attendees an opportunity to present oral and written comments, ask questions, and discuss concerns regarding the S–SWEIS with NNSA officials. Comments and recommendations can also be mailed to Elizabeth Withers at any of the identified addresses noted in the previous paragraphs of this Notice. The S–SWEIS meeting will use a format to facilitate dialogue between NNSA and the public and will be an opportunity for individuals to provide written or oral statements. NNSA welcomes specific comments or suggestions on the content of the document that could be considered. The potential scope of the S–SWEIS discussed in the previous portions of this Notice is tentative and is intended to facilitate public comment on the scope of this S–SWEIS. It is not intended to be all-inclusive, nor does it imply any predetermination of potential impacts. The S–SWEIS will describe the potential environmental impacts of the alternatives by using available data where possible and obtaining additional data where necessary. Copies of written comments and transcripts of oral comments provided to NNSA during the scoping period will be available at the following locations: Los Alamos Outreach Center, 1350 Central Avenue, Suite 101, Los Alamos, New Mexico, 87544; and the Zimmerman Library, University of New Mexico, Albuquerque, New Mexico 87131.

S–SWEIS Preparation Process: The S–SWEIS preparation process begins with the publication of this Notice of Intent in the **Federal Register**. After the close of the public scoping period, NNSA will begin developing the draft S–SWEIS. NNSA expects to issue the Draft S–SWEIS for public review in the fall of 2005. Public comments on the Draft S–SWEIS will be received during a comment period of at least 45 days following publication of the Notice of Availability. The Notice of Availability, also published in the **Federal Register**, along with notices placed in local newspapers, will provide dates and locations for public hearings on the Draft S–SWEIS and the deadline for comments on the draft document. Issuance of the Final S–SWEIS is scheduled for early 2006.

Issued in Washington, DC, this 29th day of December, 2004.

Everet H. Beckner,

Deputy Administrator for Defense Programs, National Nuclear Security Administration.

[FR Doc. 05–210 Filed 1–4–05; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

National Nuclear Security Administration

Notice of Availability of the Draft Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, NM

AGENCY: U.S. Department of Energy (DOE), National Nuclear Security Administration (NNSA).

ACTION: Notice of availability and public hearings.

SUMMARY: NNSA announces the availability of the Draft Site-wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico (LANL Draft SWEIS) (DOE/EIS – 0380), and the dates and locations for the public hearings to receive comments on the Draft LANL SWEIS. The Draft LANL SWEIS was prepared in accordance with the Council on Environmental Quality 's National Environmental Policy Act (NEPA) Implementing Regulations (40 CFR parts 1500–1508) and the DOE NEPA Implementing Procedures (10 CFR part 1021). The Draft LANL SWEIS analyzes the potential environmental impacts associated with continuing ongoing Los Alamos National Laboratory (LANL) operations and foreseeable new and modified operations and facilities. The Draft LANL SWEIS analyzes the No Action Alternative and two action alternatives: a Reduced Operations Alternative and an Expanded Operations Alternative. The No Action Alternative would continue currently assigned operations at LANL in support of DOE and NNSA missions. The Reduced Operation Alternative also includes most operations discussed under the No Action Alternative with reductions to certain LANL activities below the No Action Alternative level. The Expanded Operations Alternative includes operations discussed under the No Action Alternative plus new and expanded levels of operations in support of reasonably foreseeable future mission requirements.

DATES: The NNSA invites members of Congress, American Indian Tribal Governments, state and local governments, other Federal agencies, and the general public to provide comments on the Draft LANL SWEIS. The comment period extends from the publication of this Notice of Availability through September 5, 2006. Written comments must be received or postmarked by September 5, 2006. Comments postmarked after this date will be considered to the extent practicable. The NNSA will consider the comments in the preparation of the Final LANL SWEIS. Public hearings to present information and receive comments on the Draft LANL SWEIS will be held at three locations. This information will also be published in local New Mexico newspapers in advance of the hearings. Any necessary changes will be announced in the local media and on the web site noted in the **ADDRESSES** section of this notice. Oral and written comments will be accepted at the public hearings. The locations, dates, and times for these public hearings are as follows:

Tuesday, August 8, 2006, at 6:30 p.m. to 9:30 p.m., Fuller Lodge, Pajarito Room, 2132 Central Avenue, Los Alamos, NM.

Wednesday, August 9, 2006, at 6:30 p.m. to 9:30 p.m., Northern New Mexico Community College, Eagle Memorial Sportsplex, 921 Paseo de Onate, Española, NM.

Thursday, August 10, 2006, at 6:30 p.m. to 9:30 p.m., Santa Fe Community College, Main Building, Jemez Rooms, 6401 Richards Avenue, Santa Fe, NM.

The following Web site may be accessed for additional information: *http://www.doeal.gov/laso/nepa/sweis.htm* . For information or to record comments call 1–877–491–4957

ADDRESSES: Copies of the Draft LANL SWEIS are available for review at: The Los Alamos Outreach Center, 1619 Central Avenue, Los Alamos, New Mexico, 87544; the Office of the Northern New Mexico Citizens Advisory Board, 1660 Old Pecos Trail, Suite B, Santa Fe, New Mexico; and the Zimmerman Library, University of New Mexico, Albuquerque, New Mexico 87131. The Draft SWEIS will also be available on the Department of Energy Los Alamos Site Office 's LASO NEPA website at: *http://www.doeal.gov/laso/nepa/sweis.htm.* Additionally, a copy of the Draft LANL SWEIS or its Summary may be obtained upon request by writing to: U.S. Department of Energy, National Nuclear Security Administration, Los Alamos Site Office, Attn: Ms. Elizabeth Withers, Office of Environmental Stewardship, 528 35th Street, Los Alamos, New Mexico, 87544; or by facsimile ((505) 667–5948); or by e-mail at: *LANL_SWEIS@doeal.gov.*

Specific information regarding the public hearings can also be obtained by the means described above. Comments concerning the Draft LANL SWEIS can be submitted to the NNSA Los Alamos Site Office by the means described above or by leaving a message on the LASO EIS Hotline at (toll free) 1 –877–491–4957. The Hotline will have instructions on how to record comments. Please mark all envelopes, faxes and e-mail: "Draft LANL SWEIS Comments".

FOR FURTHER INFORMATION CONTACT: For general information on NNSA NEPA process, please contact: Ms. Alice Williams, NA–56, NEPA Compliance Officer for Defense Programs, U.S. Department of Energy, National Nuclear Security Administration, 1000 Independence Avenue, SW., Washington, DC 20585, or telephone 202–586–6847, or Ms. Elizabeth Withers, NEPA Compliance Officer, U.S. Department of Energy, Los Alamos Site Office, 528 35th Street, Los Alamos, New Mexico, 87004, or telephone 505 – 845–4984. For general information about the DOE NEPA process, please contact: Ms. Carol Borgstrom, Director, Office of NEPA Policy and Compliance (EH–42), U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585, (202) 586–4600, or leave a message at 1–800–472–2756.

SUPPLEMENTARY INFORMATION: The primary purpose and need for continued operation of LANL is to provide support for DOE and NNSA core missions as directed by Congress and the President. NNSA's need to continue operating LANL is focused on their obligation to ensure a safe and reliable nuclear weapons stockpile. LANL is also needed to support other Federal agencies, including the Department of Homeland Security. The Draft LANL SWEIS analyzes the environmental impacts of operations at LANL.

LANL is located in north-central New Mexico and covers an area of about 40 square miles (104 square kilometers). LANL was established in 1943 as "Project Y" of the Manhattan Project with a single-focused national defense mission—to build the world 's first nuclear weapon. After World War II ended, Project Y was designated a permanent research and development laboratory and its mission support work was expended from defense and related research and development to incorporate a wide variety of new work assignments in support of other Federal Government and civilian programs. LANL is now a multi-disciplinary, multipurpose institution engaged in theoretical and experimental research and development.

DOE issued a Final SWEIS and Record of Decision in 1999 for the continued operation of LANL. DOE regulations implementing NEPA require the evaluation of site-wide NEPA analyses every five years to determine their continued applicability; such a five-year evaluation was initiated for the 1999 SWEIS in 2004, and NNSA subsequently made a determination to prepare a new SWEIS for LANL operations. Decisions regarding LANL operations that will be based upon impact information contained within this SWEIS will replace previous decisions announced through the 1999 ROD for LANL operations.

The alternatives evaluated in the Draft LANL SWEIS represent a range of operational levels ranging from the minimal reasonable activity levels (Reduced Operations Alternative), to the highest reasonable activity levels that could be supported by current facilities, plus the potential expansion and construction of new facilities for existing capabilities and for specifically identified future actions (Expanded Operations Alternative). The No Action Alternative would continue current mission support work at LANL and includes approved interim actions and facility construction, expansions or modifications, and decontamination and decommissioning for which NEPA impact analysis has already been completed. All alternatives assume LANL will continue to operate as a NNSA national security laboratory for the foreseeable future.

Following the end of the public comment period described above, the NNSA will consider and respond to the comments received, and issue the Final LANL SWEIS. The NNSA will consider the environmental impact analysis presented in the Final LANL SWEIS, along with other information, in determining the Record of Decision for the continued operation of LANL.

Signed in Washington, DC, this 26th day of May 2006.

Thomas P. D'Agostino,

Acting Administrator, National Nuclear Security Administration.

[FR Doc. 06–6055 Filed 7–6–06; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

National Nuclear Security Administration

Extension of Comment Period on the Draft Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, NM

AGENCY: U.S. Department of Energy (DOE), National Nuclear Security Administration (NNSA).

ACTION: Notice of comment period extension.

SUMMARY: On July 7, 2006, NNSA published a Notice of Availability for the Draft Site-wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico (LANL Draft SWEIS) (DOE/EIS –0380) (71 FR 38638) and announced a 60-day public comment period ending September 5, 2006. Subsequently, in response to requests for additional time to review and comment on the document, NNSA is extending the public comment period until September 20, 2006.

DATES: Comments should be submitted to NNSA no later than September 20, 2006. NNSA will consider comments submitted after this date to the extent practicable.

ADDRESSES: Comments, or requests for copies of the LANL Draft SWEIS should be sent to: U.S. Department of Energy, National Nuclear Security Administration, Los Alamos Site Office, Attn: Ms. Elizabeth Withers, SWEIS Document Manager, 528 35th Street, Los Alamos, New Mexico, 87544; or by facsimile (1–505-667–5948); or by e-mail at: *LANL_SWEIS@doeal.gov*.

Requests for copies of the LANL Draft SWEIS or recorded comments may also be made by calling 1–877–491–4957. Please mark all envelopes, faxes and e-mail: "LANL Draft SWEIS Comments". The LANL Draft SWEIS and its reference documents are available for review at: the Robert J. Oppenheimer Study Center Research Library, Technical Area 3, Los Alamos National Laboratory, Los Alamos, New Mexico; the Office of the Northern New Mexico Citizens Advisory Board, 1660 Old Pecos Trail, Suite B, Santa Fe, New Mexico; and the Zimmerman Library, University of New Mexico, Albuquerque, New Mexico. The Draft SWEIS is available on the DOE Los Alamos Site Office's NEPA Web site at: *http://www.doeal.gov/laso/nepa/sweis.htm*.

FOR FURTHER INFORMATION CONTACT: U.S. Department of Energy, Los Alamos Site Office, Attn: Ms. Elizabeth Withers, SWEIS Document Manager, 528 35th Street, Los Alamos, New Mexico 87544; or telephone 1–505–845–4984.

Issued in Los Alamos, NM, this 24th day of August, 2006.

Edwin L. Wilmot,

Manager.

[FR Doc. 06–7298 Filed 8–30–06; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

Notice of Intent To Prepare a Supplement to the Stockpile Stewardship and Management Programmatic Environmental Impact Statement—Complex 2030

AGENCY: National Nuclear Security Administration, Department of Energy.

ACTION: Notice of intent.

SUMMARY: The National Nuclear Security Administration (NNSA), an agency within the U.S. Department of Energy (DOE or Department), announces its intent to prepare a *Supplement to the Stockpile Stewardship and Management Programmatic Environmental Impact Statement—Complex 2030* (Complex 2030 SEIS or SEIS, DOE/EIS–0236–S4), pursuant to the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 *et seq.*), the Council on Environmental Quality's (CEQ's) and DOE's regulations implementing NEPA (40 CFR parts 1500–1508 and 10 CFR part 1021, respectively). The SEIS will analyze the environmental impacts from the continued transformation of the United States' nuclear weapons complex by implementing NNSA's vision of the complex as it would exist in 2030, which the Department refers to as Complex 2030, as well as alternatives. Since the end of the Cold War, there continue to be significant changes in the requirements for the nation's nuclear arsenal, including reductions in the number of nuclear weapons. To fulfill its responsibilities for certifying the safety and reliability of nuclear weapons without underground testing, DOE proposed and implemented the Stockpile Stewardship and Management (SSM) Program in the 1990s. Stockpile Stewardship includes activities required to maintain a high level of confidence in the safety and reliability of nuclear weapons in the absence of underground testing, and in the capability of the United States to resume nuclear testing if directed by the President. Stockpile Management activities include dismantlement, maintenance, evaluation, repair, and replacement of weapons and their components in the existing stockpile.

NNSA's proposed action is to continue currently planned modernization activities and select a site for a consolidated plutonium center for long-term research and development, surveillance, and pit[1] manufacturing; consolidate special nuclear materials throughout the complex; consolidate, relocate, or eliminate duplicative facilities and programs and improve operating efficiencies; identify one or more sites for conducting NNSA flight test operations; and accelerate nuclear weapons dismantlement activities. This Notice of Intent (NOI), the initial step in the NEPA process, informs the public of NNSA's intention to prepare the Complex 2030 SEIS, announces the schedule for public scoping meetings, and solicits public input. Following the scoping period, NNSA will prepare and issue a draft of the Complex 2030 SEIS that will describe the Complex 2030 proposal, the alternatives analyzed, and potential impacts of the proposal and the alternatives.

This NOI also announces that NNSA has cancelled the previously planned *Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility* (DOE/EIS–0236–S2).

DATES: NNSA invites comments on the scope of the Complex 2030 SEIS. The public scoping period starts with the publication of this NOI in the **Federal Register** and will continue through January 17, 2006. Scoping comments received after this date will be considered to the extent practicable. NNSA will hold public scoping meetings to discuss issues and receive oral and written comments on the scope of the Complex 2030 SEIS. The locations, dates, and times for these public scoping meetings are listed below and will be announced by additional appropriate means. NNSA requests federal agencies that desire to be designated as cooperating agencies on the SEIS to contact NNSA's Office of Transformation at the address listed under **ADDRESSES** by the end of the scoping period.

North Augusta, South Carolina, North Augusta Community Center, 495 Brookside Avenue. November 9, 2006, 11 a.m.—3 p.m., 6 p.m.—10 p.m.

Oak Ridge, Tennessee, Oak Ridge City Center Club Room, 333 Main Street. November 13, 2006, 11 a.m.—3 p.m., 6 p.m.—10 p.m.

Amarillo, Texas, Amarillo Globe-News Center, Education Room, 401 S. Buchanan. November 15, 2006, 11 a.m.—3 p.m., 6 p.m.—10 p.m.

Las Vegas, Nevada, Cashman Center, 850 Las Vegas Boulevard North (at Washington). November 28, 2006. 11 a.m.—3 p.m., 6 p.m.—10 p.m.

Tonopah, Nevada, Tonopah Convention Center, 301 Brougher Avenue. November 29, 2006, 6 p.m.—10 p.m.

Socorro, New Mexico, Macey Center (at New Mexico Tech), 801 Leroy Place. December 4, 2006, 6 p.m.—10 p.m.

Albuquerque, New Mexico, Albuquerque Convention Center, 401 2nd St. NW. December 5, 2006, 11 a.m.—3 p.m., 6 p.m.—10 p.m.

Los Alamos, New Mexico, Mesa Public Library, 2400 Central Avenue. December 6, 2006, 10:30 a.m.—2:30 p.m.

Santa Fe, New Mexico, Genoveva Chavez Community Center, 3221 Rodeo Road. December 6, 2006, 6 p.m.—10 p.m.

Livermore, California, Robert Livermore Community Center, 4444 East Avenue. December 12, 2006, 11 a.m.—3 p.m.

Tracy, California, Tracy Community Center, 950 East Street. December 12, 2006, 6 p.m.—10 p.m.

U.S. Department of Energy, 1000 Independence Avenue, SW., Room 1E–245, Washington, DC. December 14, 2006, 1 p.m.—5 p.m.

NNSA officials will be available to informally discuss the Complex 2030 proposal during the first hour. Following this, NNSA intends to hold a plenary session at each scoping meeting in which officials will explain the Complex 2030 proposal and the SEIS, including preliminary alternatives. The meetings will provide the public with an opportunity to provide oral and written comments to NNSA on the scope of the SEIS. Input from the scoping meetings will assist NNSA in preparing the draft SEIS.

ADDRESSES: General questions concerning the NOI can be asked by calling toll-free 1–800–832–0885 (ext. 63519), e-mailing to *Complex2030@nnsa.doe.gov*, or writing to Theodore A. Wyka, Complex 2030 SEIS Document Manager, Office of Transformation, U.S. Department of Energy, NA–10.1, 1000 Independence Avenue, SW., Washington, DC 20585. Written comments on the scope of the SEIS or requests to be placed on the document distribution list can be sent to the Complex 2030 SEIS Document Manager. Additional information regarding Complex 2030 is available on Complex2030PEIS.com.

For general information on the DOE NEPA process, please contact Carol M. Borgstrom, Director, Office of NEPA Policy and Compliance, U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585, (202) 586–4600 or 1–800–472–2756. Additional information regarding DOE NEPA activities and access to many DOE NEPA documents are available on the Internet through the DOE NEPA Web site at *http://www.eh.doe.gov/nepa.*

SUPPLEMENTARY INFORMATION:

---

[1] A pit is the central core of a nuclear weapon typically containing plutonium-239 that undergoes fission when compressed by high explosives.

Background: The early days of the nuclear weapons complex after World War II saw a rapid build-up of capability and capacity to support the growth of the stockpile to fight the Cold War. By the 1960s, the United States had built a large stockpile of nuclear weapons, and the nation began to focus on improving, rather than expanding, the stockpile. NNSA's predecessor agencies began to consolidate operations and close some production facilities. In the 1980s, facilities were shut down across the nuclear weapons complex, including certain facilities at the Savannah River Site in South Carolina; the Oak Ridge Reservation in Tennessee; the Rocky Flats Plant in Colorado; the Fernald Site in Ohio; the Hanford Reservation in Washington; and elsewhere.

Prior DOE NEPA Reviews: DOE completed a Nuclear Weapons Complex Reconfiguration (''Complex-21'') Study in January 1991, which identified significant cost savings that could be achieved by further downsizing of the nuclear weapons complex.

DOE then initiated a programmatic EIS (Reconfiguration PEIS) examining alternatives for reconfiguring the nuclear weapons complex. However, in December 1991, the Department decided to separate proposals for transforming non-nuclear production from the Reconfiguration PEIS because (1) proposals to consolidate non-nuclear facilities might not require preparation of an EIS, and (2) proposals and decisions regarding transformation of non-nuclear production would neither significantly affect nor be affected by proposals and decisions regarding transformation of nuclear production. On January 27, 1992, the Department issued an NOI (57 FR 3046) to prepare an environmental assessment (DOE/EA–0792) for the consolidation of non-nuclear production activities within the nuclear weapons complex. Following the collapse of the Soviet Union, the United States reduced the budget for the nuclear weapons program. President George H. W. Bush imposed a moratorium in 1992 on underground nuclear testing.

On September 14, 1993, DOE published a Finding of No Significant Impact (FONSI) regarding its proposal to consolidate non-nuclear component production (58 FR 48043). This proposal included termination of non-nuclear production missions at the Mound Plant in Ohio, the Pinellas Plant in Florida, and the Rocky Flats Plant in Colorado. The electrical and mechanical manufacturing functions were consolidated at the Kansas City Plant. Detonators and beryllium capabilities for technology and pit support were consolidated at Los Alamos National Laboratory (LANL) in New Mexico, and neutron generator production was relocated to Sandia National Laboratories in New Mexico.

In October 1993, President William J. Clinton issued Presidential Decision Directive 15 (PDD–15), which directed DOE to establish the Stockpile Stewardship Program. PDD–15 significantly redirected the nuclear weapons program. Throughout the Cold War, the Department of Defense (DOD) and DOE's nuclear weapons laboratories had based a portion of their confidence in the reliability of nuclear weapons on performance data from atmospheric and underground tests. To ensure weapons reliability during the moratorium on testing, DOE proposed to invest in new scientific tools to assess the complex phenomena involved in the detonation of nuclear weapons. DOE also began to develop sophisticated tools and computer-based simulation techniques to assess various aging phenomena as nuclear weapons continued to serve well beyond their originally anticipated lifetimes. These actions enhanced research and development (R&D) and deferred spending on the production complex.

DOE concluded in October 1994 that the alternatives described in the Reconfiguration PEIS no longer contained realistic proposals for reconfiguration of the nuclear weapons complex. That conclusion was based on several factors, including: comments offered at the September-October 1993 Reconfiguration PEIS scoping meetings; the anticipation that no production of new nuclear weapons types would be required for the foreseeable future; budget constraints; and the Department's decision to prepare a separate PEIS on Storage and Disposition of Weapons-Usable Fissile Materials (DOE/EIS–0229; NOI published June 21, 1994, 59 FR 17344).

Consequently, the Department separated the Reconfiguration PEIS into two new PEISs: (1) A Tritium Supply and Recycling PEIS (DOE/EIS–0161); and (2) the SSM PEIS (DOE/EIS–0236). The Final PEIS for Tritium Supply and Recycling was issued on October 27, 1995 (60 FR 55021). In its Record of Decision (ROD) on May 14, 1999 (64 FR 26369[2]), DOE decided it would produce the tritium needed to maintain the nuclear arsenal at commercial light water reactors owned and operated by the Tennessee Valley Authority and extract tritium at a new DOE-owned Tritium Extraction Facility at the Savannah River Site. With regard to the SSM PEIS, DOE issued an NOI on June 6, 1995 (60 FR 31291), a final SSM PEIS on November 19, 1996 (61 FR 58871), and a ROD on December 26, 1996 (61 FR 68014) announcing its decision to transform the weapons production complex by (1) reducing the weapon assembly capacity located at the Pantex Plant in Texas; (2) reducing the high-explosives fabrication capacity at Pantex; (3) reducing the uranium, secondary, and case fabrication capacity in the Y–12 National Security Complex in Tennessee; (4) reducing nonnuclear component fabrication capacity at the Kansas City Plant; and (5) reestablishing a modest interim pit fabrication capability at Los Alamos National Laboratory in New Mexico while evaluating the need for greater pit manufacturing capacity in the future.

In accordance with the decisions in the SSM PEIS, the *Non-nuclear Consolidation Environmental Assessment* (EA), and the Tritium Supply and Recycling PEIS, DOE began transforming the nuclear weapons complex to its present configuration. DOE has also prepared other EISs that facilitated the transformation of the complex. The relevant RODs for these site-wide and project-specific EISs are listed below:

- 1996 ROD for the *EIS for the Nevada Test Site and Off-Site Locations in the State of Nevada* (61 FR 65551, December 13, 1996).
- 1997 ROD for the *EIS for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components* (62 FR 3880, January 27, 1997).
- 1999 ROD for the Site-wide EIS for Continued Operation of the Los Alamos National Laboratory (64 FR 50797, September 20, 1999).
- 1999 ROD for the *EIS for Site-wide Operation of Sandia National Laboratories* (64 FR 69996, December 15, 1999).
- 2000 *Amended ROD for the Nevada Test Site EIS* (65 FR 10061, February 25, 2000).
- 2002 ROD for the *Site-wide EIS for the Oak Ridge Y–12 National Security Complex* (67 FR 11296, March 13, 2002).
- 2002 ROD for the *EIS for the Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory* (67 FR 79906, December 31, 2002).
- 2004 ROD for the *EIS for the Chemistry and Metallurgy Research Building Replacement Project, Los*

---

[2] This ROD also contains decisions for the EIS for Construction and Operation of a Tritium Extraction Facility at the Savannah River Site (DOE/EIS–0271) and EIS for the Production of Tritium in a Commercial Light Water Reactor (DOE/EIS–0288).

Alamos National Laboratory (69 FR 6967, February 12, 2004).

- 2005 ROD for the *Site-wide EIS for Continued Operation of Lawrence Livermore National Laboratory and Supplemental Stockpile Stewardship and Management Programmatic EIS* (70 FR 71491, November 29, 2005).

Nuclear Weapons Complex: The current nuclear weapons complex consists of eight major facilities located in seven states. NNSA maintains a limited capability to design and manufacture nuclear weapons; provides surveillance of and maintains nuclear weapons currently in the stockpile; and dismantles retired nuclear weapons. Major facilities and their primary responsibilities within the nuclear weapons complex are listed below:

Savannah River Site (SRS) (Aiken, South Carolina)—Extracts tritium (when the Tritium Extraction Facility becomes operational in 2007); provides loading, unloading and surveillance of tritium reservoirs. SRS does not maintain Category I/II[3] quantities of special nuclear material (SNM)[4] associated with weapons activities, but does maintain Category I/II quantities of SNM associated with other Department activities (*e.g.*, environmental management).

Pantex Plant (PX) (Amarillo, Texas)—Dismantles retired weapons; fabricates high-explosives components; assembles high explosive, nuclear, and non-nuclear components into nuclear weapons; repairs and modifies weapons; and evaluates and performs non-nuclear testing of weapons. Maintains Category I/II quantities of SNM for the weapons program and material no longer needed by the weapons program.

Y–12 National Security Complex (Y–12) (Oak Ridge, Tennessee)—Manufactures nuclear weapons secondaries, cases, and other weapons components; evaluates and performs testing of weapon components; maintains Category I/II quantities of SNM; conducts dismantlement, storage, and disposition of nuclear weapons materials; and supplies SNM for use in naval reactors.

Kansas City Plant (KCP) (Kansas City, Missouri)—Manufactures and acquires non-nuclear weapons components; and evaluates and performs testing of weapon components. No Category I/II quantities of SNM are maintained at the KCP.

Lawrence Livermore National Laboratory (LLNL) (Livermore, California)—Conducts research and development of nuclear weapons; designs and tests advanced technology concepts; designs weapons; maintains a limited capability to fabricate plutonium components; and provides safety and reliability assessments of the stockpile. Maintains Category I/II quantities of SNM associated with the weapons program and material no longer needed by the weapons program.

Los Alamos National Laboratory (LANL) (Los Alamos, New Mexico)—Conducts research and development of nuclear weapons; designs and tests advanced technology concepts; designs weapons; provides safety and reliability assessments of the stockpile; maintains interim production capabilities for limited quantities of plutonium components (e.g., pits); and manufactures nuclear weapon detonators for the stockpile. Maintains Category I/II quantities of SNM associated with the nuclear weapons program and material no longer needed by the weapons program.

Sandia National Laboratories (SNL) (Albuquerque, New Mexico; Livermore, California)—Conducts system engineering of nuclear weapons; designs and develops non-nuclear components; conducts field and laboratory non-nuclear testing; conducts research and development in support of the nuclear weapon non-nuclear design; manufactures non-nuclear weapon components; provides safety and reliability assessments of the stockpile; and manufactures neutron generators for the stockpile. Maintains Category I/II quantities of SNM associated with the nuclear weapons program.

Nevada Test Site (NTS) (Las Vegas, Nevada)—Maintains capability to conduct underground nuclear testing; conducts experiments involving nuclear material and high explosives; provides capability to disposition a damaged nuclear weapon or improvised nuclear device; conducts non-nuclear experiments; and conducts research and training on nuclear safeguards, criticality safety and emergency response. Maintains Category I/II quantities of SNM associated with the nuclear weapons program.

Purpose and Need for the Stockpile Stewardship and Management Program: Under the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.), DOE is responsible for providing nuclear weapons to support the United States' national security strategy. The National Nuclear Security Administration Act (Pub. L. 106–65, Title XXXII) assigned this responsibility to NNSA within DOE. One of the primary missions of NNSA is to provide the nation with safe and reliable nuclear weapons, components and capabilities, and to accomplish this in a way that protects the environment and the health and safety of workers and the public.

Changes in national security needs and budgets have necessitated changes in the way NNSA meets its responsibilities regarding the nation's nuclear stockpile. As a result of a changed security environment, unilateral decisions by the United States and international arms control agreements, the nation's stockpile is significantly smaller today and by 2012, it will be the smallest since the Eisenhower administration (1953–1961). The Treaty of Moscow will eventually lead to a level of 1,700–2,200 operationally-deployed strategic nuclear weapons.

However, nuclear deterrence will continue to be a cornerstone of United States national security policy, and NNSA must continue to meet its responsibilities for ensuring the safety and reliability of the nation's nuclear weapons stockpile. The current policy is contained in the Nuclear Posture Review, submitted to Congress in early 2002, which states that the United States will:

- Change the size, composition and character of the nuclear weapons stockpile in a way that reflects that the Cold War is over;
- Achieve a credible deterrent with the lowest possible number of nuclear warheads consistent with national security needs, including obligations to allies; and
- Transform the NNSA nuclear weapons complex into a responsive infrastructure that supports the specific stockpile requirements established by the President and maintains the essential United States nuclear capabilities needed for an uncertain global future.

Complex 2030 SEIS: NNSA has been evaluating how to establish a more responsive nuclear weapons complex infrastructure since the Nuclear Posture Review was transmitted to Congress in early 2002. The Stockpile Stewardship Conference in 2003, the Department of Defense Strategic Capabilities Assessment in 2004, the recommendations of the Secretary of Energy Advisory Board (SEAB) Task Force on the Nuclear Weapons Complex Infrastructure in 2005, and the Defense

---

[3] Category I/II quantities of special nuclear material are determined by grouping materials by type, attractiveness level, and quantity. These grouping parameters are defined in DOE Manual 470.4–6, Nuclear Material Control and Accountability [see *https://www.directives.doe.gov*].

[4] As defined in section 11 of the Atomic Energy Act of 1954, special nuclear material are: (1) Plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the U.S. Nuclear Regulatory Commission determines to be special nuclear material; or (2) any material artificially enriched by plutonium or uranium 233 or 235.

Science Board Task Force on Nuclear Capabilities in 2006 have provided information for NNSA's evaluations.

In early 2006, NNSA developed a planning scenario for what the nuclear weapons complex would look like in 2030. See *http://www.nnsa.doe.gov* for more information regarding Complex 2030 planning. The Complex 2030 planning scenario incorporates many of the decisions NNSA has already made based on the evaluations in the SSM PEIS, Tritium Supply and Recycling PEIS, and other NEPA documents. See discussion in background above. The following table identifies which components of Complex 2030 are based on the existing SSM PEIS and Tritium PEIS RODs, including RODs for subsequent tiered EISs:

Components of Complex 2030 that reflect earlier decisions	SSM PEIS ROD	Tritium PEIS ROD
Maintain but reduce the existing weapon assembly capacity located at Pantex	X	
Maintain but reduce the high-explosives fabrication capacity at Pantex	X	
Maintain but reduce the existing uranium, secondary, and case fabrication capacity at the Y–12 Plant at Oak Ridge	X	
Reduce the non-nuclear component fabrication capacity at the Kansas City Plant	X	
Reestablish limited pit fabrication capability at Los Alamos National Laboratory while evaluating the need for a larger capability	X	
Irradiate tritium producing rods in commercial light water reactors; construct and operate a new Tritium Extraction Facility at DOE's Savannah River Site		X

Types of Decisions that Would Be Based on the Complex 2030 SEIS: The decisions set forth in the Complex 2030 ROD would:

- Identify the future missions of the SSM Program and the nuclear weapons complex; and
- Determine the configuration of the future weapons complex needed to accomplish the SSM Program.

For specific programs or facilities, NNSA may need to prepare additional NEPA documents to implement the decisions announced in the ROD. The baseline that will be used for the analyses of program and facility needs in the SEIS is 1,700–2,200 operationally-deployed strategic nuclear weapons, in addition to augmentation weapons, reliability-reserve weapons and weapons required to meet NATO commitments. The numbers are consistent with international arms-control agreements. Consistent with national security policy directives, replacement warhead design concepts may be pursued under the alternatives as a means of, for example, enhancing safety and security, improving manufacturing practices, reducing surveillance needs, and reducing need for underground tests.

The SEIS will evaluate reasonable alternatives for future transformation of the nuclear weapons complex. The Proposed Action and alternatives to the Proposed Action will assume continued implementation of the following prior siting decisions that DOE made in the SSM PEIS and Tritium PEIS RODs, including RODs for subsequent tiered EISs:

- Location of the weapon assembly/disassembly operations at the Pantex Plant in Texas.
- Location of uranium, secondary, and case fabrication at the Y–12 National Security Complex in Tennessee.
- Location of tritium extraction, loading and unloading, and support operations at the Savannah River Site in South Carolina.

NNSA does not believe it is necessary to identify additional alternatives beyond those present in the SSM PEIS. Regarding the uranium, secondary, and case fabrication at Y–12, NNSA is currently preparing a Y–12 Site-wide EIS to evaluate reasonable alternatives for the continued modernization of the Y–12 capabilities. The Complex 2030 SEIS will incorporate any decisions made pursuant to the Y–12 Site-wide EIS.

While the Complex 2030 planning scenario proposes to consolidate further non-nuclear production activities performed at the Kansas City Plant, this proposal will be evaluated in a separate NEPA analysis, as was done in the 1990s. NNSA believes that it is appropriate to separate the analyses of the transformation of non-nuclear production from the SEIS because decisions regarding those activities would neither significantly affect nor be affected by decisions regarding the transformation of nuclear production activities.

The SSM PEIS ROD announced NNSA's decision to establish a small interim pit production capacity at LANL. In the 1999 LANL Site-wide EIS ROD, NNSA announced it would achieve a pit production capacity at LANL of up to 20 pits per year. The 2006 draft LANL Site-wide EIS evaluates a proposal for a production capacity of 50 certified pits annually. This proposed capacity is based on an annual production rate of 80 pits per year in order to provide NNSA with sufficient flexibility to obtain 50 certified pits. Any decisions made pursuant to the LANL Site-wide EIS will be included in the Complex 2030 SEIS.

Based upon the studies [5] and analyses that led to NNSA's development of the Complex 2030 scenario, NNSA has developed alternatives that are intended to facilitate public comment on the scope of the SEIS. NNSA's decisions regarding implementation of Complex 2030 will be based on the following alternatives, or a combination of those alternatives.

The Proposed Action—Transform to a More Modern, Cost-Effective Nuclear Weapons Complex (Complex 2030). This alternative would undertake the following actions to continue the transformation of NNSA's nuclear weapons complex:

- Select a site to construct and operate a consolidated plutonium center for long-term R&D, surveillance, and manufacturing operations for a baseline capacity of 125 qualified pits per year at a site with existing Category I/II SNM.
- Reduce the number of sites with Category I/II SNM and consolidate SNM to fewer locations within each given site.
- Consolidate, relocate or eliminate duplicative facilities and programs and improve operating efficiencies, including at facilities for nuclear materials storage, tritium R&D, high explosives R&D, environmental testing, and hydrotesting facilities.
- Identify one or more sites for conducting NNSA flight test operations.

---

[5] The Stockpile Stewardship Conference in 2003, the Department of Defense Strategic Capabilities Assessment in 2004, the recommendations of the Secretary of Energy Advisory Board (SEAB) Task Force on the Nuclear Weapons Complex Infrastructure in 2005, and the recommendations of the Defense Science Board Task Force on Nuclear Capabilities in 2006.

Existing DOD and DOE test ranges (*e.g.*, White Sands Missile Range in New Mexico and Nevada Test Site in Nevada) would be considered as alternatives to the continued operation of the Tonopah Test Range in Nevada.

- Accelerate dismantlement activities.

The DOE sites that will be considered as potential locations for the consolidated plutonium center and consolidation of Category I/II SNM include: Los Alamos, Nevada Test Site, Pantex Plant, Y–12 National Security Complex, and the Savannah River Site. Other DOE sites are not considered reasonable alternative locations because they do not satisfy certain criteria such as population encroachment, or mission compatibility or synergy with the site's existing mission.

Alternatives to the Proposed Action

No Action Alternative. The No Action Alternative represents the status quo as it exists today and is presently planned. It includes the continued implementation of decisions made pursuant to the SSM PEIS and the Tritium Supply and Recycling PEIS (as summarized above) and related site-specific EISs and EAs. These decisions are contained in RODs and Findings of No Significant Impact (FONSIs), including those discussed above, and copies can be located on the DOE NEPA Document Web page at *http://www.eh.doe.gov/nepa/documents.html.*

The No Action Alternative would also include any decisions made as a result of the new Y–12 Site-wide EIS and the LANL Site-wide EIS once these EISs are finished. NNSA expects to issue RODs on these EISs prior to publication of the draft Complex 2030 SEIS.

The No Action Alternative is illustrated in the following matrix:

Capability	Sites (no action alternative)							
	KCP	LANL	LLNL	NTS	Y–12	PX	SNL	SRS
Weapons assembly/Disassembly				X		X		
Nonnuclear components	X	X					X	
Nuclear components:								
—Pits		X						
—Secondaries and cases					X			
High explosives components						X		
Tritium Extraction, Loading and Unloading								X
High explosives R&D		X	X			X	X	
Tritium R&D		X	X					X
Large Scale Hydrotesting		X	X	X				
Category I/II SNM Storage		X	X	X	X	X	X	X

The No Action Alternative also includes continuation of environmental testing at current locations and flight-testing activities at the Tonopah Test Range in Nevada.

Reduced Operations and Capability-Based Complex Alternative

In this alternative, NNSA would maintain a basic capability for manufacturing technologies for all stockpile weapons, as well as laboratory and experimental capabilities to support stockpile decisions, but would reduce production facilities to a ''capability-based'' [6] capacity. This alternative would not have a production capacity sufficient to meet current national security objectives. This alternative would be defined as follows:

- Do not construct and operate a consolidated plutonium center for long-term R&D, surveillance, and manufacturing operations; and do not expand pit production at LANL beyond 50 certified pits per year.
- Reduce the number of sites with Category I/II SNM and consolidate SNM to fewer locations within a given site.
- Consolidate, relocate or eliminate duplicative facilities and programs and improve operating efficiencies, including at facilities for nuclear materials storage, tritium R&D, high explosives R&D, environmental testing facilities, and hydrotesting facilities.
- Identify one or more sites for conducting NNSA flight test operations. Existing DOD and DOE test ranges (*e.g.* White Sands Missile Range in New Mexico and Nevada Test Site in Nevada) would be considered as potential alternatives to the continued operation of the Tonopah Test Range in Nevada.
- Production capacities at Pantex, Y–12, and the Savannah River Site would be considered for further reductions limited by the capability-based capacity.
- NNSA would continue dismantlement activities.

Proposal Not Being Considered for Further Analysis. The SEAB Task Force on the Nuclear Weapons Complex Infrastructure recommended that NNSA pursue a consolidated nuclear production center (CNPC) as a single facility for all research, development, and production activities relating to nuclear weapons that involve significant amounts (*i.e.* Category I/II quantities) of SNM. The CNPC, as envisioned by the SEAB Task Force, would contain all the nuclear weapons manufacturing, production, assembly, and disassembly facilities and associated weapon surveillance and maintenance activities for the stockpile weapons. The CNPC would include the plutonium activities of the consolidated plutonium center proposed by NNSA in its Complex 2030 vision, as well as the consolidated activities of the uranium, tritium, and high explosive operations. DOE believes that creation of a CNPC is not a reasonable alternative and does not intend to analyze it as an alternative in the SEIS because of the technical and schedule issues involved in constructing a CNPC, as well as associated costs. NNSA invites and will consider comments on this matter during the scoping process.

The SEAB Task Force developed three business cases for transforming the nuclear weapons complex, two of which were characterized as high risk. Its preferred least-risk option was to establish a CNPC ''quickly'' by accelerating site selection, NEPA analyses, regulatory approvals, and construction. The Task Force assumed that NNSA could, under these circumstances, begin operating a CNPC in 2015, start consolidation of SNM shortly thereafter, accelerate dismantlements, and begin other major transformational activities. Until the CNPC was completed, NNSA would have to maintain, and in some cases improve, existing production and research facilities. According to the Task Force's estimates, this option would require an additional 1 billion dollars per year for weapons programs

---

[6] The capability to manufacture and assemble nuclear weapons at a nominal level.

activities for the next 10 years, and lead to a net savings through 2030 of 15 billion dollars.

Accelerated construction of a CNPC would not allow NNSA to avoid immediate expenditures to restore and modernize interim production capabilities to meet essential Life Extension Program (LEP) schedules and support the existing stockpile during the next decade. LEP is the refurbishment of nuclear weapons parts and components to extend the weapon deployment life. NNSA has concluded that the SEAB Task Force underestimated the nonfinancial challenges of constructing a CNPC. A CNPC would require moving a unique and highly skilled workforce to a new location. It would require NNSA to obtain significant regulatory approvals rapidly, and to construct a unique and complex facility on a tight schedule. It would put many of the significant aspects of the weapons complex transformation into "one basket"—until the CNPC began operations, all the other facilities and activities would be delayed. NNSA's Proposed Action would achieve many of the benefits of the CNPC approach—consolidation of SNM and facilities, integrated R&D and production involving SNM, and aggressive dismantlements—in a way that addresses immediate national security needs in a technically feasible and affordable manner.

Nuclear Materials Consolidation: DOE is pursuing SNM consolidation from all DOE sites including those that comprise the nuclear weapons complex. The SEIS will look at alternatives for the storage and consolidation of nuclear materials within the nuclear weapons complex including materials needed to maintain the United States' nuclear weapons arsenal. There is a potential overlap between the SEIS and the activities of the Department's other nuclear materials consolidation activities, and DOE will ensure that there is appropriate coordination between the two activities.

Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility: NNSA issued a *Draft Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility* (MPF) on June 4, 2003 (68 FR 33487; also 68 FR 33934, June 6, 2003) that analyzed alternatives for producing the plutonium pits that are an essential component of nuclear weapons. On January 28, 2004, NNSA announced that it was indefinitely postponing any decision on how it would obtain a large capacity pit manufacturing facility. Because the Complex 2030 SEIS will analyze alternatives for plutonium-related activities that include pit production, DOE, effective upon publication of this NOI, cancels the MPF PEIS.

Public Scoping Process: The scoping process is an opportunity for the public to assist the NNSA in determining the issues for analysis. NNSA will hold public scoping meetings at locations identified in this NOI. The purpose of these meetings is to provide the public with an opportunity to present oral and written comments, ask questions, and discuss concerns regarding the transformation of the nuclear weapons complex and the SEIS with NNSA officials. Comments and recommendations can also be communicated to NNSA as discussed earlier in this notice.

Complex 2030 PEIS Supplement Preparation Process: The SEIS preparation process begins with the publication of this NOI in the **Federal Register**. NNSA will consider all public comments that it receives during the public comment period in preparing the draft SEIS. NNSA expects to issue the draft SEIS for public review during the summer of 2007. Public comments on the draft SEIS will be received during a comment period of at least 45 days following the U.S. Environmental Protection Agency's publication of the Notice of Availability in the **Federal Register**. Notices placed in local newspapers will specify dates and locations for public hearings on the draft SEIS and will establish a schedule for submitting comments on the draft SEIS, including a final date for submission of comments. Issuance of the final SEIS is scheduled for 2008.

Classified Material: NNSA will review classified material while preparing the SEIS. Within the limits of classification, NNSA will provide the public as much information as possible to assist its understanding and ability to comment. Any classified material needed to explain the purpose and need for the action, or the analyses in the SEIS, will be segregated into a classified appendix or supplement, which will not be available for public review. However, all unclassified information or results of calculations using classified data will be reported in the unclassified section of the SEIS, to the extent possible in accordance with federal classification requirements.

Issued in Washington, DC on October 11, 2006.

Linton F. Brooks,

Administrator, National Nuclear Security Administration.

[FR Doc. E6–17508 Filed 10–18–06; 8:45 am]

BILLING CODE 6450–01–P

APPENDIX B
NONRADIOLOGICAL AIR QUALITY

APPENDIX B
NONRADIOLOGICAL AIR QUALITY

Introduction

This appendix provides additional information about the nonradiological air quality analyses presented in Chapter 5 of this Site-Wide Environmental Impact Statement (SWEIS), including details on the modeling and analysis for criteria pollutants and other chemical emissions.

B.1 Assumptions, Data Sources, Standards, and Models

B.1.1 Applicable Guidelines and Standards and Emission Sources

Criteria Pollutants

The Clean Air Act mandates that the U.S. Environmental Protection Agency (EPA) establish primary and secondary National Ambient Air Quality Standards for pollutants of concern. These pollutants, known as criteria pollutants, are carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, lead, particulate matter less than or equal to 10 microns in aerodynamic diameter (PM_{10}), and particulate matter less than or equal to 2.5 microns in aerodynamic diameter ($PM_{2.5}$).

The State of New Mexico also has established ambient air quality standards for carbon monoxide, sulfur dioxide, nitrogen dioxide, total suspended particulates, hydrogen sulfide, and total reduced sulfur (New Mexico Administrative Code, Title 20, Chapter 2, Part 3). The more restrictive of the State of New Mexico ambient air quality standards and the National Ambient Air Quality Standards, are listed in **Table B–1**.

Criteria pollutants released into the atmosphere from Los Alamos National Laboratory (LANL) operations are emitted primarily from combustion facilities such as boilers, emergency generators, and motor vehicles.

Other Nonradiological Air Pollutants

Chemicals are currently used at LANL in separately located groups of operations or laboratory complexes called “technical areas” (TAs), which comprise large geographic areas. Air pollutants from these TAs may be released into the atmosphere from many ongoing activities, including laboratory, maintenance, and waste management operations. In the 1999 *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (*1999 SWEIS)* (DOE 1999), two types of toxic air pollutants were considered: noncarcinogenic and carcinogenic. Chemical pollutants are classified as hazardous air pollutants or as toxic air pollutants.

Table B–1 Criteria Pollutant Standards

Pollutant	*Time Period*	*Controlling Ambient Air Quality Standards* [a] *(micrograms per cubic meter)*
Carbon Monoxide	8 hours	7,961 [b]
	1 hour	11,987 [b]
Nitrogen Dioxide	Annual	75 [b]
	24 hours	150 [b]
Sulfur Dioxide	Annual	42 [b]
	24 hours	209 [b]
	3 hours	1,046 [c]
Total Suspended Particulates	Annual	60 [b]
	30-day	90 [b]
	7-day	110 [b]
	24 hours	150 [b]
PM_{10}	Annual	– [c,d]
	24 hours	150 [c]
$PM_{2.5}$	Annual	15 [c]
	24 hours	35 [c,d]
Ozone	8 hours	125 [c]
Lead	Calendar quarter	1.5 [c]
Hydrogen sulfide	1 hour	11.1 [b]

PM_n = particulate matter with an aerodynamic diameter less than or equal to n micrometers.

[a] Ambient standards for gaseous pollutants are stated in parts per million. These values were converted to micrograms per cubic meter, with appropriate corrections for temperature and pressure (elevation), following New Mexico *Dispersion Modeling Guidelines* (NMED 2003, LANL 2003).

[b] State standard.

[c] Federal standard.

[d] The EPA recently revoked the annual PM_{10} standard and changed the 24-hour $PM_{2.5}$ standard from 65 to 35 micrograms per cubic meter.

Note: The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (Title 40 *Code of Federal Regulations* [CFR] Part 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic $PM_{2.5}$ mean standard is attained when the expected annual arithmetic mean concentration (3 year average) is less than or equal to the standard. The 24-hour $PM_{2.5}$ standard is met when the 98th percentile over 3 years of 24-hour average concentrations is less than or equal to the standard value. The 24-hour PM_{10} standard is met when the 99th percentile over 3 years of 24-hour concentrations is less than or equal to the standard value.

Sources: NMAC 20.2.3 (New Mexico Administrative Code – Environmental Protection, Air Quality, Ambient Air Quality Standards 2002); 40 CFR Part 50 (National Ambient Air Quality Standards); 71 *Federal Register* (FR) 61143.

For the purpose of this SWEIS, the estimated chemical emissions during recent years were compared to the emissions evaluated in the *1999 SWEIS*. The total emissions of toxic or hazardous air pollutants and volatile organic compounds showed considerable variation over the period 1999 through 2004. Operation of the air curtain destructors resulted in increases of hazardous air pollutants and volatile organic compounds during 2002 and 2003. The air curtain destructors accounted for 2.1 and 22.9 tons (1.9 and 20.8 metric tons) of hazardous air pollutants and volatile organic compounds, respectively, in 2002. In 2003, they accounted for 3.3 and 36.0 tons (3.0 and 32.7 metric tons) of hazardous air pollutants and volatile organic compounds, respectively (LANL 2004b). With the completion of the Cerro Grande Fire Rehabilitation Project tree thinning and removal, emissions of hazardous air pollutants and volatile organic compounds returned to lower levels more typical of prefire conditions.

Toxic and hazardous air pollutant emissions from LANL activities are released primarily from laboratory, maintenance, and waste management operations. Unlike a production facility with well-defined operational processes and schedules, LANL is a research and development facility with great fluctuations in both the types of chemicals emitted and their emission rates. LANL has a program to review new operations for their potential to emit chemicals. Toxic air pollutant emissions from the use of chemicals are generally below the levels for which the State would require a permit for a new source under the New Mexico permit regulations for toxic air pollutant emissions (NMAC 20.2.72.400 - 502). The Title V operating permit limits the emissions of hazardous air pollutants such that operations at LANL are below the major source threshold for hazardous air pollutants. Emissions of hazardous air pollutants are monitored and reported annually to the New Mexico Environmental Department as required by the permit. Past actual emissions of hazardous air pollutants have been well below the threshold (LANL 2004a).

The chemical database information system used to estimate emissions in recent years is called ChemLog. It was used to estimate emissions for the annual *SWEIS Yearbooks* for 2002 through 2005 (LANL 2006). ChemLog includes all chemicals purchased at each LANL facility in each calendar year. Prior to 2002, another inventory system was used to estimate emissions based on chemical use. For the *1999 SWEIS*, 51 of the 382 chemicals evaluated were considered to be carcinogenic. For the purpose of the analysis, it was assumed that air emissions could result from the use of any of the 382 chemicals from any of the TAs that purchased them (DOE 1999). In the *SWEIS Yearbooks* chemical usage was summed by facility. It was then estimated that 35 percent of the chemical used was released to the atmosphere. Emission estimates for some metals were based on an emission factor of less than 1 percent because these metal emissions were assumed to result from cutting or melting activities. Fuels such as propane and acetylene were assumed to be completely combusted; therefore, no emissions were reported. A list of chemicals purchased in 2005 are provided in **Table B–2**.

Noncarcinogens

Short-Term Guideline Values. While no national or State of New Mexico standards have been established for noncarcinogens, the New Mexico Environment Department has developed guideline values for determining whether a new or modified source emitting a toxic air pollutant would be issued a construction permit (New Mexico Environment Department, Air Quality Control Regulations, revised November 17, 1994). These guideline values are 8-hour concentrations that are one-hundredth of the Occupational Exposure Limits established by the American Conference of Governmental Industrial Hygienists or the National Institute of Occupational Safety and Health. The State of New Mexico listing was supplemented with information on the lowest values for Occupational Exposure Limits from these sources. These guideline values were used in this analysis in screening for potential short-term impacts of chemical releases from LANL operations.

Annual Average Guideline Values. The guideline values used in the *1999 SWEIS* analysis were the inhalation reference concentrations from EPA’s Integrated Risk Information System. Reference concentrations are daily exposure levels to the human population (including sensitive subgroups) during a lifetime (70 years) that could occur without appreciable risk of deleterious effects.

Table B–2 Chemicals Purchased at Los Alamos National Laboratory – 2005 [a]

Chemical Name	*Key Facility*													
	CMR	*HRL – Biosciences*	*High Explosives Processing*	*High Explosives Testing*	*LANSCE*	*Machine Shops*	*Materials Science Lab*	*Pajarito Site*	*Pu Facility Complex*	*Radio-chemistry Site*	*Sigma Complex*	*Target Fabrication Facility*	*Tritium Operations*	*Waste Management Operations*
1,3,5-Trimethylbenzene					X									
1,4-Dioxane					X					X				
2- Methoxyethanol												X		
2- Nitropropane					X									
Acetic Acid		X								X		X		
Acetic Anhydride										X				
Acetone		X	X	X	X		X		X	X	X	X		
Acetonitrile		X	X		X					X		X		
Acetylene			X						X					
Acrolein			X											
Acrylamide		X												
Aluminum numerous forms											X			
Ammonia										X				
Ammonium Chloride	X								X	X				
Arsenic, El. & inorg, exc. Arsine											X			
Benzene										X		X		
Beryllium											X			
Bromine	X		X							X				
Carbon Tetrachloride	X									X				
Chlorine Trifluoride											X			
Chloroform		X			X							X		
Chromium, Metal & Cr III Compounds, as Cr	X													
Cobalt					X									
Copper	X		X											

Chemical Name	***Key Facility***													
	CMR	***HRL – Biosciences***	***High Explosives Processing***	***High Explosives Testing***	***LANSCE***	***Machine Shops***	***Materials Science Lab***	***Pajarito Site***	***Pu Facility Complex***	***Radio-chemistry Site***	***Sigma Complex***	***Target Fabrication Facility***	***Tritium Operations***	***Waste Management Operations***
Cyclohexane					X		X							
Cyclohexene														
Dicyclopentadiene										X				
Diethanolamine										X				
Diethylamine										X				
Diethylene Triamine							X				X			
Diisopropylamine										X				
Dipropylene Glycol Methyl Ether	X													
Ethanol	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ethyl Acetate			X				X			X				
Ethyl Ether					X		X			X		X		
Ethylene Diamine					X					X				
Formamide		X												
Hexane (other isomers) or n-Hexane		X	X		X		X			X		X		
Hydrogen Bromide	X									X				
Hydrogen Chloride	X	X	X		X		X		X	X	X			X
Hydrogen Cyanide												X		
Hydrogen Fluoride, as F		X			X					X	X			
Hydrogen Peroxide	X						X		X	X		X		
Hydroquinone					X					X				
Isobutane	X				X									
Isopropyl Alcohol	X	X			X		X			X	X	X		
Isopropylamine					X									
Kerosene			X			X								
Lead, elemental and inorganic compounds as lead					X									
Magnesium Oxide							X		X	X				

Chemical Name	***Key Facility***													
	CMR	***HRL – Biosciences***	***High Explosives Processing***	***High Explosives Testing***	***LANSCE***	***Machine Shops***	***Materials Science Lab***	***Pajarito Site***	***Pu Facility Complex***	***Radio-chemistry Site***	***Sigma Complex***	***Target Fabrication Facility***	***Tritium Operations***	***Waste Management Operations***
Fume														
Manganese Dust & Compounds or Fume					X									
Mercury, numerous forms											X	X		
Methyl Alcohol		X	X	X	X		X		X	X	X	X		
Methyl Ethyl Ketone			X		X							X		
Methyl Iodide										X				
Methyl Methacrylate										X				
Methyl Silicate										X		X		
Methylene Chloride		X	X	X	X					X		X		
Molybdenum	X									X	X			
Morpholine														
n,n-Dimethyl Acetamide or Dimethyl Acetamide			X				X							
n,n-Dimethylformamide		X					X			X		X		
n-Butyl Acetate							X							
Naphtalene										X	X			
n- Heptane										X				
Nitric Acid	X	X	X		X		X		X	X		X	X	
Nitromethane				X										
Oxalic Acid	X								X	X				
Pentane (all isomers)				X						X		X		
Phenol		X												
Phosphoric Acid	X						X			X	X			
Phosphorus											X			
Potassium Hydroxide		X							X	X		X		X
p-Phenylenediamine							X							

Chemical Name	***Key Facility***													
	CMR	***HRL – Biosciences***	***High Explosives Processing***	***High Explosives Testing***	***LANSCE***	***Machine Shops***	***Materials Science Lab***	***Pajarito Site***	***Pu Facility Complex***	***Radio-chemistry Site***	***Sigma Complex***	***Target Fabrication Facility***	***Tritium Operations***	***Waste Management Operations***
Propane	X			X	X	X		X	X	X			X	X
Propionic Acid										X				
Propyl Alcohol			X											
Pyridine										X				X
Rhodium Metal	X													
Selenium Compounds				X										
Silver	X													
Sulfur Hexafluoride			X											
Sulfuric Acid	X	X		X	X					X	X	X		X
Tert-Butyl Alcohol	X				X							X		
Tetrahydrofuran			X		X		X			X		X		X
Tin numerous forms					X									
Toluene	X		X							X		X		
Tributyl Phosphate									X					
Trichloroacetic Acid		X												
Tungsten as W insoluble compounds										X		X		
Uranium											X			
Vanadium					X									
VM&P Naphtha										X				
Zinc Chloride Fume								X						
Zinc Oxide Fume					X		X							

CMR = Chemistry and Metallurgy Research Building, HRL = Health Research Laboratory, LANSCE = Los Alamos Neutron Science Center, Pu = plutonium.

[a] These chemicals are representative of those purchased at LANL. Additional chemicals listed in the New Mexico permit regulations on toxic air pollutants and emission (NMAC 20.2.72.502), listed in the EPA list of hazardous air pollutants, and other chemicals could be used and potentially emitted from activities at LANL as needed.

Source: LANL 2006.

Carcinogens

The guideline values used in the *1999 SWEIS* analysis to estimate potential impacts of carcinogenic toxic air pollutants from LANL operations were based on an incremental cancer risk of one in a million (1.0×10^{-6}) (in other words, one person in a population of a million would develop cancer if this population was exposed to this concentration over a lifetime), a level of concern established in the Clean Air Act. This value was used in the screening for the estimated combined incremental cancer risk associated with all of the carcinogenic pollutants emitted from LANL facilities at any location. For the purpose of screening individual carcinogens, a cancer risk of one in one hundred million (1.0×10^{-8}) was established as the guideline value.

B.1.2 Receptors and Receptor Sets

For the purpose of evaluating the impact of criteria pollutant emissions, the analysis prepared for the LANL operating permit was used (LANL 2003). In this analysis, two sets of receptors (locations where air quality levels were estimated) were considered: 1) a regular Cartesian grid with 329 feet (100-meter) grid spacing, and 2) a discrete Cartesian grid that followed actual fence lines, property boundaries, and roads of interest. The discrete Cartesian grid distance was less than 164 feet (50 meters) between receptor points. The regular Cartesian grid was created large enough to show the full extent of the areas of significant impact and the grid spacing was fine enough that it could serve as the receptor grid for the refined analysis (LANL 2003).

For the purpose of evaluating the impact of criteria pollutant emissions from construction activities for various projects, a discrete Cartesian grid that followed the fence line, property boundary, and public roads of interest was used, plus a regular Cartesian grid with a 1,600-foot (500-meter) spacing to 6,600 feet (2 kilometers) from the boundary and a 3,300-foot (1,000-meter) spacing beyond 6,600 feet (2 kilometers).

For the purpose of the air pollutant analysis in the *1999 SWEIS*, two sets of receptor locations were used: (1) locations representing actual locations of human activity, and (2) fence line locations to which the public has access (DOE 1999).

The potential impacts of air pollutants on workers employed at LANL facilities were not considered as part of the analysis in the *1999 SWEIS*. Different regulations apply to an occupational setting, and the controlled nature of the work, along with surveillance systems associated with those controls, restricts routine exposures for workers. The analysis focused on exposure to the public and was based on a methodology that initially assumed that chemicals that were purchased were entirely available for release to the atmosphere outside the facility in which the chemicals were used.

Air quality standards have been established by the State of New Mexico and the EPA for criteria pollutants for both short-term (1-hour, 3-hour, 8-hour, and 24-hour) and long-term (30-day, quarterly, and annual) time periods. In addition, guideline values were developed for other air pollutants for both short-term (8-hour) and long-term (annual) time periods. Using these standards and guideline values, the potential impacts of the pollutant emissions from LANL operations on these receptor sets were analyzed as discussed in the following paragraphs.

Criteria Pollutants

Short-term and long-term impacts for carbon monoxide, nitrogen dioxide, sulfur dioxide, total suspended particulates, and PM_{10} were estimated at the receptor locations, and the results were compared with applicable air quality standards. Both time frames were analyzed to address the potential short-term (acute) and long-term (chronic) impacts of these pollutants at locations where the public could have both short-term and long-term exposure to emissions from LANL facilities. Hydrogen sulfide and total reduced sulfur emissions are associated mostly with oil and gas industry; therefore, analysis for these pollutants was not necessary at LANL.

Other Air Pollutants

Noncarcinogens. The potential short-term (acute) and long-term (chronic) impacts of these pollutants at locations where the public could have both short-term and long-term exposure to emissions from LANL facilities were considered.

Short-term impacts were analyzed for fence line receptors. Long-term impacts were not considered at these receptor locations because, although it is possible that the public could have access to fence line areas for short periods of time, these locations would not be inhabited or visited on a regular (long-term) basis.

Carcinogens. The annual impacts from the emissions of carcinogenic air pollutants were analyzed for sensitive receptors. Although guideline values for short-term exposure were used in the screening steps, the more meaningful comparisons were to long-term guideline values for sensitive receptors.

B.1.3 Air Quality Dispersion

Models

The EPA's Industrial Source Complex Air Quality Dispersion Model (ISCST3) was used for the nonradiological air pollutant analyses in this SWEIS and the *1999 SWEIS*. ISCST3 is a versatile model that is often used to predict pollutant concentrations from continuous point, area, volume, and open disposal cell sources (EPA 1995, 2002). This versatile model is often used because of the many features that enable the user to estimate concentrations from nearly any type of source emitting nonreactive pollutants.

EPA's PUFF computer model was used for a screening level analysis of emissions from LANL's High Explosive Firing Sites at TA-14, TA-15, TA-36, TA-39, and TA-40. The PUFF model was designed to estimate downwind concentrations from instantaneous releases of pollutants (DOE 1999). The HOTSPOT computer code was used in combination with the ISCST3 computer model for a detailed analysis of emissions from the high explosive firing sites in order to provide a more readily usable input data file than that provided by PUFF for the health effects analysis in the *1999 SWEIS*. The HOTSPOT code was designed for detonation of high explosives, and was used specifically to provide input data to the ISCST3 model (DOE 1999).

B.2 Criteria Pollutants – General Approach

The combustion sources that were evaluated in the facility-wide analysis of criteria pollutants included each permitted emission source, and, for completeness, two of the largest insignificant sources[1]. These sources included boilers, TA-3 and TA-15 carpenter shops, TA-33 generators, TA-52 paper shredder, TA-60 asphalt plant, TA-3 power plant, TA-21 rock crusher, TA-21 steam plant, boilers at TA-9 and TA-35, and air curtain destructors. An atmospheric dispersion modeling analysis was conducted to estimate the combined potential air quality impacts of the emissions from each of these emission sources (DOE 1999).

No quantitative analysis of vehicular-related emissions was performed as part of the analysis for the *1999 SWEIS,* but these emissions were assumed to be included in the background (DOE 1999). The alternatives considered in this SWEIS may have different effects on the travel patterns in the study area as a result of changes in the number of LANL employees and the future population of Los Alamos. Therefore, changes in regional emissions from traffic were considered for each alternative.

B.2.1 Criteria Pollutants – Methodology

The analysis of combustion-related pollutants used standard analytical modeling techniques based on atmospheric dispersion modeling and emissions estimated under the peak and actual annual average operating conditions of each major combustion unit. Estimates of emission rates were based on the potential emissions from each source. For the purpose of the site-wide analysis, it was assumed that all three TA-3 boilers were operating at full capacity, using the fuel with highest air emissions. This approach was taken to obtain a conservative and complete modeling analysis of these emission sources. Emission rates used in the modeling are presented in **Table B–3**. Other details of the modeling are summarized in the *Facility-Wide Air Quality Impact Analysis* report (LANL 2003). With respect to emission rates from the combustion sources, the analysis bounds the air quality impacts from all the alternatives because the analysis is based on the maximum potential emission from the sources.

B.2.2 Results of Criteria Pollutant Analysis

The results of the analysis of criteria pollutants from LANL's combustion sources are presented in Chapter 5, Table 5–8 of this SWEIS. As shown, the highest estimated concentration of each pollutant would be below the appropriate ambient air quality standard. None of the alternatives considered in this SWEIS, therefore, would exceed the applicable ambient air quality standards, and impacts on the public would be minor.

---

[1] *Stationery sources that emit criteria pollutants in quantities smaller than those requiring inclusion in the Title V operating permit are called insignificant sources. The analysis included two of the largest of these insignificant sources.*

Table B–3 Criteria Pollutant Emissions Summary [a] (grams per second)

Source	**Nitrogen Oxides**	**Sulfur Oxides**	**Carbon Monoxide**	**Total Suspended Particulates**	**PM_{10}**
TA-3 Power Plant, Stack 1 (2 boilers)	2.495	17.312	1.865	0.68	0.68
TA-3 Power Plant, Stack 2 (1 boiler)	1.247	8.656	0.932	0.34	0.34
TA-33 Diesel Generator	5.078	0.693	4.246	0.176	0.176
TA-21-357 Boilers (3)	0.563	1.38	0.315	0.093	0.093
TA-60 Asphalt Plant	0.252	0.046	4.032	0.097	0.097
TA-59-1 Boilers (2)	0.131	0.001	0.11	0.01	0.01
TA-55-6 Boilers (2)	0.303	0.002	0.255	0.023	0.023
TA-53-365 Boilers (2)	0.174	0.001	0.146	0.013	0.013
TA-50-2 Boiler	0.131	0.001	0.011	0.01	0.01
TA-48-1 Boilers (3)	0.218	0.001	0.183	0.017	0.017
TA-16-1484 Boilers (2)	0.058	0.001	0.13	0.012	0.012
TA-16-1485 Boilers (2)	0.071	0.001	0.161	0.015	0.015
TA-3-38 Carpenter Shop	0.0	0.0	0.0	0.178	0.178
TA-15-563 Carpenter Shop	0.0	0.0	0.0	0.163	0.163
TA-52-11 Paper Shredder	0.0	0.0	0.0	0.374	0.374

TA = technical area, PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

[a] Emissions represent the values modeled in the *Facility-Wide Air Quality Impact Analysis*. Not included in this table are the results of the analysis for air curtain destructors and a rock crusher that are no longer operated by LANL. About half of the boilers shown are actually backup boilers and would not be operated at the same time as the primary boiler at a facility, but were included for the purpose of bounding the potential impacts considered in the Title V permit.

Source: LANL 2003.

B.3 Other Air Pollutants – General Approach

The approach used to evaluate chemical air pollutants in the *1999 SWEIS* was based on the use of screening level emission values to identify chemicals that would be evaluated in more detail. Screening level emission values were conservatively estimated hypothetical emission rates for each of the air pollutants that could potentially be emitted from each of LANL's TAs and that would not result in air quality levels harmful to human health under current or future conditions. These screening level emission values were compared with conservatively estimated pollutant emission rates on a TA-by-TA basis to determine potential air quality impacts of air pollutants from LANL operations. This process consisted of the following steps:

- From over 2,000 chemical compounds listed as being used at LANL, 382 air pollutants (including 51 carcinogens) were selected for consideration based on chemical properties, volatility, and toxicity.

- A methodology based on screening level emission values was used to estimate the potential worst-case impacts of the air pollutants. Screening level emission values for each chemical for each TA were compared with emission rates conservatively estimated from chemical use rates. If a conservatively estimated emission rate for a given pollutant from a given TA was less than the screening level emission value, that pollutant emission source was deemed not to have the potential to cause significant air quality impacts, and, as such, no detailed analysis was required. If the screening level emission value was less than the estimated emission rate for a given pollutant from a given TA, a more detailed analysis was conducted.

- An additive impact analysis was conducted to estimate the potential total impact from the emissions of each pollutant from more than one TA and the total incremental cancer risk from all of the carcinogenic pollutants combined at any of the sensitive receptor locations considered.

The methodology used in the analysis followed modeling guidelines for toxic pollutants established by the EPA in that it first used screening level evaluations based on conservative assumptions and resulting in maximum potential impacts, followed by more detailed analyses based on more realistic assumptions. The overall procedure used for the air quality assessment, including the development of screening level emission values, is summarized in the *1999 SWEIS* (DOE 1999).

B.3.1 Other Pollutants – Methodology for Individual Pollutants

Screening Level Analysis

The following sections provide more detail on the methodology used for screening and detailed analysis for air pollutants from chemical use in the *1999 SWEIS* (DOE 1999).

Once screening level emission values (both short-term and long-term) were established for each of the air pollutants on a TA-specific basis, a comparison was made between these values and conservatively estimated emission rates. A ratio was developed for each chemical by dividing the screening level emission value by the estimated emission rate (SLEV/Q).

These results, in the form of worksheets, were presented to knowledgeable site personnel who were aware of the activities and processes occurring at each TA, as well as those that might occur in the future. To streamline the process, the relationship between screening level emission values and the estimated emission rates for each TA were presented in two data sets.

The first data set included those chemicals having SLEV/Q ratios greater than 100. For each of these chemicals, a determination was made as to whether the use of that chemical would increase by more than 100 times under future operation(s) of LANL under any of the alternatives considered in this SWEIS. Essentially, this meant that for each TA a determination had to be made as to whether the use of a chemical would increase over current use rates by a factor of 100. If a determination could be made that the future use of that chemical would not increase by this factor, no further evaluation of that chemical was required. If such a determination was not possible, a more detailed analysis was conducted.

The second data set included all chemicals having a SLEV/Q ratio less than 100, and all chemicals having an SLEV/Q ratio greater than 1 but less than 100, and all chemicals having a ratio less than 1. For each chemical having a ratio greater than 1 but less than 100, an evaluation was made as to whether the estimated emissions under any of the future alternatives would exceed the screening level emission values. Essentially, this meant that for each TA a determination had to be made as to whether the use of that chemical would increase over current rates by a factor greater than the SLEV/Q ratio. If a determination could be made that the future use of that chemical would not increase by this factor, no further evaluation of that chemical was required. If such a determination was not possible, a more detailed analysis was conducted. For those chemicals having an SLEV/Q ratio less than 1 (in other words, screening level emission values were potentially being exceeded under current conditions), more detailed analyses were conducted.

Two exceptions to the methodology described above were made. Information on the TAs for high explosive operations were derived using a model more appropriate for screening short-term exposure concentrations under those conditions. The second exception involved screening the emissions of chemicals from the Bioscience Facilities (formerly the Health Research Laboratory Complex) at TA-43. Because of the proximity of the Bioscience Facilities to actual receptors, all analyses for carcinogens, as well as noncarcinogens, were performed for actual receptors rather than fence line receptors.

Detailed Analysis

The detailed air quality analysis consisted of one or both of the following steps:

- Development of emission rates and source term parameters using actual process knowledge, and
- Dispersion modeling using actual stack parameters and receptor locations.

Two consequences may result from detailed analysis of each chemical from each TA: (1) either there is no potential to exceed a guideline value (in which case no additional analyses were required), or (2) there is a potential to exceed a guideline value (in which case additional analyses were required). A pollutant having the potential to exceed a guideline value was subject to evaluation in the health and ecological risk assessment process.

B.3.2 Other Pollutants – Results of Individual Pollutants Analysis

Screening Level

The first data set considered those chemicals having SLEV/Q ratios greater than 100. For more than 90 percent of the air pollutants from chemical use, a determination was made that the use of these chemicals would not increase by more than 100 times under any of the SWEIS alternatives. The second data set included chemicals having SLEV/Q ratios greater than 1 but less than 100, and ratios less than 1. A determination was made as to whether the use of that chemical would increase over current use rates by a factor greater than the SLEV/Q ratio. The list of carcinogens also was reduced from 51 to 35 because some of the chemicals are no longer used and were not projected for future use. Based on worksheets for the chemicals in the data sets, and information on potential future use, operations at 13 locations were identified with the potential to exceed a guideline value, and more detailed analyses were conducted.

Emissions from two sources were referred to the health and ecological risk analysis process. The analysis for TA-43 showed the potential to exceed the guideline values for four chemical carcinogens from the Bioscience Facilities: chloroform, trichloroethylene, formaldehyde, and acrylamide.

The detailed analysis for the High Explosive Firing Sites indicated that the same chemicals that had the potential to exceed a guideline value in the previous screening step would also have the potential to exceed their respective guideline values using somewhat different parameters and a different model than that used in the screening analysis. The HOTSPOT 8.0 and ISCST3 models were used in the detailed analysis in order to provide output data in a form more readily usable for the health risk analysis. Additional information on the following chemicals was referred to the health and ecological risk assessment process for the *1999 SWEIS*:

- Depleted uranium, beryllium, and lead from TA-15;
- Depleted uranium, beryllium, and lead from TA-36;
- Beryllium and lead from TA-39; and
- Depleted uranium and lead from TA-14.

The health risk analysis calculated Hazard Indices for two of the three metals. A Hazard Index equal to or greater than 1 is considered consequential from a human toxicity standpoint. The Expanded Operations Alternative in the *1999 SWEIS* is comparable to the No Action Alternative in this SWEIS. For the Expanded Operations Alternative, the worst-case Hazard Index for lead did not exceed 0.000015, and, for depleted uranium, the worst-case Hazard Index did not exceed 0.000065. Beryllium has no established EPA reference dose from which to calculate the Hazard Index. However it was evaluated as a carcinogen. The estimate of excess latent cancer fatalities for beryllium under the Expanded Operations Alternative in the *1999 SWEIS* was 1 chance in 2.7 million (3.6×10^{-7}) per year (DOE 1999).

B.3.3 Other Pollutants – Methodology for Combined Impacts Analyses

The following analyses were conducted for the *1999 SWEIS* to ensure that the combined effects from the releases of all of the chemicals from all the TAs would not exceed the guideline values.

Noncarcinogens

An analysis of potential short-term impacts at a TA's fence line receptor location showed that the 8-hour impacts from the releases of that TA were greater (more than two orders of magnitude) than the impacts from the releases of a nearby TA. This is because the TAs are relatively far apart compared to the distances between the emission sources of a TA and its fence line receptors. Therefore, it is unlikely that the additive short-term impacts of noncarcinogenic pollutants at the fence line receptors of a TA would be significantly different from the maximum concentrations previously estimated for that TA.

An analysis of annual potential impacts at sensitive receptor locations showed that these impacts were significantly less (less than two orders of magnitude) relative to the appropriate guideline values than the corresponding short-term impacts at the fence line receptors. Therefore, it would be unlikely that the additive annual impacts of the noncarcinogenic pollutants at the sensitive receptor locations would be significant.

Carcinogens

Two different versions of additive impacts for carcinogens were presented. Both versions considered impacts at sensitive receptor locations based on annual ambient concentrations of pollutants. Short-term additive impacts for carcinogens at fence line receptor locations were not considered (for the same reasons as for noncarcinogens). However, long-term impacts at sensitive receptor locations were considered because EPA considers in their standard setting process that risk from carcinogens can be additive for all carcinogenic chemicals.

The first version considered whether emissions of the same chemical from all TAs (whether or not it was actually used at that TA), at the screening level emission value rate (whether or not that maximum rate was actually projected at that TA), would exceed the total guideline risk value of 1×10^{-6}. The risk due to exposure at the maximum concentration over a lifetime for any receptor for each of the TAs was added to the separately calculated maximum concentration for any receptor for each of the other TAs, regardless of whether the same receptor was indicated.

The second version modeled simultaneous emissions of the same chemical at actual projected rates for each of the TAs, and recorded the maximum concentration at any receptor location. The risk due to exposure at that concentration over a lifetime was then added to the risks calculated in a similar fashion for each of the other chemicals. Risks were added regardless of whether the same receptor was involved. That total risk was also compared to the guideline risk value of 1×10^{-6} of any excess cancer from a lifetime of exposure.

B.3.4 Other Pollutants – Results of Combined Impact Analysis

Releases of Each Carcinogenic Pollutant from All TAs

The estimated combined cancer risk associated with releases of each of these pollutants from all TAs was 1.23 in ten million (1.23×10^{-7}), which was below the guideline value of one in a million (1.0×10^{-6}). As such, no potentially significant air quality impacts were estimated.

Releases of All Carcinogenic Pollutants from All TAs

Results of this analysis indicated that the potential combined incremental cancer risk associated with releases of all carcinogenic pollutants from all TAs would be slightly above the guideline value of one in a million (1.0×10^{-6}).

The major contributors to the estimated combined cancer risk values were chloroform, formaldehyde, and trichloroethylene from the Bioscience Facilities at TA-43, and multiple sources for methylene chloride. Of these, the relative contribution of chloroform emissions alone to the combined cancer risk value was more than 87 percent. The impacts of TA-43 emissions were due to a combination of relatively high emission rates, close proximity between receptors and sources, and the elevation of the receptors. A more detailed analysis that considered the impact at each specific receptor location was conducted. This more refined analysis estimated the combined cancer risk at each of the 180 sensitive receptor locations. The health risk analysis concluded that the combined cancer risk at the two receptor locations at the Los Alamos Medical Center was 0.73 to 0.74 in a million (7.3 to 7.4×10^{-7}). This value was below the guideline value for human health consequences from carcinogenic air emissions (DOE 1999).

B.4 References

DOE (U.S. Department of Energy), 1999, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

EPA (U.S. Environmental Protection Agency), 1995, *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Vol. 1, User Instructions*, EPA-454/B-95-003a, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, September.

EPA (U.S. Environmental Protection Agency), 2002, *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Vol. 1, User Instructions*, Addendum, EPA-454/B-95-003a, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, February.

LANL (Los Alamos National Laboratory), 2003, *Facility-Wide Air Quality Impact Analysis*, LA-UR-03-3983, RRES-MAQ, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2004a, *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement (DOE/EIS-0238)*, LA-UR-04-5631, Ecology Group, Los Alamos, New Mexico, August 17.

LANL (Los Alamos National Laboratory), 2004b, *SWEIS Yearbook—2003, Comparison of 2003 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-04-6024, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006, *SWEIS Yearbook—2005, Comparison of 2005 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-06-6020, Risk Reduction Office, Environmental Protection Division, Los Alamos, New Mexico, September.

NMED (New Mexico Environment Department), 2003, *Dispersion Modeling Guidelines*, Air Quality Bureau, Santa Fe, New Mexico, July.

APPENDIX C

EVALUATION OF HUMAN HEALTH IMPACTS FROM NORMAL OPERATIONS

APPENDIX C
EVALUATION OF HUMAN HEALTH IMPACTS FROM NORMAL OPERATIONS

This appendix provides a brief general discussion of radiation and its effects on human health, as well as the methods and assumptions used for estimating the potential impacts and risks to individuals, workers, and the general public from exposure to releases of radioactivity and hazardous chemicals during normal operations at Los Alamos National Laboratory (LANL). It also discusses methods used to safely control biological material during research activities.

This appendix addresses the methods used to assess human health impacts from normal operations at LANL. To do so, it considers: (1) radionuclides potentially released into the air from Key Facilities as a function of the three alternatives considered in this site-wide environmental impact statement (SWEIS); and (2) radionuclides and chemicals that may be present in environmental pathways (such as ground and surface water and game animals) in and around the LANL environs. In addition, background information is presented regarding the effects on human health from exposure to radiation, biological agents, and hazardous chemicals. Both the methods used to assess impacts and the impacts themselves from the proposed projects that may be implemented at LANL as part of the Expanded Operations Alternative are addressed elsewhere in this SWEIS (see Appendices G, H, I, and J).

The release of pollutants to ambient air is the focus in these analyses because they are projected to dominate possible exposures to the public as a result of future LANL operations. Other releases such as those through outfalls into surface water bodies are not expected to be dominant contributors to future exposures because of the significant reduction in the use of outfalls and the extensive implementation of environmental controls such as those of the National Pollutant Discharge Elimination System. Past releases, however, have resulted in some radiological and chemical contamination in several environmental media, and impacts from this contamination are addressed in this appendix. This approach for evaluating human health impacts from normal operations is consistent with the approach used for the 1999 *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS).*

C.1 Impacts on Human Health from Radiological Exposure

Radiation exposure and its consequences are of interest to the public. For this reason, this section provides information on the nature of radiation, emphasizes the consequences of exposure to radiation, and explains the basic concepts used to evaluate radiation health effects.

C.1.1 About Radiation and Radioactivity

C.1.1.1 What Is Radiation?

Radiation is energy transferred in the form of particles or waves. Globally, human beings are exposed constantly to radiation from the solar system and the Earth's rocks and soil. This radiation contributes to the natural background radiation that always surrounds us. Manmade sources of radiation also exist, including medical and dental x-rays, household smoke detectors, and materials released from nuclear and coal-fired power plants.

All matter in the universe is composed of atoms. Radiation comes from the activity of tiny particles within an atom. An atom consists of a positively charged nucleus (central part of an atom) with a number of negatively charged electron particles in various orbits around the nucleus. There are two types of particles in the nucleus: neutrons that are electrically neutral and protons that are positively charged. All atoms of a given chemical element have the same number of protons in their nuclei. There are more than 100 natural and manmade elements. Atoms that have the same number of protons in their nuclei, but different numbers of neutrons, are called isotopes of an element. Elements may have one or more stable isotopes and others that are unstable (decay with time).

Unstable isotopes undergo spontaneous change known as radioactive disintegration or radioactive transformation. The process of continuously undergoing spontaneous transformation is called radioactivity. The radioactivity (number of transformations per second) of a given amount of material decreases with time. Each radioactive isotope is distinguished by the time it takes for a given quantity of the material to lose half of its original radioactivity. This time is its half-life, and is characteristic of the isotope. For example, an isotope with a half-life of 8 days will lose one-half of its radioactivity in that amount of time. In 8 more days, the radioactivity will again decrease by half, to one-fourth of the original value. The half-lives of various radioactive elements can vary from millionths of a second to millions of years.

As unstable isotopes change into more stable forms, they emit electrically-charged particles. The particle may be either an alpha particle (a helium nucleus) or a beta particle (an electron) and have various levels of kinetic energy. Sometimes these particles are emitted in conjunction with gamma rays. The alpha and beta particles and gamma rays are frequently referred to as “ionizing radiation”, a term that reflects the fact that the charged particle or gamma ray can strip or displace electrons away from atoms of matter through which they pass, leaving those atoms with an electrical charge. The ionization caused by radiation can change the chemical composition of many substances, including living tissue, which can affect the way they function.

Ionizing radiation is used in a variety of ways, many of which are familiar to us in our everyday lives. The machines used by doctors to diagnose and treat medical patients typically use x-rays, which are a form of ionizing radiation. The process by which a television displays a picture is by ionizing coatings on the inside of the screen with electrons. Most home smoke detectors use a small source of ionizing radiation to detect smoke particles in room air.

When a radioactive isotope of an element emits a particle, it changes to an entirely different element, one that may or may not be radioactive. Eventually, a stable element is formed. This transformation, which may take several steps, is known as a decay chain. For example, radium, which is a member of the radioactive decay chain of uranium, has a half-life of 1,622 years. It emits an alpha particle and becomes radon, a radioactive gas with a half-life of only 3.8 days. Radon decays first to polonium, then through a series of further decay steps to bismuth, and ultimately to a stable isotope of lead. Meanwhile, the decay products will build up and eventually disappear as time progresses.

The characteristics of various forms of ionizing radiation are briefly described below and in the box to the right.

Alpha (α)—Alpha particles are the heaviest type of ionizing radiation. They can travel only a few centimeters in air. Alpha particles lose their energy almost as soon as they collide with anything. They can be stopped easily by a sheet of paper or by the surface of one's skin.

Radiation Type	*Typical Travel Distance in Air*	*Barrier*
α	Few inches	Sheet of paper or skin's surface
β	Few feet	Thin sheet of aluminum foil or glass
γ	Very large	Thick wall of concrete, lead, or steel
n	Very large	Water, paraffin, graphite

Beta (β)—Beta particles are much (7,330 times) lighter than alpha particles. They can travel a longer distance than alpha particles in the air. A high-energy beta particle can travel a few feet in the air. Beta particles can pass through a sheet of paper, but can be stopped by a thin sheet of aluminum or glass.

Gamma (γ)—Gamma rays (and x-rays), unlike alpha or beta particles, are waves of pure energy. Gamma rays travel at the speed of light. Gamma radiation is very penetrating and requires concrete, lead, or steel shielding to stop it.

Neutrons (n)—The most prolific source of neutrons is a nuclear reactor. Neutrons produce ionizing radiation indirectly by collision with hydrogen nuclei (protons) and when gamma rays and alpha particles are emitted following neutron capture in matter. A neutron has about one-quarter the weight of an alpha particle. It will travel in the air until it is absorbed in another nucleus.

C.1.1.2 Units of Radiation Measure

During the early days of radiological experience, there was no precise unit of radiation measurement. Therefore, a variety of units was used to measure the amount, type, and intensity of radiation. Just as heat can be measured in terms of its intensity or effects using units of calories or degrees, amounts of radiation or its effects can be measured in units of curies, radiation absorbed dose (rad), or dose equivalent (roentgen equivalent man, or rem). The following summarizes these units.

Curie—The curie, named after the French scientists Marie and Pierre Curie, describes the "intensity" (activity) of a sample of radioactive material. The rate of decay of 1 gram of radium was the basis for this unit of measure. Because the measured decay rate kept changing slightly as measurement techniques became more accurate, the curie was subsequently defined as exactly 3.7×10^{10} disintegrations (decays) per second.

Radiation Units and Conversions to International System of Units	
1 curie	= 3.7×10^{10} disintegrations per second
	= 3.7×10^{10} becquerels
1 becquerel	= 1 disintegration per second
1 rad	= 0.01 gray
1 rem	= 0.01 sievert
1 gray	= 1 joule per kilogram

Rad—The rad is used to measure the physical absorption of radiation. The total energy absorbed per unit quantity of tissue is referred to as absorbed dose (or simply dose). As sunlight heats pavement by giving up energy to it, radiation similarly gives up energy to objects in its path. One rad is equal to the amount of radiation that leads to the deposition of 0.01 joule of energy per kilogram of absorbing material.

Rem (roentgen equivalent man)—A rem is a measurement of the dose equivalent from radiation based on its biological effects. The rem is used to measure the effects of radiation on the body as degrees centigrade are used to measure the effects of sunlight heating pavement. Thus, 1 rem of one type of radiation is presumed to have the same biological effects as 1 rem of any other kind of radiation. This allows comparison of the biological effects of radionuclides that emit different types of radiation.

The units of radiation measurement in the International System of Units are becquerels (a measure of source intensity [activity]), grays (a measure of absorbed dose), and sieverts (a measure of dose equivalent).

An individual may be exposed to ionizing radiation externally (from a radioactive source outside the body) or internally (from ingesting or inhaling radioactive material). The external dose is different from the internal dose because an external dose is delivered only during the actual time of exposure to the external radiation source, while an internal dose continues to be delivered as long as the radioactive source is in the body. The dose from internal exposure is calculated over 50 years following the initial exposure. Both radioactive decay and elimination of the radionuclide by ordinary metabolic processes decrease the dose rate with the passage of time.

C.1.1.3 Sources of Radiation

The average American receives a total of approximately 360 millirem per year from all sources of radiation, both natural and manmade, of which approximately 300 millirem per year are from natural sources. A person living in Los Alamos receives an average background dose between 300 and 500 millirem, depending on where they live (LANL 2004d). The sources of radiation can be divided into six different categories: cosmic radiation, terrestrial radiation, internal radiation, consumer products, medical diagnosis and therapy, and other sources (NCRP 1987). These categories are discussed in the following paragraphs.

Cosmic Radiation—Cosmic radiation is ionizing radiation resulting from energetic charged particles from space continuously hitting the Earth's atmosphere. Cosmic radiation comprises these particles and the secondary particles and photons they create. Because the atmosphere provides some shielding against cosmic radiation, the intensity of this radiation increases with the altitude above sea level. The average dose to people in the United States from this source is approximately 27 millirem per year. Doses from cosmic radiation range from 50 millirem per year at lower elevations near the Rio Grande River to about 90 millirem per year in the mountains near Los Alamos (LANL 2004d).

External Terrestrial Radiation—External terrestrial radiation is the radiation emitted from the radioactive materials in the Earth's rocks and soils. The average dose from external terrestrial radiation is approximately 28 millirem per year. Doses from terrestrial radiation in Los Alamos range from about 50 to 150 millirem a year, depending on the amounts of natural uranium, thorium, and potassium in the soil (LANL 2004d).

Internal Radiation—Internal radiation results from radioactive material that has entered the body by inhalation or ingestion and is retained by the affected organs or tissues. Natural radionuclides in the body include isotopes of uranium, thorium, radium, radon, polonium, bismuth, potassium, rubidium, and carbon. The major contributors to the annual dose equivalent for internal radioactivity are the short-lived decay products of radon, which contribute approximately 200 millirem per year. The average dose from other internal radionuclides is approximately 40 millirem per year.

Consumer Products—Consumer products also contain sources of ionizing radiation. In some products, such as smoke detectors and airport x-ray machines, the radiation source is essential to the product's operation. In other products, such as televisions and tobacco, the radiation source is a byproduct of the product's function. The average dose from consumer products is approximately 10 millirem per year.

Medical Diagnosis and Therapy—Radiation is an important diagnostic medical tool and cancer treatment. Diagnostic x-rays result in an average exposure of 50 millirem per year. Nuclear medical procedures result in an average exposure of 14 millirem per year.

Radiation Source	***Average Annual Dose (millirem)***
Cosmic	50-90
External Terrestrial	50-150
Internal	240
Consumer Products	10
Medical Diagnostic and Treatment	50
Other	1 +

Other Sources—There are a few additional sources of radiation that contribute minor doses to individuals in the United States. The dose from nuclear fuel cycle facilities (for example, uranium mines, mills, and fuel processing plants) and nuclear power plants has been estimated to be less than 1 millirem per year. Radioactive fallout from atmospheric atomic bomb tests, emissions from certain mineral extraction facilities, and transportation of radioactive materials contribute less than 1 millirem per year to the average dose to an individual. Air travel contributes approximately 1 millirem per year to the average dose.

C.1.1.4 Exposure Pathways

As stated earlier, an individual may be exposed to ionizing radiation both externally and internally. The different ways that an individual can be exposed to radiation are called exposure pathways. Each type of exposure is discussed separately in the following paragraphs.

External Exposure—External exposure can result from a number of different pathways where the exposure is external to the body. These pathways include exposure to a cloud of radiation passing over the receptor (an exposed individual), standing on ground that is contaminated with radioactivity, and swimming or boating in contaminated water. If the receptor leaves the source of radiation exposure, the dose rate will be reduced. It is assumed that external exposure occurs uniformly during the year. The appropriate dose measure is called the effective dose equivalent.

Internal Exposure—Internal exposure results from a radiation source entering the human body through either inhalation of contaminated air or ingestion of contaminated food or water. In contrast to external exposure, once a radiation source enters the body, it remains there for a period of time that varies depending on its physical decay and biological half-life. The absorbed dose to each organ of the body is calculated for a period of 50 years following the intake. The calculated absorbed dose is called the committed dose equivalent. Various organs have different susceptibilities to damage from radiation. The committed effective dose equivalent takes these different susceptibilities into account and provides a broad indicator of risk to the health of an individual from radiation. The committed effective dose equivalent is a weighted sum of the committed dose equivalent in each major organ or tissue. The concept of committed effective dose equivalent applies only to internal pathways.

C.1.1.5 Limits of Radiation Exposure

Limits of exposure to members of the public and radiation workers are derived from International Commission on Radiological Protection recommendations. The U.S. Environmental Protection Agency (EPA) uses the National Council on Radiation Protection and Measurements and the International Commission on Radiological Protection recommendations to set specific annual exposure limits (usually less than those specified by the Commission) in *Radiation Protection Guidance to Federal Agencies* documents. Each regulatory organization then establishes its own set of radiation standards. The various exposure limits set by the U.S. Department of Energy (DOE) and EPA for radiation workers and members of the public are given in **Table C–1**.

Table C–1 Exposure Limits for Members of the Public and Radiation Workers

Guidance Criteria (Organization)	*Public Exposure Limits at the Site Boundary*	*Worker Exposure Limits*
10 CFR Part 835 (DOE)	Not applicable	5,000 millirem per year [a]
DOE Order 5400.5 (DOE) [b]	10 millirem per year (all air pathways) 4 millirem per year (drinking water pathway) 100 millirem per year (all pathways)	Not applicable
40 CFR Part 61 (EPA)	10 millirem per year (all air pathways)	Not applicable
40 CFR Part 141 (EPA)	4 millirem per year (drinking water pathways)	Not applicable

CFR = *Code of Federal Regulations*, EPA = U.S. Environmental Protection Agency.

[a] Although this limit (or level) is enforced by DOE, worker doses must be managed in accordance with as low as reasonably achievable (ALARA) principles. An annual limit of 2,000 millirem per year was established by DOE to assist in achieving its goal to maintain radiological doses at ALARA levels (DOE 1999b).

[b] Derived from 40 CFR Part 61, 40 CFR Part 141, and 10 CFR Part 20.

C.1.2 Health Effects

To provide a background for discussing impacts, this section explains the basic concepts used to evaluate radiation effects.

Radiation can cause a variety of damaging health effects in people. The most significant effects are induced cancer fatalities. These effects are referred to as “latent” cancer fatalities because the cancer may take many years to develop. In the discussions that follow, all fatal cancers are considered latent; therefore, the term “latent” is not used.

The National Research Council prepared a series of reports to advise the U.S. Government on the health consequences of radiation exposures. The most recent of these, *Health Effects from Exposure to Low Levels of Ionizing Radiation, BEIR VII-Phase 2* (National Research Council 2005), provides current estimates for excess mortality from leukemia and other cancers that are expected to result from exposure to ionizing radiation. Biological Effects of Ionizing

Radiation (BEIR) VII provides estimates that are not significantly different from those in its predecessor, BEIR V, and recent United Nations Scientific Committee on the Effects of Atomic Radiation and International Commission on Radiological Protection reports. The report, however, concludes that recent data and analyses have reduced the uncertainties associated with the risk estimates. BEIR V developed models in which the excess relative risk was expressed as a function of age at exposure, time after exposure, and sex for each of several cancer categories. The models were based on the assumption that the relative risks are comparable between the atomic bomb survivors and the U.S. population.

The models and risk coefficients in BEIR VII are derived through review of the most current information on the biological mechanisms of radiation tumorigenesis as well as analyses of relevant epidemiologic data that includes the Japanese atomic bomb survivors, medically-exposed persons, and large-scale occupational radiation studies. The BEIR VII Committee concluded that the balance of evidence tends to support a simple proportionate relationship at low doses between radiation dose and risk. This conclusion essentially affirms the Linear-No-Threshold model that has long been the basis for the regulation and control of occupational and environmental radiation exposure in the United States.

The National Council on Radiation Protection and Measurements (NCRP 1993), based on the radiation risk estimates provided in BEIR V and the International Commission on Radiological Protection (ICRP 1991), estimates the total detriment resulting from low dose[1] or low dose rate exposure to ionizing radiation to be 0.00076 per rem for the working population and 0.00083 per rem for the general population. The total detriment includes fatal and nonfatal cancers as well as severe hereditary (genetic) effects. The major contribution to the total detriment is from fatal cancer, estimated to be 0.0006 per rem for both radiation workers and the general population. For comparison, the BEIR VII Committee's preferred estimates of lifetime attributable risk of mortality for all solid cancers and leukemia are 0.00048 for males and 0.00066 for females. The breakdowns of the risk estimators for both workers and the general population are given in **Table C–2**. Nonfatal cancers and genetic effects are less probable consequences of radiation exposure.

Table C–2 Nominal Health Risk Estimators Associated with Exposure to 1 Rem of Ionizing Radiation

Exposed Individual	*Fatal Cancer* [a, c]	*Nonfatal Cancer* [b]	*Genetic Disorders* [b]	*Total*
Worker	0.0006	0.00008	0.00008	0.00076
Public	0.0006	0.0001	0.00013	0.00083

[a] For fatal cancer, the health effect coefficient is the same as the probability coefficient. When applied to an individual, the units are the lifetime probability of a cancer fatality per rem of radiation dose. When applied to a population of individuals, the units are the excess number of fatal cancers per person-rem of radiation dose. These factors are from DOE 2003a.

[b] In determining a means of assessing health effects from radiation exposure, the International Commission on Radiological Protection has developed a weighting method for nonfatal cancers and genetic effects. These factors are from NCRP 1993.

[c] For high individual exposures (greater than or equal to 20 rem), the health factors are multiplied by a factor of 2.

Sources: NCRP 1993, DOE 2003a.

---

[1] *Low dose is defined as the dose level where deoxyribonucleic acid (DNA) repair can occur in a few hours after irradiation-induced damage. Currently, a dose level of about 0.2 grays (20 rad), or a dose rate of 0.1 milligrays (0.01 rad) per minute is considered low enough to allow the DNA to repair itself in a short period (EPA 1994).*

EPA, in coordination with other Federal agencies involved in radiation protection, issued *Federal Radiation Guidance Report No. 13, Cancer Risk Coefficients for Environmental Exposure to Radionuclides*, in September 1999 (EPA 1999). This document is a compilation of risk factors for doses from external gamma radiation and internal intakes of radionuclides. *Federal Radiation Guidance Report No. 13* is the basis for the radionuclide risk coefficients used in the EPA Health Effects Assessment Summary Tables (EPA 2001) and in computer dose codes. The Interagency Steering Committee on Radiation Standards (ISCORS) issued a technical report entitled, *A Method for Estimating Radiation Risk from TEDE* (DOE 2003a). ISCORS technical reports are guidance to Federal agencies to assist them in preparing and reporting the results of analyses and implementing radiation protection standards in a consistent and uniform manner. This report provides dose-to-risk conversion factors where doses are estimated using total effective dose equivalent (TEDE). It is recommended for use by DOE personnel and contractors when computing potential radiation risk from calculated radiation dose for comparison purposes. For situations in which a radiation risk assessment is required for making risk management decisions, however, the radionuclide-specific risk coefficients in Federal Guidance Report No. 13 should be used.

DOE and other agencies regularly conduct dose assessments using models and codes that calculate radiation dose from exposure or intake using dose conversion factors and do not compute risk directly. In those cases where it is necessary or desirable to estimate risk for comparative purposes (for example, comparing the risk associated with alternative actions), it is common practice to simply multiply the calculated TEDE by a risk-to-dose factor. DOE previously recommended a TEDE-to-fatal cancer risk factor of 0.0005 per rem for the public and 0.0004 per rem for working-age populations. ISCORS recommends that agencies use a conversion factor of 0.0006 fatal cancers per TEDE (rem) for mortality and 0.0008 cancers per rem for morbidity when making qualitative or semi-quantitative estimates of risk from radiation exposure to members of the general public[2] (DOE 2003a).

The ISCORS report notes that the recommended risk coefficients used with TEDE dose estimates generally produce conservative radiation risk estimates (they overestimate risk). Regarding the ingestion pathway for the 11 radionuclides included in the report, the risks are overestimated compared to the values in Federal Radiation Guidance Report No. 13 for about 8 radionuclides and significantly overestimated (by up to a factor of 6) for 4 of these. The Office of Environmental Policy and Guidance also compared the TEDE-to-cancer risk conversion factor approach to Federal Radiation Guidance Report No. 13 for the inhalation pathway and found a bias toward overestimating risk, although it was not as severe as for ingestion. For 16 radionuclides and chemical states evaluated, 7 were overestimated (by more than a factor of 2) and 5 were underestimated. The remainder agreed within about a factor of two. Generally, these differences were within the uncertainty of transport and the uptake portions of dose or risk modeling; therefore, the approach recommended is fully acceptable for comparative assessments. It is recommended, however, that the more rigorous approach using Federal Radiation Guidance Report No. 13 cancer risk coefficients be employed wherever possible (DOE 2003a).

Different methods of extrapolation to the low-dose region could yield higher or lower numerical estimates of fatal cancers. Studies of human populations exposed to low doses are inadequate to

---

[2] *Such estimates should not be stated with more than one significant digit.*

demonstrate the actual level of risk. There is scientific uncertainty about cancer risk in the low-dose region below the range of epidemiologic observation, and the possibility of no risk cannot be excluded (CIRRPC 1992).

C.1.2.1 Health Effect Risk Estimators Used in this SWEIS

Health impacts from radiation exposure, whether from external or internal sources, generally are identified as “somatic” (affecting the exposed individual) or “genetic” (affecting descendants of the exposed individual). Radiation is more likely to produce somatic effects than genetic effects. The somatic risks of most importance are induced cancers. Except for leukemia, which can have an induction period (the time between exposure to a carcinogen and a cancer diagnosis) of as little as 2 to 7 years; most cancers, however, have an induction period of more than 20 years.

For a uniform irradiation of the body, the incidence of cancer varies among organs and tissues; the thyroid and skin demonstrate a greater sensitivity than other organs. Such cancers, however, also produce relatively low mortality rates because they are relatively amenable to medical treatment. Because fatal cancer is the most probable serious effect of environmental and occupational radiation exposures, estimates of cancer fatalities rather than cancer incidence are presented in this new SWEIS. The numbers of fatal cancers can be used to compare the risks among the various alternatives.

The fatal cancer estimators are used to calculate the statistical expectation of the effects of exposing a population to radiation. For example, if 100,000 people were each exposed to a one-time radiation dose of 100 millirem (0.1 rem), the collective dose would be 10,000 person-rem. The exposed population would then be expected to experience 6 additional cancer fatalities from the radiation (10,000 person-rem times 0.0006 lifetime probability of cancer fatalities per person-rem = 6 cancer fatalities).

Calculations of the number of excess fatal cancers associated with radiation exposure do not always yield whole numbers. These calculations may yield numbers less than 1, especially in environmental impact applications. For example, if a population of 100,000 were exposed to a total dose of only 0.001 rem per person, the collective dose would be 100 person-rem (100,000 persons times 0.001 rem = 100 person-rem). The corresponding estimated number of cancer fatalities would be 0.06 (100 person-rem times 0.0006 cancer fatalities per person-rem = 0.06 cancer fatalities). This estimate of 0.06 cancer fatalities means that there is 1 chance in 16.6 that the exposed population would experience 1 fatal cancer. In other words, 0.06 cancer fatalities is the *expected* number of deaths that would result if the same exposure situation were applied to many different groups of 100,000 people. In most groups, no person would incur a fatal cancer from the 0.001 rem dose each member would have received. In a small fraction of the groups, 1 cancer fatality would result; in exceptionally few groups, 2 or more cancer fatalities would occur. The *average* expected number of deaths over all the groups would be 0.06 cancer fatalities (just as the average of 0, 0, and 0 added to 1 is 1/4, or 0.25). The most likely outcome is no cancer fatalities.

C.1.2.2 Material of Interest at Los Alamos National Laboratory

LANL scientists have a large involvement in nuclear science and its applications. Therefore, many types of radioactive materials and radiation sources are in use at LANL; however, many of these uses require only very small amounts of material. Note that all radioactive materials are considered in this new SWEIS, but three radionuclides tend to dominate the human health effects at LANL due to their particular radioactive and biological characteristics, the quantities of material being used, or the potential for dispersion in an accident. These radionuclides are plutonium, uranium, and tritium.

Plutonium is a manmade element that has several applications in weapons, nuclear reactors, and space exploration. There are several types of plutonium atoms, called isotopes, which are distinguished by the different numbers of neutrons in their nucleus. (Note that isotopes of a particular element all behave the same chemically.) In most cases, the isotopes of plutonium decay by alpha particle emission and have radioactive half-lives ranging from tens to thousands of years. Plutonium that is taken into the body tends to be deposited in certain organs (notably the bone, liver and lung) and is excreted very slowly. Because alpha particles have a very short range in tissue, the radiation dose from plutonium in the body is largely delivered to the organs where the material is deposited.

Uranium is a naturally-occurring radioactive element. The discovery that an atom of uranium could be fissioned with neutrons was the starting point of the Nuclear Age. Uranium-235 is one of several fissile materials that fission with the release of energy. Various applications require the use of different isotopes of uranium. Because isotopes cannot be chemically separated, processes have been developed to enrich uranium to various isotopic ratios. Natural uranium consists mostly of uranium-238, with very small amounts of uranium-234 and uranium-235. Enriched uranium is enhanced in the isotope uranium-235 above its natural concentration of 0.72 percent. Highly enriched uranium has a greater than 20 percent concentration of uranium-235 or greater. Depleted uranium results from the enrichment process, where most of the uranium-235 is removed.

Most uranium isotopes of interest here have very long half-lives and are alpha-emitters. Their half-lives are much longer than plutonium isotopes; as a result, uranium is generally of lower radiological concern than plutonium. Its actual radiological concern, however, varies with its enrichment. As a heavy metal, uranium can be chemically toxic to the kidneys. Depending on the enrichment and chemical form, either chemical or radiological considerations dominate.

Tritium is a radioactive isotope of hydrogen. It is generated at low levels in the environment by interactions of cosmic radiation with the upper atmosphere, but for practical applications, it is normally produced in a nuclear reactor. The radioactive properties of tritium are very useful. By mixing tritium with a chemical that emits light in the presence of radiation, a phosphor, a continuous light source, is created. This can be applied to situations where a dim light is needed but using batteries or electricity is not possible. Rifle sights and exit signs are common applications. Tritium has a half-life of around 12 years and decays by emitting a low-energy beta particle that cannot penetrate the outer layer of human skin. The main hazard associated with tritium is internal exposure. Because tritium is an isotope of hydrogen, it can be incorporated into a water molecule, forming tritiated water. In the environment, tritium is most often found in its elementary form as a gas, or as water. Tritiated water is a concern to the human body because the body is composed mostly of water. Tritiated water will easily and rapidly enter the body and irradiate it rather uniformly; however, it also is removed from the body rather quickly because it can be easily displaced with regular water and has a biological half-life of about 12 days under normal conditions.

C.1.3 Methods Used to Estimate Radiological Impacts from Normal Operations

Dose assessments for members of the public were performed at LANL to determine the incremental doses that would be associated with the alternatives addressed in this SWEIS. This section provides supplemental information regarding those assessments. Incremental doses for members of the public were calculated for the following types of receptors:

- *Facility-Specific Maximally Exposed Individual (MEI)*—The facility-specific MEI represents a location near a facility where the greatest modeled dose to a hypothetical public individual would be received from all modeled emissions.

- *LANL Site-Wide MEI*—The LANL MEI represents the location where the single highest modeled dose would be received by a hypothetical public individual. The highest facility-specific MEI becomes the LANL MEI.

- Collective dose to the population within a 50-mile (80-kilometer) radius from LANL.

C.1.3.1 Key Facilities Modeled

Several facilities at LANL release radioactive materials to the ambient air through stacks, vents, or diffuse emissions. The facilities modeled for this SWEIS are listed in **Table C–3**. Those facilities not modeled were eliminated from detailed analysis because they either have historically low emission rates or would not be expected to operate during the period analyzed in this SWEIS. In addition, all of the facilities modeled in the *1999 SWEIS* as non-Key Facilities (High Pressure Tritium Facility [Technical Area (TA) 33] and Nuclear Safeguards Research Facilities [TA-35]) no longer have facility emissions. The following are changes from the *1999 SWEIS* to the list of Key Facilities:

- The Pajarito Site (TA-18) was removed from the LANL Key Facility list in both the Reduced and Expanded Operations Alternatives of this SWEIS (see Chapter 3, Section 3.1.3.9). Because the normal operational releases will still be applicable for the No Action Alternative at the Pajarito Site, a dose assessment was performed for this SWEIS.

- The Tritium Facilities in TA-21 were removed from the LANL Key Facilities list in the Expanded Operations Alternative. The buildings will continue to have radioactive air emissions until the decontamination, decommissioning, and demolition process has begun. Since these air emissions will result in potential doses to the MEI and public, a dose assessment was performed for the Tritium Facilities in TA-21 in this SWEIS.

Table C–3 Los Alamos National Laboratory Key Facilities

Technical Area	*Facility Name*
TA-3-29	Chemistry and Metallurgy Research Building
TA-3-66	Sigma Complex
TA-3-102	Machine Shops
TA-11	High Explosives Processing Facilities
TA-15 and TA-36	High Explosives Testing Facilities
TA-16	Tritium Facility [a]
TA-18	Pajarito Site [b]
TA-48	Radiochemistry Facility
TA-53	Los Alamos Neutron Science Center
TA-54	Waste Management Operations [c]
TA-55	Plutonium Facility Complex
Non-Key (TA-21)	TA-21 Non-Key Facilities [a]

[a] The Tritium Facility includes the Weapons Engineering Tritium Facility at TA-16. The non-Key Facilities at TA-21 were formerly part of the Tritium Facilities and include the Tritium Science and Fabrication Facility and the Tritium Systems Test Assembly that will continue to produce emissions while awaiting decontamination, decommissioning, and demolition and are under non-Key Facilities.

[b] A LANL Key Facility in the No Action Alternative, it will continue to produce emissions until the Solution High-Energy Burst Assembly moves to another DOE site.

[c] Area G and the Decontamination and Volume Reduction System.

The new LANL Key Facilities were reviewed for potential radiological air releases. It was determined that no significant air emissions from these facilities would produce doses that could affect the public. In addition, the radiological air emissions from the Radioactive Liquid Waste Treatment Facility at TA-50 were considered in the *1999 SWEIS* to be minimal (DOE 1999a) relative to other sources at LANL and therefore were not modeled. It was anticipated that the replacement Radioactive Liquid Waste Treatment Facility also would have minimal radiological air emissions; therefore, it was not modeled in this SWEIS (Appendix G).

As part of LANL's zero liquid discharge program, two concrete basins located at the east end of TA-53 are used to evaporate radioactive liquid discharge from the Los Alamos Neutron Science Center (LANSCE) facility. LANSCE radioactive liquid is first placed in a collection tank for decay. Measurement of the radioisotope concentration of the liquid in this tank after decay is used to determine when it can be released to one of the evaporation basins. Each basin has a 125,000-gallon (473,125-liter) capacity and is lined with a nonpermeable material. The measured radioisotope concentrations in liquid released to the evaporation basin in 2006 were used to calculate the dose to the MEI residing at the East Gate at State Highway 502 located 800 meters (2,625 feet) from the evaporation basins. The calculation used the Clean Air Act Assessment Package – 1988 (CAP88) computer code (EPA 2002) and assumed that all radioisotopes present in the liquid in the evaporation basin during the year, regardless of physical form, were released to the air. The resulting calculated dose to the MEI was 0.035 millirem per year. This 0.035 millirem evaporation basin MEI dose is less than 0.5 percent of the LANL MEI dose of 7.8 millirem for the No Action Alternative. The effect of these evaporation basins on the 50-mile (80-kilometer) population dose from normal operations was calculated to be 0.0278 person-rem per year, which is small (0.13 percent) compared to the population dose from LANSCE emissions (22 person-rem per year).

C.1.3.2 Clean Air Act Assessment Package – 88 Model

CAP88-PC Version 3.0 computer code was used for this SWEIS to calculate population radiation doses from normal releases of radioisotopes (EPA 2002). There were significant changes in dose calculations between the (CAP88-PC) DOS Version 1.0 used in the *1999 SWEIS* and the Version 3.0 used here, including:

- Incorporation of the new Federal Guidance Report No. 13 dose and risk factors;
- Incorporation of options to choose different chemical forms for each radionuclide;
- Addition of pathways, such as drinking water ingestion and external exposure from multiple depths of soil contamination;
- Ability to account for the effect of humidity; and
- Addition of more than 800 isotopes, consistent with those in Federal Guidance Report No. 13.

C.1.3.3 Model Input Parameters

The CAP88 model requires many input parameters to perform dose calculations. Most of these parameters are built into the model and require no input from the user. The user-defined inputs are discussed below, along with how the data were derived.

Population Data

The evaluation of collective offsite dose considers the population living within 50 miles (80 kilometers) of LANL. Potential doses to the local population from airborne radioactive emissions at each Key Facility at LANL were estimated using a 50-mile radius centered on the facility whose emissions were being analyzed. The 50-mile radius is typically used in EISs to evaluate impacts from both emissions from normal operations and releases from postulated accidents. Dose calculations using emissions from LANSCE were performed to support the use of the 50-mile distance. In this analysis, in addition to the dose to the MEI, the dose to an individual was calculated in the direction of the highest dose (north-northeast) for various distances out to 50 miles. As shown in **Figure C–1**, the dose dropped dramatically with increasing distance from the source, due primarily to the dispersion of the emitted contaminants, which reduced their concentrations. Therefore, anywhere beyond 50 miles in any direction, the dose would be smaller than the dose at 50 miles (0.035 millirem per year).

The Sector Population, Land Fraction, and Economic Estimation Program (NRC 2003) was used to create population distribution files that were then configured to work as data input files for CAP88. The SECPOP2000 software can calculate estimated population and economic data about any point (specified by longitude and latitude) that lies within the continental United States. SECPOP2000 used the latest (2000) census data. Population estimates were made using block level census data.

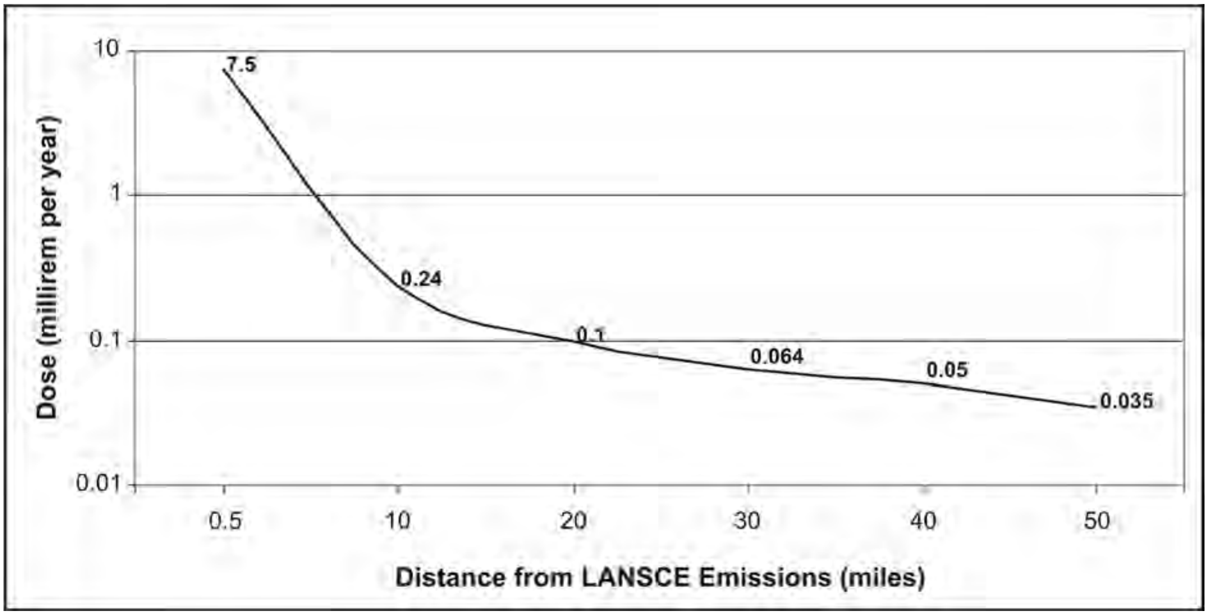


Figure C–1 Maximum Dose to an Individual at Selected Distances

In its population files, CAP88 uses edgepoints for each sector, which are entered in the population file in kilometers. The edgepoints used for CAP88 were consistent with those used for the accident analyses (1, 2, 3, 4, 5, 10, 20, 30, 40, 50 miles). Each CAP88 population file was subsequently analyzed for residents inappropriately listed as residing on LANL property. One block of 184 individuals was consistently listed on a LANL-only sector. Those 184 individuals were manually moved to the adjoining sector to ensure no individuals were assessed as living on LANL property.

Maximally Exposed Individual Locations

The facility-specific MEI represents the location near a specific facility where a hypothetical person receives the greatest dose. These locations do not represent actual residences or individuals, but rather a hypothetical receptor (see Chapter 5, Section 5.6). Some points at the LANL boundary do have residences close to them. This is especially true for those TAs located in the northern part of the LANL site, such as TA-3 and TA-53.

The facility-specific MEI locations remained the same in this SWEIS as those in the *1999 SWEIS*. Due to the expected changes in LANL boundaries near TA-21 and TA-54, the MEIs for TA-21 and TA-54 were reviewed. The review of the TA-21 MEI location included the conveyance of segments A-5-1, A-6, A-8, A-9, A-10, A-11, and A-15. The review of the TA-54 MEI location included the conveyance of segments A-19-1, A-19-2, A-19-3, B-1 and C-1, all of which are near White Rock (LANL 2006a). Since the highest dose for TA-54 in the *1999 SWEIS* was located northeast of the site at the boundary with San Ildefonso Pueblo, the conveyance of land near White Rock, further away, did not affect the TA-54 MEI location.

For some Key Facilities, there are areas nearby that are not populated by LANL workers (such as the Los Alamos County Landfill). These areas were not considered populated by public receptors. Some modeled facilities share the same MEI location. The Chemistry and Metallurgy

Research Building (TA-3-29) and the Sigma Complex (TA-3-66) share the same MEI location, as do the Radiochemistry Facility (TA-48) and the Plutonium Facility Complex (TA-55).

Meteorological Data

There are six towers that gather meteorological data. Four of the towers are located on mesa tops and are used with the CAP88 model to estimate air dispersion of emitted nuclides. The data used for each tower covered an average of 9 years (January 1, 1995 through December 31, 2003) of actual meteorological data. Using average meteorological data over a period of time better reflects conditions than data from any individual year. The tower nearest to the modeled facility was used for data input.

Tower	*Key Facility Locations*
TA-6	TA-3, TA-16, TA-48, TA-55
TA-49	TA-11, TA-15, TA-36
TA-53	TA-21, TA-53
TA-54	TA-18, TA-54

The other meteorological data used in CAP88 is listed below. Previous versions of CAP88 used a default value of 8 grams per cubic meter for the Average Absolute Humidity. For this SWEIS, a value of 3.85 grams per cubic meter (LANL 2004a) was used. All other parameters were confirmed from the *1999 SWEIS*.

- Annual precipitation = 19 inches (48 centimeters) per year.
- Annual ambient temperature = 48 degrees Fahrenheit (8.8 degrees Celsius).
- Height of lid (atmosphere mixing level) = 5,000 feet (1,525 meters).
- Average absolute humidity = 4 grams per cubic meter (3.85 grams per cubic meter rounded up by CAP88).

Emissions Data

For this SWEIS, all actual emissions from 1999 through 2004 (LANL 2000, 2001, 2002a, 2003a, 2004c, 2005a) were reviewed and analyzed to ensure that the projected emissions from the *1999 SWEIS* were bounding. Based on the above review and additional data from LANL, some changes were made to the projected air emissions. Specific changes can be found in the appropriate Radiological Air Emissions **Tables C–4** through **C–15**. In addition, each Key Facility's activities were reviewed for the three alternatives considered in this SWEIS (No Action, Reduced Operations, and Expanded Operations). The projected releases are based on those activities. A complete description of the alternatives can be found in Chapter 3.

Changes to CAP88 Version 3.0 included the ability of the user to choose the specific chemical form and type. The chemical form used in the assessments was based on each facility's process knowledge. For example, LANSCE produces a variety of materials generated through the process of activation; consequently, emissions occur as gaseous mixed activation products. Other activation products occur in particulate and vapor form.

Gaseous mixed activation product emissions included argon-41, carbon-11, nitrogen-13, nitrogen-16, oxygen-14, and oxygen-15. Various radionuclides such as mercury-193, mercury-197, germanium-68, and bromine-82 made up the majority of the particulate and vapor form emissions (LANL 2004c). Tritium can be released in different forms, either as tritium oxide (vapor) or as elemental tritium (gas), at each facility where it is present. Area G at TA-54, for instance, is a known source of diffuse emissions of tritium vapor (LANL 2004c). These forms are noted in Tables C–4 through C–15.

At some Key Facilities, the emissions were modeled using the most conservative radioisotope. For example, actinide emissions at the Chemistry and Metallurgy Research Building include plutonium, uranium, thorium, and americium isotopes. Of these isotopes, plutonium-239 was used for modeling purposes to conservatively represent all of the actinides released. By using plutonium-239, the estimated dose for members of the public presented in this SWEIS is higher than would be experienced if the actual actinides were used in the model calculations.

Some Key Facility projected emissions included radionuclides that are not in the dose conversion factor database of CAP88 Version 3.0. Impacts from these radionuclides would be minimal due to their extremely short half-lives and small inventory amounts. All of the radionuclides omitted from the dose assessment have half-lives of less than 2 minutes. Chlorine-39, whose portion among the LANSCE air emissions was negligible (less than 0.01 percent per year), also was omitted from the dose assessment.

Table C–4 Radiological Air Emissions (curies per year) from the Chemistry and Metallurgy Research Building (Technical Area 3-29) [a]

Radionuclide	*No Action*	*Reduced Operations*	*Expanded Operations*
Stack ES-14 Height (meters) = 15.9 Diameter (meters) = 1.07 Exit velocity (meters per second) = 6.8			
Actinides [b]	0.00076	0.00003	Same as No Action
Stack ES-46 [c] Height (meters) = 16.5 Diameter (meters) = 1.88 Exit velocity (meters per second) = 1.9			
Krypton-85	100	Same as No Action	Same as No Action
Xenon-131m	45	Same as No Action	Same as No Action
Xenon-133	1,500	Same as No Action	Same as No Action

[a] Projected emission rates are from the *CMRR EIS* (DOE 2003b). For the No Action and Expanded Operations Alternatives, because of the start of the Chemistry and Metallurgy Research Replacement Facility Project, there would be no emissions from the Chemistry and Metallurgy Research Building after approximately 2014. The actinide processes and resulting emissions would move to a new facility near TA-55 and the Wing 9 processes would move to the Radiological Sciences Institute. The support for hydrodynamic testing and tritium separation activities would remain at TA-55.

[b] Actinides were not broken down by isotope and were represented by plutonium-239. Actinides are emitted from almost all wings. The most conservative stack (ES-14) was chosen to model these emissions. The most conservative lung absorption rate for plutonium-239 (moderate) was chosen.

[c] Fission products are emitted from Wing 9. The most conservative stack (ES-46) was chosen for modeling.

Note: To convert meters to feet, multiply by 3.2808.

Table C–5 Radiological Air Emissions (curies per year) from the Sigma Complex (Technical Area 3-66)

Radionuclide	*No Action*	*Reduced Operations*	*Expanded Operations*
All Stacks [a] Height (meters) = 15.2 Diameter (meters) = 1.2 Exit velocity (meters per second) = 1			
Uranium-234 [b]	0.0000660	Same as No Action	Same as No Action
Uranium-238 [b, c]	0.0018	Same as No Action	Same as No Action

[a] Stacks are no longer monitored. Emissions now based on process knowledge and inventory. Depleted uranium is considered as uranium-238 and enriched uranium is considered as uranium-234.

[b] The most conservative lung absorption rate (slow) was chosen for all uranium and thorium isotopes. A moderate lung absorption rate was used for protactinium.

[c] All uranium-238 is assumed to be in equilibrium with thorium-234 and protactinium-234m.

Note: To convert meters to feet, multiply by 3.2808.

Table C–6 Radiological Air Emissions (curies per year) from the Machine Shops (Technical Area 3-102)

Radionuclide	*No Action*	*Reduced Operations*	*Expanded Operations*
Stack ES-22 Height (meters) = 13.4 Diameter (meters) = 0.91 Exit velocity (meters per second) = 0.8			
Uranium-238 [a]	0.00015	Same as No Action	Same as No Action

[a] Uranium-238 was used to model all uranium. Protactinium-234m and thorium-234 are in equilibrium with uranium-238. The most conservative lung absorption rate (slow) was chosen for uranium and thorium. A moderate lung absorption rate was used for protactinium.

Note: To convert meters to feet, multiply by 3.2808.

Table C–7 Radiological Air Emissions (curies per year) from High Explosives Processing Facilities (Technical Area 11)

Radionuclide	*No Action*	*Reduced Operations* [a]	*Expanded Operations*
Area size (square meters) = 10,000 [b]			
Uranium-234 [c]	3.71×10^{-7}	2.97×10^{-7}	3.71×10^{-7}
Uranium-235 [d, c]	1.89×10^{-8}	1.51×10^{-8}	1.89×10^{-8}
Uranium-238 [e, c]	9.96×10^{-7}	7.97×10^{-7}	9.96×10^{-7}

[a] For Reduced Operations, a 20 percent reduction in operations was assumed to result in a 20 percent reduction in air emissions.

[b] No stack emissions. This is an area source.

[c] The most conservative lung absorption rate (slow) was chosen for all uranium and thorium. A moderate lung absorption rate was used for protactinium.

[d] Thorium-231 is in equilibrium with uranium-235.

[e] Thorium-234 and protactinium-234m are in equilibrium with uranium-238.

Note: To convert square meters to square feet, multiply by 10.764.

Table C–8 Radiological Air Emissions (curies per year) from High Explosives Testing Facilities (Technical Area 15 and Technical Area 36) [a]

Radionuclide	*No Action*	*Reduced Operations* [b]	*Expanded Operations*
Area size (square meters) = 100 [c]			
Uranium-234 [f]	0.0345	0.0276	0.0345
Uranium-235 [d, f]	0.0015	0.0012	0.0015
Uranium-238 [e, f]	0.114	0.0912	0.114

[a] Depleted uranium was modeled as 27 percent uranium-234, 1 percent uranium-235, and 72 percent uranium-238 per curie of release, per LANL guidance in *Dose Assessment Using CAP88*, RRES-MAQ-501, R6 (LANL 2003b).

[b] For Reduced Operations, a 20 percent reduction in operations was assumed to result in a 20 percent reduction in air emissions. The reduction of experiments with special nuclear material at the Dual Axis Radiographic Hydrodynamic Test Facility was assumed to have no effect on air emissions.

[c] No stack emissions. This is an area source.

[d] Thorium-231 is in equilibrium with uranium-235.

[e] Thorium-234 and protactinium-234m are in equilibrium with uranium-238.

[f] The most conservative lung absorption rate (slow) was chosen for all uranium and thorium. A moderate lung absorption rate was used for protactinium.

Note: To convert square meters to square feet, multiply by 10.764.

Table C–9 Radiological Air Emissions (curies per year) from the Tritium Facility (Technical Area 16)

Radionuclide	*No Action*	*Reduced Operations*	*Expanded Operations*
Stack FE-04 Height (meters) = 18.3 Diameter (meters) = 0.46 Exit velocity (meters per second) = 19.3			
Tritium (gas)	300	Same as No Action	Same as No Action
Tritium (water vapor)	500	Same as No Action	Same as No Action

Note: To convert meters to feet, multiply by 3.2808.

Table C–10 Radiological Air Emissions (curies per year) from the Pajarito Site (Technical Area 18)

Radionuclide	*No Action*	*Reduced Operations* [a]	*Expanded Operations* [a]
Area size (square meters) = 45,200 [b]			
Argon-41	102	Same as No Action	Same as No Action

[a] Under reduced and expanded operations, the Solution High-Energy Burst Assembly would be removed from TA-18 in about 2009, thereafter there would be no radiological air emissions.

[b] No stack emissions. This is an area source from operations that activate argon atoms in the air surrounding the assembly.

Note: To convert square meters to square feet, multiply by 10.764.

Table C–11 Radiological Air Emissions (curies per year) from the Radiochemistry Facility (Technical Area 48)

Radionuclide [a]	***No Action***	***Reduced Operations***	***Expanded Operations***
Fan Exhaust FE-51/54 [b] Height (meters) = 13.1 Diameter (meters) = 0.91 Exit velocity (meters per second) = 7.9			
Plutonium-239 [c]	0.0000121	Same as No Action	Same as No Action
Uranium-235 [c]	0.000000484	Same as No Action	Same as No Action
Mixed Fission Products [d]	0.000154	Same as No Action	Same as No Action
Fan Exhaust FE-63/64 [e] Height (meters) = 13.4 Diameter (meters) = 0.3 Exit velocity (meters per second) = 12.5			
Arsenic-72 [f]	0.000121	Same as No Action	Same as No Action
Arsenic-73 [f]	0.00255	Same as No Action	Same as No Action
Arsenic-74 [f]	0.00133	Same as No Action	Same as No Action
Beryllium-7 [f]	0.0000165	Same as No Action	Same as No Action
Bromine-77 [f]	0.000935	Same as No Action	Same as No Action
Germanium-68 [f, h]	0.00897	Same as No Action	Same as No Action
Rubidium-86 [g]	0.000000308	Same as No Action	Same as No Action
Selenium-75 [g]	0.000385	Same as No Action	Same as No Action
Other Activation Products [i]	0.00000558	Same as No Action	Same as No Action

[a] All radionuclides at TA-48 were increased 10 percent (over *1999 SWEIS* amounts or highest actual emission rate, whichever was higher).

[b] Actinides are emitted through several unmonitored stacks at TA-48. The most conservative stack (Fan Exhaust FE-51/54 exits through stack 54) was chosen to model emissions from these stacks.

[c] The most conservative lung absorption rates (moderate for plutonium and slow for uranium) were chosen.

[d] Mixed Fission Products were not broken down by isotopes and were represented by strontium-90 and yttrium-90 in equilibrium. The default lung absorption rate (moderate) was used.

[e] Activation products are emitted through several stacks at TA-48. The most conservative stack (Fan Exhaust FE-63/64 exits through stack 7) was chosen to model emissions from these stacks.

[f] The lung absorption rate (moderate) was used.

[g] The default lung absorption rate (fast) was used

[h] Germanium-68 was assumed to be in equilibrium with gallium-68.

[i] Other Activation Products are a mixed group of activation products represented by strontium-90 and yttrium-90 in equilibrium. The default lung absorption rate (moderate) was used.

Note: To convert meters to feet, multiply by 3.2808.

Table C–12 Radiological Air Emissions (curies per year) from the Los Alamos Neutron Science Center (LANSCE) (Technical Area 53)[a, b]

Radionuclide	*No Action*	*Reduced Operations*	*Expanded Operations*
Stack ES-2 Height (meters) = 13.1 Diameter (meters) = 0.91 Exit velocity (meters per second) = 7			
Argon-41	453	0	453
Carbon-11 (dioxide)	18,400	0	18,400
Mercury-193	30.1	0	30.1
Nitrogen-13	2,860	0	2,860
Oxygen-15	3,820	0	3,820
Stack ES-3[c] Height (meters) = 33.5 Diameter (meters) = 0.91 Exit velocity (meters per second) = 12.5			
Argon-41	431	0	431
Carbon-11[d] (dioxide)	4,090	0	4,090
Nitrogen-13	240	0	240
Oxygen-15	60	0	60
Area size (square meters) = 1,432[e]			
Argon-41	3.2	0	3.2
Carbon-11 (dioxide)	76.8	0	76.8

[a] The total curies emitted changed from the *1999 SWEIS* emission rates based on a revised curie per microamp-hour ratio. Under the Reduced Operations Alternative, there would be no emissions due to the shutdown of all activity at LANSCE.

[b] Carbon-10 and oxygen-14 were not modeled. They both are very short-lived nuclides (less than 2 minutes) and have no published dose conversion factor. They would have minimal health impacts.

[c] Emission projections for the Isotope Production Facility were modeled as being released from stack ES-3 in addition to evacuations from experimental areas A, B, and C and associated lines B and C tunnels. Expanded Operations include emissions for up to 100 irradiated targets for medical isotope processing.

[d] Total carbon-11 from stack ES-3 and the Isotope Production Facility.

[e] These are fugitive sources created at the accelerator target cells that have migrated into room air and into the environment.

Note: To convert meters to feet, multiply by 3.2808.

Table C–13 Radiological Air Emissions (curies per year) from Waste Management Operations (Technical Area 54)

Radionuclide	*No Action*	*Reduced Operations*	*Expanded Operations*
Area size (square meters) = 5,000 [a]			
Tritium (water vapor)	60.9	Same as No Action	Same as No Action
Americium-241 [b]	6.6×10^{-7}	Same as No Action	Same as No Action
Plutonium-238 [c]	4.80×10^{-6}	Same as No Action	Same as No Action
Plutonium-239 [c]	6.80×10^{-7}	Same as No Action	Same as No Action
Uranium-234 [c]	8.00×10^{-6}	Same as No Action	Same as No Action
Uranium-235 [c]	4.10×10^{-7}	Same as No Action	Same as No Action
Uranium-238 [c]	4.00×10^{-6}	Same as No Action	Same as No Action
Stack 54-412 (DVRS) Height (meters) = 10.7 Diameter (meters) = 0.69 Exit velocity (meters per second) = 16.6			
Americium-241 [b]	3.53×10^{-6}	Same as No Action	Same as No Action
Plutonium-238 [c]	1.76×10^{-5}	Same as No Action	Same as No Action
Plutonium-239 [c]	7.78×10^{-6}	Same as No Action	Same as No Action

DVRS = Decontamination and Volume Reduction System.

[a] These emissions are from an area source. They are conservatively based on a 5-year average plus two standard deviations of nearby environmental concentration measurements.

[b] The default lung absorption rate (moderate) was used.

[c] The most conservative lung absorption rates (moderate for plutonium and slow for uranium) were chosen.

Note: To convert meters to feet, multiply by 3.2808; to convert square meters to square feet, multiply by 10.764.

Table C–14 Radiological Air Emissions (curies per year) from the Plutonium Facility Complex (Technical Area 55)

Radionuclide	*No Action*	*Reduced Operations*	*Expanded Operations* [a]
Stack ES-15 Height (meters) = 9.5 Diameter (meters) = 0.93 Exit velocity (meters per second) = 6.8			
Plutonium-239 [b]	0.0000025	Same as No Action	Same as No Action
Stack ES-16 Height (meters) = 9.5 Diameter (meters) = 0.94 Exit velocity (meters per second) = 10.8			
Plutonium-239 [b]	0.000017	Same as No Action	0.000036
Tritium (gas)	250	Same as No Action	Same as No Action
Tritium (water vapor)	750	Same as No Action	Same as No Action

[a] Expanded operations include pit production (80 pits), pit surveillance (65 pits), actinide processing 1,764 pounds (800 kilograms), and pit disassembly capacity (500 pits).

[b] No isotopic breakdown of particulates was available; therefore all particulates were represented by plutonium-239. The most conservative lung absorption rate (moderate) was chosen.

Note: To convert meters to feet, multiply by 3.2808.

Table C–15 Radiological Air Emissions (curies per year) from Non-Key Facilities (Technical Area 21)

Radionuclide	*No Action* [a]	*Reduced Operations* [a]	*Expanded Operations* [a]
Stack ES-1 (TA-21 Tritium Science and Fabrication Facility) Height (meters) = 22.9 Diameter (meters) = 1.22 Exit velocity (meters per second) = 10.3			
Tritium (water vapor) [b]	50	Same as No Action	Same as No Action
Stack ES-5 (TA-21 Tritium Systems Test Assembly) Height (meters) = 29.9 Diameter (meters) = 0.79 Exit velocity (meters per second) = 7.8			
Tritium (gas)	100	Same as No Action	Same as No Action
Tritium (water vapor) [c]	400	Same as No Action	Same as No Action

TA = technical area.

[a] Emissions from TA-21 stacks were stopped in September 2006 as part of TA-21 shutdown activities. Decontamination, decommissioning, and demolition of TA-21 under the Expanded Operations Alternative would permanently eliminate this potential source of emissions.

[b] Tritium emissions are based on LANL estimates of neutron target tube loading operations through the end of 2006 while awaiting decontamination, decommissioning, and demolition. The more conservative water vapor form of tritium was used.

[c] Tritium emissions (water vapor) were increased from the *1999 SWEIS* based on actual emission data (1999 through 2004) and expected emission rate while awaiting decontamination, decommissioning, and demolition.

Note: To convert meters to feet, multiply by 3.2808.

Stack Parameters

The height and diameter measurements of monitored stacks were taken from the 2003 LANL Radionuclide Air Emissions Report (LANL 2004c). The same exit velocities for those stacks were used as in the *1999 SWEIS*. The parameters used for unmonitored stacks were obtained from LANL staff (LANL 2006a). Stack parameters are listed in Tables C–4 through C–15.

Agricultural Data

One pathway of exposure modeled by CAP88 is emission of radionuclides to the air and their subsequent ingestion through food crops. CAP88 uses average agricultural productivity data for New Mexico based on the address of LANL when determining the agricultural data. The EPA Food Source Scenario used in CAP88 describes the fraction of vegetables, milk, and meat produced in the area. The ingestion (consumption) rates are the same for all scenarios. The “rural” scenario was used and included the following fractions.

Fraction	*Vegetable*	*Milk*	*Meat*
Produced at home	0.7	0.399	0.442
From the region (not imported)	0.3	0.601	0.558

C.1.3.4 Results of Analyses

The sequence of analyses performed to generate the radiological impact estimates from normal operations included selection of normal operational modes, estimation of source terms, estimation of environmental transport and uptake of radionuclides, calculation of radiation doses to exposed individuals, and estimation of health effects. There are uncertainties associated with each of these steps. Uncertainties exist in the way the physical systems being analyzed are represented by the computational models and in the data required to exercise the models (due to measurement, sampling, or natural variability).

The analysis was designed to ensure—through judicious selection of release scenarios, models, and parameters—that the results represent the potential risks. This was accomplished by making conservative assumptions in the calculations at each step. The models, parameters, and release scenarios used in the calculations were selected such that most intermediate results and, consequently, final estimates of impacts, were greater than would be expected. As a result, even though the range of uncertainty in a quantity might be large, the value calculated for any one modeled dose would be close to one of the extremes in the range of possible values, so the chance of the actual dose being greater than the calculated value would be low. The goal of the radiological assessment for normal operations in this SWEIS is to produce conservative results in order to capture any uncertainties in normal operations.

Maximally Exposed Individual

The facility-specific MEI represents a location near a facility that was modeled as having the greatest dose to a hypothetical public individual from all modeled emissions. This location was determined for each Key Facility and was calculated based on meteorological data for the site, as well as the type and amount of radiological air emissions from the Key Facility. For the purposes of this analysis, it was very conservatively assumed that the MEI is a person who stays in the same location 24 hours a day, 365 days a year. Furthermore, it was assumed that this person is not shielded from emissions by clothing or shelter (for example, a building, auto, home, etc.).

The doses were then calculated at each facility-specific MEI location from all other modeled facilities; thus, the facility-specific MEI represents the estimated dose to an individual near the specified facility from all modeled facilities. **Table C–16** summarizes the dose to each facility MEI from emissions from all modeled facilities. **Tables C–17** through **C–19** compare the facility-specific MEI for each of the three alternatives considered in this SWEIS. Each facility-specific MEI was totaled and the facility-specific MEI with the highest total dose was designated the LANL site-wide MEI for that alternative. Therefore any facility-specific MEI dose would be less than the LANL site-wide MEI for that alternative.

Table C–16 Summary of Facility-Specific Maximally Exposed Individual Dose (millirem per year) [a, b]

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Chemistry and Metallurgy Research Building and Sigma Complex [c]	0.46	0.13	0.46
Machine Shops	0.37	0.08	0.37
High Explosives Processing Facilities	0.38	0.11	0.38
High Explosives Testing Facilities	2.9	0.78	2.9
Tritium Facility	0.32	0.09	0.32
Pajarito Site [d]	2.9	0.78	2.9
Radiochemistry Facility and Plutonium Facility Complex [e]	0.78	0.20	0.78
Los Alamos Neutron Science Center [f]	14	0.24	14
Waste Management Operations	1.2	0.33	1.2
Non-Key Facilities (TA-21) [g]	1.9	0.29	1.9

TA = technical area.

[a] Doses are from all modeled facilities.

[b] Under the No Action Alternative and the Expanded Operations Alternative, the LANL site-wide MEI would be located near LANSCE. Under the Reduced Operations Alternative, the LANL site-wide MEI would be located near the Firing Sites at TA-36.

[c] Chemistry and Metallurgy Research Building and Sigma Complex had the same MEI location.

[d] Under the Reduced and Expanded Operations Alternatives, Pajarito Site (TA-18) would not be operational after about 2009, thereby eliminating the need for a designated facility-specific MEI dose.

[e] Radiochemistry Facility and Plutonium Facility Complex had the same MEI location.

[f] As a mitigating measure, operational controls at LANSCE would limit their portion of the MEI dose to 7.5 millirem, resulting in lower doses.

[g] Emissions from TA-21 stacks were stopped in September 2006 as part of TA-21 shutdown activities. Decontamination, decommissioning, and demolition of TA-21 under the Expanded Operations Alternative would permanently eliminate this potential source of radiation dose.

LANL site-wide MEI dose impacts for the No Action (Table C–17) and Expanded Operations (Table C–19) Alternatives reflect the change in location of the actinide processes at the Chemistry and Metallurgy Research Building to the new Chemistry and Metallurgy Research Replacement Facility near TA-55. These impacts on the doses were determined by calculating the net dose (removal of the dose from operations at the Chemistry and Metallurgy Research Building and addition of the dose from operations at the new Chemistry and Metallurgy Research Replacement Facility). These impacts to the MEI were minimal. For the Reduced Operations Alternative (Table C–18), LANL site-wide MEI dose impacts reflect the continued operations at the existing Chemistry and Metallurgy Research Building in TA-3.

Under the No Action and Expanded Operations Alternatives, operational controls at LANSCE would limit the amount of radiological air emissions. It is assumed that there is a dose limit of 7.5 millirem to the MEI from LANSCE emissions. This dose limit, when added to the doses from operations at all other Key Facilities, would result in a LANL site-wide MEI dose of 7.8 millirem under the Expanded Operations Alternative. The regulatory limit of 10 millirem per year (Title 40 *Code of Federal Regulations* [CFR] 61.92) to a member of the public, therefore, would not be exceeded under any of the SWEIS alternatives. The highest estimated dose to the MEI from normal LANL operations, 8.2 millirem per year, would be under the Expanded Operations Alternative and includes the additional dose (0.42 millirem per year) from remediation activities (see Chapter 5, Section 5.6 and Appendix I, Section I.5.6).

Table C–17 Maximally Exposed Individual Dose for the No Action Alternative (millirem per year)

Source	*CMR/ Sigma MEI*	*Machine Shop MEI*	*TA-11 MEI*	*TA-15/ TA-36 MEI*	*TA-16 MEI*	*TA-18 MEI*	*TA-48/ TA-55 MEI*	*TA-53 MEI*	*TA-54 MEI*	*Non-Key (TA-21) MEI*
CMR Building	0.0639	0.0435	0.00540	0.0158	0.00513	0.0111	0.0549	0.0113	0.00609	0.0158
Sigma Complex	0.0262	0.0114	0.00206	0.00598	0.00135	0.00411	0.0243	0.00412	0.00225	0.00598
Machine Shops	0.00225	0.00225	0.000165	0.000450	0.000165	0.000315	0.00165	0.000315	0.000180	0.000450
High Explosives Processing Facilities	0.00000118	0.00000127	0.0000212	0.00000230	0.00000736	0.00000212	0.00000281	0.00000134	0.00000109	0.00000142
High Explosives Testing Facilities	0.0866	0.0551	0.102	0.899	0.0716	0.809	0.131	0.247	0.304	0.292
Tritium Facility	0.00522	0.00491	0.0184	0.00447	0.0243	0.00455	0.00478	0.00362	0.00375	0.00393
Pajarito Site	0.000551	0.000520	0.000683	0.00796	0.000530	0.0979	0.000898	0.00704	0.0194	0.00326
Radiochemistry Facility	0.000192	0.000161	0.0000778	0.000496	0.0000703	0.000304	0.00194	0.000289	0.000151	0.000350
LANSCE	0.269	0.240	0.241	1.88	0.209	1.97	0.516	13.3 [a]	0.81	1.57
Waste Management Operation	0.00107	0.00106	0.00107	0.00116	0.00106	0.00121	0.00107	0.00117	0.0520	0.00110
Plutonium Facility Complex	0.00715	0.00663	0.00530	0.0240	0.00496	0.0145	0.0399	0.0117	0.00856	0.0153
TA-21 Non-Key Facilities	0.00266	0.00252	0.00242	0.00705	0.00209	0.00478	0.00374	0.0115	0.00277	0.0223
Total	**0.46**	**0.37**	**0.38**	**2.85**	**0.32**	**2.92**	**0.78**	**13.56** [a, b]	**1.21**	**1.93**

CMR = Chemistry and Metallurgy Research, MEI = maximally exposed individual, TA = technical area, LANSCE = Los Alamos Neutron Science Center.

[a] As a mitigating measure, operational controls at LANSCE would limit their portion of the MEI dose to 7.5 millirem resulting in a LANL site-wide MEI dose of 7.8 millirem.

[b] After approximately 2014, actinide emissions will move from the Chemistry and Metallurgy Research Building to the Chemistry and Metallurgy Research Replacement Facility near TA-55. The resulting dose (an additional 0.0023 millirem) will have minimal impact on the LANL MEI dose.

Table C–18 Maximally Exposed Individual Dose for the Reduced Operations Alternative (millirem per year)

Source	*CMR/ Sigma MEI*	*Machine Shop MEI*	*TA-11 MEI*	*TA-15/ TA-36 MEI*	*TA-16 MEI*	*TA-18 MEI*	*TA-48/ TA-55 MEI*	*TA-53 MEI*	*TA-54 MEI*	*Non-Key (TA-21) MEI*
CMR Building	0.0135	0.00921	0.00117	0.00342	0.00111	0.00235	0.0119	0.00250	0.00134	0.00342
Sigma Complex	0.0262	0.0114	0.00206	0.00598	0.00135	0.00411	0.0243	0.00412	0.00225	0.00598
Machine Shops	0.00225	0.00225	0.000165	0.000450	0.000165	0.000315	0.00165	0.000315	0.000180	0.000450
High Explosives Processing Facilities	0.000000947	0.00000102	0.0000169	0.00000184	0.00000589	0.00000169	0.00000225	0.00000107	0.000000872	0.00000114
High Explosives Testing Facilities	0.0693	0.0441	0.0816	0.720	0.0573	0.648	0.105	0.198	0.243	0.234
Tritium Facility	0.00522	0.00491	0.0184	0.00447	0.0243	0.00455	0.00478	0.00362	0.00375	0.00393
Pajarito Site [a]	0.000551	0.000520	0.000683	0.00796	0.000530	0.0979	0.000898	0.00704	0.0194	0.00326
Radiochemistry Facility	0.000192	0.000161	0.0000778	0.000496	0.0000703	0.000304	0.00194	0.000289	0.000151	0.000350
LANSCE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Waste Management Operation	0.00107	0.00106	0.00107	0.00116	0.00107	0.00121	0.00107	0.00117	0.0520	0.00110
Plutonium Facility Complex	0.00715	0.00663	0.00530	0.0240	0.00496	0.0145	0.0399	0.0117	0.00856	0.0153
TA-21 Non-Key [b] Facilities	0.00266	0.00252	0.00242	0.00705	0.00209	0.00478	0.00374	0.0115	0.00277	0.0223
Total (millirem per year)	**0.13**	**0.08**	**0.11**	**0.78**	**0.09**	**0.78**	**0.20**	**0.24**	**0.33**	**0.29**

CMR = Chemistry and Metallurgy Research, MEI = maximally exposed individual, TA = technical area, LANSCE = Los Alamos Neutron Science Center.

[a] Pajarito Site (TA-18) would not be operational after 2009 under this alternative and would therefore not produce emissions. These values are potentially applicable for the first few years.

[b] Emissions from TA-21 stacks were stopped in September 2006 as part of TA-21 shutdown activities. However, some emissions are assumed until decontamination, decommissioning, and demolition are complete.

Table C–19 Maximally Exposed Individual Dose for the Expanded Operations Alternative (millirem per year)

Source	CMR/ Sigma MEI	Machine Shop MEI	TA-11 MEI	TA-15/ TA-36 MEI	TA-16 MEI	TA-18 MEI	TA-48/ TA-55 MEI	TA-53 MEI	TA-54 MEI	Non-Key (TA-21) MEI
CMR Building	0.0639	0.0435	0.00540	0.0158	0.00513	0.0111	0.0549	0.0113	0.00609	0.0158
Sigma Complex	0.0262	0.0114	0.00206	0.00598	0.00135	0.00411	0.0243	0.00412	0.00225	0.00598
Machine Shops	0.00225	0.00225	0.000165	0.000450	0.000165	0.000315	0.00165	0.000315	0.000180	0.000450
High Explosives Processing Facilities	0.00000118	0.00000127	0.0000212	0.00000230	0.00000736	0.00000212	0.00000281	0.00000134	0.00000109	0.00000142
High Explosives Testing Facilities	0.0866	0.0551	0.102	0.899	0.0716	0.809	0.131	0.247	0.304	0.292
Tritium Facility	0.00522	0.00491	0.0184	0.00447	0.0243	0.00455	0.00478	0.00362	0.00375	0.00393
Pajarito Site [a]	0.000551	0.000520	0.000683	0.00796	0.000530	0.0979	0.000898	0.00704	0.0194	0.00326
Radiochemistry Facility	0.000192	0.000161	0.0000778	0.000496	0.0000703	0.000304	0.00194	0.000289	0.000151	0.000350
LANSCE	0.269	0.240	0.241	1.88	0.209	1.97	0.516	13.3 [b]	0.81	1.57
Waste Management Operation	0.00107	0.00106	0.00107	0.00116	0.00106	0.00121	0.00107	0.00117	0.0520	0.00110
Plutonium Facility Complex	0.00729	0.00675	0.00538	0.0248	0.00503	0.0149	0.0412	0.0120	0.00874	0.0157
TA-21 Non-Key Facilities [a]	0.00266	0.00252	0.00242	0.00705	0.00209	0.00478	0.00374	0.0115	0.00277	0.0223
Total (millirem per year)	**0.46**	**0.37**	**0.38**	**2.85**	**0.32**	**2.92**	**0.78**	**13.56** [b, c]	**1.21**	**1.93**

CMR = Chemistry and Metallurgy Research, MEI = maximally exposed individual, TA = technical area, LANSCE = Los Alamos Neutron Science Center.

[a] TA-18 and TA-21 are expected to be decontaminated, decommissioned, and demolished under this alternative and would not produce emissions after that time. These values are applicable for the first few years.

[b] As a mitigating measure, operational controls at LANSCE would limit their portion of the MEI dose to 7.5 millirem resulting in a LANL site-wide MEI dose of 7.8 millirem.

[c] After approximately 2014, actinide emissions will move from the Chemistry and Metallurgy Research Building to the Chemistry and Metallurgy Research Replacement Facility near TA-55. The resulting dose (an additional 0.0023 millirem) will have minimal impact on the LANL MEI dose.

Collective Population Dose

The collective dose to the population living within a 50-mile (80-kilometer) radius from normal operations at LANL was calculated based on emissions from all modeled facilities. The population doses from emissions at each Key Facility were compared and then totaled in **Table C–20**. The majority of the population dose comes from emissions at the High Explosives Testing Facilities and LANSCE under both the No Action and Expanded Operations Alternatives. Under the Reduced Operations Alternative, LANSCE would not be operating; therefore, it would produce no emissions contributing to a population dose.

Table C–20 Collective Population Dose Summary (person-rem per year)

Source	*No Action Alternative Estimated Dose*	*Reduced Operations Alternative Estimated Dose*	*Expanded Operations Alternative Estimated Dose*
Chemistry and Metallurgy Research Building [a]	0.43	0.11	0.43
Sigma Complex	0.16	0.16	0.16
Machine Shops	0.01	0.01	0.01
High Explosives Processing Facilities	0.00005	0.00004	0.00005
High Explosives Testing Facilities	6.4	5.2	6.4
Tritium Facility	0.09	0.09	0.09
Pajarito Site	0.23	0.23 [b]	0.23 [b]
Radiochemistry Facility	0.01	0.01	0.01
Los Alamos Neutron Science Center	22	0.00	22
Waste Management Operations	0.04	0.04	0.04
Plutonium Facilities Complex	0.19	0.19	0.20
Non-Key Facilities (TA-21)	0.09	0.09	0.09 [b]
Total Dose (person-rem per year)	**30**	**6.1**	**36.2** [c]

TA = technical area.

[a] For the No Action and Expanded Operations Alternatives, because of the start of the Chemistry and Metallurgy Research Replacement project there would be no emissions from the Chemistry and Metallurgy Research Building after approximately 2014. The actinide processes and resulting emissions would move to a new facility near TA-55 and the Wing 9 processes would move to the Radiological Sciences Institute. There would be no change in the population dose impact from this move.

[b] TA-18 and TA-21 would be decontaminated, decommissioned, and demolished under these alternatives and would not produce emissions after that time. These values are applicable for the first few years.

[c] The population dose includes 6.2 person-rem that is the maximum annual contribution that may occur from material disposal area remediation (see Appendix I).

Minority and Low-Income Population Dose

Radiological impacts of normal operations on minority, Hispanic, American Indian[3], and low-income populations are determined by applying a methodology similar to that used to determine dose to the total population. This approach is discussed in detail in Section C.1.3. It should be noted that the exposure scenario used to model the minority, Hispanic, American Indian, and low-income populations assumes that these individuals would be exposed in the same manner as

---

[3] *The term American Indian is used in this environmental justice analysis to reflect definitions used in the 2000 Census. The term Native American is used elsewhere in this SWEIS.*

the general population, that is, by external exposure to a radioactive plume and deposited radioactive materials and by internal exposure from inhalation and from ingestion of foodstuffs.

For purposes of evaluating potential for disproportionately high and adverse impacts caused by radiological emissions from normal operations, an annual collective dose was calculated for each of the subsets of the population being evaluated (minority, Hispanic, American Indian, and low-income) within 50 miles (80 kilometers) of the emission source. **Table C–21** shows the population estimates used for this environmental justice analysis. The average dose to an individual of the minority or low-income population is then calculated to compare to the average dose to an individual from the remainder of the population. The average dose to an individual of the population subset being evaluated is derived by dividing the annual collective dose for the subset by the number of people in the subset.

Table C–21 Potentially Affected Populations

Source Location	*Total Population*	*Total Minority Population*	*Hispanic Population*	*American Indian Population*	*Low-Income Population*
TA-53	283,766	155,261	127,641	17,811	35,826
TA-36	375,495	185,474	151,110	21,263	39,206

The result is then compared to the average dose to an individual who is not a member of the subset being evaluated. The average dose to a member of the remaining population is derived by dividing the annual collective dose to the remainder of the population (collective dose to the total population minus the collective dose to the subset population) by the number of people within 50 miles (80 kilometers) that are not in the population subset. The total minority population includes all Hispanic persons regardless of race. In addition, the American Indian population may include persons who indicated that they were of Hispanic ethnicity in the 2000 Census.

As shown in Table C–20, the total population within 50 miles (80 kilometers) of LANL is projected to receive an annual dose of about 30 person-rem under the No Action Alternative, and 36 person-rem under the Expanded Operations Alternative. Because the majority of these doses (22 person-rem) result from operations at LANSCE, the environmental justice analysis for these alternatives uses the 50-mile (80-kilometer) population centered on LANSCE in TA-53. For the Reduced Operations Alternative, the majority of the collective dose of 6.4 person-rem results from operations at the High-Explosive Testing firing sites at TA-36, therefore, the environmental justice analysis for this alternative uses the 50-mile (80-kilometer) population centered on TA-36.

Table C–22 shows the collective and annual average individual doses used to examine the potential for disproportionately high and adverse impacts on minority, Hispanic, American Indian, and low-income populations. The collective population dose is highest for those populations with the highest number of individuals. Under all alternatives, the largest population is associated with the white, non-Hispanic, and non-low-income populations. The differences, if any, would be most evident on the basis of average individual doses to members of the different population groups. As shown in Table C–22, there are no appreciable differences between the average dose to any minority, Hispanic, American Indian, or low-income individual and the comparable non-minority or non-low-income individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on minority and low-income populations or individuals surrounding each facility site.

Table C–22 Comparison of Total Minority, Hispanic, American Indian and Low-income Population and Average Individual Annual Doses

	No Action [a] Alternative	*Reduced [a] Operations Alternative*	*Expanded [a] Operations Alternative*
Collective Population Dose (person-rem) [b]	29.2	4.9	29.2
Average Individual Dose (millirem)	0.10	0.013	0.10
White (non-Hispanic) Population Dose (person-rem)	15.0	2.7	15.0
Non-Minority Average Individual Dose (millirem)	0.11	0.014	0.11
Minority Population Dose (person-rem)	14.1	2.2	14.1
Minority Average Individual Dose (millirem)	0.088	0.012	0.088
Hispanic Population Dose (person-rem) [c]	11.3	1.9	11.3
Hispanic Average Individual Dose (millirem)	0.086	0.012	0.086
American Indian Population Dose (person-rem) [d]	1.8	0.20	1.8
American Indian Average Individual Dose (millirem)	0.092	0.0094	0.092
Non-low-income Population Dose (person-rem)	25.9	4.4	25.9
Non-low-income Average Individual Dose (millirem)	0.10	0.013	0.10
Low-Income Population Dose (person-rem)	3.0	0.44	3.0
Low-Income Average Individual Dose (millirem)	0.082	0.011	0.082

[a] The collective population dose displayed in this table, accounts for the estimated dose from LANSCE at TA-53 and the High Explosive Testing firing sites at TA-36 for the No Action and Expanded Operations Alternatives, and the firing sites at TA-36 for the Reduced Operations Alternative.

[b] The collective population doses for this environmental justice analysis differ by plus or minus 3 to 6 percent from those in Table C–20. This difference is due to different models used to estimate the populations; both estimates are based on data drawn from the 2000 decennial census. The SECPOP computer program used for the analysis for Table C–20 does not allow for the identification of minority and low-income populations. Therefore an alternate method that uses a more refined distribution of the population is used for this analysis. The minor differences do not affect the conclusions supported by the analyses.

[c] The total Hispanic population includes all Hispanic persons regardless of race.

[d] The American Indian population may include persons who indicated that they were of Hispanic ethnicity in the 2000 census.

Under all alternatives, the annual population and average individual dose would be highest for the white (non-Hispanic) population. Similarly the projected annual population and average individual dose for persons living above the poverty level (non-low-income populations) would be higher than for those living below the poverty threshold. These data indicate that under all alternatives there would not be disproportionately high and adverse impacts on minority, Hispanic, American Indian, and low-income populations surrounding LANL.

C.1.4 Impacts to Offsite Resident, Recreational User, and Special Pathways Receptors from Radionuclides and Chemical Contaminants in the Environment

C.1.4.1 Methodology

Earlier investigation of exposure pathways in the vicinity of LANL (DOE 1999a) concluded that ingestion of foodstuffs and water and incidental ingestion of soil and sediment were of primary interest. Several other contact exposure pathways (including dermal absorption of contaminants from clays used in pottery, bathing or ceremonial use of springs, and smoking of native vegetation) were examined at that time and were not found to be significant contributors to risk. Recent environmental surveillance results and other reports on conditions following the 2000 Cerro Grande Fire indicated that diet, land use, and cultural practices remain largely unchanged from conditions noted in the *1999 SWEIS* analysis, and that, apart from inhalation, ingestion continues to be the only significant pathway by which people in the region adjacent to LANL might be exposed to radioactive and other contaminants resulting from operations at the site. Risks from radionuclides and chemicals in the environment, therefore, were evaluated for three receptors and ingestion exposure scenarios, collectively referred to as "specific receptors." The specific receptors and the rationale for the selection of ingestion exposure parameters for this analysis are as follows:

- **Offsite Resident.** This receptor represents the resident of Los Alamos County whose living habits and diet tend to produce higher than average exposures to radioactive materials and chemicals in the local environment. The resident also was assumed to use water from the Los Alamos County water supply and to have a garden at their home that produced the fruit and vegetables that they consumed. The resident also was assumed to consume local game animals, game fish, honey, and pinyon nuts, as well as beef and milk produced on local farms and ranches. Accordingly, the pathways considered for this resident include ingestion of groundwater and the above-listed foods, plus inadvertent ingestion of soils and sediments on produce, such as leafy greens and root vegetables. The assumption that the offsite resident consumes all components of the diet and that all the foodstuffs are produced locally (that is no dilution by store-bought or processed foods from outside the area) tends to raise the intake of contaminants well above that of the average person living near LANL. In fact, at the 95th percentile consumer (high-intake) rates published by EPA for each foodstuff, a diet consisting of locally-raised beef, milk, fruits, and vegetables, plus local big game animals and fish, fairly approximates a "subsistence" diet (over 4 pounds [1.83 kilograms] of fruits and vegetables, 1.2 pounds [0.55 kilograms] of meat and fish, and 1.7 pints [0.8 liters] of milk per day), particularly when combined with the additional foods described under "specials pathways". The 95th percentile consumer eats these foodstuffs at a rate greater than 95 percent of the population.

- **Recreational User of Wildlands.** The recreational user represents a hypothetical outdoor enthusiast who regularly uses the canyons on and near LANL for recreation (as a hiker, rockhound, photographer, etc.). This receptor was assumed to make an average of two visits per month to the canyons, spending 8 hours per visit. This receptor was assumed to be exposed to environmental contaminants by consumption of surface water and the incidental ingestion of soils and sediments at concentrations typical of the LANL canyons. Ingestion of sediments and soils occurs from consuming surface water and from swallowing inhaled dust. It is reasonable to assume that the recreational user is a local resident and that, in the extreme case, exposures received in the course of outdoor recreation might be *additional to* those depicted by the offsite resident.

- **Special Pathways – Subsistence Consumption of Fish and Wildlife**. Section 4–4 of Executive Order 12898 directs that "Federal agencies whenever practicable and appropriate, shall collect, maintain, and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence" and that "Federal agencies shall communicate to the public the risks of those consumption patterns." Therefore, special exposure and diet pathways were evaluated to assess the potential impacts to Native American, Hispanic, and other residents whose traditional living habits and diets could cause larger exposures to environmental contaminants than those experienced by the hypothetical offsite resident. The foodstuffs and pathways of specific interest for this group are ingestion of game animals, including consumption of some organ meats not assumed for the "resident" receptor, ingestion of game fish and other fish taken from local waters, and ingestion of native vegetation through use of Indian Tea (Cota). In general, these intakes can be assumed to be *in addition to* the meat, milk, produce, water, and soil and sediment consumption reflected in the offsite resident plus recreational user pathway assumptions.

The types and amounts of foods represented in the offsite resident diet package suggested that consumption of all items at the *high* intake rates, plus the three additional special pathways components (non-game fish, herbal teas, organ meats), approximates a subsistence diet for someone living in the vicinity of LANL. To confirm that proposition, a trial was done in which the combined intakes (offsite resident plus recreational user plus special pathways) were adjusted to create a model diet consisting entirely of items that would likely be staple foods for a person living a subsistence life near Los Alamos. Milk, beef, and game fish were removed from the offsite resident diet package and groundwater was replaced by surface (stream) water as the sole source of drinking water. The intakes of the remaining foods – deer, elk, non-game fish; produce (beans, corn, squash, and greens); fruit (plums, apricots, and apples); honey and pinyon nuts – were then scaled up to deliver a total of 2,700 calories per day. The radiation dose from consumption of this subsistence diet was determined to be 9.1 millirem per year, consistent with the special pathways consumer at the high intake rates.

Concentrations of radionuclides and chemicals in environmental media reported in LANL Environmental Surveillance Reports for 2001 through 2004 (LANL 2002b, 2004b, 2004d, 2005b) were used in the dose and risk analysis except where noted in the table (see Tables C–24 through C–40). Chemical and radionuclide concentrations in the *2005 LANL Environmental Surveillance Report* (LANL 2006b) were reviewed and found to be enveloped by the 2001 through 2004 measurements. For each environmental medium, the mean and 95 percent upper confidence limit[4] of the reported values were calculated. Data from locations near the LANL boundary, identified in the reports as "perimeter" locations, were used to calculate dose and risk to the offsite resident receptor. For the special pathways receptor, data from bottom-feeder fish

---

[4] *Calculated using the methodology described in Appendix F.*

taken at locations downstream from LANL were used to represent the maximum impact of LANL emissions and runoff. Data from the limited number of published LANL analysis results for elk heart and liver and Indian Tea (Cota) were used to complete the intake for the special pathways receptor. For the recreational user receptor, soil, sediment and surface water analysis results for onsite locations accessible to the public were used.

Because of the small number of samples reported for some media (all items are not necessarily sampled every year) calendar year 1999 and 2000 results for foodstuffs were also considered, thereby increasing the number of data points used to develop the 95 percent upper confidence limit values and reducing uncertainty. Uncertainties associated with measured contaminant concentrations in environmental media may be quite large, and the 95 percent upper confidence limit values were used when calculating dose to hypothetical individuals to help ensure that the dose and risk estimates were conservative. For radionuclides, additional conservatism was introduced by calculating the 95 percent upper confidence limit values using only those reported values that were greater than zero. This was performed for several reasons. First, the same method was used to develop the 95 percent upper confidence limit values for calculating ingestion doses in the *1999 SWEIS.* By using the same approach, the results of the current analysis can be compared directly with the 1999 results for each pathway component. Second, concentrations of the radionuclides of interest in environmental media are typically quite low (near the threshold of detection) and, when corrected for counting background radiation, negative concentrations of some radionuclides were reported. Setting the negative values to zero or to the limit of detection for a particular radionuclide is complicated by the fact that analytical methods, detection limits, and data reporting formats may vary from year to year. Finally, the ingestion pathway doses are quite small even when they are biased upwards by eliminating the zero and negative sample results. When calculating 95 percent upper confidence limit values for nonradioactive contaminants, a similar conservatism was introduced by using a value *equal to the lower limit of detection* for all samples reported as below the detection limit.

Based on a review of LANL environmental surveillance data and the results of ingestion pathway exposure calculations published in the *1999 SWEIS*, it was determined that consumption of water, soil, sediment, fish, and produce would account for essentially all ingestion exposure to nonradioactive contaminants. Accordingly, only those five pathway components were analyzed for contribution to nonradiological risk. **Table C–23** summarizes the ingestion exposure pathway components that were evaluated for each receptor.

The consumption rate of each component of the ingestion pathway was assumed to equal the average adult daily intake. The average adult daily intake of each foodstuff is defined as the 50th percentile. The "high" daily consumer is defined as the 95th percentile consumer. In other words, 95 percent of the population eats at a rate less than the high daily consumption rate. These rates and doses are typically 2-3 times higher than for the average case. The intake rates, their sources, and the doses for both intake rates are reported in the notes following the dose calculation tables for the various components of the ingestion pathway. For chemicals, the health hazard index and cancer risk were calculated using the most current Reference Doses and Slope Factors published by EPA Region 6 (EPA 2005b).

Table C–23 Ingestion Exposure Pathway Components Evaluated for Offsite Resident, Recreational User, and Special Pathways Receptors

Exposure Pathway Component	*Offsite Resident* [a]	*Recreational User* [b]	*Special Pathways* [c]
Produce	✓	✓	✓
Meat (free-range beef)	✓	✓	✓
Milk	✓	✓	✓
Fish (game)	✓	✓	✓
Elk	✓	✓	✓
Deer	✓	✓	✓
Honey	✓	✓	✓
Pinyon nuts	✓	✓	✓
Groundwater	✓	✓	✓
Soil	✓	✓	✓
Sediment	✓	✓	✓
Surface water		✓	✓
Soil [d]		✓	✓
Sediment [d]		✓	✓
Fish (non-game)			✓
Elk (heart, liver)			✓
Indian Tea (Cota)			✓

[a] A hypothetical person who is conservatively assumed to intake various foodstuffs, water, soil and sediments with concentrations of contaminants at the 95 percent upper confidence limit for each contaminant.

[b] Assumed to visit the canyons on and near LANL 24 times per year, 8 hours per visit.

[c] Assumed to have traditional Native American or Hispanic lifestyles and diet.

[d] Soil and sediments from onsite locations.

C.1.4.2 Estimates of Ingestion Pathway Radiation Dose and Risk

The results of the radiation dose calculations for each of the receptors and components of the ingestion pathway are summarized in **Tables C–24** through **C–40**. Except where noted, all intake rates are in grams dry weight per year. The total doses from all pathway components are presented in **Table C–41**.

Table C–24 Dose from the Consumption of Produce

Exposure Pathway: Produce Ingestion				
Intake (grams per year)	*Nuclide*	*Concentration (picocuries per gram)*	*Dose Conversion Factor (rem per picocurie)*	*Dose (rem per year)*
32,200	Americium-241	0.000858	4.50×10^{-6}	0.000124
32,200	Cesium-137	0.0175	5.00×10^{-8}	0.0000282
32,200	Plutonium-238	0.00128	3.80×10^{-6}	0.000156
32,200	Plutonium-239, Plutonium-240	0.000430	4.30×10^{-6}	0.0000595
32,200	Strontium-90	0.129	1.30×10^{-7}	0.000541
32,200	Tritium	1.04	6.30×10^{-11}	2.11×10^{-6}
32,200	Uranium	0.0167	2.60×10^{-7}	0.000140
Total		–	–	**0.00105**

Notes: Average annual intakes are (4.5 grams per kilogram-day for vegetables + 3.7 grams per kilogram-day for fruits) × (a dry to wet weight ratio of 0.15) × 71.8-kilogram adult × (365 days per year) = 32,200 grams dry weight per year (EPA 2003). The *1999 SWEIS* reported 0.00162 rem per year (average intake) from combined fruit and vegetable consumption. High intake is 25.5 grams wet weight per kilogram-day. Thus, dose at high intake is (25.5/8.2) × 0.00105 or 0.00327 rem per year. To convert grams to ounces, multiply by 0.035274. To convert grams to ounces, multiply by 0.035274.

Table C–25 Dose from the Consumption of Free Range Beef

Exposure Pathway: Meat Ingestion				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
14,900	Americium-241	0.000301	4.50×10^{-6}	0.0000202
14,900	Cesium-137	0.0560	5.00×10^{-8}	0.0000417
14,900	Plutonium-238	0.000230	3.80×10^{-6}	0.0000130
14,900	Plutonium-239, Plutonium-240	0.000218	4.30×10^{-6}	0.0000140
14,900	Strontium-90	0.0843	1.30×10^{-7}	0.000163
14,900	Tritium	0.00	6.30×10^{-11}	0.00
14,900	Uranium	0.00105	2.60×10^{-7}	4.07×10^{-6}
Total		–	–	**0.000256**

Notes: Average annual intake is 2.1 grams per kilogram-day × 0.27 dry to wet ratio × 71.8 kilogram adult × 365 days per year = 14,900 grams dry weight per year (EPA 1997). Concentration values are from the 1999 LANL Environmental Surveillance Report, Table 6-14 (mean plus 2 sigma). The *1999 SWEIS* reported 0.00027 rem per year from this source and pathway. High intake is 5.1 grams per kilogram-day. Thus, dose at high intake is (5.1/2.1) × 0.000256 or 0.000622 rem per year. To convert grams to ounces, multiply by 0.035274.

Table C–26 Dose from the Consumption of Milk

Exposure Pathway: Milk Ingestion				
Intake (liters per year)	***Nuclide***	***Concentrations (picocuries per liter)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
110	Americium-241	0.0785	4.50×10^{-6}	0.0000388
110	Cesium-137	25.8	5.00×10^{-8}	0.000142
110	Plutonium-238	0.00710	3.80×10^{-6}	2.97×10^{-6}
110	Plutonium-239, Plutonium-240	0.0856	4.30×10^{-6}	0.0000405
110	Strontium-90	3.76	1.30×10^{-7}	0.0000538
110	Tritium	450	6.30×10^{-11}	3.12×10^{-6}
110	Uranium	0.120	2.60×10^{-7}	3.43×10^{-6}
Total		–	–	**0.000284**

Notes: Average annual intake is 0.3 liters per day × 365 days per year 110 liters per year. Uranium total is 0.065 (U-234) + 0.013 (U-235) + 0.042 (U-238) = 0.120 picocuries per liter. The *1999 SWEIS* reported 0.0000733 rem per year (0.000195 for high intake) from this source and pathway. High intake is 0.8 liters per day. Thus, dose at high intake is (0.8/0.3) × 0.000284 or 0.000757 rem per year (DOE 1999a). To convert liters to gallons, multiply by 0.26418.

Table C–27 Dose from the Consumption of Fish

Exposure Pathway: Fish Ingestion				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
1,880	Americium-241	0.000764	4.50×10^{-6}	6.46×10^{-6}
1,880	Cesium-137	0.0226	5.00×10^{-8}	2.13×10^{-6}
1,880	Plutonium-238	0.000517	3.80×10^{-6}	3.69×10^{-6}
1,880	Plutonium-239, Plutonium-240	0.000315	4.30×10^{-6}	2.55×10^{-6}
1,880	Strontium-90	0.0462	1.30×10^{-7}	0.0000113
1,880	Tritium	0.669	6.30×10^{-11}	7.92×10^{-8}
1,880	Uranium	0.00678	2.60×10^{-7}	3.31×10^{-6}
Total		–	–	**0.0000295**

Notes: Average annual intake is 20.1 grams per day (5.15 grams per day dry weight × 365 days = 1,880 grams per year dry weight). High intake is 53 grams per day (13.6 grams per day dry weight). Thus, dose at high intake is (53/20.1) × 0.0000295 or 0.0000778 rem per year (EPA 1997). The *1999 SWEIS* reported 0.0000542 rem per year (average intake) from this source and pathway (DOE 1999a). Uranium concentration of 9.55 nanograms per gram dry weight (0.00955 micrograms per gram dry weight) equates to 0.00678 picocuries per gram. Applying the reported 0.23 picocuries per milliliter tritium concentration value to the water fraction (1-0.256) yields: 0.744/0.256 or 2.91 grams water per gram dry weight × 0.23 picocuries per milliliter × 1 milliliter per gram water = 0.669 picocuries tritium per gram dry weight. To convert grams to ounces, multiply by 0.035274.

Table C–28 Dose from the Consumption of Elk

Exposure Pathway: Elk Ingestion				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
2,420	Americium-241	0.000221	4.50×10^{-6}	2.40×10^{-6}
2,420	Cesium-137	0.0208	5.00×10^{-8}	2.52×10^{-6}
2,420	Plutonium-238	0.0000518	3.80×10^{-6}	4.76×10^{-7}
2,420	Plutonium-239, Plutonium-240	0.000210	4.30×10^{-6}	2.18×10^{-6}
2,420	Strontium-90	0.0315	1.30×10^{-7}	9.92×10^{-6}
2,420	Tritium	1.00	6.30×10^{-11}	1.52×10^{-7}
2,420	Uranium	0.00570	2.60×10^{-7}	3.59×10^{-6}
Total		–	–	**0.0000212**

Notes: Average annual intake is 26 grams per day × 0.255 dry to wet ratio × 365 days per year = 2,420 grams per year. Uranium concentration of 8.04 nanograms per gram dry weight (0.00804 micrograms per gram) equates to 0.00570 picocuries per gram. The *1999 SWEIS* reported 0.0000773 rem per year (average intake) from this source and pathway. High intake is 63 grams per day . Thus, dose at high intake is 63/26 × 0.0000212 or 0.0000514 rem per year (DOE 1999a). To convert grams to ounces, multiply by 0.035274.

Table C–29 Dose from the Consumption of Deer

Exposure Pathway: Deer Ingestion				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
2,370	Americium-241	0.000150	4.50×10^{-6}	1.60×10^{-6}
2,370	Cesium-137	0.0351	5.00×10^{-8}	4.16×10^{-6}
2,370	Plutonium-238	0.000132	3.80×10^{-6}	1.19×10^{-6}
2,370	Plutonium-239, Plutonium-240	0.000297	4.30×10^{-6}	3.03×10^{-6}
2,370	Strontium-90	0.0386	1.30×10^{-7}	0.0000119
2,370	Tritium	4.86	6.30×10^{-11}	7.26×10^{-7}
2,370	Uranium	0.00162	2.60×10^{-7}	9.98×10^{-7}
Total		–	–	**0.0000236**

Notes: Average annual intake is 26 grams per day × 0.25 dry to wet ratio × 365 days per year = 2,370 grams per year (dry weight). High intake is 63 grams per day. Thus, dose at high intake is 63/26 × 0.0000236 or 0.0000572 rem per year. Uranium concentration of 2.28 nanograms per gram dry weight (0.00228 micrograms per gram) equates to 0.00162 picocuries per gram. Tritium concentration on a dry weight basis equals picocuries per milliliter of water × milliliters of water per gram dry weight. If the dry to wet ratio is 0.25, 0.75 grams water (0.75 milliliter) is present for each 0.25 grams dry weight. Tritium concentration is 1.62 picocuries per milliliter × 0.75 milliliters/0.25 grams or 4.86 picocuries per gram dry weight. The *1999 SWEIS* reported 0.0000181 rem per year (average intake) from this source and pathway (DOE 1999a). To convert grams to ounces, multiply by 0.035274.

Table C–30 Dose from the Consumption of Honey

Exposure Pathway: Honey Ingestion				
Intake (milliliters per year)	***Nuclide***	***Concentration (picocuries per milliliter)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
989	Americium-241	0.000599	4.50×10^{-6}	2.67×10^{-6}
989	Cesium-137	0.0177	5.00×10^{-8}	8.73×10^{-7}
989	Plutonium-238	0.0000294	3.80×10^{-6}	1.10×10^{-7}
989	Plutonium-239, Plutonium-240	0.0000728	4.30×10^{-6}	3.10×10^{-7}
989	Strontium-90	0.00406	1.30×10^{-7}	5.22×10^{-7}
989	Tritium	2.07	6.30×10^{-11}	1.29×10^{-7}
989	Uranium	0.00712	2.60×10^{-7}	1.83×10^{-6}
Total		–	–	**6.44×10^{-6}**

Notes: Average intake is 3.84 grams per day. At a specific gravity of 1.4171 (18 percent water, 20 degrees centigrade) this equates to 2.71 milliliters per day or 989 milliliters per year. High intake is 13.7 grams per day or 3,528 milliliters per year. Thus, dose at high intake is 13.7/3.84 × 6.44×10^{-6} or 0.0000230 rem per year. Uranium value is 0.00356 (uranium-234) plus 0.000394 (uranium-235) plus 0.00317 (uranium-238) = 0.00712 picocuries per milliliter. The *1999 SWEIS* reported 7.37×10^{-7} rem per year from this source and pathway (average intake), but addressed only tritium and did not include the contributions from the other nuclides reported here (DOE 1999a).

Table C–31 Dose from the Consumption of Pinyon Nuts

Exposure Pathway: Pinyon Nut Ingestion				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
1,410	Beryllium-7	0.140	1.10×10^{-10}	2.17×10^{-8}
1,410	Americium-241	0.00	4.50×10^{-6}	0.00
1,410	Cesium-137	0.0200	5.00×10^{-8}	1.41×10^{-6}
1,410	Plutonium-238	0.0170	3.80×10^{-6}	0.0000911
1,410	Plutonium-239, Plutonium-240	0.0130	4.30×10^{-6}	0.0000788
1,410	Strontium-90	0.230	1.30×10^{-7}	0.0000422
1,410	Tritium	0.364	6.30×10^{-11}	3.23×10^{-8}
1,410	Uranium	0.0568	2.60×10^{-7}	0.0000208
Total		–	–	**0.000234**

Notes: Calculated using concentrations from *1999 SWEIS* Table D.3.3-50 corrected for dry to wet ratio of 0.94 versus 0.06 (NutritionData 2006). Average intake of 1,500 grams per year corresponds to 1,410 grams per year dry weight. Tritium concentration is (0.06/0.94) × (1 milliliter per gram water) × (5.7 picocuries per milliliter) = 0.364 picocuries per gram. The *1999 SWEIS* reported 0.0000155 rem per year for from this source and pathway (DOE 1999a). No high intake was found. Thus, dose at high intake equals dose at average intake. To convert grams to ounces, multiply by 0.035274.

Table C–32 Dose from the Consumption of Groundwater

Exposure Pathway: Groundwater Ingestion				
Intake (liters per year)	***Nuclide***	***Concentration (picocuries per liter)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
551	Americium-241	0.0551	4.50×10^{-6}	0.000137
551	Cesium-137	6.49	5.00×10^{-8}	0.000179
551	Plutonium-238	0.0127	3.80×10^{-6}	0.0000267
551	Plutonium-239, Plutonium-240	0.0244	4.30×10^{-6}	0.0000577
551	Strontium-90	0.101	1.30×10^{-7}	7.26×10^{-6}
551	Tritium	311	6.30×10^{-11}	1.08×10^{-5}
551	Uranium	0.866	2.60×10^{-7}	0.000124
Total		–	–	**0.000542**

Notes: Average intake is 1.51 liters per day (551 liters per year). High intake is 2.44 liters per day. Thus, dose at high intake is (2.44/1.51) × 0.000542 or 0.000876 rem per year. Calculated using groundwater composite data (95 percent upper confidence limit) for 2001-2004 for "Water Supply Wells" (see Appendix F of this SWEIS). The *1999 SWEIS* reported 0.00234 rem per year for the offsite Los Alamos County resident from this source and pathway (DOE 1999a). To convert liters to gallons, multiply by 0.26418.

Table C–33 Dose from the Consumption of Soil

Exposure Pathway: Soil Ingestion				
Intake (grams per year)	**Nuclide**	**Concentration (picocuries per gram)**	**Dose Conversion Factor (rem per picocurie)**	**Dose (rem per year)**
36.5	Americium-241	0.0126	4.50×10^{-6}	2.07×10^{-6}
36.5	Cesium-137	0.346	5.00×10^{-8}	6.31×10^{-7}
36.5	Plutonium-238	0.00358	3.80×10^{-6}	4.96×10^{-7}
36.5	Plutonium-239, Plutonium-240	0.0671	4.30×10^{-6}	0.0000105
36.5	Strontium-90	0.177	1.30×10^{-7}	8.39×10^{-7}
36.5	Tritium	1.04	6.30×10^{-11}	2.39×10^{-9}
36.5	Uranium	2.39	2.60×10^{-7}	0.0000227
Total		–	–	**0.0000372**

Notes: Average intake is 36.5 grams per year. High intake is 146 grams per year. Thus, dose at high intake is (146/36.5) × 0.0000372 or 0.000149 rem per year. Calculated using 2001-2004 composite data (95 percent upper confidence limit) for perimeter stations (see Appendix F of this SWEIS). The *1999 SWEIS* reported 0.000313 rem per year for the offsite resident from this source and pathway (DOE 1999a). To convert grams to ounces, multiply by 0.035274.

Table C–34 Dose from the Consumption of Sediment

Exposure Pathway: Sediment Ingestion				
Intake (grams per year)	**Nuclide**	**Concentration (picocuries per gram)**	**Dose Conversion Factor (rem per picocurie)**	**Dose (rem per year)**
36.5	Americium-241	0.365	4.50×10^{-6}	0.0000600
36.5	Cesium-137	0.327	5.00×10^{-8}	5.97×10^{-7}
36.5	Plutonium-238	0.220	3.80×10^{-6}	3.05×10^{-5}
36.5	Plutonium-239, Plutonium-240	0.947	4.30×10^{-6}	0.000149
36.5	Strontium-90	0.244	1.30×10^{-7}	1.16×10^{-6}
36.5	Tritium	127	6.30×10^{-11}	2.92×10^{-7}
36.5	Uranium	1.77	2.60×10^{-7}	0.0000168
Total		–	–	**0.000258**

Notes: Average intake is 36.5 grams per year. High intake is 146 grams per year. Thus, dose at high intake is (146/36.5) × 0.000258 or 0.00103 rem per year. Calculated using 2001-2004 composite data (95 percent upper confidence limit) for perimeter stations (see Appendix F of this SWEIS). The *1999 SWEIS* reported 0.00262 rem per year for the offsite resident from this source and pathway (DOE 1999a). To convert grams to ounces, multiply by 0.035274.

Table C–35 Dose to the Recreational User Receptor from the Consumption of Surface Water

Exposure Pathway: Surface Water Ingestion (Recreational User)				
Intake (liters per year)	***Nuclide***	***Concentration (picocuries per liter)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
5.34	Americium-241	17.7	4.50×10^{-6}	0.000426
5.34	Cesium-137	13.9	5.00×10^{-8}	3.72×10^{-6}
5.34	Plutonium-238	20.4	3.80×10^{-6}	0.000415
5.34	Plutonium-239, Plutonium-240	14.6	4.30×10^{-6}	0.000336
5.34	Strontium-90	3.97	1.30×10^{-7}	2.75×10^{-6}
5.34	Tritium	380	6.30×10^{-11}	1.28×10^{-7}
5.34	Uranium	16.6	2.60×10^{-7}	0.0000230
Total		–	–	**0.00121**

Notes: Average intake is 5.34 liters per year. High intake is 8.64 liters per year. Thus, dose at high intake is (8.64/5.34) × 0.00121 or 0.00195 rem per year. Calculated using surface water onsite stations 2001-2004 composite data (95 percent upper confidence limit). The *1999 SWEIS* reported 0.000740 rem per year for the "resident recreational user" from this source and pathway (DOE 1999a). To convert liters to gallons, multiply by 0.26418.

Table C–36 Dose to the Recreational User Receptor from the Consumption of Soil

Exposure Pathway: Soil Ingestion (Recreational User)				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
1.07	Americium-241	0.0176	4.50×10^{-6}	8.49×10^{-8}
1.07	Cesium-137	0.365	5.00×10^{-8}	1.95×10^{-8}
1.07	Plutonium-238	0.00236	3.80×10^{-6}	9.60×10^{-9}
1.07	Plutonium-239, Plutonium-240	0.0669	4.30×10^{-6}	3.08×10^{-7}
1.07	Strontium-90	0.154	1.30×10^{-7}	2.14×10^{-8}
1.07	Tritium	1.14	6.30×10^{-11}	7.71×10^{-11}
1.07	Uranium	2.34	2.60×10^{-7}	6.51×10^{-7}
Total		–	–	$\mathbf{1.09 \times 10^{-6}}$

Notes: Average intake is 1.07 grams per year. High intake is 4.27 grams per year. Thus, dose at high intake is (4.27/1.07) × 1.09×10^{-6} or 4.37×10^{-6} rem per year. Calculated using 2001-2004 composite data (95 percent upper confidence limit) for onsite stations (see Appendix F of this SWEIS). The *1999 SWEIS* reported 0.0000125 rem per year for the "resident recreational user" from this source and pathway (DOE 1999a). To convert grams to ounces, multiply by 0.035274.

Table C–37 Dose to the Recreational User Receptor from the Consumption of Sediment

Exposure Pathway: Sediment Ingestion (Recreational User)				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
1.07	Americium-241	0.696	4.50×10^{-6}	3.35×10^{-6}
1.07	Cesium-137	1.48	5.00×10^{-8}	7.89×10^{-8}
1.07	Plutonium-238	0.422	3.80×10^{-6}	1.72×10^{-6}
1.07	Plutonium-239, Plutonium-240	0.692	4.30×10^{-6}	3.18×10^{-6}
1.07	Strontium-90	0.286	1.30×10^{-7}	3.98×10^{-8}
1.07	Tritium	352	6.30×10^{-11}	2.37×10^{-8}
1.07	Uranium	1.86	2.60×10^{-7}	5.17×10^{-7}
Total		–	–	**8.91×10^{-6}**

Notes: Average intake is 1.07 grams per year. High intake is 4.27 grams per year. Thus, the dose at high intake is (4.27/1.07) × 8.91×10^{-6} or 0.0000356 rem per year. Calculated using 2001-2004 composite data (95 percent upper confidence limit) for onsite stations (see Appendix F of this SWEIS). The *1999 SWEIS* reported 0.000176 rem per year for the “resident recreational user” from this source and pathway (DOE 1999a). To convert grams to ounces, multiply by 0.035274.

Table C–38 Dose to the Special Pathways Receptor from the Consumption of Fish

Exposure Pathway: Fish Ingestion (Special Pathways)				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
6,540	Americium-241	0.000482	4.50×10^{-6}	0.0000142
6,540	Cesium-137	0.00866	5.00×10^{-8}	2.83×10^{-6}
6,540	Plutonium-238	0.000653	3.80×10^{-6}	0.0000162
6,540	Plutonium-239, Plutonium-240	0.000210	4.30×10^{-6}	5.90×10^{-6}
6,540	Strontium-90	0.0450	1.30×10^{-7}	0.0000382
6,540	Tritium	1.16	6.30×10^{-11}	4.78×10^{-7}
6,540	Uranium	0.0184	2.60×10^{-7}	0.0000313
Total		–	–	**0.000109**

Notes: Calculated using average intake of 70 grams per day (17.92 grams per day dry weight). High intake is 170 grams per day (43.52 grams per day dry weight.). Thus, dose at high intake is (170/70) × 0.000109 or 0.000265 rem per year (EPA 1997). The *1999 SWEIS* reported 0.000189 rem per year (average intake) from this source and pathway. Uranium concentration of 24.5 nanograms per gram dry weight. (0.0245 micrograms per gram) equates to 0.0174 picocuries per gram. Applying the reported 0.40 picocuries per milliliter tritium concentration value to the water fraction (1-0.256) yields: 0.744 grams water per 0.256 grams dry weight × 0.40 picocuries per milliliter × 1 milliliter per gram water = 1.163 picocuries per gram dry weight. To convert grams to ounces, multiply by 0.035274.

Table C–39 Dose to the Special Pathways Receptor from the Consumption of Elk Heart and Liver

Exposure Pathway: Elk Ingestion (Special Pathways)				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
436	Americium-241	0.00	4.50×10^{-6}	0.00
436	Cesium-137	0.0679	5.00×10^{-8}	1.48×10^{-6}
436	Plutonium-238	0.00	3.80×10^{-6}	0.00
436	Plutonium-239, Plutonium-240	0.000655	4.30×10^{-6}	1.23×10^{-6}
436	Strontium-90	0.00650	1.30×10^{-7}	3.68×10^{-7}
436	Tritium	0.00	6.30×10^{-11}	0.00
436	Uranium	0.0347	2.60×10^{-7}	3.93×10^{-6}
Heart Total		–	–	**7.01×10^{-6}**
763	Americium-241	0.00	4.50×10^{-6}	0.00
763	Cesium-137	0.596	5.00×10^{-8}	0.0000227
763	Plutonium-238	0.0000750	3.80×10^{-6}	2.17×10^{-7}
763	Plutonium-239, Plutonium-240	0.0000950	4.30×10^{-6}	3.12×10^{-7}
763	Strontium-90	0.00820	1.30×10^{-7}	8.13×10^{-7}
763	Tritium	0.00	6.30×10^{-11}	0.00
763	Uranium	0.0160	2.60×10^{-7}	3.17×10^{-6}
Liver Total		–	–	**0.0000273**
Heart + Liver Total		–	–	**0.0000343**

Notes: This represents consumption of heart and liver in addition to the meat consumption calculated for the resident. Average heart intake is based on 3.2 pounds per year for an individual × 454 grams per pound × 0.30 (wet to dry ratio). Average liver intake is based on 5.6 pounds per year for an individual × 454 grams per pound × 0.30 (wet to dry ratio). The *1999 SWEIS* reported 0.0000343 rem per year from this source and pathway (no new data were found – same data and consumption rates were used here as for *1999 SWEIS*) (DOE 1999a). To convert grams to ounces, multiply by 0.035274.

Table C–40 Dose to the Special Pathways Receptor from the Consumption of Indian Tea (Cota)

Exposure Pathway: Indian Tea (Cota) Ingestion (Special Pathways)				
Intake (liters per year)	***Nuclide***	***Concentration (picocuries per liter)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
213	Americium-241	0.0362	4.50×10^{-6}	0.0000347
213	Cesium-137	21.2	5.00×10^{-8}	0.000226
213	Plutonium-238	0.0250	3.80×10^{-6}	0.0000202
213	Plutonium-239, Plutonium-240	0.0302	4.30×10^{-6}	0.0000277
213	Strontium-90	0.642	1.30×10^{-7}	0.0000178
213	Tritium	117	6.30×10^{-11}	1.58×10^{-6}
213	Uranium	0.780	2.60×10^{-7}	0.0000432
Total		–	–	**0.000371**

Notes: Average intake is 0.58 liters per day (213 liters per year). High intake is 2.03 liters per day (741 liters per year). Thus, dose at high intake is (2.03/0.58) × 0.000371 or 0.00130 rem per year. The *1999 SWEIS* reported 0.000749 rem per year (average intake) from this source and pathway (DOE 1999a). To convert liters to gallons, multiply by 0.26418.

Table C–41 Summary of Ingestion Pathway Doses for Offsite Resident, Recreational User, and Special Pathways Receptors

Exposure Pathway	*Dose to Receptor (rem per year)*		
	Offsite Resident [a]	*Recreational User* [b]	*Special Pathways* [c]
Produce	0.00105	0.00105	0.00105
Meat (free-range beef)	0.000256	0.000256	0.000256
Milk	0.000284	0.000284	0.000284
Fish (game)	0.0000294	0.0000294	0.0000294
Elk	0.0000212	0.0000212	0.0000212
Deer	0.0000236	0.0000236	0.0000236
Honey	6.44×10^{-6}	6.44×10^{-6}	6.44×10^{-6}
Pinyon nuts	0.000234	0.000234	0.000234
Groundwater	0.000542	0.000542	0.000542
Soil	0.0000372	0.0000372	0.0000372
Sediment	0.000258	0.000258	0.000258
Surface water	–	0.00121	0.00121
Soil [d]	–	1.09×10^{-6}	1.09×10^{-6}
Sediment [d]	–	8.91×10^{-6}	8.91×10^{-6}
Fish (non-game)	–	–	0.000109
Elk (heart, liver)	–	–	0.0000343
Indian Tea (Cota)	–	–	0.000371
Totals	**0.00274**	**0.00396**	**0.00448**

[a] A hypothetical person who is conservatively assumed to intake various foodstuffs, water, soil and sediments with concentrations of contaminants at the 95 percent upper confidence limit for each contaminant.
[b] Assumed to visit the canyons on and near LANL 24 times per year, 8 hours per visit.
[c] Assumed to have traditional Native American or Hispanic lifestyles and diet.
[d] Soil and sediments from onsite locations.

The offsite resident receptor was estimated to receive a dose of about 0.00274 rem, or about 2.7 millirem, per year from the ingestion exposures reported here. Eliminating all zero and negative values when calculating the 95 percent upper confidence limit concentration from the reported environmental surveillance results adds a degree of conservatism. It is also quite unlikely that any given individual would derive all of their diet from local sources, as was assumed in this consumption model. Additional exposures to a person whose diet and activities reflect those of the recreational user and special pathways receptors would bring their total doses to about 4.0 and 4.5 millirem per year, respectively. Using a risk estimator value of 0.0006 lifetime probability of fatal cancer per person-rem, 4.5 millirem (0.0045 rem) per year would equate to a probability of fatal cancer of 2.7×10^{-6}, or just under a 3 in 1 million chance of developing a fatal cancer from the ingestion pathway. The high consumption rates for all components of the ingestion pathway are detailed in their respective tables (C–24 through C–40). The total doses to each receptor as a result of potential consumption at these higher rates would be increased by less than a factor of three. Using the high consumption rates, the lifetime probability of developing a fatal cancer would be about 4.3×10^{-6} for the offsite resident total dose of 0.0072 rem; 5.5×10^{-6} for the recreational user total dose of 0.0091 rem; and 6.4×10^{-6} for the special pathways receptor total dose of 0.0107 rem per year of exposure.

For perspective, the ingestion pathway doses of 2.7 to 10.7 millirem per year calculated here for the offsite resident and other specific receptors should be viewed against the dose of about 400 millirem (dose ranges from 300 to 500 millirem) per year that the average Los Alamos resident receives from all background radiation sources (see Section C.1.1.3). That average includes about 240 millirem from radioactive material that has entered the body by inhalation or ingestion. The largest fraction of the internal dose (about 200 millirem on average) is due to the short-lived decay products of naturally-occurring radon gas. It is also important to compare these ingestion pathway doses to the more significant inhalation pathway dose, where the bulk of the radiological air emissions and resulting dose come from LANSCE and the High Explosives Testing Key Facility (see Chapter 5, Section 5.6).

As shown in Table C–41, the highest estimated ingestion pathway dose to any specific receptor is about 4.5 millirem per year from radionuclides in the environment resulting from past LANL operations, global fallout, and naturally-occurring geologic sources. If a particular specific receptor also were to receive the maximum impact from projected future radionuclide LANL emissions to the atmosphere (see Tables C–19, C–20, and C–21), that specific receptor might receive a total annual dose from past and future site operations ranging from about 5.3 millirem (4.5 millirem plus the dose to the MEI of 0.79 millirem) for the Reduced Operations Alternative to about 12.3 millirem (4.5 millirem plus the dose to the MEI of 7.8 millirem) for the No Action and Expanded Operations Alternatives. The fatal cancer risk associated with these doses ranges from about 3 in 1 million to 7 in 1 million. To place these doses in perspective, that same individual would be expected to receive an annual dose from background sources of about 400 millirem. In addition, these are conservatively calculated doses because no one person would actually consume such a large concentration from each pathway component. These large concentrations are found at scattered locations around LANL.

When calculating ingestion pathway radiation doses, river surface water was considered as a potential dose source for certain recreational user and special pathways receptors. Surface water radioisotope concentrations were measured at locations both upstream and downstream of LANL on the Rio Grande and Jemez River during 2005 (LANL 2006b). The 95 percent upper confidence limit values of these measurements were used to calculate the radiation dose to an individual that consumed all their drinking water, at the rate of 2 liters per day, from these surface water sources. The total surface drinking water doses are presented in **Table C–42**. This table shows the location of the sampling station relative to LANL (that is, upstream or downstream), as well as the fraction of the EPA 4 millirem per year drinking water limit that the calculated dose at each location represents. Consumption of all drinking water from all of the river locations around LANL resulted in doses of less than 10 percent of the EPA limit. There was no trend between upstream and downstream locations relative to LANL.

The doses calculated here are generally lower than those reported in the *1999 SWEIS* for the same ingestion pathway components. Only 5 of the 17 pathway component doses are greater than those reported in the *1999 SWEIS*. The dose from honey consumption is greater than that reported in the *1999 SWEIS* because the 1999 dose calculation considered only the dose from tritium, whereas this calculation includes the dose from tritium and all other radionuclides reported in the LANL environmental surveillance data for honey. The dose from pinyon nut consumption reported here is higher because this calculation makes use of a higher dry to wet weight ratio than was assumed in the *1999 SWEIS* calculation. The doses from consumption of surface water (recreational user), milk, and deer are also higher, but not remarkably so. The calculated dose from consumption of elk heart and liver is unchanged from the *1999 SWEIS* because no more current radionuclide concentration data were found. The lower doses calculated here for the other 12 pathway components are due to lower average radionuclide concentrations in environmental media reported during the 2001 through 2004 period compared to the 1991 through 1996 data used in the *1999 SWEIS* calculations.

Table C–42 Total Los Alamos National Laboratory River Surface Water Consumption Radiation Doses

Surveillance Sample River Site	*Location Upstream or Downstream of LANL*	*Total Annual (2 liters per day) Drinking Water Dose (millirem)*	*Percent of Annual EPA Drinking Water Dose Limit of 4 Millirem*
Jemez River	Upstream	0.384	9.6%
Embudo at Rio Grande	Upstream	0.118	3.0%
Otowi at Rio Grande	Upstream	0.159	4.0%
Chamita at Rio Grande	Upstream	0.236	5.9%
Frijoles at Rio Grande	Downstream	0.297	7.4%
Cochiti at Rio Grande	Downstream	0.172	4.3%

C.2 Impacts on Human Health from Nonradioactive Contaminants in the Environment

Many nonradioactive substances (chemical elements, compounds, and mixtures) found in the environment are potentially harmful to human health. Some substances, small amounts of which are beneficial or necessary for good health, may be harmful in larger amounts or higher concentrations (examples: iron, selenium, zinc). Even at very low concentrations or levels of intake, exposure to some substances may cause long-term health effects or increase the likelihood of developing certain diseases, particularly when the exposure continues over a long period of time (that is, chronic exposure). The health impact (harmful effect) of taking any substance into the body depends on the toxicity of the material (a measure of the amount needed to produce a given harmful effect) and the dose or intake (the rate at which the substance was taken into the body). For many substances, humans have the capacity to metabolize, excrete, or otherwise detoxify small quantities or small chronic intakes without showing ill effects. Substances that accumulate in the body over time, however, may cause harm that becomes evident only after many years of exposure.

Humans may be exposed to toxic substances in their environment by several different routes, of which ingestion, inhalation, and skin contact are usually most important. At concentrations typically found in the general living environment, acute health effects (those having a rapid onset followed by a short, severe course of symptoms) are seldom observed. Elevated levels of some contaminants in air, water, soil, and other environmental media, however, have been linked statistically to the occurrence rate (or frequency) of specific health problems in populations exposed to those media. The health effects from exposure to carcinogenic substances are evaluated using risk factors from the EPA Integrated Risk Information System database (EPA 2005a). The risk factor for a substance is an estimate of the upper-bound lifetime probability, per unit oral intake or concentration in the air, of an individual developing cancer from exposure to the substance. The potential for noncancer health effects from exposure to a toxic substance is evaluated by dividing the estimated average daily intake of that substance by its Oral Reference Dose value (RfD) to obtain a hazard index. The Oral Reference Dose is an estimate of the average daily oral intake that is believed to pose no appreciable risk of harmful health effects (EPA 2005b). If the calculated hazard index is greater than 1, the individual is considered to be at some risk of adverse health effects as a result of exposure to the substance.

C.2.1 Methods Used to Estimate Risks from Ingestion of Nonradioactive Contaminants

Environmental media and foodstuffs collected on and near LANL are regularly analyzed for various nonradioactive contaminants. Measured concentrations of contaminants in food, water, soils and sediments are used here to calculate the health risks to residents and special pathways receptors from the ingestion of those materials. The same dietary intake assumptions used to calculate radiation dose and risk were used to estimate health risk from a range of nonradioactive contaminants, some of which occur naturally in the LANL environment and others that are a result of past LANL operations, natural processes, or human activities in the region.

Naturally-occurring contaminants with possible health implications for residents include metals derived from local soil and rock that are consumed via ingestion of groundwater, surface water, soil, sediment and various foodstuffs. As part of this group, arsenic and beryllium are known to be present in concentrations that represent a significant increment of ingestion risk. Contaminants known to have been released to the environment from site operations include nitrates and perchlorate, as well as various high explosives and organics. These materials are present in groundwater and surface water on and near LANL, and therefore represent a potential direct impact on the health of the current population from past LANL operations. Finally, residues from environmentally persistent pesticides used in the surrounding forests and agricultural land can be detected in various media, as can organic contaminants of natural (such as wildland fires) or undetermined origin. These substances and others have been monitored, either regularly or episodically as part of the LANL Environmental Surveillance Program.

Groundwater Ingestion

To estimate human health impacts to the public, only contaminants that could be ingested by the postulated receptors were included in the impact calculations. For the groundwater component of the ingestion pathway, only analysis results from the water supply wells were used to calculate the 95 percent upper confidence limit concentration.

Groundwater at LANL occurs as a regional aquifer at depths ranging from 600 to 1,200 feet (180 to 370 meters) and as perched groundwater of limited thickness and horizontal extent, either in canyon alluvium or at intermediate depths of a few hundred feet. All water produced by the Los Alamos County water supply system comes from the regional aquifer and meets Federal and state drinking water standards. No drinking water is supplied from the alluvial and intermediate groundwater sources. Water supply wells are present in Guaje Canyon, Pueblo Canyon, upper Los Alamos Canyon, Mortandad Canyon, Pajarito Canyon, and White Rock Canyon.

Liquid effluent disposal is the primary means by which LANL contaminants have had an effect, albeit limited, on the regional aquifer. Liquid effluent disposal at LANL has significantly degraded the quality of alluvial groundwater in some canyons. Because flow through the underlying approximately 900-foot-thick (270-meter-thick) zone of unsaturated rock is slow, the impact of effluent disposal is seen to a lesser degree in intermediate-depth perched groundwater and is only seen in a few wells that draw from the regional aquifer. In general, groundwater quality would improve as outfalls are eliminated, the volume of liquid discharges is reduced, and the water quality (concentrations of contaminants) of the discharges is improved.

During the last decade, EPA has recognized the potential for perchlorate toxicity at concentrations in the parts per billion range. No EPA regulatory limit exists for perchlorate in drinking water, though several states have set limits in the range of 10 to 20 parts per billion. EPA Region VI has established a level of 3.7 parts per billion.

LANL and the New Mexico Environment Department DOE Oversight Bureau have found perchlorate in most groundwater samples analyzed from across northern New Mexico at concentrations below 1 part per billion. At LANL, perchlorate was the byproduct of the perchloric acid used in nuclear chemistry research. Water samples from most LANL locations show low perchlorate concentrations, but samples taken downstream from inactive perchlorate release sites show distinctly higher values.

As indicated by the LANL environmental surveillance program (LANL 2005b), the presence of high metal values (compared with regulatory standards) in groundwater samples is believed to be due to ubiquitous well-sampling-related issues rather than to contamination resulting from LANL operations. Well-drilling fluids; the metal in well casings, fittings, and pump housings; dissolved surface minerals from the aquifer's rock framework; and alterations to aquifer water chemistry due to the presence of a well all may contribute to increases of some metal values.

Arsenic was detected in measurable amounts in some water supply wells. As noted in Appendix D of the *1999 SWEIS*, the primary sources of arsenic in food and water sources in the LANL area are naturally-occurring soil and basalt. The concentrations of arsenic in groundwater supply wells are not significantly different between Los Alamos and San Ildefonso. The main use of arsenic in the United States is pesticide formulation, and LANL does not use large amounts of arsenic in any of its research and development or processing activities.

Some supply wells have shown elevated levels of nitrate. LANL environmental surveillance program results (LANL 2005b) indicate that a possible source of these contaminants is effluent from a local sewage treatment plant. In addition, some past effluent discharges from the Radioactive Liquid Waste Treatment Facility contained high levels of nitrates (LANL 2004b).

The LANL environmental surveillance program analyzed samples from selected springs and wells for organic constituents. Samples were analyzed for some or all of the following types of organics: volatile organic compounds, semivolatile organic compounds, polychlorinated biphenyls, pesticides, diesel-range organics, and high explosives (HMX, RDX, TNT). Certain organic compounds used in analytical laboratories are frequently detected in samples, probably as a result of contamination introduced by the laboratory process. These compounds include acetone, methylene chloride, 2-butanone, and bis(2-ethylhexyl)phthalate. Since there was no definitive evidence that these compounds were introduced as part of the laboratory process, they were conservatively retained as part of the group of organics considered as contributing to risk from ingestion of groundwater.

Volatile and semi-volatile organic compounds were not found in any of the water supply wells in significant concentrations; therefore, they were not included in the group of compounds that contribute to risk from groundwater consumption.

High-explosive compounds also were not found in statistically significant quantities in the water supply wells. They have been found in other regional aquifer wells, however, and are a known contaminant in surface waters and sediments. As a result, any supply well sample results containing high-explosive compounds were conservatively retained for consideration.

In August 2004, the LANL environmental surveillance program identified several positive pesticide results, notably results for 4,4'-DDT and 4,4'-DDE, in LANL samples. These results were not supported by previous data or by process knowledge at the sample locations. Subsequent examination of the data revealed that some glassware used in the process was only rinsed, without further cleaning, between uses. This finding meant that pesticide contamination could be transferred from one sample to another during the sample preparation. As a result, all pesticide results for 2004 are considered unusable (LANL 2005b).

Table C–43 shows the contribution to health risk to the offsite resident receptor from ingestion of trace metals, nitrates, perchlorate, and organic compounds in groundwater. Arsenic, the contaminant with the highest Hazard Index and cancer risk, occurs naturally at relatively high concentrations in soil and groundwater throughout northern New Mexico. Arsenic is not known to have been used in significant quantities at LANL and the elevated groundwater concentrations do not appear to be related to any past or current LANL operations or effluents. Vanadium, the contaminant with the second-highest Hazard Index, is also a naturally-occurring trace element in the region. Elevated concentrations of vanadium seen in surface water and groundwater samples do not appear to be related to any past or current LANL operations or effluents. See Section C.2 for additional information.

Surface Water and Sediment Ingestion

LANL personnel monitor surface water and stream sediments in northern New Mexico and southern Colorado to evaluate the potential environmental effects of LANL operations. LANL personnel analyze samples for radionuclides, high explosives, metals, a wide range of organic compounds, and (for surface water) general chemistry.

Watercourses that drain from LANL property are dry most of the year. No perennial surface water extends completely across LANL in any canyon. The canyons consist of over 85 miles (140 kilometers) of watercourses located within LANL and Los Alamos Canyon upstream of the site. Of the 85 (140 kilometers) miles of watercourse, approximately 2 miles (3.2 kilometers) are naturally perennial, and approximately 3 miles (4.8 kilometers) are perennial waters created by effluent. The remaining 80 or more miles (130 kilometers) of watercourse dry out for varying lengths of time. The driest segments may flow only in response to local precipitation or snowmelt. Although most of the watercourses are dry throughout the year, occasional floods can redistribute sediment in a streambed to locations far downstream from where a release or spill occurs.

Table C–43 Hazard Index and Cancer Risk to the Offsite Resident Receptor from the Ingestion of Nonradioactive Contaminants in Groundwater

Groundwater Consumption: 1.51 Liters per Day Average, 2.44 Liters per Day High Intake

Analytes	*95% UCL Concentration (μg/L)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Silver	1.08	0.0000227	0.0000367	0.005		0.00454	0.00735		
Aluminum	176	0.0037	0.00599	1.00		0.0037	0.00599		
Arsenic	13	0.00027	0.000443	0.0003	1.5	0.912	1.48	0.00041	0.000664
Boron	1,350	0.0283	0.0459	0.2		0.142	0.229		
Barium	182	0.00383	0.0062	0.2		0.0192	0.0310		
Beryllium	0.229	4.80×10^{-6}	7.77×10^{-6}	0.002	4.3	0.0024	0.0039	0.0000206	0.0000334
Cadmium	0.164	3.43×10^{-6}	5.56×10^{-6}	0.0005	0.0018	0.00687	0.0111	6.18×10^{-9}	1.00×10^{-8}
Perchlorate	2.88	0.00006	0.0000987	0.0007		0.0863	0.140		
Cobalt	2.95	0.0000619	0.0001	0.02		0.00309	0.00501		
Chromium	8.48	0.000178	0.00029	1.5		0.000119	0.000192		
Copper	22.9	0.000481	0.00079	0.037		0.013	0.021		
Mercury	0.248	5.21×10^{-6}	8.43×10^{-6}	0.0003		0.0174	0.0281		
Manganese	12.6	0.000265	0.000429	0.047		0.00564	0.00912		
Molybdenum	33.3	0.0007	0.00113	0.005		0.14	0.227		
Nickel	4.45	0.0000935	0.00015	0.02		0.00468	0.00757		
Nitrate	1,910	0.0402	0.065	1.6		0.0251	0.0406		
Lead	5.21	0.00011	0.000177	0.0014		0.0781	0.126		
Antimony	0.419	8.79×10^{-6}	0.0000142	0.0004		0.022	0.0356		
Selenium	6.55	0.00014	0.000223	0.005		0.0275	0.0446		
Tin	5.46	0.00012	0.000186	0.6		0.000191	0.00031		
Strontium	835	0.0175	0.0284	0.6		0.0292	0.0473		
Thallium	0.318	6.68×10^{-6}	0.0000108	0.00008		0.0835	0.135		
Uranium	0.875	0.0000184	0.0000298	0.0006		0.0306	0.0496		
Vanadium	3.65	0.00077	0.00124	0.001		0.766	1.24		
Zinc	189	0.00397	0.00643	0.3		0.0132	0.0214		

Analytes	95% UCL Concentration (µg/L)	Average Chronic Daily Intake (mg/kg-day)	High Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg-day)	Oral Slope Factor (per mg/kg-day)	Average Case Hazard Index	High Intake Hazard Index	Average Case Cancer Risk	High Intake Cancer Risk
Acetone	10.6	0.00022	0.00036	0.9		0.000246	0.00399		
Bis(2-ethylhexyl)phthalate	1.59	0.0000334	0.0000541	0.02	0.014	0.00167	0.0027	4.67×10^{-7}	7.57×10^{-7}
Butanone(2)	0.36	7.56×10^{-6}	0.0000122	0.6		0.0000126	0.0000204		
Chloromethane	1.22	0.0000256	0.0000415	0.026	0.0063	0.000985	0.0016	1.61×10^{-7}	2.61×10^{-7}
Heptachlor epoxide	0.01	2.10×10^{-7}	3.40×10^{-7}	0.0000130	9.1	0.0162	0.0262	1.91×10^{-6}	3.09×10^{-6}
Methylene chloride	3.7	0.0000777	0.000126	0.06	0.0075	0.0013	0.0021	5.83×10^{-7}	9.44×10^{-7}
RDX	0.25	5.25×10^{-6}	8.50×10^{-6}	0.003	0.11	0.00175	0.00283	5.78×10^{-7}	9.35×10^{-7}
Styrene	0.78	0.0000164	0.0000265	0.2		0.0000819	0.000133		
Tetrachloroethene	0.92	0.0000193	0.0000313	0.06	0.2	0.000322	0.000521	3.86×10^{-6}	6.26×10^{-6}
Tetryl	0.04	8.40×10^{-7}	1.36×10^{-6}	0.004		0.000210	0.000340		

kg = kilogram, L = liter, mg = milligram, µg = microgram, RDx = hexahydro-1, 3, 5-trinitro-1, 3, 5-triazine, RfD = Reference Dose, UCL = upper confidence limit.

Notes: Chronic Intake (mg/kg-day) = Water Concentration (µg/L) × Consumption rate (L/day) × 1×10^{-3} (mg/µg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

The overall quality of most surface water in the Los Alamos area is very good, with very low levels of dissolved solutes. Of the more than 100 analytes tested in sediment and surface water within LANL, most are at concentrations far below regulatory standards or risk-based advisory levels. Nearly every major watershed, however, shows indications of some effect from LANL operations, often for just a few analytes.

Although many of the above-background results in sediment and surface water are from the major liquid effluent discharges, other possible sources include isolated spills, former photographic-processing facilities, highway runoff, and residual ash from the Cerro Grande Fire. At monitoring locations below other industrial or residential areas, particularly in the Los Alamos and Pueblo Canyon watersheds, above-background contaminant levels reflect contributions from non-LANL sources such as urban runoff.

Guaje Canyon is a major tributary in the Los Alamos Canyon watershed that heads in the Sierra de los Valles and lies north of LANL. The canyon has not received any effluent from LANL activities. Concentrations of metals, organics, and radionuclides in Guaje Canyon base flow and sediments were below regulatory limits or screening levels. Active channel sediments contained background ranges of metals and radionuclides.

Los Alamos Canyon, including Bayo, Acid, Pueblo, and DP Canyons, has a large drainage that heads in the Sierra de los Valles. Land in the Los Alamos Canyon watershed has been continuously used since the mid-1940s, with operations conducted at some time in all of the subdrainages. Each of the canyons draining the watershed also receives urban runoff from the Los Alamos town site.

Nonradiological contaminants detected at significant concentrations in the Los Alamos Canyon watershed include polychlorinated biphenyls, benzo(a)pyrene, mercury, copper, lead, and zinc. Analysis detected benzo(a)pyrene in sediment samples from Acid Canyon above Pueblo; the LANL environmental surveillance staff concluded that the major source of benzo(a)pyrene in the drainage was urban runoff rather than a LANL-related source (LANL 2005b).

Mercury was detected in Los Alamos Canyon above DP Canyon. LANL sources of mercury and polychlorinated biphenyls are known to exist in the drainage system, and erosion control features have been installed near the sources to minimize downstream movement. Elevated concentrations of copper, lead, and zinc were detected in DP Canyon above LANL facilities and are likely derived from urban runoff sources rather than LANL operations.

Sandia Canyon begins on the Pajarito Plateau within TA-3 and has a total drainage area of about 5.5 square miles. This relatively small drainage extends eastward across the central part of LANL and crosses San Ildefonso Pueblo land before joining the Rio Grande. Effluent discharges primarily from power plant blowdown support perennial flow conditions along a 2-mile (3.2-kilometer) reach. The upper portion of the canyon contains some of the highest polychlorinated biphenyl concentrations of any watercourse within LANL boundaries. Downstream sediment concentrations of polychlorinated biphenyls decline quickly and are near background ranges at the LANL downstream boundary. Along an approximately 2-mile (3.2-kilometer) segment are found above-background concentrations of chromium, copper, mercury, and zinc in surface water and sediments. Measurements in 2004 also found concentrations of dissolved copper and lead above regulatory standards.

Mortandad Canyon begins on the Pajarito Plateau near the main complex at TA-3. The canyon crosses San Ildefonso Pueblo land before joining the Rio Grande. Analysis detected dissolved copper concentrations and benzo(a)pyrene above screening levels; potential sources are many and include road runoff, ash from the Cerro Grande Fire, and industrial sources.

Pajarito Canyon begins on the flanks of the Sierra de los Valles on U.S. Forest Service lands. The canyon crosses the south-central part of LANL before entering Los Alamos County lands in White Rock. Dissolved copper concentrations greater than the regulatory standards were detected in channels throughout the Pajarito Canyon watershed. A review of sediment data from the drainage did not indicate a LANL source for the copper. In 2004, a sediment sample from Pajarito Canyon contained many metals and radionuclides at concentrations two to five times above background levels (LANL 2005b). Concentrations of organic compounds in sediments from Pajarito Canyon are far below EPA residential soil screening levels, with the exception of benzo(a)pyrene. Low levels of polychlorinated biphenyls were detected in sediments. Polychlorinated biphenyls were not detected in stormwater runoff samples.

Water Canyon heads on the flanks of the Sierra de los Valles on U.S. Forest Service land and extends across LANL to the Rio Grande. Water Canyon and its tributary Cañon de Valle pass through the southern portion of LANL where explosives development and testing has been conducted in the past and continues to take place. Elevated concentrations of barium, HMX, and RDX have been measured in sediment and surface water.

Tables C–44 and **C–45** show the contribution to health risk to the recreational user receptor from ingestion of metals, nitrates, perchlorate, and organic compounds in surface water and sediment. **Table C–46** shows the health risk to the offsite resident receptor from ingestion of contaminants in sediment that may be transported offsite by streams and seasonal runoff.

Soil Ingestion

In the past, soils within and around LANL were analyzed for 22 light, heavy, and nonmetal trace elements (occurrence in amounts less than 1,000 micrograms per gram in soil) and 3 light and heavy abundant elements (occurrence in amounts greater than 1,000 micrograms per gram in soil). Most of these elements, with the exception of barium, beryllium, mercury, and lead, were either below the limits of detection or within the regional statistical reporting limits. Therefore, recent analyses only address the four metals that were consistently detected above the limit of detection in past years (barium, beryllium, mercury, and lead). In general, very few individual sites from either perimeter or onsite areas had barium, beryllium, mercury, or lead concentrations above the regional statistical reporting limits, and these concentrations were far below the screening action levels.

Table C–44 Hazard Index and Cancer Risk to the Recreational User Receptor from the Ingestion of Nonradioactive Contaminants in Surface Water

Surface Water Consumption: 5.34 Liters per Year Average, 8.64 Liters per Year High Intake

Analytes	*95% UCL Concentration (µg/L)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Silver	5.19	1.06×10^{-6}	1.71×10^{-6}	0.005		0.000212	0.0003		
Aluminum	129,000	0.0263	0.0426	1.00		0.0263	0.0426		
Arsenic	2.89	5.89×10^{-6}	9.53×10^{-6}	0.0003	1.50	0.0196	0.0318	8.84×10^{-6}	0.0000143
Boron	231	0.0000471	0.0000762	0.2		0.000236	0.0004		
Barium	3,270	0.000666	0.00108	0.2		0.00333	0.00539		
Beryllium	13.4	2.72×10^{-6}	4.41×10^{-6}	0.002	4.30	0.00136	0.0022	0.0000117	0.0000189
Cadmium	10.4	2.11×10^{-6}	3.42×10^{-6}	0.0005	0.0018	0.00423	0.00684	3.80×10^{-9}	6.15×10^{-9}
Perchlorate	16.8	3.42×10^{-6}	5.53×10^{-6}	0.0007		0.00489	0.00791		
Cobalt	54.2	0.0000111	0.0000179	0.02		0.000553	0.00089		
Chromium	117	0.0000238	0.0000385	1.5		0.0000159	0.0000257		
Copper	115	0.0000234	0.0000378	0.037		0.000632	0.00102		
Mercury	0.389	7.94×10^{-8}	1.28×10^{-7}	0.0003		0.000265	0.000428		
Manganese	11,200	0.0029	0.00371	0.047		0.0488	0.0789		
Molybdenum	23.5	4.80×10^{-6}	7.76×10^{-6}	0.005		0.000959	0.00155		
Nickel	73.8	0.0000151	0.0000243	0.02		0.000753	0.00122		
Nitrate	21,200	0.0043	0.007	1.60		0.0027	0.00437		
Lead	191	0.0000390	0.0000631	0.0014		0.0278	0.045		
Antimony	72	0.0000147	0.0000238	0.0004		0.0367	0.0594		
Selenium	9.36	1.91×10^{-6}	3.09×10^{-6}	0.005		0.000382	0.0006		
Tin	8.98	1.83×10^{-6}	2.96×10^{-6}	0.6		3.05×10^{-6}	4.94×10^{-6}		
Strontium	711	0.000145	0.0002	0.6		0.000242	0.0004		
Thallium	9.20	1.88×10^{-6}	3.04×10^{-6}	0.00008		0.0235	0.0379		
Uranium	79.3	0.0000162	0.0000262	0.0006		0.0270	0.0436		
Vanadium	150	0.0000306	0.0000496	0.001		0.0306	0.0496		

Analytes	*95% UCL Concentration (µg/L)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Zinc	862	0.000176	0.000284	0.3		0.00586	0.000948		
Acetone	78.3	0.000016	0.0000258	0.9		0.0000177	0.0000287		
AROCLOR 1260	0.5	1.02×10^{-7}	1.65×10^{-7}		2.00			2.04×10^{-7}	3.30×10^{-7}
Benzo(a)pyrene	3.85	7.85×10^{-7}	1.27×10^{-6}		7.30			5.73×10^{-6}	9.27×10^{-6}
Bis(2-ethylhexyl)phthalate	10.9	2.23×10^{-6}	3.61×10^{-6}	0.02	0.014	0.000111	0.00018	3.12×10^{-8}	5.05×10^{-8}
HMX	150	0.0000307	0.0000496	0.05		0.000613	0.000992		
RDX	7.78	1.59×10^{-6}	2.57×10^{-6}	0.003	0.11	0.000529	0.000856	1.75×10^{-7}	2.82×10^{-7}
Trinitrotoluene	0.35	7.14×10^{-8}	1.16×10^{-7}	0.0005	0.03	0.000143	0.000231	2.14×10^{-9}	3.47×10^{-9}

HMx = octahydro-1, 3, 5, 7-tetranitro-3, 5, 7-tetrazocine, kg = kilogram, L = liter, mg = milligram, µg = microgram, RfD = Reference Dose, UCL = upper confidence limit.
Notes: Chronic Intake (mg/kg-day) = Water Concentration (µg/L) × Consumption rate (L/day) × 1×10^{-3} (mg/µg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

Table C–45 Hazard Index and Cancer Risk to the Recreational User Receptor from the Ingestion of Nonradioactive Contaminants in Sediment

Sediment Consumption: 1.07 g per Year Average, 4.27 g per Year High Intake

Analytes	*95% UCL Concentration (µg/g)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Silver	1.95	7.97×10^{-8}	3.18×10^{-7}	0.005		0.0000159	0.0000636		
Aluminum	16,400	0.00067	0.00268	1		0.00067	0.00268		
Arsenic	3.75	1.53×10^{-7}	6.11×10^{-7}	0.0003	1.5	0.00059	0.00204	2.29×10^{-7}	9.16×10^{-7}
Boron	5.9	2.41×10^{-7}	9.61×10^{-7}	0.2		1.20×10^{-6}	4.81×10^{-6}		
Barium	244	9.95×10^{-6}	0.0000398	0.2		0.0000498	0.000199		
Beryllium	1.1	4.49×10^{-8}	1.79×10^{-7}	0.002	4.3	0.0000225	0.0000897	1.93×10^{-7}	7.72×10^{-7}
Cadmium	0.841	3.43×10^{-8}	1.37×10^{-7}	0.0005	0.0018	0.0000686	0.00274	6.17×10^{-11}	2.47×10^{-10}
Cobalt	5.37	2.19×10^{-7}	8.75×10^{-7}	0.02		0.0000110	0.0000438		
Chromium	30.7	1.25×10^{-6}	5.01×10^{-6}	1.5		8.35×10^{-7}	3.34×10^{-6}		
Copper	19.4	7.92×10^{-7}	3.16×10^{-6}	0.037		0.0000214	0.0000855		

Analytes	*95% UCL Concentration (μg/g)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Mercury	0.103	4.21×10^{-9}	1.68×10^{-8}	0.0003		0.0000140	0.0000561		
Manganese	824	0.0000336	0.000134	0.047		0.000715	0.00286		
Molybdenum	1.88	7.69×10^{-8}	3.07×10^{-7}	0.005		0.0000154	0.0000614		
Nickel	10.8	4.41×10^{-7}	1.76×10^{-6}	0.02		0.0000221	0.0000882		
Lead	24.9	1.02×10^{-6}	4.06×10^{-6}	0.00140		0.000726	0.0029		
Antimony	0.197	8.04×10^{-9}	3.21×10^{-8}	0.0004		0.0000201	0.0000803		
Selenium	3.80	1.55×10^{-7}	6.20×10^{-7}	0.005		0.0000310	0.000124		
Tin	8.89	3.63×10^{-7}	1.45×10^{-6}	0.6		6.04×10^{-7}	2.41×10^{-6}		
Strontium	51.9	2.12×10^{-6}	8.45×10^{-6}	0.6		3.53×10^{-6}	0.0000141		
Thallium	0.232	9.48×10^{-9}	3.79×10^{-8}	8.00×10^{-5}		0.000118	0.000473		
Vanadium	23.9	9.77×10^{-7}	3.90×10^{-6}	0.001		0.000977	0.0039		
Zinc	148	6.04×10^{-6}	0.0000241	0.3		0.0000201	0.0000804		
AROCLOR 1260	165	6.72×10^{-6}	0.0000268		2.00			0.0000134	0.0000537
Benzo(a)anthracene	1,010	0.0000413	0.000165		0.73			0.0000302	0.000121
Benzo(a)pyrene	741	0.0000303	0.000121		7.3			0.000221	0.000882
Benzo(b)fluoranthene	982	0.0000401	0.000160		0.73			0.0000293	0.000117
Bis(2-ethylhexyl)phthalate	2,310	0.0000945	0.000377	0.02	0.014	0.00472	0.0189	1.32×10^{-6}	5.28×10^{-6}
HMX	1,100	0.0000448	0.000179	0.05		0.000896	0.00358		
RDX	1,130	0.0000460	0.000184	0.003	0.11	0.0153	0.0612	5.06×10^{-6}	0.0000202
Trinitrotoluene	199	8.14×10^{-6}	0.0000325	0.0005	0.03	0.0163	0.065	2.44×10^{-7}	9.75×10^{-7}

g = grams, HMx = octahydro-1, 3, 5, 7-tetranitro-3, 5, 7-tetrazocine, kg = kilogram, L = liter, mg = milligram, μg = microgram, RDx = hexahydro-1, 3, 5-trinitro-1, 3, 5-triazine, RfD = Reference Dose, UCL = upper confidence limit.

Notes: Chronic Intake (mg/kg-day) = Sediment Concentration (μg/g) × Consumption rate (g/day) × 1×10^{-3} (mg/μg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

Table C–46 Hazard Index and Cancer Risk to the Offsite Resident Receptor from the Ingestion of Nonradioactive Contaminants in Sediment

Sediment Consumption: 36.5 g per Year Average, 146 g per Year High Intake

Analytes	*95% UCL Concentration (µg/g)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Case Cancer Risk*
Silver	0.921	1.28×10^{-6}	5.13×10^{-6}	0.005		0.000256	0.00103		
Aluminum	40,000	0.0556	0.223	1		0.056	0.223		
Arsenic	6.28	8.73×10^{-6}	0.0000350	0.0003	1.5	0.0291	0.117	0.0000131	0.0000525
Boron	15.3	0.0000212	0.0000851	0.2		0.000106	0.000426		
Barium	371	0.0005	0.00207	0.2		0.00258	0.0103		
Beryllium	2.00	2.78×10^{-6}	0.0000111	0.002	4.3	0.00139	0.0056	0.0000119	0.0000478
Cadmium	1.08	1.50×10^{-6}	6.03×10^{-6}	0.0005	0.0018	0.00301	0.0121	2.71×10^{-9}	1.08×10^{-8}
Cobalt	11.5	0.0000160	0.0000643	0.02		0.000802	0.00321		
Chromium	24.7	0.0000343	0.000138	1.5		0.0000229	0.0000917		
Copper	26.0	0.0000361	0.000145	0.037		0.000976	0.00391		
Mercury	0.143	1.99×10^{-7}	7.96×10^{-7}	0.0003		0.000662	0.00265		
Manganese	1,370	0.0019	0.00761	0.047		0.0404	0.162		
Molybdenum	0.809	1.13×10^{-6}	4.51×10^{-6}	0.005		0.000225	0.000902		
Nickel	22.8	0.0000316	0.000127	0.02		0.00158	0.00634		
Lead	26.8	0.0000372	0.000149	0.0014		0.0266	0.106		
Antimony	0.14	1.94×10^{-7}	7.79×10^{-7}	0.0004		0.000486	0.00195		
Selenium	1.55	2.15×10^{-6}	8.63×10^{-6}	0.005		0.000431	0.00173		
Tin	2.74	3.81×10^{-6}	0.0000153	0.6		6.35×10^{-6}	0.0000254		
Strontium	212	0.000294	0.00118	0.6		0.000490	0.00196		
Thallium	0.400	5.57×10^{-7}	2.23×10^{-6}	0.00008		0.00696	0.0279		
Vanadium	51.1	0.000071	0.000285	0.001		0.071	0.285		
Zinc	96.6	0.000134	0.000538	0.3		0.000447	0.00179		
AROCLOR 1260	12.0	0.0000167	0.0000668		2.00			0.0000334	0.000134
Bis(2-ethylhexyl)phthalate	198	0.000275	0.0011	0.02	0.014	0.00138	0.055	3.85×10^{-6}	0.0000154

g = grams, kg = kilogram, L = liter, mg = milligram, µg = microgram, RfD = Reference Dose, UCL = upper confidence limit.

Notes: Chronic Intake (mg/kg-day) = Sediment Concentration (µg/g) × Consumption rate (g/day) × 1×10^{-3} (mg/µg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

A comparison of the means of these elements collected in soils from perimeter and onsite areas with those from regional areas shows that the concentrations of beryllium, mercury, and lead in soils collected from onsite areas were significantly higher than concentrations from regional soils. Although beryllium, mercury, and lead concentrations in soils from onsite areas were statistically higher than in regional soils, the differences were very small.

Tables C–47 and **C–48** show the contribution to health risk to the offsite resident and the recreational user receptors from the ingestion of trace metals in surface soil.

Produce and Fish Ingestion

A wide variety of wild and domestic edible vegetable, fruit, grain, and animal products are harvested in the area surrounding LANL. Ingestion of foodstuffs constitutes an important pathway by which nonradioactive contaminants can be transferred to humans. Therefore, foodstuff samples are routinely collected (fruits, vegetables, grains, fish, milk, eggs, honey, herbal teas, mushrooms, pinyon nuts, domestic animals, and large and small game animals) from the surrounding area and communities to determine the impacts of LANL operations on the human food chain.

The metal elements analyzed in food were either those that have been consistently detected above the limit of detection in past years, those that have a history of use at LANL, or those that have been detected in significantly higher concentrations in soils. Of the five metals analyzed in produce collected from perimeter and onsite areas, only three (barium, lead, and selenium) were found to be above their limits of detection; beryllium and mercury were below the limits of detection. Of the three elements that were found to be above their limits of detection, all were within regional statistical reporting limits. As a group, the levels of all of the metal elements analyzed in produce from all perimeter and onsite areas were not significantly higher than those in produce collected from regional areas. Of special note is that beryllium and lead were found at significantly higher levels in soils collected in perimeter and onsite areas, but were not found at significantly higher levels in produce collected from perimeter or onsite areas than in produce collected from around the region.

Monitoring results reported in 2002 (LANL 2004b) show trace elements in produce collected before and after the Cerro Grande Fire. From almost all sites, only selenium was present in higher concentrations in produce collected after the Cerro Grande Fire than in produce collected before the fire. It is hard to say that selenium concentrations in produce collected from these sites increased because of the Cerro Grande Fire because (1) no other trace elements were elevated after the fire, and (2) selenium concentrations in soil samples collected from these same sites in 2000 and 2002 were not significantly higher than in soils collected in 1999.

The 2003 Environmental Surveillance Report presents the results of a special study on perchlorates found in vegetables and irrigation waters (LANL 2004d). Perchlorates are used at LANL in explosive and actinide research and were released into the environment as treated and untreated effluent discharges. They are highly soluble, mobile, and long-lived, and they have migrated from shallow depths to deeper groundwater levels within LANL lands. Perchlorates are

Table C–47 Hazard Index and Cancer Risk to the Offsite Resident Receptor from the Ingestion of Nonradioactive Contaminants in Soil

Soil Consumption: 36.5 g per Year Average, 146 g per Year High Intake

Analytes	*95% UCL Concentration (μg/g)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Barium	164	0.000229	0.001	0.2		0.00114	0.00458		
Beryllium	0.924	1.28×10^{-6}	5.15×10^{-6}	0.002	4.3	0.000642	0.00257	5.52×10^{-6}	0.0000221
Mercury	0.0222	3.08×10^{-8}	1.24×10^{-7}	0.0003		0.000103	0.000412		
Lead	23.5	0.0000326	0.000131	0.0014		0.0233	0.0934		
Selenium	0.13	1.81×10^{-7}	7.24×10^{-7}	0.005		0.0000361	0.000145		

g = grams, kg = kilogram, L = liter, mg = milligram, μg = microgram, RfD = Reference Dose, UCL = upper confidence limit.

Notes: Chronic Intake (mg/kg-day) = Soil Concentration (μg/g) × Consumption rate (g/day) × 1×10^{-3} (mg/μg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

Table C–48 Hazard Index and Cancer Risk to the Recreational User Receptor from the Ingestion of Nonradioactive Contaminants in Soil

Soil Consumption: 1.07 g per Year Average, 4.27 g per Year High Intake

Analytes	*95% UCL Concentration (μg/g)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Barium	184	7.52×10^{-6}	0.0000301	0.2		0.0000376	0.000150		
Beryllium	0.932	3.80×10^{-8}	1.52×10^{-7}	0.002	4.3	0.0000190	0.0000760	1.64×10^{-7}	6.53×10^{-7}
Mercury	0.0242	9.87×10^{-10}	3.94×10^{-9}	0.0003		3.29×10^{-6}	0.0000131		
Lead	18.3	7.48×10^{-7}	2.99×10^{-6}	0.0014		0.000534	0.00213		

g = grams, kg = kilogram, L = liter, mg = milligram, μg = microgram, RfD = Reference Dose, UCL = upper confidence limit.

Notes: Chronic Intake (mg/kg-day) = Soil Concentration (μg/g) × Consumption rate (g/day) × 1×10^{-3} (mg/μg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

readily taken up by plants, and the major source of water for home garden irrigation in the Los Alamos vicinity is from deep groundwater sources. Perchlorates inhibit thyroid function, but there is no current Federal standard for protection of human health. Therefore, a special study was conducted to evaluate the possible existence of perchlorates in locally grown foods. Results showed no perchlorate concentrations in any of the vegetable samples or water samples above the minimum reporting level or the minimum detection level.

The 2004 Environmental Surveillance Report (LANL 2005b) discussed the results of a special monitoring study to identify polychlorinated biphenyls in the Rio Grande. Polychlorinated biphenyls are extensively distributed worldwide and are ubiquitous in the environment. Concern has existed for years that LANL has released polychlorinated biphenyls into the environment that may have reached the Rio Grande. From 1997 to 2002, studies were conducted on polychlorinated biphenyls in fish taken from the Rio Grande and from Cochiti and Abiquiu reservoirs. One of the goals of the studies was to determine whether LANL has contributed to the polychlorinated biphenyl burdens. Results showed only a small amount of similarity between the type of aroclors indicated in the Rio Grande below LANL and aroclors known to exist at LANL. In addition, the studies concluded that, for the particular time period studied, LANL was not likely contributing polychlorinated biphenyls to the Rio Grande as indicated by the statistically similar total polychlorinated biphenyls concentrations at the two stations above LANL and the station immediately below LANL. This same conclusion was made in reports on the previous fish studies.

Fish normally collected each year include two types: predators and bottom-feeders. In any given year, predator fish may include the following: northern pike (*Esox lucius*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieui*), white crappie (*Pomoxis annularis*), brown trout (*Salmo trutta*), white bass (*Morone chrysops*), and walleye (*Stizostedion vitreum*). Similarly, bottom-feeding fish may include the following: white sucker (*Catostomus commersoni*), channel catfish (*Ictalurus punctatus*), carp (*Cyprinus carpio*), and carp sucker (*Carpiodes carpio*). Bottom-feeding fish are better indicators of environmental contamination than predator game fish because the bottom-feeding fish forage on the bottom where contaminants readily bind to sediments.

In general, most of the trace elements in both predator and bottom-feeding fish collected upstream and downstream of LANL were below the limit of detection. Concentrations of the elements that were above the limit of detection (barium, mercury, and selenium) were within historical regional background concentrations and were statistically similar to concentrations in fish from other bodies of water in the region. Mercury concentrations, a major problem in New Mexico fisheries, were statistically significant in most fish collected. The levels of mercury in predator and bottom-feeding fish muscle (fillets) collected were still below the U.S. Food and Drug Administration's ingestion limit.

Tables C–49 and **C–50** show the contributions to health risk to the offsite resident from the ingestion of trace metals in produce and predator fish. **Table C–51** shows the contribution to health risk to the special pathways receptor from ingestion of trace metals in non-predator (bottom-feeding) fish.

Table C–49 Hazard Index and Cancer Risk to the Offsite Resident Receptor from the Ingestion of Nonradioactive Contaminants in Produce

Produce Consumption: 8.2 g/kg-day Average, 25.5 g/kg-day High Intake

Analytes	*95% UCL Concentration (µg/g wet weight)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Barium	4.48	0.0367	0.114	0.2		0.184	0.571		
Beryllium	0.03	0.000246	0.000765	0.002	4.3	0.123	0.383	0.00106	0.00329
Mercury	0.0117	0.0000957	0.000297	0.0003		0.319	0.992		
Lead	0.658	0.00540	0.0168	0.00140		3.86	12		
Selenium	0.103	0.000844	0.00263	0.005		0.169	0.525		

g = grams, kg = kilogram, L = liter, mg = milligram, µg = microgram, RfD = Reference Dose, UCL = upper confidence limit.

Notes: Chronic Intake (mg/kg-day) = Produce Concentration (µg/g) × Consumption rate (g/day) × 1 × 10^{-3} (mg/µg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

Table C–50 Hazard Index and Cancer Risk to the Offsite Resident Receptor from the Ingestion of Nonradioactive Contaminants in Fish

Fish Consumption: 20.1 g/day Average, 53 g/day High Intake

Analytes	*95% UCL Concentration (µg/g)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Silver	1.42	0.000399	0.00105	0.005		0.0797	0.21		
Arsenic	0.5	0.00014	0.000369	0.0003	1.5	0.467	3.5	0.00021	0.00158
Barium	0.536	0.00015	0.000396	0.2		0.000751	0.00198		
Beryllium	0.264	0.0000738	0.000195	0.002	4.3	0.0369	0.0973	0.000317	0.000837
Cadmium	0.25	0.0000700	0.000185	0.0005	0.0018	0.14	0.369	1.26×10^{-7}	3.32×10^{-7}
Chromium	0.5	0.00014	0.000369	1.5		0.0000933	0.00246		
Mercury	0.6	0.000168	0.000443	0.00003		0.56	1.48		
Nickel	1	0.00028	0.000738	0.02		0.014	0.0369		
Lead	0.15	0.0000420	0.000111	0.001		0.03	0.0791		
Antimony	0.4	0.000112	0.000295	0.0004		0.28	0.738		
Selenium	1.10	0.000309	0.000814	0.005		0.0617	0.163		

g = grams, kg = kilogram, L = liter, mg = milligram, µg = microgram, RfD = Reference Dose, UCL = upper confidence limit.

Notes: Chronic Intake (mg/kg-day) = Fish Concentration (µg/g wet weight) × Consumption rate (g/day) × 1 × 10^{-3} (mg/µg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

Table C–51 Hazard Index and Cancer Risk to the Special Pathways Receptor from the Ingestion of Nonradioactive Contaminants in Fish

Fish Consumption: 70 g per Day Average, 170 g per Day High Intake

Analytes	*95% UCL Concentration (µg/g)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Silver	0.5	0.000488	0.00119	0.005		0.0975	0.237		
Arsenic	0.526	0.000513	0.00125	0.0003	1.50	1.71	4.16	0.000770	0.00187
Barium	1.20	0.00117	0.00285	0.2		0.00587	0.0143		
Beryllium	0.264	0.000257	0.0006	0.002	4.30	0.129	0.312	0.0011	0.00269
Cadmium	0.25	0.000244	0.000593	0.0005	0.0018	0.488	1.19	4.39×10^{-7}	1.07×10^{-6}
Chromium	0.5	0.000488	0.00119	1.5		0.000325	0.000790		
Mercury	0.398	0.000388	0.000944	0.003		1.29	3.15		
Nickel	1.00	0.000975	0.00237	0.02		0.0488	0.119		
Lead	0.168	0.000163	0.000397	0.0014		0.117	0.284		
Antimony	0.4	0.00039	0.000948	0.0004		0.975	2.37		
Selenium	0.866	0.000844	0.00205	0.005		0.169	0.41		

g = grams, kg = kilogram, L = liter, mg = milligram, µg = microgram, RfD = Reference Dose, UCL = upper confidence limit.

Notes: Chronic Intake (mg/kg-day) = Fish Concentration (µg/g wet weight) × Consumption rate (g/day) × 1×10^{-3} (mg/µg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

C.3 Impacts on Human Health from Biological Agents

C.3.1 Introduction

The research capacity of LANL deals with a multitude of world-class scientific topics and is focused on advancing environmental and biomedical knowledge and supporting both the DOE mission and the national bio-defense mission. Current biological research covers a range of topics including, but not limited to, genomic (or genetic) and proteomic (the study of proteins generated by the genes of a particular cell) science, measurement science and diagnostics, molecular synthesis, structural biology, cell biology, computational biology, and environmental microbiology. All of these divisions are focused on understanding the interaction between humans, the microbial world, and the environment. This task is accomplished by the detailed study of microorganisms and their characteristics using technology specific to each of the groups mentioned above. Microorganisms are found naturally in the environment; they are living things that have or can develop the ability to act or function independently. There are different categories of microorganisms, including bacteria, viruses, and fungi. Bacteria are single-celled organisms that can multiply rapidly and live anywhere in the environment. Only a very small percentage of these can cause infection and mild-to-severe disease in humans. Bacteria are also capable of producing toxins that can be harmful to humans, animals, and plants. A virus is an acellular organism (that is, a single particle) that depends on the host cell's metabolic functions to multiply. Most but not all viruses can infect humans. Fungi are plant-like organisms that lack chlorophyll; a small number of these organisms are capable of causing disease in humans.

C.3.2 Principles of Biosafety

All laboratories within the United States, including LANL, follow a specific set of guidelines for all laboratory practices that is issued by the Centers for Disease Control and Prevention and the National Institutes of Health. These guidelines are safety protocols that provide a baseline for all laboratory work.

The term "containment" is used to describe safe methods of managing infectious materials in the laboratory environment where they are being handled or maintained. The purpose of containment is to reduce or eliminate exposure of laboratory workers, other persons, and the outside environment to potentially hazardous agents (HHS 2007).

Primary containment, the protection of personnel and the immediate laboratory environment from exposure to infectious agents, is provided by both good microbiological technique and the use of appropriate safety equipment. Secondary containment, the protection of the environment external to the laboratory from exposure to infectious materials, is provided by a combination of facility design and operational practices. Therefore, the three elements of containment include laboratory practice and technique, safety equipment, and facility design. The risk assessment of the work to be performed with a specific agent will determine the appropriate combination of these elements (HHS 2007).

C.3.2.1 Safety Equipment (Primary Barriers)

Safety equipment includes biological safety cabinets, enclosed containers, and other engineering controls designed to remove or minimize exposures to hazardous biological materials. The biological safety cabinet is the principal device used to provide containment of infectious splashes or aerosols generated by many microbiological procedures. Three types of biological safety cabinets (Class I, II, and III) are used in microbiological laboratories. Open-fronted Class I and Class II biological safety cabinets are primary barriers that offer significant levels of protection to laboratory personnel and the environment when used with good microbiological techniques. The Class II biological safety cabinet also provides protection from external contamination of the materials (for example, cell cultures, microbiological stocks) being manipulated inside the cabinet. The gas-tight Class III biological safety cabinet provides the highest attainable level of protection to personnel and the environment. Safety equipment also may include items for personal protection such as gloves, coats, gowns, shoe covers, boots, respirators, face shields, safety glasses, or goggles. Personal protective equipment is often used in combination with biological safety cabinets and other devices that contain the agents, animals, or materials being handled (HHS 2007).

C.3.2.2 Facility Design and Construction (Secondary Barriers)

The design and construction of the facility contributes to laboratory workers’ protection, provides a barrier to protect persons outside the laboratory, and protects persons or animals in the community from infectious agents that may be accidentally released from the laboratory. Laboratory management is responsible for providing facilities commensurate with the laboratory’s function and the recommended biosafety level for the agents being manipulated.

The recommended secondary barrier(s) will depend on the risk of transmission of specific agents. For example, the exposure risks for most laboratory work in Biosafety Level 1 and 2 facilities will be direct contact with the agents or inadvertent contact exposures through contaminated work environments. Secondary barriers in these laboratories may include separation of the laboratory work area from public access, availability of a decontamination facility, and handwashing facilities. When the risk of infection by exposure to an infectious aerosol is present, higher levels of primary containment and multiple secondary barriers may be necessary to prevent infectious agents from escaping into the environment. Such design features include specialized ventilation systems to ensure directional airflow, air treatment systems to decontaminate or remove agents from exhaust air, controlled access zones, airlocks at laboratory entrances, or separate buildings or modules to isolate the laboratory. Design engineers for laboratories may refer to specific ventilation recommendations such as those found in the Applications Handbook for Heating, Ventilation, and Air-Conditioning published by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (HHS 2007).

C.3.2.3 Waste

Biological waste being removed from a laboratory is disinfected with a 10 percent Clorox solution or by autoclaving (a process using temperature and pressure to produce steam) regardless of the safety level. These processes, when implemented correctly, ensure that all waste is decontaminated before it leaves the confinement of the facility (HHS 2007). Normal laboratory waste is handled in an appropriate manner in accordance with the type of waste being discarded via the LANL Safety Plan.

C.3.2.4 Biological Release

LANL operates Biosafety Level 1 and 2 (see the discussion of Biosafety Levels in Section C.3.3) facilities as discussed in Chapter 3, Section 3.1.3.11, of this SWEIS. If released into the environment, Biosafety Level 1 material at LANL would pose little to no risk to the workers, public, or environment in general because this biological material is not known to consistently cause disease and is not contagious. Biosafety Level 2 facilities use an extensive set of procedures, safety equipment, and containment facilities that prevent any releases of Biosafety Level 2 agents that would affect workers or the public. Laboratory personnel are still subject to non-biological hazards that are associated with all workplaces and are subject to Occupational Safety and Health Administration regulations.

C.3.3 Biosafety Levels

Four biosafety levels represent combinations of laboratory practices and techniques, safety equipment, and laboratory facilities. Each combination is specifically appropriate for the operations performed, the documented or suspected routes of transmission of the infectious agents, and the laboratory function or activity. The recommended biosafety level(s) for specific organisms represent those conditions under which the agent(s) ordinarily can be safely handled. When specific information is available to suggest that the human body's ability to resist the type, strength, and rate of infection is insufficient, or that antibiotic resistance patterns, vaccine and treatment availability, or other factors are significantly altered, more (or less) stringent practices may be specified (HHS 2007).

C.3.3.1 Biosafety Level 1

Biosafety Level 1 practices, safety equipment, and facility design and construction are appropriate for undergraduate and secondary educational training and teaching laboratories, as well as other laboratories in which work is performed with defined and characterized strains of viable microorganisms that are not known to consistently cause disease in healthy adult humans. *Bacillus subtilis, Naegleria gruberi,* infectious canine hepatitis virus, and exempt organisms under the National Institutes of Health Recombinant DNA Guidelines represent microorganisms that meet these criteria. Vaccine strains that have undergone multiple in vivo (that is, within a living organism) passages should not be considered infectious simply because they are vaccine strains. Biosafety Level 1 represents a basic level of containment that relies on standard microbiological practices with no special primary or secondary barriers recommended, other than a sink for handwashing (HHS 2007).

C.3.3.2 Biosafety Level 2

Biosafety Level 2 practices, equipment, and facility design and construction are applicable to clinical, diagnostic, teaching, and other laboratories in which work is performed with the broad spectrum of naturally occurring moderate-risk agents that are present in the community and associated with human disease of varying severity. With good microbiological techniques, these agents can be used safely in activities conducted on the open bench, provided the potential for producing splashes or aerosols is low. Hepatitis B virus, HIV, *salmonellae*, and *Toxoplasma spp.* (a parasite that spreads from animals to humans) are representative of microorganisms assigned to this containment level. Biosafety Level 2 is appropriate when work is performed with any human-derived blood, body fluids, tissues, or primary human cell lines where the presence of an infectious agent may be unknown. (Laboratory personnel working with human-derived materials should refer to the Occupational Safety and Health Administration Bloodborne Pathogen Standard for specific required precautions.) Primary hazards to personnel working with these agents relate to accidental skin absorption, mucous membrane exposures, or ingestion of infectious materials. Extreme caution should be taken with contaminated needles or sharp instruments. Even though organisms routinely manipulated at Biosafety Level 2 are not known to be transmissible by the aerosol route, procedures with aerosol or high splash potential that may increase the risk of such personnel exposure must be conducted in primary containment equipment or in devices such as a biological safety cabinet. Other primary barriers should be used as appropriate, such as splash shields, face protection, gowns, and gloves. Secondary barriers such as handwashing sinks and waste decontamination facilities must be available to reduce potential environmental contamination (HHS 2007).

C.3.3.3 Biosafety Level 3

Biosafety Level 3 practices, safety equipment, and facility design and construction are applicable to clinical, diagnostic, teaching, research, or production facilities in which work is performed with indigenous or exotic agents with a potential for respiratory transmission, and thus may cause serious and potentially lethal infection. *Mycobacterium tuberculosis*, St. Louis encephalitis virus, and *Coxiella burnetii* are representative of the microorganisms assigned to this level. Primary hazards to personnel working with these agents relate to autoinoculation (that is, inoculation with a vaccine made from microorganisms obtained from the recipient’s own body), ingestion, and exposure to infectious aerosols. At Biosafety Level 3, more emphasis is placed on primary and secondary barriers to protect personnel in contiguous areas, the community, and the environment from exposure to potentially infectious aerosols. For example, all laboratory manipulations should be performed in a biological safety cabinet or other enclosed equipment such as a gas-tight aerosol generation chamber. Secondary barriers for this level include controlled access to the laboratory and ventilation requirements that minimize the release of infectious aerosols from the laboratory (HHS 2007). The Biosafety Level 3 work being proposed for LANL is being addressed in a separate environmental impact statement and is not addressed in this SWEIS.

C.3.3.4 Biosafety Level 4

Biosafety Level 4 practices, safety equipment, and facility design and construction are applicable to work with dangerous and exotic agents that pose a high individual risk of life-threatening disease, may be transmitted via the aerosol route, and have no available vaccine or therapy. Agents with similar genetics to Biosafety Level 4 agents also should be handled at this level. When sufficient data are obtained, work with these agents may continue at this level or at a lower level. Viruses such as Marburg or Congo-Crimean hemorrhagic fever are manipulated at Biosafety Level 4 (HHS 2007). No Biosafety Level 4 work is currently performed or proposed to be performed at LANL. **Table C–52** delineates containment design practices and levels of biological agents for each Biosafety Level Facility.

Table C–52 Containment Design Practices and Levels of Biological Agents for Each Biosafety Level Facility

Biosafety Level	*Agents*	*Practices*	*Safety Equipment (Primary Barriers)*	*Facilities (Secondary Barriers)*
1	Not known to consistently cause disease in healthy adults.	Standard Microbiological Practices	None required.	Open bench top sink required.
2	Associated with human disease; hazard = percutaneous injury (that is, injury obtained through the skin or skin puncture), ingestion, and mucous membrane exposure.	Biosafety Level 1 practices plus: - Limited access, - Biohazard warning signs, - “Sharps” precautions, and - Biosafety manual defining any needed waste decontamination or medical surveillance policies	Primary barriers = Class I or II biological safety cabinets or other physical containment devices used for all manipulations of agents that cause splashes or aerosols of infectious materials; personal protective equipment: laboratory coats; gloves; and face protection as needed.	Biosafety Level 1 plus: - Autoclave (a strong, pressurized, steam-heated vessel, used for sterilization).
3	Indigenous or exotic agents with potential for aerosol transmission; disease may have serious or lethal consequences.	Biosafety Level 2 practices plus: - Controlled access, - Decontamination of all waste, - Decontamination of lab clothing before laundering, and - Baseline serum.	Primary barriers = Class I or II biological safety cabinets or other physical containment devices used for all open manipulations of agents; personal protective equipment: protective lab clothing; gloves; and respiratory protection as needed.	Biosafety Level 2 plus: - Physical separation from access corridors; - Self-closing, double-door access; - Exhausted air not recirculated; and - Negative airflow into laboratory.
4	Dangerous or exotic agents which pose high risk of life-threatening disease from aerosol-transmitted lab infections or related agents with unknown risk of transmission.	Biosafety Level 3 practices plus: - Clothing change before entering, - Shower on exit, and - All material decontaminated on exit from facility.	Primary barriers = All procedures conducted in Class III biological safety cabinets or Class I or II biological safety cabinets in combination with full-body, air-supplied, positive pressure personnel suit.	Biosafety Level 3 plus: - Separate building or isolated zone; - Dedicated supply and exhaust, vacuum, and decontamination systems; and - Other requirements outlined in Section C.3.3.3.

Source: HHS 2007.

C.3.4 Detection

Unlike chemical or radiological hazards, biological organisms cannot be recognized instantaneously due to the complexity of differentiating normal background organisms from potentially deadly organisms. Therefore, the scientific community has been working diligently to develop methods and assays that will allow collection and identification of an organism within any sample within an acceptable time. The detection of a biological agent starts with being able to collect samples from surfaces, air, water, soil, or bodily fluids that contain the potentially harmful organism. The next step in detection is identifying the presence of a harmful organism and its identification. These assays must be capable of utilizing specificity, time, and accuracy to identify the unknown agent; the more specific assays take a longer period of time. The methods that are most commonly used are Polymerase Chain Reaction, Enzyme-Linked Immunosorbent Assay, and Culturing. Polymerase Chain Reaction is a method in which specific DNA sequences are amplified to identify the presence or absence of a given organism. Enzyme-Linked Immunosorbent Assay is a method that determines the presence of antibodies to a foreign substance. Culturing, the gold standard method for many reference laboratories, is a method in which a given sample is spread on a nutrient culture plate containing the appropriate media for the organism of interest and allowed to grow for a given length of time at a given temperature. This method allows investigators to identify all living organisms within a sample, unlike the previous methods that cannot distinguish between living or dead organisms. All of these methods together are being developed to help protect the public from a biological attack.

C.3.5 Select Biological Agents

Select agents are specifically regulated pathogens and toxins as defined in 42 CFR Part 73, including pathogens and toxins regulated by both the U.S. Department of Health and Human Services and U.S. Department of Agriculture (specifically overlapping agents or toxins). These agents are select agents because they have been or could be used by a nation state or terrorist group to attack the United States in the form of biological warfare; therefore they are a risk to national security. These select agents are a concern because:

- They can be easily or moderately disseminated or transmitted from person to person;
- They result in high mortality rates, moderate morbidity rates, and have the potential for a major public health impact;
- They might cause public panic and social disruption;
- They require special action for public health preparedness;
- They require specific enhancements of the Center for Disease Control and Prevention’s diagnostic capacity and enhanced disease surveillance;
- Their ease of production and dissemination; and
- They can be engineered for mass dissemination in the future.

C.3.6 Transmission

These different types of agents are also categorized by route of infection or transmission; that is, how they are passed via an animal (zoonotic), a host – mosquito (vector-borne), or a human. A “zoonotic disease is a disease caused by infectious agents that can be transmitted between (or are shared by) animals and humans” (Olsen 2000). These categories of agents also can be described by whether or not they just cause infection in the person that had contact with that organism (infectious) and whether the infection is passed from person to person (contagious).

C.4 Key Differences Between Biological, Radiological, and Chemical Agents

Although each is always present in our environment and can be both beneficial and detrimental to human health, there are several important distinctions between biological, radiological, and chemical agents, including those listed below:

- Biological organisms have the capability to survive and replicate within a given environment, whereas both radiological and chemical agents will decay or remain constant over time.
- Detection time for chemicals and ionizing radiation is faster than for biological materials (minutes versus hours).
- Only biological materials are capable of contagious spread from person to person.
- There are levels of radiation and concentrations of chemicals below which there are no discernible health effects; but even at minute concentrations, certain biological agents may cause health effects ranging from mild illness (morbidity) to fatal illness (mortality).
- All chemical agents and some biological agents can be neutralized by the use of other chemicals, but radiation cannot be neutralized; it can only be shielded or contained.

C.5 References

CIRRPC (Committee on Interagency Radiation Research and Policy Coordination), 1992, *Use of BEIR V and UNSCEAR 1988 in Radiation Risk Assessment, Lifetime Total Cancer Mortality Risk Estimates at Low Doses and Low Dose Rates for Low-LET Radiation*, ORAU 92/F-64, Science Panel Report No. 9, Office of Science and Technology Policy, Executive Office of the President, Washington, DC, December.

DOE (U.S. Department of Energy), 1999a, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 1999b, *DOE Standard, Radiological Control*, DOE-STD-1098-99, Washington, DC, July.

DOE (U.S. Department of Energy), 2003a, *Estimating Radiation Risk from Total Effective Dose Equivalent (TEDE), ISCORS Technical Report No. 1*, DOE/EH-412/0015/0802, Rev. 1, Office of Environmental Policy and Guidance, Washington, DC, January.

DOE (U.S. Department of Energy), 2003b, *Final Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/EIS-0350, Los Alamos, New Mexico, November.

EPA (U.S. Environmental Protection Agency), 1994, *Estimating Radiogenic Cancer Risks,* EPA 402-R-93-076, Office of Radiation and Indoor Air, Washington, DC, June.

EPA (U.S. Environmental Protection Agency), 1997, *Exposure Factors Handbook,* National Center for Environmental Assessment, Office of Research and Development, Washington, DC, August.

EPA (U.S. Environmental Protection Agency), 1999, *Cancer Risk Coefficients for Environmental Exposure To Radionuclides,* Federal Guidance Report, No. 13, EPA 402-R-99-001, Office of Radiation and Indoor Air, Washington, DC, September.

EPA (U.S. Environmental Protection Agency), 2001, *Office of Radiation and Indoor Air, Health Effects Assessment Summary Tables (HEAST) - Radionuclides Table*, April 16.

EPA (U.S. Environmental Protection Agency), 2002, *CAP88-PC Version 3.0 User Guide, Draft Revision 1*, Office of Radiation and Indoor Air, Washington, DC, August.

EPA (U.S. Environmental Protection Agency), 2003, *CSFII Analysis of Food Intake Distributions,* EPA/600/R-03/029, National Center for Environmental Assessment–Washington Office, Office of Research and Development, Washington, DC, March.

EPA (U.S. Environmental Protection Agency), 2005a, *Integrated Risk Information System, IRIS Substance List,* (accessed at www.epa.gov/IRIS).

EPA (U.S. Environmental Protection Agency), 2005b, *Region 6 Human Health Medium-Specific Screening Levels 2006*, (accessed at *www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm)*, EPA Region 6, Dallas, TX, December.

HHS (U.S. Department of Health and Human Services), 2007, *Biosafety in Microbiological and Biomedical Laboratories*, Centers for Disease Control and Prevention, National Institutes of Health, Health and Human Services, Fifth Edition, February.

ICRP (International Commission on Radiological Protection), 1991, *1990 Recommendations of the International Commission on Radiological Protection*, Annals of the ICRP, ICRP Publication 60, Vol. 21, No. 1-3, Pergamon Press, New York, New York, November.

LANL (Los Alamos National Laboratory), 2000, *U.S. Department of Energy Report, 1999 LANL Radionuclide Air Emissions*, LA-13732-ENV, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2001, *U.S. Department of Energy Report, 2000 LANL Radionuclide Air Emissions*, LA-13839-MS, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2002a, *U.S. Department of Energy Report, 2001 LANL Radionuclide Air Emissions*, LA-13957-PS, Office of Los Alamos Site Operations, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2002b, *Environmental Surveillance at Los Alamos during 2001*, LA-13979-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2003a, *U.S. Department of Energy Report, 2002 LANL Radionuclide Air Emissions*, LA-14058-PR, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2003b, *Dose Assessment Using CAP88*, RRES-MAQ-501, R6, Meteorology and Air Quality, August 26.

LANL (Los Alamos National Laboratory), 2004a, *Air-Sampling Data from Area G: A Radioactive-Waste Management Site*, LA-14090, January.

LANL (Los Alamos National Laboratory), 2004b, *Environmental Surveillance at Los Alamos during 2002*, LA-14085-ENV, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2004c, *U.S. Department of Energy Report, 2003 LANL Radionuclide Air Emissions*, LA-14155-PR, Los Alamos Site Office, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2004d, *Environmental Surveillance at Los Alamos during 2003*, LA-14162-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005a, *U.S. Department of Energy Report, 2004 LANL Radionuclide Air Emissions*, LA-14233, Los Alamos Site Office, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2005b, *Environmental Surveillance at Los Alamos during 2004*, LA-14239-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006a, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document*, Data Call Materials, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006b, *Environmental Surveillance at Los Alamos during 2005*, LA-14304-ENV, Los Alamos, New Mexico, September.

National Research Council, 2005, Free Executive Summary, *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII – Phase 2, Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation*, (accessed February 28, 2006 at www.nap.edu/catalog/11340.html).

NCRP (National Council on Radiation Protection and Measurements), 1987, *Ionizing Radiation Exposure of the Population of the United States*, NCRP Report No. 93, Bethesda, Maryland, September 1.

NCRP (National Council on Radiation Protection and Measurements), 1993, *Risk Estimates for Radiation Protection*, NCRP Report No. 115, Bethesda, Maryland, December 31.

NRC (U.S. Nuclear Regulatory Commission), 2003, *SECPOP2000: Sector Population, Land Fraction, and Economic Estimation Program*, NUREG/CR-6525, Rev. 1, Washington, DC, August.

NutritionData, 2006, "Nutritional Summary for Nuts, pine nuts, pinyon, dried," (accessed at www.nutritiondata.com/ facts-001-02s02f2.html), Nutrition Facts and Calorie Counter, New York, New York.

Olsen, C., 2000, "Zoonotic Diseases Tutorial," (accessed February 28, 2006, www.vetmed.wisc.edu/pbs/zoonoses), Department of Pathobiological Sciences, School of Veterinary Medicine, University of Wisconsin, Madison, Wisconsin.

APPENDIX D
EVALUATION OF HUMAN HEALTH IMPACTS FROM FACILITY ACCIDENTS

APPENDIX D
EVALUATION OF HUMAN HEALTH IMPACTS FROM FACILITY ACCIDENTS

D.1 Introduction

This appendix provides additional information and details to support the analysis of the impacts of potential facility accidents presented in Chapter 5. It includes, in Section D.2, an evaluation of the present applicability of the methodology and accident data that were reported in the *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS)* (DOE 1999a) to inform the public of the differences in analyses between that document and the current site-wide environmental impact statement (SWEIS) for continued operation of Los Alamos National Laboratory (LANL). This is followed in Section D.3 with a discussion of the postulated radiological and chemical accident scenarios and their estimated impacts to workers and the public. Section D.4 discusses site-wide seismic impacts. Wildfires in the LANL vicinity and their potential for causing the release of hazardous radiological and chemical materials are a subject of public concern. A wildfire accident scenario was analyzed and its potential impacts to workers and the public are discussed in Section D.5. The impact discussions in Sections D.3 through D.5 address the general population and specific bounding individuals (the noninvolved worker and the maximally exposed individual [MEI]). Section D.6 discusses the impacts to the worker directly involved in the operation being analyzed, that is, the involved worker. Section D.7 presents impacts on individuals at various distances up to 3,281 yards (3,000 meters) from each hypothesized accident source. Two computer codes were used to analyze the postulated accidents and to estimate their impacts: (1) MACCS for radiological releases; and (2) ALOHA for chemical releases. These codes are described in Sections D.8 and D.9, respectively.

D.2 Data and Analysis Changes from the *1999 SWEIS*

Accident scenarios are generally chosen for analysis in an environmental impact statement to represent the range of possible initiating events and impacts. Accidents resulting in severe (often bounding) consequences and risks are typically presented as well. In the case of the current SWEIS, scenarios from the *1999 SWEIS* were considered. Changes to LANL operations since 1999 and any new information that could change the scenarios evaluated in 1999 were incorporated. In addition, operations that are planned or have been initiated since 1999 were included. Scenarios for these changed and new operations were chosen to demonstrate the range of possible accidents and to describe the bounding impacts.

The differences between accidents analyzed in the *1999 SWEIS* and this SWEIS are provided in **Table D–1**. Most of the differences are the result of updated environmental information (such as population and meteorology data) and changes in facility operations (facilities added, deleted, or material at risk [MAR] changes). Additional, relevant aspects of the overall study that pertain to other environmental resource areas are addressed elsewhere in this SWEIS.

The first column of Table D–1 refers to an accident topic or issue discovered during the review of documented information. Designations such as RAD-01, CHEM-01, and SITE-01 refer to specific accidents that were postulated and analyzed in the *1999 SWEIS*. The relevant facilities are also identified in the column, where applicable. The second column contains a qualitative description to reflect any changes in scenarios since the *1999 SWEIS* was issued. The third column is an evaluation of the current information on the listed topic or issue. The information contained in Table D–1 played a dominant role in directing the course of the facility accident analyses performed for this SWEIS.

Much of the background data, such as meteorology or plume characteristics, and its use in the present analysis are described in **Table D–2**. As indicated in the table, an offsite population distribution based on the 2000 census was determined for each LANL technical area (TA); this distribution was then applied to any releases from that area. Populations were considered to a distance of 50 miles (80 kilometers) from the TA.

D.3 Radiological and Chemical Accidents

This section provides information and data that supports the analysis of radiological and chemical impacts of facility accidents for each alternative presented in Chapter 5. It includes the accident frequency of occurrence and impacts, scenarios, material at risk, source terms, and factors used in the calculation of source terms.

These scenarios represent potential accidents at individual facilities. Earthquakes and wildfires that could impact multiple facilities are considered in Sections D.4 and D.5, respectively.

D.3.1 Radiological and Chemical Scenarios and Source Terms

The accident scenarios and source terms used to calculate the radiological and chemical accident impacts are shown in **Table D–3**. The evolution of choosing these scenarios is described in Table D–1. As described there, most of these scenarios evolved from those analyzed in the *1999 SWEIS*.

The Decontamination and Volume Reduction System (DVRS) is a new operation that was not considered in the *1999 SWEIS*. The impacts from an operational spill at DVRS are presented to depict the consequences of a relatively high probability operational accident. The forklift collision and spill associated with the building fire scenario are included because they represent high consequence and high risk (relative to other DVRS scenarios) impacts to the general public and workers.

Table D–1 Evaluation of Accident Data from the *1999 SWEIS*

Topic/Issue	***Scenario Notes***	***Evaluation***
Offsite population	None	Offsite population has increased in magnitude by 20 to 30 percent.
Modeling Methodology		Dose-to-LCF factor has increased by 20 percent (public) and 50 percent (worker). Other SWEIS modeling parameters that were not specified in the *1999 SWEIS* can affect MEI and population doses.
Meteorological Data		Post-*1999 SWEIS* meteorological data are available through 2003. Sensitivity analysis using more recent data show increases in population dose of up to 20 percent. Chemical accident impacts would also increase.
RAD-01 TA-54, RANT	Increased source term	Reanalyzed based on scenario changes including increased source term from 2006 BIO. Now noted as RANT Lightning Strike Fire.
RAD-02 TA-3, CMR	New CMR scenario	The *CMRR EIS* (DOE 2003a) was published after the *1999 SWEIS*. The maximum risk no action accident from that document was selected to represent CMR. The scenario is called CMR HEPA filter fire.
RAD-03 TA-18, GODIVA IV	No longer operating	Not analyzed because this TA-18 mission is being relocated to the Nevada Test Site. MAR that was formerly at TA-18 has been moved to the TA-55 SST Facility and is considered part of the site-wide seismic scenarios.
RAD-04 TA-15, DARHT	Nonnuclear	Not analyzed; now a nonnuclear facility.
RAD-05 TA-21, TSFF	MAR moved to WETF	Replaced with WETF Fire. Remaining MAR analyzed as part of site-wide seismic scenarios.
RAD-06 TA-50-37, RAMROD	Radiological facility	Not analyzed; facility is no longer a nuclear facility and thus would not impact offsite receptors.
RAD-07 TA-50-69, WCRR	Increased Source Term	Now called WCRR Lightning Strike Fire. New accident scenario from 2006 BIO.
RAD-08 TA-54, TWISP	New transuranic waste storage scenario	Replaced with Waste Storage Dome Fire. Major risk accident from the Safety Evaluation Report for TA-54 Area G (DOE 2003b).
RAD-09 TA-54, TWISP	New waste storage domes scenario	Replaced with Onsite Transuranic Waste Fire Accident. Major risk accident from the Safety Evaluation Report for TA-54 Area G (DOE 2003b).
RAD-10 TA-55-4, Plutonium Facility	Increased Source Term	Now called Plutonium Facility Materials Staging Area Fire.
RAD-11 TA-15, DARHT	Nonnuclear	Not analyzed; now a nonnuclear facility.
RAD-12 TA-16-411	Radiological facility	Not analyzed; facility is no longer a nuclear facility and thus would not impact offsite receptors. Remaining MAR analyzed as part of Site-wide Wildfire.
RAD-13 TA-18, Pajarito Site, Kiva #3	No longer operating	Replaced with scenario for only operating reactor, SHEBA Hydrogen Detonation. Scenario is major risk SHEBA accident scenario from the *TA-18 Relocation EIS* (DOE 2002a). MAR that was formerly at TA-18 has been moved to the TA-55 SST Facility and is considered part of the site-wide seismic scenarios.
RAD-14 TA-55-4, Plutonium Facility	Deleted	Replaced by Materials Staging Area Fire Accident Scenario.

Topic/Issue	***Scenario Notes***	***Evaluation***
RAD-15 TA-3-29 CMR	New CMR scenario	See RAD02. Wing Fire now considered part of Radiological Sciences Institute.
RAD-16 TA-3-29, CMR	New CMR scenario	See RAD02.
SITE-01 (Rad) Site-wide Earthquake	Change in source term and components	Renamed Seismic 1. CMR source term replaced based on CMR EIS (DOE 2003a). TA-18 source term changed based on TA-18 Relocation EIS (DOE 2002a), plus movement of material from TA-18 to TA-55 (see Seismic 02). RAMROD deleted because it is no longer a nuclear facility. Decrease in TA-21 source term. Change in scenario and increase in RANT source term. No release from waste storage domes during this event (DOE 2003b). DVRS glovebox processing campaign added (DOE 2004b). Nominally PC-2.
SITE-02 (Rad) Site-wide Earthquake	Change in source term and components	Renamed Seismic 2. Seismic 1 changes (above) carry to this scenario. Increase in WETF source term. TWISP (now Domes) scenario revised; source term increase based on all domes (DOE 2003b). Plutonium Facility releases based on 2002 BIO. Added SST Facility (material moved from TA-18 and awaiting shipment to the Nevada Test Site). Nominally PC-3. All else unchanged from *1999 SWEIS* with exception of new higher source term for TA-50-69 and TA-55-4.
SITE-03 (Rad) Site-wide Earthquake	Deleted	No significant scenarios beyond those of Seismic 2. Surface rupture not considered in source document (DOE 2003a).
SITE-04 (Rad) Site-wide Wildfire	Change in source term and components	Renamed Wildfire. TA-21 source terms decreased. Sigma Complex, Radiochemistry Laboratory, waste storage domes added.
CHEM-01 TA-00-1109	Deleted	Accident is no longer applicable because MAR has been moved offsite (LANL 2004).
CHEM-02 TA-3-476	Deleted	Chlorine no longer stored for water treatment (LANL 2004).
CHEM-03 TA-3-476	Deleted	Chlorine no longer stored for water treatment (LANL 2004).
CHEM-04 TA-54-216	No change	Now labeled 75 liters selenium hexafluoride from waste cylinder storage at TA-54-216 (LANL 2004).
CHEM-05 TA-54-216	No change	Now labeled 300 pounds sulfur dioxide from waste cylinder storage at TA-54-216 (LANL 2004).
CHEM-06 TA-55-4	No change	Now labeled 150 pounds of chlorine gas released outside of Plutonium Facility (LANL 2004).
Helium at TA-55-41	New	Added to represent possible asphyxiant release accident.
SITE-01 (Chem) Site-wide Earthquake	Change in source term and components	Renamed Seismic 1. Chlorine at TA-00 and TA-3 deleted; no longer at site. Phosgene and formaldehyde sources decreased.
SITE-02 (Chem) Site-wide Earthquake	Change in source term and components	Renamed Seismic 2. Seismic 1 changes carry over to this scenario.
SITE-03 (Chem) Site-wide Earthquake		Same scenario as Seismic 2. SITE-03 was combined with SITE-02 to create Seismic 2.

Topic/Issue	***Scenario Notes***	***Evaluation***
SITE-04 (Chem) Site-wide Wildfire	Change in source term and components	Renamed Wildfire. Hydrogen cyanide from Sigma Complex added.
TA-54, DVRS	New	DVRS glovebox processing campaign scenarios are added (DOE 2004b).
Sealed Sources at CMR	New	Sealed source MAR at CMR added.
MDA G	New	Scenario (explosion) that could potentially affect offsite receptors chosen (see Appendix I).
Aircraft Crash	New	*1999 SWEIS* aircraft crash scenarios changed because either MAR moved (see RAD-05); facilities are no longer operating (see RAD-06); or a more bounding, non-aircraft crash scenario was chosen for analysis (see RAD-08 and RAD-16). Aircraft crash scenario analyzed in Appendix J (Human Health Impacts section) of this SWEIS for Sealed Sources in Waste Storage Domes at TA-54, Area G. Highest-risk sealed source scenario (Sealed Sources at CMR) brought forward to this appendix (see Sealed Sources at CMR above).
CMRR	Bounded by CMR	DOE 2003a considered accidents from both CMR (No Action) and the CMRR (Preferred Action). Results (Tables C–3 and C–5 of that document) show that CMRR accident risks are bounded by those of CMR. Therefore, the latter is analyzed here.
WORK-01 thru -05	Not included	Involved worker accident consequences were addressed qualitatively in the *1999 SWEIS*. Designations Work-01 through -05 were dropped and replaced with discussion in Section D.6.
Criticality Scenario	Involved worker issue	Considered in *1999 SWEIS* for TA-18 (facility not operating in the alternatives for this SWEIS) and qualitatively for involved workers (WORK-03). SHEBA (TA-18) criticality considered in the TA-18 Relocation EIS (DOE 2002a) and risks to the public and non-involved worker shown (Table C–6 of that document) to be inconsequential and bounded by the SHEBA Hydrogen Detonation scenario analyzed in this SWEIS. Criticality scenario impacts are short range and affect involved workers only. Involved worker impacts are discussed in Section D.6.
Detonation of High Explosives Scenario	Involved worker issue	Considered qualitatively in *1999 SWEIS* for involved workers (WORK-01). No potential for associated radionuclide or toxic chemical release consequences to public. High explosive detonation scenario impacts are short range and affect involved workers only. Involved worker impacts are discussed in Section D.6.

LCF = latent cancer fatality; MEI = maximally exposed individual; TA = technical area; RANT = Radioassay and Nondestructive Testing; BIO = basis of interim operation; CMR = Chemistry and Metallurgy Research Building; CMRR EIS = *Final Environmental Impact Statement for the Chemistry and Metallurgy Research and Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico*; HEPA = high-efficiency particulate air; GODIVA = fast burst reactor formerly operating in TA-18; MAR = material at risk; SST = Safe Secure Transport; DARHT = Dual-Axis Radiographic Hydrodynamic Test; TSFF = Tritium Science and Fabrication Facility; WETF = Weapons Engineering Tritium Facility; RAMROD = Radioactive Materials Research, Operations, and Demonstration; WCRR = Waste Characterization, Reduction, and Repackaging Facility; TWISP = Transuranic Waste Inspectable Storage Project; SHEBA = Solution High-Energy Burst Assembly; DVRS = Decontamination and Volume Reduction System; PC = performance category; MDA = material disposal area; CMRR = Chemistry and Metallurgy Research Replacement Facility.

Table D–2 General Analysis Assumptions Independent of Scenario

Parameter	*General Population*	*MEI, Workers*	*Comments*
MACCS2			**Version 1.13.1**
Population	SECPOP2000 (NRC 2003) 2000 census. General population distribution centered at accident source facility.	Noninvolved worker at 100 meters from source.	Facility locations from LANL 2006. MEI and noninvolved worker using "peak dose at a distance" MACCS2 results.
Population Ring Boundaries	1, 2, 3, 4, 5, 10, 20, 30, 40, 50 miles	Not applicable	General population to 50 miles.
Inhalation and external exposure from plume	Yes	Yes	
Inhalation and external exposure from deposition and resuspension	Yes	No	MEI and noninvolved worker are short-term exposures.
Breathing rate	0.000347 cubic meters per second	0.000347 cubic meters per second	DOE 1992.
Exposure from agricultural pathway, except tritiated water, strontium-90 and cesium-137	No	No, due to short exposure time.	Plutonium and uranium chief inhalation risks.
Exposure from agricultural pathway, tritiated water, strontium-90, and cesium-137	Yes, HTO estimated using CAP88. Derived factor.	No, due to short exposure time.	Ratio of ingestion to inhalation as determined from unit release of HTO using CAP88 (EPA 2005). No worker or individual ingestion pathway.
Evacuation	No	No	Assume no protective actions taken.
Relocation	No	No	Assume no protective actions taken.
Cloud shielding factor	0.75	1	General population from Chanin and Young 1997.
Protection factor for inhalation	0.41	1	General population from Chanin and Young 1997.
Skin protection factor	0.41	1	General population from Chanin and Young 1997.
Ground shielding factor	0.33	1	General population from Chanin and Young 1997. No deposition for workers.
Groundshine weathering coefficients	0.5, 0.5	0.5, 0.5	Chanin and Young 1997. Not applicable to workers.
Groundshine weathering coefficient half-lives	1.6×10^{7}, 2.8×10^{9} seconds	1.6×10^{7}, 2.8×10^{9} seconds	Chanin and Young 1997. Not applicable to workers.
Resuspension concentration coefficient	10^{-5}, 10^{-7}, 10^{-9} per meter	10^{-20}, 10^{-20}, 10^{-20} per meter	General population from Chanin and Young 1997. No resuspension for workers.
Resuspension concentration coefficient half-lives	1.6×10^{7}, 1.6×10^{8}, 1.6×10^{9} seconds	1.6×10^{7}, 1.6×10^{8}, 1.6×10^{9} seconds	0.5, 5, and 50 years, respectively (Chanin and Young 1997). Not applicable to workers.
Wet deposition	Yes	No	No wet deposition for workers. No wet deposition of noble gases (Chanin and Young 1997).
Dry deposition	Yes	No	No dry deposition for workers (conservative). No dry deposition of noble gases (Chanin and Young 1997).

Parameter	***General Population***	***MEI, Workers***	***Comments***
Washout coefficient	0.000095, 0.8	0.000095, 0.8	Chanin and Young 1997. Not applicable to workers and MEI.
Deposition velocity	.01, .005, .001 meters per second	.01, .005, .001 meters per second	Unfiltered particulates, tritiated water, filtered particulates, respectively. Not applicable to workers and MEI.
Long-term exposure period (resuspension)	317 years (1×10^{10} sec)	317 years (1×10^{10} sec)	Maximum allowed by MACCS2. Not applicable to workers and MEI.
Sigma-y, Sigma-z (dispersion parameters)	Tadmor-Gur Tables	Tadmor-Gur Tables	Chanin and Young 1997.
Surface roughness length correction	1.27	1.66	Corresponds to z0=10 centimeters (rural) for general population and z0=38 centimeters (DOE 2004b) for workers.
Plume meander time base	600 seconds	600 seconds	Chanin and Young 1997.
xpfac1	0.2	0.01	Plume meander exponential factor for time less than break point (1 hour). General population from DOE 1992, workers set to .01 (minimum value allowed by MACCS), so no plume meander for 1 hour (conservative).
xpfac2	0.25	0.25	Chanin and Young 1997; plume meander exponential factor for times greater than 1 hour.
Plume segment reference time	0	0	Plume segment reference at leading edge of plume (for dispersion, deposition, decay calculations).
TA releases for which TA-6 Meteorological Tower data are used	[3], 6, 8, 9, [16], 22, 35, 40, 43, 48, [50], 52, [55], 59, 60, 61, 63, 64, 66, 69	[3], 6, 8, 9, [16], 22, 35, 40, 43, 48, [50], 52, [55], 59, 60, 61, 63, 64, 66, 69	Closest Meteorological Tower to TAs. All TAs with workers listed; TAs with accident releases in *1999 SWEIS* indicated with brackets [ ].
TA releases for which TA-49 Meteorological Tower data are used	11, [15], 33, 36, 39, 49	11, [15], 33, 36, 39, 49	Closest Meteorological Tower to TAs. All TAs with workers listed; TAs with accident releases in *1999 SWEIS* indicated with brackets [ ].
TA releases for which TA-53 Meteorological Tower data are used	0, [21], 46, 51, 53	0, [21], 46, 51, 53	Closest Meteorological Tower to TAs. All TAs with workers listed; TAs with accident releases in *1999 SWEIS* indicated with brackets [ ].
TA releases for which TA-54 Meteorological Tower data are used	[18], [54]	[18], [54]	Closest Meteorological Tower to TAs. All TAs with workers listed; TAs with accident releases in *1999 SWEIS* indicated with brackets [ ].

Parameter	***General Population***	***MEI, Workers***	***Comments***
Meteorological dataset	2003	2003	Overall year of maximum worker and general population dose for the years 1995 through 2003 for unit ground level release of plutonium-239. All TA Meteorology data for 2003 within 11 percent of maximum year (1995 through 2003) except TA-46 (16 percent).
Atmospheric mixing height	350, 550, 500, 380; 1,500, 3,400, 4,000, 2,200 meters	350, 550, 500, 380; 1,500, 3,400, 4,000, 2,200 meters	Corresponding to the numbers in the previous two columns: morning-winter, spring, summer, fall; afternoon-winter, spring, summer, fall (Holzworth 1972).
Wind shift without rotation	Yes	Yes	Plume direction follows wind direction every hour.
metcod	5	5	Stratified random samples for each day of the year (see nsmpls below).
nsmpls	24	24	24 Meteorology samples per day (sample each hour).
Boundary conditions used in last ring	Yes	No	General population boundary conditions (rainfall) conservatively chosen so that releases are accounted for within modeled area. Sensitivity shows that not including boundary conditions (open boundary) results in decrease of 12 percent in median population dose and no change in extreme population dose for TA-6.
Model boundary mixing height	1,600 meters	1,600 meters	Average of seasonal mixing heights as given in Meteorology files.
Model boundary stability class and wind speed	D-2.2 meters per second	D-2.2 meters per second	50 percent MET conditions (see average Meteorology conditions below). Not applicable to workers.
Model boundary rain fall rate	23 millimeters per hour	0 millimeters per hour	Conservative maximum hourly rate from all 2003 Meteorology files (noted at TA-53 and 54). Not applicable to workers.
Dose conversion factors	FGR 11,12	FGR 11,12	Increase tritiated water inhalation by 50 percent to account for skin absorption (EPA 1988, EPA 1993).
Presented dose results	TEDE-mean	TEDE-mean	
Health risk	0.0006	0.0006	Fatal cancers per rem (total effective dose equivalent) (DOE 2003c).
ALOHA			**Version 5.3.1.**
Ground roughness length	38 centimeters	38 centimeters	DOE 2004b. ALOHA defaults to vertical dispersion parameter (Sigma-z) values consistent with urban environment for the indicated roughness length, z0, of 38 centimeters. For z0 less than 20 centimeters,

Parameter	***General Population***	***MEI, Workers***	***Comments***
			ALOHA defaults to a rural environment. Distances of interest expected to be close to release. General population uses same parameters as workers.
Meteorological measurement height	10 meters	10 meters	Consistent with MACCS MET data files.
Humidity	50 percent	50 percent	DOE 2004c. Within range for LANL (LANL 2006).
Median MET conditions	D-2.2	D-2.2	Stability class and wind speed in meters per second. 50 percent x/q at 2,000 meters, typical distance of interest. Minimum median wind speed from any MET Tower for 2003 (noted at TA-6). Other areas range up to D-2.8.
Median MET conditions (Wildfire)	D-3.5	D-3.5	Stability class and wind speed in meters per second. 50 percent x/q at 2,000 meters, typical distance of interest. Minimum median wind speed from any MET Tower for cumulative period 2000 through 2003 (noted at TA-49) for months of April through June. Other areas range up to D-4.0 (for TA-53).
Date and time, median MET conditions	June 22 - 1 p.m.	June 22 - 1 p.m.	DOE 2004c (summer, midday). Consistent with hours of average MET conditions from 2003 TA-6 MET tower data.
Air temperature, median MET conditions	81 degrees Fahrenheit	81 degrees Fahrenheit	LANL 2006.
Cloud cover, median MET conditions	10 tenths	10 tenths	Complete cloud cover; chosen to be consistent with other median meteorological conditions and stability class D.
Inversion height (mixing height), median MET conditions	4,000	4,000	(Meters) Summer afternoon mixing height (see "Atmospheric Mixing Height" above) consistent with date and time.
Presented effects	Distance to ERPG-2 and 3	Distance to ERPG-2 and 3	DOE 2004c.

MEI = maximally exposed individual, MET = meteorological, HTO = tritiated water, TA = technical area, FGR = Federal Guidance Report, TEDE = total effective dose equivalent, ERPG = Emergency Response Planning Guideline.

Note: To convert meters to feet, multiply by 3.2808; from miles to kilometers, multiply by 1.609.

Table D–3 Facility Accident Source Term Data

Accident Phase	*Nuclide*	*MAR (curies or grams)*	*MAR*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fractions*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Identifier: RANTLIT. **Scenario:** Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38).													
Spilled and expelled	Plutonium Equivalent	curies	–	–	–	–	–	–	0.18	1	0	0	Yes
Burning			–	–	–	–	–	–	18.36	60	0.1	0	Yes
Identifier: WETF. **Scenario:** Weapons Engineering Tritium Facility Fire (TA-16-205).													
Fire	Tritiated Water	grams	1,000	1	1	1	–	1	1,000	60	0	23	Yes
Fire	Plutonium-238		5.00	1	0.0005	1	–	1	0.0025	60	0	23	Yes
Suspension	Plutonium-238		5.00	1	–	1	0.00004	1	0.0048	1,440	0	0	Yes
Identifier: WCRLITN. **Scenario:** Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69).													
Spill inside building	Plutonium Equivalent	curies	800	1	0.001	1	–	1	0.8000	1	0	0	Yes
Spill outside building			1,000	1	0.001	0.1	–	1	0.1000	1	0	0	Yes
Fire inside building			799.2	1	0.01	1	–	1	7.992	60	0.1	0	Yes
Resuspension outside building			999.9	1	–	0.1	0.00004	1	0.09599	1,440	0	0	Yes
Identifier: DOMEF. **Scenario:** Waste Storage Dome Fire (TA-54).													
Combustible													
Burning expelled in lid loss	Plutonium Equivalent	curies	3,380	0.123	0.01	1	–	1	4.15	60	0	0	No
Burning (in drums)			3,380	0.877	0.0005	1	–	1	1.48	60	0	0	No
Noncombustible													
Burning	Plutonium Equivalent	curies	9,210	1	0.006	0.01	–	1	0.553	60	0	0	No
Total													
Burning	Plutonium Equivalent	curies	–	–	–	–	–	–	6.18	60	0	0	No
Impact release			12,600	0.123	0.001	1	–	1	1.55	1	0	0	No
Identifier: DOMET **Scenario:** Onsite Transuranic Waste Fire (TA-54).													
Initial (expelled)	Plutonium Equivalent	curies	1,100	1	0.001	0.3	–	1	0.33	1	0	0	No
Uncontained burn (high heat)			1,100	1	0.01	1	–	0.5	5.49	60	15.3	0	No

Accident Phase	***Nuclide***	***MAR (curies or grams)***	***MAR***	***Damage Ratio***	***Airborne Release Fraction***	***Respirable Fractions***	***Airborne Release Rate (per hour)***	***Leak Path Factor***	***Source Term (units of MAR)***	***Release Duration (minutes)***	***Plume Heat (mega-watts)***	***Release Height (meters)***	***Wake?***
Uncontained burn (smoldering)			1,100	1	0.01	1	–	0.5	5.49	60	0.1	0	No
Suspension			1,090	1	–	1	0.00004	1	1.04	1,440	0	0	No
Identifier: PF4MFIR. **Scenario:** Plutonium Facility Materials Staging Area Fire (TA-55-4).													
Fire	Plutonium-238	curies	–	–	–	–	–	–	0.229	60	0.1	0	No
	Plutonium-239		–	–	–	–	–	–	8.015	60	0.1	0	No
	Plutonium-240		–	–	–	–	–	–	1.857	60	0.1	0	No
	Plutonium-241		–	–	–	–	–	–	26.85	60	0.1	0	No
	Plutonium-242		–	–	–	–	–	–	0.0001083	60	0.1	0	No
	Americium-241		–	–	–	–	–	–	0.747	60	0.1	0	No
Resuspension	Plutonium-238	curies	–	–	–	–	–	–	0.06428	1,440	0	0	No
	Plutonium-239		–	–	–	–	–	–	2.25	1,440	0	0	No
	Plutonium-240		–	–	–	–	–	–	0.5213	1,440	0	0	No
	Plutonium-241		–	–	–	–	–	–	7.537	1,440	0	0	No
	Plutonium-242		–	–	–	–	–	–	0.0000304	1,440	0	0	No
	Americium-241		–	–	–	–	–	–	0.2097	1,440	0	0	No
Identifier: DVRS01. **Scenario:** Decontamination and Volume Reduction System Operational Spill (TA-54-412).													
	Plutonium Equivalent	curies	1,100	1	0.001	0.3	–	1	0.33	10	0	0	Yes
Identifier: DVRS05. **Scenario:** Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412).													
	Plutonium Equivalent	curies	1,100	1	0.01	1	–	1	11.0	120	0.1	0	Yes

Accident Phase	*Nuclide*	*MAR (curies or grams)*	*MAR*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fractions*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (units of MAR)*	*Release Duration (minutes)*	*Plume Heat (megawatts)*	*Release Height (meters)*	*Wake?*
Identifier: SHEBA. **Scenario:** SHEBA Hydrogen Detonation (TA-18-168) No Action Alternative Only.													
Metal	Plutonium Equivalent	grams	9,020	1	0.0005	0.5	–	1	2.25	–	–	–	No
Ceramic			924	1	0.005	0.4	–	1	1.85	–	–	–	No
Liquid			9.00	1	0.00005	0.8	–	1	0.00036	–	–	–	No
Powder			0.06	1	0.005	0.4	–	1	0.00012	–	–	–	No
Gas			0.00	1	1.0	1	–	1	0	–	–	–	No
Total													
High Heat	Plutonium Equivalent	grams	–	–	–	–	–	–	2.05	60	2.1	1.5	No
Smoldering			–	–	–	–	–	–	2.05	60	0.1	0	No
Identifier: CMR02. **Scenario:** Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29).													
Fire (high heat)	Plutonium Equivalent	curies	0.613	1	0.4	1	–	0.5	0.123	26.7	1.696	1.5	Yes
Fire (smoldering)			0.613	1	0.4	1	–	0.5	0.123	26.7	0.1	1.5	Yes
Identifier: SEAL2CF. **Scenario:** Chemistry and Metallurgy Research Building Fire Impacting Sealed Sources, Wing 9 (Expanded Operations Only).													
Impact	Cobalt-60	curies	3,420,000	0.05	0.001	0.3	–	1	51.3	30	2.04	0	No
	Strontium-90		580,000	0.05	0.001	0.3	–	1	8.70	30	2.04	0	No
	Cesium-137		23,500,000	0.05	0.001	0.3	–	1	353	30	2.04	0	No
	Iridium-192		26,400,000	0.05	0.001	0.3	–	1	396	30	2.04	0	No
	Radium-226		87,400	0.05	0.001	0.3	–	1	1.31	30	2.04	0	No
	Curium-244		2,850	0.05	0.001	0.3	–	1	0.0428	30	2.04	0	No
	Californium-252		6,100	0.05	0.001	0.3	–	1	0.0915	30	2.04	0	No
Fire (high heat)	Cobalt-60	curies	3,420,000	0.05	0.006	0.01	–	0.5	5.13	30	2.04	0	No
	Strontium-90		580,000	0.05	0.006	0.01	–	0.5	0.870	30	2.04	0	No
	Cesium-137		23,500,000	0.05	0.006	0.01	–	0.5	35.2	30	2.04	0	No
	Iridium-192		26,400,000	0.05	0.006	0.01	–	0.5	39.6	30	2.04	0	No
	Radium-226		87,400	0.05	0.006	0.01	–	0.5	0.131	30	2.04	0	No
	Curium-244		2,850	0.05	0.006	0.01	–	0.5	0.00427	30	2.04	0	No
	Californium-252		6,100	0.05	0.006	0.01	–	0.5	0.00915	30	2.04	0	No

Accident Phase	Nuclide	MAR (curies or grams)	MAR	Damage Ratio	Airborne Release Fraction	Respirable Fractions	Airborne Release Rate (per hour)	Leak Path Factor	Source Term (units of MAR)	Release Duration (minutes)	Plume Heat (mega-watts)	Release Height (meters)	Wake?
Subtotal (impact plus high heat fire)	Cobalt-60	curies	–	–	–	–	–	–	56.4	30	2.04	0	No
	Strontium-90		–	–	–	–	–	–	9.57	30	2.04	0	No
	Cesium-137		–	–	–	–	–	–	388	30	2.04	0	No
	Iridium-192		–	–	–	–	–	–	436	30	2.04	0	No
	Radium-226		–	–	–	–	–	–	1.44	30	2.04	0	No
	Curium-244		–	–	–	–	–	–	0.0470	30	2.04	0	No
	Californium-252		–	–	–	–	–	–	0.101	30	2.04	0	No
Fire (smoldering)	Cobalt-60	curies	3,420,000	0.05	0.006	0.01	–	0.5	5.13	60	0.1	0	No
	Strontium-90		580,000	0.05	0.006	0.01	–	0.5	0.870	60	0.1	0	No
	Cesium-137		23,500,000	0.05	0.006	0.01	–	0.5	35.2	60	0.1	0	No
	Iridium-192		26,400,000	0.05	0.006	0.01	–	0.5	39.6	60	0.1	0	No
	Radium-226		87,400	0.05	0.006	0.01	–	0.5	0.131	60	0.1	0	No
	Curium-244		2,850	0.05	0.006	0.01	–	0.5	0.00427	60	0.1	0	No
	Californium-252		6,100	0.05	0.006	0.01	–	0.5	0.00915	60	0.1	0	No
Identifier: MDAGEXP. **Scenario:** Explosion at a Pit at Material Disposal Area G (Expanded Operations Only).													
Explosion	Americium-241	curies	352	0.02 [a]	0.005	0.3	–	1	0.0104	1	0	0	No
	Gadolinium-148	curies	0.466	1	0.005	0.3	–	1	0.000699	1	0	0	No
	Thorium-230	curies	2.67	1	0.005	0.3	–	1	0.00401	1	0	0	No
	Actinium-227	curies	0.0430	1	0.005	0.3	–	1	0.0000645	1	0	0	No
	Plutonium-238	curies	591	0.88 [a]	0.005	0.3	–	1	0.780	1	0	0	No
	Plutonium-239	curies	319	0.96 [a]	0.005	0.3	–	1	0.459	1	0	0	No
	Plutonium-240	curies	74.7	1	0.005	0.3	–	1	0.112	1	0	0	No
	Plutonium-241	curies	219	1	0.005	0.3	–	1	0.329	1	0	0	No
	Uranium-233	curies	1.03	0	0.005	0.3	–	1	0	1	0	0	No
	Uranium-234	curies	0.392	1	0.005	0.3	–	1	0.000588	1	0	0	No
	Uranium-238	curies	1.72	1	0.005	0.3	–	1	0.00258	1	0	0	No

Accident Phase	Nuclide	MAR (curies or grams)	MAR	Damage Ratio	Airborne Release Fraction	Respirable Fractions	Airborne Release Rate (per hour)	Leak Path Factor	Source Term (units of MAR)	Release Duration (minutes)	Plume Heat (mega-watts)	Release Height (meters)	Wake?
Suspension	Americium-241	curies	352	0.02 [a]	–	1	0.000004	1	0.000659	1,440	0	0	No
	Gadolinium-148	curies	0.464	1	–	1	0.000004	1	0.0000445	1,440	0	0	No
	Thorium-230	curies	2.66	1	–	1	0.000004	1	0.0002550	1,440	0	0	No
	Actinium-227	curies	0.0428	1	–	1	0.000004	1	0.00000411	1,440	0	0	No
	Plutonium-238	curies	588	0.88 [a]	–	1	0.000004	1	0.0497	1,440	0	0	No
	Plutonium-239	curies	318	0.96 [a]	–	1	0.000004	1	0.0292	1,440	0	0	No
	Plutonium-240	curies	74.3	1	–	1	0.000004	1	0.00714	1,440	0	0	No
	Plutonium-241	curies	218	1	–	1	0.000004	1	0.0209	1,440	0	0	No
	Uranium-233	curies	1.03	0 [a]	–	1	0.000004	1	0	1,440	0	0	No
	Uranium-234	curies	0.390	1	–	1	0.000004	1	0.0000374	1,440	0	0	No
	Uranium-238	curies	1.71	1	–	1	0.000004	1	0.000164	1,440	0	0	No

MAR = material at risk, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, HEPA = high-efficiency particulate air filter.

[a] Damage ratios less than 1 indicate that all or part of the inventory is in a waste form such as concrete that would not release respirable particles in this accident scenario.

Storage of sealed sources represents a potential source of radionuclides that were not included in the earlier *1999 SWEIS*. These radionuclides (for example, cobalt-60 and cesium-137) represent external gamma radiation dose risks that are unlike those in most other scenarios (for example, tritium, uranium, and transuranics), which represent chiefly internal dose risks. A scenario that results in the largest risk from these sources, seismic event and fire at the Chemistry and Metallurgy Research Building impacting sealed sources, is included. Doses to individuals located close to the sources (for example, the noninvolved worker) include a component from direct (external) exposure to exposed source material. Appendix J describes the calculation of direct exposure to sealed sources in an accident and includes additional sealed source scenarios.

Material Disposal Area (MDA) cleanup was not considered in the *1999 SWEIS*. Appendix I of the current SWEIS describes proposed environmental remediation of MDAs and contains estimated impacts to offsite and worker receptors from severe accidents (relative to other MDA scenarios) at MDA G (maximum inventory MDA) and MDA B (close proximity to offsite receptors). The consequences and risks from the greater of the two are included in the discussion of the Expanded Operations Alternative in Section D.3.2.3.

D.3.2 Radiological Accident Impacts

Estimated facility accident impacts are represented in terms of consequences and risks. All consequences assume that the accident has occurred; therefore, the probability or frequency of the accident occurring is not taken into account. The risk of an accident does reflect the probability or frequency of occurrence and is calculated by multiplying the accident’s frequency of occurrence by its consequences. Dose consequences are estimated for the MEI (reported in rem) located at the nearest site boundary, a noninvolved worker (reported in rem) located 328 feet (100 meters) from the accident, and the offsite population (reported in person-rem) out to a distance of 50 miles (80 kilometers). The MACCS offsite population dose calculation for radiological accidents includes an assumption that forces a conservatively large amount of radioactive material to be deposited in the last 10 miles (16 kilometers) of the 50-mile (80-kilometer) distance. This assumption results in a significantly higher calculated population dose than would be calculated if the real meteorology was used in this area. For the largest population dose radiological accident, the TA-54 waste storage dome wildfire, this MACCS methodology results in a 15 percent higher dose as compared to using real meteorology. Applying this conservative MACCS methodology to the population within 100 miles (160 kilometers) resulted in an increase of only 3 percent in the population dose even though the population increased by 194 percent. This comparison demonstrates the conservative nature of the methodology used in calculating the population dose, which encompasses radiological consequences for the population out to greater distances. Impacts at locations of public access closer than the nearest site boundary are also discussed.

Consequences are also expressed in terms of the likelihood of a latent cancer fatality (LCF) for the MEI and noninvolved worker and in terms of the number of additional LCFs for the offsite population. A conversion factor, 0.0006 LCFs (or the number of LCFs) per rem (or person-rem), is used to convert rem (or person-rem) to the likelihood of an LCF (or number of LCFs); this factor is doubled for doses to an individual in excess of 20 rem. The calculated doses and associated LCFs do not take into account any medical intervention that could be taken to lower the consequences of exposure.

D.3.2.1 No Action Alternative

The estimated consequences and annual risks of postulated accidents for the No Action Alternative are shown in **Tables D–4** through **D–6**. The maximum consequences and risks from facility accidents are chiefly a result of Plutonium Facility Operations at TA-55-4 and TA-54 operations (Radioassay and Nondestructive Testing [RANT], waste storage domes, DVRS).

The nearest public access to the Chemistry and Metallurgy Research Building, located on Diamond Drive approximately 170 feet (50 meters) from the CMR Building, is closer than the nearest site boundary to this facility. Doses were calculated for an individual at Diamond Drive during the duration of the high-efficiency particulate air (HEPA) filter fire at the Chemistry and Metallurgy Research Building. The same assumptions used to calculate the dose to the MEI were applied to this individual. The dose to an individual at Diamond Drive would be 8.1 rem, more than 10 times the value indicated in Table D–4. The consequences and risks at this location also would be 10 times the value indicated in Tables D–4 and D–6 for this scenario.

The relatively large RANT and Waste Characterization, Reduction, and Repackaging Facility (WCRR) lightning strike fire accident annual frequency is based on the conservative assumption that any lightning strike on these facilities, regardless of lightning energy or strike location on the facility, would result in a fire with the same source term as the largest building fire from the facility accident analysis.

D.3.2.2 Reduced Operations Alternative

Accident impacts under the Reduced Operations Alternative are similar to those under the No Action Alternative, as shown in Tables D–4 through D–6. Solution High-Energy Burst Assembly (SHEBA) operations at LANL would cease. The tables show that SHEBA operations are a small component of the facility impacts at LANL; its elimination would not significantly alter the overall risk profile from individual facility operations. All other impacts in the No Action Alternative tables are equally applicable for this alternative.

D.3.2.3 Expanded Operations Alternative

Accident impacts under the Expanded Operations Alternative are shown in **Tables D–7** through **D–9**. SHEBA operations at LANL would cease under the Expanded Operations Alternative, so its relatively small impacts, have been eliminated from the tables. Additional or replacement risks from accident impacts would result from expanded waste management activities. Transuranic waste at DVRS and the waste storage domes would be moved offsite or to a new facility, the TRU (Transuranic) Waste Facility (formerly the Transuranic Waste Consolidation Facility), which would be located in a TA along the Pajarito Road Corridor. The impacts to the public of this new facility would be less than those of the existing facilities because of the new location and because less material would be stored while the rest would be moved offsite. Tables D–7 through D–9 reflect the present DVRS and waste storage domes operations because they would be active for most of the time period of interest and would bound the impacts of the new TRU Waste Facility. Accident impacts for the new facility are described in Appendix H.

Table D–4 Radiological Accident Offsite Population Consequences for the No Action and Reduced Operations Alternatives

Accident Scenario	*MEI*		*Population to 50 Miles (80 kilometers)*	
	Dose (rem) [a]	*LCF* [b]	*Dose (person-rem)*	*LCF* [c, d]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	410	0.49	11,000	6 (6.3)
Weapons Engineering Tritium Facility Fire (TA-16-205)	5.9	0.0036	190	0 (0.11)
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	46	0.055	4,800	3 (2.9)
Waste Storage Dome Fire (TA-54)	420	0.50	4,200	3 (2.5)
Onsite Transuranic Waste Fire (TA-54)	190	0.22	5,700	3 (3.4)
Plutonium Facility Materials Staging Area Fire (TA-55-4)	73	0.087	9,000	5 (5.4)
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	20	0.012	190	0 (0.11)
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	320	0.39	6,100	4 (3.7)
SHEBA Hydrogen Detonation (TA-18-168) [e]	0.88	0.00053	69	0 (0.041)
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	0.77	0.00046	200	0 (0.12)

MEI = maximally exposed individual, LCF = latent cancer fatality, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, HEPA = high-efficiency particulate air filter.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Increased number of LCFs for the offsite population, assuming the accident occurs; value in parentheses is the calculated result.

[d] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 334,100 (TA-18-168), 271,600 (TA-21-155, and TA-21-209), 302,000 (TA-50-69), 343,100 (TA-54-38, TA-54-412, Domes), 301,900 (TA-55-4).

[e] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations Alternative.

Table D–5 Radiological Accident Onsite Worker Consequences for the No Action and Reduced Operations Alternatives

Accident Scenario	Noninvolved Worker at 110 Yards (100 meters)	
	Dose (rem) [a]	LCF [b]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	1,900	2.2 [c]
Weapons Engineering Tritium Facility Fire (TA-16-205)	8.9	0.0054
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	1,100	1.3 [c]
Waste Storage Dome Fire (TA-54)	2,000	2.3 [c]
Onsite Transuranic Waste Fire (TA-54)	760	0.91
Plutonium Facility Materials Staging Area Fire (TA-55-4)	1,600	1.9 [c]
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	51	0.062
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	890	1.1 [c]
SHEBA Hydrogen Detonation (TA-18-168) [d]	15	0.0092
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	5.4	0.0032

LCF = latent cancer fatality, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, HEPA = high-efficiency particulate air filter.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.0 as shown. This means that it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For calculation purposes, the actual value is shown here; however, because the exposed recipient is an individual, the equivalent tables in Chapter 5, Section 5.12 show an LCF of 1.0.

[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations Alternative.

Table D–6 Radiological Accident Offsite Population and Worker Risks for the No Action and Reduced Operations Alternatives

Accident Scenario	Frequency (per year)	Onsite Worker	Offsite Population	
		Noninvolved Worker at 110 Yards (100 meters) [a]	MEI [a]	Population to 50 Miles (80 kilometers) [b, c]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	0.12 [d]	0.12	0.059	0.76
Weapons Engineering Tritium Facility Fire (TA-16-205)	1.1×10^{-5}	6.0×10^{-8}	4.0×10^{-8}	1.3×10^{-6}
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	0.14 [d]	0.14	0.0077	0.4
Waste Storage Dome Fire (TA-54)	0.001	0.001	0.0005	0.0025
Onsite Transuranic Waste Fire (TA-54)	0.001	0.00091	0.00022	0.0034
Plutonium Facility Materials Staging Area Fire (TA-55-4)	0.01	0.01	0.00087	0.054
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	0.02	0.0012	0.00024	0.0022
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	0.001	0.001	0.00039	0.0037
SHEBA Hydrogen Detonation (TA-18-168) [e]	0.0054	0.00005	2.8×10^{-6}	0.00022
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	0.01	0.000032	4.6×10^{-6}	0.0012

MEI = maximally exposed individual, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, HEPA = high-efficiency particulate air filter.

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs in the offsite population per year; value in parentheses is the calculated result.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-69), 343,100 (TA-54-38, TA-54-412, Domes), 301,900 (TA-55-4).

[d] The lightning strike fire accident scenarios conservatively assumes that any lightning strike on the facility will result in a source term equivalent to a structure fire.

[e] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations Alternative.

Table D–7 Radiological Accident Offsite Population Consequences for the Expanded Operations Alternative

Accident Scenario	*MEI*		*Population to 50 Miles (80 kilometers)*	
	Dose (rem) [a]	*LCF* [b]	*Dose (person-rem)*	*LCF* [c, d]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	410	0.49	11,000	6 (6.3)
Weapons Engineering Tritium Facility Fire (TA-16-205)	5.9	0.0036	190	0 (0.11)
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	46	0.055	4,800	3 (2.9)
Waste Storage Dome Fire (TA-54)	420	0.50	4,200	3 (2.5)
Onsite Transuranic Waste Fire (TA-54)	190	0.22	5,700	3 (3.4)
Plutonium Facility Materials Staging Area Fire (TA-55-4)	73	0.087	9,000	5 (5.4)
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	20	0.012	190	0 (0.11)
Explosion at Material Disposal Area G (TA-54)	55	0.066	770	0 (0.46)
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	320	0.39	6,100	4 (3.7)
Chemistry and Metallurgy Research Building Fire Involving Sealed Sources (TA-3-29)	0.099	0.000059	12,000	7.0
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	0.77	0.00046	200	0 (0.12)

MEI = maximally exposed individual, LCF = latent cancer fatality, TA = technical area, HEPA = high-efficiency particulate air filter.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Increased number of LCFs for the offsite population, assuming the accident occurs; value in parentheses is the calculated result.

[d] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 271,600 (TA-21-155, -209), 302,000 (TA-50-69), 343,100 (TA-54-38, TA-54-412, Domes), 301,900 (TA-55-4).

Table D–8 Radiological Accident Onsite Worker Consequences for the Expanded Operations Alternative

Accident Scenario	Noninvolved Worker at 110 Yards (100 meters)	
	Dose (rem) [a]	**LCF** [b]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	1,900	2.2 [c]
Weapons Engineering Tritium Facility Fire (TA-16-205)	8.9	0.0054
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	1,100	1.3 [c]
Waste Storage Dome Fire (TA-54)	2,000	2.3 [c]
Onsite Transuranic Waste Fire (TA-54)	760	0.91
Plutonium Facility Materials Staging Area Fire (TA-55-4)	1,600	1.9 [c]
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	51	0.062
Explosion at Material Disposal Area G (TA-54)	410	0.49
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	890	1.1 [c]
Chemistry and Metallurgy Research Building Fire Involving Sealed Sources (TA-3-29)	1.2	0.00073
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	5.4	0.0032

LCF = latent cancer fatality, TA = technical area, HEPA = high-efficiency particulate air filter.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF, assuming the accident occurs.

[c] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.0 as shown. This means that it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For calculation purposes, the actual value is shown here; however, because the exposed recipient is an individual, the equivalent tables in Chapter 5, Section 5.12, show an LCF of 1.0.

Table D–9 Radiological Accident Offsite Population and Worker Risks for the Expanded Operations Alternative

Accident Scenario	Frequency (per year)	Onsite Worker	Offsite Population	
		Noninvolved Worker at 110 Yards (100 meters) [a]	MEI [a]	Population to 50 Miles (80 kilometers) [b, c]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	0.12 [d]	0.12	0.059	0.76
Weapons Engineering Tritium Facility Fire (TA-16-205)	1.1×10^{-5}	6.0×10^{-8}	4.0×10^{-8}	1.3×10^{-6}
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	0.14 [d]	0.14	0.0077	0.4
Waste Storage Dome Fire (TA-54)	0.001	0.001	0.0005	0.0025
Onsite Transuranic Waste Fire (TA-54)	0.001	0.00091	0.00022	0.0034
Plutonium Facility Materials Staging Area Fire (TA-55-4)	0.01	0.01	0.00087	0.054
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	0.02	0.0012	0.00024	0.0022
Explosion at Material Disposal Area G (TA-54)	0.01	0.0049	0.00066	0.0046
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	0.001	0.001	0.00039	0.0037
Chemistry and Metallurgy Research Building Fire Involving Sealed Sources (TA-3-29)	0.00024	1.7×10^{-7}	1.4×10^{-8}	0.0017
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	0.01	0.000032	4.6×10^{-6}	0.0012

MEI = maximally exposed individual, TA = technical area, HEPA = high-efficiency particulate air filter.

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs for the offsite population per year.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-69), 343,100 (TA-54-38, TA-54-412, Domes), 301,900 (TA-55-4).

[d] The lightning strike fire accident scenarios conservatively assumes that any lightning strike on the facility will result in a source term equivalent to a structure fire.

MDA cleanup is a component of the Expanded Operations Alternative. A number of scenarios were considered for this activity, and an explosion during cleanup operations that breaches the MDA enclosure and bypasses the HEPA filtration was chosen for analysis. MDA G, because of its relatively large inventory, was found to bound the accident impacts from MDA cleanup. The consequences and risks from this scenario are included in Tables D–7 through Table D–9. As with the No Action Alternative, TA-54 operations generally dominate the accident risks from Expanded Operations. Cleanup of MDA G, although not bounding, adds a component to this risk. Appendix I includes more details about MDA cleanup accident impacts.

Another component of the Expanded Operations Alternative (but not of the No Action Alternative) is the onsite storage of sealed sources. The important exposure pathways are different for some of the radionuclides that might be released from the sealed sources. Previously, sources received for management at LANL consisted chiefly of alpha emitters such as americium and plutonium that are chiefly internal risks with doses to the body that are delivered over an extended time period. The nuclides associated with other sealed sources now being considered for management at LANL can be strong gamma emitters and thus may result in significant prompt external as well as internal exposure in the event of an accident.

A number of different radionuclides are present in the sealed sources, as shown in Table D–3. The MARs shown there represent the maximum allowable inventory of each of the nuclides if that individual nuclide only were present. Each of the nuclides was separately analyzed. It was found that cobalt-60 would lead to maximum exposure of the individuals closest to the release, such as the noninvolved worker, from exposure to source material as well as plume exposure. Transuranics such as californium-252 would lead to maximum exposure of individuals further from the release, such as the MEI at the Chemistry and Metallurgy Research Building, from plume exposure. Cesium-137 would lead to maximum exposure of the general public from ground exposure to deposited material, internal exposure from ingestion of foodstuffs, and exposure to the release plume. The dose to an individual outside at Diamond Drive during the hypothetical fire at the Chemistry and Metallurgy Research Building involving sealed sources scenario would be 4.3 rem, 42 percent of which would be from external exposure to gamma radiation. Such a dose would result in an increased chance of a fatal cancer during the lifetime of the individual of 0.0026, or approximately 1 chance in 385.

The accident analysis for sealed sources conservatively assumes that the maximum allowable limit of one single radioisotope is present instead of a more realistic expected mix of several radioisotopes at lower activity levels. This assumption provides a bounding consequence in the event of a postulated accident that releases sealed source inventory or exposes gamma or neutron emitters so that direct radiation affects the dose to individuals close to the source. The analysis also assumes that the shipping containers that hold the source and the building within which the containers are stored both fail, resulting in external exposure and release of these radionuclides. Appendix J, Section J.3.3.2, contains further discussion of sealed source accident scenarios and risks.

D.3.3 Chemical Accident Impacts

This section provides data that support the impacts of facility accidents presented in Chapter 5, including estimated accident frequencies of occurrence, scenarios, and materials released.

The chemicals of concern at LANL facilities and their potential impacts under the No Action, Reduced, and Expanded Operations Alternatives are shown in **Table D–10**. These were selected from a complete set of chemicals used onsite based on their quantities, chemical properties, and human health effects. The tables show the impact of each postulated chemical release and the applicable concentration guidelines. The first guideline is the concentration of a substance in air at a level that generally requires action to prevent or mitigate exposures. The second guideline is the concentration above which severe irreversible health effects or a fatality may occur. Emergency Response Planning Guideline (ERPG) -2 and -3 values published by the American Industrial Hygiene Association (AIHA 2005) are used in this analysis to represent those levels of impact, consistent with DOE emergency management hazards assessment and planning practices (DOE 2005a, DOE 1997).[1] ERPG-2 and ERPG-3 are defined in terms of the expected health impacts from a 1-hour exposure, as follows:

> *ERPG-2: The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.*
>
> *ERPG-3: The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.*

ERPGs are used throughout industry and government to assess chemical hazards and plan for emergencies; however, ERPGs have been issued for fewer than 120 chemicals as of 2005. To provide its sites and facilities with impact criteria for other chemicals, DOE commissions the development of alternative values, termed Temporary Emergency Exposure Limits (TEELs). As of late 2005, TEEL values have been issued for nearly 3,000 chemicals (DOE 2005b). The TEEL levels of TEEL-2 and TEEL-3 are defined in the same words as the corresponding ERPGs, but without reference to any duration of exposure. When no ERPGs have been published for a substance, the TEEL-2 and -3 values are used in this analysis to represent the ERPG-2 and ERPG-3 levels of health impact.

---

[1] *Beginning with the recent issuance of DOE Order 151.1C (November 2005) Acute Exposure Guideline Levels published by the U.S. Environmental Protection Agency (EPA) are specified as the chemical impact criteria of first choice, and these values are being incorporated into hazards assessments and emergency plans throughout DOE. Acute Exposure Guideline Levels are defined in terms of several different exposure times ranging from 10 minutes to 8 hours. In general, the Acute Exposure Guideline Levels-2 and -3 values for a 60-minute exposure are about the same as the ERPGs used in this analysis.*

Table D–10 Chemical Accident Impacts

Chemical	Frequency (per year)	Quantity Released	ERPG-2 [a]		ERPG-3 [b]		Concentration	
			Value	Distance to Value (meters)	Value	Distance to Value (meters)	Noninvolved Worker at 100 Meters	MEI at Site Boundary
Selenium hexafluoride from waste cylinder storage at TA-54-216	0.0041	75 liters (20 gallons)	0.6 ppm [c]	2,800	5 ppm [c]	880	140 ppm	12 ppm at 491 meters
Sulfur dioxide from waste cylinder storage at TA-54-216	0.00051	300 pounds (136 kilograms)	3 ppm	1,650	15 ppm	690	310 ppm	27 ppm at 491 meters
Chlorine gas released outside of Plutonium Facility (TA-55-4)	0.063	150 pounds (68 kilograms)	3 ppm	1,080	20 ppm	380	170 ppm	3.4 ppm at 1,016 meters
Helium at TA-55-41	0.063	9,230,000 cubic feet (261,366 cubic meters) (at STP)	280,000 ppm [c]	186	500,000 ppm [c]	139	greater than ERPG-3	10,000 ppm at 1,048 meters

ERPG = Emergency Response Planning Guideline, MEI = maximally exposed individual, TA = technical area, ppm = parts per million, STP = standard temperature and pressure, TEEL = Temporary Emergency Exposure Limits.

[a] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their ability to take protective action (DOE 2004a).

[b] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2004a).

[c] The TEEL value is used. ERPGs have not been issued for this substance.

Note: To convert meters to yards, multiply by 1.0936.

D.3.3.1 No Action Alternative

The chemicals of concern at LANL facilities under the No Action Alternative are shown in Table D–10. Selenium hexafluoride, sulfur dioxide, and chlorine are all toxic gases that, at elevated levels, can cause respiratory dysfunction as well as other health effects. Helium is an asphyxiant that can cause health effects by displacing breathable oxygen.

Table D–10 shows the concentrations of each chemical, if released, at specified distances. The inventory of each chemical is assumed to be released from a break in a line over a 10-minute interval. The cause of the break could be mechanical failure, corrosion, mechanical impact, or natural phenomena. The noninvolved worker, if directly downwind from the release and unable to take evasive action, would be exposed to levels in excess of ERPG-3 for these releases. Under the same circumstances, the MEI located at the LANL and San Ildefonso Pueblo boundary would be exposed to selenium hexafluoride and sulfur dioxide in excess of ERPG-3 levels.

D.3.3.2 Reduced Operations Alternative

The chemicals of concern that could be released in a facility accident are the same for the Reduced Operations Alternative as for the No Action Alternative. None of the chemicals identified for the latter are eliminated in this alternative. The information in Table D–10, then, is applicable to the Reduced Operations Alternative.

D.3.3.3 Expanded Operations Alternative

The chemicals of concern that could be released in a facility accident for the No Action Alternative apply equally to the Expanded Operations Alternative. In addition, MDA cleanup is a component of the Expanded Operations Alternative that has a potential for accidental releases of toxic chemicals. A fire during excavation that breaches the MDA enclosure and bypasses the HEPA filtration was chosen as a severe scenario. There is a great deal of uncertainty regarding which chemicals and quantities were disposed of in the MDAs. MDA B, the MDA closest to the public (and thus with the potential for the greatest impact on the public), was chosen to bound the chemical accident impacts for MDA cleanup. Two chemicals, sulfur dioxide (a gas) and beryllium (assumed in powder form), were chosen based on their restrictive ERPG values to bound the impacts of an extensive list of possible chemicals disposed of in the MDAs. **Table D–11** shows that both of these chemicals, if present in MDA B at the quantities assumed, would dissipate to below ERPG-3 levels very close to the release. Appendix I includes more details about MDA cleanup chemical accident impacts.

Table D–11 Chemical Accident Impacts for the Expanded Operations Alternative

			ERPG-2 [a]		*ERPG-3* [b]		*Concentration*	
Chemical	*Frequency (per year)*	*Quantity Released*	*Value*	*Distance to Value (meters)*	*Value*	*Distance to Value (meters)*	*Noninvolved Worker at 100 Meters*	*MEI at Site Boundary*
Selenium hexafluoride from waste cylinder storage at TA-54-216	0.0041	75 liters (20 gallons)	0.6 ppm [c]	2,800	5 ppm [c]	880	140 ppm	12 ppm at 491 meters
Sulfur dioxide from waste cylinder storage at TA-54-216	0.00051	300 pounds (136 kilograms)	3 ppm	1,650	15 ppm	690	310 ppm	27 ppm at 491 meters
Chlorine gas released outside of Plutonium Facility (TA-55-4)	0.063	150 pounds (68 kilograms)	3 ppm	1,080	20 ppm	380	170 ppm	3.4 ppm at 1,016 meters
Helium at TA-55-41	0.063	9,230,000 cubic feet (261,366 cubic meters) (at STP)	280,000 ppm [c]	186	500,000 ppm	139	> ERPG-3	10,000 ppm at 1,048 meters
Sulfur dioxide at MDA B	Unknown	1 pound (0.45 kilogram)	3 ppm	83	15 ppm	34	2.1 ppm	9.2 ppm at 45 meters
Beryllium powder at MDA B	Unknown	22 pounds [d] (10 kilograms)	0.025 mg/cu m	23	0.1 mg/cu m	9	0.0025 mg/cu m	0.0088 mg/cu m at 45 meters

ERPG = Emergency Response Planning Guideline, MEI = maximally exposed individual, TA = technical area, ppm = parts per million, STP = standard temperature and pressure, MDA = material disposal area, mg/cu m = milligrams per cubic meter.

[a] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their ability to take protective action (DOE 2004a).

[b] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2004a).

[c] The TEEL value is used. ERPGs have not been issued for this substance.

[d] This quantity represents the total material at risk. A fraction (6×10^{-5}) of this solid would be released as respirable particles in the hypothesized scenario.

Note: To convert meters to yards, multiply by 1.0936.

D.4 Site-Wide Seismic Impacts

Two site-wide seismic events, Seismic 1 and Seismic 2, were postulated to estimate the effects of potential radiological and chemical releases. Seismic 1 is nominally represented by a Performance Category-2 (PC-2) earthquake. Such an event is characterized by a return period of 1,000 years (annual probability of exceedance of 1×10^{-3}) with a peak horizontal ground acceleration of 0.22 g (gravitational acceleration).[2] Seismic 2 is nominally represented by a PC-3 earthquake with a return period of 2,000 years (annual probability of exceedance of 5×10^{-4}) and a peak horizontal ground acceleration of 0.31 g (Cuesta 2004). Were such a seismic event to occur, simultaneous radiological and chemical releases from multiple locations could result. The rationale for choosing these scenarios is described in Table D–1. Most of these scenarios evolved from those analyzed in the *1999 SWEIS*. Revisions to the seismic releases in that earlier document (called site releases there) were based on information that became available subsequent to the writing of the *1999 SWEIS*. This new information was reviewed and significant scenarios were added as appropriate. One example is the addition of the Safe Secure Transport Facility (TA-55-355). That facility houses material that was at TA-18 at the time of the *1999 SWEIS*. The current document considers the new location and storage design, while deleting the TA-18 buildings that are no longer operating.

The health effects calculated for these two postulated seismic events should be considered within the context of the nonradiological human health impacts expected. These seismic events would cause widespread failures of both nonnuclear LANL structures and structures outside of LANL. A much larger number of fatalities and injuries from structure collapse would be expected for these seismic events.

Effects of Updated Probabilistic Seismic Hazards Analysis

An updated probabilistic seismic hazard analysis that uses new geotechnical, geologic, and geophysical data collected at the Chemistry and Metallurgy Research Replacement Facility location (particularly of the Bandelier Tuff) and current seismic hazard analysis methodology has been developed for the LANL site (LANL 2007a). Probabilistic seismic hazards were calculated for specific locations, the Chemistry and Metallurgy Research Replacement Facility, TA-3, TA-16, and TA-55. The envelope of these site-specific hazards can be applied in a generic fashion to other locations at the LANL site. The seismic accident scenarios (Seismic 1 and 2) analyzed in the SWEIS were developed based on the *Seismic Hazards Evaluation of the Los Alamos National Laboratory (February 24, 1995)*. LANL nuclear structures, systems, and components were evaluated specifically for peak horizontal ground accelerations of 0.22g and 0.31g corresponding to an annual earthquake return period of 1,000 and 2,000 years or annual probabilities of exceedance of 0.001 (1 in 1000) and 0.0005 (1 in 2000), respectively. The updated seismic hazards analysis (LANL 2007a) results indicate a site-wide peak horizontal ground acceleration of about 0.27g with a corresponding expected return period of 1,000 years and about 0.45g with an expected return period of 2,000 years. The expected return periods for the 0.22g and 0.31g peak horizontal ground acceleration are now established at about 700 and 1,250 years, respectively. The revised annual probabilities of exceedance are thus 0.0015 and

---

[2] *The term "g" stands for the acceleration of an object due to gravity at a rate of 32 feet per second (9.8 meters per second) and is used as a standard measure of ground movement associated with seismic events.*

0.0008, respectively. Using these larger probabilities, however, the seismic accident risks for the MEI, the noninvolved worker, and the population are less than 1 percent of accident risks for other types of accidents in the SWEIS such as fires at the Radioassay and Nondestructive Testing Facility, the Waste Characterization, Reduction, and Repackaging Facility, and the TA-54 waste storage domes.

For many facilities involved in the Seismic 1 and 2 accident scenarios, a conservative assumption is made that there is a complete failure of structures, systems, and components (given the Seismic 1 and 2 ground shaking) thereby resulting in the maximum possible radioisotope or chemical release to the environment. Higher seismic accelerations at the same annual frequency of exceedance based on the updated probabilistic seismic hazard analysis would result in identical consequences for these facilities. Therefore, larger seismic peak ground acceleration associated with the updated probabilistic seismic hazard analysis would not increase the consequence of these accident scenarios. The facilities for which the consequences would be the same include: the Chemistry and Metallurgy Research Building, the Weapons Engineering Test Facility, the Tritium Science and Fabrication Facility, the Tritium System Test Assembly, the Radioactive Liquid Waste Treatment Facility, Waste Characterization, Reduction, and Repackaging Facility, and the Radioassay and Nondestructive Testing Facility. Facilities for which the consequences of higher ground acceleration may be greater include: the Plutonium Facility, the TA-55 Storage Facility, the Decontamination and Volume Reduction System, Waste Storage Domes, and the Safe Secure Transport Facility.

Typically, structures are designed with considerable factors of safety against failure of the structure subjected to a variety of loads (including earthquake loads). These factors of safety produce reliable structures. For the LANL facilities that are not assumed to completely fail (given the Seismic 1 and Seismic 2 levels of ground shaking), it is not possible to state the impacts of different peak horizontal ground accelerations without detailed structural analysis of facilities using the updated probabilistic seismic hazard analysis results. A bounding approach was used to estimate the maximum expected effect of the updated seismic hazards on the SWEIS seismic accident risks. The revised annual probabilities of exceeding the peak ground horizontal accelerations used in the accident analysis of 0.22g and 0.31g are approximately 1.5×10^{-3} and 8×10^{-4}. Using the accident source terms that were developed for the Seismic 1 and Seismic 2 accident scenarios, the effect of the revised estimates of annual probability of exceedance would be an increase in the radiological risk of 50 percent for Seismic 1 scenarios and 60 percent for Seismic 2 scenarios. This results in a maximum risk of an LCF of 0.00012 for the MEI, 0.0015 for the noninvolved worker and 0.0077 for the total population for the Seismic 1 accident scenario. The comparable MEI, noninvolved worker, and population risks for the Seismic 2 accident scenario are: 0.00045, 0.0008, and 0.0144, respectively. These estimated higher seismic accident risks do not take credit for facilities in which complete failure has already been assumed and therefore no larger accident source term would be expected at higher seismic ground accelerations. Although these seismic risks have increased due to the results of the updated seismic analysis, they remain less than 1 percent of the highest MEI, noninvolved worker, and population risks for other types of accidents that are analyzed in the SWEIS.

Just as the updated probabilistic seismic hazards analysis used new data and advanced methods to calculate LANL seismic hazards, revised structural analysis methods tied to damage states credited in the safety assessments will be used to update the seismic structural integrity evaluation of LANL facilities. The effect of the higher values of peak horizontal ground acceleration on calculated seismic accident consequences and risks will be analyzed in future facility safety analyses and incorporated as appropriate into future National Environmental Policy Act (NEPA) documents. The LANL management and operating contractor has developed and NNSA has accepted a site-wide justification for continued operation as a result of the estimates of increased seismic event frequency and acceleration associated with the updated probabilistic seismic hazards analysis. The justification for continued operation presents a qualitative evaluation of the effect of this increased seismic hazard on site-wide transportation and on the following LANL facilities: Chemistry and Metallurgy Research Building, Beryllium Technology Facility, Dual-Axis Radiographic Hydrodynamic Test Facility, Weapons Engineering Test Facility, Radioactive Liquid Waste Treatment Facility, Waste Characterization, Reduction, and Repackaging Facility, TA-53 underground spent resin tank, LANSCE, Area G waste operations, Radioassay and Nondestructive Testing Facility, Plutonium Facility, Safe and Secure Transport Facility, and the nuclear environmental sites (MDA A, MDA B, MDA C, MDA H, MDA T, MDA W, TA-35 Wastewater Treatment Plant, TA-35 Pratt Canyon, and MDA AB). The justification for continued operation determined that existing bounding seismic accident analyses; new facility safety analyses; compensatory measures of limiting radioactive material inventory, new programs, and procedures; and the low probability of a seismic event during the anticipated time period for detailed quantitative analysis of each facility's safety documentation provide the basis for an acceptable risk for continued operation of LANL (LANL 2007b, NNSA 2007).

The Los Alamos Site Office directed the LANL management and operating contractor to develop a project execution plan to perform specific detailed facility seismic analyses; incorporate necessary changes to facility safety bases; and develop a list of potential facility modifications to address deficiencies identified in the seismic analyses (NNSA 2007c). If necessary, facility-specific justifications for continued operation will be developed as part of this process. This project will provide for the evaluation of each LANL facility using the updated probabilistic seismic hazard analysis seismic accelerations and frequencies and in accordance with appropriate LANL structural engineering standards for seismic events using all applicable industry, federal government, and international standards, codes, and criteria.

D.4.1 Source Term Data

Table D–12 shows the source term data used to calculate impacts to workers and the public that could result from a site-wide earthquake. A single table is presented for the two earthquake scenarios (Seismic 1 and 2); the scenario corresponding to each release is indicated under the facility name.

Table D–12 Site-Wide Earthquake Source Term Data

Accident Phase	*Nuclide*	*MAR (curies or grams)*	*MAR*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fractions*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (in units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Seismic													
Identifier: CMR08. **Facility Name:** Chemistry and Metallurgy Research Building (TA-3-29) *Seismic 1 and 2*													
Initial	Plutonium Equivalent	curies	1,240	1	0.01	0.5	–	1	6.19	10	0	0	No
Suspension			1,230	1	0	1	0.000004	1	0.118	1,440	0	0	No
Identifier: SIT02. **Facility Name:** Weapons Engineering Tritium Facility (TA-16-205) *Seismic 2*													
Tritium release	Tritiated Water	grams	1,000	1	1.0	1	–	1	1,000	10	0	0	No
Identifier: SIT08 **Facility Name:** SHEBA (TA-18-168) *Seismic 1 and 2*													
Metal	Plutonium Equivalent	grams	9,020	1	0.00	1	–	1	0	10	0	0	No
Ceramic			924	1	0.00006	1	–	1	0.0554	10	0	0	No
Liquid			9.00	1	0.0002	0.8	–	1	0.00144	10	0	0	No
Powder			0.06	1	0.002	0.3	–	1	0.000036	10	0	0	No
Gas			0	1	1.0	1	–	1	0	10	0	0	No
Total													
Initial	Plutonium Equivalent	grams	–	–	–	–	–	–	0.0569	10	0	0	No
Suspension			0.0599	1	0.00	1	0.000004	1	0.00000575	1,440	0	0	No
Identifier: SIT09. **Facility Name:** Tritium System Test Assembly (TA-21-155) *Seismic 1 and 2*													
Tritium release	Tritiated Water	grams	0.1	1	1.0	1	–	1	0.1	10	0	0	No
Identifier: SIT10. **Facility Name:** Tritium Science and Fabrication Facility (TA-21-209) *Seismic 1 and 2*													
Tritium release	Tritiated Water	grams	0.88	1	1.0	1	–	1	0.88	10	0	0	No
Identifier: SIT11. **Facility Name:** Radioactive Liquid Waste Treatment Facility (TA-50-1) *Seismic 1 and 2*													
Initial	Plutonium-238	grams	–	–	–	–	–	–	0.000058	10	0	0	No
	Plutonium-239		–	–	–	–	–	–	0.27	10	0	0	No
	Americium-241		–	–	–	–	–	–	0.005	10	0	0	No
Suspension	Plutonium-238		–	–	–	–	–	–	0.00013	1,440	0	0	No
	Plutonium-239		–	–	–	–	–	–	5.85	1,440	0	0	No
	Americium-241		–	–	–	–	–	–	0.11	1,440	0	0	No

Accident Phase	*Nuclide*	*MAR (curies or grams)*	*MAR*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fractions*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (in units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Identifier: WCRSEIS. **Facility Name:** Waste Characterization, Reduction, and Repackaging Facility (TA-50-69) *Seismic 2 and Fire*													
Spill inside building	Plutonium Equivalent	curies	800	1	0.001	1	–	1	0.8	1	0	0	No
Spill outside building			1,000	1	0.001	0.1	–	1	0.1	1	0	0	No
Fire inside building			799.2	1	0.01	1	–	1	7.992	60	0.1	0	No
Resuspension inside building			791.2	1	–	1	0.00004	1	0.7596	1,440	0	0	No
Resuspension outside building			999.9	1	–	0.1	0.00004	1	0.09599	1,440	0	0	No
Identifier: SIT14. **Facility Name:** Radioassay and Nondestructive Testing Facility (TA-54-38) *Seismic 1 and 2*													
Initial	Plutonium Equivalent	curies	1,860	1	0.001	1	–	1	1.86	10	0	0	No
Suspension			1,860	1	–	1	0.000004	1	0.178	1,440	0	0	No
Identifier: PF4SEIS. **Facility Name:** Plutonium Facility (TA-55-4) *Seismic 2 and Fire*													
Spill and Fire	Plutonium-238	curies	–	–	–	–	–	–	7.47	60	0.1	0	No
Spill and Fire	Plutonium-239		–	–	–	–	–	–	10.59	60	0.1	0	No
Spill and Fire	Plutonium-240		–	–	–	–	–	–	2.71	60	0.1	0	No
Spill and Fire	Plutonium-241		–	–	–	–	–	–	68.95	60	0.1	0	No
Spill and Fire	Plutonium-242		–	–	–	–	–	–	0.036	60	0.1	0	No
Spill and Fire	Americium-241		–	–	–	–	–	–	1.95	60	0.1	0	No
Identifier: SIT19. **Facility Name:** Safe, Secure Transport Facility (TA-55-355) *Seismic 2*													
Free fall spill	Plutonium-239	grams	50,000	0.093	0.002	0.3	–	1	2.80	10	0	0	Yes
Powder impacted by object			50,000	0.047	0.01	0.2	–	1	4.67	10	0	0	Yes
Identifier: DOMEP. **Facility Name:** Waste Storage Domes (TA-54) (for population [a]) *Seismic 2*													
Combustibles													o
Drums	Plutonium Equivalent	curies	25,800	0.333	0.001	0.3		1	2.58	10	0	0	No
Overpacks			11,300	0.167	0.001	0.3		1	0.566	10	0	0	No
Suspension			10,500	1	–	1	0.000004	1	1.01	1,440	0	0	N

Accident Phase	*Nuclide*	*MAR (curies or grams)*	*MAR*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fractions*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (in units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Noncombustibles													
Drums	Plutonium Equivalent	curies	70,400	0.333	0.000849	0.3		1	5.98	10	0	0	No
Overpacks			30,900	0.167	0.000762	0.3		1	1.18	10	0	0	No
Suspension			23,800	1	–	1	0.000004	1	2.29	1,440	0	0	No
Total													
Initial	Plutonium Equivalent	curies	–	–	–	–	–	–	10.3	10	0	0	No
Suspension			–	–	–	–	–	–	3.30	1,440	0	0	No
Identifier: DOMEM **Facility Name:** Waste Storage Domes (TA-54) (for MEI and Noninvolved Worker [a]) *Seismic 2*													
Combustibles											0	0	No
Drums	Plutonium Equivalent	curies	15,900	0.333	0.001	0.3	–	1	1.59	10	0	0	No
Overpacks			6,960	0.167	0.001	0.3	–	1	0.348	10	0	0	No
Suspension			6,440	1	–	1	0.000004	1	0.619	1,440	0	0	No
Noncombustibles													
Drums	Plutonium Equivalent	curies	44,100	0.333	0.000849	0.3	–	1	3.75	10	0	0	No
Overpacks			19,400	0.167	0.000762	0.3	–	1	0.737	10	0	0	No
Suspension			14,900	1	–	1	0.000004	1	1.43	1,440	0	0	No
Total													
Initial	Plutonium Equivalent	curies	–	–	–	–	–	–	6.42	10	0	0	No
Suspension			–	–	–	–	–	–	2.05	1,440	0	0	No
Identifier: SIT16. **Facility Name:** Storage Facility (TA-55-185) *Seismic 1 and 2*													
Initial	Plutonium Equivalent	grams	48,900	1	0.00021	1	–	1	10.3	10	0	0	No
Suspension			48,900	1	–	1	0.000004	1	4.69	1,440	0	0	No
Identifier: DVRS08. **Facility Name:** Decontamination and Volume Reduction System (TA-54-412) (PC-2) *Seismic 1*													
PC-2 Seismic Event	Plutonium Equivalent	curies	900	1	0.001	0.1	–	1	0.09	1,440	0	0	No
Identifier: DVRS12. **Facility Name:** Decontamination and Volume Reduction System (TA-54-412) (PC-3) *Seismic 2*													
PC-3 Seismic Event	Plutonium Equivalent	curies	1,100	1	0.001	1	–	1	1.10	1,440	0	0	No

MAR = material at risk, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, MEI = maximally exposed individual, PC = performance category.

[a] Separate analyses were performed for the population and for the MEI and noninvolved worker because releases from all of the doses would affect the population, but an individual would be affected by only a subset of doses that are close to each other.

D.4.2 No Action Alternative Impacts

D.4.2.1 Site-Wide Seismic 1 – Radiological Impacts

Site-wide Seismic 1 is associated with seismic events up to approximately PC-2 in severity. **Tables D–13** and **D–14** show the potential consequences (dose and probability of an LCF) should such an earthquake occur under the No Action Alternative. **Table D–15** shows the health risk (frequency multiplied by the LCF consequence) per year of operation. The largest risk from this event is from potential Chemistry and Metallurgy Research Building releases.

If a Seismic 1 event were to occur, all of the releases shown in Table D–15 could emanate simultaneously. Accordingly, the sum of the health risk from each facility to the general population is indicated at the bottom of that table. This sum can be thought of as the overall health risk to the general population from a Seismic 1 event. The overall risk is seen to be approximately 0.005 per year; that is, a mean of one cancer fatality in the entire general population (out to 50 miles [80 kilometers] from each release) every 200 years of LANL operation.

Table D–13 Site-Wide Seismic 1 Radiological Accident Offsite Population Consequences for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Seismic 1 Event	*MEI*		*Population to 50 Miles (80 kilometers)*	
	Dose (rem)	*LCF* [a]	*Dose (person-rem)*	*LCF* [b, c]
Chemistry and Metallurgy Research Building (TA-3-29)	62	0.075	6,100	4 (3.7)
SHEBA (TA-18-168) [d]	0.03	0.000018	0.77	0 (0.00046)
Tritium System Test Assembly (TA-21-155)	0.0015	8.8×10^{-7}	0.049	0 (0.00003)
Tritium Science and Fabrication Facility (TA-21-209)	0.013	7.5×10^{-6}	0.43	0 (0.00026)
Radioactive Liquid Waste Treatment Facility (TA-50-1)	3	0.0018	520	0 (0.31)
Radioassay and Nondestructive Testing Facility (TA-54-38)	64	0.077	1,100	1 (0.67)
Storage Facility (TA-55-185)	6	0.0036	590	0 (0.35)
Decontamination and Volume Reduction System (TA-54-412) (PC-2 Seismic)	2.8	0.0017	49	0 (0.03)
	Max 64	Max 0.077	Sum 8,400	Sum 5 (5.1)

MEI = maximally exposed individual, LCF = latent cancer fatality, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.

[a] Increased risk of an LCF to an individual, assuming the accident occurs.

[b] Increased number of LCFs for the offsite population, assuming the accident occurs; value in parentheses is the calculated result.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-1), 343,100 (TA-54-38, TA-54-412).

[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations and Expanded Operations Alternatives.

Table D–14 Site-Wide Seismic 1 Radiological Accident Onsite Worker Consequences for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Seismic 1 Event	*Noninvolved Worker at 110 Yards (100 meters)*	
	Dose (rem) [a]	*LCF* [b]
Chemistry and Metallurgy Research Building (TA-3-29)	2,000	2.4 [c]
SHEBA (TA-18-168) [d]	1.1	0.00064
Tritium System Test Assembly (TA-21-155)	0.011	6.7×10^{-6}
Tritium Science and Fabrication Facility (TA-21-209)	0.097	0.000058
Radioactive Liquid Waste Treatment Facility (TA-50-1)	120	0.15
Radioassay and Nondestructive Testing Facility (TA-54-38)	580	0.69
Storage Facility (TA-55-185)	240	0.29
Decontamination and Volume Reduction System (TA-54-412) (PC-2 Seismic)	10	0.0061

LCF = latent cancer fatality, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.0 as shown. This means that it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For calculation purposes, the actual value is shown here; however, since the exposed recipient is an individual, the equivalent tables in Chapter 5, Section 5.12, show an LCF of 1.0.

[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations and Expanded Operations Alternatives.

Table D–15 Site-Wide Seismic 1 Radiological Accident Offsite Population and Worker Risks for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Seismic 1 Event	*Frequency (per year)*	*Onsite Worker*	*Offsite Population*	
		Noninvolved Worker at 110 Yards (100 meters) [a]	*MEI* [a]	*Population to 50 Miles (80 kilometers)* [b, c]
Chemistry and Metallurgy Research Building (TA-3-29)	0.001	0.001	0.000075	0.0037
SHEBA (TA-18-168) [d]	0.001	6.4×10^{-7}	1.8×10^{-8}	4.6×10^{-7}
Tritium System Test Assembly (TA-21-155)	0.001	6.7×10^{-9}	8.8×10^{-10}	3×10^{-8}
Tritium Science and Fabrication Facility (TA-21-209)	0.001	5.8×10^{-8}	7.5×10^{-9}	2.6×10^{-7}
Radioactive Liquid Waste Treatment Facility (TA-50-1)	0.001	0.00015	1.8×10^{-6}	0.00031
Radioassay and Nondestructive Testing Facility (TA-54-38)	0.001	0.00069	0.000077	0.00067
Storage Facility (TA-55-185)	0.001	0.00029	3.6×10^{-6}	0.00035
Decontamination and Volume Reduction System (TA-54-412) (PC-2 Seismic)	0.001	6.1×10^{-6}	1.7×10^{-6}	0.00003
		Max 0.001 [e]	Max 0.000077 [e]	Sum 0.0051 [e]

MEI = maximally exposed individual, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs for the offsite population per year.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-1), 343,100 (TA-54-38, TA-54-412).

[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations and Expanded Operations Alternatives.

[e] See the discussion in Section D.4 regarding the impacts of the 2007 update of the probabilistic seismic hazard analysis.

Risks to individuals, on the other hand, cannot be summed because a single individual likely would not be exposed to multiple facility releases. Instead, only releases upwind from the individual's location would result in exposure. Table D–15, therefore, indicates the maximum health risk to the MEI from a release at any facility.

There is a potential for an individual at publicly accessible Diamond Drive, approximately 55 yards (50 meters) from the Chemistry and Metallurgy Research Building, to receive an exposure from that facility in excess of the MEI exposure. MACCS2 dispersion calculations, the underlying basis for this result, are generally considered to be conservatively high within 330 feet (100 meters) of a release. The calculated dose at Diamond Drive is 6,400 rem, 100 times the Chemistry and Metallurgy Research Building MEI dose indicated in Table D–13. Depending on the specific radionuclides released and the route of human exposure, a radiation dose of this magnitude would result in near-term health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose to the exposed individual or mitigating any health impacts. The dose calculated for an individual on Diamond Drive is based on an assumption that no protective action is taken during the entire time of exposure and that no subsequent medical intervention occurs.

D.4.2.2 Site-Wide Seismic 2 – Radiological Impacts

Site-wide Seismic 2 is associated with events up to approximately PC-3 in severity. **Tables D–16** and **D–17** show the potential consequences (dose and probability of an LCF) should such an earthquake occur under the No Action Alternative. **Table D–18** shows the health risk (frequency multiplied by the LCF consequence) per year of operation. All of the releases from the Seismic 1 event would, of course, be released during this event as well. The waste storage domes would be among the facilities that would have no releases during a Seismic 1 event, but would have releases in the event of the larger Seismic 2 event. This facility, TA-55, and the Chemistry and Metallurgy Research Building represent the major sources of risk for this event. The overall health risk to the general population from this event is approximately 0.009 per year; that is, a mean of one LCF in the entire general population (out to 50 miles [80 kilometers] from each release) every 111 years of LANL operation. Therefore, the risk from a Seismic 1 or 2 event is roughly equivalent.

Table D–16 Site-Wide Seismic 2 Radiological Accident Offsite Population Consequences for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Seismic 2 Event	*MEI*		*Population to 50 Miles (80 kilometers)*	
	Dose (rem) [a]	*LCF* [b]	*Dose (person-rem)*	*LCF* [c, d]
Chemistry and Metallurgy Research Building (TA-3-29)	62	0.075	6,100	4 (3.7)
Weapons Engineering Tritium Facility (TA-16-205)	17	0.01	110	0 (0.063)
SHEBA (TA-18-168) [e]	0.03	0.000018	0.77	0 (0.00046)
Tritium System Test Assembly (TA-21-155)	0.0015	8.8×10^{-7}	0.049	0 (0.00003)
Tritium Science and Fabrication Facility (TA-21-209)	0.013	7.5×10^{-6}	0.43	0 (0.00026)
Radioactive Liquid Waste Treatment Facility (TA-50-1)	3	0.0018	520	0 (0.31)
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	43	0.052	5,100	3 (3.1)
Radioassay and Nondestructive Testing Facility (TA-54-38)	64	0.077	1,100	1 (0.67)

	MEI		*Population to 50 Miles (80 kilometers)*	
Facility Impacted by Seismic 2 Event	***Dose (rem)*** [a]	***LCF*** [b]	***Dose (person-rem)***	***LCF*** [c, d]
Plutonium Facility (TA-55-4)	150	0.17	14,000	9 (8.6)
Storage Facility (TA-55-185)	6	0.0036	590	0 (0.35)
Decontamination and Volume Reduction System (TA-54-412) (PC-3 Seismic)	34	0.04	600	0 (0.36)
Waste Storage Domes (TA-54)	460	0.55	7,400	5 (4.5)
Safe, Secure Transport Facility (TA-55-355)	3.9	0.0024	290	0 (0.18)
	Max 460	Max 0.55	Sum 36,000	Sum 22

MEI = maximally exposed individual, LCF = latent cancer fatality, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual per year.

[c] Increased number of LCFs for the offsite population per year; value in parentheses is the calculated result.

[d] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-1, -69), 343,100 (TA-54-38, TA-54-412, Domes), 301,900 (TA-55-4, -185, -355).

[e] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations and Expanded Operations Alternatives.

Table D–17 Site-Wide Seismic 2 Radiological Accident Onsite Worker Consequences for the No Action, Reduced Operations, and Expanded Operations Alternatives

	Noninvolved Worker at 110 Yards (100 meters)	
Facility Impacted by Seismic 2 Event	***Dose (rem)*** [a]	***LCF*** [b]
Chemistry and Metallurgy Research Building (TA-3-29)	2,000	2.4 [c]
Weapons Engineering Tritium Facility (TA-16-205)	150	0.17
SHEBA (TA-18-168) [d]	1.1	0.00064
Tritium System Test Assembly (TA-21-155)	0.011	6.7×10^{-6}
Tritium Science and Fabrication Facility (TA-21-209)	0.097	0.000058
Radioactive Liquid Waste Treatment Facility (TA-50-1)	120	0.15
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	1,100	1.3 [c]
Radioassay and Nondestructive Testing Facility (TA-54-38)	580	0.69
Plutonium Facility (TA-55-4)	2,700	3.3 [c]
Storage Facility (TA-55-185)	240	0.29
Decontamination and Volume Reduction System (TA-54-412) (PC-3 Seismic)	120	0.15
Waste Storage Domes (TA-54)	2,200	2.6 [c]
Safe, Secure Transport Facility (TA-55-355)	130	0.16

LCF = latent cancer fatality, TA = technical area, SHEBA = Solution High-Energy Burst Assembly.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.0 as shown. This means that it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For calculation purposes, the actual value is shown here; however, since the exposed recipient is an individual, the equivalent tables in Chapter 5, Section 5.12 show an LCF of 1.0.

[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations and Expanded Operations Alternatives.

Table D–18 Site-Wide Seismic 2 Radiological Accident Offsite Population and Worker Risks for the No Action, Reduced Operations, and Expanded Operations Alternatives

		Onsite Worker	*Offsite Population*	
Facility Impacted by Seismic 2 Event	***Frequency (per year)***	***Noninvolved Worker at 110 Yards (100 meters)*** [a]	***MEI*** [a]	***Population to 50 Miles (80 kilometers)*** [b, c]
Chemistry and Metallurgy Research Building (TA-3-29)	0.0005	0.0005	0.000037	0.0018
Weapons Engineering Tritium Facility (TA-16-205)	0.0005	8.7×10^{-5}	5×10^{-6}	0.000032
SHEBA (TA-18-168) [d]	0.0005	3.2×10^{-7}	9×10^{-9}	2.3×10^{-7}
Tritium System Test Assembly (TA-21-155)	0.0005	3.3×10^{-9}	4.4×10^{-10}	1.5×10^{-8}
Tritium Science and Fabrication Facility (TA-21-209)	0.0005	2.9×10^{-8}	3.8×10^{-9}	1.3×10^{-7}
Radioactive Liquid Waste Treatment Facility (TA-50-1)	0.0005	0.000073	9.1×10^{-7}	0.00016
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	0.0001 [e]	0.0001	5.2×10^{-6}	0.00031
Radioassay and Nondestructive Testing Facility (TA-54-38)	0.0005	0.00035	0.000039	0.00034
Plutonium Facility (TA-55-4)	0.0004 [e]	0.0004	7×10^{-5}	0.0035
Storage Facility (TA-55-185)	0.0005	0.00014	1.8×10^{-6}	0.00018
Decontamination and Volume Reduction System (TA-54-412) (PC-3 Seismic)	0.0005	0.000074	0.00002	0.00018
Waste Storage Domes (TA-54)	0.0005	0.0005	0.00028	0.0022
Safe, Secure Transport Facility (TA-55-355)	0.0005	0.000077	1.2×10^{-6}	0.000088
		Max 0.0005 [f]	Max 0.00028 [f]	Sum 0.009 [f]

MEI = maximally exposed individual, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs for the offsite population per year.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-1, -69), 343,100 (TA-54-38, TA-54-412, Domes), 301,900 (TA-55-4, -185, -355).

[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations and Expanded Operations Alternatives.

[e] Different frequency than other seismic events due to assumption of other additional failures.

[f] See the discussion in Section D.4 regarding the impacts of the 2007 update of the probabilistic seismic hazard analysis.

The consequence to an individual at publicly accessible Diamond Drive from a Seismic 2 release from the Chemistry and Metallurgy Research Building could exceed that from the nearest site boundary. This consequence is the same as for the Seismic 1 event; the effects of the Chemistry and Metallurgy Research Building release are discussed in detail under that heading.

D.4.2.3 Site-Wide Seismic 1 – Chemical Impacts

The facilities and chemicals of concern under site-wide Seismic 1 conditions are shown in **Table D–19**. There are numerous chemicals in small quantities onsite that could be released under these conditions. The listed chemicals were selected from a complete set of chemicals used onsite based on their larger quantities, chemical properties, and human health effects.

Table D–19 shows the ERPG concentration values for which excess concentrations could have harmful health or life-threatening implications as defined in the table's footnotes. Hydrogen cyanide, phosgene, and formaldehyde are toxic gases that, at elevated levels, can cause respiratory or cardiovascular (in the case of hydrogen cyanide) dysfunction. The hypothetical MEI could be exposed to formaldehyde concentrations in excess of ERPG-3 values in the event of such an earthquake, depending on the meteorological conditions at the time. This high exposure is a result of the proximity of TA-43-1 to the site border with the Los Alamos townsite.

Table D–19 Chemical Accident Impacts Under Seismic 1 Conditions

Chemical	*Frequency* [c] *(per year)*	*Quantity Released*	*ERPG-2* [a]		*ERPG-3* [b]		*Concentration*	
			Value	*Distance to Value (meters)*	*Value*	*Distance to Value (meters)*	*Noninvolved Worker at 100 Meters*	*MEI at Site Boundary*
Hydrogen Cyanide at TA-3-66 (Sigma Complex)	0.001	13.5 pounds (6 kilograms)	10 ppm	140	25 ppm	86	19 ppm	0.25 ppm at 924 meters
Phosgene at TA-9-21	0.001	1 pound (0.45 kilogram)	0.2 ppm	280	1 ppm	120	1.4 ppm	0.025 ppm at 823 meters
Formaldehyde at TA-43-1 (Bioscience Facilities)	0.001	14.1 liters (3.7 gallons)	10 ppm	180	25 ppm	110	31 ppm	Exceeds ERPG-3 at 12 meters

ERPG = Emergency Response Planning Guideline, MEI = maximally exposed individual, TA = technical area, ppm = parts per million.

[a] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their ability to take protective action (DOE 2004a).

[b] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2004a).

[c] Based on the updated 2007 update of the probabilistic seismic hazard analysis, the annual probability of exceedance for this earthquake is estimated to be 0.0015 (1 chance in 670). See discussion in Section D.4.

Note: To convert meters to yards, multiply by 1.0936.

The noninvolved worker could be exposed to phosgene or formaldehyde in excess of ERPG-3 values if located directly downwind of the releases and unable to take evasive action.

Table D–19 shows the concentration of each chemical, if it were released, at specified distances. The estimated frequency of this seismic event is shown in the table.

D.4.2.4 Site-Wide Seismic 2 – Chemical Impacts

The facilities and chemicals of concern under site-wide Seismic 2 conditions are shown in **Table D–20**. There are numerous chemicals in small quantities onsite that could be released under these conditions. The listed chemicals were selected from a complete set of chemicals used onsite based on their larger quantities, chemical properties, and human health effects. The table shows the ERPG concentration values for which excess concentrations could have harmful health or life-threatening implications, as defined in the table's footnotes.

Table D–20 Chemical Accident Impacts Under Seismic 2 Conditions

			ERPG-2 [a]		*ERPG-3* [b]		*Concentration*	
Chemical	*Frequency* [c] *(per year)*	*Quantity Released*	*Value*	*Distance to Value (meters)*	*Value*	*Distance to Value (meters)*	*Noninvolved Worker at 100 Meters*	*MEI at Site Boundary*
Hydrogen cyanide at TA-3-66 (Sigma Complex)	0.0005	13.5 pounds (6.1 kilograms)	10 ppm	137	25 ppm	86	18.6 ppm	0.25 ppm at 924 meters
Phosgene at TA-9-21	0.0005	1 pound (0.45 kilogram)	0.2 ppm	276	1 ppm	118	1.38 ppm	0.025 ppm at 823 meters
Formaldehyde at TA 43-1 (Bioscience Facilities)	0.0005	14.1 liters (3.7 gallons)	10 ppm	178	25 ppm	112	31.3 ppm	Exceeds ERPG-3 at 12 meters
Chlorine gas released outside of TA-55-41 Plutonium Facility	0.0005	150 pounds (68 kilograms)	3 ppm	1,080	20 ppm	380	165 ppm	3.4 ppm at 1,016 meters
Nitric acid spill at TA-55-4 (Plutonium Facility)	0.0005	6,100 gallons (23,090 liters)	6 ppm	49	78 ppm	6.6	1.61 ppm	0.019 ppm at 1,016 meters
Hydrochloric acid spill at TA-55-249	0.0005	5,200 gallons (19,684 liters)	20 ppm	185	150 ppm	64.5	65.9 ppm	0.65 ppm at 1,117 meters
Beryllium at TA-3-141 (Beryllium Technology Facility)	0.0005	110 pounds (49 kilograms) (powder) [d]	0.025 milligrams per cubic meter	282	0.1 milligrams per cubic meter	116	0.126 ppm	0.0043 milligrams per cubic meter at 880 meters

ERPG = Emergency Response Planning Guideline, MEI = maximally exposed individual, TA = technical area, ppm = parts per million.

[a] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action (DOE 2004a).

[b] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2004a).

[c] Based on the updated 2007 update of the probabilistic seismic hazard analysis, the annual probability of exceedance for this earthquake is estimated to be 0.0008 (1 chance in 1,250). See discussion in Section D.4.

[d] This quantity represents the total material at risk. A fraction (0.0006) of this solid would be released for the hypothesized scenario.

Note: To convert meters to yards, multiply by 1.0936.

The Seismic 1 chemical releases would be repeated here. In addition, because of the increased severity of this event, beryllium, chlorine, nitric acid, and hydrochloric acid could be released in sufficient quantities to create plausible health effects near the release site. Exposure to beryllium can result in acute lung damage; elevated levels of chlorine and acids can cause respiratory dysfunction. The beryllium powder release could result from a Beryllium Technology Facility structural failure in a Seismic 2 earthquake with subsequent container breaching. Chlorine could be released as a result of line or tank failures. The integrity of the nitric and hydrochloric acid tanks could be compromised. It is assumed that their entire contents spill and are contained within the seismically qualified berms surrounding each tank. Release from these acid pools would be by evaporation.

Table D–20 shows the concentration of each chemical, if released, at specified distances. The estimated frequency of the Seismic 1 event is shown in the table. The hydrogen cyanide, phosgene, and formaldehyde releases projected during a Seismic 1 event also would occur during the more severe Seismic 2 event; the distances and environmental concentration levels would be unchanged from the former event. None of the additional releases would result in MEI exposure in excess of ERPG-3 levels. A noninvolved worker, if directly downwind from the release and unable to take evasive action, could be exposed to beryllium or chlorine in excess of ERPG-3 levels. The additional releases (except beryllium) are from TA-55, and its distance from the site boundary, together with the quantities potentially released, would prevent ERPG-3 exposure to the public. The inventory of beryllium kept at TA-3-141 is limited to minimize accident impacts.

D.4.3 Reduced Operations Alternative Impacts

The site-wide seismic radiological accident impacts from the Reduced Operations Alternative would be similar to those from the No Action Alternative, as given in Tables D–13 through D–18. SHEBA operations at LANL would cease under this alternative. Inspection of the tables shows that SHEBA operations are a small component of the site-wide seismic accident impacts at LANL; its elimination would not significantly alter the overall site risk profile from such an event. All other impacts in the tables are equally applicable for this alternative.

The chemicals of concern that could be released in a site-wide seismic event are the same for the Reduced Operations Alternative as for the No Action Alternative. None of the chemicals identified for the latter are eliminated in this alternative. The information in Tables D–19 and D–20, then, is applicable to the Reduced Operations Alternative.

D.4.4 Expanded Operations Alternative Impacts

D.4.4.1 Site-Wide Seismic 1 – Radiological Impacts

The Seismic 1 accident impacts from the Expanded Operations Alternative would be similar to those from the No Action Alternative. SHEBA operations at LANL would cease under the Expanded Operations Alternative. Its impacts are relatively small; deleting SHEBA impacts would not change the overall Seismic 1 risk profile of this alternative. Replacement risks from accident impacts would result from expanded waste management activities. Transuranic waste managed at DVRS would be moved offsite or to a new facility, the TRU Waste Facility, which would be located in a TA along the Pajarito Road Corridor. The impacts from this new facility would be less than those of the existing facility because of the new location. The entries in Tables D–13 through D–15 reflect present DVRS operations because it could be active for most of the time period of interest. The accident impacts from DVRS bound the impacts of its replacement facility. Accident impacts for the new facility are described in Appendix H.

D.4.4.2 Site-Wide Seismic 2 – Radiological Impacts

The Seismic 2 accident impacts from the Expanded Operations Alternative would be similar to those from the No Action Alternative. SHEBA operations at LANL would cease under the Expanded Operations Alternative. Its impacts are relatively small; deleting its impacts would not change the overall Seismic 2 risk profile of this alternative. Replacement risks from accident impacts would result from expanded waste management activities. Transuranic waste managed at DVRS and the waste storage domes would be moved offsite or to a new facility, the TRU Waste Facility, located in a TA along the Pajarito Road Corridor. The impacts from this new facility would be less than those of the existing facility because of the new location and because less material would be stored, the rest being moved offsite. The entries in Tables D–16 through D–18 reflect present DVRS and the waste storage domes operations because they could be active for most of the time period of interest and because their accident impacts bound the impacts of the new facility. The TRU Waste Facility accident impacts are described in Appendix H.

D.4.4.3 Site-Wide Seismic 1 – Chemical Impacts

The chemicals of concern that could be released in a site-wide Seismic 1 event are the same under the Expanded Operations Alternative as under the No Action Alternative. No additional chemicals were identified in this alternative that would have impacts exceeding those for the No Action Alternative. The information in Table D–19, then, is applicable to the Expanded Operations Alternative.

D.4.4.4 Site-Wide Seismic 2 – Chemical Impacts

The chemicals of concern that could be released in a site-wide Seismic 2 event are the same under the Expanded Operations Alternative as under the No Action Alternative. No additional chemicals were associated with this alternative that would have impacts exceeding those under the No Action Alternative. The information in Table D–20, then, is applicable to the Expanded Operations Alternative.

D.5 Wildfire Accidents

This section discusses the potential for a wildfire at LANL (LANL 2004) that could cause the release of hazardous radioactive and chemical materials that would affect the health and safety of LANL workers and the public.

D.5.1 Background

Wildfires were evaluated in the *1999 SWEIS* and were studied further following the Cerro Grande Fire in May 2000. The following sections provide background information on the potential for LANL wildfires since the *1999 SWEIS* was prepared.

D.5.1.1 Consuming Combustible Structures and Vegetation

A theoretical wildfire resulting in the exposure of humans to airborne radiation was one of several operational site-wide accident scenarios analyzed and reported in the *1999 SWEIS*. The health impact of the wildfire accident was 0.34 LCFs, resulting from an estimated population dose of 675 person-rem. The dose to the MEI member of the public was less than 25 rem, and the estimated frequency of occurrence was approximately once every 10 years. While the estimated radiological dose consequence of a wildfire accident was small, the high frequency of occurrence resulted in a risk (the product of the frequency and consequence) that was surpassed by only one other postulated accident in the *1999 SWEIS*.

The wildfire accident analysis assumed multiple source releases, including radiological inventories from buildings, suspended soils with environmental (very low) levels of contamination, and ash from burned vegetation (this ash also had very low levels of contamination). Since the analysis in 1999, radiological inventories in buildings have changed; the vulnerability of buildings to ignition by wildfire has changed as a result of tree thinning; more accurate and more comprehensive data have been compiled on concentrations of radionuclides in vegetation; vegetation fuel loads have changed; and the frequency of occurrence has possibly changed.

The LANL site and surrounding vicinity are generally forested areas with high fuel loading (Balice, Oswald, and Martin 1999; Balice et al. 2000). Wildfires are frequent occurrences on nearby U.S. Forest Service land and have an obvious potential for encroaching on the LANL site, as demonstrated by recent events (Balice, Oswald, and Martin 1999, Balice et al. 2000). Recently, an analysis was completed to help determine areas of concern for continued wildfire risk at LANL that consider the extensive environmental changes since 1999. Based on the results of this analysis, areas of concern were determined that are consistent with those found in another recent wildfire risk analysis (Balice et al. 2005). A particular scenario, a wildfire starting southwest of LANL near the border of the Bandelier National Monument and the Dome Wilderness Area, was postulated. While there is a potential for initiation of a wildfire at many locations within and near the LANL site, this location was considered to have the greatest potential for widespread environmental impacts to LANL because continuous fuel is available from these offsite locations near the southwest corner of LANL.

D.5.1.2 Recent Widespread Environmental Changes

Since completion of the *1999 SWEIS* wildfire analysis, the Cerro Grande Fire occurred. On May 4, 2000, the National Park Service initiated a prescribed burn on the flanks of Cerro Grande Peak within the boundary of Bandelier National Monument. The intended burn was a meadow of about 300 acres (120 hectares), located 3.5 miles (5.6 kilometers) west of TA-16, near the southwest corner of LANL. The prescribed burn began in the evening; by 1:00 p.m. the following day, the burn was declared a wildfire.

LANL's meteorological data showed above–average temperatures and low humidity for the first 10 days of the wildfire, with wind speeds averaging 6 to 17 miles per hour (10 to 27 kilometers per hour) and gusting from 27 to 54 miles per hour (44 to 87 kilometers per hour). Generally, winds tended to be from the southwest to west during this period. By May 8, day 5 of the wildfire, spot fires began to occur on LANL lands. By May 10, the fire moved into the Los Alamos townsite and proceeded north and east across the TA-16 mesa top. The fire moved eastward down Water Canyon, Cañon de Valle, Pajarito Canyon, and Cañada del Buey by May 11. Eventually the fire extended northward on LANL lands to Sandia Canyon and eastward down Mortandad Canyon into San Ildefonso Pueblo lands. The residential areas of Los Alamos and White Rock were in the fire's path, and more than 18,000 residents were evacuated. By the end of the day on May 10, the fire had burned 18,000 acres (7,280 hectares), destroyed 235 homes, and damaged many other structures. The fire also spread toward LANL; although the fire moved onto LANL land, all major structures were secured and no releases of radiation occurred. The wildfire was declared fully contained on June 6, after burning nearly 43,000 acres (17,400 hectares) of land extending to Santa Clara Canyon on Santa Clara Pueblo lands to the north of the townsite. LANL had approximately 6,757 acres (2,734 hectares) of low-burn severity; 844 acres (342 hectares) of moderate-burn severity; and 50 acres (20 hectares) of high-burn severity (Balice, Bennett, and Wright 2004).[3]

---

[3] *The sum of these areas is approximately equal to 7,700 acres as cited elsewhere in this SWEIS.*

The Cerro Grande Fire had enormous adverse impacts on forests around LANL. Immediately there were concerns about increased erosion and flooding and the potential impacts on contaminated soil and sediment. Seventy-seven contaminant potential release sites and two nuclear facilities at LANL that contain hazardous and radioactively contaminated soils and materials are located within floodplain areas. Without DOE action, these potential release sites and nuclear facilities could have released contaminants and materials downstream during rainfall events. In addition, numerous cultural resource sites and traditional cultural properties are located in canyons or along drainage areas and were at increased risk of flood damage.

LANL conducted assessments and implemented on-the-ground rehabilitation efforts. Under the DOE Special Environmental Assessment (DOE 2000), LANL was to conduct mitigation measures and monitor the condition of the burned area annually. In all, LANL treated over 1,800 acres (728 hectares) with techniques similar to those used by the Burned Area Emergency Rehabilitation team. The project was successful, increasing vegetative cover on the severely burned units from around 0 percent to almost 45 percent. Most of the straw wattles that were installed held sediment onsite and allowed vegetation to grow. The LANL management and operating contractor developed best management practices for all potential release sites that were potentially impacted by the fire to eliminate contaminant transport.

The drought that began in 2000 in the southwestern United States, although not unprecedented, has been one of the more severe in 50 years (Breshears et al. 2005). Precipitation for this region was 25 percent below average during 2000 and 2001, and 65 percent below average through the summer months. The combined effects of prolonged drought and severe outbreak of bark beetles (*Ips confusus*) resulted in tens of millions of dead trees over thousands of square miles in Arizona, New Mexico, Colorado, and Utah (McHugh, Kolb, and Wilson 2003). Highest mortality levels have been seen in ponderosa pine (*Pinus ponderosa*), douglas-fir (*Pseudotsuga menziesii*) and pinyon (*Pinus edulis*) pine trees. In many areas of pinyon-juniper habitat, entire stands of pinyon have died, leaving only juniper (*Juniperus monosperma*). Bark beetle infestations in western North America has been documented to cause large areas of high tree mortality that has been linked to both drought and fire in the region (USDA 2002). The Pajarito Plateau, where LANL is located, had an average 85 percent tree mortality for trees over 5 feet (1.5 meters) tall from 2002 to 2003, leaving a mosaic of live and dead trees.

To decrease the risk from catastrophic environmental fire, LANL began a tree-thinning project in January 2002. The goals of this project were to reduce the threat of wildfire to forested areas and structures on LANL property, to enhance and maintain wildlife habitat and tree species diversity by ensuring vertical and horizontal heterogeneity of age class and structure throughout the forest, and to promote forest health. Tree thinning has been completed on 7,283 acres (2,947 hectares), including both ponderosa pine and pinyon–juniper habitats (LANL 2005). Tree thinning and environmental changes were incorporated into the wildfire risk analysis of this SWEIS.

D.5.1.3 Wildfire Occurrence

D.5.1.3.1 General Approach

The following analysis of the risk of wildfire initiation and spread was taken from the *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement* (LANL 2004).

This analysis was largely based on data produced during earlier studies and field monitoring activities. A dataset of lightning strike locations and intensities was used to represent wildfire ignitions. Polygons (multi-sided geometric shapes) of previously modeled fires were used to evaluate the relative potential for fires to burn within the study area. Fuels data and an existing land cover map were used to characterize the fuels and fire hazards in the study region. It was assumed that lightning, modeled fires, and fuels characterizations represent ignitions, fire spread, and flammability, respectively. These are all important components of wildfire risk. The three intermediate results were weighted and combined in the geographical information system (GIS) software to create a preliminary relative risk rating for each cell in the study region. All analyses were completed using ArcView 3.2a GIS software. Cell (a term used in ArcView for a specific bounded surface area) resolution was set at 49 feet by 49 feet (15 meters by 15 meters).

D.5.1.3.2 Region of Interest

The study region was based on an area used for previous analyses of wildfire behavior (Balice et al. 2000). This included most of LANL and all of its areas west of TA-18. To the west, north, and south, the region of interest extends to the crest of the Sierra de los Valles and the eastern portion of the Valles Caldera National Preserve, the northern extent of the Los Alamos townsite, and Frijoles Canyon, respectively. Typical vegetation in this area consists of pinyon-juniper woodlands, ponderosa pine forests, mixed conifer forests, aspen forests and grasslands. Occasional barren areas, shrub lands, and spruce-fir forests also are found in the study region. Numerous developed areas, including the Los Alamos townsite and the TAs at LANL, are also interspersed throughout the study region.

D.5.1.3.3 Lightning Strike Densities and Intensities

Lightning strikes that were less than 100,000 amps in intensity were removed from the dataset. Lightning strikes that were located outside of a test region were also removed from the dataset. The 131 remaining lightning strike locations and their relative intensities were analyzed in ArcView. From these point locations, a map of densities by relative strike intensities was created and scaled from 0 to 1, with 1 representing the greatest combined strike density and intensity. The cell-based output of scaled values represents the relative tendencies that fires would be ignited within the polygons.

D.5.1.3.4 Modeled Fire Polygons

To assess the potential for fires to burn within each ArcView cell, wildfires were simulated from each lightning strike location using scenarios that reflected conditions in the Los Alamos region for the 1999 time period (57 lightning strikes) and the 2002 time period (49 lightning strikes), respectively. FARSITE was used as the modeling software (USDA 1998). FARSITE was previously parameterized with locally collected data representing the fuels and fire hazards of the Los Alamos region. The parameterized fire behavior modeling system also was validated against the burn histories of known fires.

The databases representing the 1999 time period were derived from vegetation and fuels conditions that were present in the Los Alamos region before the Cerro Grande Fire, before the initiation of major thinning and fire hazard reduction activities, and before the initiation of drought-induced mortality. All other conditions for fire behavior simulations were assumed to be those that existed immediately before or during the Cerro Grande Fire. The databases representing the 2002 time period incorporated changes that resulted from the Cerro Grande Fire, large-scale forest thinning activities, and tree mortality.

Each simulation produced a polygon representing the potential area burned by a wildfire. These multiple theme layers or polygons were then superimposed in the GIS, and the total number of fire polygons that occurred in each cell was summed. For both the 1999 time period and the 2002 time period, the greatest number of simulated fires in any given cell was 11. Cell values were then scaled from 0 to 1 based on these values, with 1 representing those cells where 11 simulated fires occurred. The final scaled values represent the relative tendency of a fire to burn through a cell under the conditions of the simulation. Those cells with more fires were assumed to be at greater risk of a fire actually burning through that cell.

D.5.1.3.5 Fuel Conditions

The fuel model concept, canopy heights, and percent canopy cover were used to model the fuel conditions at each ArcView cell. Values for these parameters were established from previous field sampling conducted throughout the Los Alamos region from 1997 through 2004. The fuel models were ranked by their relative ability to support more intense fires. Similarly, 100 feet (30 meters) was assumed to be the maximum canopy height, and all other canopy heights were ranked proportionally to this maximum value and scaled from 0 to 1. For canopy cover, 100 percent cover was set as the maximum possible, and the actual percent canopy cover values were rated proportionately between 0 and 1.

Previously developed land cover classification systems for assignment of fuel model, canopy heights, and percent canopy cover values to each land cover class were used. This was performed for conditions that were typical of the 1999 and 2002 time period. These scaled class assignments were applied to ArcView versions of land cover maps that were developed before and after the Cerro Grande Fire.

D.5.1.3.6 Wildfire Model Development

The five data layers of lightning, modeled fires, and fuel conditions (three layers) for each time period were mathematically combined in the GIS to assess spatial trends of fire risk across the study region. Equal weight was given to each of these three major risk groups according to the following relationship:

> {Density of lightning strikes by their relative intensity + relative number of simulated fires + [relative canopy height + relative percent canopy cover + relative fuel model]/3}/3.

Finally, the values for these calculated fire risks were scaled from 0 to 1. The analysis was repeated for conditions that existed in approximately 1999. This was before the Cerro Grande Fire, before extensive thinning was initiated, before rehabilitation treatments were applied to the forests of the region, and before the onset of major mortality events. Then the process was repeated for the 2002 conditions, after the Cerro Grande Fire, after the thinning of approximately 7,000 additional acres (2,800 hectares), and after the onset of tree mortality.

D.5.1.3.7 Wildfire Model Results

Results indicate that the risk of wildfires within the study region is not homogeneous through space and time. With regard to time, the relative wildfire risks are seen to decrease from the 1999 time period (see **Figure D–1**) to the 2002 time period (see **Figure D–2**). The greatest decrease in the wildfire risk appears to have taken place in the mountainous regions on the western boundary of LANL and further to the west, as well as in the mesa and canyon regions of the western and central portions of LANL.

Spatial variations in wildfire risk for the 2002 time period show a general decrease in risk from the mountainous regions in the west to the lower elevations in the eastern portion of the study region. A general ranking of the specific areas for their relative risk is also possible.

First, the greatest fire risk occurs along the Pajarito Ridge from New Mexico (NM) 501 to the Pajarito Ski Area.

Second, the next greatest fire risk occurs in the southwest corner of LANL, adjacent to the Back Gate.

Third, relatively high fire risks occur in the intervening areas along NM 501 and the western boundary of LANL.

Fourth, relatively high fire risks occur along portions of the mesa-canyon areas between TA-40 and TA-21. This is particularly true for the north-facing slopes of the canyons, although some of the other topographic positions in this area resulted in lower fire risk levels.

Fifth, the remaining portions of LANL and its immediate surroundings are at relatively less risk from wildfires.

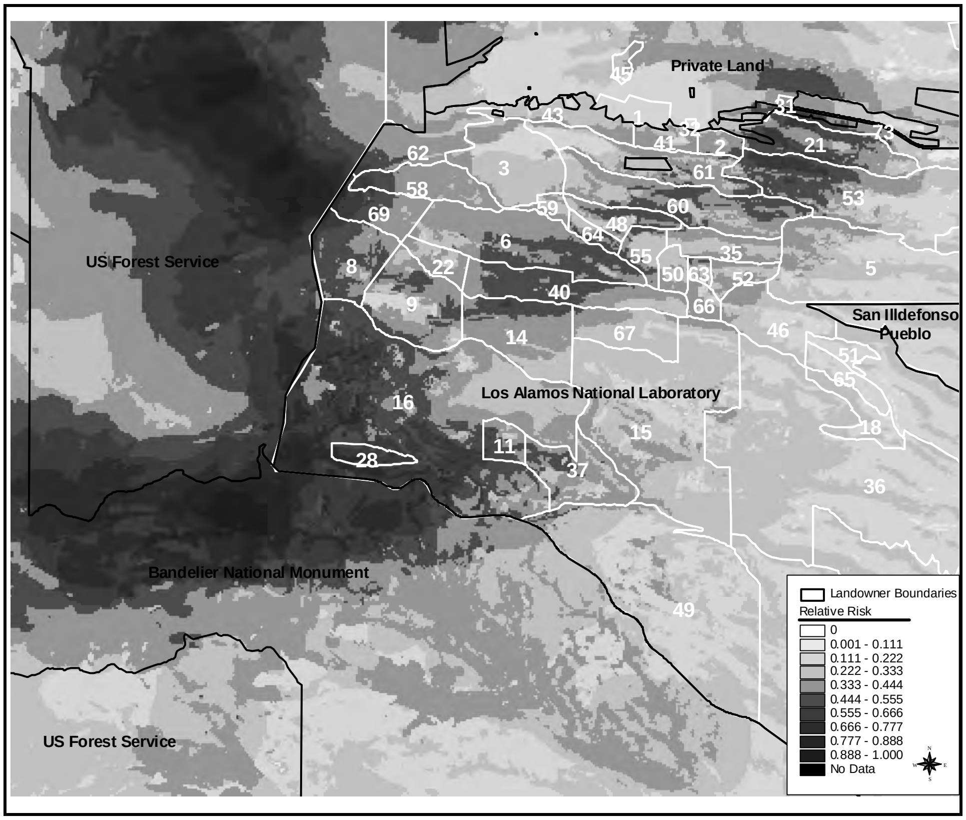


Figure D–1 Relative Risk of Wildfire in the Los Alamos Region (1999)

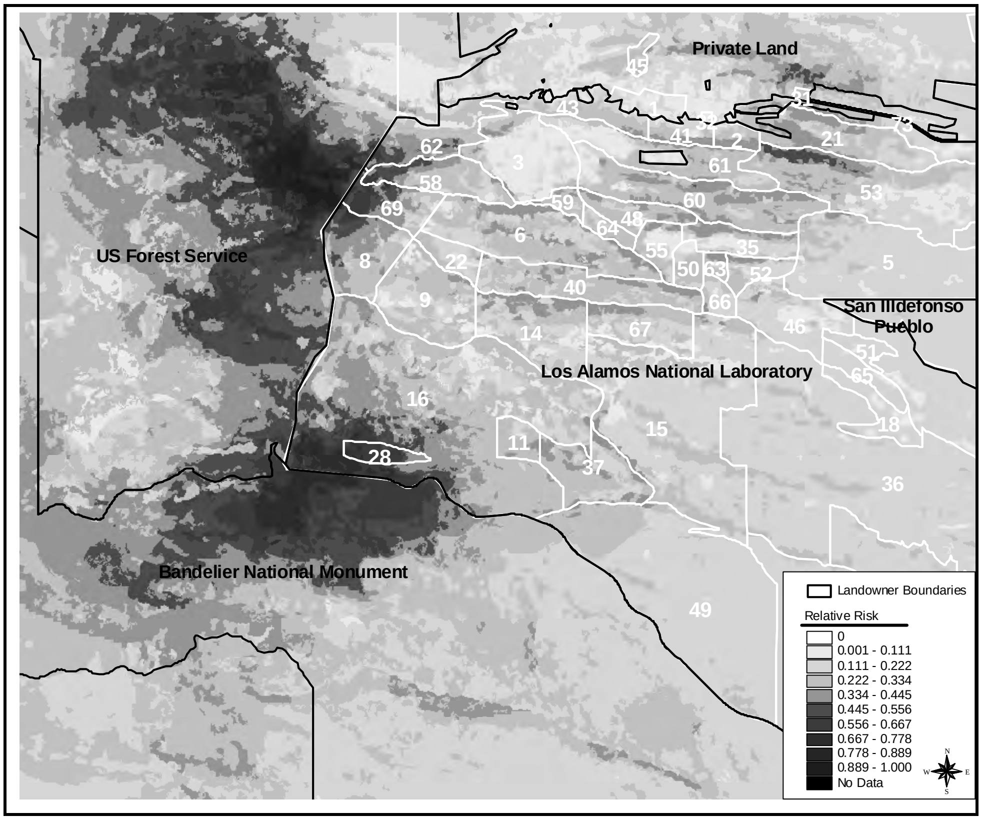


Figure D–2 Relative Risk of Wildfire in the Los Alamos Region (2002)

D.5.2 Current Wildfire Hazard Conditions

This section discusses the current wildfire hazard conditions and likelihood, reflecting changes that have occurred since the late 1990s. The analysis is taken from LANL 2004.

D.5.2.1 Changes to the Fuels and Fire Hazard Conditions in the Past 5 Years

Current fuels and fire hazard conditions in the Los Alamos region are not the same as those that existed in the late 1990s. This is reflected in the most credible wildfire scenario that would be expected in the present time period, which is considerably different from what would have been expected before 2000. In the wildfire scenario reported in the *1999 SWEIS* (DOE 1999a), fuels were heavy and continuous throughout most of the mixed conifer forests of the Sierra de los Valles and extended eastward to the ponderosa pine forests on most of the western portions of LANL property. As ponderosa pine forests transitioned to pinyon-juniper woodlands toward the eastern half of LANL, the canopy heights and the total fuel loads were reduced somewhat, but maintained the continuous nature of their overstory cover. These heavy and continuous fuels, especially in the mountainous environments, coupled with the southwest-to-northeast wind patterns that are typically prevalent during the fire season, suggested a general wildfire scenario that was validated by the Dome Fire and the Cerro Grande Fire.

In the general wildfire scenario of the 1990s, fire would be ignited by lightning or by humans in the mountains during high to extreme fire danger levels. A small fire of this type would burn lightly for a day or two until the combination of temperature, humidity, and wind worsened to the point that the fire extended from the ground surface through the fuel ladders into the forest overstory. At this time, the winds would carry the fire through the tree crowns from the mountains in a northeasterly direction toward LANL. The fire would continue to spread across LANL for up to 10 days. During this time, all unprotected buildings and facilities in its path would be destroyed. Suppression of the fire would be impossible until the weather conditions moderated sufficiently to allow the application of effective suppression measures.

Since the writing of the *1999 SWEIS*, several aspects of the wildfire conditions in the Los Alamos region have changed significantly; however, some aspects of the wildfire conditions in the region have not changed. For example, ignition sources have not changed since the *1999 SWEIS*. During both time periods, fires most likely would be ignited by lightning or by humans. Moreover, ignitions would typically occur most prevalently in the mountainous environments to the west of LANL. Topographic conditions in the Los Alamos region also have not changed since the *1999 SWEIS*. The mountainous environments to the west of LANL and the canyon-mesa environments at LANL present difficulties in managing and suppressing fires and create safety and management issues related to transportation and movements across these topographic barriers. In addition, the patchwork of land management agencies in the Los Alamos region has not changed since the *1999 SWEIS*, which creates unique problems for wildfire hazard management that can only be resolved through strong interaction and collaboration among the individual agencies.

Some aspects of weather have changed since the *1999 SWEIS* and some have not. Severe wildfire weather conditions tend to occur from mid-April to early July, and these have not been altered since 1999. Similarly, there is still a significantly strong tendency for intense winds to occur during this time period, and the direction of these winds tends to be from the southwest to the northeast. Moreover, the density of lightning strikes is high during the latter portions of the wildfire season, and this has altered since the writing of the *1999 SWEIS*. What has changed with respect to weather conditions since the *1999 SWEIS* is that the climate has grown significantly hotter and drier. Precipitation levels are somewhat similar to the 1950s drought; however, recent temperatures have been significantly higher (Breshears et al. 2005).

The wildfire hazard that changed extensively since the *1999 SWEIS* is fuel levels in the Los Alamos region. First, the Cerro Grande Fire greatly reduced fuels in more than 42,000 acres (17,000 hectares) of forested landscape at LANL and to the west of LANL. This was especially true in the severely burned areas where re-establishment of fuels has been limited to regrowth from sprouting shrubs and from seeded grasses. In contrast, regrowth of vegetation in the lightly burned and moderately burned sections of the Cerro Grande Fire has resulted in very little net change in fuel levels in these areas. Moreover, reseeding with grasses in the severely burned areas of the Cerro Grande Fire and other rehabilitation techniques have resulted in major changes to the post-fire fuel conditions. Immediately after the fire, severely burned forests were essentially unburnable; however, with the establishment of seeded grasses and with the addition of dead trees that have fallen to the ground, many of these areas can now support a surface fire.

In addition to past fires, fire hazard reduction activities in forests and adjacent to facilities at LANL have altered the fuel structures. Before 1997, the forests and woodlands at LANL were essentially unmanaged and severely overstocked with trees and shrubs. The result was a situation that was dangerously high in fuels and fire hazards throughout most of the forests and woodlands at LANL. Between 1997 and 1999, approximately 800 acres (324 hectares) of ponderosa pine forest on the western perimeter of LANL and near critical facilities were thinned from below. These fire hazard reduction activities increased dramatically after the Cerro Grande Fire. Between 2001 and 2003, approximately 6,000 acres (2,428 hectares) of ponderosa pine forests and pinyon-juniper woodlands were thinned. These fire hazard reduction activities focused on creating defensible space around critical buildings and facilities, underneath power lines and along transportation corridors, and in the surrounding forests and woodlands.

D.5.2.2 Potential Wildfire Scenarios

The results of the wildfire risk analysis incorporating altered fuel conditions that have occurred in the past few years suggest the heightened likelihood that some general wildfire scenarios will occur compared to other scenarios at LANL. Wildfires that occur today would still be ignited by lightning or by humans. These fires would tend to be ignited in the mountainous regions to the west of LANL, but fires also could be started on the LANL site. High winds during the fire season from mid-April to early July would still tend to carry actively burning wildfires from the southwest to the northeast. This general scenario is consistent with another recent wildfire risk analysis for LANL (Balice et al. 2005). Early suppression of wildfires is important to the successful protection of buildings and facilities. Once these fires enter the canopy of forests, they are difficult to control until weather conditions moderate.

The major impact of fire hazard reduction activities in recent years at LANL is that fires would tend to remain on the ground surface and would more readily drop from the canopies back to the ground surface. This, in combination with the creation of defensible space adjacent to LANL facilities, would facilitate management and suppression with the result that buildings and facilities would be easier to protect.

With the greatest modeled risk from wildfires occurring along the Pajarito Ridge and along the margins of the Frijoles Canyon, the risk to LANL would still largely arise from the west and the southwest. TA-16, TA-28, TA-58, TA-62, and TA-69 would be at the greatest risk from wildfires. The second greatest risk from wildfires would occur along the western borders of LANL; TA-8 and TA-9, and portions of TA-16 would be at risk from wildfires arising in this area. Secondarily, TA-3, TA-6, TA-11, TA-14, TA-22, TA-37, TA-40, and TA-59 also would be at risk from fires arising along the western boundary at LANL. In all of these cases, fires would enter the canyon environments on LANL property. This would create difficulties for control and management and increase the danger to adjacent buildings and facilities.

Fires that originate from within the boundaries of LANL likely would be ignited at firing sites at central locations of the site. These would primarily impact TA-14, TA-15, TA-40, and TA-67. Numerous canyons dissect this area, which would add to the difficulties of suppressing these fires as they spread across adjacent mesas from canyon to canyon. In addition, the canyon environments contain conditions (topographic barriers, heavy fuel loads on north-facing aspects, and modified canyon wind patterns) that would complicate the direction of wildfire spread. The result would be that fires would tend to spread readily in down-canyon and up-canyon directions and travel across mesas or via airborne embers to adjacent canyons.

D.5.2.3 Frequency of Wildfires

The probability component of the risk equation reported in the *1999 SWEIS* only considered the advancement of a large wildfire to the LANL boundary and assumed that this fire would continue on a path through LANL, reaching and igniting LANL buildings and causing a radiological release.

The frequency of a large fire encroaching on LANL (1 in 10 years) was estimated in 1999 as the joint probability of ignition in the adjacent forests, high to extreme fire danger, failure to promptly extinguish the fire, and fire-favorable weather. The frequency estimate for ignition in the adjacent forests was based on a 21-year period (1976 to 1996) and probably has not changed appreciably in the years since. Fire ignitions have continued to occur in adjacent forests. Periods of high to extreme fire danger have continued to occur frequently during the summer months, and fire-favorable conditions have continued as well. The estimated likelihood of a fire reaching a LANL boundary did not include the likelihood of a fire advancing across LANL to encroach on buildings containing radiological materials (in appreciable amounts), the likelihood of buildings igniting, and the likelihood of a release occurring once buildings are assumed to ignite. The likelihood of a fire encroaching on a building containing radioactive material depends on, among other factors, fuel load and continuity of fuel leading up to the space surrounding the buildings. The likelihood of a nuclear facility igniting depends on the joint probability of fuel load indices for fuel adjacent to buildings, the slope on which the adjacent fuel loads exist, and the combustibility of buildings. This factor was quantified in 1999 and has been updated recently. The likelihood of a release would be related to the damage ratio (likelihood that the material at risk was actually impacted by the accident) and the leak path factor (likelihood that confinement, if any, is breached). While the probability of a large fire encroaching on LANL remains moderate to high depending on location, probably still on the order of 1 in 10 years (0.1 per year), the probability of a LANL facility containing an appreciable radiological inventory being ignited by a wildfire and releasing some or all of the inventory has been reduced somewhat by the "defensible space" thinning and by the reductions in fuel caused by the Cerro Grande Fire.

Since the probability estimate for the *1999 SWEIS* stopped at the LANL boundary, there is no value for the probability of the fire advancing across LANL to nuclear facilities, igniting buildings, and causing a release. Without this value, an assessment of how this probability might have changed cannot be made. Gonzales, Ladino, and Valerio (2004) conservatively estimated that there is a 50 percent chance that the three factors just mentioned occur and combined this probability value (0.5) with the assumed probability for a wildfire reaching the LANL boundary (0.1). This resulted in a conservative estimate of the probability that a release would occur due to a wildfire and result in radiological exposures of 0.05 per year. This translates to a 5-in-100-year chance of occurrence, which is equal to 1 in 20 years. This estimate is in agreement with the draft Documented Safety Analysis for Area G. The fact that the Cerro Grande Fire did not result in the ignition of a LANL nuclear facility is evidence that thinning works and preventative maintenance will keep key facilities safer from wildfire than in the past.

D.5.2.4 Conditions that Favor Wildfire

In view of the present density and structure of fuel surrounding and within LANL and the occurrence of five major fires in the past 50 years it is evident that there is the potential for wildfire occurrence at LANL. Some protection is afforded LANL by the fire scars of the previous Dome and La Mesa Fires, but there is ample fuel continuity remaining to bring an offsite wildfire to the southwest and western boundary of LANL. The current analysis accounts for the environmental changes and fuel reduction mitigation that have occurred due to the Cerro Grande Fire.

The probability of high to extreme fire danger is determined by the frequency of meteorological conditions of low precipitation for 2 to 3 weeks preceding; low relative humidity for 3 consecutive days; and high temperatures. When the high to extreme fire danger exists in New Mexico in May through July, there are certain to be multiple ignition sources (from lightning and human causes). The high frequency of lightning and lightning-caused fires in the Jemez Mountains was used in the analysis of fire risk. The frequency of a large fire encroaching on LANL is estimated as the joint probability of ignition in the adjacent forests, high to extreme fire danger, failure to promptly extinguish the fire, and a 3-day spell of southwesterly to westerly wind over 11 miles per hour (5 meters per second), low humidity, and no precipitation.

D.5.2.5 Determining the Joint Probability of Occurrence of Weather and Fire Danger Conditions

The probability of occurrence of the weather and fire conditions needed for a wildfire were determined using wind and fire danger data for April through June, the months when fire risk and frequency are greatest, of 1980 through 1998. Note that site-wide fires also are possible, but less probable, in other months besides April through June; thus, the annual frequency of fire–favorable weather is somewhat greater than quantified for April through June.

In general, wind direction at any location varies and does not persist in a single direction for a few days. LANL is no exception. At LANL, persistent daytime winds are interrupted for a few hours when nighttime drainage winds occur; however, granting short interludes of drainage flow, there are many instances in which a dominant direction, such as southwesterly, westerly, northerly, can exist for 3 days without precipitation.

To determine a fire-favorable weather frequency, 15-minute average wind data from the lower level of the TA-6 and TA-59 meteorological towers was used. For each day in April through June of 1980 through 1998, an average afternoon wind was calculated from the 15-minute data to eliminate the local diurnal changes in wind speed and direction that are common to the area. Average afternoon wind speeds of greater than 10 miles per hour (4.5 meters per second) are chosen to represent strong winds. While this threshold may seem low for a strong wind, wind gusts of over 30 miles per hour (13 meters per second) and sometimes over 40 miles per hour (18 meters per second) are seen on most days when the afternoon average wind is above 10 miles (16 kilometers) per hour. The wind direction thresholds are set at 180 degrees (southerly) through 292.5 degrees (west-northwesterly). Three-day periods from the same dataset were then examined to determine whether the precipitation, wind speed, and wind direction fell above or within set limits. All 3-day periods falling within the set limits were then extracted.

The results show that it is not uncommon to see a 3-day period exhibiting the selected characteristics in a given year and that, when such a 3-day period appears, it is likely that more than one such period will occur within that year. Specifically, the resulting statistics show that, of the 19 years examined, 5 displayed at least one 3-day period within the limits, or one every 4 years. Of these 5 years, 4 had an average of 3.6 3-day periods (an instance of 5 days in a row is counted as three 3-day periods.) This comes to 15.4 instances in 19 springs.

In summary, fire-favorable weather conditions occur on the order of once per year; the ignition sources are prevalent; and firefighting is hampered by limited accessibility. Therefore, analysis concludes that a major fire moving up to the edge of LANL is not only credible but likely, probably on the order of 0.10 per year. This frequency is the same for all alternatives.

D.5.3 General Wildfire Scenario

D.5.3.1 Description

The SWEIS wildlife scenario used in 1999 predicted a path and outcome very similar to the Cerro Grande Fire. Due to the extent and size of the Cerro Grande Fire and subsequent fire mitigation actions completed since the *1999 SWEIS*, a new fire risk analysis was completed to incorporate the environmental changes and lessons learned from the Cerro Grande Fire.

The scenario fire begins midday in the late April through June timeframe, at a time of high or extreme fire danger, and is not extinguished in the first hour. The initial location is in an area populated with heavy ponderosa pine fuels that is found at between roughly 6,500 and 8,200 feet (1,980 and 2,500 meters) elevation. As the fire grows, local jurisdictions respond to the fire, but are not effective due to characteristics such as remoteness, travel time, lack of road access, and fire behavior. Resources from more distant jurisdictions are alerted, but cannot arrive in a short time because of distance, limited roads, and opposing evacuation traffic. It proves impossible to put out the fire with the available resources and existing forest access before it enters LANL. Unlike the Water Canyon Fire (greater than 3,000 acres [1,214 hectares] in June 1954), La Mesa Fire (15,300 acres [6,191 hectares] in June 1977), Dome Fire (16,500 acres [6,677 hectares] April 25 to May 5, 1996), and Oso Fire (greater than 5,000 acres [2,023 hectares] in June 1998), but very much like the Cerro Grande Fire in May 2000 (43,000 acres [17,401 hectares]), the weather does not change in time to prevent the fire from sweeping across the western part of LANL and into the townsite.

This specific analysis assumes a common meteorological situation that favors the fire. In this scenario, the fire begins about 10 a.m., reaches a size of 1,000 acres (400 hectares) in 3 hours, and becomes a well-developed crown fire on a broad fire front containing 6,000 acres (2,400 hectares) on the second day. Like the La Mesa Fire, at times it advances at a rate of 0.5 miles (0.7 kilometers) per hour. It starts spot fires 0.5 to 1.25 miles (0.8 to 2.0 kilometers) in advance, aided by prevailing southwest winds of 20 miles per hour (9 meters per second) and low daytime humidity. It easily jumps canyons and existing fuel break lines around LANL and the townsite, similar to the Cerro Grande Fire.

The daytime convection column reaches to 20,000 to 25,000 feet (6,000 to 7,600 meters). In the Oso Fire, the fire burned as actively at night as in the day, with flame heights on the order of 100 feet (30 meters). In this scenario, in order to have a conservative (low height) plume rise, at night the temperature drops and the relative humidity increases. The nighttime plume rise is then about 2,000 feet (600 meters). The fire regains its intensity at 10:00 a.m. each day. Following fire passage, the smoldering remains of vegetation and structures emit smoke and contaminants at the surface level.

The fire reaches NM 4 and NM 501, the southwest edge of LANL, at noon on the second day. Protective actions are already being undertaken by LANL management, such as relocating some radionuclides, barricading some windows, and releasing nonessential personnel following existing emergency plans. The fuel break along these roads proves inadequate. At this point, the fire has progressed in areas where access is limited, hampering fire suppression activities due to concern for the safety of the firefighters. A control line is established at Pajarito Road and resources are concentrated there. Consequently, Pajarito Road is closed and is not available for public evacuation. The fire burns forest to the west of and within LANL, but its eastern extent within LANL is constrained by pinyon-juniper woodlands and defined by fuel continuity and density.

From the completed specific analysis of fuel loads and prediction of fire risks, it is estimated the TAs most at risk include TA-8, TA-16, TA-28, TA-58, TA-62, and TA-69. This differs slightly from the previous wildfire scenario, in which TA-15, TA-37, and TA-66 were used. Following the continuous fuel lines and steered somewhat by southwesterly winds, the fire enters and crosses Pajarito Canyon and Twomile Canyon; by 1:00 a.m. on the third day, it burns up to the Pajarito Road control line just west of TA-66.

Although the control line would be expected to contain most fires, in this conservative accident scenario, an adverse meteorological situation exists where the wind picks up to 54 mph (24 meters per second), as it did in the Cerro Grande Fire, causing the fire to cross NM 501. On the LANL site, the fire is assumed to consume all combustible structures in its path that are evaluated to be at moderate or higher risk from wildfire under the LANL Building Appraisal Program. The fire also exposes the surface of contaminated earth that was previously protected by vegetation in the firing sites and canyons. This text separately discusses exposures from fire that burns the soil cover and suspends the underlying soil and exposures from burning structures. Exposures from the latter are calculated individually, enabling the assessment of fires of lesser extent than the site-wide fire.

This accident analysis does not consider offsite damage directly caused by the flames and smoke from LANL fires or the direct effects of the fire on the townsite. It is recognized that continuous fuel joins the National Forest and the residential areas, and that fires in the canyons at LANL also could propagate into the townsite.

D.5.3.2 Dispersion Meteorology, Thermal Energy, and Soil Resuspension Following the Fire

The wildfire radiological release exposure analysis was performed using MACCS2, the same computer code used on the other radiological release scenarios described in this appendix. That code was exercised stochastically, sampling each hour of an annual meteorological dataset and using that hour as the initial conditions for plume transport. The reported doses are the mean values of each of these trials. Because the wildfire is more likely to occur in April through June, the meteorology for those months was extracted from a recent 4-year dataset (2000 through 2003) of hourly meteorology to form a synthetic annual dataset consisting of April through June 2000 through 2003 (with meteorology from July 1, 2003, filling out the final day of the set). The MACCS2 wildfire analysis used this synthetic meteorology dataset.

The wildfire chemical release exposure analysis was performed using ALOHA, the same code used in the other chemical release scenarios described in this appendix. That code uses deterministic meteorology such as a single wind speed and stability class to calculate downwind dispersion. Table D-2 shows that stability class D and 7.8 mph (3.5 meters per second) wind speed represent median dispersion conditions for the synthetic dataset used in the MACCS2 analysis.

Exposures were calculated at 330 feet (100 meters) and the nearest public access to a release. These exposure locations are consistent with those chosen for the other scenarios included in this appendix. In the event of a wildfire scenario such as that considered here, the location of the public and onsite personnel such as firefighters might not correspond to those associated with the other scenarios considered. Chemical exposure at an additional location, 3,300 feet (1,000 meters) from each release, is therefore included. Radiological exposures at additional downwind distances, including 3,300 feet (1,000 meters), from each release are given in Section D.7.

The thermal energy of the contaminant plumes is a strong determinant of plume exposure; the greater the energy, the greater the plume buoyancy and the less impact on receptors along the ground. As described in the previous subsection, the daytime plume rise could reach up to 25,000 feet (7,600 meters), while the nighttime plume rise is conservatively assumed to be only 2,000 feet (600 meters). MACCS2 was run with the meteorological dataset described above and a plume heat input of 20 megawatts was found to result in a plume rise of approximately 2,000 feet (600 meters). That heat input was used for the fire phase of all radiological releases. ALOHA conservatively assumes no heat input; therefore, no buoyant rise due to heat is included in the chemical exposure calculations.

Following the fire release, a 24-hour wind suspension release period was assumed. It is thought that after the fire has passed, mitigation may not occur for this time period. An airborne release rate, 4×10^{-6} (4 parts per million) per hour, was chosen to reflect that contamination remaining at the source will likely be covered with fire debris.

D.5.3.3 Exposures from Burning Vegetation and Suspended Soil

Suspended ash from vegetation and suspended soil contributed about 7 percent (approximately 50 person-rem) of the total population radiological dose reported in the *1999 SWEIS*. Concentrations of radionuclides in vegetation at LANL were largely unavailable when that SWEIS analysis was performed in the late 1990s. Given plant and soil uptake coefficients for some radionuclides in the published literature, concentrations of radionuclides in plants were largely based on concentrations in soil. Since the *1999 SWEIS*, data have been compiled on concentrations of radionuclides in vegetation at LANL. Comparing data used in the *1999 SWEIS* with more recent data on concentrations of radionuclides in plants, perspective can be gained on the change in vegetation as a radiation source term for wildfire. One concentration used in the *1999 SWEIS* was 320 micrograms (μg) uranium per gram (g) of dry vegetation, which was taken from a sample collected in 1975 where uranium concentrations in surface soils were 20 to 3,500 times background levels. This compares to maximum concentrations of 0.65 μg/g-dry in the bark of shrubs that were rooted in transuranic waste material; 0.073[4] μg/g-dry in understory vegetation collected at one of 12 LANL Environmental Surveillance Program onsite locations in 1998; 0.066[3] μg/g-dry in overstory vegetation at one of the same 12 locations in the same year; 0.05[3] μg/g-dry in pine needles from TA-16 in 1985; 0.72[5] μg/g-dry in overstory vegetation at the Dual-Axis Radiographic Hydrodynamic Test (DARHT) Facility in 2002; and 1.5[6] μg/g-dry in pinyon tree bark at a firing site in 2001 (Gonzales et al. 2004). Other than total uranium, the *1999 SWEIS* does not identify the concentrations used in source term calculations. Ignoring the other radionuclides and based on comparison of the total uranium concentration assumed in the earlier SWEIS with other, more recent data on concentrations of total uranium in plants, the source term from vegetation used in the *1999 SWEIS* is still bounding of any that would be calculated using more recent concentration data. The predicted MEI dose from vegetation and soil in a site-wide fire remains less than 1 millirem. Although the Cerro Grande Fire burned only about 7,500 acres (3,040 hectares) of forest within LANL, the estimated inhalation dose to an MEI based on measurements of 0.2 millirem (LANL 2001) supports the hypothesis that vegetation and soil contribute very little radiation dose.

The effect of the existing radioisotope concentration in the soil in and around LANL on the calculated radiological consequences of a postulated wildfire was evaluated. Environmental

---

[4] *Computed using an ash/dry weight ratio of 0.1 from Fresquez and Ferenbaugh (1999).*

[5] *Computed using an ash/dry weight ratio of 0.08 from Fresquez and Ferenbaugh (1999).*

[6] *Computed by converting radioisotopic data to uranium mass data and using an ash/dry weight ratio of 0.029 for bark from Gonzales et al. (2004).*

surveillance data from the top 2 inches of soil measured in the 2001 through 2004 time period were used. These measurements were made for the following radioisotopes: tritium, strontium-90, cesium-137, uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239, plutonium-240, and americium-241. Assuming a wildfire occurred that burned the same 43,000 acres (17,400 hectares) as the Cerro Grande Fire and that the mean radioisotope soil concentration was the same as the mean measured for the onsite LANL areas, the airborne respirable source term was calculated to be approximately 10 curies of tritium and 0.2 curies of uranium and transuranic radioisotopes. The total released respirable source term for all of the buildings affected by the postulated wildfire accident in Appendix D is approximately 1.45×10^6 curies of tritium and 100 curies of uranium and transuranic radioisotopes. Therefore, the conservatively calculated soil-released source term from a Cerro Grande-size fire is a factor of about 500 to 100,000 times smaller than the source term released by buildings affected by the fire. This much smaller magnitude of source term, coupled with the fact that it would be released over a very large distributed area, shows that the radiological effect of releasing radioisotopes in the soil during a large fire at LANL is insignificant compared to the radiological consequence of the fire's effects on certain buildings at LANL.

D.5.4 Methodology

D.5.4.1 Evaluation of Building Fires

The *1999 SWEIS* analyzed potential individual and population radiological and chemical exposures from buildings burning as a result of wildfire initiation. Each building was first screened for its vulnerability to wildfire. Building vulnerabilities were updated in 2004 for this analysis. The building vulnerabilities at TA-54 and the Weapons Engineering Tritium Facility in TA-16 were validated in the field to incorporate the many fuel load mitigations that occurred in the recent past. Those buildings that were evaluated as vulnerable were then screened for chemical and radiological inventories that were updated in May 2004.

Criteria and Process for Determining Building Vulnerability to Wildfire

The evaluation of vulnerability to wildfire is based on building construction, materials and exposure, slope, and the quantity and structure of external fuel as described below. The total wild land fire vulnerability of over 500 buildings is frequently updated by the LANL Fire Protection Group. The vulnerability is the product of the structure hazard times the sum of the fuel hazard and slope hazard, as defined below.

Structure Hazard

The structure hazard rating considers the combustibility of the exterior structure:

- Underground – 0
- Noncombustible exterior (windowless) – 1
- Noncombustible exterior (window exposures) – 2
- Combustible exterior – 3

Fuel Hazard

The fuel hazard is the product of two components, fuel loading and distance factor. Fuel loading is taken as 0 for short grass and asphalt; for other conditions, it is determined by the fuel model type, as described in *Aids to Determining Fuel Models For Estimating Fire Behavior* (Anderson 1982).

The distance factor (DF) expresses the distance of the fuel from the structure:

- DF–0 – distance is greater than 4 times the height of the fuel.
- DF–1 – distance is greater than 2 times the height of the fuel.
- DF–2 – distance is the height of the fuel.
- DF–3 – distance is less than one-half the height of the fuel.

Slope Hazard

Exposing slopes are rated as follows:

Slope Hazard	***Slope***
5	Mild (0 to 5 percent)
10	Moderate (6 to 20 percent)
15	Steep (21 to 40 percent)
20	Extreme (41 percent and greater)

The total vulnerability is then calculated as the product of the structure hazard times the sum of the fuel hazard and slope hazard. This number is converted to a word description as follows:

Numerical Rating	***Vulnerability***
0 to 5	None
6 to 49	Very Low
50 to 79	Low
80 to 149	Moderate
150 to 259	High
260 and above	Extreme

Note that this method does not estimate the probability that a wildfire will consume the building. Rather, it quantifies the relative vulnerability of a building to wildfire on the basis of the conditions immediately surrounding a building and the construction type for each building. **Table D–21** lists the buildings that have a moderate or higher risk. Other buildings have no significant amounts of MAR and were not evaluated for this accident analysis.

Since 1999 when the results of this vulnerability assessment were first reported, a reduction in vulnerability from 51 to 21 buildings classified as moderate or higher has been achieved, largely as the result of clearing or thinning the forested areas (defensible space) immediately adjacent to the buildings. More importantly, buildings of concern that are located in the wildfire high-risk area, such as Weapons Engineering Tritium Facility in TA-16, have been downgraded to low vulnerability.

The *1999 SWEIS* analysis assumed that buildings with a moderate, high, or extreme wildfire vulnerability burned and released their entire content of radiological inventories. A reduction in the wildfire vulnerability of key buildings through reductions in the fuel load around the buildings could substantially reduce the likelihood of the buildings igniting and could also reduce the release of radiological materials by lowering the intensity of the fire. Since 1999, however, the wildfire vulnerabilities of two formerly high risk waste storage domes (Buildings 229 and 230) at TA-54 have been lowered to moderate. The Weapons Engineering Tritium Facility wildfire vulnerability has been reduced from moderate to very low.

Table D–21 Evaluation of Vulnerability of Los Alamos National Laboratory Buildings to Wildfire

Technical Area	*Building*	*Wildfire Risk*	*Nuclear Facility*	*Hazards*	*Construction Type* [a]
03	0016 and 0208	Moderate	No	Radiological	2
03	0040	Moderate	No	Radiological	2
03	0066 and 0451	High	No	Radiological, Chemical	2
03	0169	Moderate	No	Radiological	
08	0023	High	No	Radiological	2
21	0155	Moderate	No	Radiological	
21	0209	Extreme	No	Radiological, Chemical	2
36	0001	Moderate	No	Radiological	
41	0001 and 0004	Moderate	No	Radiological	
43	0001	Extreme	No	Radiological, Chemical	2
54	0033	High	Yes	Radiological	
54	0048	Moderate	Yes	Radiological	
54	0049	Moderate	Yes	Radiological	
54	0153	Moderate	Yes	Radiological	3
54	0215	Moderate	No	Radiological	3
54	0224	Moderate	No	Radiological	3
54	0226	Moderate	Yes	Radiological	3
54	0229	Moderate	Yes	Radiological	3
54	0230	Moderate	Yes	Radiological	3
54	0231	Moderate	Yes	Radiological	3
54	0232	Moderate	Yes	Radiological	3

[a] Construction type: 2 = noncombustible exterior with window exposures, 3 = combustible exterior.

Current sources of information were consulted for data on the relative quantities of radiological material at risk of potentially being impacted and released in an accident situation. By definition, only Hazard Category 1 and 2 nuclear facilities can have offsite impacts from their radiological material inventories when considered on an individual basis. However, because site-wide accidents can involve releases from several facilities, Hazard Category 3 nuclear facilities and nonnuclear (radiological) facilities were also considered. Nuclear facilities that are rated extreme, high, or moderate vulnerability in Table D–21 and were within relatively high wildfire risk areas were selected for quantitative contaminant risk assessment. Three additional facilities in TA-16, Building 205 (WETF), Building 411 (Device Assembly), and TA-50-69 (WCRR Transportainer) were also included because, even though individual facilities may have low vulnerabilities, TA-16 is among the TAs at greatest risk from a wildfire and TA-50 has an outside vulnerable transportainer.

D.5.4.2 Public Exposure from Burning Buildings

The individual exposures assume no sheltering inside buildings or vehicles and no protective actions taken by the individual at those locations. Although Area G is not in the direct path of the fire, it borders a canyon and could be susceptible to a canyon fire even in the absence of a site-wide fire. The results of the *1999 SWEIS* found that Area G contributed 75 percent of the total population exposure. Therefore, it was again included in the wildfire analysis.

D.5.4.3 Effects of Hazardous Chemicals

Vulnerable buildings and the outdoors in the fire path were screened for their chemical inventories and updated for 2004. Six of the 12 facilities included in the *1999 SWEIS* eliminated their chemical inventories. Only TA-3-66 increased its inventory from 11.5 pounds (5.2 kilograms) of hydrogen cyanide to 13.5 pounds (6.1 kilograms) of hydrogen cyanide. For fire-vulnerable facilities, the earthquake scenario chemical results are acceptable representations of the site-wide fire because the entire inventories are assumed to be released.

D.5.4.4 Onsite Workers and Offsite Population

In the event of a wildfire approaching from the south, LANL would begin evacuation of the southern area of LANL as soon as it was determined that the fire posed a threat and would proceed north with the evacuation. Personnel deemed essential to shutdown operations would remain until such actions were completed. Some emergency response personnel and security personnel would remain at all times in some areas. In 1999, there were 10,200 LANL employees (including contractors), of which approximately 4,000 lived outside of Los Alamos County and 6,200 within Los Alamos County. The *1999 SWEIS* reported that the Main Hill Road (New Mexico 502) could evacuate 800 cars per hour, and the combination of the East Jemez and Pajarito Roads could evacuate another 800 cars per hour.

During the Cerro Grande Fire, it was decided that, if the fire jumped Los Alamos Canyon, the entire town of Los Alamos would have to be evacuated. Shortly after noon on May 10, the fire jumped Los Alamos Canyon, which was the last natural barrier before the townsite. At 1:15 p.m., county emergency personnel broadcast the directive for all of the people of Los Alamos to evacuate their homes immediately. Although some projections indicated that it would take up to 12 hours to get all 12,000 Los Alamos residents down the mountain using the single road (New Mexico 502), the entire town evacuated in 4 hours, directed by the small police force. On May 10, 2000, the fire burned over 15,500 acres (62,700 hectares) in 9 hours—in other words, the Cerro Grande Fire consumed in 9 hours the same amount of acreage that the 1996 Dome Fire consumed in 9 days. By late afternoon, the wind-whipped 200-foot (60-meter) wall of flame reached the western edge of town; by 6:00 p.m., the first reports of loss of houses came in to the Emergency Operations Center.

In the aftermath of the Cerro Grande Fire, there was considerable interest in describing the potential radiological impacts of the fire itself and of the radionuclides of LANL origin that may have dispersed during the fire. Radiological dose calculations were performed based on air monitoring data collected by the LANL AIRNET system during the Cerro Grande Fire. The dose calculated was the committed effective dose equivalent, which is the dose received during the 50 years following the inhalation of radionuclides. The inhalation dose to an MEI in Los Alamos was 0.2 millirem (LANL 2001). A dose of similar magnitude was conservatively calculated for Rio Grande water use, chiefly from assumed irrigation during peak runoff from a storm event (LANL 2002). These doses can be considered in the context of exposure to naturally occurring radioactivity in the LANL area of at least 400 millirem per year (see Chapter 4, Section 4.6.1.2, of this SWEIS).

All workers in threatened areas would be evacuated prior to arrival of the fire front. Aircraft crashes with fatalities have occurred while dropping slurry on wildfires. Firefighters on the ground are at risk if they enter an area without an alternate escape route, and there have been historical fatalities from such events. However, because life safety is given priority over protection of property at LANL, it is not likely that there would be worker fatalities. Some firefighters and other emergency personnel could have significant, but transient, effects from smoke inhalation.

D.5.5 Wildfire Accident Impacts Analysis

There are no significant impact differences among the wildfire risks for the three alternatives, No Action, Reduced Operations, and Expanded Operations. Therefore, only a single set of wildfire impacts are presented. The radiological impact section, D.5.5.2, includes a discussion of the alternatives.

D.5.5.1 Facility Source Terms

A wildfire accident scenario was postulated for evaluation of impacts to onsite workers and the offsite population. Details of this scenario are given in the preceding sections. **Table D–22** shows the LANL buildings that could be affected by the wildfire, inventory of hazardous radiological materials, source term factors, and estimated source terms.

D.5.5.2 Radiological Impacts

The estimated consequences for the public and workers as a result of a wildfire are shown in **Tables D–23** and **D–24** for each listed facility. The values shown assume that a wildfire has occurred and therefore do no reflect any credit for the probability of a wildfire occurrence. The estimated annual risks for the wildfire scenario are shown in **Table D–25**. The values shown in that table take credit for the probability of a wildfire's occurrence. The risk from a wildfire is dominated by the TA-54 waste storage domes. The second largest risk (although significantly less than the domes) is also from TA-54, DVRS.

Table D–22 Wildfire Accident Source Term Data

Accident Phase	*Nuclide*	*MAR (curies or grams)*	*MAR*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fractions*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (in units of MAR)*	*Release Duration (Delta T) (minutes)*	*Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Identifier: WILDF01. **Facility Name:** Sigma Complex (TA-3-66/451).													
Fire	Depleted Uranium	grams	11,500,000	1	0.04	0.17	–	1	78,200	60	20	0	No
Suspension			11,000,000	1	–	1	0.00004	1	10,600	1,440	0.1	0	No
Identifier: WILDF02. **Facility Name:** Weapons Engineering Tritium Facility (TA-16-205).													
Fire	Tritiated Water	grams	1,000	1	1	1	–	1	1,000	60	20	0	No
Identifier: WILDF05. **Facility Name:** Radiochemistry Facility (TA-48-1).													
Fire	Plutonium Equivalent	grams	7.56	1	0.001	1	–	1	0.00756	60	20	0	No
Suspension			7.55	1	–	1	0.00004	1	0.00725	1,440	0.1	0	No
Identifier: DOMEP-Population. **Facility Name:** Waste Storage Domes (TA-54) (all domes).													
Combustibles													
Burning Expelled in Lid Loss	Plutonium Equivalent	curies	37,100	0.333	0.001	1	–	1	124	60	–	0	No
Burning (in drums)			37,100	0.667	0.0005	1	–	1	12.4	60	–	0	No
Noncombustibles													
Burning	Plutonium Equivalent	curies	101,000	1	0.006	0.01	–	1	6.08	60	–	0	No
Total													
Burning (high-heat)	Plutonium Equivalent	curies	–	–	–	–	–	–	71.1	60	20	0	No
Burning (smoldering)			–	–	–	–	–	–	71.1	60	0.1	0	No
Impact Release			138,000	0.33	0.001	1	–	1	45.7	1	0	0	No
Suspension			138,000	0.33	–	1	0.000004	1	43.6	1,440	0	0	No
Identifier: DOMEM-MEI. **Facility Name:** Waste Storage Domes (TA-54) (six western domes).													
Combustibles													
Burning Expelled in Lid Loss	Plutonium Equivalent	curies	22,800	0.333	0.01	1	–	1	76.1	60	–	0	No
Burning (in drums)			22,800	0.667	0.0005	1	–	1	7.61	60	–	0	No

Accident Phase	Nuclide	MAR (curies or grams)	MAR	Damage Ratio	Airborne Release Fraction	Respirable Fractions	Airborne Release Rate (per hour)	Leak Path Factor	Source Term (in units of MAR)	Release Duration (Delta T) (minutes)	Heat (mega-watts)	Release Height (meters)	Wake?
Noncombustibles													
Burning	Plutonium Equivalent	curies	63,500	1	0.006	0.01	–	1	3.81	60	–	0	No
Total													
Burning (high-heat)	Plutonium Equivalent	curies	–	–	–	–	–	–	43.8	60	20	0	No
Burning (smoldering)			–	–	–	–	–	–	43.8	60	0.1	0	No
Impact Release			86,300	0.33	0.001	1	–	1	28.5	1	0	0	No
Suspension			86,100	0.33	–	1	0.00004	1	27.2	1,440	0	0	No
Identifier: WILDF08. **Facility Name:** Device Assembly (TA-16-411).													
Fire	Uranium-238	grams	4,000	1	0.0005	1	–	1	2.00	60	20	0	No
Suspension			4,000	1	–	1	0.00004	1	3.84	1,440	0.1	0	No
Identifier: WDVRS06. **Facility Name:** Decontamination and Volume Reduction System (TA-54-412).													
Ejected (from drums)	Plutonium Equivalent	curies	1,100	0.333	0.001	0.3	–	1	0.11	60	20	0	No
Burning (ejected material)			366	1	0.01	1	–	1	3.66	60	20	0	No
Burning (in drums)			1,100	0.667	0.0005	1	–	1	0.367	60	20	0	No
Total													
Fire	Plutonium Equivalent	curies	–	–	–	–	–	–	4.14	60	20	0	No
Suspension			363	1	–	1	0.00004	1	0.348	1,440	0.1	0	No
Identifier: WILDF10. **New Name:** Radiography (TA-8-23).													
Fire	Plutonium Equivalent	curies	–	–	–	–	–	–	0.0026	60	20	0	No
Identifier: WCRWILD. **New Name:** Waste Characterization, Reduction, and Repackaging Facility (TA-50-69).													
Fire	Plutonium Equivalent	curies	1,800	1	0.01	1	–	1	18	60	1	0	No
Resuspension			1,782	1	–	1	0.00004	1	1.711	1,440	0	0	No

MAR = material at risk, TA = technical area, MEI = maximally exposed individual.

Table D–23 Radiological Accident Offsite Population Consequences for a Wildfire Accident

Facility Impacted by Wildfire	*MEI*		*Population to 50 Miles (80 kilometers)*	
	Dose (rem) [a]	*LCF* [b]	*Dose (person-rem)*	*LCF* [c, d]
Sigma Complex (TA-3-66/451)	0.0039	2.3×10^{-6}	4.8	0 (0.0029)
Weapons Engineering Tritium Facility (TA-16-205)	0.061	0.000036	110	0 (0.067)
Radiochemistry Facility (TA-48-1)	0.0011	6.4×10^{-7}	0.44	0 (0.00026)
Waste Storage Domes (TA-54)	1,900	2.3 [e]	91,000	55 (54.8)
Device Assembly (TA-16-411)	1.6×10^{-6}	8.9×10^{-10}	0.00017	0 (1×10^{-7})
Decontamination and Volume Reduction System (TA-54-412)	4.9	0.003	1,200	0 (0.7)
Radiography (TA-8-23)	0.00033	2×10^{-7}	0.56	0 (0.00034)
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	27	0.032	6,900	4 (4.2)

MEI = maximally exposed individual, LCF = latent cancer fatality, TA = technical area.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Increased number of LCFs for the offsite population, assuming the accident occurs; value in parentheses is the calculated result.

[d] Offsite population size is approximately 297,030 for TA-03-66/451; 404,913 for TA-16-205 and TA-16-411; 299,508 for TA-48-1; 343,069 for Domes and TA-54-412; and 349,780 for TA-8-23.

[e] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.0 as shown. This means that it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For calculation purposes, the actual value is shown here; however, since the exposed recipient is an individual, the equivalent tables in Chapter 5, Section 5.12 show an LCF of 1.0.

Table D–24 Radiological Accident Onsite Worker Consequences for a Wildfire Accident

Accident	*Noninvolved Worker at 110 Yards (100 meters)*	
	Dose (rem) [a]	*LCF* [b]
Sigma Complex (TA-3-66/451)	0.076	0.000046
Weapons Engineering Tritium Facility (TA-16-205)	0.33	0.0002
Radiochemistry Facility (TA-48-1)	0.016	9.3×10^{-6}
Waste Storage Domes (TA-54)	8,700	11 [c]
Device Assembly (TA-16-411)	0.000017	1×10^{-8}
Decontamination and Volume Reduction System (TA-54-412)	16	0.0098
Radiography (TA-8-23)	0.0019	1.2×10^{-6}
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	440	0.53

LCF = latent cancer fatality, TA = technical area.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.0 as shown. This means it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For calculation purposes, the actual value is shown here; however, because the exposed recipient is an individual, the equivalent tables in Chapter 5, Section 5.12 show an LCF of 1.0.

Table D–25 Radiological Accident Offsite Population and Worker Risks for a Wildfire Accident

Accident	Frequency (per year)	Onsite Worker	Offsite Population	
		Noninvolved Worker at 110 Yards (100 meters) [a]	MEI [a]	Population to 50 Miles (80 kilometers) [b, c]
Sigma Complex (TA-3-66/451)	0.05	2.3×10^{-6}	1.2×10^{-7}	0.00014
Weapons Engineering Tritium Facility (TA-16-205)	0.05	1×10^{-5}	1.8×10^{-6}	0.0034
Radiochemistry Facility (TA-48-1)	0.05	4.7×10^{-7}	3.2×10^{-8}	1.3×10^{-5}
Waste Storage Domes (TA-54)	0.05	0.05	0.05	2.7
Device Assembly (TA-16-411)	0.05	5.2×10^{-10}	4.4×10^{-11}	5.2×10^{-9}
Decontamination and Volume Reduction System (TA-54-412)	0.05	0.00049	0.00015	0.035
Radiography (TA-8-23)	0.05	5.7×10^{-8}	1×10^{-8}	1.7×10^{-5}
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	0.01 [d]	0.0053	0.00032	0.042

MEI = maximally exposed individual, TA = technical area.

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs for the offsite population per year; value in parentheses is the calculated result.

[c] Offsite population size is approximately 297,030 for TA-03-66/451; 404,913 for TA-16-205 and TA-16-411; 299,508 for TA-48-1; 343,069 for Domes and TA-54-412; and 349,780 for TA-8-23.

[d] Assumes additional failures for source term used in calculation.

Inventories at TA-48-1 (Radiochemistry Laboratory) and TA-8-23 (Radiography Facility) were assumed to be at the building limits. Radiological source material would be at these locations only during material testing. The impacts and risks presented in this section conservatively assume the presence of this material at the allowable limits.

The health risks in Table D–25 (and consequences in D–23 and D–24) are given for individual building releases; it is unlikely that a wildfire would impact all of these facilities. For the case of a wildfire impacting all of these facilities, the overall health risk to the general population, dominated by waste storage domes and DVRS releases, is 2.7 per year, equivalent to a mean of 14 cancer fatalities in the entire general population (out to 50 miles [80 kilometers] from each release) every 5 years of LANL operation. This risk can be contrasted with the more than 2,500 normally occurring cancer fatalities to this same population over 5 years (see Chapter 4, Section 4.6.1). Risks to individuals, on the other hand, cannot be summed, because a single individual would not be exposed to multiple facility releases. Instead, only releases upwind from the individual's location would result in exposure. The maximum health risk to the MEI from any facility's release for exposure at the nearest Pueblo boundary to the waste storage domes is 0.05 probability (5 chances in 100) of an LCF per year of operation. It is highly unlikely that an individual would remain at this location during the entire wildfire event; therefore, this risk is thought to be very conservative.

Each of the building releases (except for the WCRR) was ascribed the same frequency of occurrence, 0.05. Section D.5.2 describes the potential of a wildfire affecting the various onsite technical areas. TA-54 is considered at a low (but not 0) risk of wildfire impacts relative to the other areas.

Tables D–23, D–24 and D–25 are strictly applicable to the No Action Alternative. The Reduced Action Alternative would include a 20 percent reduction in high explosives processing and a likely reduction in risk from the Device Assembly Building. However, the consequences and risk from that facility are insignificant; a decrease in its risk would not affect the overall wildfire risk.

Replacement risks from wildfire accident impacts would result from implementation of the Expanded Operations Alternative. Transuranic waste storage at DVRS and waste storage domes in TA-54 would be moved to a new facility, the TRU Waste Facility, located in TA-50 or TA-63. The impacts of this new facility would be less than those of the existing facilities because of the new location and because less material would be stored and the rest would be moved offsite. The entries in Tables D–23 through D–25 reflect present DVRS and waste storage domes operations because they would be active for part of the time period of interest and because their accident impacts bound the impacts of the new facility. TRU Waste Facility accident impacts are described in Appendix H.

D.5.5.3 Chemical

The chemicals of concern at LANL facilities under the No Action, Reduced Operations, and Expanded Operations Alternatives are shown in **Table D–26**. These have been selected from a complete set of chemicals used onsite based on their quantities, chemical properties, and human health effects. The table shows the ERPG concentration values for which excess concentrations could have harmful health or life-threatening implications, as defined in the table's footnote.

Table D–26 Chemical Accident Impacts under Wildfire Conditions

			ERPG-2 [a]		*ERPG-3* [b]		*Concentration*		
Chemical	*Frequency (per year)*	*Quantity Released*	*Value (ppm)*	*Distance to Value (meters)*	*Value (ppm)*	*Distance to Value (meters)*	*Noninvolved Worker at 100 Meters (ppm)*	*MEI at 1,000 Meters (ppm)*	*Nearest Site Boundary (12 m TA-43) (924 m TA-3)*
Formaldehyde at TA-43-1	0.05	3.7 gallons (14.1 liters)	10	141	25	89	20	0.23	Exceeds ERPG-3
Hydrogen Cyanide at TA-3-66	0.05	13.5 pounds (6 kilograms)	10	108	25	68	12	0.14	0.16 ppm

ERPG = Emergency Response Planning Guideline, ppm = parts per million, MEI = maximally exposed individual, m = meters, TA = technical area.

[a] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their ability to take protective action (DOE 2004a).

[b] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2004a).

Note: To convert meters to yards, multiply by 1.0936.

Table D–26 shows the concentrations of each chemical, if it were released, at specified distances. For a formaldehyde release, the distances to the ERPG-2 and ERPG-3 levels of concern are 154 yards (141 meters) and 97 yards (89 meters), respectively. For a hydrogen cyanide release, the distances to the ERPG-2 and ERPG-3 levels of concern are 118 yards (108 meters) and 74 yards (68 meters), respectively. Depending on the magnitude of the release and plume characteristics, workers and members of the public could be exposed to harmful concentrations of each chemical within these distances from the point of release. Table D–26 also shows the estimated concentration of each chemical at a distance of about 110 yards (100 meters) from the release point where a representative noninvolved worker is assumed to be located. The seriousness of the exposure of a noninvolved worker at this distance is determined by comparing the concentration at that distance to the ERPG-2 and ERPG-3 levels of concern. In addition, Table D–26 also shows the estimated concentration at the nearest site boundary located at a distance from the release point of 13 yards (12 meters) and 1,010 yards (924 meters) for TA-43 and TA-3, respectively. The accident evaluation assumes a hypothetical member of the public is located at this site boundary. As in the case of the noninvolved worker, the seriousness of the exposure of a member of the public located at the nearest site boundary is determined by comparing the concentration at that distance to the ERPG-2 and ERPG-3 levels of concern. If concentration levels exceeding ERPG-2 and ERPG-3 were estimated to occur at distances beyond the site boundary, a segment of the offsite population could be exposed to harmful levels of the released chemical. The direction traveled by the chemical plume would depend upon meteorological conditions at the time of the accident.

D.5.5.4 Additional Environmental Effects

Firewater. Firewater (water used in fighting building fires) at nonnuclear facilities is captured by outdoor containment and temporary dikes erected for firefighting. Firewater at nuclear facilities is captured by the drain system and is sent to TA-50 for processing. Conceivably, some radioactively contaminated water from the nuclear facilities could reach the outdoor environment, but would be of such small volume that it would not leave the building environs. If there were a fire at TA-50, most of the firewater would wash off down the roads. If fire trucks had to spray water, some of that water would go to the adjacent canyon. Resultant contaminated soil would be eroded, pending the return of vegetative cover. As with other contaminated soils, the environmental and human health threat from the new contamination would be assessed and mitigated.

Loss of Protective Cover. The charred plant remains following a severe wildfire are the only immediate visual consequences. The consequences of a wildfire are diverse, continuous through time and space, and frequently include significant changes in geomorphology and biological communities and processes. LANL is perhaps unique in potential consequences because, in addition to a rich presence of biological communities and cultural remains and resources, the site contains soil-bearing legacy contaminants from historical operations.

Trees, grass and herbaceous cover, and forest litter are important features in stabilizing soils by: (1) reducing the velocity and impact of falling raindrops; (2) reducing the velocity of runoff, thereby encouraging infiltration and discouraging its transport by water and wind; and (3) reducing runoff quantities. Loss of vegetative cover will create a setting that can have pronounced effects on flow dynamics, soil erosion, and sediment deposition. These changes also can have significant ramifications for plant and animal communities and cultural resources.

Runoff, Soil Erosion, and Sedimentation. It has been well established through studies around the world that runoff and sediment yields can dramatically increase following wildfires. Accompanying these physical changes are changes in the composition or quality of runoff water. At Los Alamos, these changes may be severe due to the steepness of the burned terrain and the high severity of the burn, creating water-shedding hydrophobic soils. These higher runoff quantities would be discharged into the Rio Grande where they would contribute to the overall floodwater storage of Cochiti Lake. Modified hydrologic conditions likely would cause some watercourses that have only rarely had sufficient flows to reach the Rio Grande to increase their frequency of discharge.

Commensurate with higher runoff quantities and velocities would be an increase in soil erosion. Sheetflow would begin transporting soil suspended by rainfall droplet impact. Both rills and gullies would form on sloping ground surfaces with the first significant rainfall event. Higher channel volumes and velocities would promote both downward and lateral scouring of channels in the steeper portions of the watershed and sediment deposition in the lower portions. (These conditions depend on the quantity of runoff discharges and resulting changes in channel hydraulics.) Headcutting would increase throughout the channel system. Delta formation would increase at the confluence of watercourses and tributaries to the Rio Grande, and added sediment would contribute to the depletion of the sediment reserve of Cochiti Lake.

The gradual establishment of ground cover would correspondingly retard soil erosion and a more stabilized hydrologic regime would return. Extensive rehabilitation after the Cerro Grande Fire minimized runoff, soil erosion, and sedimentation. To understand the possible impact to downstream water bodies, runoff events after the fire were monitored and sampled by LANL staff. An extensive network of automated samplers and stream gages served as the cornerstone of this effort. Due to a general lack of intense “monsoon-like” rainfall during the summer of 2000, severe runoff passing across LANL was limited to a single event on June 28. Record peak discharges were recorded for several drainages leading onto LANL during that event. For example, in Water Canyon above NM 501, the estimated peak of 840 cubic feet (23,800 liters) per second dwarfed the prefire maximum of 0.3 cubic feet (8.5 liters) per second. Concentrations of most metals dissolved in stormwater remain below the Environmental Protection Agency or New Mexico drinking water standards; however, a few (for example, aluminum, barium, manganese) are above the standards in many samples. Dissolved manganese concentrations increased by about 50 times above prefire levels; barium by 20. Concentrations of radionuclides dissolved in stormwater are slightly elevated or comparable to prefire levels.

Effects on Legacy Contaminants. Active erosion processes have moved some contaminants bound to sediment from the watershed into the Rio Grande, mainly as suspended sediment and bedload sediment. Conversely, many of the remaining legacy contaminants at LANL are present in situ, have not been transported far from their origin, or remain onsite. Water transport is a major mechanism for the transport of contaminants in both the dissolved and suspended sediment phases. Because vegetation acts to hold soil and reduce erosion, its loss, however short-term, may significantly increase the potential for erosion and the transportation of contaminants. Some watercourses only rarely have had sufficient flow to reach the Rio Grande; as a result, they have become “discharge sinks” for some contaminants. Increases in runoff amounts and frequency would increase the potential to remove and transport contaminants from LANL’s ground surface, subsurface, and stream channels into the Rio Grande and downstream to Cochiti Lake.

Effects on Biological Systems. Although fire is a natural part of biological systems, anthropogenic influences such as grazing, logging, and fire suppression have produced conditions that have had pronounced adverse effects on forest ecosystems. Natural high-frequency, low-intensity fire regimes have been replaced with low-frequency, high-intensity fires that consume a higher percentage of vegetation. As reflected in other nearby areas that have experienced severe wildfires in the past (for example, the Water Canyon, La Mesa, Dome, and Oso Complex Fires), a wildfire at LANL would result in a period of disequilibrium with a reversion to early seral development and a corresponding change in animal use (Allen 1996). Fire debris, fallen trees, and needle cast would gradually begin to check erosion and develop soil conditions that would promote the establishment of grasses and herbaceous vegetation that would further reduce erosion. This gradual re-establishment of ground cover would begin the dynamic process of seral progression toward a wooded or forested plant community.

A loss of forest or woodland habitat would result in a temporary loss of habitat for a broad spectrum of animals. As vegetation is re-established, an altered community of animal species would follow, its composition changing with the evolution of the plant community. The pattern of burned vegetation would play a significant role in renewed wildlife use. Early plant communities of grasses and herbaceous growth can have a high biomass and species diversity, as exhibited by nearby areas affected by recent wildfires. This expansion of grass and herbaceous growth could provide additional forage for the large elk population in and around LANL and contribute to existing management concerns.

Impacts on threatened and endangered species (such as the Mexican spotted owl, *Strix occidentalis lucida*) would depend on several factors such as the burn pattern, the time of day the burn occurs, the type of fire, topography, and whether nesting is occurring. Threatened and endangered species have remained in or returned to nearby areas that have experienced recent burns. Individual response to fire also would vary. Perhaps the most significant impact to threatened and endangered species precipitated by a wildfire would be the general disturbance caused by the firefighting effort itself (firefighting crews, aircraft, and vehicular traffic).

As discussed previously, increased runoff discharges would result in a commensurate increase in channel scouring, enlargement, and headcutting. This process and any accompanying sedimentation would have the potential to degrade or remove the limited riparian vegetation on LANL. Wetlands associated with watercourses also would be affected, and perhaps several would be removed for a period because of changes in channel morphology. The degradation of riparian vegetation and wetlands would result in a reduction or loss of habitat for a variety of invertebrates, small and large mammals, amphibians, reptiles, and diverse bird species.

Effects on Cultural Resources. LANL is located in a region of abundant and culturally significant prehistoric and historic resources, including traditional cultural properties. As stated, fire is a normal feature of the landscape that has played and continues to play a natural role in the culture of regional communities. Because of anthropogenic influences, the character of recent fires will be different from historic fires and will affect resources differently. The need to protect property and life from wildfire will necessitate measures that can affect cultural resources.

As discussed, high intensity fires can burn an appreciable amount of ground cover and accelerate erosion. Surface erosion can physically disturb surface features and confuse and distort the contextual integrity of the site. More pronounced erosion in the form of gully formation and lateral bank cutting can permanently remove site features. A high-intensity fire also can scorch organic remains located near the ground surface, decreasing their interpretive value. Historical structures can suffer through direct incineration. Damage to these resources also can occur as a consequence of vehicular traffic and mechanical disturbance (from bulldozers and fire trucks for example) and other soil-disturbing activities connected with the firefighting effort.

Traditional cultural properties present on and adjacent to LANL include ceremonial and archaeological sites, natural features, ethnobotanical sites, artisan material sites, and subsistence features. These resources are an integral part of the landscape and almost certainly are and have been affected by natural fires. Because of the altered character of fires, these resources may be affected to a greater extent. Depending on the characteristics of these properties, they could be either permanently or temporarily affected by a wildfire and its subsequent ancillary effects, such as erosion.

D.5.6 Mitigation

After the *1999 SWEIS* was completed, actions were initiated to reduce the wildfire risk to major facilities with significant radiological inventories. Specifically, considerations were given to reducing the risk to low or very low for the following facilities:

- TA-3 Building 66/451, Sigma Complex
- TA-54 (Area G) Pads
- TA-21 Building 209, Tritium Science and Fabrication Facility
- TA-21 Building 155, Tritium Storage and Test Assembly
- TA-16 Building 205/205A, Weapons Engineering Tritium Facility

The planning, evaluation, and beginning of fire mitigation (described in DOE 1999b) that was completed prior to the Cerro Grande Fire undoubtedly contributed to minimizing the impacts to facilities and, possibly, human lives. There is an ongoing, interagency, collaborative program to reduce the threat of catastrophic wildfire occurring at LANL and the townsite by thinning and removing vegetation at the perimeter and in the surrounding Santa Fe National Forest and Bandelier National Monument. This will reduce the frequency and intensity of wildfires that could impact LANL.

D.6 Involved Worker Hazards

Facility workers generally fall into two groups: noninvolved worker and involved worker. Noninvolved workers have assigned duties on the site at a location beyond the general vicinity of an accident. The impacts of postulated accidents to the noninvolved worker are evaluated in this appendix and are presented in Chapter 5. Involved workers actively participate or support operation of the facilities directly involved with the Proposed Action. The analysis to determine involved worker risks are usually presented qualitatively due to the dynamics and potential worker proximity. In general, involved workers are protected by design safety features and operational procedures. Involved workers who are at the greatest risk of serious injury or fatality are those that are located in the immediate vicinity of where an accident takes place. Factors such as the time of the accident, an individual’s distance from the accident, and the effects of shielding mechanisms are highly variable. Given the severity of some accidents, involved worker fatalities could be expected. The number of fatalities could range from zero to the maximum number of workers involved within the facility. For example, an accident involving spills and exposure to contamination could lead to an individual receiving a measurable dose, but not lead to a fatality; however, in a severe earthquake accident, involved workers are likely to be hurt and killed by the collapse of a building before they can be evacuated.

No attempt is made in this SWEIS to evaluate the involved worker effects of such accidents for the following reasons. There is limited information on the circumstances that cause such accidents and the hazardous conditions they involve are difficult to characterize in a manner that would differentiate between alternatives and provide meaningful information for decisionmakers. Modeling methods such as those used for radiological and chemical accidents exposures are not accurate at close distances. Quantitative or qualitative representation of such accidents would introduce data uncertainties that would complicate the decisionmaking process.

The analyses performed by the authors of this SWEIS carefully considered the provisions of NEPA, Council on Environmental Quality Guidelines, and DOE NEPA Guidelines regarding acceptable procedures for estimating the environmental impacts of events where the available data are both uncertain and limited. These provisions and guidelines permit the use of the "sliding scale approach" (DOE 2002b), which allows the analyst to consider specified key factors for determining an appropriate level of technical analysis for estimating impacts.

According to DOE NEPA Guidelines, the key factors to consider in applying a sliding scale approach to accident analyses include:

- Probability that accidents will occur;
- Severity of the potential accident consequences;
- Context of the Proposed Action and alternatives;
- Degree of uncertainty regarding the analyses (for example, whether sufficient engineering design information is available to support detailed analysis); and
- Level of technical controversy regarding the potential impacts.

More recent DOE guidance was also used for the preparation of this SWEIS (DOE 2004e).

D.7 Maximally Exposed Individual-Type Doses versus Distance

Sections D.3, D.4, and D.5 describe various facility and site-wide accident scenarios and the estimated exposures to the accident releases, were such accidents to occur. Exposure to radiological releases is described by dose, measured in rem, to an individual. Exposure to a population is generalized by summing the dose to each individual of that population; the population dose is thus measured in person-rem.

Exposures of the hypothetical noninvolved worker and MEI have been given in the previous sections. These are conservative representations of the exposure to any single individual from the plume that could emanate as a result of an accident. They are mean values, and thus include components of exposure to all of the meteorological conditions that could be experienced throughout the year. A number of assumptions are employed in the calculation of these exposures to individuals (see Table D–2) which result in conservatively large doses.

Foremost, is the assumption that the individual is always downwind of the plume. That is, the direction from the release to the individual is not taken into account (although the distance is); such a dose is sometimes called a sector independent representation of the exposure to the individual. In reality, were there to be an accident resulting in a release, the probability of the plume blowing toward a particular individual would be small. A second conservative assumption is that the individual lies directly in the path of the plume centerline, meaning the portion of the plume in which the release concentration is greatest. Again, even if the wind were blowing from the release in the general direction of the individual, the probability that the individual would be exposed directly to the plume centerline is small. Other conservative assumptions governing the calculation of exposure to the individual include his remaining at the nearest site boundary to the release (MEI) or 100 meters downwind from the release (noninvolved worker) for the duration of the event; no protection (the individual is assumed to remain outside directly in the path of the plume); no deposition (thereby maximizing the inhalable plume concentration), no plume meander (the individual is assumed to be exposed to the plume centerline for the entire event); and use of an annual Meteorology (MET) dataset (2003), which maximizes downwind plume concentrations.

The downwind location of the noninvolved worker, 100 meters from the hypothesized release, does not vary among scenarios. The downwind location at which each MEI exposure is calculated (at the nearest site boundary to a hypothesized release) is specific to each scenario and release location. Although the scenarios and exposure locations correspond to the actions analyzed in this SWEIS, MEI-type doses at other locations could be of present or future interest. An example could be associated with the site-wide wildfire event. In a wildfire event, the locations of the public and onsite personnel such as firefighters may not correspond to those associated with the other accident scenarios. Another example could be interest in the MEI dose at an onsite, publicly accessible location such as a road. These data would also be useful if NNSA were considering changing public accessibility to portions of the site or if the site boundaries were to change.

Table D–27 gives the MEI-type doses at various downwind distances for the accident scenarios considered in this SWEIS. The scenarios are grouped by their section in this and other appendices. Some of the action-specific scenarios (for example, the MDA G explosion scenario) are reported both in this appendix and in the appendix discussing the action.

Table D–27 Maximally Exposed Individual-Type Doses versus Downwind Distance by Accident Scenario

Accident Scenario	*Identifier*	*MEI Location (downwind distance, in meters)*	*MEI Dose (rem)*	*Noninvolved Worker Dose (rem) at 100 Meters Downwind*	*Dose (rem) at Downwind Distance (in meters) of:*						
					250	*500*	*750*	*1,000*	*1,500*	*2,000*	*3,000*
Facility Accidents (Section D.3)											
RANT Lightning Strike Area Fire (TA-54-38)	RANTLIT	Pueblo Boundary (402)	410	1,900	730	310	180	120	69	45	24
WETF Fire (TA-16-205)	WETFF	W. Jemez Rd (393)	5.9	8.9	7.3	5.1	3.7	2.8	1.7	1.1	0.63
WCRR Lightning Strike Fire (TA-50-69)	WCRLITN	Trailer Park (1161)	46	1,100	360	150	84	56	32	20	11
Waste Storage Dome Fire (TA-54)	DOMEF	Pueblo Boundary (267)	420	2,000	460	160	84	54	29	18	9.3
Onsite Transuranic Waste Accident (TA-54)	DOMET	Pueblo Boundary (267)	190	760	200	87	52	36	21	14	8
Plutonium Facility Materials Staging Area Fire (TA-55-4)	PF4MFIR	Royal Crest Trailer Park (1016)	73	1,600	400	170	110	74	44	28	15
DVRS Operational Spill (TA-54)	DVRS01	Site Boundary (227)	20	51	17	6.8	3.8	2.5	1.4	0.88	0.46
DVRS Building Fire and Spill Due to Forklift Collision (TA-54)	DVRS05	Site Boundary (227)	320	890	290	110	64	43	24	16	8.4
SHEBA Hydrogen Detonation	SHEBA	Pueblo Boundary (976)	0.88	15	4.4	1.9	1.2	0.85	0.52	0.36	0.21
CMR HEPA Filter Fire (TA-3-29)	CMR02	Town Site Boundary (924)	0.77	5.4	2.7	1.5	0.97	0.71	0.45	0.3	0.18
Fire Impacting Sealed Sources, CMR, Wing 9 (TA-3-29)	SEAL2CF	Town Site Boundary (924)	0.099	1.2 [a]	0.28	0.13	0.11	0.096	0.08	0.065	0.044
Explosion in a Pit at MDA G	MDAGEXP	Pueblo Boundary (355)	55	410	96	33	17	11	6	3.7	1.9
Site Wide Seismic Event (Section D.4)											
TA-3-29 (CMR) Seismic 1 & 2	CMR08	Town Site Boundary (924)	62	2,000	480	160	86	55	30	18	9.1
TA-16-205 (WETF) Seismic 2	SIT02	W. Jemez Rd (393)	17	150	35	12	6	4	2.2	1.3	0.66
TA-18-168 (SHEBA) Seismic 2	SIT08	Pueblo Boundary (976)	0.03	1.1	0.25	0.085	0.045	0.029	0.016	0.0098	0.005

Accident Scenario	*Identifier*	*MEI Location (downwind distance, in meters)*	*MEI Dose (rem)*	*Noninvolved Worker Dose (rem) at 100 Meters Downwind*	*Dose (rem) at Downwind Distance (in meters) of:*						
					250	*500*	*750*	*1,000*	*1,500*	*2,000*	*3,000*
TA-21-155 (TSTA) Seismic 1 & 2	SIT09	New Mexico 502 (357)	0.0015	0.011	0.0026	0.00088	0.00046	0.0003	0.00016	0.000095	0.000048
TA-21-209 (TSFF) Seismic 1 & 2	SIT10	New Mexico 502 (363)	0.013	0.097	0.023	0.0077	0.0041	0.0026	0.0014	0.00084	0.00042
TA-50-1 (RLWTF) Seismic 1 & 2	SIT11	Royal Crest Trailer Park (1082)	3.02	120	29	9.9	5.3	3.4	1.8	1.1	0.57
TA-50-69 (WCRR) Seismic 2 and Fire	WCRSEIS	Royal Crest Trailer Park (1161)	43	1,100	290	120	75	52	31	20	11
TA-54-38 (RANT) Seismic 1 & 2	SIT14	Pueblo Boundary (402)	64	580	140	46	25	16	8.6	5.3	2.7
TA-55-4 (Plutonium Facility) Seismic 2 and Fire	PF4SEIS	Royal Crest Trailer Park (1016)	150	2,700	760	340	210	150	88	57	31
TA-55-185 (Storage Shed) Seismic 1 & 2	SIT16	Royal Crest Trailer Park (1068)	6	240	57	19	10	6.6	3.6	2.1	1.1
TA-55-355 (SST Facility) Seismic 2	SIT19	Royal Crest Trailer Park (1048)	3.9	130	33	12	6.3	4.1	2.2	1.3	0.67
DVRS (PC-2 Seismic) Seismic 1	DVRS08	Site Boundary NNE (227)	2.8	10	2.4	0.82	0.44	0.28	0.15	0.096	0.05
DVRS (PC-3 Seismic) Seismic 2	DVRS12	Site Boundary NNE (227)	34	120	29	10	5.4	3.5	1.9	1.2	0.61
TA-54 Waste Storage Domes Seismic 2	DOMEM	Pueblo Boundary (267)	460	2,200	510	170	92	59	32	20	10
Site Wide Wildfire Event (Section D.5)											
TA-03-66/451 (Sigma Complex)	WILDF01	Town Site Boundary (924)	0.0039	0.076	0.02	0.0083	0.005	0.0036	0.0025	0.0022	0.002
TA-16-205 (WETF)	WILDF02	W. Jemez Rd (393)	0.061	0.33	0.1	0.05	0.035	0.034	0.04	0.048	0.054
TA-48-1 (Radiochemistry Lab)	WILDF05	Royal Crest Trailer Park (677)	0.0011	0.016	0.0041	0.0016	0.00094	0.00064	0.00038	0.00025	0.00015
TA-54 (Waste Storage Domes)	DOMEM	Pueblo Boundary (267)	1,900	8,700	2,100	760	420	280	160	100	56

Accident Scenario	Identifier	MEI Location (downwind distance, in meters)	MEI Dose (rem)	Noninvolved Worker Dose (rem) at 100 Meters Downwind	Dose (rem) at Downwind Distance (in meters) of:						
					250	500	750	1,000	1,500	2,000	3,000
TA-16-411 (Device Assembly)	WILDF08	Site Boundary South of Facility (576)	1.5×10^{-6}	0.000017	4.5×10^{-6}	1.8×10^{-6}	1.1×10^{-6}	7.1×10^{-7}	4.1×10^{-7}	2.7×10^{-7}	1.6×10^{-7}
TA-54 (DVRS)	WDVRS06	NNE of facility (227)	4.9	16	4.4	1.8	1.1	0.86	0.72	0.75	0.77
TA-8-23 (Radiography)	WILDF10	WSW Boundary (412)	0.00033	0.0019	0.00059	0.00029	0.0002	0.00019	0.00023	0.00028	0.00031
TA-50-69 (WCRR)	WCRWILD	Trailer Park (1161)	27	440	110	51	38	30	21	16	9.6
Radiological Sciences Institute Accidents (Section G.3)											
Hot Cell Fire Involving Plutonium-238 in General Purpose Heat Source Modules	MRSC11	Royal Crest Trailer Park (941)	6.3	33	17	9.4	7.1	6.1	5.1	4.2	3.1
Seismic Induced Building Collapse and Fire Involving Plutonium-238 in General Purpose Heat Source Modules	MRSC16	Royal Crest Trailer Park (941)	30	150	79	44	33	29	24	20	14
Seismic Induced Building Collapse with No Fire Involving Plutonium-238 in General Purpose Heat Source Modules	MRSC15	Royal Crest Trailer Park (941)	19	170	82	41	26	18	11	6.9	3.7
Spill of Plutonium-238 Residue from 2-Liter Bottles Outside of Hot Cell	MRSC13	Royal Crest Trailer Park (941)	0.0066	0.045	0.024	0.013	0.0085	0.0062	0.0039	0.0025	0.0014
Hot Cell Plutonium-238 Spill with No Confinement	MRSC14	Royal Crest Trailer Park (941)	2.1	14	7.6	4.1	2.7	2	1.2	0.81	0.45
Main Vault Fire	MRSC17	Royal Crest Trailer Park (941)	13	66	34	19	14	12	10	8.6	6.2

Accident Scenario	Identifier	MEI Location (downwind distance, in meters)	MEI Dose (rem)	Noninvolved Worker Dose (rem) at 100 Meters Downwind	Dose (rem) at Downwind Distance (in meters) of:						
					250	500	750	1,000	1,500	2,000	3,000
RH-Transuranic Waste Management Facilities Accidents (Section H.3)											
Explosion at MDA G RH-Transuranic Shaft 205	GS205EX	Pueblo Boundary (355)	0.31	2.3	0.54	0.18	0.097	0.063	0.034	0.021	0.011
Explosion at MDA G RH-Transuranic Shaft 206	GS206EX	Pueblo Boundary (355)	0.74	5.4	1.3	0.44	0.23	0.15	0.081	0.05	0.026
Seismic Event Affecting RH-Transuranic in the TRU Waste Facility	DOMSEIS	Trailer Park (1,437)	0.037	2.3	0.56	0.19	0.1	0.065	0.035	0.021	0.011
Seismic Event Affecting Transuranic Relocated from Area G Waste Domes to the TRU Waste Facility	DOMES	Trailer Park (1,437m)	29	1,800	430	150	78	50	27	16	8.3
Material Disposal Area Remediation Accidents (Section I.5)											
Explosion at MDA G	MDAGEXP	Pueblo Boundary (355)	55	410	96	33	17	11	6	3.7	1.9
Fire at MDA B [b]	MDABFIR	Nearest Boundary (45)	7.1	1.6	0.37	0.13	0.066	0.043	0.023	0.014	0.0068
Sealed Sources Accidents (Section J.3)											
Aircraft Crash at TA-54, Area G	SEAL1CM	Site Boundary NNE (267)	0.084	0.52 [a]	0.091	0.04	0.024	0.017	0.01	0.0066	0.0036
Severe Earthquake and Fire at CMR	SEAL2CF	Town Site Boundary (924)	0.099	1.2 [a]	0.28	0.13	0.11	0.096	0.08	0.065	0.044
Severe Earthquake and Fire at TA-48	SEAL3CF	Royal Crest Trailer Park (941)	0.098	1.2 [a]	0.28	0.13	0.11	0.096	0.08	0.065	0.044

MEI = maximally exposed individual, RANT = Radioassay and Nondestructive Testing, TA = technical area, WETF = Weapons Engineering Tritium Facility, WCRR = Waste Characterization, Reduction, and Repackaging, DVRS = Decontamination and Volume Reduction System; SHEBA = Solution High-Energy Burst Assembly, CMR = Chemistry and Metallurgy Research Building, HEPA = high-efficiency particulate air (filter), MDA = material disposal area, TSTA = tritium systems test assembly, TSFF = Tritium Science and Fabrication Facility, RLWTF = Radioactive Liquid Waste Treatment Facility, WCRR = Waste Characterization, Reduction, and Repackaging Facility, SST = safe secure trailer, RH = remote-handled, PC = performance category.

[a] Doses include component from external exposure to source.

[b] See Appendix I, Section I.5.12.1 regarding a revision to the material at risk; conclusions of this analysis remain valid.

Note: To convert meters to yards, multiply by 1.0936.

D.8 MACCS2 Code Description

The MACCS2 computer code is used to estimate the radiological doses and health effects that could result from postulated accidental releases of radioactive materials to the atmosphere. The specification of the release characteristics, designated a “source term,” can consist of up to four Gaussian plumes that are often referred to simply as “plumes.”

The radioactive materials released are modeled as being dispersed in the atmosphere while being transported by the prevailing wind. During transport, particulate material can be modeled as being deposited on the ground. The extent of this deposition can depend on precipitation. If contamination levels exceed a user-specified criterion, mitigating actions can be triggered to limit radiation exposures.

Atmospheric conditions during an accident scenario’s release and subsequent plume transport are taken from the annual sequential hourly meteorological data file. Scenario initiation is assumed to be equally likely during any hour contained in the file’s dataset, with plume transport governed by the succeeding hours. The model was applied by calculating the exposure to each receptor for accident initiation during each hour of the 8,760 hour-dataset. The mean results of these samples, which include contributions from all meteorological conditions, are presented in this SWEIS.

Two aspects of the code’s structure are important to understanding its calculations: (1) the calculations are divided into modules and phases; and (2) the region surrounding the facility is divided into a polar-coordinate grid. These concepts are described in the following sections.

MACCS2 is divided into three primary modules: ATMOS, EARLY, and CHRONC. Three phases are defined as the emergency, intermediate, and long-term phases. The relationship among the code’s three modules and the three phases of exposure are summarized below.

The ATMOS module performs all of the calculations pertaining to atmospheric transport, dispersion, and deposition, as well as the radioactive decay that occurs before release and while the material is in the atmosphere. It uses a Gaussian plume model with Pasquill-Gifford dispersion parameters. The phenomena treated include building wake effects, buoyant plume rise, plume dispersion during transport, wet and dry deposition, and radioactive decay and in-growth. The results of the calculations are stored for subsequent use by EARLY and CHRONC. In addition to the air and ground concentrations, ATMOS stores information on wind direction, arrival and departure times, and plume dimensions.

It is noted that dispersion calculations such as used in MACCS2 are generally recognized to be less applicable within 100 meters of a release than they are to further downwind distances (DOE 2004d); such close-in results frequently over-predict the atmospheric concentrations because they do not account for the initial momentum or size of the release, or for the impacts of structures and other obstacles on plume dispersion. Although most of the results presented in this SWEIS are for distances at least 100 meters downwind from a hypothesized release source, two (MEIs from the Chemistry and Metallurgy Research Building and MDA B) are not. The latter results should be interpreted in the above light.

The EARLY module models the period immediately following a radioactive release. This period is commonly referred to as the emergency phase. The emergency phase begins at each successive downwind distance point when the first plume of the release arrives. The duration of the emergency phase is specified by the user, and it can range between 1 and 7 days. The exposure pathways considered during this period are direct external exposure to radioactive material in the plume (cloud shine); exposure from inhalation of radionuclides in the cloud (cloud inhalation); exposure to radioactive material deposited on the ground (ground shine); inhalation of resuspended material (resuspension inhalation); and skin dose from material deposited on the skin. Mitigating actions that can be specified for the emergency phase include evacuation, sheltering, and dose-dependent relocation.

The CHRONC module performs all of the calculations pertaining to the intermediate and long-term phases. CHRONC calculates the individual health effects that result from both direct exposures to contaminated ground and from inhalation of resuspended materials.

The intermediate phase begins at each successive downwind distance point upon conclusion of the emergency phase. The user can configure the calculations with an intermediate phase that has a duration as short as 0 or as long as 1 year. In the zero-duration case, there is essentially no intermediate phase, and a long-term phase begins immediately upon conclusion of the emergency phase.

Intermediate models are implemented on the assumption that the radioactive plume has passed and the only exposure sources (ground shine and resuspension inhalation) are from ground-deposited material.

The mitigating action model for the intermediate phase is very simple. If the intermediate phase dose criterion is satisfied, the resident population is assumed to be present and subject to radiation exposure from ground shine and resuspension for the entire intermediate phase. If the intermediate phase exposure exceeds the dose criterion, then the population is assumed to be relocated to uncontaminated areas for the entire intermediate phase.

The long-term phase begins at each successive downwind distance point upon conclusion of the intermediate phase. The exposure pathways considered during this period are ground shine and resuspension inhalation.

The exposure pathways considered are those resulting from ground-deposited material. A number of protective measures, such as decontamination, temporary interdiction, and condemnation, can be modeled in the long-term phase to reduce doses to user-specified levels. The decisions on mitigating action in the long-term phase are based on two sets of independent actions: (1) decisions related to whether land at a specific location and time is suitable for human habitation (habitability), and (2) decisions related to whether land at a specific location and time is suitable for agricultural production (ability to farm). For the current SWEIS, no mitigation or special protective measures were assumed for the exposure calculations.

All of the calculations of MACCS2 are stored based on a polar-coordinate spatial grid with a treatment that differs somewhat between calculations of the emergency phase and calculations of the intermediate and long-term phases. The region potentially affected by a release is represented with a (r, Θ) grid system centered on the location of the release. Downwind distance is represented by the radius "r". The angle, "Θ", is the angular offset from the north, going clockwise.

The user specifies the number of radial divisions as well as their endpoint distances. The angular divisions used to define the spatial grid are fixed in the code. They correspond to the 16 points of the compass, each being 22.5 degrees wide. The 16 points of the compass are used in the United States to express wind direction. The compass sectors are referred to as the coarse grid.

Since emergency phase calculations use dose-response models for early fatalities and early injuries that can be highly nonlinear, these calculations are performed on a finer grid basis than the calculations of the intermediate and long-term phases. For this reason, the calculations of the emergency phase are performed with the 16 compass sectors divided into 3, 5, or 7 equal, angular subdivisions. The subdivided compass sectors are referred to as the fine grid.

Lifetime doses are the conventional measure of detriment used for radiological protection. These are 50-year dose commitments to a weighted sum of tissue doses defined by the International Commission on Radiological Protection and referred to as "effective dose equivalent." Lifetime doses may be used to calculate the stochastic health effect risk resulting from exposure to radiation. The calculated lifetime dose was used in cancer risk calculations.

D.9 ALOHA Code Description

Consequences of accidental chemical releases were determined using the ALOHA computer code (EPA 2004). ALOHA is an EPA and National Oceanic and Atmospheric Administration-sponsored computer code that has been widely used in support of chemical accident responses and also in support of safety and NEPA documentation for DOE facilities. The ALOHA code is a deterministic representation of atmospheric releases of toxic and hazardous chemicals. The code can predict the rate at which chemical vapors escape (such as from puddles or leaking tanks) into the atmosphere; a specified direct release rate is also an option.

ALOHA performs calculations for chemical source terms and resulting downwind concentrations. Source term calculations determine the rate at which the chemical material is released to the atmosphere, release duration, and the physical form of the chemical upon release. The term "cloud" is used in this document to refer to the volume that encompasses the chemical emission. In general, the released chemical may be a gas, a vapor, or an aerosol. The aerosol release may consist of either solid (fume, dust) or liquid (fog, mist, spray) particles that are suspended in a gas or vapor medium. Liquid particles are also referred to as droplets. The analyst specifies the chemical and then characterizes the initial boundary conditions of the chemical with respect to the environment through the source configuration input. The ALOHA code allows the source to be defined in one of four ways (direct source, puddle source, tank source, or pipe source) to model various accident scenarios. The source configuration input is used either to specify the chemical source term or to provide ALOHA with the necessary information and data to calculate transient chemical release rates and the physical state of the chemical upon release. ALOHA calculates time-dependent release rates for up to 150 time steps (DOE 2004c). ALOHA then averages the release rates from the individual time steps over one to five averaging periods, each lasting at least 1 minute (DOE 2004c). The five averaging periods are selected to most accurately portray the peak emissions. The five average release rates are inputs to the ALOHA algorithms for atmospheric transport and dispersion (DOE 2004c). ALOHA tracks the evolution of the mean concentration field of the five separate chemical clouds and calculates the concentration at a given time and location through superimposition. ALOHA limits releases to 1 hour.

Evolution of the mean concentration field of the chemical cloud is calculated through algorithms that model the turbulent flow phenomena of the atmosphere. The prevailing wind flows and associated atmospheric turbulence serve to transport, disperse, and dilute the chemical cloud that initially forms at the source. For an instantaneous or short-duration release, the chemical cloud will travel downwind as a puff. In contrast, a plume will form for a sustained or continuous release.

The wind velocity is a vector term defined by a direction and magnitude (wind speed). The wind direction and speed determine where the puff or plume will go and how long it will take to reach a given downwind location. For sustained or continuous releases, the wind speed has the additional effect of stretching out the plume and establishing its initial dilution. It also determines the relative proportion of ambient air that initially mixes with the chemical source emission. Atmospheric turbulence causes the puff or plume to mix increasingly with ambient air and grow (disperse) in the lateral and vertical direction as it travels downwind. Longitudinal expansion also occurs for a puff. These dispersion effects further enhance the dilution of the puff or plume. The two sources of atmospheric turbulence are mechanical turbulence and buoyant turbulence. Mechanical turbulence is generated from shear forces that result when adjacent parcels of air move at different velocities (either at different speeds or directions). Fixed objects on the ground, such as trees or buildings, increase the ground roughness and enhance mechanical turbulence in proportion to their size. Buoyant turbulence arises from vertical convection and is greatly enhanced by the formation of thermal updrafts that are generated from solar heating of the ground.

The ALOHA code considers two classes of atmospheric transport and dispersion based upon the assumed interaction of the released cloud with the atmospheric wind flow.

- For airborne releases in which the initial chemical cloud density is less than or equal to that of the ambient air, ALOHA treats the released chemical as neutrally buoyant. A neutrally buoyant chemical cloud that is released to the atmosphere does not alter the atmospheric wind flow; therefore, the term "passive" is used to describe the phenomenological characteristics associated with its atmospheric transport and dispersion. As a passive contaminant, the released chemical follows the bulk movements and behavior of the atmospheric wind flow.

- Conversely, if the density of the initial chemical cloud is greater than that of the ambient air, then the possibility exists for either a neutrally buoyant or a dense-gas type of atmospheric transport and dispersion. In dense-gas atmospheric transport and dispersion, the dense-gas cloud resists the influences of the hydraulic pressure field associated with the atmospheric wind, and the cloud alters the atmospheric wind field in its vicinity. Dense-gas releases can occur with gases that have a density greater than air due either to a high molecular weight or to being sufficiently cooled. A chemical cloud with sufficient

> aerosol content can also result in a bulk cloud density that is greater than that of the ambient air. Dense-gas releases undergo what has been described in the literature as "gravitational slumping."

Gravitational slumping is characterized by significantly greater lateral (crosswind) spreading and reduced vertical spreading compared to the spreading that occurs with a neutrally buoyant release.

In addition to the source term and downwind concentration calculations, ALOHA allows specification of concentration limits for the purpose of consequence assessment (such as assessment of human health risks from contaminant plume exposure). ALOHA refers to these concentration limits as level-of-concern (LOC) concentrations. Safety analysis work uses the ERPGs and TEELs for assessing human health effects for both facility workers and the public. While ERPGs and TEELs are not explicitly part of the ALOHA chemical database, ALOHA allows the user to input any value, including an ERPG or TEEL value, as the LOC concentration. The LOC value is superimposed on the ALOHA-generated plot of downwind concentration as a function of time to facilitate comparison. In addition, ALOHA will generate a footprint that shows the area (in terms of longitudinal and lateral boundaries) where the ground-level concentration reached or exceeded the LOC during puff or plume passage (the footprint is most useful for emergency response applications).

The ALOHA code uses a constant set of meteorological conditions (such as wind speed and stability class) to determine the downwind atmospheric concentrations. The sequential meteorological datasets used for the radiological accident analyses were reordered from high to low dispersion by applying a Gaussian dispersion model (such as that used by ALOHA) to a representative downwind distance. The median set of hourly conditions for each site (that is, mean wind speed and mean stability) was used for the analysis; this is roughly equivalent to the conditions corresponding to the mean radiological dose estimates of MACCS2.

ALOHA contains physical and toxicological properties for the chemical spills included in the SWEIS and for approximately 1,000 additional chemicals. The physical properties were used to determine which of the dispersion models and accompanying parameters were applied. The toxicological properties were used to determine the levels of concern. Atmospheric concentrations at which health effects are of concern (that is ERPG-2 or ERPG-3 levels) are used to define the footprint of concern. Because the meteorological conditions specified do not account for wind direction (that is, it is not known *a priori* in which direction the wind would be blowing in the event of an accident), the areas of concern can be defined by a circle of radius equivalent to the downwind distance at which the concentration decreases to levels less than the level of concern. In addition, the concentration at 328 feet (100 meters) (potential exposure to a noninvolved worker) and at the nearest public access, typically the site boundary distance, (exposure to the MEI) are calculated and presented.

D.10 References

AIHA (American Industrial Hygiene Association), 2005, Current AIHA ERPGs (2005), Available at http://www.aiha.org/Committees/documents/erpglevels.pdf, January.

Allen, C., 1996, "Elk Response to the La Mesa Fire and Current Status in The Jemez Mountains", *Fire Effects in Southwestern Forests; Proceedings of the Second La Mesa Fire Symposium, Los Alamos, New Mexico, March 29-31, 1994*, USDA Forest Service, General Technical Report RM-GTR-286, September.

Anderson, H., 1982, *Aids to Determining Fuel Models for Estimating Fire Behavior*, General Technical Report INT-122, U.S. Department of Agriculture, Forest Service, April.

Balice, R. G., B. P. Oswald, and C. Martin, 1999, *Fuels Inventories in the Los Alamos National Laboratory Region: 1997*, LA-13572-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, March.

Balice, R. G., J. D. Miller, B. P. Oswald, C. Edminster, and S. R. Yool, 2000, *Forest Surveys and Wildfire Assessment in the Los Alamos Region; 1998-1999*, LA-13714-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, June.

Balice, R. G., K. Bennett and M. A. Wright, 2004, *Burn Severities, Fire Intensities, and Impacts to Major Vegetation Types from the Cerro Grande Fire*, LA-14159, Los Alamos National Laboratory, Los Alamos, New Mexico, December.

Balice, R. G., S. D. Johnson, K. D. Bennett, T. L. Graves, S. Donald, P. D. Braxton, and W. F. Chiu, 2005, *A Preliminary Probabilistic Wildfire Risk Model for Los Alamos National Laboratory*, LA-UR-05-3321, Los Alamos National Laboratory, Los Alamos, New Mexico, June.

Breshears, D. D., N. S. Cobb, P. M. Rich, K. P. Price, C. D. Allen, R. G. Balice, W. H. Romme, J. H. Kastens, M. L. Floyd, J. Belnap, J. J. Anderson, O. B. Myers, and C. W. Meyer, 2005, "Regional vegetation die-off in response to global-change-type drought," LA-UR-05-4982, *Proceedings of the National Academy of Sciences* (102:15144-15148), October 18.

Chanin, D. and M. L. Young, 1997, *Code Manual for MACCS2: Volume 1, User's Guide*, NUREG/CR-6613, SAND97-0594, Vol. 1, Washington, DC, March.

Cuesta, I., 2004, *Design-Load Basis for LANL Structures, Systems, and Components*, LA-14165, Los Alamos National Laboratory, Los Alamos, New Mexico, September.

DOE (U.S. Department of Energy), 1992, *DOE Standard, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, DOE-STD-1027-92, Washington, DC, December.

DOE (U.S. Department of Energy), 1997, *Emergency Management Guide Volume II, Hazards Surveys and Hazards Assessments*, DOE G 151.1-1, Office of Emergency Management, Washington, DC, August 21.

DOE (U.S. Department of Energy), 1999a, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 1999b, *Mitigation Action Plan for the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, DOE/EIS-0238, Albuquerque Operations Offices, Albuquerque, New Mexico, October.

DOE (U.S. Department of Energy), 2000, *Special Environmental Analysis for the Department of Energy, National Nuclear Security Administration, Actions taken in Response to the Cerro Grande Fire at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/SEA-03, Los Alamos Area Office, Los Alamos, New Mexico, September.

DOE (U.S. Department of Energy), 2002a, *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory*, DOE/EIS-0319, Washington, DC, August.

DOE (U.S. Department of Energy), 2002b, *Recommendations for Analyzing Accidents under the National Environmental Policy Act*, Office of NEPA Policy and Compliance, Available at http://www.eh.doe.gov/nepa/tools/guidance/analyzingaccidentsjuly2002.pdf, July.

DOE (U.S. Department of Energy), 2003a, *Final Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0350, Los Alamos Site Office, Los Alamos, New Mexico, November.

DOE (U.S. Department of Energy), 2003b, *Safety Evaluation Report for TA-54 Area G Documented Safety Analysis*, National Nuclear Security Administration, Los Alamos Site Operations, Los Alamos, New Mexico, November 25.

DOE (U.S. Department of Energy), 2003c, *Estimating Radiation Risk from Total Effective Dose Equivalent (TEDE), ISCORS Technical Report No. 1*, DOE/EH-412/0015/0802 Rev. 1, Office of Environmental Policy and Guidance, Washington, DC, January.

DOE (U.S. Department of Energy), 2004a, *ERPGs and TEELs for Chemicals of Concern*: Rev. 20, DKC-04-0003, Available at http://www.eh.doe.gov/chem_safety/teel/TEELs_Rev20_Introduction.pdf and http://www.eh.doe.gov/chem_safety/teel/TEELs_Rev20_Table2.pdf, April.

DOE (U.S. Department of Energy), 2004b, *Safety Evaluation Report (SER), Basis for Interim Operation (BIO) and Technical Safety Requirements (TSRs) for the Decontamination and Volume Reduction (DVRS) Glovebox in Support of the Quick-to-WIPP Project*, Technical Area 54-412, ABD-WFM-009, Rev. 0, National Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, June 8.

DOE (U.S. Department of Energy), 2004c, *ALOHA Computer Code Application Guidance for Documented Safety Analysis*, DOE-EH-4.2.1.3-ALOHA Code Guidance, Office of Environment, Safety, and Health, Washington, DC, June.

DOE (U.S. Department of Energy), 2004d, *MACCS2 Computer Code Application Guidance for Documented Safety Analysis*, DOE-EH-4.2.1.4-MACCS2-Code Guidance, Office of Environment, Safety and Health, Washington, DC, June.

DOE (U.S. Department of Energy), 2004e, *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements,* Second Edition, Office of NEPA Policy and Compliance, December.

DOE (U.S. Department of Energy), 2005a, *Comprehensive Emergency Management System*, DOE Order 151.1C, Office of Emergency Operations, Available at http://www.directives.doe.gov/pdfs/doe/doetext/neword/ 151/01511c.pdf, November 2.

DOE (U.S. Department of Energy), 2005b, Revision 21 of AEGLs, ERPGs and TEELs for Chemicals of Concern, DKC-05-0002, Available at: http://www.eh.doe.gov/chem_safety// teel.html, November.

EPA, (U.S. Environmental Protection Agency), 1988, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report No. 11, EPA-520/1-88-020, Washington, DC, September.

EPA, (U.S. Environmental Protection Agency), 1993, *External Exposure to Radionuclides in Air, Water, and Soil, Exposure-to-Dose Coefficients for General Application, Based on the 1987 Federal Radiation Protection Guidance,* Federal Guidance Report No. 12, EPA-402-R-93-081, Washington, DC, September.

EPA (U.S. Environmental Protection Agency), 2004, *ALOHA – Areal Locations of Hazardous Atmospheres – User's Manual*, Chemical Emergency Preparedness and Prevention Office, Washington, DC, Available at http://www.epa.gov/ceppo/cameo/pubs/aloha.pdf, March.

EPA (U.S. Environmental Protection Agency), 2005, Radiation Risk Assessment Software: CAP88 PC, Version 3.0 User Guide, Radiation Protection Division, Available at http://www.epa.gov/radiation/assessment/CAP88/index.html.

Fresquez, P. R., and J. K. Ferenbaugh, 1999, *Moisture Conversion Ratios for the Foodstuffs and Biota Environmental Surveillance Programs at Los Alamos National Laboratory (Revision 1),* LA-UR-99-253, Los Alamos National Laboratory, Los Alamos, New Mexico, January.

Gonzales, G. J., A. F. Ladino, and P. J. Valerio, 2004, *Qualitative Assessment of Wildfire-Induced Radiological Risk at the Los Alamos National Laboratory,* LA-UR-03-7237, Los Alamos National Laboratory, Los Alamos, New Mexico, January.

Gonzales, G. J., C. M. Bare, P. J. Valerio, and S. F. Mee, 2004, *Radionuclide Activity Concentrations in Conifer Trees at the Los Alamos National Laboratory*, LA-UR-03-7237, Los Alamos National Laboratory, Los Alamos, New Mexico, April 16.

Holzworth, G. C., 1972, *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States,* PB-207 103, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, January.

LANL (Los Alamos National Laboratory), 2001, *Updated Calculation of the Inhalation Dose from the Cerro Grande Fire Based on Final Air Data*, LA-UR-01-1132, Los Alamos National Laboratory, Los Alamos, New Mexico, February.

LANL (Los Alamos National Laboratory), 2002, *Radiological and Nonradiological Effects after the Cerro Grande Fire*, LA-13914, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2004, *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement (DOE/EIS-0238)*, LA-UR-04-5631, Ecology Group, Risk Reduction and Environmental Stewardship, Los Alamos, New Mexico, August 17.

LANL (Los Alamos National Laboratory), 2005, *SWEIS Yearbook—2004, Comparison of 2004 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-05-6627, Ecology Group, Environmental Stewardship Division, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2006, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document*, Data Call Materials, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2007a, *Update of the Probabilistic Seismic Hazard Analysis and Development of Seismic Design Ground Motions at the Los Alamos National Laboratory*, LA-UR-07-3965, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 2007b, Letter to J. Vozella, National Nuclear Security Administration, from R. McQuinn, Nuclear High Hazards Operations, Justification for Continued Operation, LANL Site-Wide Nuclear and High Hazard Operations, Reference No. AD-NHHO:07-145, Los Alamos, New Mexico, June 22.

McHugh, C. W., T. E. Kolb and J. L. Wilson, 2003, “Bark Beetle Attacks on Ponderosa Pine Following Fire in Northern Arizona,” *Environmental Entomology*, 32(3): 510-522, June.

NNSA (National Nuclear Security Administration), 2007, Memorandum to R. McQuinn, Nuclear and High Hazards Operations, from D. Winchell, Los Alamos Site Office, Response to Justification for Continued Operations Related to Seismic Hazards Assessment, Los Alamos, New Mexico, July 31.

NRC (U.S. Nuclear Regulatory Commission), 2003, *SECPOP2000: Sector Population, Land Fraction, and Economic Estimation Program*, NUREG/CR-6525, Rev. 1, Washington, DC, August.

USDA (United States Department of Agriculture), 1998, Forest Service, *Farsite: Fire Area Simulator—Model Development and Evaluation*, Missoula, Montana, March.

USDA (United States Department of Agriculture) 2002, “Changes in Fire Hazard as a Result of the Cerro Grande Fire,” *Fire Management Today*, Volume 62, No. 1, Winter 2002, Forest Service, Washington, DC.

APPENDIX E

CURRENT UNDERSTANDING OF THE GROUNDWATER REGIME AT LOS ALAMOS NATIONAL LABORATORY

APPENDIX E
CURRENT UNDERSTANDING OF THE GROUNDWATER REGIME AT LOS ALAMOS NATIONAL LABORATORY

This appendix summarizes the current understanding of groundwater flow at Los Alamos National Laboratory (LANL) and the conceptual models that have been developed for the purpose of numerical modeling of groundwater flow and contaminant transport. This appendix presents the components by which researchers develop their concepts of the geohydrologic system at LANL.

E.1 Introduction

A comprehensive study of the geology, hydrologic processes, and site characteristics of an area must be understood to formulate a conceptual model of a groundwater flow system. Geologic information must be used in conjunction with the hydrologic data to define hydrostratigraphic units. A geologic unit can be used as a model layer or several units can be combined into model layers if their hydrologic characteristics are similar. Knowledge of the geology is required to define the areal extent of the units. Inferences about the flow system's hydraulic behavior and transport characteristics are drawn from information about geologic structures, lithologic properties, and groundwater geochemistry.

The setting occupied by LANL is geologically and hydrologically complex. Before recent drilling activities were implemented, conceptual models and numerical simulations of regional groundwater flow that had been developed were based on sparse data (Keating, Robinson, and Vesselinov 2005). The knowledge base regarding recharge, discharge, and how waterborne contaminants interact with and move through rock fractures and rock matrix in the vadose zone into perched water zones and the regional aquifer below LANL is growing. In 2005, the LANL contractor was regularly sampling 74 surface monitoring stations and 137 groundwater-monitoring locations based on agreements with the New Mexico Environment Department and the U.S. Environmental Protection Agency. These activities have resulted in modification of the conceptual models (Newman and Robinson 2005). As a result of further agreements, the LANL contractor will be expanding its data collection activities while conducting further analysis of existing data. This understanding of the hydrologic and chemical components at the site will aid in the development of sound conceptual models of flow and transport through the fractures and the matrix of the vadose zone into the saturated zone. It is anticipated that the new data, coupled with improvement in numerical flow and transport models and improved calculational techniques, will enable better prediction of flow and transport of groundwater in the LANL region and more accurately define the ultimate impacts on the regional groundwater resources below LANL.

This appendix provides a framework for understanding the geohydrology and the development of numerical models. In 2005, a series of reports of investigations in the *Vadose Zone Journal* developed conceptual models and discussed flow and transport through the vadose zone to perched groundwater bodies and the regional aquifer below LANL. Some of the reports from this series are discussed. The descriptions are brief and references are provided.

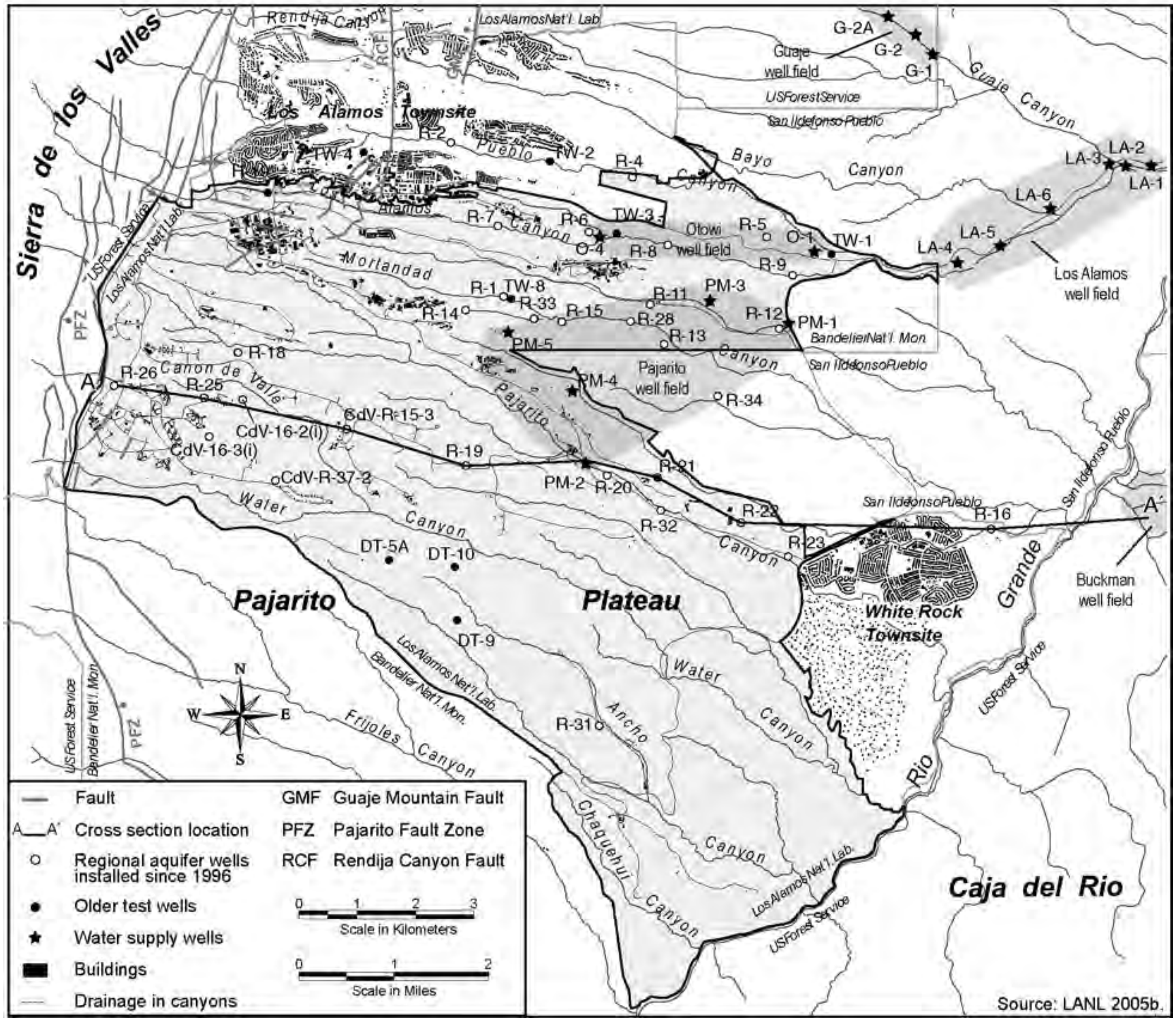
E.2 Regional Setting

LANL and the adjacent communities of Los Alamos and White Rock are located on the Pajarito Plateau (**Figure E–1** and Chapter 4, Figure 4–9). The plateau is an accumulation of east-sloping volcanic material that lies over the western part of the Española Basin and extends from the Sierra de los Valles on the eastern rim of the Jemez Mountains to White Rock Canyon and the Española Valley west of the Rio Grande. The plateau covers an area of about 240 square miles (620 square kilometers), of which about 90 square miles (230 square kilometers) is in the central part of the plateau and includes the area covered by LANL (Broxton and Vaniman 2005) (Figure E–1). The plateau is drained by easterly flowing ephemeral and intermittent streams that have formed deeply incised canyons separated by elongated mesas. The mesas range in elevation from west to east from 7,700 feet (2,350 meters) on the slopes of the Sierra de los Valles to 6,200 feet (1,900 meters) at their ends overlooking the Española Valley (Broxton and Vaniman 2005).

The drainage of the high slopes of the Jemez region (Sierra de los Valles) extends across the tuff outcrops of LANL. Precipitation potential in the north-central part of New Mexico is strongly altitude-dependent. Precipitation in the form of rainfall and snowfall at the higher elevations is about 18 inches (46 centimeters) and about 14 inches (36 centimeters) on the semiarid lower slopes of the area (Broxton and Vaniman 2005). Flow across the Pajarito Plateau from the higher elevations to the Rio Grande has resulted in the mesa and canyon landscape of the area. The steeply cut canyons slope eastward from the Jemez Mountains toward the Rio Grande and are the cumulative result of the alternating humid and arid climatic cycles of the past 2.8 million years (Pleistocene glacial and interglacial). The canyon bottoms are covered with a relatively thin layer of alluvium. The mesa tops display little soil formation and are sparsely vegetated with water-efficient plants. Devitrification of the tuffs on the surface of the plateau has generated a nutrient-poor soil with smectitic clays as its principal argillaceous component. The mesa surfaces are generally quite flat and receive no runoff from the higher elevations. Soil moisture infiltration and runoff is controlled by plant growth and downward transport of precipitation that falls on the mesa surfaces.

E.3 Structural Setting

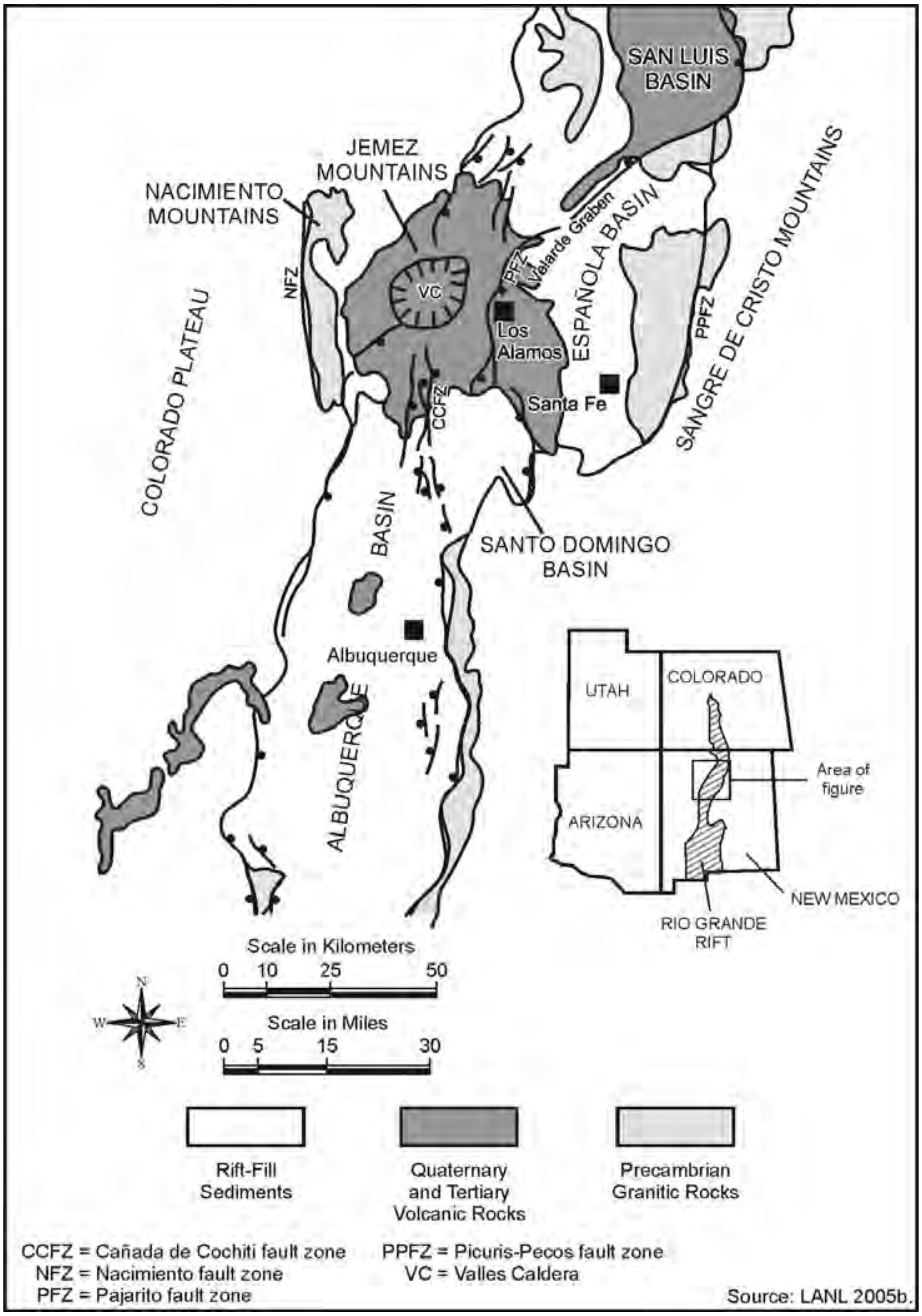
The tectonic episodes that occurred in southern Colorado and north-central New Mexico from the late Campanian stage of the Cretaceous Period (approximately 75 million years ago) through the Eocene Epoch (about 35 million years ago) formed the Rocky Mountains (Cather 2004). The mountain building (termed the Laramide orogeny) was caused by compression of the Earth's crust and formed two large basins that are separated by an uplifted area in north and central New Mexico and extend into southern Colorado. The structures formed were the San Juan Basin to the west and the Raton Basin to the east, which are separated by the San Luis Uplift. The southern part of the San Luis Uplift in the LANL vicinity has been called the Pajarito Uplift (Cather 2004). The Pajarito Uplift is bounded by the Picuris-Pecos fault zone in the Sangre de Cristo Mountains to the east and the Pajarito fault zone to the west (Broxton and Vaniman 2005).



Source: LANL 2005b.

Figure E–1 Location Map of the Central Pajarito Plateau

At the end of the Eocene Epoch, three large-scale processes began and continued until the late Pleistocene Epoch: (1) widespread volcanism, (2) extension of the crust (rifting) from Colorado through New Mexico to west Texas, and (3) extensive erosion of the High Plains east of a rift zone that is delineated by the Rio Grande (from which the zone's name is derived) and the Colorado Plateau west of the Rio Grande rift (Smith 2004). The Pajarito Uplift and other uplifts began to undergo extensional inversion (lowering) along the rift zone. In northern New Mexico, the Rio Grande Rift formed a series of semi-coaxial, elongated, oppositely tilted grabens that became narrow, sediment-filled basins (Smith 2004, Broxton and Vaniman 2005, LANL 2005a) (**Figure E–2**). The basins along the axis of the rift are flanked by a series of discontinuous mountains (Smith 2004). The Española Basin is flanked by the Nacimiento Mountains and the Jemez Mountains to the west and the Sangre de Cristo Mountains to the east. The western margin of the basin is obscured by Jemez volcanics and the margin may be further west at the Laramide Nacimiento Uplift (Smith 2004).



Source: LANL 2005b.

Figure E–2 Locations of Major Structural and Geologic Elements in the Vicinity of Los Alamos National Laboratory

Basins along the Rio Grande Rift are bounded by normal faulting that occurs along the margins and within the basins. The Española Basin is a west-tilting half graben bounded on the west edge by north-trending faults called the Pajarito fault zone (Figure E–2); on the north by northeast-trending transverse faults of the Embudo fault zone; and on the south by northwest-trending transverse faults called the Bajada fault zone (LANL 2005a). Gravity evidence indicates that deep within the Española Basin are three buried grabens associated with the Pajarito and Embudo fault zones (Smith 2004, Broxton and Vanimin 2005). One graben forms the north-trending Los Alamos sub-basin and is near Los Alamos. It is bounded by the Pajarito fault zone on the west and by the buried faults that lie east of the southern projections of Rendija Canyon and Guaje Mountain (Smith 2004, Broxton and Vaniman 2005).

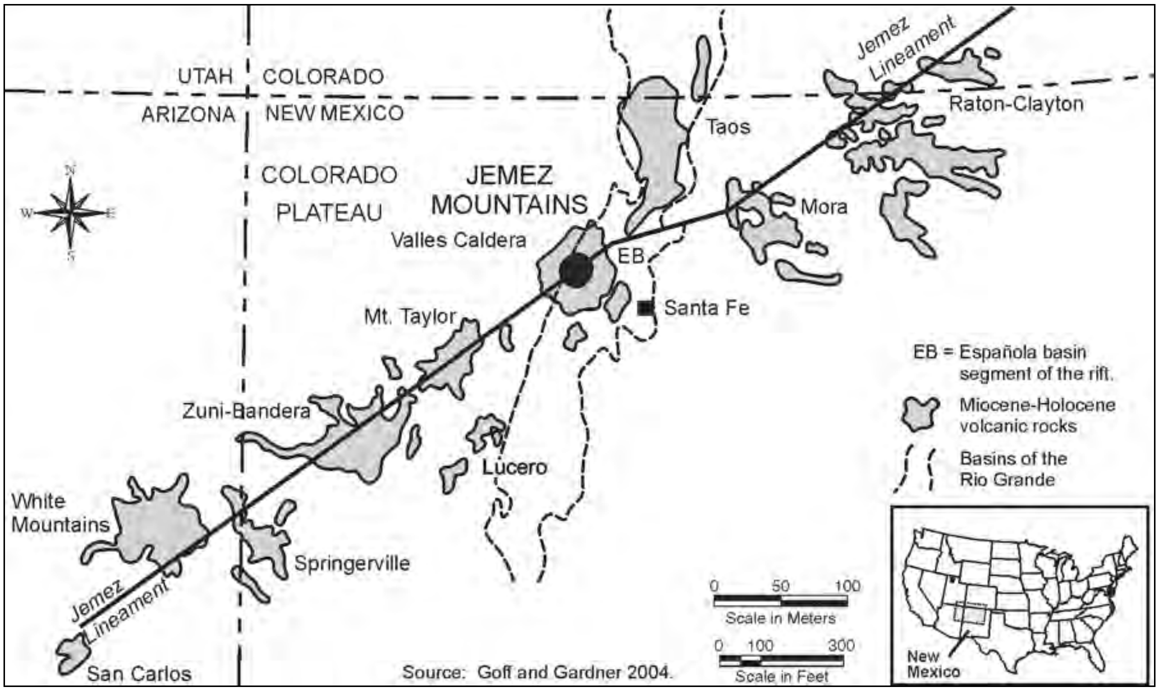
The Pajarito fault zone forms a 400-foot (120-meter)-high escarpment on the western margin of the plateau that looks like a monocline, but examination along the strike reveals a simple normal fault, several small normal faults, and faulted and unfaulted monoclines (Broxton and Vaniman 2005).

Other major fault zones in the LANL area include the north-trending Rendija Canyon fault that is down-to-the-west, and the north-trending Guaje Mountain fault that is also down-to-the-west (Broxton and Vaniman 2005). The faults are parallel in the northern part of the plateau. Additional faults are buried beneath or within the Bandelier Tuffs under the Pajarito Plateau. Faulting also occurs in the older Santa Fe Group rocks on the eastern side of the Española Basin.

E.4 Volcanic Setting

Jemez Volcanic Field

The Jemez Mountains were formed by rift-related volcanism along the Jemez lineament (**Figure E–3**) where the Colorado Plateau abuts the Española Basin. The lineament is a feature that may be a reactivated zone of ancient crustal weakness that trends northeast from eastern Arizona through the Jemez Mountains into southeastern Colorado (Goff and Gardner 2004, Broxton and Vaniman 2005). The volcanic zone that forms the Jemez Mountains overlaps the Colorado Plateau and western Española Basin (Broxton and Vaniman 2005). The region around the Valles Caldera in the Jemez Mountains west of the Pajarito Plateau is the source of most of the volcano-derived material that forms the Pajarito Plateau (Broxton and Vaniman 2005).



Source: Goff and Gardner 2004.

Figure E–3 Location Map of the Jemez Mountains and Valles Caldera with Respect to the Jemez Volcanic Lineament, the Colorado Plateau, and the Rio Grande Rift

For the past 14 million years, the structural province of this region has been extensively affected by tectonic forces. Volcanic activity and subsidence due to rifting were contemporaneous. The early Española Basin was the depositional site of alluvium derived from the Colorado Plateau and later from the Jemez Mountain volcanic field (to the west) and the Sangre de Cristo Mountains (to the east). The volcaniclastics from the Jemez Mountain volcanic field and the Precambrian basement rocks to the east and north formed large alluvial fans that intertongued, forming a vertical intergradation of wedge-shaped layers (Goff and Gardner 2004; Smith 2004; and Broxton and Vanimin 2005).

The Jemez Mountain volcanic field is divided into three groups. The oldest groups are the Keres Group in the south and the Polvadera Group in the north. These are succeeded by the Tewa Group in the central part and on the flanks of the Jemez Mountain volcanic field (Goff and Gardner 2004). This is not to imply that some of the volcanic eruptions that formed these three groups did not occur at the same time. Eruptions in different areas can overlap in time. The Lobato Basalt of the Polvadera Group was somewhat synchronous with the Keres Group basalts (Broxton and Vaniman 2005). LANL staff is conducting detailed examination of basalt and rhyolite outcrops and drill-hole data from beneath the Pajarito Plateau. The new data provide insight into the ages of the rocks and are being used to determine whether the rocks can be correlated throughout the volcanic field.

Knowledge gained from the study of the rock materials present in the LANL area is important to understanding hydrologic and chemical properties when developing conceptual models of groundwater flow and transport. A summary of the units present in the region, including their approximate ages and short descriptions, is given in **Table E–1**. Further descriptions and the relationships of these units with the alluvial units under the Pajarito Plateau are provided in Section E.5, Stratigraphic Framework of the Pajarito Plateau.

In the LANL area, on the east side of the Rio Grande, is the Caja del Rio Basalt Plateau (Figure E–1). It is an exposed part of the Cerros del Rio volcanic field that extends westward 7 miles (11 kilometers) underneath the Pajarito Plateau where it is covered by Bandelier Tuff (Goff and Gardner 2004; Broxton and Vaniman 2005). These volcanics are dissected by the Rio Grande, forming the steep-sided White Rock Canyon.

Caldera formation and subsequent collapse during the Late Pliocene to Late Pleistocene Epochs formed the Jemez Mountains and resulted in significant chemical evolution of the magma-, ash-, and tuff-forming phases. The Bandelier Tuff Formation consists of ashfalls, pumiceous beds, and flow tuffs and ranges up to tens of feet thick in the plateau area and is spread widely east and south of the main caldera. These tuffaceous deposits of the Bandelier Tuff, the Otowi, Cerro Toledo interval, and Tshirege define the geomorphology of the plateau and control the development of the terrain of canyons and mesas at LANL.

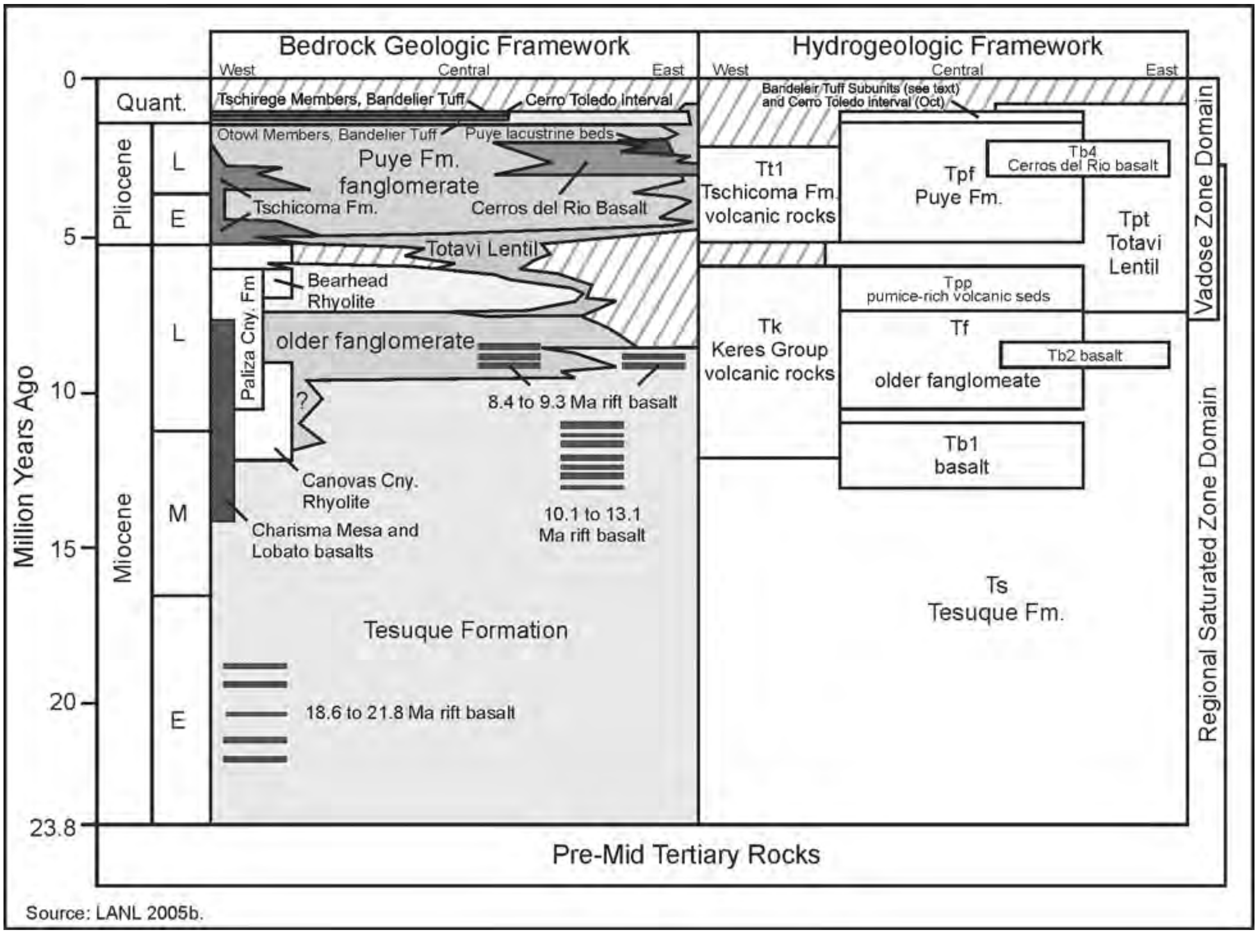
Table E–1 Summary of Jemez Mountain Volcanic Field Names, Rock Types, and Rock Ages

Group Name	*Unit Name*	*Description*
Middle Miocene Units		
Polvadera Group (Oldest unit in north part of LANL. Contemporaneous with parts of the Keres Group.)	Lobato Basalt (14 to 7.6 million years ago)	Multiple flows and cinder deposits coeval with Chamisa Mesa Basalt. Primarily olivine; dikes intruded Santa Fe Formation; interbedded with Santa Fe Formation.
Keres Group (Oldest unit in south part of LANL. Contemporaneous with parts of the Polvadera Group.)	Chamisa Mesa Basalt (13 to 9 million years ago)	Thin flows of basaltic lavas and cinder deposits that overlie rhyolitic tuff; forms mesa tops to the south and northeast of LANL. May be oldest unit in the Jemez Mountain volcanic field.
	Canovas Canyon Rhyolite (12.4 to 8.8 million years ago)	Domes, plugs, and pyroclasts (tuff, ash); weathered; intrudes Paliza Canyon Formation; rhyolite and basalt.
	Paliza Canyon Formation (10.6 to 7.1 million years ago)	Thick flows, domes, and pyroclasts; basalt, andesite and dacite composition.
	Peralta Member (6 to 7.1 million years ago)	Thick, tuffaceous deposits.
	Bearhead Rhyolite (6 to 7.1 million years ago)	Domes, intrusions, and pyroclasts; high silica rhyolites, plugs, domes, and tuffs.
	Cochiti Formation. (< 13 to < 6 million years ago)	Volcaniclastic rocks derived from Keres group rocks and interfingers with Santa Fe Group, Canovas Canyon Rhyolite, and Paliza Canyon Formation.
Late Miocene to Late Pliocene Units		
Polvadera Group	Tschicoma Formation (5 to 3 million years ago)	Large, overlapping domes and flows of dacite, rhyodacite, and andesite.
Late Pliocene to Late Pleistocene Units		
Tewa Group	Bandelier Tuff Pumice fall covered by ash-flow – High silica Rhyolite tuff; exposures at Pajarito Plateau in canyons; forms Pajarito Plateau east of and Jemez Plateau west of the Jemez Mountain Volcanic Zone.	
	Otowi Member (1.61 million years ago)	Guaje Pumice – Eruption formed the Toledo caldera, which was destroyed; less welded than Tshirege Member; basal pumice fall overlain by ash-flow tuffs.
	Cerro Toledo Interval	Cerro Toledo Rhyolite, Rhyolite domes.
	Tshirege Member (1.22 million years ago)	Tsankawi Pumice – Eruption formed the Valles Caldera that subsequently collapsed; basal pumice fall overlain by ash-flow tuffs.
Peripheral Lavas	Basalts of the Cerros del Rio (2.8 to < 1 million years ago)	Basalt lavas and dikes; relationship to Otowi unclear (Goff and Gardner 2004).

Source: Summarized from Broxton and Vaniman 2005 and Goff and Gardner 2004.

E.5 Stratigraphic Framework of the Pajarito Plateau

This section describes the stratigraphy of the Pajarito Plateau and shows how the volcanics described above fit in the sequence of deposition (**Figure E–4**). As mentioned above, volcaniclastics and sediments derived from the volcaniclastics from the Jemez Mountain volcanic field to the west of the Pajarito Plateau and sediment from the Precambrian basement rocks to the east and north formed alluvial fans that intertongued, forming a vertical intergradation of wedge-shaped layers.



Source: LANL 2005b.

Figure E–4 Pajarito Plateau Stratigraphy and Hydrogeologic Units

E.5.1 Santa Fe Group

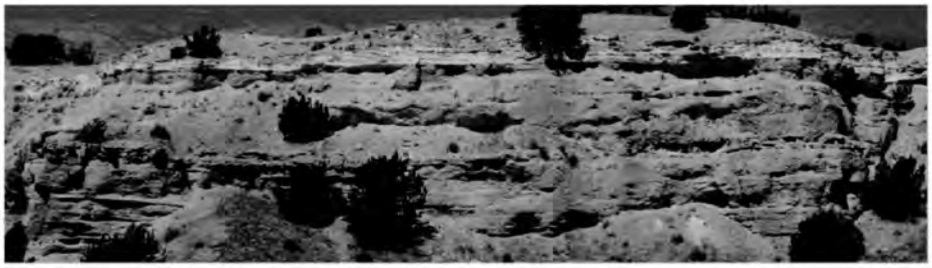
The basins along the Rio Grande Rift average several tens of miles long and are filled with sediments that reach depths of a few tens of thousands of feet. This thick accumulation of sediments in the Española Basin was derived from Precambrian rocks exposed in the highlands north and east of the basin. The basin sediments in north-central New Mexico were first collectively termed the Santa Fe Formation, but the formation was later elevated to a group name and subdivided into several formations. The Tesuque Formation is subdivided into, in ascending order, the Bishop’s Lodge, Nambe, Skull Ridge, Pojoaque, Chama-El Rito, and Ojo Caliente Members and the Chamita Formation. The Puye Formation was added and the Ojo Caliente was elevated to a formation (Broxton and Vaniman 2005). The age of the Tesuque ranges from about 30.45 to 8.48 million years ago. The name Tesuque Formation was used for the youngest formation of the Santa Fe Group in the Española Basin because it was felt that some of the members and formation designations could not be mapped properly because they were not defined over a large enough area (Smith 2004). Interfingered into these sediments are volcaniclastic sediments from the Jemez volcanic field (Broxton and Vaniman 2005).

Most of the rocks that were pre-Española Basin were stripped away in the Pajarito Plateau vicinity. Denudation of Paleozoic and Mesozoic rocks may have been due to erosion of the Pajarito Uplift (Cather 2004, Smith 2004), resulting in the absence of pre-Eocene rocks.

Mesozoic units may be present under the Pajarito Plateau, but at this time there is no supporting evidence (Broxton and Vaniman 2005). There are no exposures of the Santa Fe Group within the LANL boundaries; but on the eastern margins of the Pajarito Plateau and north of LANL, there are exposures in deep canyons such as Rendija Canyon and lower Los Alamos Canyon (**Figure E–5**). East of the Pajarito fault, the Santa Fe Group may be 6,650 feet (2,000 meters) thick, but much thinner (less than 1,640 feet [500 meters]) west of the fault, as indicated by examination of outcrops and drill-hole data (Goff and Gardner 2004, Broxton and Vaniman 2005). Because of the thickness of the Santa Fe Group, not much is known about units that are of hydrologic significance and are older than the Tesuque in the LANL region. Most of what is known about the Tesuque Formation's lithologic and hydrologic properties comes from drill holes.

Outcrop of the Puye Formation, Rendija Canyon (North of LANL).

Outcrop of the Santa Fe Group, Lower Los Alamos Canyon (East of LANL).



Outcrop of the Santa Fe Group, near Española.

Source: LANL 2005b.

Figure E–5 Deep Canyon Exposures

New drill hole data and exposures of rocks near the Rio Grande provide much of what is known about the stratigraphy, lithology, and ages of the Santa Fe Group in the LANL area. A recent attempt to address controversies dealing with stratigraphy and mechanisms that formed the Española Basin is reported in a synthesis of work performed up to the present (Smith 2004). Units believed to be of significance in the Pajarito Plateau area, in ascending order, are the Tesuque Formation, older fanglomerate deposits of the Jemez Mountain volcanic field, the Totavi Lentil and older river deposits, pumice-rich volcaniclastic rocks, and the Puye Formation (Broxton and Vaniman 2005).

Tesuque Formation

The Miocene Tesuque Formation has been characterized from data taken from partially penetrating water production wells for local communities west of the Rio Grande on the eastern edge of the Pajarito Plateau and from exposures east of the Rio Grande. The Tesuque Formation below the plateau is derived from arkosic sediments from the Precambrian Eon and sedimentary rocks of the Sangre de Christo Range to the east, and from Tertiary volcanic material to the north. The partly lithified fluvial sediments are thin-bedded (less than 10 feet, [3 meters]), massive to planar, cross-bedded, light pink to buff sandstones (Smith 2004; Broxton and Vaniman 2005). West of Española, the Tesuque Formation is interbedded with Lobato Basalt (Smith 2004). The Tesuque Formation dips to the west-northwest at about 11 degrees on the east side of the plateau (Broxton and Vaniman 2005).

Miocene Basalts

There are two groups of Miocene basalts underneath the east edge of the Pajarito Plateau. One group is 10.9 to 13.1 million years old near Guaje Canyon north of LANL, and the other is 8.4 to 9.3 million years old and extends from Bayo Canyon on the north end of the eastern part of the plateau to almost the southern end of LANL.

Older Fanglomerate

This unit of the Santa Fe Group is important because high-yield municipal water supply wells with low drawdown have been developed in these rocks. Recent data indicate that the older fanglomerates are widespread below the Pajarito Plateau (Broxton and Vaniman 2005). The unit is made up of volcanic detritus from the Keres Group and possibly from the Tschicoma Formation of the Polvadera Group. Data for the Otowi-4 well show that the older fanglomerate is a thick (1,650 feet [500 meters]) unit made up of dark, lithic sandstone with gravel and cobbles (Broxton and Vaniman 2005). An interpretive cross-section was developed using well data that indicate the older fanglomerate interfingers with the upper Tesuque Formation (Broxton and Vaniman 2005). This is consistent with data from Guaje Canyon wells that suggest that the fanglomerate may have accumulated as the Los Alamos sub-basin subsided (Broxton and Vaniman 2005).

Totavi Lentil and Older River Deposits

The Totavi Lentil (**Figure E–6**) is made up of poorly consolidated and well-rounded sands, gravels, and cobbles formed by the ancestral Rio Grande (Broxton and Vaniman 2005; Goff and Gardner 2004) and is used as a marker bed for supply wells beneath the Pajarito Plateau. The deposits at some locations are conformable with the Puye Formation and are used by some workers to delineate the base of the Puye Formation (Broxton and Vaniman 2005). The Totavi Lentil is highly variable in thickness and ranges from 50 feet (15 meters) to more than 323 feet (98 meters). New well data show a range in thickness of 30 to 100 feet (10 to 30 meters), but data from Well H-19 at the western limit of the Totavi Lentil indicate that the unit is only 10 feet (3 meters) thick.

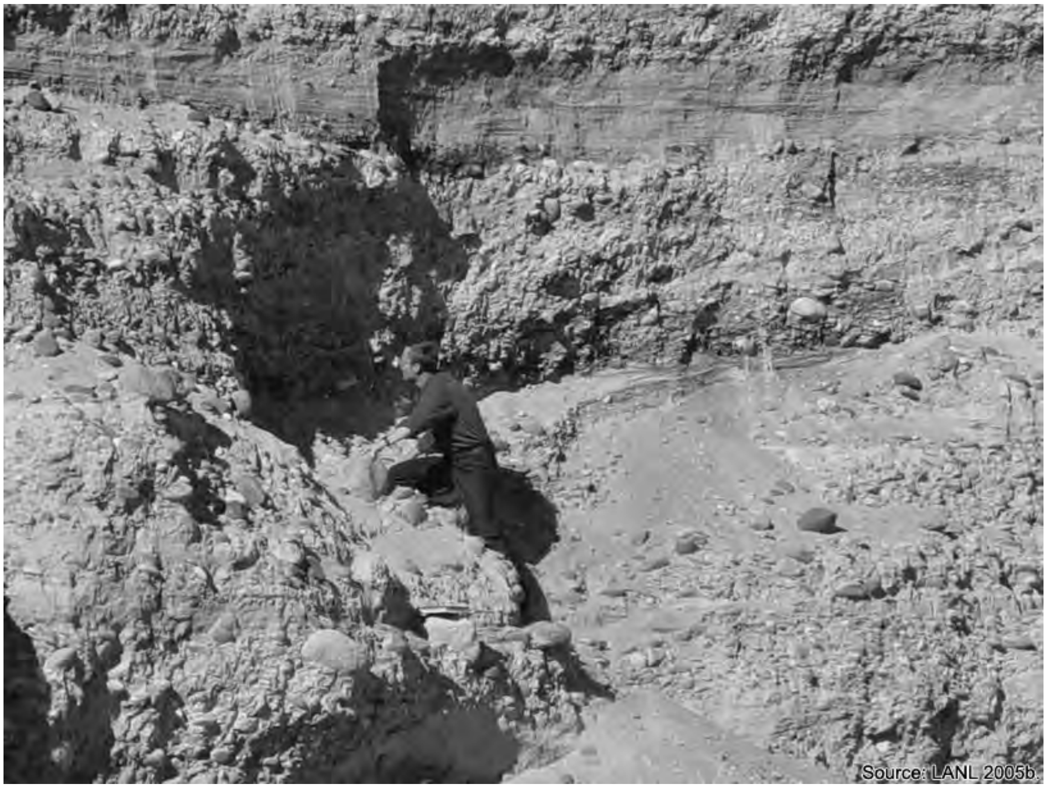


Figure E–6 Outcrop of Totavi Lentil Along SR 304

New well data show that the unit is coeval with several stratigraphic units and late Miocene river gravels and put the age of through-going rivers (rivers that are regional in nature with origins outside of the study area) at about 6.96 million years (Broxton and Vaniman 2005).

Pumice-Rich Volcaniclastic Rocks

The pumice-rich volcaniclastic rocks have well-bedded horizons of light-colored, reworked tephra-rich sedimentary deposits and subordinate primary ash- and pumice-fall deposits. The rocks consist mainly of tuffaceous sandstones with a few beds of gravels made of reworked lava (Broxton and Vaniman 2005). The deposits of pumice-rich volcaniclastic rocks become thinner eastward over the Pajarito Plateau and are made up of subangular to rounded lapilli (30 percent) and ash and lithic sands (70 to 90 percent). Samples of material from the saturated zone taken from wells in and near the Otowi Well Field (R-5, R-8, R-9, R-12) at the northeastern edge of LANL contained diagenetically altered volcanic glass replaced by smectite, but in other areas the lapilli are still vitric with only some surface oxidation and minor clay development (Broxton and Vaniman 2005). The source rocks may be from the Keres Group volcanism.

Tschicoma Formation

The Tschicoma Formation consists of thick dacite and low-silica rhyolite lava flows erupted from major peaks of the Sierra de los Valles highlands north and east of Valles Caldera and west of Los Alamos (Broxton and Vaniman 2005). The formation interfingers with the deposits of the Puye Formation, becomes thinner eastward across the Pajarito Plateau, and is absent at the eastern end of the plateau (Goff and Gardner 2004, Broxton and Vaniman 2005). The Tschicoma

Formation is lenticular, resulting in variable thicknesses (up to 2,500 feet [762 meters] in the Sierra de los Valles) (Broxton and Vaniman 2005).

Puye Formation

The Puye Formation is a large complex of alluvial fans made up of volcanic material and alluvium. It is well exposed north of the Pajarito Plateau; unconformably overlies the Santa Fe Group; and is intersected by most deep wells on the Pajarito Plateau (Goff and Gardner 2004, Broxton and Vaniman 2005). The formation's source rocks are the domes and flows of the Sierra de los Valles; consequently, the formation overlaps and postdates the Tschicoma Formation (Broxton and Vaniman 2005). The unit has two facies, fanglomerate and lacustrine. The fanglomerate is a widespread intertonguing mixture of stream flow, sheet flow, debris flow, block and ash fall, pumice fall, and ignimbrite deposits and may be up to 1,100 feet (330 meters) thick (Goff and Gardner 2004). The lacustrine facies include lake and riverine deposits in the upper part of the Puye; consist of fine sand, silt, and clay; and may be up to 30 feet (9 meters) thick. The lacustrine deposits are discontinuously exposed along Los Alamos Canyon (Broxton and Vaniman 2005).

Basaltic Rocks of the Cerros Del Rio Volcanic Field

These thick sequences of stacked lava unconformably overlie the Tesuque Formation and intertongue with the upper Puye under the Pajarito Plateau. Basalt outcrops occur east of the river and in Frijole Canyon and White Rock Canyon (Broxton and Vaniman 2005). The features are typical of basalt flows; that is, there is a flow base of vesicular basalt with scoria and clinkers, a collonade structure, a complex overlapping fractured zone, and a flow top with clinkers and scoria. The cooling rates of the basalts influenced the different zones of materials. The lower part of the interior units cooled more slowly than the upper part and formed columnar structures separated by vertical fractures. As cooling rates increased upward, the upper part developed into an array of web-like random fractures. The interflows consist of clastics, ash, and sedimentary deposits. The flows are generally 200 to 300 feet (61 to 183 meters) thick and reach a maximum of 983 feet (300 meters). There are some maar deposits formed when molten basalt encountered water (Broxton and Vaniman 2005).

E.5.2 Upper Pliocene and Quaternary Units

Bandelier Tuff

The Bandelier Tuff comprises the surface and near surface materials in the LANL area. It is an extensive, wedge-shaped pyroclastic unit that gets thinner as it extends eastward from Sierra de los Valles toward the eastern edge of the Pajarito Plateau and was deposited during a recent eruptive phase of the Jemez volcanic complex (1.6 to 1.2 million years ago) (Goff and Gardner 2004; Broxton and Vaniman 2005). The Bandelier Tuff is made up of two similar units, the Otowi Member (the oldest) and the Tschirege Member. The two members are divided into subunits, a basal pumice layer overlain by multiple tuff layers, and their characteristics are based mostly on thermal and depositional features. The two members are separated by a layer of tephras and volcaniclastics and make up the Cerro Toledo interval (Birdsell et al. 2005, Goff and Gardner 2004, Broxton and Vaniman 2005).

Otowi Member of the Bandelier Tuff

The Otowi Member (equivalent to the Qbo hydrologic unit discussed in Section E.6.3) is exposed in Los Alamos Canyon, the deeper canyons to the north at the edge of the Pajarito Plateau, and in the deeper canyons at the edge of the Jemez Plateau west of the Jemez Mountains (Goff and Gardner 2004; Birdsell et al. 2005; Broxton and Vaniman 2005). The basal layer of the Otowi Member, the Guaje Pumice (equivalent to the Qbog hydrologic unit discussed in Section E.6.3), is a pumice layer, ranges in thickness from about 7 to 50 feet (2 to 15 meters) (Birdsell et al. 2005), and averages about 30 feet (9 meters) (Broxton and Vaniman 2005). The pumice, a distinctive marker bed, is overlain by a series of poorly welded rhyolitic ash-flow units that collectively form an extensive, homogeneous rock unit. The Otowi Member is wedge-shaped and thins eastward away from its source, the caldera, over the central part of the plateau. The Otowi Member on the western part of the Pajarito Plateau has two thick zones ranging from 350 to 400 feet (100 to 125 meters) separated by an elongated zone ranging from less than 100 to 300 feet (30 to 90 meters). The thin zone is overlain with a thick deposit of Cerro Toledo sediments (equivalent to the Qct hydrologic unit discussed in Section E.6.3). Erosion removed a large amount of the Otowi Member in some parts of the plateau, leading to a suggestion that the thin zone is indicative of an east-trending drainage incised into the surface of the member (Broxton and Vaniman 2005).

Cerro Toledo Interval

The Otowi and Tshirege Members of the Bandelier Tuff are separated by a stratified sequence of volcaniclastics informally named the Cerro Toledo interval (Goff and Gardner 2004, Broxton and Vaniman 2005). The unit is exposed in Los Alamos Canyon and the deeper canyons to the north at the edge of the Pajarito Plateau. The Cerro Toledo is variable in thickness, ranging from 3 to 390 feet (1 to 120 meters) (Broxton and Vaniman 2005), and is composed of rhyolites that are representative of the Toledo caldera before it collapsed (Goff and Gardner 2004). Dacite and andesite detritus from the Tschicoma Formation are intertongued with reworked Otowi deposits and Cerro Toledo interval rhyolites (Goff and Gardner 2004, Broxton and Vaniman 2005).

Tschirege Member of the Bandelier Tuff

The Tschirege Member is the most distinctive and widely exposed unit on the Pajarito Plateau. It is somewhat more resistant to weathering and erosion in the western part of the plateau because the tuffs are strongly welded and form steep, narrow canyons that become wider downgradient where the tuff is not as strongly welded (Goff and Gardner 2004, Broxton and Vaniman 2005, Birdsell et al. 2005). Like the Otowi, the Tschirege Member has a basal pumice layer, the Tsankawi Pumice, that unconformably overlies the Cerro Toledo sediments (Goff and Gardner 2004; Broxton and Vaniman 2005). The pumice layer is much thinner than the Guaje Pumice and ranges in thickness from 20 to 30 inches (50 to 75 centimeters). The Tsankawi Pumice is overlain by a compound cooling sequence of four welded ash-flows (Goff and Gardner 2004). The thickness of the four units ranges from 200 feet (61 meters) in the north-central part of LANL to 600 feet (183 meters) at the southern edge of LANL (Broxton and Vaniman 2005). The degree of welding in the Tschirege increases westward on the plateau as one approaches the caldera that is the source of the tuff (Broxton and Vaniman 2005). The high temperatures were maintained longer due to the thicker deposits, which increases welding.

Cooling joints in the Otowi tuffs and poorly welded portions of the Tschirege are mostly lacking (Birdsell et al. 2005).

The four mappable cooling units of the Tschirege tuffs have been subdivided into subunits based on distinctive lithologic characteristics because the units occupy a “significant portion of the vadose zone” (Broxton and Vaniman 2005). The unit names are also used for the hydrologic units discussed in Section E.6.3. Briefly, from the oldest to the youngest, the designations for the units are:

> **Qbt 1g**. This unit is a porous, nonwelded tuff with no devitrification or vapor phase alteration of the glass (g). The unit has a resistant caprock that protects the soft tuffs underneath, forming steep cliffs.
>
> **Qbt 1v**. This unit is nonwelded, porous, crystalline tuff that has undergone vapor-phase (v) crystallization of pumice and glass shards. The lower part (Qbt 1vc) is a collonade tuff with columnar cooling joints. The tuff alternates between cliff-forming and slope-forming units.
>
> **Qbt 2**. This unit is a series of surge beds, forming brownish vertical cliffs. The unit conformably overlies Qbt 1v in some parts of LANL. The unit is dense and porosity is lower than the other units. Welding increases upward.
>
> **Qbt 3**. This unit is a nonwelded to partly welded, vapor-phase tuff that forms the cap rock of mesas. It grades upward from a soft basal unit that is a purple-gray, porous, unconsolidated, crystal-rich, nonwelded tuff to a partly welded, white cliff-forming tuff that becomes moderately to densely welded in the western part of LANL. Qb 3t, a subunit of Qbt 3, is moderately to densely welded ash-flow tuff in the far-western part of LANL and is transitional to Qbt 4.
>
> **Qbt 4**. This unit is a complex unit in the western part of LANL made up of nonwelded to partly welded ash-flow tuffs with pumice and surge deposits in the lower part of the unit and densely welded ash-flow tuffs that form caprocks. The unit has mostly undergone devitrification and vapor phase alteration, but locally there are thin rhyolitic, vitric ash-flow tuff deposits.

Alluvium

Alluvium of the Holocene and Pleistocene occurs on the canyon floors at LANL. Continuous alluvial deposits from the Pleistocene occur at the foot of the eastern slopes of Sierra de los Valles and on the Pajarito Plateau on top of the Bandelier Tuff (Broxton and Vaniman 2005). The alluvium on the floors of small canyons that head (begin) on the Bandelier Tuff consists of Bandelier Tuff detritus. Canyons that have headwaters farther west in the Sierra de los Valles have detritus from the Bandelier and the Tschicoma Formations. The alluvium consists of unconsolidated fluvial sands and gravels and forms stratified lenticular-shaped deposits along the canyon floors and at the mouths of canyons. The alluvium deposits intertongue with the colluvium, which may have blocks of material up to 10 feet (3 meters) in cross-section at the bases of the walls of the canyons. The deposits are cross-cut by the ephemeral or intermittent streams, forming complex deposits on the canyon floors and at the mouths of the canyons. The alluvial deposits vary in thickness within the canyons and from canyon to canyon. Alluvium thickness in Pueblo Canyon ranges from 11 feet (3.4 meters) on the west side of the plateau to about 18 feet (5.5 meters) at the confluence with Los Alamos Canyon (Broxton and Vaniman 2005; Robinson et al. 2005); at Mortandad Canyon, the range is from 1 to 2 feet (0.3 to 0.6 meters) at its headwaters to 100 feet (30 meters) at the eastern margin of LANL.

E.6 Hydrogeology

E.6.1 Comparison of the Bedrock Geologic Framework with the Hydrologic Framework

Cross-sections that represent subsurface geology result from the integration of:

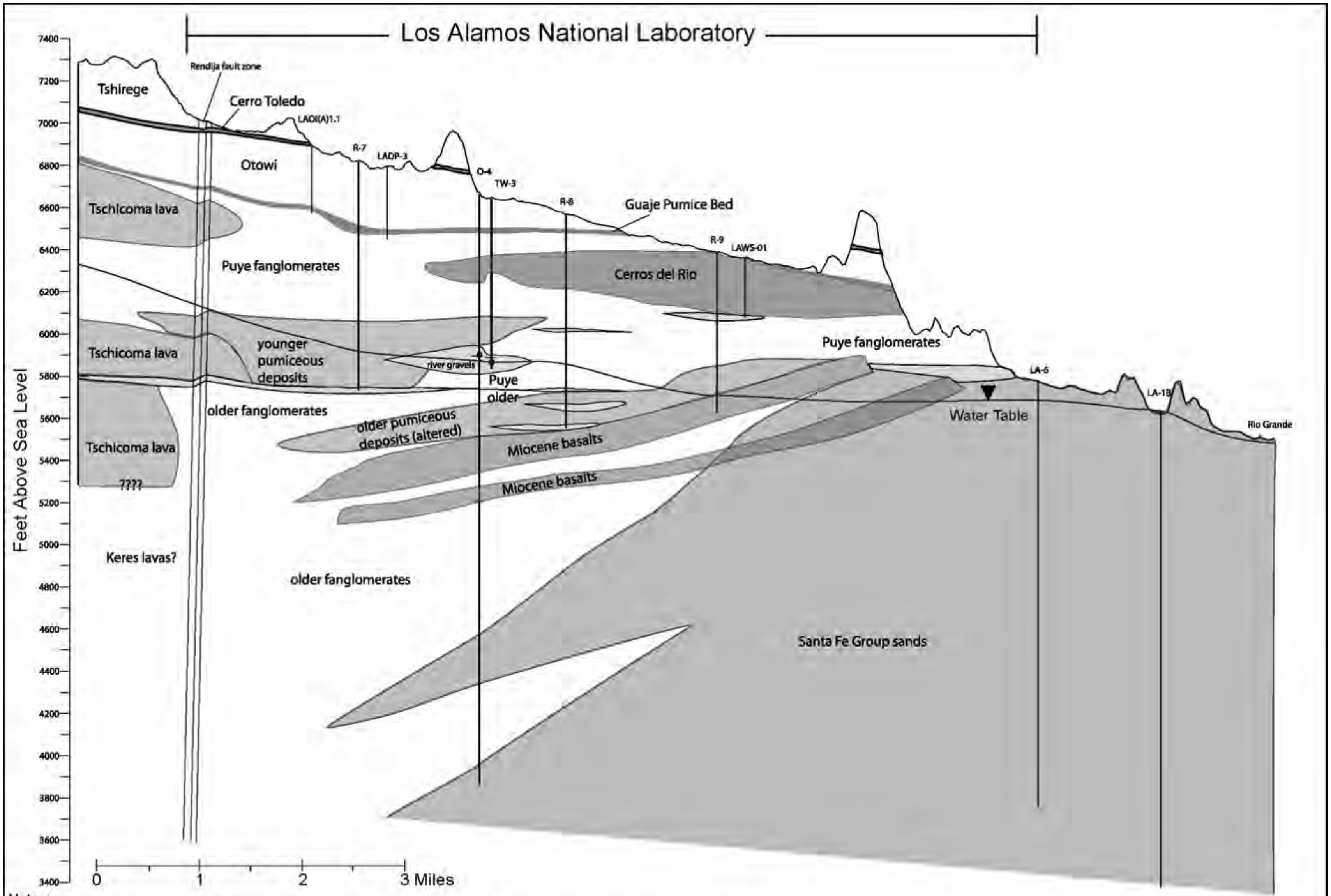
- Structural geologic observations consisting mostly of the elevations of contacts between rock bodies of different character measured in wells,
- Stratigraphic descriptions of the character and thickness of individual rock bodies from wells and the study of outcrops, and
- Down-hole geophysical studies.

The observations from wells define the fundamental data necessary to accurately construct cross-sections. The cross-sections, structural contour maps, and interpreted character of the rocks around LANL serve as the framework for flow and transport models (Figure E–4). Cross-sections drawn from west to east across the Pajarito Plateau are presented in **Figures E–7** (along Los Alamos Canyon) and **E–8** (along Pajarito Canyon).

The comparison shows how the geologic units differ from the hydrologic units. The geologic units are combined because they possess similar hydrologic properties, which allows for modeling efficiency. This does not imply that the hydrologic units are homogeneous regions of unvarying properties. Large local internal variations in hydrologic properties have been noted and are due to rock texture, composition, and structure. The basis for defining the hydrologic units is that the gross character of a unit can be modeled relatively consistently. The following discussion compares the geologic and hydrologic frameworks (Broxton and Vaniman 2005).

E.6.2 Groundwater Occurrence

There are three modes of groundwater occurrence in the Pajarito Plateau: (1) perched alluvial groundwater in canyon bottoms; (2) zones of intermediate-depth perched groundwater whose location is controlled by availability of recharge and by subsurface changes in permeability; and (3) the regional aquifer beneath the Pajarito Plateau (Broxton and Vaniman 2005). In wet canyons, stream runoff percolates through the alluvium until downward flow is impeded by less permeable layers, maintaining shallow bodies of perched groundwater within the alluvium. Contaminant distributions in the groundwater under the Pajarito Plateau suggest that the three systems may be in communication under certain conditions (Robinson, McLin, and Viswanathan 2005). The hydrogeology of the Pajarito Plateau is typical of the semi-arid, sediment-filled basins along the Rio Grande Rift in that the basins receive recharge from mountain ranges along the margins (Broxton and Vaniman 2005). This section discusses alluvial, perched, and regional groundwater.

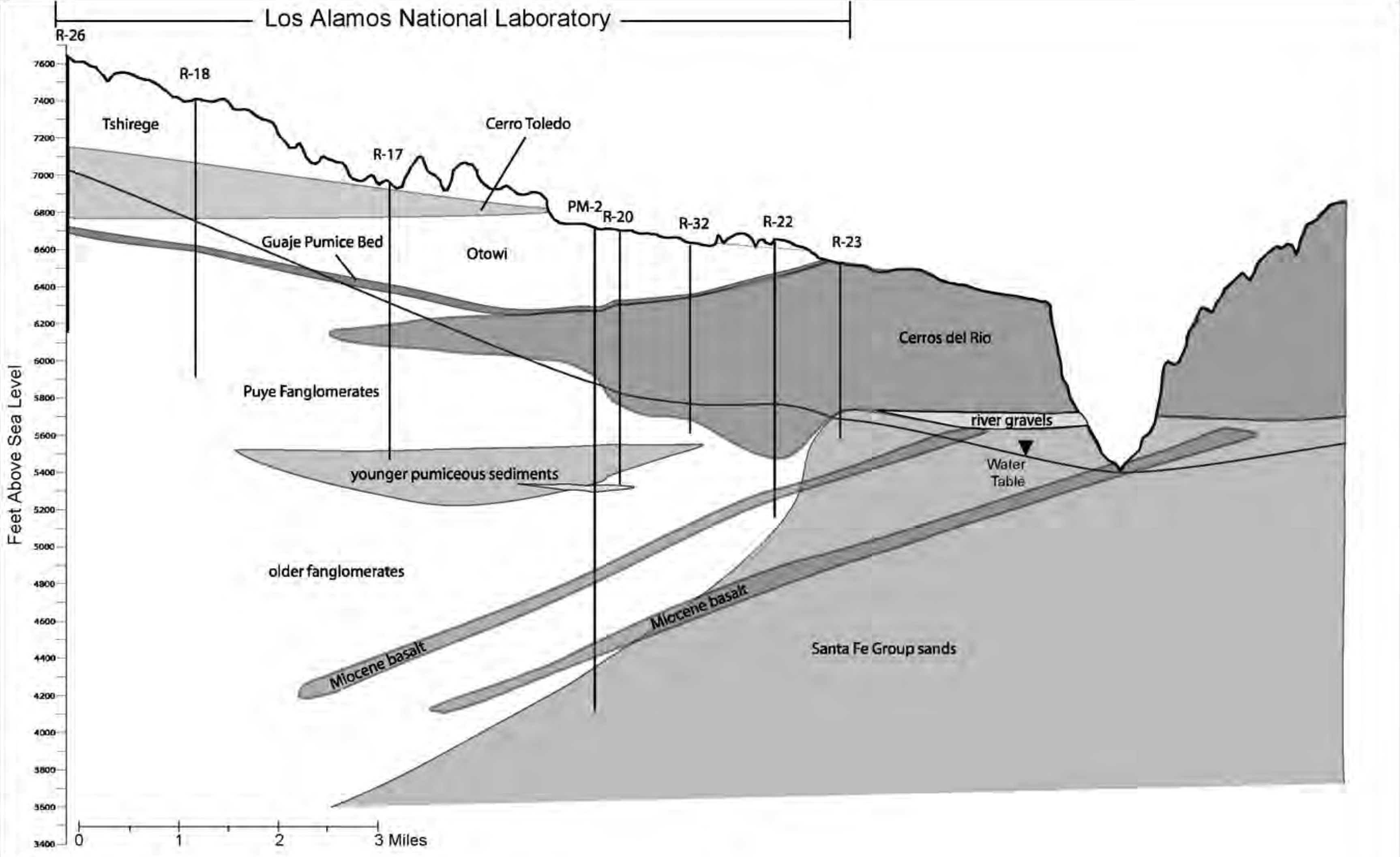


Notes:

1. The thickness of geologic units has been exaggerated on this figure to illustrate unit relationships and topography.
2. To convert feet to meters, multiply by 0.3048.

Source: LANL 2005b.

Figure E–7 Conceptual Cross-Section Across the Pajarito Plateau Along Los Alamos Canyon



Notes:
1. The thickness of geologic units has been exaggerated on this figure to illustrate unit relationships and topography.
2. To convert feet to meters, multiply by 0.3048.

Source: LANL 2005b.

Figure E–8 Conceptual Cross-Section Across the Pajarito Plateau Along Pajarito Canyon

The geology of the regional aquifer was discussed above. Knowledge of the origin and depositional history of the rocks at LANL, coupled with groundwater sampling and aquifer testing, helps to determine the hydraulic properties of the regional aquifer. Single well tests of small volumes of rock have been conducted by withdrawing water from or injecting water into a well and measuring the rate of recovery of the original water surface. Multiple-well tests of large volumes of rock involve pumping a well and then making observations of the effects on nearby wells completed in the same interval. Extensive downhole geophysical studies are also a part of the deep-well program. Studies of rock properties and geochemical information with hydrologic testing results provide a basis for evaluating travel times and transport in the vadose zone (Keating, Robinson, and Vesselinov 2005). Summaries of these properties obtained from well tests, sampling programs, and analyses have been reported previously (Keating, Robinson, and Vesselinov 2005; Robinson, McLin, and Viswanathan 2005; Birdsell et al. 2005). Potentiometric maps, hydraulic gradients, and permeability data for the regional aquifer have also been discussed (Keating, Robinson, and Vesselinov 2005).

E.6.2.1 Alluvial Groundwater

Alluvial groundwater in the LANL area primarily occurs in canyons that originate in the Sierra de los Valles or in the Pajarito Plateau watersheds. Groundwater in the canyons is supported by seasonal runoff from the mountains, by episodic precipitation events on the plateau, perennial springs, and by discharge from LANL outfalls. Liquid wastewater from LANL released to the outfalls above the canyons was responsible for contamination of alluvial groundwater in the past. The wastewater also plays a part in the hydrogeology of the canyons.

As mentioned above in the stratigraphy section, the canyon floors are covered with alluvium of variable thickness and consist of fluvial sands, gravels, and cobbles. The alluvium is derived from the mountains to the west and from rocks that have been incised by the ephemeral and intermittent streams that formed the canyons (parts of some canyon streams have perennial flow). The alluvium is intermingled laterally with colluvium from the canyon walls. Groundwater in the canyons occurs above permeability barriers at the base of the alluvium above the Bandelier Tuff or above well-sorted tight sequences of canyon floor alluvium. Seasonal variation in the amount of snowmelt or storm runoff affects the saturated thickness and lateral extent of alluvial groundwater.

E.6.2.2 Deep Perched Groundwater

The extent and nature of deep perched water beneath Pajarito Plateau has been investigated to determine whether the alluvial systems on the plateau are in communication with the deep perched water or the regional aquifer and whether there is a potential for contaminants to travel to the regional groundwater (Robinson, Broxton, and Vaniman 2005). At the time of the investigation, 33 perched water zones had been identified in 29 wells. The study defined perched water "as a hydrologic condition in the rock or sediment above the regional aquifer in which the rock pores are completely saturated with water." Perched water may occur because of capillary barriers or because of low permeability barriers coupled with structures in the stratigraphic section. For example, faults may intersect hydraulically conductive zones with low permeability materials and block flow paths. Another cause may be that, when a saturated zone becomes unsaturated due to a decline in water level, water may become trapped in a zone of high permeability where it is unable to move to the new level.

The perched zones at LANL do not have enough water to warrant putting in municipal water supply wells, but the perched groundwater zones are important for four reasons: (1) the water is protected under state law; (2) transport rates through the unsaturated rocks are affected by the chemistry of the perched zones; (3) the zones restrict vertical movement of groundwater or may indicate the presence of fast-paths; and (4) the zones can be used for monitoring movement of groundwater toward the regional aquifer (Robinson, Broxton, and Vaniman 2005). The deep, perched zones get water from surface and alluvial groundwater associated with the large canyons that head in the Sierra de los Valles; deep, perched water below the smaller canyons on the plateau can also be recharged by liquid effluent from LANL. The deep, perched water zones have a saturated thickness ranging from 100 to 400 feet (30 to 120 meters) (Robinson, Broxton, and Vaniman 2005).

Perched water bodies are important elements of the hydrogeology of the site for several reasons. There is a probability that the zones can intercept contaminants being transported downward through the vadose zone. The perched water can be a permanent or long-term residence for contaminants because the chemical makeup of the rocks may result in adsorption. Perched water can also serve as a place where dilution occurs, lowering the concentration of contaminants. There is a possibility that perched zones may be intersected by streams in the lower parts of the canyons, resulting in lateral flow under the influence of gravity out of the canyon walls into the alluvial aquifer and subsequently to the Rio Grande.

E.6.2.3 Regional Groundwater

The regional aquifer below LANL is very deep (up to 1,200 feet [360 meters]) and is separated from the surface by a thick vadose zone with some perched water zones (Keating, Robinson, and Vesselinov 2005). The depth to the water of the regional aquifer on the eastern part of the plateau near the rim of White Rock Canyon is about 614 feet (200 meters), about 210 feet (65 meters) above the level of the Rio Grande (Broxton and Vaniman 2005). It has been reported that a well drilled in the lower Los Alamos Canyon near the Rio Grande flowed to the surface when installed in the regional aquifer, indicating confined or semi-confined conditions, and that there are seeps and springs in White Rock Canyon (Broxton and Vaniman 2005).

Sedimentary bedrock units at the top of regional saturation zones below the Pajarito Plateau at LANL include the Puye Formation (Tpf), pumiceous deposits (Tpp), older fanglomerate (Tf), and Tesuque Formation (Ts). The volcanic rocks in which groundwater occurs are the Cerros del Rio basalts (Tb4), the Tschicoma Formation (Tt), and Miocene basalt (Tb2) (Broxton and Vaniman 2005). Groundwater recharge to the regional aquifer under the Pajarito Plateau comes from underflow from the Sierra de los Valles and from drainages across the plateau (Kwicklis et al. 2005). The stratigraphy of the rocks is discussed in Section E.5. The most productive wells on the plateau occur in the central part of the plateau within the basin fill deposits consisting of the Puye Formation, the pumiceous deposits, the Totavi Lentil, the older fanglomerates, and the Tesuque Formation. The wells have screens up to 1,600 feet (500 meters) long spanning these units (Broxton and Vaniman 2005). The Tesuque is the primary productive unit in the eastern part of the plateau, in Guaje Canyon, and in the lower Los Alamos Canyon.

E.6.3 Hydrogeologic Units

Basal Confining Units

The rock units that occur below the regional aquifer are considered to be all of the units below the Tesuque Formation, including Precambrian igneous and metamorphic rocks, Paleozoic and Mesozoic sedimentary rocks, and mid-to-upper Tertiary terrestrial sediments.

Santa Fe Group Rocks

Hydrologic unit Ts is generally considered to be equivalent to the Tesuque Formation. The lithology of the unit is silty to sandy with some basalt and flow breccias (Tb1). The basalts are about 11 to 13 million years old and have intercalated sedimentary units. Water supply wells in the lower Los Alamos Canyon completed in this unit yield about 600 gallons per minute (2,200 liters per minute), and in the western part of LANL where the Ts is coarser, supply wells yield about 1,000 gallons per minute (3,800 liters per minute). Flow in the volcaniclastics and altered basalts is associated with fractures; the interflow breccias are plugged with secondary minerals (Broxton and Vaniman 2005).

Older Fanglomerate

This hydrogeologic unit (Tf) is a thick sequence of gravel and cobble beds and interbedded sandstones. It has been identified as the most productive zone (1,000 gallons per minute [3,800 liters per minute]) in the LANL area. The Tf is vertically heterogeneous and anisotropic because of the bedding, but may be strongly isotropic in the lateral direction. Reinterpretation of earlier well logs puts the contact with the Ts at the transition zone where coarse grain gravels and cobbles overlay sands and silts (Broxton and Vaniman 2005). Basalts (8.4 to 9.3 million years old) and intercalated sedimentary rocks in the Tf are designated as Tb2. Hydrologic unit Tk is intertongued with the Tf and is made up of Keres Group volcanic rocks.

Hydrologic unit Tpt represents the Totavi Lentil and older river deposits that make up a poorly consolidated conglomerate. Data from one water production well completed in this interval show that 18 percent of the water produced comes from only 2.5 percent of the screened interval (Broxton and Vaniman 2005). The hydrologic unit Tpp below the Tpt is a well-stratified, heterogeneous, pumice-rich, volcaniclastic rock. It is fine grained and more porous than the more coarsely grained overlying and underlying hydrologic units. The unit is anisotropic because, vertically, the alternating fine grained bedding is less hydraulically conductive than in the lateral direction. These pumice rich rocks also have a lower bulk density than Tpt and Tf (Broxton and Vaniman 2005; Birdsell et al. 2005).

Beneath the pumice deposits is the hydrologic unit Tpf that is similar to, but predates, the lacustrine deposits of the Puye Formation (Birdsell et al. 2005). The lacustrine deposits are equivalent, which may indicate that the rocks are contemporaneous (Broxton and Vaniman 2005). The Tpf is a deposit of coalesced alluvial fans and consists of much coarser material than the Tpp; like the Tpp, however, it is heterogeneous and anisotropic. Vertically, heterogeneity is due to layering; laterally, it is due to cross-cutting and variable grain size characteristic of fluvial deposits in an alluvial fan environment. It has been hypothesized that the hydraulic conductivity in the vertical direction is less than the hydraulic conductivity in the horizontal direction parallel to the bedding planes (Broxton and Vaniman 2005).

Basaltic Rocks of the Cerros del Rio Volcanic Field

The heterogeneous hydrologic unit Tb4 basalts are intercalated with subordinate amounts of upper Puye Formation and constitute the top of the regional aquifer at the southeast corner of LANL (Birdsell et al. 2005; Broxton and Vaniman 2005). As noted above, these basalts are exposed on the east side of the Rio Grande. In the LANL region, the basalts are located under the central and eastern part of the Pajarito Plateau. The connected porosity of the highly brecciated clinker and scoria zones and sediments at the tops and bottoms of the stacked lavas may extend for hundreds of yards or may be limited in some areas where the voids are filled with clay minerals (Birdsell et al. 2005; Broxton and Vaniman 2005). The dense lava flow interiors are impermeable, with flow of gases and liquid water restricted to fractures. Flow in the scoriated breccia zones is lateral along the beds and mostly vertical in the interflow zones.

Bandelier Tuff

The stratigraphic divisions presented in Table E–1 were retained for the hydrologic units because the rock properties for the stratigraphic subunits are laterally ubiquitous and traceable throughout the plateau (Broxton and Vaniman 2005). This section presents the hydrologic units of the Bandelier Tuff with descriptions from oldest to youngest (Broxton and Vaniman 2005, Birdsell et al. 2005, Springer 2005).

Ash-flow tuffs and fall deposits (the Guaje Pumice Bed) of the Otowi Member are hydrologic units Qbog and Qbo, respectively. Qbo is uniform with respect to vertical density and density-porosity profiles in the central and eastern parts of the plateau, but is more variable in the west where changes are more abrupt (Broxton and Vaniman 2005). The ash-flow tuffs of the Otowi do not have pervasive cooling joints found in the welded tuffs in the upper Bandelier (Birdsell et al. 2005). The Guaje Pumice Bed (fall deposits) at the base of the Otowi Member is designated hydrologic unit Qbog. It is well sorted and stratified; has less matrix ash than the other Bandelier units; and is an excellent marker bed between the Bandelier Tuff and the units below it.

The stratified volcaniclastic deposits of the Cerro Toledo Interval are designated as hydrologic unit Qct. Because the unit consists of rocks that are variable in grain size, sorting, and bedding thickness, a strong vertical anisotropy exists above Qct within the Bandelier (Broxton and Vaniman 2005). These characteristics provide a favorable setting for perched groundwater.

The upper Tshirege Member is a complex hydrologic unit of welded ash-flow tuffs separated by poorly welded tuffs and a basal unit of pumice fall deposits. The welded tuffs have joints and fractures caused by cooling and tectonic processes that die out in the nonwelded layers (Birdsell et al. 2005). The basal hydrologic unit Qbt t is equivalent to the Tsankawi Pumice Bed (Broxton and Vaniman 2005). Unit Qbt t is overlain by hydrologic subunits Qbt 1g and Qbt 1v. Qbt t and Qbt 1g are the only ash and pumice falls in the Tshirege that are made up of similar, unaltered volcanic glass.

Volcanic glass above Qbt 1g in hydrologic unit Qbt 1v has undergone post-depositional devitrification and vapor-phase crystallization. These processes may affect grain size and decrease effective porosity by creating poorly connected pore spaces (Broxton and Vaniman 2005). Unit Qbt 1vc is indurated and poorly welded with a system of well-developed columnar joints. Unit Qbt 1vu is generally nonwelded to partly welded, but lacks extensive jointing (Broxton and Vaniman 2005, Birdsell et al. 2005).

Hydrologic unit Qbt 2 is separated from the altered beds of unit Qbt v by a thin pyroclastic surge bed in the eastern part of the Pajarito Plateau; but in other parts of the plateau, Qbt 1v grades into Qbt 2. In the western part of the plateau, density and density-porosity profiles indicate that Qbt 2 has a cooling break present at its center. The break is not present in the eastern part of the plateau. Upper Qbt 2 is strongly welded, becomes less welded down-section, and has higher bulk densities than other Tshirege units.

Hydrologic unit Qbt 3 is strongly welded in the western part of the plateau and becomes less welded eastward. The strongly welded interior of Qbt 3 has a high bulk density and low density porosity. Hydrologic unit Qbt 4 is a nonwelded to strongly welded unit and is present only in the western Pajarito Plateau.

E.7 Conceptual Models

Potential contamination of the regional aquifer below LANL is of major concern. It is the responsibility of LANL to determine whether past contaminant releases pose a threat to human health. Flow and transport mechanisms through the vadose zone are being examined. This section discusses recent papers in the *Vadose Zone Journal* published on August 16, 2005. The papers collectively describe the work that has been completed or contemplated for the purpose of developing conceptual models of the hydrogeology and numerical models of groundwater flow and transport under the Pajarito Plateau in general and under LANL in particular. The journal articles summarize extensive observational data regarding deep perched water on the plateau and discuss the controls on the distribution of deep perched water and the ways perched zones may develop (Robinson et al. 2005). There is a description and a numerical model of the regional aquifer below the Pajarito Plateau that is used for determining fluxes and transport (Keating, Robinson, and Vesselinov 2005). There is a report on net infiltration on the plateau, which is a major concern when modeling groundwater flow under LANL and streamflow on the plateau (Kwicklis et al. 2005). A comprehensive discussion of a statistical analysis of hydrologic properties also is presented (Springer 2005). Several articles discuss the roles of matrix and fracture flow within the Bandelier Tuffs and basalts (Robinson, Broxton, and Vaniman 2005, Levitt et al. 2005, Stauffer and Stone 2005). There is also a summary paper that describes the hydrogeologic setting and site history of LANL (Newman and Robinson 2005).

Conceptual models constantly change as knowledge about hydrologic processes and events that control groundwater movement increases for a particular site. The following section includes a discussion of the conceptual models, numerical model development, modeling results, and conclusions. The papers are presented in the order of the hydrostratigraphy of the region: the vadose zone; the deep perched zones; and the regional aquifer.

E.7.1 Geochemical Conceptual Model

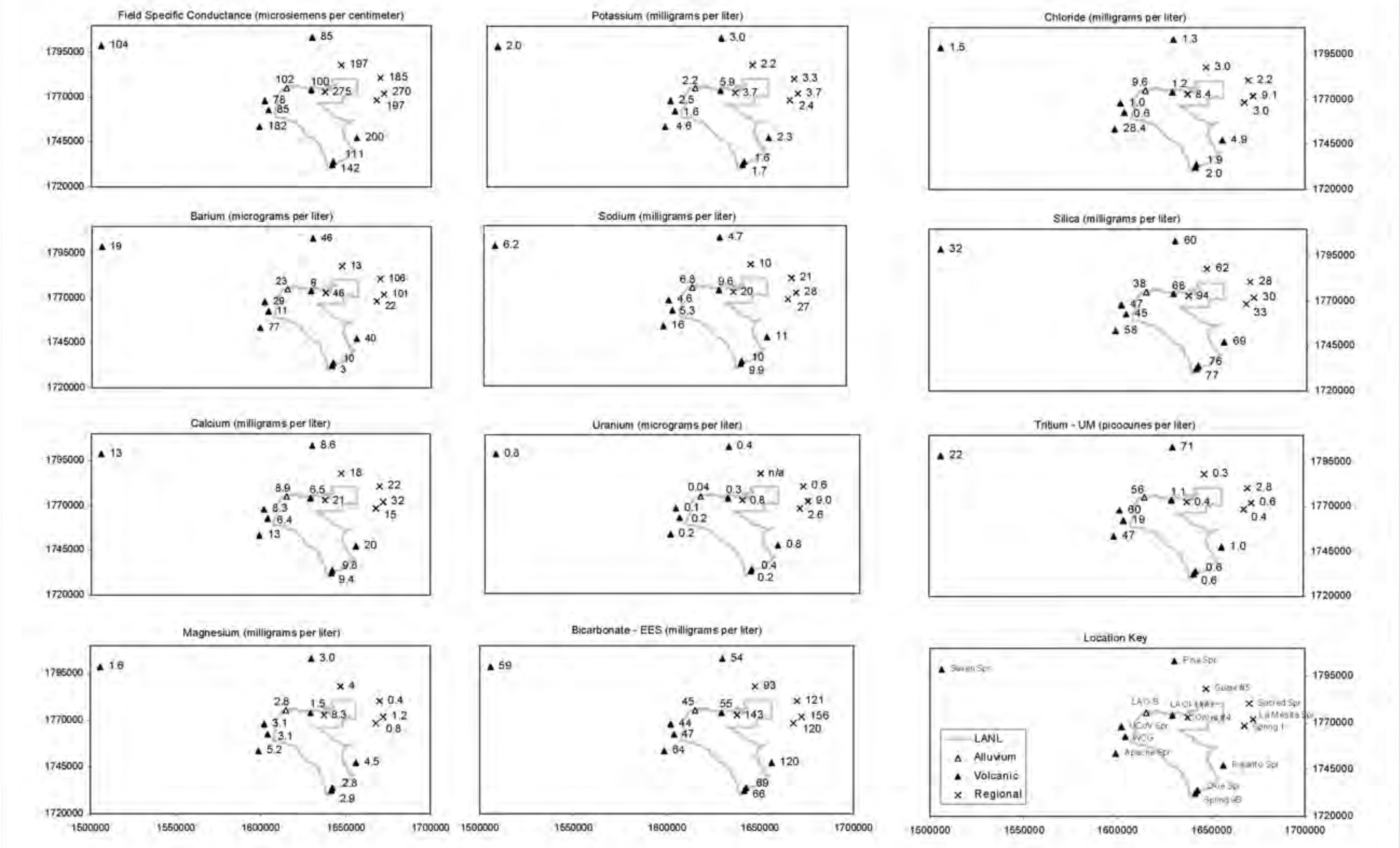
This section is a discussion of the geochemistry of the groundwater in the LANL region as presented in *Los Alamos National Laboratory's Hydrogeologic Studies of the Pajarito Plateau: A Synthesis of Hydrogeologic Workplan Activities (1998-2004) (Hydrogeologic Synthesis Report)* (LANL 2005b). First, the *Hydrogeologic Synthesis Report* discusses a geostatistical methodology of reducing the data from many sources outside the area that might have been contaminated and develops a groundwater chemistry baseline. Second, it presents conceptual models of each reach of canyon drainage that is thought to be unique in its natural and artificial flow and its contaminant transport history. Third, alternative models of contaminant transport to the perched water bodies and the regional groundwater are presented to relate the contaminant concentrations, recharge, and transport processes to probable sources, predominantly the canyon bottom alluvial aquifers. Last, it presents a discussion of conceptual models of the hydrogeology and geochemistry of the canyon springs.

The discussion of the components of geochemical conceptual models was broken into seven parts in the *Hydrogeologic Synthesis Report*. The components are:

- Natural geochemical composition of groundwater,
- Residence time of contaminant ions in the perched alluvial aquifer and the rocks of the vadose zone,
- Reactive minerals controlling groundwater composition and solute mobility,
- Adsorption and precipitation reactions,
- Redox conditions,
- Chemical speciation, and
- Colloids.

Natural Composition of Groundwater

Groundwater sampling to establish a baseline (background) of the chemistry of groundwater in the LANL area was conducted from 1997 to 2000. The composition of natural groundwater in the LANL area ranges from calcium-sodium bicarbonate water at the Sierra de los Valles to sodium-calcium bicarbonate water east and northeast of LANL. Sodium bicarbonate groundwater occurs in deep wells in the lower Los Alamos Canyon and along the Rio Grande and in springs in White Rock Canyon (LANL 2005b). This characterization of the natural groundwater permits the discrimination of natural components in the groundwater from manmade contaminants. **Figure E–9** shows the average concentrations of solutes, including specific conductance, major cations and anions, silica, tritium, and several trace elements such as uranium and barium from six sampling rounds.



Source: LANL 2005b.

Figure E–9 Average Spatial Distribution (n=6) for Key Analytes in Los Alamos National Laboratory Background Wells and Springs

Residence time

Residence time refers to the distribution of the ages of groundwater in the various groundwater environments under the Pajarito Plateau. Determining the residence time helps determine transport rates through the rocks. The residence time of natural major ions and trace elements in natural groundwater under the Pajarito Plateau increases from west to east and with depth in all modes of groundwater occurrence. Measurements of tritium in groundwater from within the Sierra de los Valles fractured volcanic rocks indicate that the groundwater is less than 60 years old; however, groundwater in the discharge area at White Rock Canyon ranges from 3,000 to 10,000 years old (LANL 2005b). Carbon-14 dating of regional groundwater in the LANL area indicates that a component of the groundwater is several tens of thousands of years old, becoming older from west to east. The presence of tritium indicates that younger water is mixing with the older water. Future studies are planned to determine the fractions of young and old water (LANL 2005b).

Reactive minerals

Groundwater reacts with the minerals in rocks through which it passes or in which it is stored. These reactions control basic chemical conditions such as pH and influence mineral precipitation and dissolution, as well as sorption of ions from groundwater by minerals. These are important controls on the evolution of groundwater as it migrates and on the mobility of contaminant ions.

In the natural groundwater, sodium, calcium, and bicarbonate are the most abundant major ion solutes. Silica is the second most abundant due to the interaction of volcanic glass with the groundwater. Average concentrations of natural arsenic and fluoride were highest in the Cerros del Rio basalts. Average concentrations of dissolved natural barium, boron, bromide, strontium, and uranium in the regional aquifer were highest at La Mesita Spring. Silica-rich rocks such as the Bandelier Tuffs contain more natural uranium than the basalts, which are silica-poor. Uranium in trace minerals such as zircon may exceed 1,000 parts per million, but zircon is highly refractory and has a low aqueous solubility ($10^{-15.4}$ molar at pH 7); consequently, it does not dissolve readily in the natural groundwaters at LANL. Some uranium is associated with volcanic glass in the Bandelier Tuff. In comparison with zircon, volcanic glass has a higher aqueous solubility ($10^{-27.1}$ molar at pH 7), but a low concentration of uranium. Therefore, even though the leachability is higher for volcanic glass, the concentration of uranium in perched water in the Bandelier Tuff is low (LANL 2005b).

Dissolved organic carbon is a component of groundwater derived from leaching solid organic matter from forests and grasslands. At LANL, organic matter is found in the perched water in the intermediate zones and in the regional aquifer and is typically less than 2 milligrams of carbon per liter. Higher concentrations are found in alluvial groundwater, soil, and surface water (20 milligrams of carbon per liter) (LANL 2005b). Ash from the Cerro Grande Fire in May 2000 increased the amount of leachable carbon in the LANL area. The increased concentration of total organic carbon can be used as a tracer for tracking recharge. Perched zones in the Cellos del Rio basalt in Los Alamos Canyon have exceeded 300 milligrams of carbon per liter.

Calcite, smectite, hydrous ferric oxide, manganese hydroxide, and zeolites are highly adsorptive for trace elements including chromium, lead, strontium, and thorium. As groundwater flows through the intermediate perched zones, the soluble silica glass that is present reacts with the groundwater and forms clay minerals, including kaolinite and smectite. Smectite increases the adsorption capacity of aquifer material under circumneutral (6.5 to 7.5) pH conditions. These interactions are only partially known in the specific groundwater environments beneath the Pajarito Plateau, but knowledge is expanding as new programs are being incorporated.

Adsorption and Precipitation

Adsorption and precipitation are the principal mechanisms that retard the transport of contaminants and keep them in residence in the vadose zone. These reactions are well documented for most of the contaminant ions present under the Pajarito Plateau. The specific groundwater environment in terms of pH and parallel mineral reactions are important controls on sorption and precipitation reactions. Definition of those relationships is an interactive process that is underway in the areas of specific concern at LANL (LANL 2005b). Geochemical processes increase concentrations (measured as total dissolve solids) of trace elements downward from the alluvial aquifer to perched water and on to the regional aquifer from west to east due to residence time and rock and water interactions such as adsorption-desorption (LANL 2005b). Relatively fresh water in the form of precipitation recharges the groundwater at the Sierra de los Valles and reacts with the rocks as it moves along flow paths, becoming more mineralized toward its discharge points. Notice in Figure E-9 that tritium decays along the flow path from west to east and that the concentration decreases within the noncontaminated intermediate perched water and the regional aquifer.

Redox Conditions

Redox condition refers to whether the local groundwater conditions are oxidizing or reducing. This influences mineral stability and sorption reactions and is another aspect of groundwater chemistry that controls contaminant mobility. As mentioned above, uranium is a naturally occurring trace element found in groundwater below the Pajarito Plateau. It is processed at LANL and is discussed at length in the *Hydrogeologic Synthesis Report* (LANL 2005b). As stated above, some other natural components of groundwater are calcium, bicarbonate, and silica compounds. The *Hydrogeologic Synthesis Report* (LANL 2005b) concludes that the temperature, pH, redox potential, and dissolved activities of the ions mentioned influence precipitation and dissolution of uranium compounds. These conclusions were based on geochemical calculations and the oxidizing conditions of natural groundwater beneath the Pajarito Plateau. The *Hydrogeologic Synthesis Report* (LANL 2005b) also concluded that, although it is useful to perform saturation index calculations to evaluate mineral equilibrium, most of the deep groundwaters are not in equilibrium with respect to the uranium compounds. Based on the results of the calculations they presented, adsorption processes appear to control dissolved concentrations of uranium in groundwater.

Chemical Speciation

Ions can exist as various stable isotopes and as parts of stable compounds (some organic) in groundwater. The form in which each contaminant ion exists influences its entry into precipitating minerals or sorption, and thus influences its mobility (LANL 2005b).

Colloids

The role of colloids in transport of contaminants at LANL is largely unknown and uninvestigated.

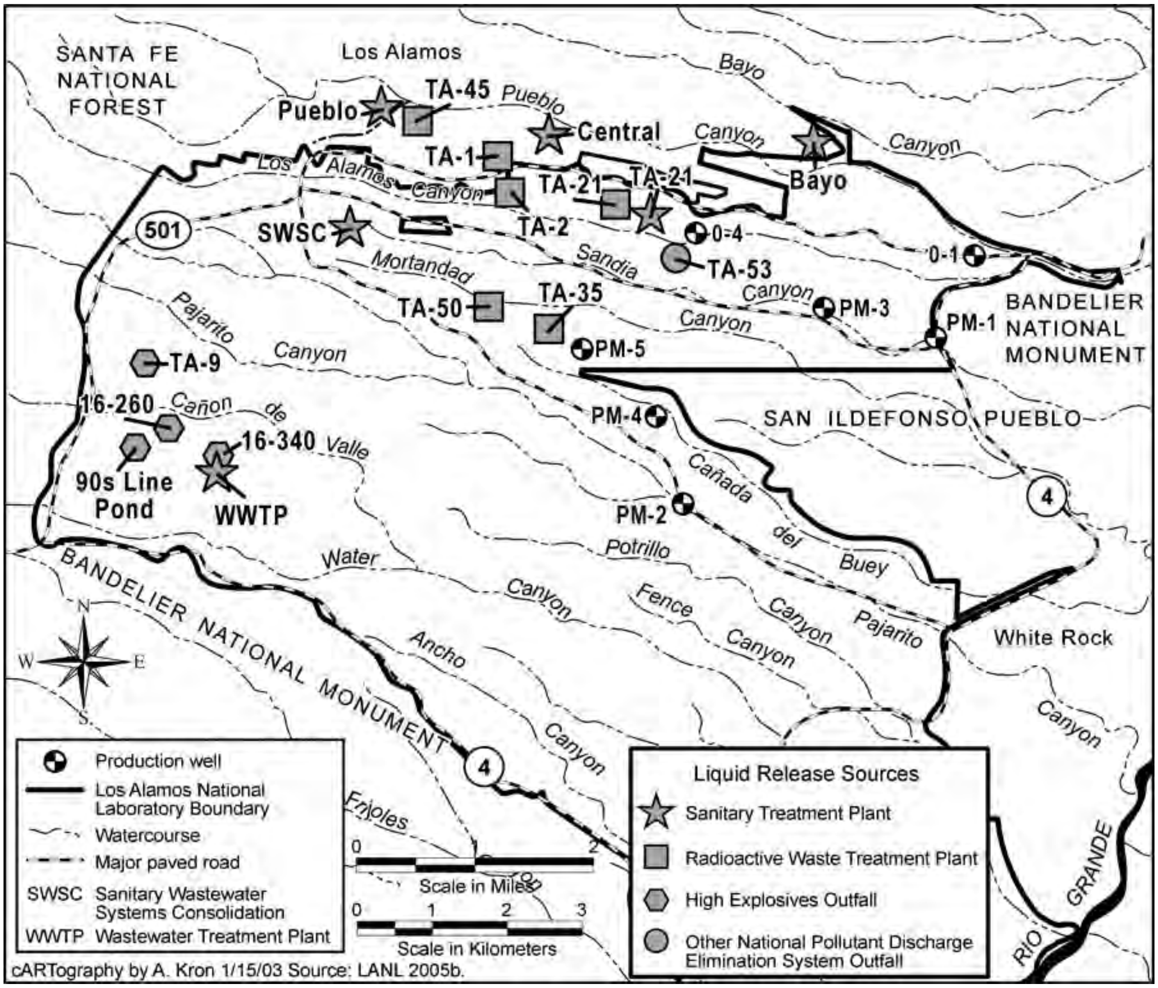
E.7.1.1 Contaminant Distributions

Anthropogenic contaminants in the groundwater at LANL generally derive from liquid effluent disposal into canyons or from surface impoundments on the mesa tops rather than from solid waste disposal. (Most solid waste disposal sites are located on mesa tops where there is little natural or artificial percolation to carry anthropogenic constituents to groundwater.) These effluents have degraded shallow perched water in some canyons (LANL 2005b). Canyons that have received radioactive effluent include Mortandad Canyon, Pueblo Canyon from its tributary Acid Canyon, and Los Alamos Canyon from its tributary DP Canyon. Effluents from high explosive processing and experiments contributed effluent to Water Canyon, its tributary Cañon de Valle, and Pajarito Canyon. Los Alamos County and the LANL contractor have operated sanitary treatment plants over the years (**Figure E–10**).

Effluent releases have impacted alluvial groundwater and in a few cases perched groundwater at depths of a few hundred feet. Little contamination from the perched groundwater zones under the mesas reaches the deep regional groundwater because the perched water is separated from the deep aquifer by hundreds of feet of unsaturated rock. LANL contaminants are found in groundwater below the alluvial aquifers in some canyons or below mesa tops where large retention ponds were located or where there were large-quantity discharges to the surface (LANL 2005b). The *Hydrogeologic Synthesis Report* (LANL 2005b) contains a summary of monitoring data by watershed and groundwater zone.

Observation of contaminant data and knowledge of geochemistry and the history of releases of contaminants provides a method of determining the rates and modes of groundwater flow through the subsurface to the regional aquifer. Nonreactive chemicals and compounds like tritium, perchlorate, and nitrate are used to determine how groundwater moves through the rocks. Some compounds or constituents (uranium, strontium-90, barium, some high explosive compounds, and solvents) are slowed by adsorption, precipitation-dissolution, oxidation-reduction, or radioactive decay, and some constituents (americium-241, plutonium) are strongly absorbed onto sediment and are nearly immobile (LANL 2005b).

Alluvial groundwater does not extend beyond LANL boundaries and has a short residence time. Tritium studies have shown that there is a rapid turnover of alluvial groundwater volume in the alluvial aquifers in the canyons and that contaminants do not accumulate. Since effluent limits were adopted in 2001, LANL has improved effluent quality and the once high values of tritium contamination are not present today. Since that time, tritium activity is barely detectable in Pueblo Canyon, DP Canyon, and Los Alamos Canyon and is below the maximum contaminant level in Mortandad Canyon.



cARTography by A. Kron 1/15/03 Source: LANL 2005b.

Figure E–10 Major Liquid Release Sources that have Potentially Affected Groundwater at Los Alamos National Laboratory (most of these are now inactive)

As mentioned above, perched groundwater is separated from alluvial groundwater by several hundred feet of unsaturated rock; even though recharge occurs slowly, contaminants in alluvial groundwater may reach the intermediate perched groundwater. Contaminant concentration data from the perched water zones below Mortandad Canyon indicate alluvial groundwater is the source of recharge to the intermediate groundwater by a process of infiltration (LANL 2005b).

The regional aquifer is separated from the intermediate perched groundwater by hundreds of feet of unsaturated rock. Recharge through these rocks to the regional aquifer occurs over a longer time than under the alluvial aquifers. Contaminants are found below alluvial groundwater in canyon bottoms or in perched water below mesa-tops where large amounts of effluents had been discharged to the surface. Tritium concentrations are much lower than values found in alluvial or intermediate groundwater due to dilution or to radioactive decay (LANL 2005b). Some high values are found in conjunction with effluent discharges near the liquid radioactive waste treatment plants shown in Figure E–10, at a past tritium disposal site (R-22 near Material Disposal Area G), and at a spring that had a value of 45 picocuries per liter, which may be due to a component of surface water because it is similar to rainfall and Rio Grande data (LANL 2005b).

Four alternative models are presented in the *Hydrogeologic Synthesis Report* (LANL 2005b). The models are described and examined to identify the strengths and weaknesses of the possible interpretations of available data. There is also a discussion of how the alternative models would change the current conceptual model and how the alternatives could be tested.

E.7.2 Geohydrologic Conceptual Model

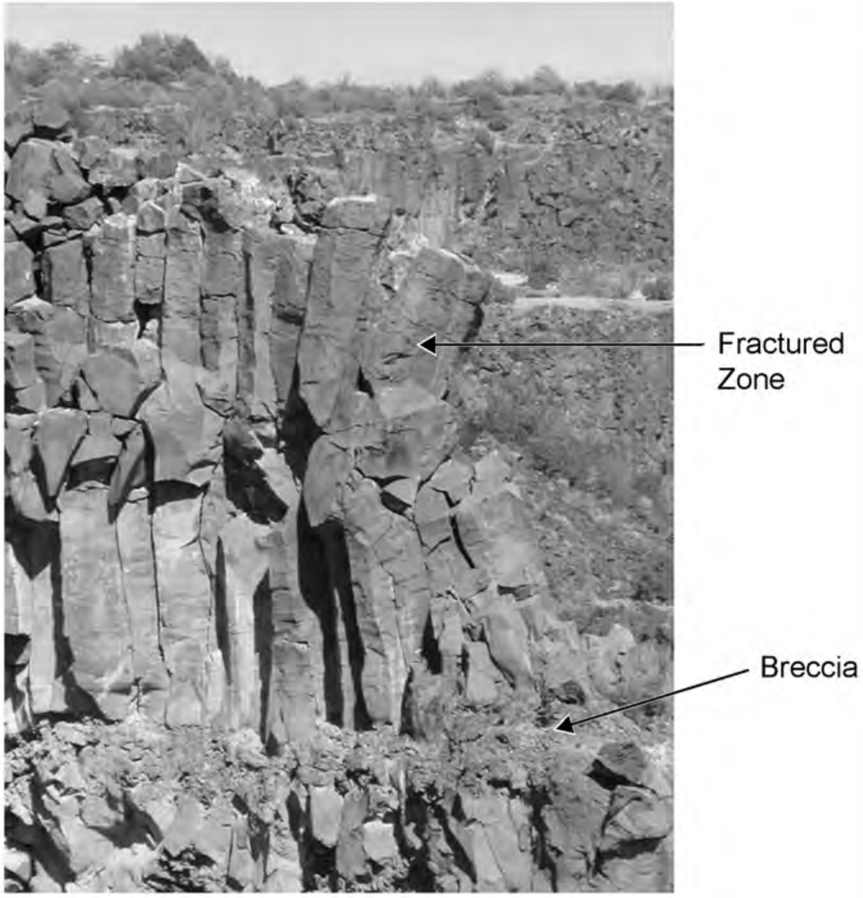
A conceptual model of the geohydrologic system at LANL is used for most numerical simulations by LANL workers and others (Robinson et al. 2005; Robinson, McLin, and Viswanathan 2005; Robinson, Broxton, and Vaniman 2005; Birdsell et al. 2005; Stauffer and Stone 2005; LANL 1995). The conceptual model was developed and supported based on field data. This section describes the components of the conceptual model and how they fit into the conceptual model.

Topography and Surface Water Setting. Deep canyons that begin in the Sierra de los Valles have large catchment areas, frequent surface flow, and perched alluvial groundwater (Birdsell et al. 2005). The wet canyons receive discharge from outfalls and wastewater treatment (anthropogenic water), as well as from infiltration of water from precipitation and shallow groundwater flow in the alluvium. Dry canyons originate on the plateau and have small catchment areas, infrequent flows, and no saturated alluvium in their floors. The dry canyons may display characteristics of the wet canyons if they receive anthropogenic water. In contrast to the wet canyons, there is little infiltration from these canyons. Mountain fronts receive more infiltration and this gives rise to localized perched water. Mountain front groundwater also flows laterally through fractures to nearby canyon walls, forming springs. As evidence for this conceptual model component, there are water budget studies (Kwicklis et al. 2005); moisture profile measurements and model simulations; major ion, stable-isotope, and contaminant concentration studies; and tracer tests in perched water for the mountain front case.

Anthropogenic Impacts. A second conceptual model component examines how anthropogenic activities significantly modified canyons and the intervening mesas of the Pajarito Plateau (Birdsell et al. 2005). Asphalt pavements have reduced evapotranspiration and built up subsurface moisture underneath. In addition, asphalt may focus runoff or may crack and cause infiltration where it may not have normally occurred. Effluent discharges to canyons from LANL or Los Alamos County sources have increased surface and groundwater flows, which have increased the infiltration rate to the vadose zone. In support of this component, water content measurements, contaminant transport measurements, and numerical simulations of paved areas and canyons influenced by LANL facilities are cited.

Flow and Transport Mechanisms. A third conceptual model component examines matrix and fracture flow transport mechanisms through the vadose zone to the regional aquifer (Robinson, McLin, and Viswanathan 2005; Birdsell et al. 2005; Springer 2005). Two principal hydrostratigraphic units with respect to vadose zone flow are the Bandelier Tuff and the Cerros del Rio basalts. Water movement in tuffs and basalts was examined. In poorly welded and fractured areas of the Bandelier Tuff, water moves into the fractures and is quickly absorbed into the high-permeability matrix; as a result, fractures play only a minor role in groundwater movement (Robinson, McLin, and Viswanathan 2005).

It was stated above that, at the Sierra de los Valles mountain front above the Pajarito fault zone west of LANL, the Bandelier tuffs are more densely welded than they are eastward under LANL toward the Rio Grande. Wellbore injection testing shows that water moves primarily in fractures of densely welded tuffs and basalts and is not absorbed as readily into the low-permeability rocks as it is into the fractures of poorly welded tuff (Robinson, McLin, and Viswanathan 2005; Birdsell et al. 2005). Typically, groundwater flow through basalts is controlled by cooling structures. Groundwater flow is vertical through the interior basalts where slow cooling occurred and columnar structures were formed with pronounced vertical fractures. **Figure E–11** is a photograph of the Cerros del Rio basalts below the Bandelier Tuff Otowi Member. Note the vertically fractured, dense interior columnar section and the more porous horizontal breccia zone. Groundwater flow is horizontal through these rapidly cooled breccias that make up the tops and bottoms of the basalt-flows. Groundwater flow is also horizontal in the interflow sediments. Perched water occurs in these porous brecciated zones underlying highly fractured basalt that overlies a massive unfractured flow interior (Birdsell et al. 2005). This conceptual model is supported by cited reports of water content measurements, major ion measurements, contaminant transport measurements, numerical simulations, field measurements at instrumented sites, and fluid injection tests (Birdsell et al. 2005).



Source: LANL 2005b.

Figure E–11 Outcrop of Cerros del Rio Basalt at White Rock Overlook (East of Los Alamos National Laboratory)

Vadose Zone Travel Times. Travel times in the vadose zone at LANL vary from several years to several decades. Travel time is shortest in fractured basalts, decades long where there are significant thicknesses of Bandelier Tuff, and in excess of thousands of years in dry canyons (Birdsell et al. 2005). The conceptual model was supported by numerical modeling of wet canyons (Robinson et al. 2005, as discussed in Section E.8.1), contaminant profiles in vadose zone boreholes, chloride and isotope profiles, and groundwater surveillance reports.

These conceptual model components provide a basis for numerical simulations of groundwater flow and transport through the vadose zone at LANL. Summaries of numerical modeling research at LANL are provided below.

E.8 Numerical Modeling Studies

This section describes numerical modeling activities by LANL workers. The numerical simulations mainly incorporate the conceptual model developed by Birdsell et al. (2005), as presented in the previous section.

E.8.1 A Vadose Zone Flow and Transport Model for Los Alamos Canyon, Los Alamos, New Mexico (Robinson et al. 2005)

Purpose: The purpose of this effort was to develop a large-scale numerical model to advance understanding of vadose zone flow and the transport of contaminants to the regional aquifer. This required applying a conceptual model to knowledge of the hydrostratigraphy, hydrologic conditions, and field measurements. Primarily, the purpose was to develop a numerical simulation of flow; but the transport of tritium in the form of tritiated water beneath Los Alamos Canyon was also modeled. Tritiated water is a good tracer and acted as a constraint on the numerical model (Robinson et al. 2005).

Conceptual Flow Model: The hydrologic system was characterized as an equivalent continuum model; that is, the model captured the characteristics of both the fractures and the matrix. The fractures are predicted to be dry until the capillary pressure of the matrix is a low value (saturated), fracture flow begins, and liquid permeability rises. The equivalent continuum model then behaves like a single continuum model (Robinson et al. 2005).

The infiltration rates used for the canyons and mesa tops were based on the Birdsell et al. (2005) conceptual model outlined above for wet canyons. Infiltration rates used in the simulation were calculated from previous studies using the rates from direct drainage from the alluvium to the vadose zone along the floor of Los Alamos Canyon (Birdsell et al. 2005). The highest rate (42.4 inches [1,076 millimeters] per year) occurs in the upper reaches of the canyon near the Guaje Fault zone where it is probably highly fractured due to faulting.

The source of contaminants used for this model was the Omega West reactor site that was used from 1943 to 1994 to house various reactors. Tritium was one of various radionuclides released into the canyon from a cooling water system leak discovered in 1993 that may have started in late 1969 or early 1970 (Robinson et al. 2005). It is used as a tracer because of its chemical state as a water molecule; it is not readily sorbed; and it does not precipitate out of solution or have complicated speciation processes.

Model Development: Information from 20 geological units was integrated into computational grids using a three-dimensional framework. Site-specific data from LANL's program of site characterization and their comprehensive drilling program, coupled with previous numerical modeling activities, were used for the framework. The accepted stratigraphic designation described previously was used (Broxton and Vaniman 2005). Los Alamos Canyon cuts deep into the Bandelier Tuff with the result that the Tshirege Member is not very thick at the canyon head and absent at the lower reach of the canyon. The Otowi Member is the first unit encountered below the canyon alluvium in much of the model domain. In the lower reach of the canyon, the Cerros del Rio basalts (Tb4) are below the alluvium.

Numerical Grids: The numerical model incorporated both two- and three-dimensional finite element grids. The model used was the Finite Element Heat and Mass code. This code was used because it was used in previous numerical modeling efforts at LANL for saturated and unsaturated flow and the code solved the equations needed for two-phase flow of air and water (Robinson et al. 2005; Birdsell et al. 2005). A two-dimensional grid was used for scoping and sensitivity analysis because it has a smaller number of nodes and elements and is computationally efficient.

Results: Model results suggest that the nonwelded and partially welded Bandelier Tuffs dampen episodic infiltration events; that is, the steady-state model shows that, if infiltration occurs all at once or is averaged over a year, the result yields a similar water content profile. Transients caused by anthropogenic activities over a decade or longer significantly affect predicted water content. Tritium transport modeling indicates that tritium has decayed and that most other contaminants released reside in the vadose zone. The model also suggests that, where the tuffs are absent, such as the lower Los Alamos Canyon near the confluence with Pueblo Canyon, there is a risk of contaminants getting to the regional groundwater.

E.8.2 Hydrologic Behavior of Unsaturated, Fractured Tuff: Interpretation and Modeling of a Wellbore Injection Test (Robinson, McLin, and Viswanathan 2005)

Purpose: This study interprets and models a reported injection test in the Tshirege Member of the Bandelier Tuff and examines different conceptual models. Four conceptual models were developed for flow and transport in fractured tuffs utilizing data from an early injection test in the Tshirege Member of the Bandelier Tuff.

Model Development: The first conceptual model tested was a single continuum model where fractures play no role in flow and transport. A second conceptual model was an equivalent continuum model that captures characteristics of both fractures and matrix. The third conceptual model was a dual-permeability model where it is assumed that the fractures and matrix represent two separate, but coupled, continua. The fourth conceptual model was a discrete fracture model that represents the fractures with distinct hydrologic properties within a model domain that includes the rock matrix. A numerical simulation was then run for each conceptual model. For kilometer-scale simulations, basalts are considered by some workers as a homogeneous continuum with a high permeability and low porosity (Stauffer and Stone 2005).

The same numerical grid, boundary conditions, and hydrologic properties were used for all of the numerical simulations of the conceptual models except for the discrete fracture model. For the discrete fracture model, idealized calculations were performed to develop a mechanistic explanation of how the hydrologic behavior of the tuffs changes when water is injected into a dry fracture.

Results: The study results suggest that flow and transport in the tuffs is through the matrix rather than fractures. This is the result of the high matrix permeability of the tuff. The matrix-dominated flow decreases travel velocities and increases retardation by sorption. Sorption is increased because more water comes in contact with the rock by absorbtion into the rock rather than by contact with the walls of a fracture. Rocks with rather high capillary suction properties would be expected to result in more lateral movement and spreading of a plume.

E.8.3 Development and Application of Numerical Models to Estimate Fluxes through the Regional Aquifer beneath the Pajarito Plateau (Keating, Robinson, and Vesselinov 2005)

Purpose: This study integrates new site-wide data into a model of the regional aquifer beneath the plateau and provides new insight into large-scale aquifer properties. This aquifer is the primary source of water for Santa Fe, Española, Los Alamos, various Pueblos, and LANL. There is a concern about dropping water levels because in 2002 there was a decrease in baseflow to the Rio Grande. There is also a concern that water quality is decreasing because of contamination from LANL sources. This study provides a comprehensive literature review for the aquifer and supplements it with interpretations of new data. This appendix synopsis of the study includes other supporting citations.

Recharge and Discharge: This study (Keating, Robinson, and Vesselinov 2005) discusses and cites various concepts of recharge to the regional aquifer. Early workers thought recharge occurred at various places: Sierra de los Valles, along stream channels on the western edge of the Pajarito Plateau, and in Valles Caldera. Water chemistry did not support these concepts. It was then proposed by various workers that recharge areas were either from the Sangre de Cristo Mountains to the east or from the north and east, but not from the west. Water balance and chloride mass-balance analyses indicate that basin recharge does occur in the mountains at the margins of the basins. Findings based on stable isotope ratios suggest that recharge to groundwater under Pajarito Plateau is from Sierra de los Valles and very little is from Valles Caldera (LANL 2005a). Some recharge is also from streamflow infiltration along arroyos and canyons on the plateau and some recharge, although volumetrically small compared to mountain recharge, is from the surface of the mesas. This study (Keating, Robinson, and Vesselinov 2005) reports that tritium data indicate that water below LANL is relatively young and derives from fast-path flow through the vadose zone. Tritium studies in groundwater discharging from springs within the Sierra de los Valles indicate that the water is about 60 years old. However, groundwater from springs in White Rock Canyon has no tritium and probably ranges in age somewhere between 3,000 to 10,000 years (LANL 2005a).

Discharge of groundwater from under the plateau is assumed by many workers to be to the Rio Grande at White Rock Canyon and may occur as lateral flow, upward flow, or flow from springs. One hypothesis being explored is that the springs come from draining perched aquifers. A second hypothesis is that discharge of groundwater from the regional aquifer may also be southeasterly to the lower Albuquerque Basin, but a structural high at the boundary of the

Española Basin and the Albuquerque Basin may be impeding flow. This would cause interflow upward to the surface. This hypothesis has not been resolved because no studies have been conducted in the lower part of the Española Basin (Keating, Robinson, and Vesselinov 2005).

Aquifer Properties: The hydrostratigraphic units were described above. It is apparent that the units are complex because of the tectonic, volcanic, and sedimentary processes that occurred in the LANL region. Santa Fe Group and Puye Formation rocks are made up of intertonguing alluvial fans separated by layers of volcaniclastics, lava deposits, breccia zones, and other materials, resulting in vertically anisotropic conditions. This is supported by short-term well tests where permeability data are derived from production wells with large screened intervals. The well test results show permeability perpendicular to bedding planes is less than permeability parallel to bedding planes (Keating, Robinson, and Vesselinov 2005). Anisotropy may also be the result of the numerous north-south faults in the basin interfering with spatial continuity of low- or high-permeability rocks. For instance, a layer may look as if it has good permeability, but when tested on a large scale, it may appear to have a poor hydraulic connection to other parts of the same unit because it is interrupted by a low-permeability fault zone.

Several conceptual models regarding the regional aquifer have been developed. The complex geologic structures and data from well tests have several interpretations. Earlier workers postulated the Santa Fe Group is under water table conditions near the Sierra de los Valles and becomes confined eastward. Specific storage data indicate that parts of the aquifer exhibit "leaky-confined" conditions because of semi-confining layers of rocks. Another conceptual model proposes that the anisotropic condition of the aquifer interferes with vertical movement of groundwater, making it appear to be confined during short-term pumping tests. A third conceptual model is that a laterally extensive low-permeability layer confines the lower part of the aquifer and is overlain by groundwater under water table conditions.

Model Development: Three numerical models were integrated: a three-dimensional hydrostratigraphic framework model, a three-dimensional numerical flow and transport model (based on the Finite Element Heat and Mass Transfer Model discussed above), and a model of recharge based on precipitation data. The model incorporates no-flow boundaries at the Santa Clara River to the north, the Valles Caldera to the west, the Rio Frijoles to the south, and the Rio Grande to the east. The upper boundary represents the top of the saturated zone, which has a constant thickness throughout the simulation. The eastern edge of the upper boundary of the model is the Rio Grande and has a specified head. The Buckman well field is a transient flux (sink) to simulate production.

Results: Groundwater flow in the numerical model was to the south-southeast and generally fits the conceptual models of flow. Calculated heads near wells R-9, R-12, R-22, and R-16 were not matched well with actual heads. The model showed that transport calculations would benefit from a refinement of the hydrostratigraphic framework. It was felt that a low-permeability layer separating the upper aquifer from the lower aquifer would allow a closer match of the calculated heads and fluxes with actual data. Calculated total recharge to the aquifer was within the range of early estimates and does occur to the west. The simple recharge model demonstrated that production water is coming from storage from the deeper zones in the aquifer rather than from the shallow zones that receive water from local recharge. Parameter uncertainty impacts the ability to make predictions of fluxes and velocities through individual units downgradient from

LANL. Estimated pore-water velocities varied from 3.3 feet per year (1 meter per year) to 415 feet per year (125 meters per year) in the deep Miocene basalt unit Tb2. This makes predictions of lateral contaminant movement difficult where the basalts are present and brings up the possibility that contaminants may have traveled a significant distance laterally (Keating, Robinson, and Vesselinov 2005). Uncertainties about porosity and permeability also lead to model uncertainty.

E.8.4 Observations and Modeling of Deep Perched Water beneath the Pajarito Plateau (Robinson, Broxton, and Vaniman 2005)

Purpose: The purpose of this study was to perform numerical simulations using vadose zone flow models of two deep perched water zones. One zone is relatively stagnant and the other more dynamic.

Conceptual Model: The conceptual model is also presented in Section E.7.2. Much has been learned about perched water in spite of some difficulties encountered. Small perched bodies are not easily identified because of the drilling techniques required. The lateral extent of deep perched water bodies is also difficult to determine because of the cost of drilling wells. Identification of perched water systems is mostly from observation of saturation in open boreholes using video logs, water measurements, electric logs, neutron logs, wells, and piezometers. Thirty-three occurrences of deep perched water across the Pajarito Plateau are reported (Robinson, Broxton, and Vaniman 2005). The depth to perched water ranges from 118 to 894 feet (36 to 272 meters). The principle occurrence of perched groundwater is in the large wet canyons (Los Alamos and Pueblo Canyons), the smaller watersheds (Sandia and Mortandad Canyons), and Cañon de Valle. Perched water is found in the Puye Fanglomerates, Cerros del Rio basalts, and Bandelier Tuffs (Robinson, Broxton, and Vaniman 2005). Perched water is less common under the dry mesas.

Some deep perched water contains mobile (nonsorbing) anthropogenic chemicals, but no direct measurements have been made to determine how the chemicals reached the perched water. Two conceptual models that are at present untestable are presented to explain the process: a low-velocity, stagnant water resting in a depression above the perching horizon and a high-velocity, laterally migrating fluid that travels on top of the perching horizon (Robinson, Broxton, and Vaniman 2005). Perching horizons in the low-velocity model slow the downward percolation of water, but seem to become dry when penetrated by a borehole and not recharged. In the high-velocity model, water percolates into a deep perched zone; then moves laterally to where the zone pinches out or reaches another vertical, permeable pathway; and then moves downward. This is repeated until it can no longer move downward or it reaches the regional aquifer. These two scenarios can occur together. Deep perched water does not appear to extend far below the dry mesas (Robinson, Broxton, and Vaniman 2005).

Model Development: A model that considers perching horizons as interfaces between hydrostratigraphic units was developed. It uses an interface reduction factor method to account for perched water. When mean values for hydraulic conductivity are used in a model, the water will move through the unsaturated zone and will not perch or move laterally. The derivation of an equation called the permeability reduction factor was added to the Finite Element Heat and Mass Transfer code. The reduction factor allows the user to enter a multiplier that will reduce the permeability at the interface of two hydrostratigraphic units and allow increased saturation. A two-dimensional model was then run using permeability reduction factors for simulating the perched zone. Models without the low-permeability barrier were run for comparison.

Results: The results were compared to information from wells LADP-3 and LAOI(A)-1.1, which penetrate the Guaje Pumice Bed-Puye Formation interface. The Guaje Mountain fault zone was used as the high-infiltration zone. The base case had no permeability reduction factor, but showed a slight increase in saturation at the Guaje Pumice Bed; however, no perching occurred. When the reduction factor was used, perching occurred and increased as the factor was lowered. Particle tracking showed that, as the reduction factor was decreased, migration of contaminants moved laterally. Some contaminants moved through the interface.

Perched water zones in the Pajarito Plateau and Yucca Mountain, Nevada, are being extensively studied and have some similarities. Both places have the low-permeability zones required for perching to occur. The low-permeability zone at Yucca Mountain is an extensive low-permeability zone of zeolites. At Pajarito Plateau, the low-permeability zones are limited in area and are associated with stratified sedimentary units and dense basalts.

Fluid velocity in the perched zones is unknown and hydrologic testing, tracer tests, or groundwater dating methods are required to determine the age of the groundwater. Anthropogenic chemicals found in perched zones in some wet canyons allow for some estimates of travel times that may be only on the order of decades.

E.9 References

Birdsell, K. H., B. D. Newman, D. E. Broxton, and B. A. Robinson, 2005, "Conceptual Models of Vadose Zone Flow and Transport beneath the Pajarito Plateau, Los Alamos, New Mexico," *Vadose Zone Journal*, 4:620-636, August 16.

Broxton, D. E., and D. T. Vaniman, 2005, "Geologic Framework of a Groundwater System on the Margin of a Rift Basin, Pajarito Plateau, North-Central New Mexico," *Vadose Zone Journal*, 4:522-550, July 18.

Cather, S. M., 2004, "Laramide Orogeny in Central and Northern New Mexico and Southern Colorado," *The Geology of New Mexico, A Geologic History,* p. 203-248, Special Publication 11, The New Mexico Geological Society, Socorro, New Mexico.

Goff, F., and J. N. Gardner, 2004, "Late Cenozoic Geochronology of Volcanism and Mineralization in the Jemez Mountains and Valles Caldera, North Central New Mexico," *The Geology of New Mexico, A Geologic History,* p. 295-312, Special Publication 11, The New Mexico Geological Society, Socorro, New Mexico.

Keating, E. H., B. A. Robinson, and V. V. Vesselinov, 2005, "Development and Application of Numerical Models to Estimate Fluxes through the Regional Aquifer beneath the Pajarito Plateau," *Vadose Zone Journal*, 4:653-671, August 16.

Kwicklis, E., M. Witkowski, K. Birdsell, B. Newman, and D. Walther, 2005, "Development of an Infiltration Map for the Los Alamos Area, New Mexico," *Vadose Zone Journal*, 4:672-693, August 16.

LANL (Los Alamos National Laboratory), 1995, *The Unsaturated Hydraulic Characteristics of the Bandelier Tuff*, LA-12968-MS, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005a, *Groundwater Background Investigation Report*, LA-UR-05-2295, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2005b, *Los Alamos National Laboratory's Hydrogeologic Studies of the Pajarito Plateau: A Synthesis of Hydrogeologic Workplan Activities (1998-2004)*, LA-14263-MS, Los Alamos, New Mexico, December.

Levitt, D. G., D. L. Newell, W. J. Stone, and D. S. Wykoff, 2005, "Surface Water–Groundwater Connection at the Los Alamos Canyon Weir Site: Part 1. Monitoring Site Installation and Tracer Tests," *Vadose Zone Journal*, 4:708-717, August 16.

Newman, B. D., and B. A. Robinson, 2005, "The Hydrogeology of Los Alamos National Laboratory: Site History and Overview of Vadose Zone and Groundwater Issues," *Vadose Zone Journal*, 4:614-619, August 16.

Robinson, B. A., D. E. Broxton, and D. T. Vaniman, 2005, "Observations and Modeling of Deep Perched Water Beneath the Pajarito Plateau," *Vadose Zone Journal*, 4:637-652, August 16.

Robinson, B. A., G. Cole, J. W. Carey, M. Witkowski, C. W. Gable, Z. Lu, and R. Gray, 2005, “A Vadose Zone Flow and Transport Model for Los Alamos Canyon, Los Alamos, New Mexico,” *Vadose Zone Journal*, 4:729-743, August 16.

Robinson, B. A., S. G. McLin, and H. S. Viswanathan, 2005, “Hydrologic Behavior of Unsaturated, Fractured Tuff: Interpretation and Modeling of a Wellbore Injection Test,” *Vadose Zone Journal*, 4:694-707, August 16.

Smith, G. A., 2004, “Middle to Late Cenozoic Development of the Rio Grande Rift and Adjacent Regions in Northern New Mexico,” *The Geology of New Mexico, A Geologic History*, p. 331-358, Special Publication 11, The New Mexico Geological Society, Socorro, New Mexico.

Springer, E. P., 2005, “Statistical Exploration of Matrix Hydrologic Properties for the Bandelier Tuff, Los Alamos, New Mexico,” *Vadose Zone Journal*, 4:505-521, July 18.

Stauffer, P. H., and W. J. Stone, 2005, “Surface Water–Groundwater Connection at the Los Alamos Canyon Weir Site: Part 2. Modeling of Tracer Test Results,” *Vadose Zone Journal*, 4:718-728, August 16.

APPENDIX F
ENVIRONMENTAL SAMPLE DATA

APPENDIX F
ENVIRONMENTAL SAMPLE DATA

Appendix F presents an analysis of 2001 through 2005 environmental monitoring analytical results for use in this *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (LANL SWEIS). In Appendix F these results are evaluated for the following three purposes:

- To summarize and present the 2001 through 2005 environmental sample data in a manner[1] analogous to that used in the *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS)* (DOE 1999);
- To evaluate the effects of the Cerro Grande Fire of May 2000, at an aggregate level, on the concentration of radioisotope analytical results in groundwater, sediment, stormwater runoff, and soil samples in and around LANL (in Section F.2); and
- To provide conservative assessments of environmental concentrations of radioisotopes and chemicals (in Section F.3) for use in calculating the Offsite Resident (Los Alamos County resident), Recreational User, and Special Pathways receptor impacts presented in Appendix C, Section C.1.4.

Appendix F is not intended to replace or supplement the LANL annual Environmental Surveillance Reports (LANL 2002, 2004a, 2004b, 2005, 2006b). Those reports provide analyses of environmental measurement results along with statistical interpretation of the data and assessments of data importance. The statistical analysis in the LANL Environmental Surveillance Reports results in a determination as to whether each specific chemical or radioisotope (denoted an analyte) is conclusively present, that is, has actually been detected, in a sample. The data analysis in Appendix F is for the purposes described above and is not intended to indicate the presence of known contamination in the environment.

F.1 Environmental Monitoring Selection

Los Alamos National Laboratory (LANL) staff conducts an ongoing environmental monitoring program that encompasses locations within LANL, along the perimeter of LANL, and throughout the region of non-LANL land in the adjoining counties. This program provides an extensive set of measurements of radiological and hazardous chemical substances in the air, surface water or stormwater runoff, groundwater, sediment, and soil.

For radiological monitoring, periodic samples are obtained and measured for a wide range of radioisotopes, as well as gross alpha, beta, and gamma radiation. Monitored radioisotopes

---

[1] *A similar approach is used in Section F.2 as was used to average the environmental data presented in the 1999 SWEIS. This allows the 2001 through 2005 environmental data in Section F.2 to be compared with the data from 1991 through 1996 presented in the 1999 SWEIS. The statistical treatment of data and the comparison between the two time frames does not account for differences in measurement techniques or instrument accuracy.*

include americium-241, cesium-137, cobalt-60, iodine-129, neptunium-237, plutonium-238, plutonium-239, plutonium-240, potassium-40, radium-226, radium-228, sodium-22, strontium-90, technetium-99, tritium, uranium-234, uranium-235, uranium-236, and uranium-238. Radioisotope concentrations in the soil collected within and around LANL has been very low and, for the most part, has not increased over time. Soils are now sampled every 3 years. Tritium is measured in both solid and liquid samples because of its high affinity for the liquid state as tritiated water. Most of these radioisotopes have relatively long half-lives (greater than 10 years, except for cobalt-60, radium-228, and sodium-22), can have significant health impacts in sufficient quantities, and represent many of the radioisotopes that are handled, managed, and stored at LANL. They also constitute the entire range of high-energy emitters of alpha, beta, gamma, and neutron radiation.

During 2001 through 2005, radiological samples were obtained from 15 onsite canyons, as well as sites along LANL's borders. Further measurements were made of samples from the surrounding counties. These samples were used to measure radioactivity levels, and the data were subjected to statistical analysis. The data were subdivided into three principal regions of interest: Regional, Perimeter, and Onsite.

F.2 Evaluation of Los Alamos National Laboratory Environmental Sampling Data

Numerous studies and analyses have been performed on the effects of the Cerro Grande Fire at LANL. One area of major interest is the redistribution of radioisotopes in the environment in and around LANL due to this wildfire. The current measured[2] distribution of radioisotopes in the environment was used to calculate doses to special receptors as reported in Appendix C of this SWEIS. The current measured radioisotope distribution in soil, surface water or stormwater runoff, sediment, and groundwater was also used to calculate worker and public doses from a postulated wildfire accident in Appendix D.

As environmental measurements of radioisotopes in and around LANL now exist for 2001 through 2005 and the same data were developed for the *1999 SWEIS* for the years 1991 through 1996, a graphical presentation was prepared to compare the distribution for selected radioisotopes in each of the four environmental media (groundwater, sediment, soil, and surface water or stormwater runoff). Only those radioisotopes that were measured in both sets of data were presented graphically. **Figures F–1** through **F–23** present the mean measured concentration of a specific radioisotope at a specific location in or near LANL. One symbol represents the 2001 through 2005 data, while a different symbol represents the 1991 through 1996 data, resulting in a "scatter plot" for each radioisotope and medium. The use of this type of plot allows the observer to make general observations regarding any trend.

The data in these figures were based on measurements at Regional, Perimeter, and Onsite locations. Each mean measured concentration data point was calculated from annual measurements at one of the various locations. The radioisotopes of interest that were plotted are americium-241, cesium-137, plutonium-238, plutonium-239 and plutonium-240, strontium-90, and tritium. These isotopes represent relatively long half-life nuclides with potentially

---

[2] In this appendix, the use of the terms measured or measurements refers to values derived from the sample analytical data in accordance with the statistical evaluation described in Section F.3.

significant health hazards that may have been released by LANL facilities. For soil environmental data, only the mean for the composite Regional, Perimeter, and Onsite stations is presented because those are the only data available for both periods. In addition, strontium-90 data are not available for soil data from both time periods. Each sediment and soil graph also presents the LANL human health risk-based Screening Action Level (SAL) (LANL 2001) that LANL uses as a criterion for acceptable sediment and soil radioisotope mass concentration level except for tritium, which is defined as a volumetric concentration value. The SAL indicates whether further study or environmental remediation is required. These LANL SALs for sediments and soil were first developed in 2001 and are based on the U.S. Environmental Protection Agency (EPA) guidance limit of 15 millirem per year for residential, commercial, recreational, and industrial use of the land. The SAL calculation includes inhalation, ingestion, and external exposure pathways. The radionuclide SALs were calculated for a 1,000-year timeframe with no loss by erosion or leaching (LANL 2001).

The grouping of the data has changed over the years. To allow visual comparison in graphs, the data for 1991 through 1996 are related to 2001 through 2005 data as shown in **Table F–1**. **Figures F–1** through **F–6** are graphs for groundwater data for measured isotopes for the groundwater data sets as shown in Table F–1. Table F–1 also indicates the Section F.3 data tables that correspond to the 2001 through 2005 data sets.

Table F–1 Groundwater Data Set Comparison

Location Number	*1991 through 1996 Data Set Identifier*	*2001 through 2005*	
		Data Set Identifier	*Data from Table*
1	Alluvial Groundwater	Canyon Alluvial Groundwater Systems [a]	F–15, F–16
2	Spring from Basalt	Basalt Springs [b]	F–18
3	Main Aquifer	Regional Aquifer Wells [c]	F–10
4	Test Wells	Test Wells	F–12
5	Springs	Regional Aquifer Springs	F–14
6	Springs from Volcanics [d]	Water Gallery (2001-2003) [d]	F–18
7	San Ildefonso	San Ildefonso Pueblo	F–19
8	Intermediate Perched	Intermediate Perched Groundwater Systems [e]	F–17, F–18
9	Not Measured	Hydrogeologic Characterization Wells	F–11
10	Not Measured	Water Supply Wells	F–13
11	Not Measured	Santa Fe Water Supply Wells	F–20

[a] Canyon Alluvial Groundwater Systems encompasses Canyon Alluvial Wells and Canyon Alluvial Springs, which are separated into Table F–15 and Table F–16.

[b] Basalt springs is a subset of the Los Alamos Canyon data in Table F–18, Intermediate Perched Springs.

[c] Regional Aquifer Wells is a summation of Hydrogeologic Characterization Wells, Test Wells, and Water Supply Wells.

[d] Data from the location identified as Springs from Volcanics in 1991 through 1996 most closely correlates with data from Water Gallery (2001-2003). Water Gallery data are a subset of the Water Canyon data in Table F–18, Intermediate Perched Springs.

[e] Intermediate Perched Groundwater Systems encompasses Intermediate Perched Wells and Intermediate Perched Springs, which are separated into Table F–17 and Table F–18.

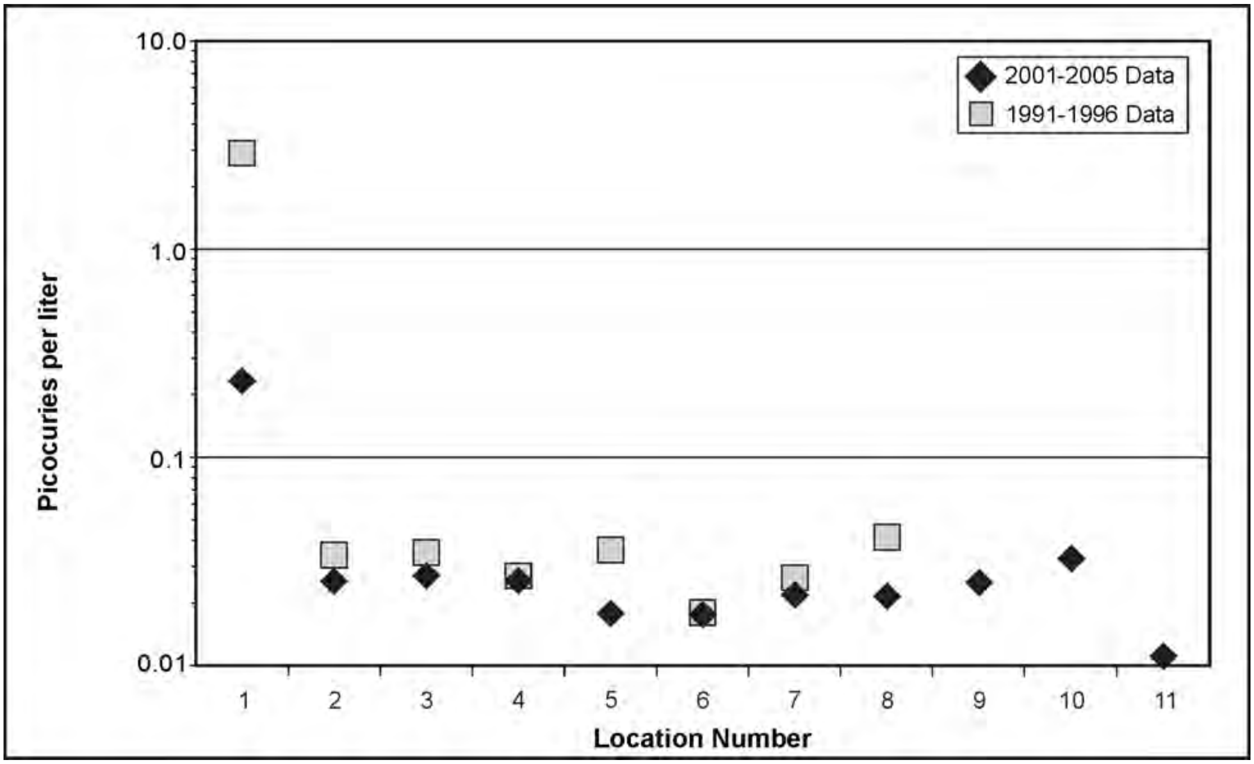


Figure F–1 **Americium-241 Measured Mean Concentration Value for Groundwater**

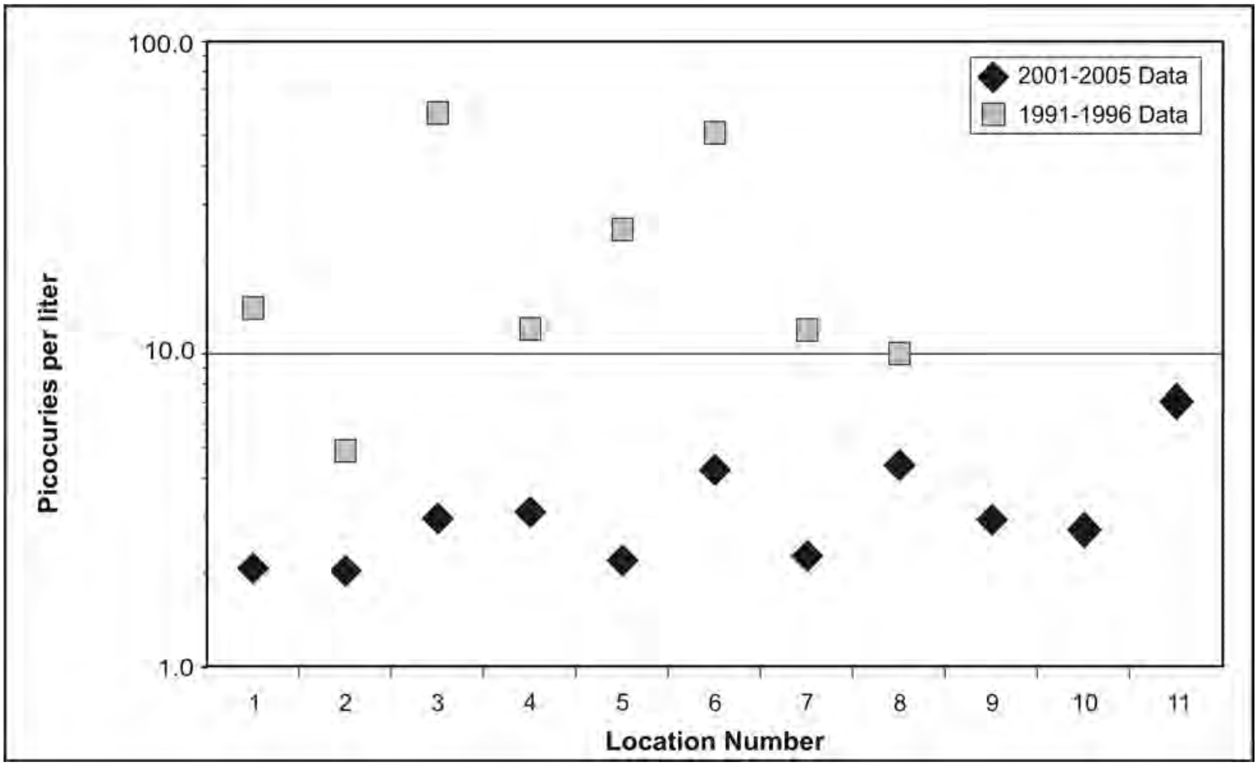


Figure F–2 **Cesium-137 Measured Mean Concentration Value for Groundwater**

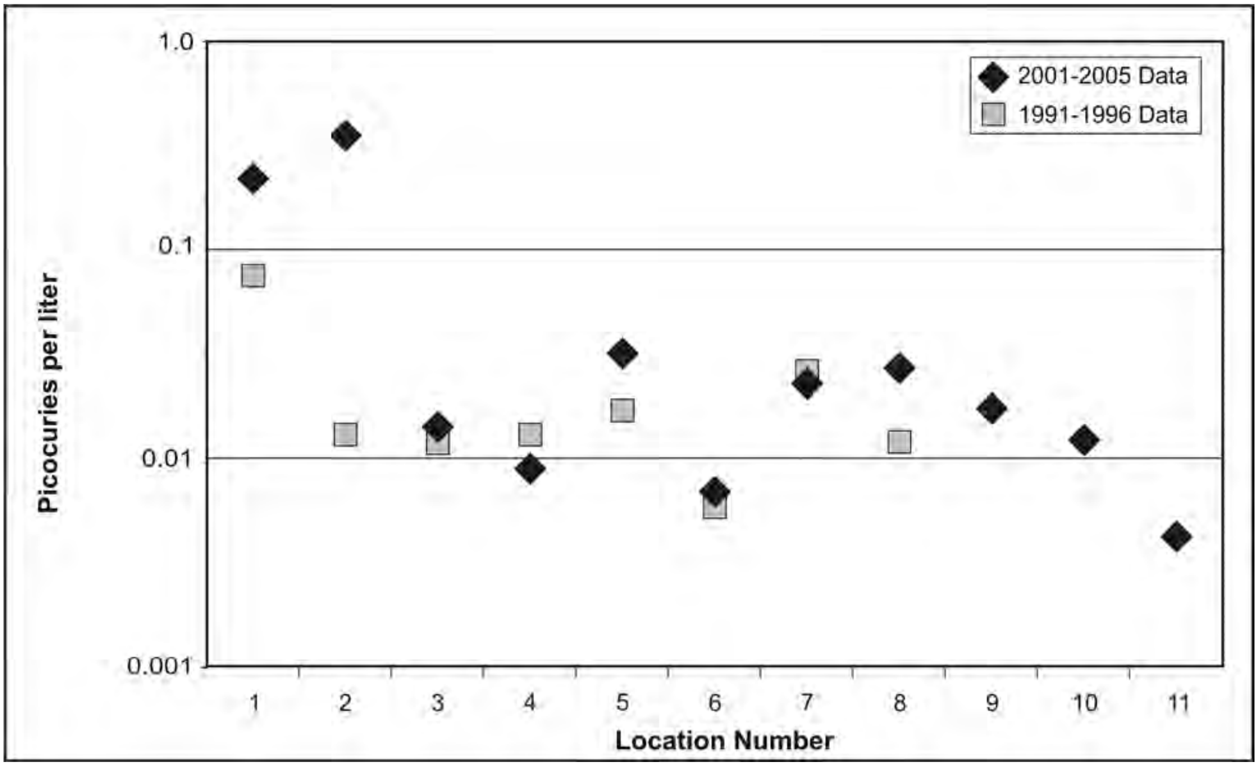


Figure F–3 Plutonium-238 Measured Mean Concentration Value for Groundwater

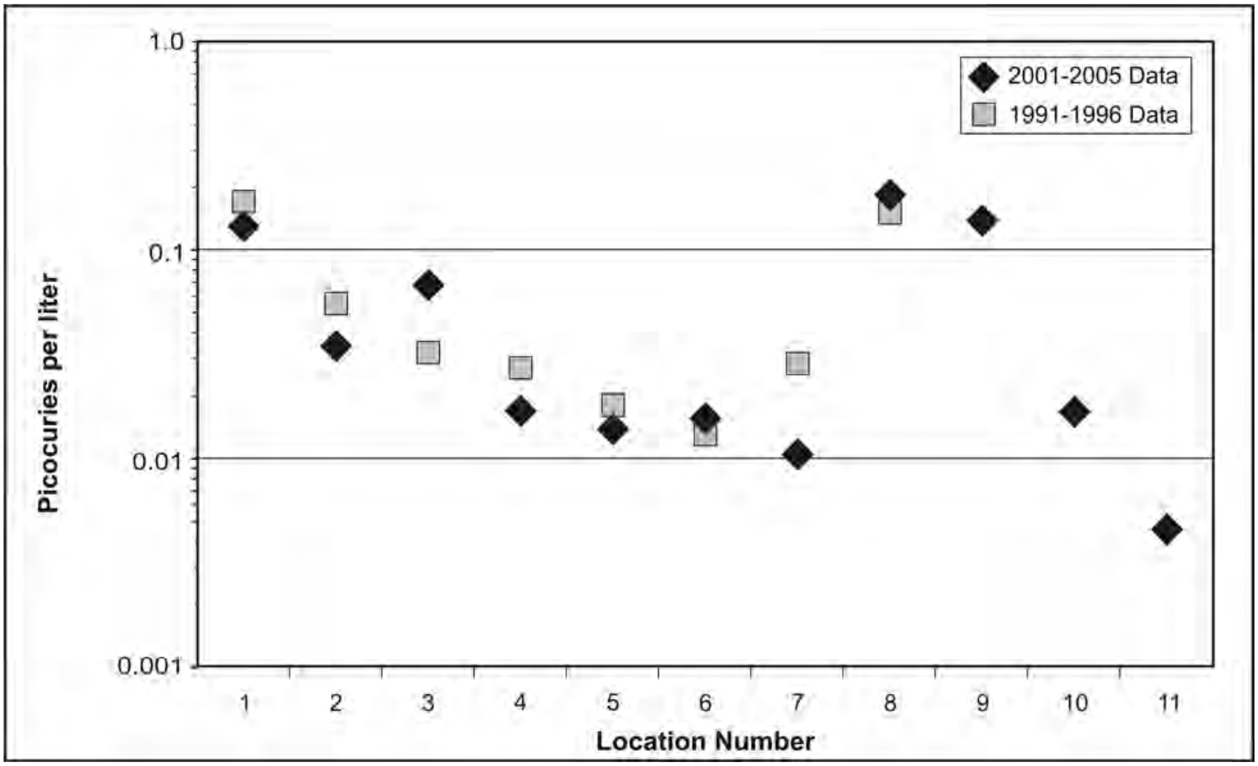


Figure F–4 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Groundwater

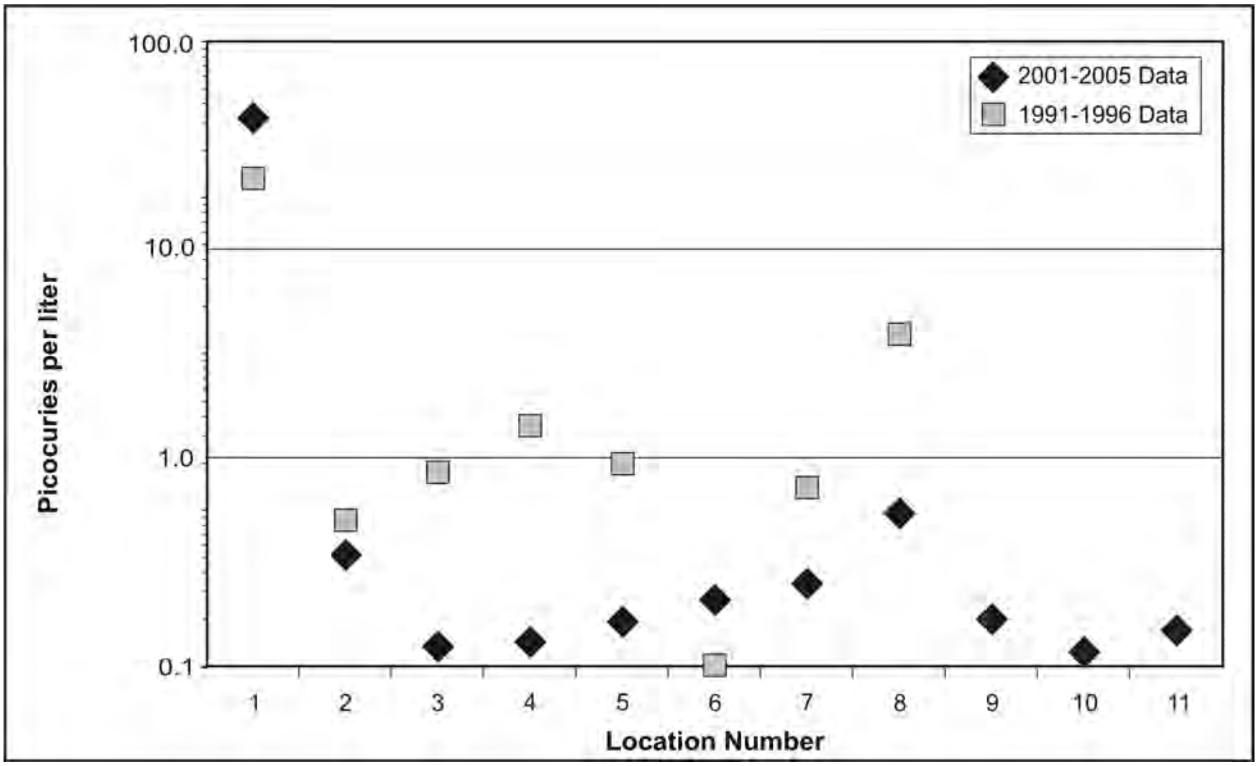


Figure F–5 Strontium-90 Measured Mean Concentration Value for Groundwater

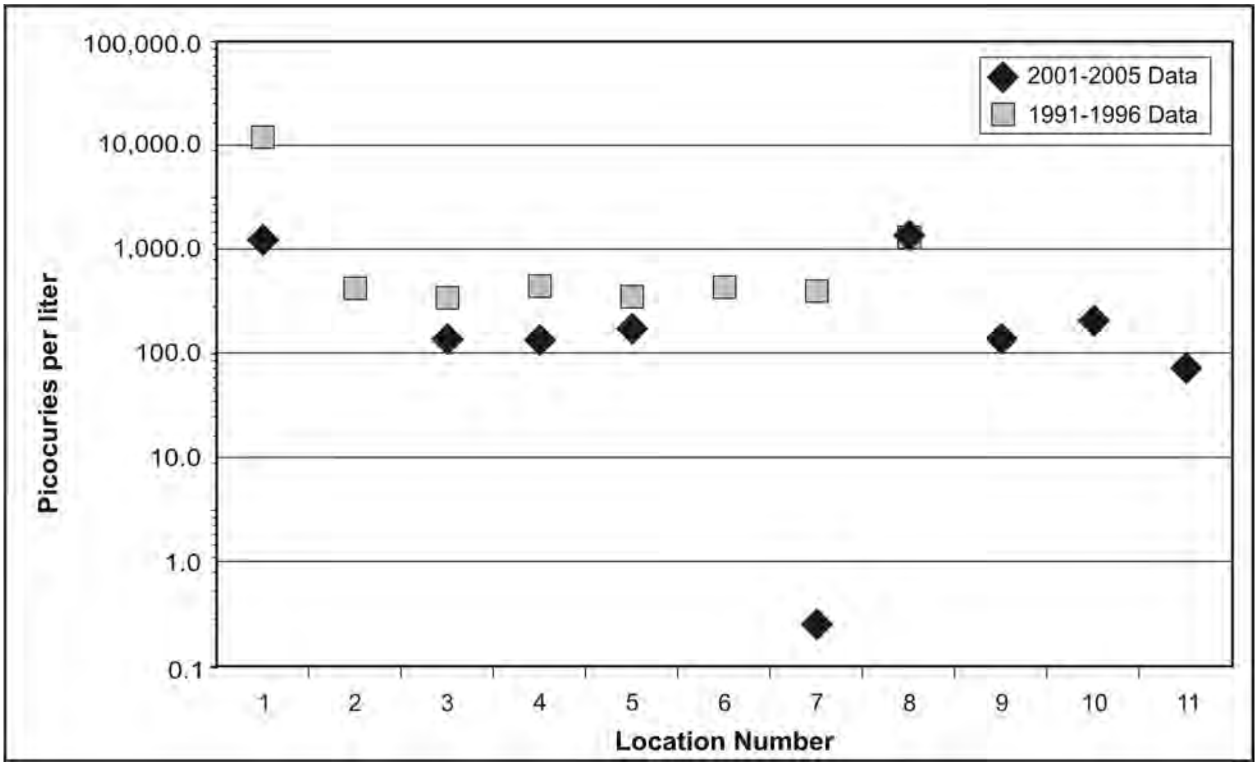


Figure F–6 Tritium Measured Mean Concentration Value for Groundwater

Figures F–7 through **F–12** are graphs for isotopes measured in sediments. The data points are in the order shown in **Table F–2**. Table F–2 also indicates the Section F.3 data table that corresponds to the 2001 through 2005 data sets. In 2001 through 2005 data, measurements in sediments were provided for Fence and Indio Canyons for some isotopes that were not considered in the 1991 through 1996 data. Plutonium-238 and tritium do not have measured values for Indio Canyon in the 2001 through 2005 data. For Bayo Canyon, strontium-90 and plutonium-239 and plutonium-240 do not have measured values in the 2001 through 2005 data.

Table F–2 Sediment Data Set Comparison

Location Number	*1991 through 1996 Data Set Identifier*	*2001 through 2005*	
		Data Set Identifier	***Data from Table***
1	Regional Stations	Regional Stations	F–21
2	Perimeter Stations	Perimeter Stations	F–21
3	Onsite Stations	Onsite Stations	F–21
4	Ancho Canyon	Ancho Canyon	F–21
5	Bayo Canyon	Bayo Canyon	F–21
6	Cañada del Buey Canyon	Cañada del Buey Canyon	F–21
7	Chaquehui Canyon	Chaquehui Canyon	F–21
8	Not Measured	Fence Canyon	F–21
9	Frijoles Canyon	Frijoles Canyon	F–21
10	Gauje Canyon	Gauje Canyon	F–21
11	Not Measured	Indio Canyon	F–21
12	Los Alamos Canyon	Los Alamos Canyon	F–21
13	Mortandad Canyon	Mortandad Canyon	F–21
14	Pajarito Canyon	Pajarito Canyon	F–21
15	Potrillo Canyon	Potrillo Canyon	F–21
16	Pueblo Canyon	Pueblo Canyon	F–21
17	Sandia Canyon	Sandia Canyon	F–21
18	Water Canyon	Water Canyon	F–21

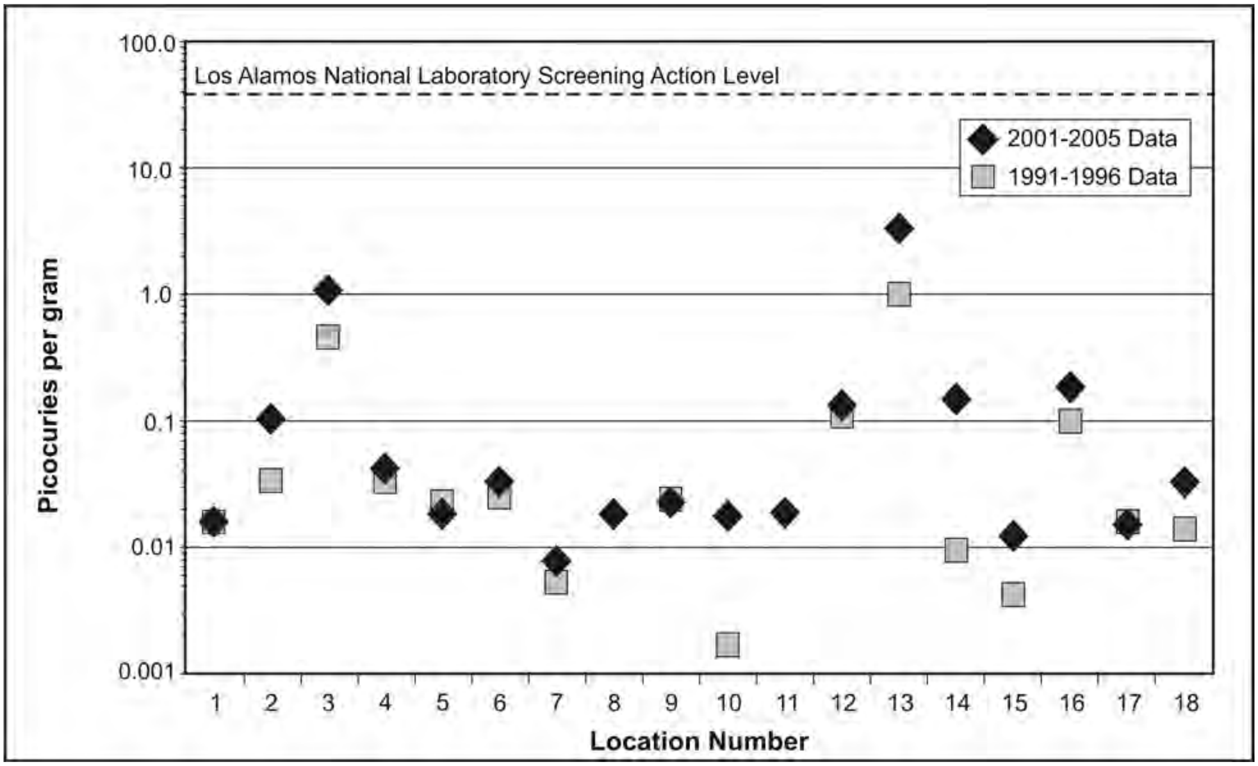


Figure F–7 Americium-241 Measured Mean Concentration Value for Sediment

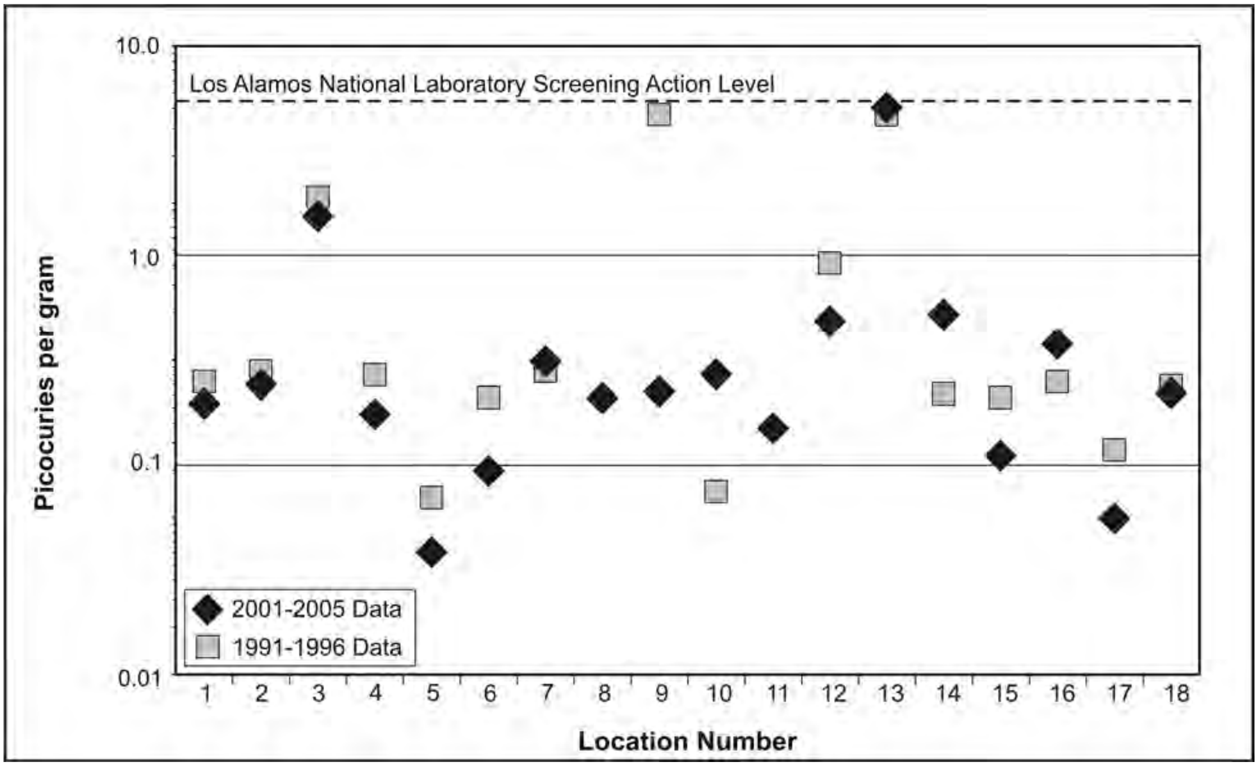


Figure F–8 Cesium-137 Measured Mean Concentration Value for Sediment

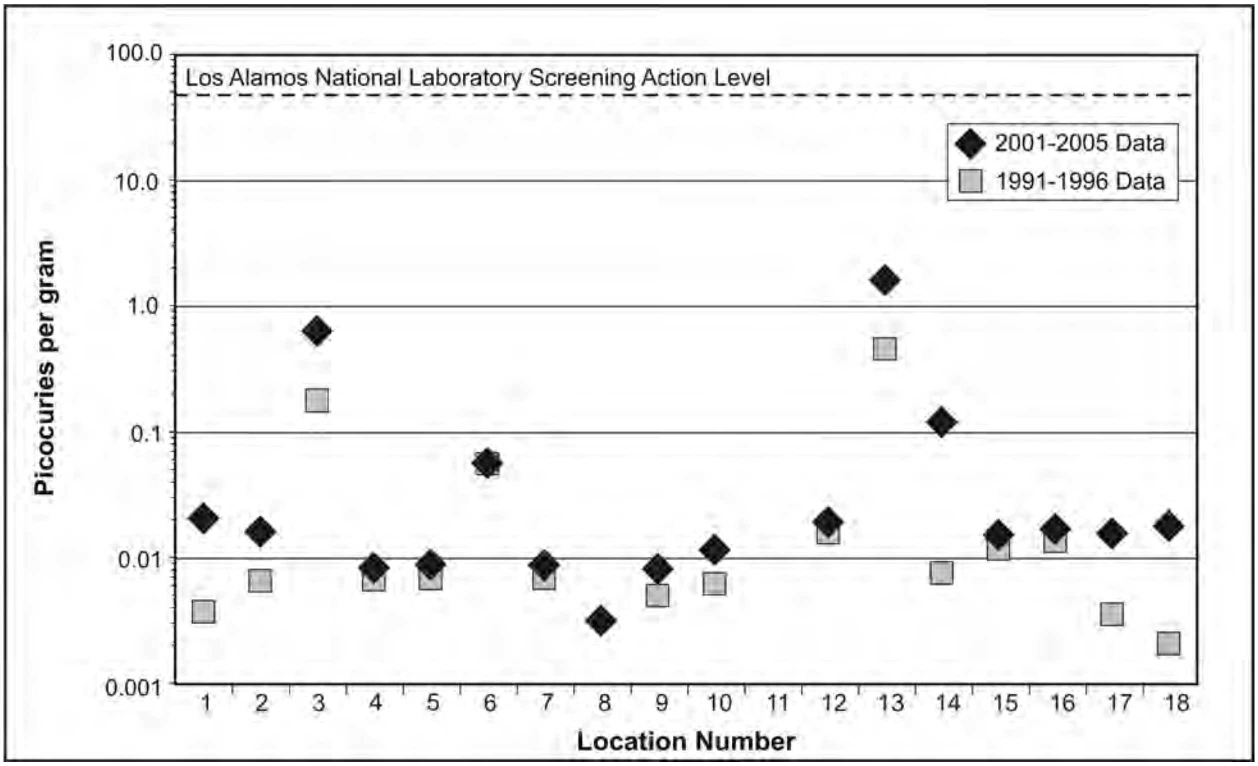


Figure F–9 Plutonium-238 Measured Mean Concentration Value for Sediment

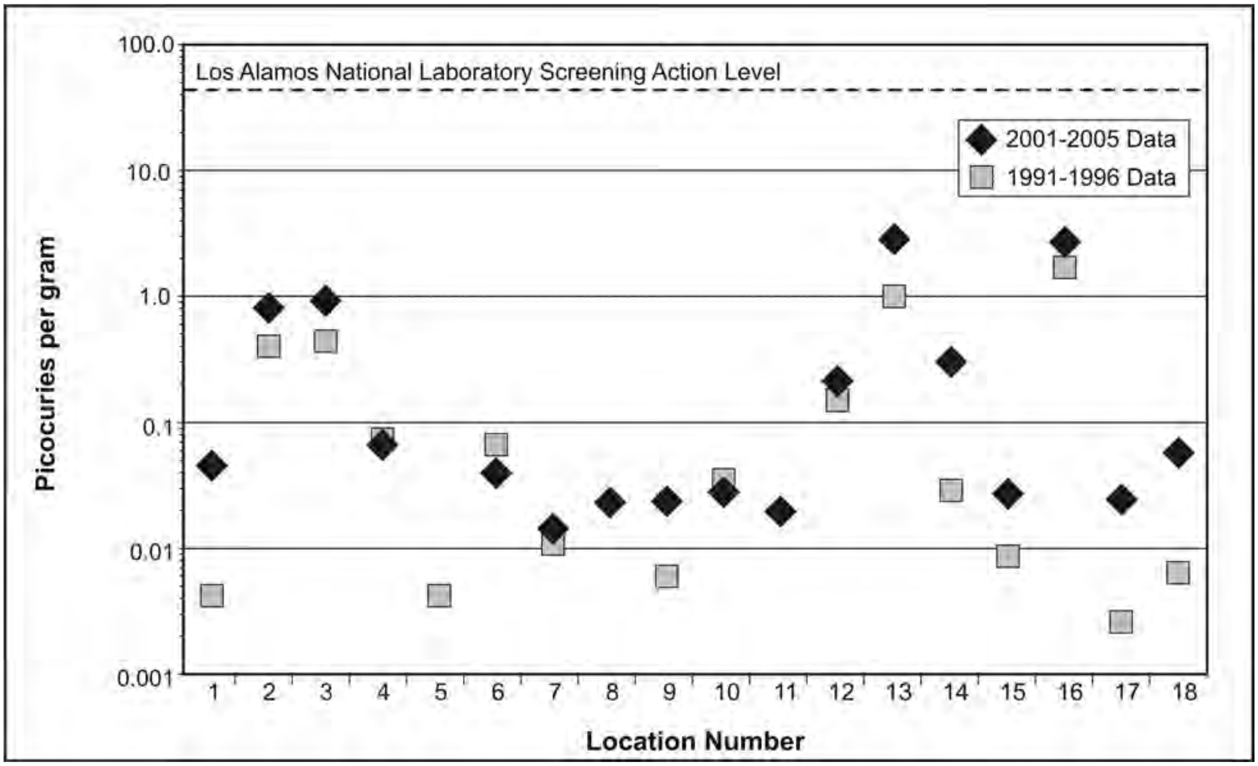


Figure F–10 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Sediment

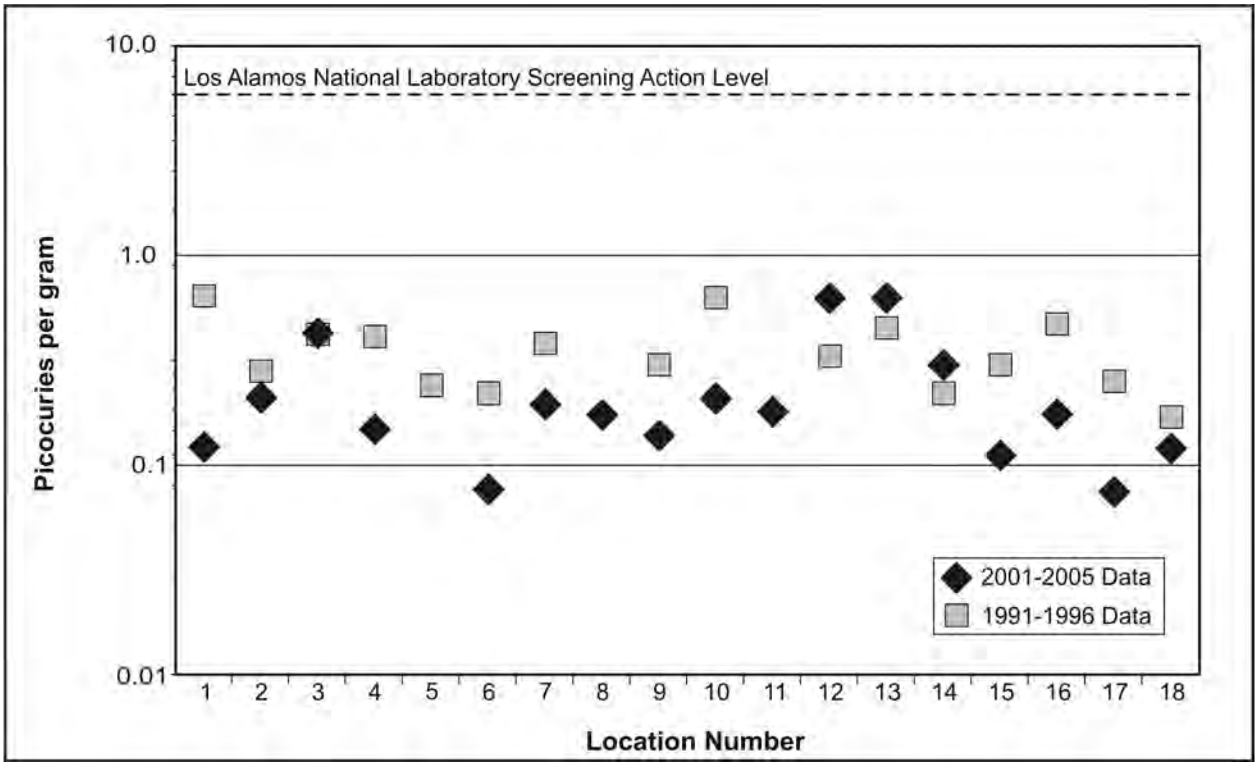


Figure F–11 Strontium-90 Measured Mean Concentration Value for Sediment

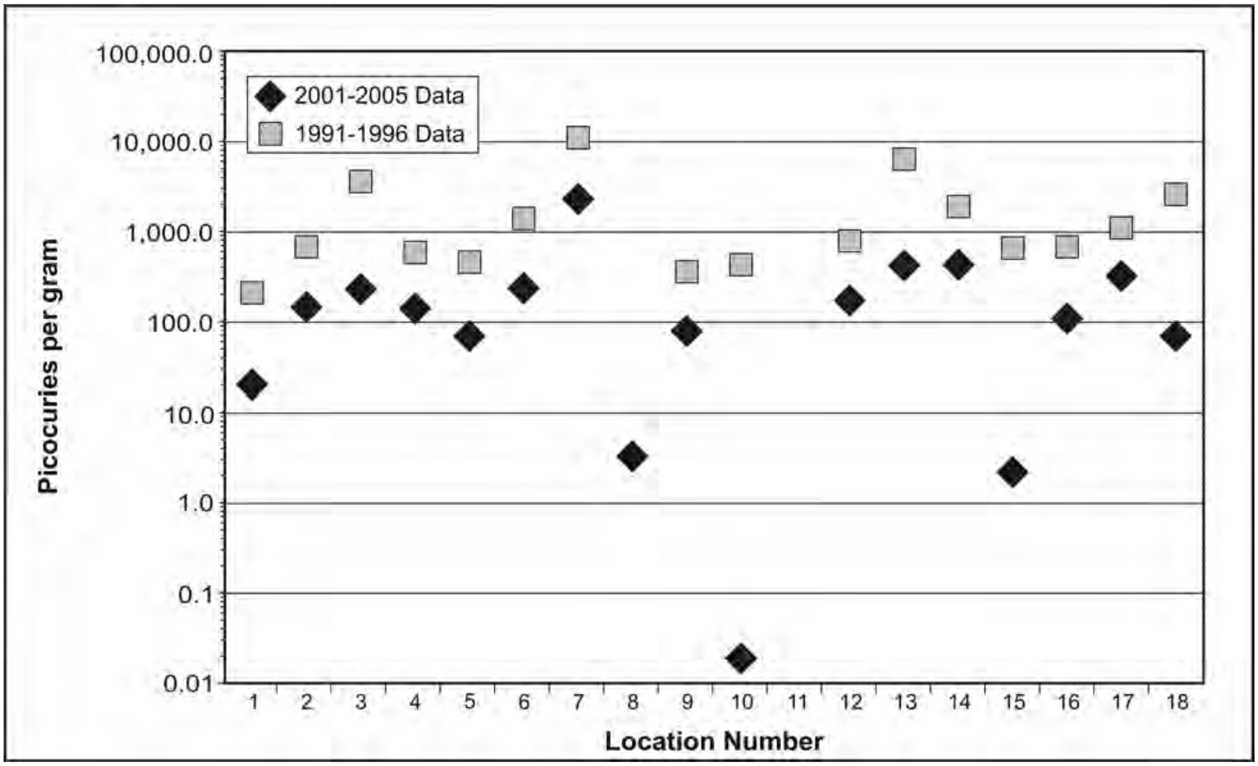


Figure F–12 Tritium Measured Mean Concentration Value for Sediment

Figures F–13 through **F–18** are graphs for stormwater runoff data for each measured isotope. Data points are in the canyon order provided in **Table F–3**. Table F–3 also indicates the Section F.3 data table that corresponds to the 2001 through 2005 data sets. The 1991 through 1996 data include Cañada del Buey and Chaquehui Canyons (unlike the 2001 through 2005 data). Cesium-137 data are not available for Chaquehui Canyon from 1991 through 1996. Plutonium-239 and plutonium-240 data are not available for Ancho Canyon from 2001 through 2005 data. Strontium-90 data are not available for Guaje Canyon from 1991 through 1996 and for Ancho Canyon for 2001 through 2005.

Table F–3 Runoff Data Set Comparison

Location Number	*1991 through 1996 Data Set Identifier*	*2001 through 2005*	
		Data Set Identifier	*Data from Table*
1	Regional Stations	Regional Canyons	F–22
2	Perimeter Stations	Perimeter Canyons	F–22
3	Onsite Stations	Onsite Canyons	F–22
4	Ancho Canyon	Ancho Canyon	F–22
5	Cañada del Buey Canyon	Not measured	Not applicable
6	Chaquehui Canyon	Not measured	Not applicable
7	Frijoles Canyon	Frijoles Canyon	F–22
8	Guaje Canyon	Guaje Canyon	F–22
9	Los Alamos Canyon	Los Alamos Canyon	F–22
10	Mortandad Canyon	Mortandad Canyon	F–22
11	Pajarito Canyon	Pajarito Canyon	F–22
12	Pueblo Canyon	Pueblo Canyon	F–22
13	Sandia Canyon	Sandia Canyon	F–22
14	Water Canyon	Water Canyon	F–22

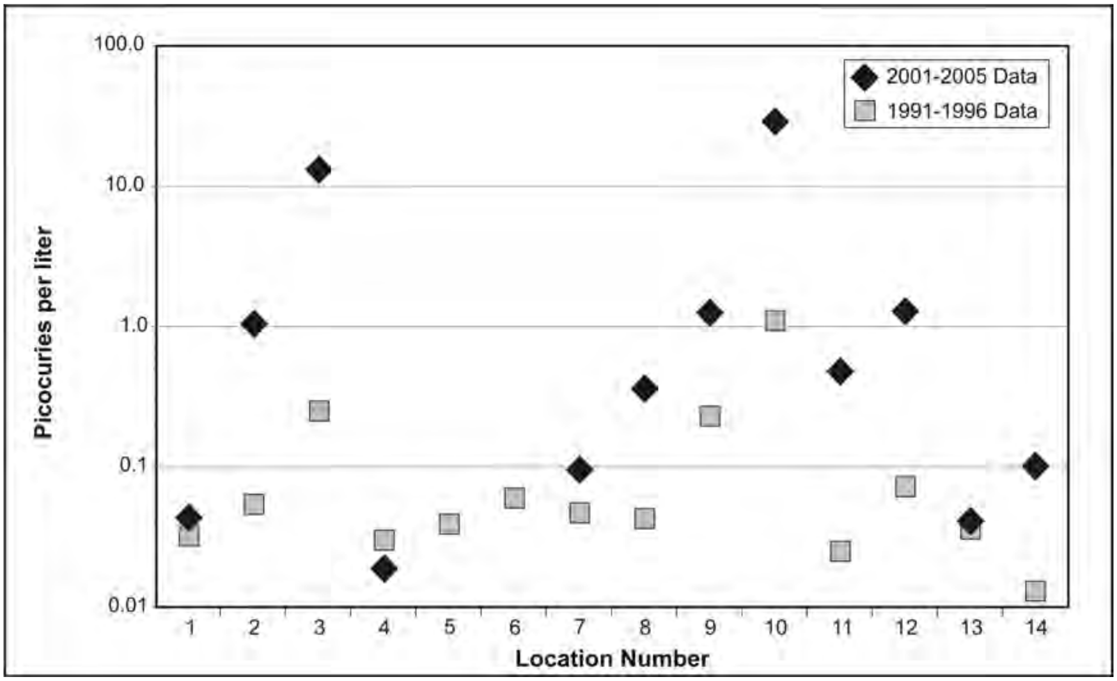


Figure F–13 Americium-241 Measured Mean Concentration Value for Runoff

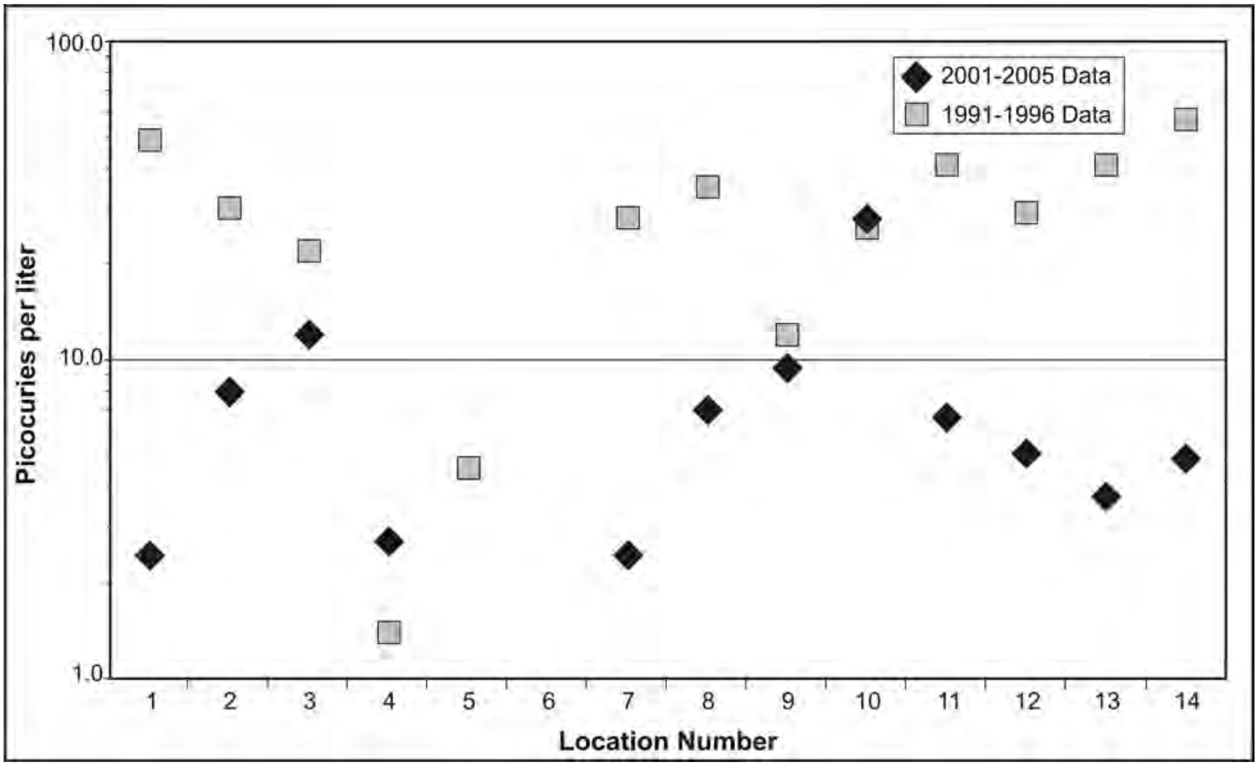


Figure F–14 Cesium-137 Measured Mean Concentration Value for Runoff

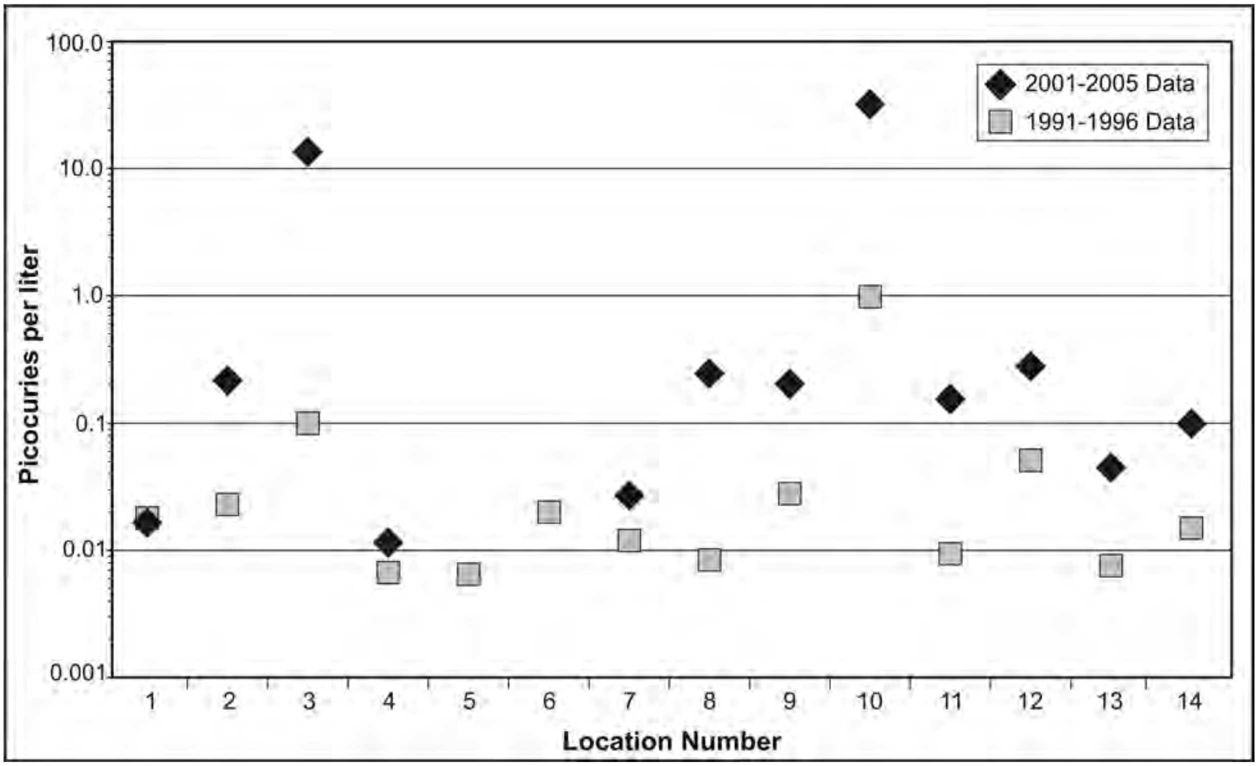


Figure F–15 Plutonium-238 Measured Mean Concentration Value for Runoff

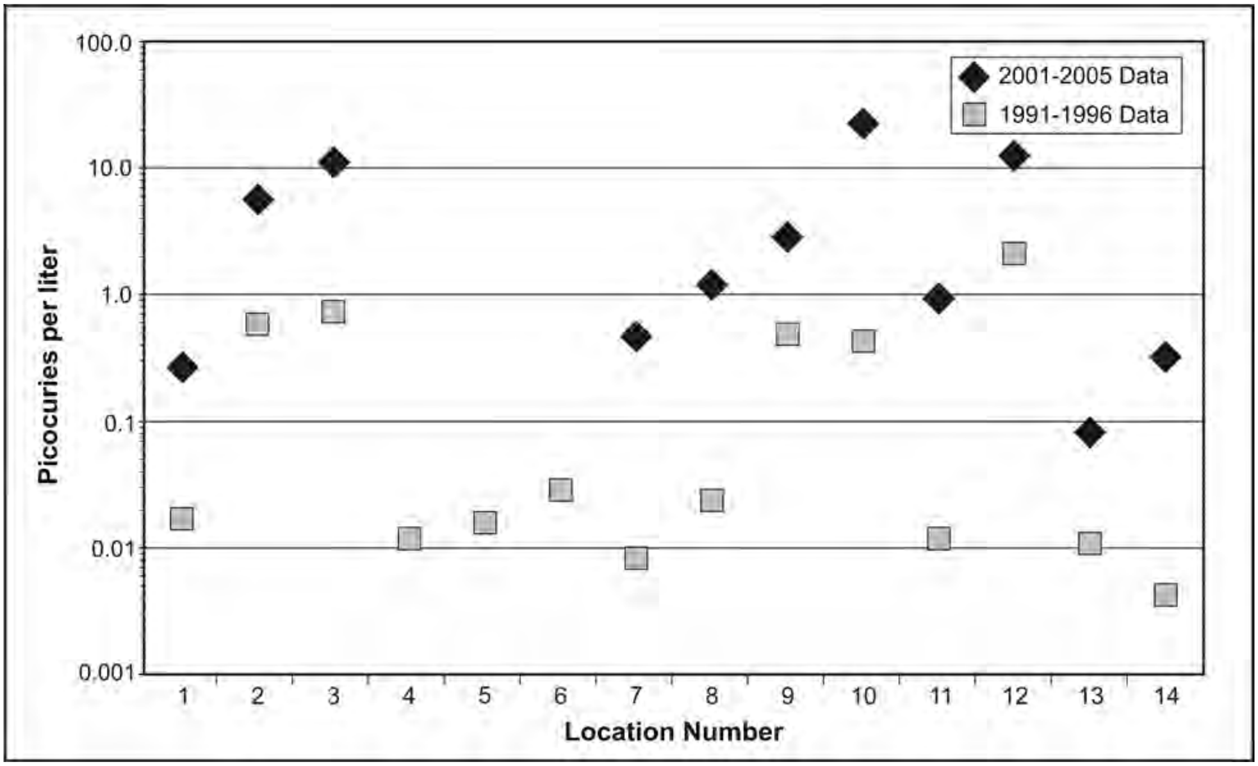


Figure F–16 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Runoff

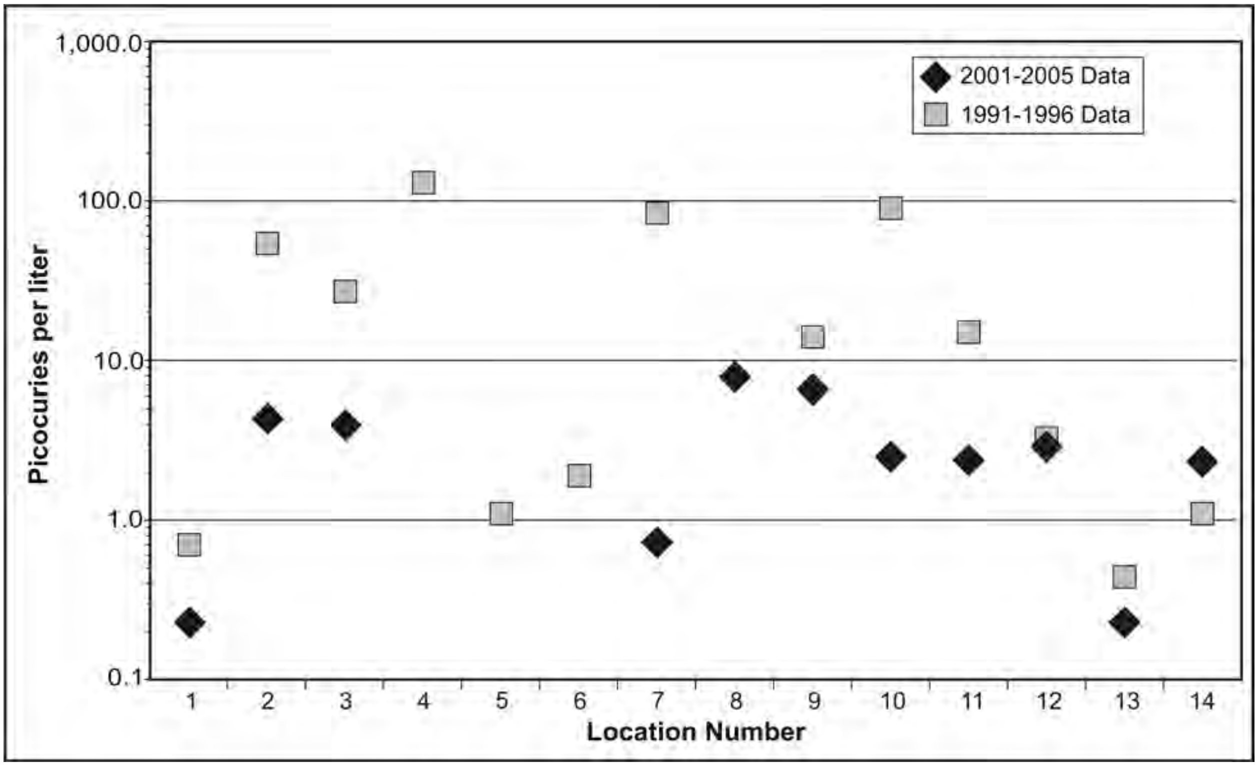


Figure F–17 Strontium-90 Measured Mean Concentration Value for Runoff

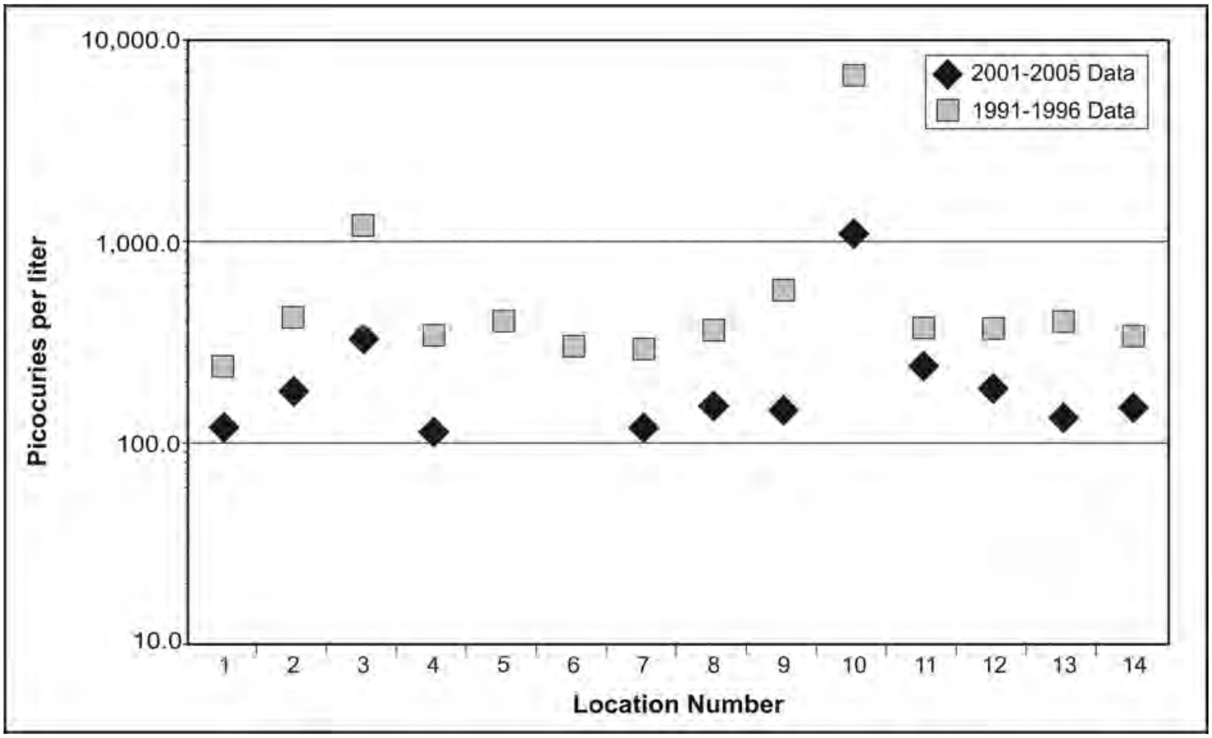


Figure F–18 Tritium Measured Mean Concentration Value for Runoff

Figures F–19 through **F–23** show graphs for soils for each measured isotope. The data are grouped into the three principal regions of interest of Regional, Perimeter, and Onsite. The corresponding data are presented in Section F.3, Table F–23.

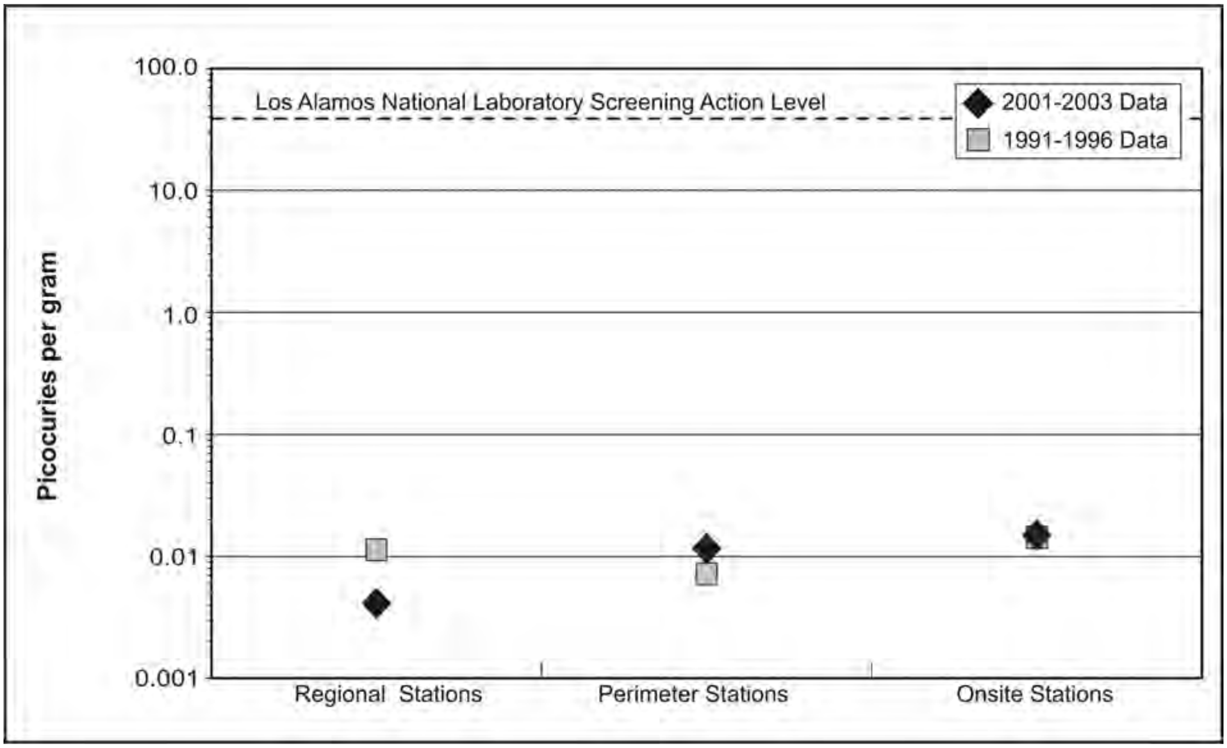


Figure F–19 Americium-241 Measured Mean Concentration Value for Soils

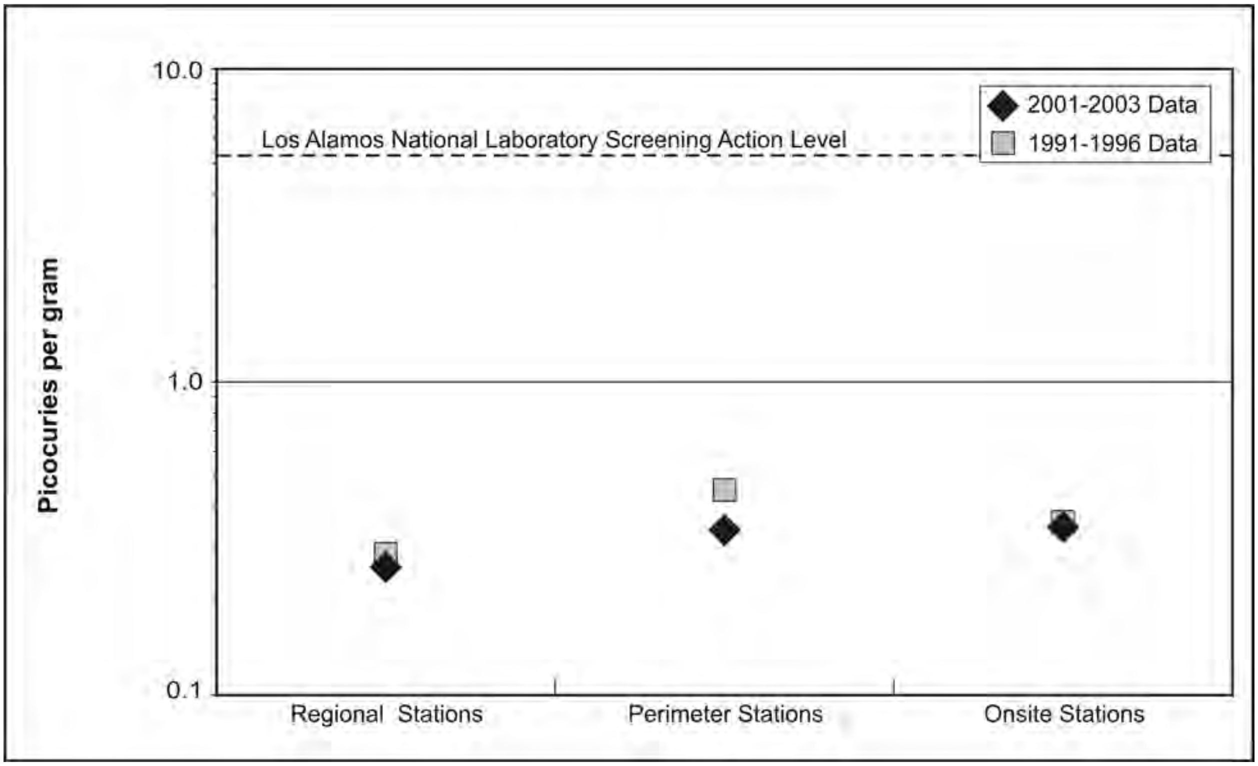


Figure F–20 Cesium-137 Measured Mean Concentration Value for Soils

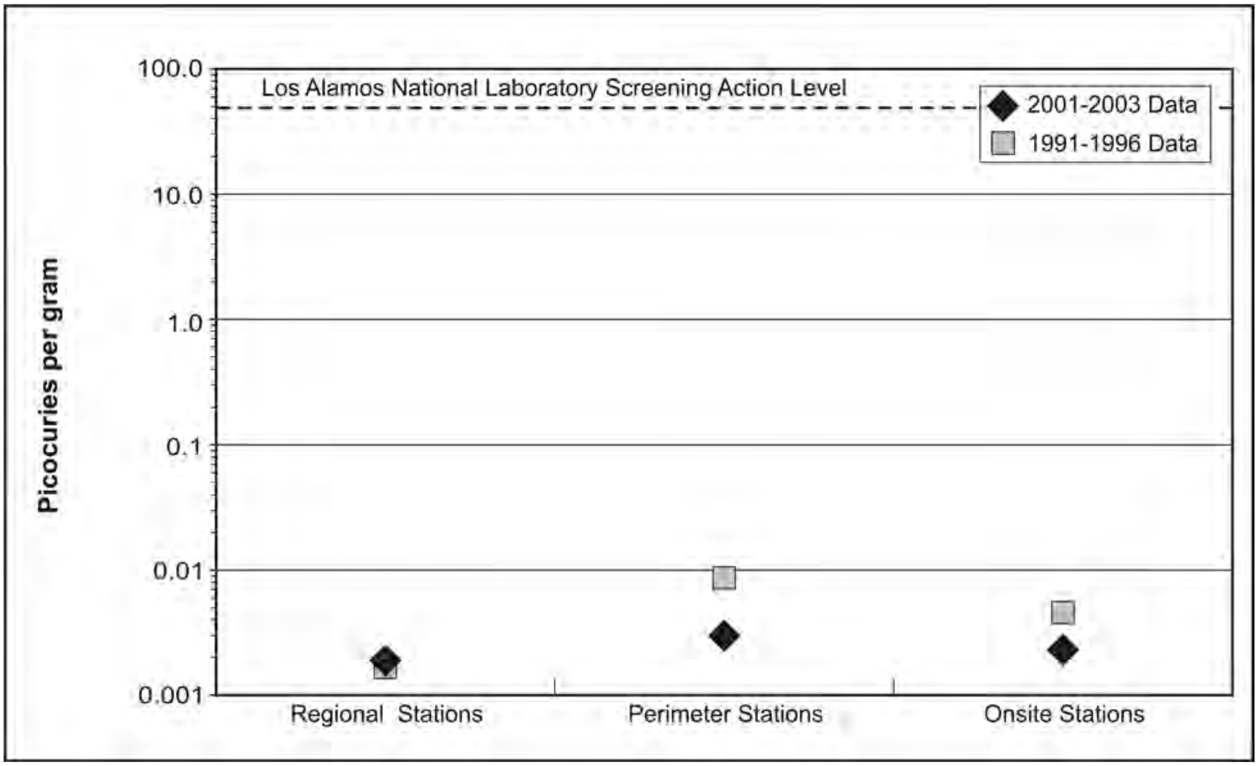


Figure F–21 Plutonium-238 Measured Mean Concentration Value for Soils

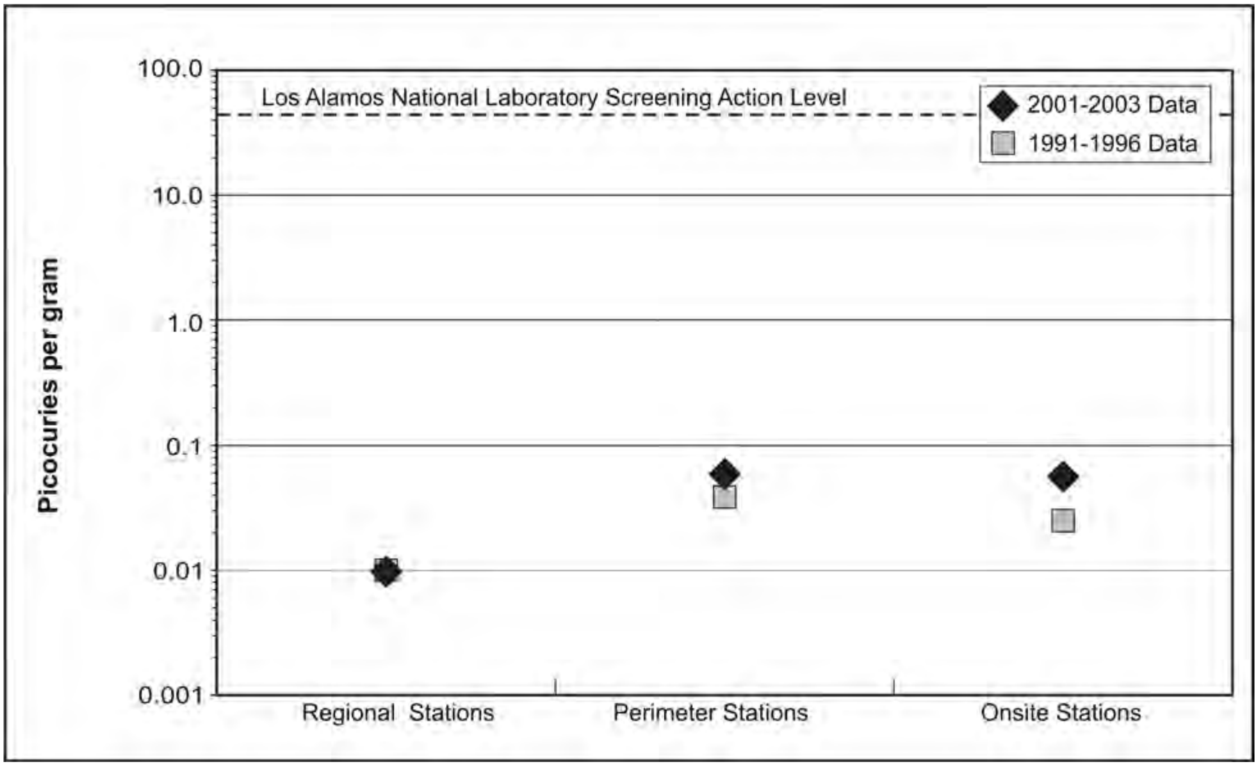


Figure F–22 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Soils

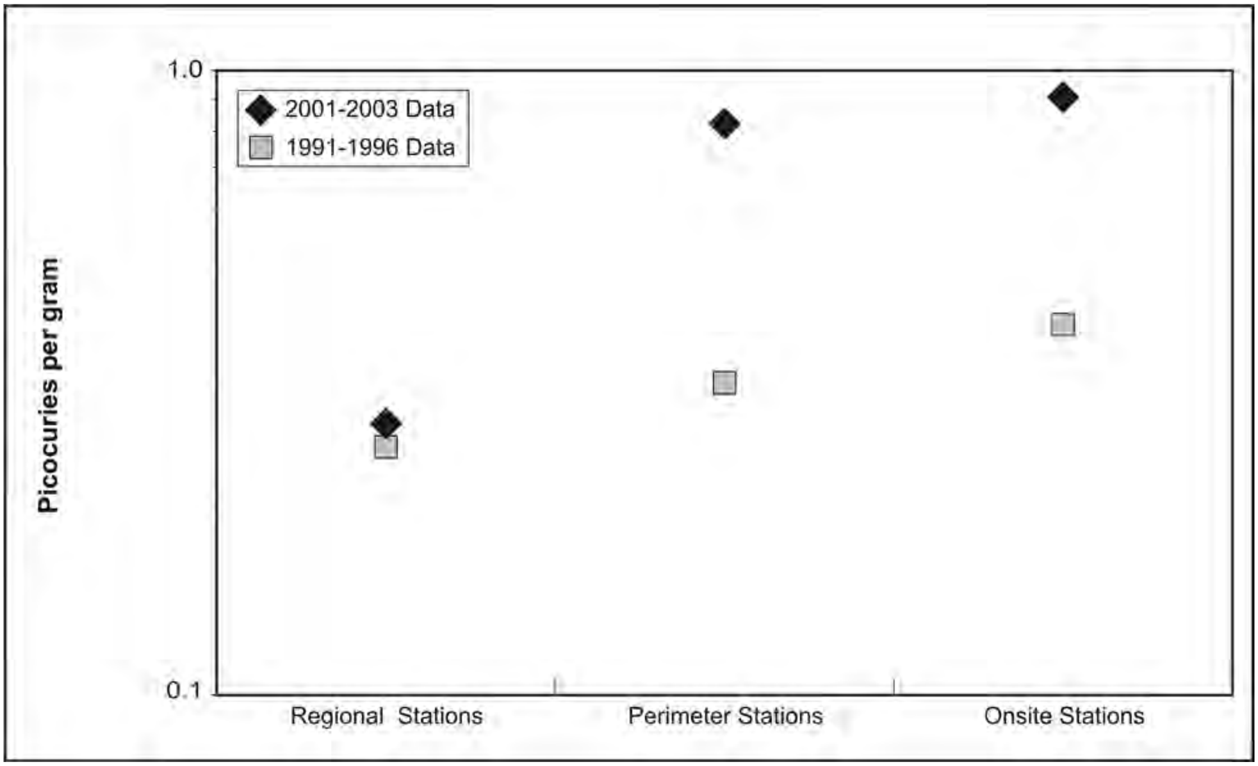


Figure F–23 Tritium Measured Mean Concentration Value for Soils

Groundwater data show a more marked shift in the transuranics toward higher concentrations in the 1991 through 1996 data than in the runoff or sediment data (see **Table F–4**). Unlike runoff and sediment, groundwater is much more slowly diluted or replenished, especially in the LANL region. Groundwater is also a potential source of drinking water for residences that use wells. In general, both transuranics and lighter radioisotopes showed higher concentrations in groundwater in the 1991 through 1996 data than in the 2001 through 2005 data. No measurements exceeded applicable (tritium and strontium-90) EPA limits for drinking water (40 CFR 141.66).

Table F–4 Comparison of Measured 2001 through 2005 Radioisotope Groundwater Data to 1991 through 1996 Data

Radioisotope	*Noticeably Larger Concentration Timeframe*	*Qualitative Trend Comments*
Americium-241	Equivalent	Other than one data point, both the 1991 through 1996 data and the 2001 through 2005 data are concentrated over one order of magnitude (0.01 to 0.1 picocuries per liter). The maximum data point of about 3 picocuries per liter is from 1991 through 1996, and is much higher than the largest 2001 through 2005 data point of 0.5 picocuries per liter. Most of the 2001 through 2005 data points are slightly lower than or equal to the 1991 through 1996 data points.
Cesium-137	1991 through 1996	All 2001 through 2005 data points are significantly lower in value than the 1991 through 1996 data points by as much as a factor of 10 to 20.
Plutonium-238	Equivalent	Both data sets are closely clustered over the same two orders of magnitude. The highest 2001 through 2005 data point is about 0.45 picocuries per liter; the largest 1991 through 1996 data point is about 0.08 picocuries per liter.
Plutonium-239, Plutonium-240	Equivalent	Both sets of data show a small spread over the same two orders of magnitude.
Strontium-90	1991 through 1996	Some (six out of eight data points) of the 2001 through 2005 data are lower in value than the 1991 through 1996 data by factors of 2 to 10.
Tritium	1991 through 1996	Most of the 2001 through 2005 data points are a factor of 2 to 4 times lower in value than the comparable 1991 through 1996 data points. It should be noted that the largest mean values for the 1991 through 1996 data and the 2001 through 2005 data are smaller than the U.S. Environmental Protection Agency annual drinking water limit of 20,000 picocuries per liter (assumed to be equivalent to a total body dose of 4 millirem) (40 CFR 141.66).

In qualitatively evaluating the graphical presentation of measured radioisotope concentrations in and around LANL between the 1991 through 1996 and 2001 through 2005 periods, only general observations can be made. More specific conclusions would require much more extensive statistical and measurement methodology analysis and would only quantify results in a statistical framework, which might not convey any more information to the reader. **Table F–5** presents the assessment of the differences between the two data sets for sediment.

As previously stated, qualitative interpretation of the data presented graphically for LANL sediment radioisotope concentrations is limited by the extent of this evaluation. However, some general conclusions can be drawn (see Table F–5). Transuranic isotope concentrations all have increased from the 1991 through 1996 period to the 2001 through 2005 period, while lower atomic weight radioisotopes have decreased. Because sediments are subject to the actions of water over time, it is reasonable to assume that the lighter weight radioisotopes (strontium-90, cesium-137, and tritium) would have been preferentially carried with the rainwater and

Table F–5 Comparison of Measured 2001 through 2005 Radioisotope Sediment Data to 1991 through 1996 Data

Radioisotope	*Noticeably Larger Concentration Timeframe*	*Qualitative Trend Comments*
Americium-241	Equivalent	Two 2001 through 2005 data points are about a factor of 10 times larger than the 1991 through 1996 data points. All other data points are close to each other. All data are below the LANL SAL.
Cesium-137	Equivalent	A third of the 2001 through 2005 data points are half the value of their 1991 through 1996 counterparts. Most of the data points from 2001 through 2005 are in the same range as the preponderance of 1991 through 1996 data points. All data are below the LANL SAL.
Plutonium-238	2001 through 2005	Both sets of data exhibit a similar large spread over three orders of magnitude, but 2001 through 2005 data points are greater than their 1991 through 1996 data points. All data are below the LANL SAL
Plutonium-239, Plutonium-240	2001 through 2005	Both sets of data showed a similar large spread of four orders of magnitude (from 0.001 to 10 picocuries per gram); all data are below the LANL SAL.
Strontium-90	1991 through 1996	Data points from both time periods are clustered over two orders of magnitude (from 0.01 to 1 picocurie per gram); nonetheless, all data are well below the LANL SAL. Most of the 2001 through 2005 data are lower than the 1991 through 1996 data by factors of 2 to 3. Three data points from 2001 through 2005 are greater than the 1991 through 1996 data points.
Tritium	1991 through 1996	The two sets of data are distinctly separate and are tightly confined to a narrow band. All of the 2001 through 2005 data points are a factor of 5 to 15,000 times smaller than the comparable 1991 through 1996 data points.

SAL = Screening Action Level.

surface runoff water, whereas a greater fraction of the heavier transuranics would have stayed in the sediment due to their higher density. It is also important to note that tritium is highly soluble, as tritiated water in rain and surface water. Another consideration is that the 12.2-year half-life of tritium would have resulted in the decay of a significant fraction of tritium between 1991 through 1996 and 2001 through 2005, which together represent a period of anywhere from 5 to 14 years. Assuming no dramatic changes in emissions of these measured radioisotopes from 1991 through 1996 to 2001 through 2005, the sediment data indicate that any radioactive material movement involving this sediment due to the Cerro Grande Fire was acted upon by the natural forces of rain and surface water that significantly depleted the sediment content of lighter-weight, more soluble radioisotopes.

Transuranic radioisotopes exist in larger concentrations in the 2001 through 2005 data than in the 1991 through 1996 data surface runoff; the opposite is true for all lighter radioisotopes such as tritium, strontium-90, and cesium-137 (see **Table F–6**). As in the case of sediment, the lighter radioisotopes would be transported farther by runoff than the heavier transuranic radioisotopes since the Cerro Grande Fire. As noted above, radioactive decay of tritium could also account for some of the difference in the data.

Table F–6 Comparison of Measured 2001 through 2005 Radioisotope Runoff Data to 1991 through 1996 Data

Radioisotope	*Noticeably Significant Larger Concentration Timeframe*	*Qualitative Trend Comments*
Americium-241	2001 through 2005	The 2001 through 2005 data are spread out between four orders of magnitude, whereas the 1991 through 1996 data are spread out within two orders of magnitude (from 0.01 to 1 picocurie per liter). Most of the 2001 through 2005 data are 2 to 50 times higher than the corresponding 1991 through 1996 data points.
Cesium-137	1991 through 1996	A majority of the 2001 through 2005 data points are significantly lower than the 1991 through 1996 data points by as much as a factor of 20. Only 2 of the 11 data points from 2001 through 2005 are higher than the 1991 through 1996 data points.
Plutonium-238	2001 through 2005	The data sets exhibit a large spread over four orders of magnitude. The 1991 through 1996 data extend from 0.001 to 1 picocuries per liter and the 2001 through 2005 data extend from 0.01 to 100 picocuries per liter. Most 2001 through 2005 data points are factors of 3 to over 100 greater than the 1991 through 1996 data points.
Plutonium-239, Plutonium-240	2001 through 2005	Both sets of data showed a large spread over four orders of magnitude, but the 1991 through 1996 data are spread over a range of 0.001 to 10 picocuries per liter and the 2001 through 2005 data are spread over a range of 0.1 to 100 picocuries per liter. The 2001 through 2005 data points are 6 to 80 times greater than the 1991 through 1996 data points.
Strontium-90	1991 through 1996	A large amount (10 of 11 data points) of the 2001 through 2005 data are lower than the equivalent 1991 through 1996 data by factors of 2 to 100. No 2001 through 2005 data points exceeded 10 picocuries per liter, but seven 1991 through 1996 data points are between 10 and 200 picocuries per liter.
Tritium	1991 through 1996	All of the 2001 through 2005 data points are a factor of 2 to 10 times smaller than the comparable 1991 through 1996 data points. It should be noted that the largest mean values of less than 6,700 picocuries per liter for the 1991 through 1996 data and about 1,000 picocuries per liter for the 2001 through 2005 data are much lower than the U.S. Environmental Protection Agency drinking water limit of 20,000 picocuries per liter.

Unlike the sediment, surface runoff water, and groundwater data, the soil data show that the 2001 through 2003 measurements are at equivalent concentration for most radioisotopes to the 1991 through 1996 data (see **Table F–7**). The redistribution due to the Cerro Grande Fire of these radioisotopes, formerly present in vegetation and trees, to the soil is a possible explanation. A review of actual radiological emissions from LANL facilities' stacks from 1999 through 2005 does not show any significant increase in emissions of these radioisotopes.

Table F–7 Comparison of Measured 2001 through 2003 Radioisotope Soil Data to 1991 through 1996 Data

Radioisotope (average worldwide soil concentration)	*Noticeably Larger Concentration Timeframe*	*Qualitative Trend Comments*
Americium-241 (0.01 picocuries per gram)	Equivalent	All measurement values are more than a factor of 1,000 below the LANL SAL, and Regional station data are equivalent to average worldwide concentrations.
Cesium-137 (0.4 picocuries per gram)	Equivalent	Both data sets are almost identical with the 1991 through 1996 data slightly (10 percent to 50 percent) higher. All data are a factor of 10 below the SAL and at or near the worldwide measured level.
Plutonium-238 (0.01 to 0.1 picocuries per gram)	Equivalent	The 2001 through 2003 data are lower than the comparable 1991 through 1996 data at Onsite and Perimeter stations. The data are a factor of about 10,000 times lower than the LANL SAL. Data are at or below worldwide average concentrations.
Plutonium-239, Plutonium-240 (0.01 to 0.1 picocuries per gram)	Equivalent	All measurement values are more than a factor of 400 below the LANL SAL. All measurements are at or below worldwide average levels.
Tritium	2001 through 2003	The 2001 through 2003 data are significantly higher for the Onsite and Perimeter stations by as much as a factor of 2 compared to the 1991 through 1996 data.

SAL = Screening Action Level.
Sources: ANL 2005a, 2005b, 2005c, 2005d, 2005e.

Table F–8 presents several key parameters for radioisotopes measured by LANL including typical background concentrations, EPA drinking water limits, relative solubility, and soil adhesion characteristics.

Table F–8 Key Parameters of Radioisotopes Measured in the Los Alamos National Laboratory Environment

Radioisotope	*Background Concentration (EPA Drinking Water Limit)*	*Water Solubility*	*Soil Adhesion Characteristics (LANL soil is generally sandy-loam)*
Americium-241	0.01 picocuries per gram soil	Very insoluble	Ratio of sandy soil to water adhesion equals 1,900. Ratio of loam/clay to water adhesion is greater than 1,900.
Cesium-137	0.1 to 1 picocuries per gram soil; average 0.4 picocuries per gram	Very insoluble	Ratio of sandy soil to water adhesion equals 280. Ratio of clay/loam soil to water adhesion equals 2,000 to 4,000.
Plutonium-238, Plutonium-239, Plutonium-240	0.01 to 0.1 picocuries per gram soil	Very insoluble	Radio of sediment/soil to water adhesion equals 2,000.
Strontium-90	0.1 picocuries per gram soil (36 picocuries per liter)	Soluble	Ratio of sandy soil to water adhesion equals 15. Ratio of clay soil to water adhesion equals 110.
Tritium	10 to 30 picocuries per liter surface water (20,000 picocuries per liter)	Very soluble	No adhesion to soil; chemically identical to water.

EPA = U.S. Environmental Protection Agency.
Sources: ANL 2005a, 2005b, 2005c, 2005d, 2005e.

Several general and qualitative conclusions can be drawn by examination of the graphically presented environmental surveillance data on radioisotopes in and around the LANL site.

- Most radioisotopes measured in and around LANL exist in concentrations equivalent to worldwide averages based on non-LANL atmospheric releases.

- Many monitored radioisotope concentrations in groundwater decreased after 2000.
- All 2001 through 2005 tritium data for surface water and stormwater runoff and groundwater are 10 to 100 times lower than the EPA drinking water limit.
- The largest difference in data between 1991 through 1996 and 2001 through 2005 is that the 2001 through 2005 sediment tritium concentration data are 1,000 to 100,000 times smaller than the 1991 through 1996 data.
- In general, transuranic concentrations in sediment and surface water or stormwater runoff increased after 2000, while lighter radioisotope (strontium-90, cesium-137, and tritium) concentrations in sediments and surface water or stormwater runoff decreased after 2000.
- Changes in radioisotope concentration in surface water or stormwater runoff and sediment from 1991 through 1996 to 2001 through 2005 coincide with the radioisotopes that are much more soluble in water.
- Both sets of data show tritium in surface water or stormwater runoff at LANL from all the data at concentrations 10 to 100 times greater than the worldwide average.
- Most soil radioisotope concentrations increased after 2000 (possibly attributable to the redistribution of radioisotopes in biologic material that burned during the Cerro Grande Fire).
- The 2001 through 2003 soil data show a plutonium-238 concentration about 100 times greater than the 1991 through 1996 data and 10 to 100 times greater than worldwide averages.
- All 2001 through 2003 soil data are much lower (by orders of magnitude) than the relevant LANL SAL.

These aforementioned observations are based on a qualitative assessment of plots of mean measured radioisotope concentration data. Differences in measurement technique or instrument accuracy between the 1991 through 1996 data and the 2001 through 2005 data are not accounted for, nor are differences in LANL stack emissions from 1991 through 2005 incorporated. This evaluation has not accounted for other radioisotopes or hazardous chemicals. Spatial variations in measured concentrations are not included in this assessment.

F.3 Environmental Sample Data

Groundwater, sediment, and stormwater runoff data are collected and analyzed for individual canyons. Soil data are grouped under three regions of interest: regional locations, perimeter locations, and onsite locations. The measured values of radioisotope and radioactivity that are presented are derived from environmental surveillance analytical data. Groundwater, sediment, stormwater runoff, and soil values from annual environmental surveillance data tables are used to calculate "Detected per ESR," "Used in This SWEIS," "Analyzed," "Minimum," "Mean," "Standard Deviation," "Maximum," and "95 percent Upper Confidence Limit (UCL)" values.

Analytical data are identified in a number of categories in this appendix. The "Analyzed" value is the total number of samples for which analyses were performed for a particular isotope or chemical. The "Detected per ESR" value is the number of analyzed samples that are determined to have detectable contamination as reported in the LANL environmental surveillance reports. The “Used in This SWEIS” value is the number of analyzed samples, in accordance with the guidanceprocess below, that are used in the following statistical analysis. The “Minimum” value is the smallest, positive measured analytical result for an isotope or chemical. The “Maximum” value is the greatest measured analytical result for an isotope or chemical. The “Mean” value is the average of the “Used in This SWEIS” samples for an isotope or chemical. The “Standard Deviation” value is a statistical measure of the amount by which each sample deviates from the mean. The “95 Percent UCL” value is a statistical representation of the concentration of a specific measured radioisotope, radioactivity, or chemical that is equal to or greater than 95 percent of all the expected measured values assuming a normal distribution.

Measurement of each parameter involves obtaining a known sample volume or mass, transporting it to an analytical laboratory, and subjecting the sample to the detection of a specific type and energy of radiation, which is detected and counted by an instrument for a set time. Each radioisotope has a unique set of radiation emission energies that identifies it just as fingerprints identify each human individual. A chemical or isotope is considered to be detected if it exceeds the lowest concentration that can be measured in a sample and reported with 99 percent confidence. It depends on the sample matrix, the instrument used, and the operator skill. For purposes of this SWEIS, the analytical results were evaluated in accordance with the following process:

- Any “Analyzed” sample for which the analytical result is less than zero is eliminated from further consideration.

- An “Analyzed” sample (in the following tables) for which the analytical result plus two standard deviations exceeds the instrument’s minimum detectable activity is “Used in This SWEIS.”

In applying the above process, analytical results below the instrument’s minimum detectable activity are included as part of the conservative assessment approach to data treatment in this SWEIS, but will not be continued in future SWEIS updates. Future data treatments will include only those analytical results exceeding the minimum detectable activity.

The following process is then applied to the analytical results that are identified as “Used in This SWEIS.”

- A minimum of two data values is required to calculate and present a Mean, Minimum, and Maximum value.

- A minimum of three data values is required to calculate and present a Standard Deviation and 95 Percent UCL value.

- The 95 Percent UCL value is calculated by first calculating the Mean and Standard Deviation on the Mean of the Used in This SWEIS data, then adding two Standard Deviations to the Mean Value.

Measured concentrations are in terms of picocuries per liter (pCi/L), picocuries per gram (pCi/g), micrograms per gram (µg/g) or micrograms per liter (µg/L) depending on whether the sample medium is solid or liquid and whether the parameter is measured in terms of radioactivity or mass.

The numbers of groundwater, sediment, surface water or stormwater runoff, and soil data samples from 2001 through 2005 that meet the criteria for "Used in This SWEIS" are shown in **Table F–9**. Table F–9 also shows the numbers of samples with "Detected" activity. The statistical analysis of measured samples (LANL 2002, 2004a, 2004b, 2005, 2006b) is presented in **Tables F–10** through **F–20** for groundwater (2001 to 2005), **Table F–21** for sediments (2001 to 2005), **Table F–22** for surface water or stormwater runoff (2001 to 2005), and **Table F–23** for soil (2001 to 2003). The most recent soil survey data available at the time of this analysis was from 2003.

The LANL environmental surveillance program uses statistical criteria to determine whether a particular radioisotope is actually detected in a sample. For a radioisotope to be detected, the sample measurement (the number of radioactive emissions counted in a given time period by a detector) must be equal to or greater than the minimum detectable activity and also must be equal to or greater than three times the total propagated uncertainty, which accounts for both the measurement instrumentation uncertainty as well as the sample background uncertainty. These criteria, which have been used for groundwater, sediment, surface water, and soil from 2001 through 2005, provide a high degree of confidence (99.7 percent) that a measurement result classified as detected is actually present in the sample. This is not the case for a number of the values indicated as "Used in This SWEIS." The number of detected measurements for each analyte, as reported in the Environmental Surveillance Reports, is presented in Tables F–10 through F–23 under the column heading of "Detected per ESR". The number of usable measurements for the purpose of this SWEIS is delineated under the column "Used in This SWEIS" in Tables F–10 through F–23. The number of usable measurements for each analyte is equal or greater than the LANL detected measurements because of the different method that was used in the SWEIS to select measurements. The method used in this SWEIS allows comparison with the environmental surveillance data presented in the *1999 SWEIS* (DOE 1999) which used a similar statistical approach to select usable measurements from the 1991 through 1996 environmental surveillance data. A usable measurement (Used in This SWEIS) in Tables F–10 through F–23 does not indicate that the analyte actually exists in the sample at a level greater than the analytical instrument was able to detect, but only that the measurement met the previously described guidance. There is a large difference between the number of environmental samples analyzed that are reported as detected and the number of samples that are reported as "Used in This SWEIS" for uranium. Uranium is a naturally occurring element in the LANL environment. The criterion for detected samples eliminates uranium concentrations below the 5 microcuries per gram whereas the "Used in This SWEIS" data do not screen out background uranium concentrations in environmental samples and therefore results in a higher number of numerical values. Only the usable measurements were used to develop the mean values and 95 percent UCL values shown in Tables F–10 through F–23. The 95 percent UCL values are used in Appendix C of this SWEIS to estimate human health impacts.

Table F–9 Number of Detectable Radiological Data Samples at Los Alamos National Laboratory Exceeding Analytical Thresholds

Radioisotope	*Number of Samples Exceeding Analytical Thresholds (2001 through 2005)*							
	Groundwater		*Sediment*		*Surface Water or Stormwater Runoff*		*Soil (2001 through 2003)*	
	Detected per ESR	*Used in This SWEIS*	*Detected per ESR*	*Used in This SWEIS*	*Detected per ESR*	*Used in This SWEIS*	*Detected per ESR*	*Used in This SWEIS*
Americium-241	84	237	132	353	63	499	75	75
Cesium-137	14	134	82	570	0	273	76	76
Plutonium-238	25	135	77	246	23	325	61	61
Plutonium-239, Plutonium-240	37	132	212	363	78	483	76	76
Strontium-90	133	328	33	231	45	518	73	73
Tritium	105	190	11	201	15	303	71	71
Uranium-234	47	675	23	599	37	693	51	51
Uranium-235, Uranium-236	3	414	4	508	3	546	–	–
Uranium-238	19	635	1	599	34	706	51	51

ESR = Environmental Surveillance Reports.

Table F–10 Radiochemical Statistical Analysis of Groundwater – Regional Aquifer Wells

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Regional Aquifer Wells Composite [a]									
Americium-241	pCi/L	7	64	311	0.002	0.027	0.009	0.157	0.03
Cesium-137	pCi/L	4	45	322	0.021	2.97	1.84	16.3	3.51
Cobalt-60	pCi/L	2	30	198	0.264	2.1	0.545	7.83	2.3
Iodine-129	pCi/L	0	5	37	0.339	0.562	0.167	0.794	0.709
Neptunium-237	pCi/L	0	29	166	2.02	12.2	0.622	28.4	12.4
Plutonium-238	pCi/L	0	28	310	0.0	0.014	0.009	0.038	0.017
Plutonium-239, Plutonium-240	pCi/L	4	26	310	0.0	0.068	0.068	0.601	0.094
Potassium-40	pCi/L	5	168	198	0.47	31.1	3.04	105	31.5
Radium-226	pCi/L	26	57	79	0.123	0.42	0.12	1.17	0.451
Sodium-22	pCi/L	0	11	198	1.04	1.99	0.028	2.74	2
Strontium-90	pCi/L	8	122	447	0.004	0.123	0.045	0.434	0.131
Technetium-99	pCi/L	1	11	48	1.27	2.44	1.23	5.24	3.17
Tritium	pCi/L	17	50	216	0.0	136	81.3	874	158
Uranium-234	pCi/L	0	265	306	0.009	0.473	0.111	2.66	0.486
Uranium-235, Uranium-236	pCi/L	0	138	307	0.005	0.043	0.023	0.181	0.047
Uranium-238	pCi/L	0	253	307	0.008	0.205	0.105	1.53	0.218
Uranium (calculated)	µg/L	0	333	342	0.01	0.627	0.131	4.6	0.641
Uranium (measured)	µg/L	0	80	80	0.02	0.63	0.038	3.46	0.639
Gross Alpha	pCi/L	4	134	285	0.173	1.55	0.567	14.5	1.65

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Gross Beta	pCi/L	0	234	284	0.504	3.38	0.499	15.6	3.44
Gross Gamma	pCi/L	0	84	258	44.1	141	29.1	1,920	147

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite includes data from Hydrogeologic Characterization Wells (Table F–11), Test Wells (Table F–12), Water Supply Wells (Table F–13). The corresponding data set identifier is indicated in Table F–1.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–11 Radiochemical Statistical Analysis of Groundwater – Hydrogeologic Characterization Wells

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Hydrogeologic Characterization Wells [a] Composite									
Americium-241	pCi/L	4	30	193	0.002	0.025	0.009	0.047	0.029
Cesium-137	pCi/L	0	23	196	0.251	2.95	1.61	14.6	3.6
Cobalt-60	pCi/L	2	21	147	0.264	2.07	0.517	7.83	2.29
Iodine-129	pCi/L	0	5	37	0.339	0.562	0.167	0.794	0.709
Neptunium-237	pCi/L	0	14	114	5.24	10.1	0.553	21	10.4
Plutonium-238	pCi/L	0	4	197	0.006	0.017	0.017	0.038	0.034
Plutonium-239, Plutonium-240	pCi/L	4	6	197	0.011	0.138	0.09	0.601	0.21
Potassium-40	pCi/L	5	124	147	0.471	35.7	10.8	105	37.6
Radium-226	pCi/L	15	29	37	0.149	0.437	0.146	1.17	0.49
Sodium-22	pCi/L	0	10	147	1.04	1.94	0.095	2.74	2
Strontium-90	pCi/L	4	45	191	0.078	0.167	0.02	0.434	0.172
Technetium-99	pCi/L	1	11	48	1.27	2.44	1.23	5.24	3.17
Tritium	pCi/L	4	20	94	63.4	137	32.2	523	151
Uranium-234	pCi/L	0	161	193	0.009	0.392	0.144	2.66	0.414
Uranium-235, Uranium-236	pCi/L	0	86	194	0.016	0.047	0.011	0.164	0.049
Uranium-238	pCi/L	0	151	194	0.01	0.215	0.061	1.53	0.225
Uranium (calculated)	µg/L	0	235	244	0.01	0.486	0.153	4.6	0.506
Uranium (measured)	µg/L	0	46	46	0.02	0.627	0.065	2.03	0.646
Gross Alpha	pCi/L	3	74	157	0.268	1.92	0.91	14.5	2.13
Gross Beta	pCi/L	0	122	157	0.504	3.8	0.795	15.6	3.94
Gross Gamma	pCi/L	0	52	167	44.1	158	66.7	1,920	177
***Ancho Canyon* [b]**									
Americium-241	pCi/L	0	0	8	–	–	–	–	–
Cesium-137	pCi/L	0	1	8	–	2.03	–	–	–
Cobalt-60	pCi/L	0	3	8	0.801	2.09	1.15	3	3.39
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	8	–	15.1	–	–	–
Plutonium-238	pCi/L	0	0	8	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	8	–	–	–	–	–

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Potassium-40	pCi/L	0	7	8	15.1	33.2	14.7	55.8	44.1
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	8	–	–	–	–	–
Strontium-90	pCi/L	1	1	8	–	0.228	–	–	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	1	4	–	122	–	–	–
Uranium-234	pCi/L	0	8	8	0.058	0.236	0.23	0.618	0.395
Uranium-235, Uranium-236	pCi/L	0	2	8	0.03	0.031	–	0.033	–
Uranium-238	pCi/L	0	7	8	0.047	0.163	0.16	0.398	0.281
Uranium (calculated)	µg/L	0	8	8	0.083	0.4	0.406	1.1	0.682
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	5	8	0.873	2.33	1.33	4.28	3.49
Gross Beta	pCi/L	0	8	8	2.35	4.52	1.81	6.44	5.77
Gross Gamma	pCi/L	0	3	8	73.5	92.7	20.3	114	116
Cañada del Buey [b]									
Americium-241	pCi/L	0	13	57	0.002	0.025	0.01	0.039	0.03
Cesium-137	pCi/L	0	7	60	1.24	2.89	1.39	7.29	3.91
Cobalt-60	pCi/L	0	4	33	0.304	0.95	0.914	1.75	1.85
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	5	33	5.24	12.3	5.71	21	17.3
Plutonium-238	pCi/L	0	1	58	–	0.038	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	2	58	0.025	0.026	–	0.026	–
Potassium-40	pCi/L	1	31	33	4.2	42.5	16.6	103	48.3
Radium-226	pCi/L	0	7	8	0.216	0.373	0.188	0.752	0.512
Sodium-22	pCi/L	0	2	33	1.7	2.12	–	2.53	–
Strontium-90	pCi/L	0	8	56	0.099	0.147	0.018	0.248	0.16
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	1	4	30	77	247	241	523	483
Uranium-234	pCi/L	0	42	58	0.009	0.361	0.171	2.1	0.413
Uranium-235, Uranium-236	pCi/L	0	21	58	0.016	0.042	0.02	0.129	0.05
Uranium-238	pCi/L	0	38	58	0.01	0.218	0.109	1.31	0.253
Uranium (calculated)	µg/L	0	55	58	0.01	0.471	0.398	3.8	0.577
Uranium (measured)	µg/L	0	14	14	0.02	0.494	0.089	2.03	0.541
Gross Alpha	pCi/L	0	23	56	0.35	1.82	0.468	3.55	2.01
Gross Beta	pCi/L	0	36	56	1.18	4.94	0.972	10.3	5.26
Gross Gamma	pCi/L	0	21	61	49.2	217	134	1,920	274
Los Alamos Canyon [b]									
Americium-241	pCi/L	1	7	27	0.019	0.029	0.006	0.047	0.033
Cesium-137	pCi/L	0	5	29	0.251	2.65	2.336	5.51	4.7
Cobalt-60	pCi/L	0	2	16	3.14	5.49	–	7.83	–
Iodine-129	pCi/L	0	1	5	–	0.524	–	–	–
Neptunium-237	pCi/L	0	0	12	–	–	–	–	–
Plutonium-238	pCi/L	0	2	26	0.006	0.013	–	0.019	–

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Plutonium-239, Plutonium-240	pCi/L	1	2	26	0.011	0.031	–	0.051	–
Potassium-40	pCi/L	0	10	16	6.41	31.4	17.2	73.4	42.1
Radium-226	pCi/L	2	8	10	0.316	0.415	0.14	1.17	0.512
Sodium-22	pCi/L	0	1	16	–	2.74	–	–	–
Strontium-90	pCi/L	2	10	25	0.124	0.164	0.039	0.278	0.188
Technetium-99	pCi/L	0	0	5	–	–	–	–	–
Tritium	pCi/L	0	4	12	63.4	94.2	3.57	120	97.7
Uranium-234	pCi/L	0	21	26	0.036	0.496	0.304	1.72	0.626
Uranium-235, Uranium-236	pCi/L	0	16	27	0.016	0.057	0.025	0.137	0.070
Uranium-238	pCi/L	0	20	27	0.024	0.293	0.214	0.962	0.386
Uranium (calculated)	µg/L	0	21	23	0.019	0.642	0.401	3	0.813
Uranium (measured)	µg/L	0	5	5	0.02	0.78	0.229	1.8	0.981
Gross Alpha	pCi/L	1	16	23	0.268	2.28	2.21	13.5	3.37
Gross Beta	pCi/L	0	19	23	1.08	3.48	1.08	6.79	3.97
Gross Gamma	pCi/L	0	4	25	66.6	137	91.5	243	227
Mortandad Canyon [b]									
Americium-241	pCi/L	0	4	42	0.011	0.012	0.001	0.014	0.014
Cesium-137	pCi/L	0	3	42	1.26	2.53	1.19	3.62	3.88
Cobalt-60	pCi/L	1	6	39	0.576	1.61	0.7	2.42	2.17
Iodine-129	pCi/L	0	3	14	0.339	0.55	0.229	0.79	0.81
Neptunium-237	pCi/L	0	5	27	5.44	6.75	2.01	10.3	8.52
Plutonium-238	pCi/L	0	0	44	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	1	1	44	–	0.601	–	–	–
Potassium-40	pCi/L	3	36	39	0.471	33.2	13.2	92	37.5
Radium-226	pCi/L	7	9	12	0.162	0.389	0.258	0.926	0.558
Sodium-22	pCi/L	0	3	39	1.04	1.48	0.381	1.71	1.91
Strontium-90	pCi/L	1	10	43	0.079	0.183	0.051	0.434	0.215
Technetium-99	pCi/L	1	6	25	1.27	2.56	1.42	5.24	3.7
Tritium	pCi/L	1	6	22	88.4	139	48.3	210	178
Uranium-234	pCi/L	0	39	42	0.051	0.336	0.126	0.892	0.376
Uranium-235, Uranium-236	pCi/L	0	21	42	0.028	0.046	0.005	0.084	0.048
Uranium-238	pCi/L	0	38	42	0.07	0.169	0.061	0.395	0.189
Uranium (calculated)	µg/L	0	43	43	0.05	0.491	0.137	1.1	0.532
Uranium (measured)	µg/L	0	8	8	0.315	0.394	0.04	0.463	0.422
Gross Alpha	pCi/L	1	11	30	0.647	1.59	1.33	14.5	2.37
Gross Beta	pCi/L	0	26	30	0.504	2.29	1.98	14.1	3.05
Gross Gamma	pCi/L	0	11	31	44.1	157	85.8	778	207
Pajarito Canyon [b]									
Americium-241	pCi/L	2	2	16	0.008	0.019	–	0.031	–
Cesium-137	pCi/L	0	2	16	1.08	7.84	–	14.6	–
Cobalt-60	pCi/L	0	0	16	–	–	–	–	–

		2001 through 2005							
Measured Radiochemical		***Detected per ESR***	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	16	6.7	13	–	19.2	–
Plutonium-238	pCi/L	0	0	16	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	16	–	–	–	–	–
Potassium-40	pCi/L	0	11	16	10.9	28.1	13.3	49.3	35.9
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	1	16	–	2.01	–	–	–
Strontium-90	pCi/L	0	2	16	0.088	0.17	–	0.252	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	8	–	–	–	–	–
Uranium-234	pCi/L	0	12	16	0.061	0.317	0.193	0.582	0.426
Uranium-235, Uranium-236	pCi/L	0	5	16	0.033	0.043	0.011	0.061	0.053
Uranium-238	pCi/L	0	12	16	0.033	0.162	0.089	0.269	0.212
Uranium (calculated)	µg/L	0	16	16	0.05	0.294	0.301	0.98	0.442
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	1	6	16	0.574	1.76	1.86	5.37	3.25
Gross Beta	pCi/L	0	13	16	1.52	3.55	2.08	8.67	4.68
Gross Gamma	pCi/L	0	8	16	45.5	77.3	29.8	139	98
Potrillo Canyon [b]									
Americium-241	pCi/L	0	1	9	–	0.035	–	–	–
Cesium-137	pCi/L	0	2	9	1.77	2.39	–	3	–
Cobalt-60	pCi/L	0	1	9	–	0.264	-	-	-
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	9	–	–	–	–	–
Plutonium-238	pCi/L	0	0	11	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	1	1	11	–	0.163	–	–	–
Potassium-40	pCi/L	0	6	9	3.25	26.1	12.8	60.3	36.3
Radium-226	pCi/L	0	2	3	0.149	0.176	–	0.202	–
Sodium-22	pCi/L	0	2	9	1.87	2.23	–	2.58	–
Strontium-90	pCi/L	0	4	9	0.167	0.215	0.061	0.282	0.275
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	1	5	–	67.7	–	–	–
Uranium-234	pCi/L	0	9	9	0.215	0.476	0.012	0.918	0.484
Uranium-235, Uranium-236	pCi/L	0	4	9	0.035	0.077	0.025	0.104	0.102
Uranium-238	pCi/L	0	9	9	0.076	0.237	0.013	0.669	0.245
Uranium (calculated)	µg/L	0	9	9	0.26	0.628	0.1	1.44	0.693
Uranium (measured)	µg/L	0	8	8	0.02	0.678	0.225	1.89	0.834
Gross Alpha	pCi/L	0	4	9	0.924	2.39	1.16	4.99	3.53
Gross Beta	pCi/L	0	8	9	1.11	3.27	1.2	6.34	4.1
Gross Gamma	pCi/L	0	0	9	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Pueblo Canyon [b]									
Americium-241	pCi/L	0	0	7	–	–	–	–	–
Cesium-137	pCi/L	0	0	7	–	–	–	–	–
Cobalt-60	pCi/L	0	1	7	–	2.19	–	–	–
Iodine-129	pCi/L	0	0	7	–	–	–	–	–
Neptunium-237	pCi/L	0	0	0	–	–	–	–	–
Plutonium-238	pCi/L	0	0	7	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	7	–	–	–	–	–
Potassium-40	pCi/L	0	5	7	22.8	30.3	4.44	33.7	34.2
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	7	–	–	–	–	–
Strontium-90	pCi/L	0	1	7	–	0.121	–	–	–
Technetium-99	pCi/L	0	2	7	2.18	3.13	–	4.07	–
Tritium	pCi/L	0	0	0	–	–	–	–	–
Uranium-234	pCi/L	0	6	7	0.493	0.638	0.129	0.846	0.741
Uranium-235, Uranium-236	pCi/L	0	2	7	0.048	0.053	–	0.057	–
Uranium-238	pCi/L	0	6	7	0.183	0.261	0.04	0.289	0.293
Uranium (calculated)	µg/L	0	13	13	0.05	0.689	0.246	1.1	0.823
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	0	0	–	–	–	–	–
Gross Beta	pCi/L	0	0	0	–	–	–	–	–
Gross Gamma	pCi/L	0	0	0	–	–	–	–	–
Sandia Canyon [b]									
Americium-241	pCi/L	1	3	21	0.016	0.02	0.005	0.025	0.025
Cesium-137	pCi/L	0	3	19	1.08	3.31	2.16	2.48	5.75
Cobalt-60	pCi/L	0	2	13	2.4	2.4	–	2.4	–
Iodine-129	pCi/L	0	1	7	–	0.634	–	–	–
Neptunium-237	pCi/L	0	1	7	–	9.68	–	–	–
Plutonium-238	pCi/L	0	1	21	–	0.03	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	21	–	–	–	–	–
Potassium-40	pCi/L	1	12	13	6.5	38	25	105	52.2
Radium-226	pCi/L	2	3	4	0.208	0.48	0.269	0.745	0.784
Sodium-22	pCi/L	0	1	13	–	2.04	–	–	–
Strontium-90	pCi/L	0	9	21	0.078	0.128	0.044	0.247	0.156
Technetium-99	pCi/L	0	3	7	1.36	1.73	0.590	2.41	2.4
Tritium	pCi/L	0	4	10	110	111	0.0	112	–
Uranium-234	pCi/L	0	18	21	0.016	0.713	0.274	2.66	0.839
Uranium-235, Uranium-236	pCi/L	0	14	21	0.017	0.06	0.017	0.164	0.069
Uranium-238	pCi/L	0	16	21	0.022	0.404	0.09	1.53	0.448
Uranium (calculated)	µg/L	0	23	27	0.05	1.19	0.246	4.6	1.29
Uranium (measured)	µg/L	0	7	7	0.051	1.1	0.058	1.64	1.15

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Gross Alpha	pCi/L	0	9	13	0.614	1.36	0.32	2.49	1.57
Gross Beta	pCi/L	0	10	13	1.32	4.23	2.19	15.6	5.59
Gross Gamma	pCi/L	0	3	15	70.2	114	61.3	220	183
Water Canyon [b]									
Americium-241	pCi/L	0	0	6	–	–	–	–	–
Cesium-137	pCi/L	0	0	6	–	–	–	–	–
Cobalt-60	pCi/L	1	2	6	3.12	4.81	–	6.5	–
Iodine-129	pCi/L	0	0	4	–	–	–	–	–
Neptunium-237	pCi/L	0	0	2	–	–	–	–	–
Plutonium-238	pCi/L	0	0	6	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	6	–	–	–	–	–
Potassium-40	pCi/L	0	6	6	10.6	20.4	9.86	37.2	28.2
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	6	–	–	–	–	–
Strontium-90	pCi/L	0	0	6	–	–	–	–	–
Technetium-99	pCi/L	0	0	4	–	–	–	–	–
Tritium	pCi/L	0	0	3	–	–	–	–	–
Uranium-234	pCi/L	0	6	6	0.048	0.225	0.09	0.297	0.298
Uranium-235, Uranium-236	pCi/L	0	1	6	–	0.031	–	–	–
Uranium-238	pCi/L	0	5	6	0.121	0.135	0.012	0.151	0.145
Uranium (calculated)	µg/L	0	47	47	0.05	0.234	0.187	0.54	0.288
Uranium (measured)	µg/L	0	4	4	0.046	0.388	0.278	0.727	0.66
Gross Alpha	pCi/L	0	0	2	–	–	–	–	–
Gross Beta	pCi/L	0	2	2	1.89	1.97	–	2.04	–
Gross Gamma	pCi/L	0	2	2	94.1	102	–	109	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier is indicated in Table F–1.

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–12 Radiochemical Statistical Analysis of Groundwater – Test Wells

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Test Wells [a] Composite									
Americium-241	pCi/L	1	17	54	0.003	0.026	0.008	0.066	0.03
Cesium-137	pCi/L	3	12	60	0.132	3.12	2	16.3	4.25
Cobalt-60	pCi/L	0	3	25	1.71	2.84	1.14	3.99	4.13
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	7	26	8.51	13.45	2.04	21.2	15

Measured Radiochemical		**2001 through 2005**							
		Detected per ESR	**Used In This SWEIS**	**Analyzed**	**Minimum**	**Mean**	**Standard Deviation**	**Maximum**	**95 Percent UCL**
Plutonium-238	pCi/L	0	12	53	0.0	0.009	0.005	0.015	0.012
Plutonium-239, Plutonium-240	pCi/L	0	8	53	0.005	0.017	0.009	0.027	0.023
Potassium-40	pCi/L	0	22	25	1.91	30.1	5.67	68	32.5
Radium-226	pCi/L	4	11	16	0.173	0.496	0.087	0.904	0.548
Sodium-22	pCi/L	0	1	25	–	2.06	–	–	–
Strontium-90	pCi/L	3	26	71	0.004	0.129	0.07	0.238	0.156
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	6	19	50	0.0	133	70.7	303	165
Uranium-234	pCi/L	0	45	53	0.035	0.562	0.139	2.14	0.602
Uranium-235, Uranium-236	pCi/L	0	16	53	0.006	0.067	0.046	0.181	0.089
Uranium-238	pCi/L	0	43	53	0.008	0.254	0.141	1.18	0.296
Uranium (calculated)	µg/L	0	49	49	0.011	0.649	0.064	3.6	0.666
Uranium (measured)	µg/L	0	20	20	0.02	0.491	0.235	3.46	0.593
Gross Alpha	pCi/L	0	24	52	0.173	1.37	0.49	4.73	1.56
Gross Beta	pCi/L	0	45	52	0.708	2.34	0.535	5.75	2.5
Gross Gamma	pCi/L	0	14	44	52.3	88.4	42.9	271	111
Ancho Canyon [b]									
Americium-241	pCi/L	1	7	28	0.003	0.029	0.011	0.066	0.036
Cesium-137	pCi/L	0	3	25	1.9	4.52	3.59	7.06	8.59
Cobalt-60	pCi/L	0	1	12	–	2.82	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	3	13	8.51	9.89	1.96	13.1	12.1
Plutonium-238	pCi/L	0	5	27	0.0	0.006	0.005	0.009	0.01
Plutonium-239, Plutonium-240	pCi/L	0	5	27	0.005	0.016	0.01	0.027	0.024
Potassium-40	pCi/L	0	11	12	11.3	33.1	1.08	57.7	33.7
Radium-226	pCi/L	3	4	6	0.22	0.61	0.286	0.904	0.89
Sodium-22	pCi/L	0	0	12	–	–	–	–	–
Strontium-90	pCi/L	1	10	28	0.004	0.124	0.07	0.233	0.167
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	2	7	22	0.0	154	148	303	263
Uranium-234	pCi/L	0	23	27	0.086	0.271	0.069	0.644	0.299
Uranium-235, Uranium-236	pCi/L	0	6	27	0.027	0.043	0.006	0.054	0.048
Uranium-238	pCi/L	0	22	27	0.021	0.098	0.048	0.31	0.118
Uranium (calculated)	µg/L	0	27	27	0.011	0.322	0.116	0.67	0.365
Uranium (measured)	µg/L	0	10	10	0.02	0.28	0.04	0.547	0.305
Gross Alpha	pCi/L	0	10	24	0.173	0.858	0.499	1.9	1.17
Gross Beta	pCi/L	0	19	24	0.8	1.61	0.411	2.97	1.79
Gross Gamma	pCi/L	0	5	22	52.3	81.5	15.9	99.2	95.5

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Los Alamos Canyon [b]									
Americium-241	pCi/L	0	4	11	0.01	0.015	0.009	0.028	0.024
Cesium-137	pCi/L	3	5	14	0.132	4.36	4.91	16.3	8.66
Cobalt-60	pCi/L	0	1	5	–	3.99	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	5	–	–	–	–	–
Plutonium-238	pCi/L	0	3	11	0.0	0.007	0.007	0.015	0.015
Plutonium-239, Plutonium-240	pCi/L	0	2	11	0.012	0.02	–	0.027	–
Potassium-40	pCi/L	0	3	5	10.6	25.6	6.4	31.5	32.8
Radium-226	pCi/L	0	2	5	0.173	0.399	–	0.625	–
Sodium-22	pCi/L	0	1	5	–	2.06	–	–	–
Strontium-90	pCi/L	0	5	14	0.057	0.133	0.085	0.226	0.207
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	3	9	53.1	84.8	44.8	117	136
Uranium-234	pCi/L	0	9	11	0.049	0.209	0.191	0.444	0.333
Uranium-235, Uranium-236	pCi/L	0	0	11	–	–	–	–	–
Uranium-238	pCi/L	0	8	11	0.02	0.062	0.067	0.18	0.108
Uranium (calculated)	µg/L	0	9	9	0.041	0.283	0.247	0.55	0.444
Uranium (measured)	µg/L	0	4	4	0.02	0.337	0.413	0.629	0.742
Gross Alpha	pCi/L	0	3	12	0.381	0.63	0.217	0.774	0.876
Gross Beta	pCi/L	0	11	12	0.708	2.53	1.17	5.26	3.22
Gross Gamma	pCi/L	0	5	7	55	69.2	13.3	99.8	80.9
Mortandad Canyon [b]									
Americium-241	pCi/L	0	1	4	–	0.009	–	–	–
Cesium-137	pCi/L	0	2	8	2.16	2.23	–	2.3	–
Cobalt-60	pCi/L	0	0	2	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	2	9.62	15.4	–	21.2	–
Plutonium-238	pCi/L	0	1	4	–	0.0	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	4	–	–	–	–	–
Potassium-40	pCi/L	0	2	2	28.8	31.2	–	33.6	–
Radium-226	pCi/L	0	1	1	–	0.268	–	–	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–
Strontium-90	pCi/L	0	3	11	0.004	0.132	0.119	0.238	0.266
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	2	7	0.0	40.5	–	80.9	–
Uranium-234	pCi/L	0	4	4	0.264	0.377	0.042	0.412	0.418

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium-235, Uranium-236	pCi/L	0	2	4	0.038	0.044	–	0.049	–
Uranium-238	pCi/L	0	4	4	0.023	0.125	0.089	0.194	0.212
Uranium (calculated)	µg/L	0	4	4	0.39	0.486	0.083	0.6	0.567
Uranium (measured)	µg/L	0	5	5	0.52	0.66	0.167	0.845	0.806
Gross Alpha	pCi/L	0	3	4	0.96	1.08	0.132	1.22	1.23
Gross Beta	pCi/L	0	3	4	2.36	2.7	0.445	3.01	3.2
Gross Gamma	pCi/L	0	0	5	–	–	–	–	–
Pueblo Canyon [b]									
Americium-241	pCi/L	0	5	11	0.015	0.024	0.009	0.04	0.032
Cesium–137	pCi/L	0	2	13	0.971	1.5	–	2.03	–
Cobalt-60	pCi/L	0	1	6	–	1.71	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	6	15.5	18.3	–	21.1	–
Plutonium-238	pCi/L	0	3	11	0.0	0.009	0.007	0.014	0.017
Plutonium-239, Plutonium-240	pCi/L	0	1	11	–	0.005	–	–	–
Potassium-40	pCi/L	0	6	6	1.91	24.6	15.5	68	37.1
Radium-226	pCi/L	1	4	4	0.176	0.411	0.16	0.629	0.568
Sodium-22	pCi/L	0	0	6	–	–	–	–	–
Strontium-90	pCi/L	2	8	18	0.017	0.099	0.08	0.19	0.155
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	4	7	12	53.4	151	33.6	208	176
Uranium-234	pCi/L	0	9	11	0.035	1.74	0.441	2.14	2.03
Uranium-235, Uranium-236	pCi/L	0	8	11	0.006	0.098	0.073	0.181	0.148
Uranium-238	pCi/L	0	9	11	0.008	0.832	0.441	1.18	1.12
Uranium (calculated)	µg/L	0	9	9	0.018	2.19	0.715	3.6	2.66
Uranium (measured)	µg/L	0	1	1	–	3.46	–	–	–
Gross Alpha	pCi/L	0	8	12	0.429	2.38	0.818	4.73	2.95
Gross Beta	pCi/L	0	12	12	1.85	3.44	0.672	5.75	3.82
Gross Gamma	pCi/L	0	4	10	53.9	98	70	271	167

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier is indicated in Table F–1.

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–13 Radiochemical Statistical Analysis of Groundwater – Water Supply Wells

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Water Supply Wells [a] Composite									
Americium-241	pCi/L	2	17	64	0.003	0.033	0.03	0.157	0.047
Cesium-137	pCi/L	1	10	66	0.021	2.73	2.59	15.2	4.33
Cobalt-60	pCi/L	0	6	26	1.35	2.12	0.502	3.53	2.52
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	8	26	2.02	13.3	3.77	28.4	15.9
Plutonium-238	pCi/L	0	12	60	0.004	0.012	0.001	0.019	0.013
Plutonium-239, Plutonium-240	pCi/L	0	12	60	0.0	0.017	0.014	0.031	0.024
Potassium-40	pCi/L	0	22	26	0.47	27.3	5.88	63.9	29.8
Radium-226	pCi/L	7	17	26	0.123	0.338	0.124	0.671	0.397
Sodium-22	pCi/L	0	0	26	–	–	–	–	–
Strontium-90	pCi/L	1	51	185	0.035	0.116	0.043	0.272	0.127
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	7	11	72	60.8	204	180	874	311
Uranium-234	pCi/L	0	59	60	0.13	0.523	0.082	1.29	0.544
Uranium-235, Uranium-236	pCi/L	0	36	60	0.005	0.048	0.017	0.142	0.054
Uranium-238	pCi/L	0	59	60	0.017	0.226	0.11	0.642	0.254
Uranium (calculated)	µg/L	0	49	49	0.025	0.82	0.053	1.78	0.835
Uranium (measured)	µg/L	0	14	14	0.02	0.849	0.547	1.77	1.14
Gross Alpha	pCi/L	1	36	76	0.528	1.48	0.669	9.09	1.69
Gross Beta	pCi/L	0	67	75	0.872	3.43	0.77	8.93	3.61
Gross Gamma	pCi/L	0	18	47	48.4	114	39.6	355	132
***Cañada del Buey* [b]**									
Americium-241	pCi/L	0	0	3	–	–	–	–	–
Cesium-137	pCi/L	0	2	3	0.021	1.04	–	2.05	–
Cobalt-60	pCi/L	0	1	1	–	1.35	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	1	–	–	–	–	–
Plutonium-238	pCi/L	0	1	3	–	0.017	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	3	–	–	–	–	–
Potassium-40	pCi/L	0	1	1	–	26.6	–	–	–
Radium-226	pCi/L	0	1	1	–	0.242	–	–	–
Sodium-22	pCi/L	0	0	1	–	–	–	–	–
Strontium-90	pCi/L	1	2	7	0.085	0.154	–	0.224	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	3	–	–	–	–	–
Uranium-234	pCi/L	0	3	3	0.213	0.247	0.031	0.275	0.283

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium-235, Uranium-236	pCi/L	0	1	3	–	0.035	–	–	–
Uranium-238	pCi/L	0	3	3	0.019	0.094	0.066	0.144	0.169
Uranium (calculated)	µg/L	0	2	2	0.37	0.39	–	0.41	–
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	1	3	–	1.94	–	–	–
Gross Beta	pCi/L	0	3	3	1.14	3.33	2.48	6.03	6.14
Gross Gamma	pCi/L	0	2	2	54.1	72.3	–	90.5	–
Guaje Canyon [b]									
Americium-241	pCi/L	0	5	29	0.006	0.018	0.0	0.032	0.018
Cesium-137	pCi/L	0	3	29	1.61	2.80	1.18	3.97	4.14
Cobalt-60	pCi/L	0	2	12	2.36	2.95	–	3.53	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	12	12.2	12.6	–	13	–
Plutonium-238	pCi/L	0	5	29	0.004	0.013	0.008	0.019	0.02
Plutonium-239, Plutonium-240	pCi/L	0	4	29	0.0	0.017	0.02	0.031	0.036
Potassium-40	pCi/L	0	10	12	0.47	30.1	5.19	40	33.3
Radium-226	pCi/L	5	9	12	0.139	0.355	0.11	0.608	0.427
Sodium-22	pCi/L	0	0	12	–	–	–	–	–
Strontium-90	pCi/L	0	24	83	0.035	0.108	0.046	0.272	0.127
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	7	8	30	67.8	257	255	874	434
Uranium-234	pCi/L	0	28	29	0.254	0.415	0.043	0.627	0.431
Uranium-235, Uranium-236	pCi/L	0	19	29	0.005	0.038	0.009	0.068	0.042
Uranium-238	pCi/L	0	28	29	0.019	0.198	0.098	0.347	0.235
Uranium (calculated)	µg/L	0	24	24	0.025	0.661	0.074	1.05	0.69
Uranium (measured)	µg/L	0	7	7	0.02	0.589	0.284	0.858	0.799
Gross Alpha	pCi/L	0	15	36	0.528	0.955	0.378	1.84	1.15
Gross Beta	pCi/L	0	31	36	1.32	2.72	0.743	6.25	2.98
Gross Gamma	pCi/L	0	9	25	48.4	91.2	18.1	123	103
Los Alamos Canyon [b]									
Americium-241	pCi/L	0	0	4	–	–	–	–	–
Cesium-137	pCi/L	0	0	5	–	–	–	–	–
Cobalt-60	pCi/L	0	0	2	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	2	5.77	10.7	–	15.6	–
Plutonium-238	pCi/L	0	1	4	–	0.017	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	1	4	–	0.016	–	–	–
Potassium-40	pCi/L	0	2	2	31.1	33.8	–	36.4	–

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Radium-226	pCi/L	1	1	2	–	0.349	–	–	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–
Strontium-90	pCi/L	0	4	15	0.067	0.086	0.019	0.104	0.104
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	6	–	–	–	–	–
Uranium-234	pCi/L	0	4	4	0.516	0.585	0.053	0.641	0.638
Uranium-235, Uranium-236	pCi/L	0	2	4	0.031	0.063	–	0.095	–
Uranium-238	pCi/L	0	4	4	0.028	0.211	0.125	0.31	0.334
Uranium (calculated)	µg/L	0	3	3	0.74	0.814	0.108	0.937	0.935
Uranium (measured)	µg/L	0	1	1	–	0.784	–	–	–
Gross Alpha	pCi/L	0	3	5	1.02	1.28	0.304	1.49	1.62
Gross Beta	pCi/L	0	5	5	2.66	3.7	0.952	4.94	4.54
Gross Gamma	pCi/L	0	1	3	–	120	–	–	–
Mortandad Canyon [b]									
Americium-241	pCi/L	1	2	5	0.012	0.085	–	0.157	–
Cesium-137	pCi/L	1	1	5	–	15.2	–	–	–
Cobalt-60	pCi/L	0	1	2	–	2.52	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	2	–	17.4	–	–	–
Plutonium-238	pCi/L	0	0	4	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	4	–	–	–	–	–
Potassium-40	pCi/L	0	1	2	–	16.6	–	–	–
Radium-226	pCi/L	0	2	2	0.23	0.306	–	0.382	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–
Strontium-90	pCi/L	0	3	13	0.115	0.135	0.028	0.194	0.166
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	6	–	–	–	–	–
Uranium-234	pCi/L	0	4	4	0.228	0.332	0.076	0.391	0.407
Uranium-235, Uranium-236	pCi/L	0	2	4	0.039	0.041	–	0.044	–
Uranium-238	pCi/L	0	4	4	0.019	0.143	0.086	0.218	0.227
Uranium (calculated)	µg/L	0	3	3	0.43	0.487	0.05	0.521	0.544
Uranium (measured)	µg/L	0	1	1	–	0.553	–	–	–
Gross Alpha	pCi/L	0	1	5	–	0.665	–	–	–
Gross Beta	pCi/L	0	5	5	1.71	2.69	0.963	4.01	3.53
Gross Gamma	pCi/L	0	0	3	–	–	–	–	–
Pajarito Canyon [b]									
Americium-241	pCi/L	0	3	5	0.016	0.031	0.008	0.059	0.041
Cesium-137	pCi/L	0	2	5	1.53	1.71	–	1.88	–
Cobalt-60	pCi/L	0	1	2	–	2.59	–	–	–

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	2	–	28.4	–	–	–
Plutonium-238	pCi/L	0	1	4	–	0.01	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	1	4	–	0.003	–	–	–
Potassium-40	pCi/L	0	2	2	20.9	42.4	–	63.9	–
Radium-226	pCi/L	0	1	2	–	0.466	–	–	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–
Strontium-90	pCi/L	0	5	16	0.073	0.1	0.007	0.11	0.106
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	7	–	–	–	–	–
Uranium-234	pCi/L	0	4	4	0.13	0.201	0.054	0.257	0.253
Uranium-235, Uranium-236	pCi/L	0	2	4	0.018	0.025	–	0.033	–
Uranium-238	pCi/L	0	4	4	0.017	0.076	0.039	0.099	0.115
Uranium (calculated)	µg/L	0	3	3	0.266	0.296	0.028	0.320	0.328
Uranium (measured)	µg/L	0	1	1	–	0.236	–	–	–
Gross Alpha	pCi/L	0	1	5	–	1.03	–	–	–
Gross Beta	pCi/L	0	4	5	0.872	2.08	1.17	3.55	3.23
Gross Gamma	pCi/L	0	1	3	–	281	–	–	–
Pueblo Canyon [b]									
Americium-241	pCi/L	1	4	8	0.018	0.055	0.057	0.121	0.111
Cesium-137	pCi/L	0	0	7	–	–	–	–	–
Cobalt-60	pCi/L	0	0	3	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	3	–	2.02	–	–	–
Plutonium-238	pCi/L	0	2	7	0.012	0.015	–	0.018	–
Plutonium-239, Plutonium-240	pCi/L	0	3	7	0.002	0.006	0.004	0.009	0.01
Potassium-40	pCi/L	0	3	3	3.3	27.6	15	38.2	44.5
Radium-226	pCi/L	0	1	3	–	0.123	–	–	–
Sodium-22	pCi/L	0	0	3	–	–	–	–	–
Strontium-90	pCi/L	0	4	19	0.06	0.074	0.004	0.09	0.078
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	2	7	60.8	79.7	–	98.5	–
Uranium-234	pCi/L	0	7	7	0.753	0.891	0.108	1.04	0.971
Uranium-235, Uranium-236	pCi/L	0	4	7	0.027	0.101	0.064	0.142	0.163
Uranium-238	pCi/L	0	7	7	0.044	0.409	0.245	0.594	0.591
Uranium (calculated)	µg/L	0	6	6	1.33	1.5	0.079	1.56	1.56
Uranium (measured)	µg/L	0	2	2	1.72	1.75	–	1.77	–
Gross Alpha	pCi/L	0	6	8	0.691	1.62	0.604	2.21	2.1

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Gross Beta	pCi/L	0	8	8	2.46	3.74	0.632	6.1	4.18
Gross Gamma	pCi/L	0	2	4	91.3	104	–	116	–
Sandia Canyon [b]									
Americium-241	pCi/L	0	3	10	0.003	0.023	0.021	0.037	0.046
Cesium-137	pCi/L	0	2	12	0.322	1.59	–	2.85	–
Cobalt-60	pCi/L	0	1	4	–	1.76	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	4	–	11.8	–	–	–
Plutonium-238	pCi/L	0	2	9	0.01	0.010	–	0.011	–
Plutonium-239, Plutonium-240	pCi/L	0	3	9	0.0	0.008	0.011	0.016	0.02
Potassium-40	pCi/L	0	3	4	8.37	12.4	3.28	21.1	16.1
Radium-226	pCi/L	1	2	4	0.234	0.453	–	0.671	–
Sodium-22	pCi/L	0	0	4	–	–	–	–	–
Strontium-90	pCi/L	0	9	32	0.05	0.106	0.052	0.178	0.14
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	1	13	–	96.4	–	–	–
Uranium-234	pCi/L	0	9	9	0.595	0.957	0.125	1.29	1.04
Uranium-235, Uranium-236	pCi/L	0	6	9	0.047	0.078	0.015	0.125	0.09
Uranium-238	pCi/L	0	9	9	0.039	0.336	0.2	0.642	0.467
Uranium (calculated)	µg/L	0	8	8	0.860	1.18	0.234	1.78	1.34
Uranium (measured)	µg/L	0	2	2	0.931	1.35	–	1.77	–
Gross Alpha	pCi/L	1	9	14	0.696	2.24	1.16	9.09	3
Gross Beta	pCi/L	0	11	13	2.47	5.57	1.55	8.93	6.48
Gross Gamma	pCi/L	0	3	7	81.7	167	73.1	355	249

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier is indicated in Table F–1.

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–14 Radiochemical Statistical Analysis of Groundwater – Regional Aquifer Springs

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Regional Aquifer Springs [a] Composite									
Americium-241	pCi/L	3	25	119	0.005	0.018	0.004	0.037	0.02
Cesium-137	pCi/L	0	15	120	1.21	2.18	0.738	3.98	2.55
Cobalt-60	pCi/L	0	3	61	0.353	1.82	1.61	3.55	3.65
Iodine-129	pCi/L	0	0	0	–	–	–	–	–

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Neptunium-237	pCi/L	0	11	62	2.71	14	4.43	29.6	16.6
Plutonium-238	pCi/L	2	12	118	0.0	0.032	0.019	0.074	0.042
Plutonium-239, Plutonium-240	pCi/L	0	7	118	0.005	0.014	0.005	0.021	0.018
Potassium-40	pCi/L	3	43	61	0.4	30.5	1.33	65.4	30.9
Radium-226	pCi/L	5	18	28	0.118	1.22	1.11	3.45	1.73
Sodium-22	pCi/L	0	2	61	2.04	2.44	–	2.84	–
Strontium-90	pCi/L	2	22	113	0.056	0.162	0.028	0.3	0.174
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	17	25	117	54.8	171	113	588	216
Uranium-234	pCi/L	7	107	117	0.044	1.04	0.412	7.22	1.12
Uranium-235, Uranium-236	pCi/L	0	68	116	0.009	0.077	0.03	0.552	0.084
Uranium-238	pCi/L	0	107	117	0.019	0.563	0.28	4.4	0.616
Uranium (calculated)	µg/L	0	111	112	0.008	1.76	0.553	11.8	1.86
Uranium (measured)	µg/L	0	67	67	0.02	3.98	2.98	19.6	4.7
Gross Alpha	pCi/L	9	65	118	0.625	2.87	0.957	11.5	3.1
Gross Beta	pCi/L	0	96	117	0.649	3.36	1.32	17.0	3.63
Gross Gamma	pCi/L	0	27	104	50.4	198	67.9	1,420	224
Sandia Canyon [b]									
Americium-241	pCi/L	1	1	9	–	0.035	–	–	–
Cesium-137	pCi/L	0	1	9	–	3.17	–	–	–
Cobalt-60	pCi/L	0	0	5	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	5	–	29.6	–	–	–
Plutonium-238	pCi/L	0	2	9	0.002	0.005	–	0.007	–
Plutonium-239, Plutonium-240	pCi/L	0	0	9	–	–	–	–	–
Potassium-40	pCi/L	0	3	5	30.3	41	2.48	48.1	43.8
Radium-226	pCi/L	1	2	2	0.381	1.32	–	2.25	–
Sodium-22	pCi/L	0	0	5	–	–	–	–	–
Strontium-90	pCi/L	1	2	9	0.114	0.127	–	0.14	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	2	3	9	122	194	88.8	293	294
Uranium-234	pCi/L	0	8	9	0.264	0.589	0.239	0.99	0.754
Uranium-235, Uranium-236	pCi/L	0	4	9	0.031	0.118	0.106	0.193	0.222
Uranium-238	pCi/L	0	8	9	0.042	0.279	0.163	0.634	0.392
Uranium (calculated)	µg/L	0	8	8	0.05	0.862	0.256	1.21	1.04
Uranium (measured)	µg/L	0	1	1	–	0.62	–	–	–
Gross Alpha	pCi/L	0	5	9	0.839	1.13	0.196	1.62	1.3
Gross Beta	pCi/L	0	8	9	1.8	3.21	1.22	4.85	4.06

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Gross Gamma	pCi/L	0	2	7	105	237	–	369	–
White Rock Canyon and Rio Grande [b]									
Americium-241	pCi/L	2	24	110	0.005	0.018	0.004	0.037	0.02
Cesium-137	pCi/L	0	14	111	1.21	2.14	0.738	3.98	2.53
Cobalt-60	pCi/L	0	3	56	0.353	1.82	1.61	3.55	3.65
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	10	57	2.71	12.6	6.33	28.2	16.6
Plutonium-238	pCi/L	2	10	109	0.0	0.032	0.018	0.074	0.044
Plutonium-239, Plutonium-240	pCi/L	0	7	109	0.005	0.014	0.005	0.021	0.018
Potassium-40	pCi/L	3	40	56	0.4	29.8	1.28	65.4	30.2
Radium-226	pCi/L	4	16	26	0.118	1.16	1.02	3.45	1.66
Sodium-22	pCi/L	0	2	56	2.04	2.44	–	2.84	–
Strontium-90	pCi/L	1	20	104	0.056	0.167	0.035	0.3	0.182
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	15	22	108	54.8	182	124	588	234
Uranium-234	pCi/L	7	99	108	0.044	1.07	0.438	7.22	1.16
Uranium-235, Uranium-236	pCi/L	0	64	107	0.009	0.078	0.031	0.552	0.085
Uranium-238	pCi/L	0	99	108	0.019	0.586	0.293	4.4	0.644
Uranium (calculated)	µg/L	0	103	104	0.008	1.83	0.585	11.8	1.94
Uranium (measured)	µg/L	0	66	66	0.02	4.01	2.94	19.6	4.72
Gross Alpha	pCi/L	9	60	109	0.625	3.03	1.1	11.5	3.31
Gross Beta	pCi/L	0	88	108	0.649	3.39	1.35	17	3.67
Gross Gamma	pCi/L	0	25	97	50.4	193	65.3	1,420	218

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier is indicated in Table F–1.

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–15 Radiochemical Statistical Analysis of Groundwater – Canyon Alluvial Wells [a]

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Canyon Alluvial Wells [a] Composite									
Americium-241	pCi/L	72	109	152	0.0	0.422	0.402	3.98	0.497
Cesium-137	pCi/L	7	35	149	0.0	3.46	1.82	16.5	4.06
Cobalt-60	pCi/L	0	9	80	1.03	2.16	0.142	4.29	2.25
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	11	80	1.39	11.7	1.79	20.9	12.8

		2001 through 2005							
Measured Radiochemical		**Detected per ESR**	**Used In This SWEIS**	**Analyzed**	**Minimum**	**Mean**	**Standard Deviation**	**Maximum**	**95 Percent UCL**
Plutonium-238	pCi/L	21	65	151	0.0	0.422	0.432	2.19	0.528
Plutonium-239, Plutonium-240	pCi/L	30	67	151	0.0	0.239	0.157	1.96	0.277
Potassium-40	pCi/L	10	70	80	0.535	41.7	12.5	154	44.6
Radium-226	pCi/L	39	49	51	0.137	0.803	0.441	2.27	0.927
Sodium-22	pCi/L	1	31	80	1.47	3.8	0.367	6.48	3.93
Strontium-90	pCi/L	107	121	149	0.1	17.4	5	81.6	18.3
Technetium-99	pCi/L	19	19	23	6.25	12.8	4.8	23.1	14.9
Tritium	pCi/L	56	74	108	84.2	2,200	441	8,770	2,300
Uranium-234	pCi/L	0	134	152	0.014	0.515	0.212	3.24	0.55
Uranium-235, Uranium-236	pCi/L	0	92	152	0.0	0.059	0.017	0.222	0.063
Uranium-238	pCi/L	0	131	152	0.0	0.248	0.084	1.53	0.263
Uranium (calculated)	µg/L	0	163	166	0.0	0.821	0.481	28.5	0.895
Uranium (measured)	µg/L	0	64	64	0.02	0.475	0.228	1.6	0.531
Gross Alpha	pCi/L	11	107	150	0.512	2.85	0.758	19.3	3
Gross Beta	pCi/L	79	142	148	1.93	51.2	15.5	262	53.8
Gross Gamma	pCi/L	0	41	118	55	201.7	133	2,340	242
Los Alamos Canyon [b]									
Americium-241	pCi/L	9	29	51	0.0	0.035	0.014	0.273	0.04
Cesium-137	pCi/L	1	11	50	0.0	2.62	1.67	4.9	3.6
Cobalt-60	pCi/L	0	3	14	1.32	1.8	0.371	2.06	2.22
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	3	14	6.62	10	0.007	13.4	10
Plutonium-238	pCi/L	3	20	51	0.0	0.103	0.142	0.313	0.165
Plutonium-239, Plutonium-240	pCi/L	2	21	51	0.0	0.023	0.01	0.103	0.027
Potassium-40	pCi/L	3	13	14	0.535	46.5	41.1	154	68.9
Radium-226	pCi/L	9	14	14	0.137	0.589	0.397	1.78	0.797
Sodium-22	pCi/L	0	0	14	–	–	–	–	–
Strontium-90	pCi/L	38	44	50	0.1	15.29	2.94	71.5	16.2
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	14	26	40	84.2	173	40.89	399	189
Uranium-234	pCi/L	0	41	51	0.017	0.227	0.194	1.39	0.286
Uranium-235, Uranium-236	pCi/L	0	25	51	0.007	0.056	0.048	0.222	0.075
Uranium-238	pCi/L	0	38	51	0.009	0.084	0.049	0.243	0.1
Uranium (calculated)	µg/L	0	43	44	0.01	0.239	0.08	1.12	0.263
Uranium (measured)	µg/L	0	30	30	0.02	0.234	0.064	0.653	0.257
Gross Alpha	pCi/L	0	22	49	0.512	1.3	0.453	3.08	1.49
Gross Beta	pCi/L	22	45	49	3.19	36.2	7.6	107	38.4
Gross Gamma	pCi/L	0	12	31	55	410	528	2,340	709

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Mortandad Canyon [b]									
Americium-241	pCi/L	62	64	69	0.012	0.728	0.651	3.98	0.888
Cesium-137	pCi/L	5	19	68	0.8	5	3.26	16.5	6.47
Cobalt-60	pCi/L	0	5	54	1.03	2.78	1.21	4.29	3.84
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	6	54	9.34	12.87	2.09	20	14.5
Plutonium-238	pCi/L	18	34	68	0.01	0.601	0.611	2.19	0.807
Plutonium-239, Plutonium-240	pCi/L	19	29	68	0.01	0.436	0.385	1.96	0.576
Potassium-40	pCi/L	5	47	54	3.1	33.5	3.2	77	34.4
Radium-226	pCi/L	24	27	29	0.242	1.02	0.436	2.27	1.18
Sodium-22	pCi/L	1	31	54	1.47	3.80	0.367	6.48	3.93
Strontium-90	pCi/L	53	57	69	0.214	31	11.1	81.6	33.8
Technetium-99	pCi/L	19	19	23	6.25	12.78	4.8	23.1	14.9
Tritium	pCi/L	42	44	45	108	4,240	1,420	8,770	4,660
Uranium-234	pCi/L	0	67	69	0.088	1.04	0.392	3.24	1.13
Uranium-235, Uranium-236	pCi/L	0	60	69	0.025	0.072	0.016	0.212	0.076
Uranium-238	pCi/L	0	67	69	0.044	0.432	0.102	1.53	0.456
Uranium (calculated)	µg/L	0	49	49	0.0	1.5	0.55	28.5	1.66
Uranium (measured)	µg/L	0	25	25	0.529	0.927	0.093	1.6	0.964
Gross Alpha	pCi/L	10	62	67	0.777	4.01	1.87	12.4	4.47
Gross Beta	pCi/L	56	66	67	4.97	104	33.4	262	111
Gross Gamma	pCi/L	0	23	66	59.1	146	92.1	1,480	184
Pajarito Canyon [b]									
Americium-241	pCi/L	0	7	12	0.005	0.037	0.02	0.058	0.052
Cesium-137	pCi/L	1	1	12	–	9.39	–	–	–
Cobalt-60	pCi/L	0	0	5	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	5	–	20.9	–	–	–
Plutonium-238	pCi/L	0	6	12	0.0	0.004	0.01	0.024	0.012
Plutonium-239, Plutonium-240	pCi/L	0	5	12	0.005	0.01	0.006	0.02	0.015
Potassium-40	pCi/L	1	4	5	10.2	34.3	19.7	53.9	53.7
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	5	–	–	–	–	–
Strontium-90	pCi/L	2	6	11	0.197	0.344	0.075	0.491	0.404
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	2	6	161	180	–	199	–
Uranium-234	pCi/L	0	10	12	0.014	0.272	0.205	1.08	0.399
Uranium-235, Uranium-236	pCi/L	0	3	12	0.0	0.045	0.039	0.069	0.089

Measured Radiochemical		**2001 through 2005**							
		Detected per ESR	**Used In This SWEIS**	**Analyzed**	**Minimum**	**Mean**	**Standard Deviation**	**Maximum**	**95 Percent UCL**
Uranium-238	pCi/L	0	9	12	0.0	0.209	0.146	0.869	0.305
Uranium (calculated)	µg/L	0	12	13	0.0	0.553	0.335	2.62	0.743
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	8	12	0.807	1.5	0.607	3.07	1.92
Gross Beta	pCi/L	0	12	12	1.93	6.19	0.045	12.9	6.21
Gross Gamma	pCi/L	0	1	5	–	76.9	–	–	–
***Pueblo Canyon* [b]**									
Americium-241	pCi/L	0	7	14	0.014	0.025	0.01	0.04	0.033
Cesium-137	pCi/L	0	2	13	0.577	0.635	–	0.693	–
Cobalt-60	pCi/L	0	1	5	–	1.11	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	5	–	1.39	–	–	–
Plutonium-238	pCi/L	0	4	14	0.004	0.023	0.021	0.045	0.044
Plutonium-239, Plutonium-240	pCi/L	9	11	14	0.03	0.114	0.062	0.276	0.15
Potassium-40	pCi/L	1	5	5	3.66	21.9	9.34	42.5	30.1
Radium-226	pCi/L	4	6	6	0.202	0.556	0.102	1.04	0.637
Sodium-22	pCi/L	0	0	5	–	–	–	–	–
Strontium-90	pCi/L	14	14	14	0.275	0.777	0.346	1.42	0.958
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	2	11	115	130	–	145	–
Uranium-234	pCi/L	0	13	14	0.053	0.189	0.117	0.407	0.253
Uranium-235, Uranium-236	pCi/L	0	2	14	0.013	0.03	–	0.046	–
Uranium-238	pCi/L	0	14	14	0.02	0.11	0.075	0.278	0.15
Uranium (calculated)	µg/L	0	10	10	0.061	0.35	0.256	0.83	0.508
Uranium (measured)	µg/L	0	9	9	0.109	0.201	0.121	0.31	0.28
Gross Alpha	pCi/L	0	8	14	0.718	1.3	0.389	2.97	1.57
Gross Beta	pCi/L	0	14	14	4.9	12.8	4.69	19.5	15.2
Gross Gamma	pCi/L	0	4	11	63.1	97.8	30.2	156	127
***Water Canyon* [b]**									
Americium-241	pCi/L	0	0	2	–	–	–	–	–
Cesium-137	pCi/L	0	0	2	–	–	–	–	–
Cobalt-60	pCi/L	0	0	2	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	2	–	–	–	–	–
Plutonium-238	pCi/L	0	0	2	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	2	–	–	–	–	–
Potassium-40	pCi/L	0	1	2	–	31.1	–	–	–
Radium-226	pCi/L	2	2	2	0.45	0.74	–	1.03	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Strontium-90	pCi/L	0	0	2	–	–	–	–	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	2	–	–	–	–	–
Uranium-234	pCi/L	0	0	2	–	–	–	–	–
Uranium-235, Uranium-236	pCi/L	0	0	2	–	–	–	–	–
Uranium-238	pCi/L	0	0	2	–	–	–	–	–
Uranium (calculated)	µg/L	0	46	46	0.027	1.37	3.28	16.6	2.32
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	2	2	0.766	0.882	–	0.998	–
Gross Beta	pCi/L	0	2	2	2.45	3.04	–	3.63	–
Gross Gamma	pCi/L	0	1	2	–	1,070	–	–	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier on Table F–1 includes data from Canyon Alluvial Wells (Table F–15) and Canyon Alluvial Springs (Table F–16).

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–16 Radiochemical Statistical Analysis of Groundwater – Canyon Alluvial Springs

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Canyon Alluvial Wells [a] Composite									
Americium-241	pCi/L	1	6	14	0.011	0.046	0.039	0.091	0.077
Cesium-137	pCi/L	0	4	15	0.044	0.666	0.803	2.39	1.45
Cobalt-60	pCi/L	0	2	12	1.4	2	–	2.6	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	12	3.74	10.6	–	17.5	–
Plutonium-238	pCi/L	0	2	14	0.013	0.016	–	0.018	–
Plutonium-239, Plutonium-240	pCi/L	0	4	14	0.007	0.02	0.01	0.026	0.029
Potassium-40	pCi/L	1	8	12	7.71	35.6	20.3	49.9	49.6
Radium-226	pCi/L	2	3	4	0.36	0.505	0.138	0.602	0.661
Sodium-22	pCi/L	0	0	12	–	–	–	–	–
Strontium-90	pCi/L	5	8	14	0.101	68.5	42.1	115	97.7
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	2	5	9	105	276	160	455	416
Uranium-234	pCi/L	0	7	14	0.067	0.392	0.246	0.977	0.574
Uranium-235, Uranium-236	pCi/L	0	5	14	0.011	0.045	0.048	0.104	0.087
Uranium-238	pCi/L	0	10	14	0.028	0.073	0.03	0.14	0.092
Uranium (calculated)	µg/L	0	12	12	0.05	0.183	0.088	0.3	0.233

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium (measured)	µg/L	0	3	3	0.119	0.168	0.07	0.22	0.247
Gross Alpha	pCi/L	0	10	14	0.248	2.04	1.44	3.88	2.93
Gross Beta	pCi/L	5	12	14	3.37	97.2	96.2	228	152
Gross Gamma	pCi/L	0	8	13	53.3	78.8	1.19	138	79.7
Los Alamos Canyon [b]									
Americium-241	pCi/L	1	5	5	0.017	0.048	0.037	0.091	0.08
Cesium-137	pCi/L	0	2	5	0.044	0.398	–	0.753	–
Cobalt-60	pCi/L	0	1	2	–	1.4	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	2	–	–	–	–	–
Plutonium-238	pCi/L	0	2	5	0.013	0.016	–	0.018	–
Plutonium-239, Plutonium-240	pCi/L	0	4	5	0.007	0.02	0.01	0.026	0.029
Potassium-40	pCi/L	0	2	2	29.7	29.8	–	29.9	–
Radium-226	pCi/L	1	1	2	–	0.602	–	–	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–
Strontium-90	pCi/L	5	5	5	60.5	83.8	27.4	115	108
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	2	2	3	349	402	–	455	–
Uranium-234	pCi/L	0	5	5	0.378	0.599	0.326	0.977	0.885
Uranium-235, Uranium-236	pCi/L	0	5	5	0.011	0.045	0.048	0.104	0.087
Uranium-238	pCi/L	0	5	5	0.028	0.081	0.051	0.14	0.125
Uranium (calculated)	µg/L	0	3	3	0.09	0.176	0.122	0.262	0.314
Uranium (measured)	µg/L	0	1	1	–	0.119	–	–	–
Gross Alpha	pCi/L	0	4	5	1.43	2.8	0.953	3.88	3.73
Gross Beta	pCi/L	5	5	5	123	161	52.8	228	207
Gross Gamma	pCi/L	0	1	3	–	104	–	–	–
Pajarito Canyon [b]									
Americium-241	pCi/L	0	1	9	–	0.011	–	–	–
Cesium-137	pCi/L	0	2	10	0.382	1.39	–	2.39	–
Cobalt-60	pCi/L	0	1	10	–	2.6	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	10	3.74	10.6	–	17.5	–
Plutonium-238	pCi/L	0	0	9	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	9	–	–	–	–	–
Potassium-40	pCi/L	1	6	10	7.71	33.8	22.7	49.9	52
Radium-226	pCi/L	1	2	2	0.36	0.407	–	0.454	–
Sodium-22	pCi/L	0	0	10	–	–	–	–	–
Strontium-90	pCi/L	0	3	9	0.101	0.131	0.033	0.166	0.168
Technetium-99	pCi/L	0	0	0	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Tritium	pCi/L	0	3	6	105	125	28.6	146	158
Uranium-234	pCi/L	0	2	9	0.067	0.07	–	0.073	–
Uranium-235, Uranium-236	pCi/L	0	0	9	–	–	–	–	–
Uranium-238	pCi/L	0	5	9	0.048	0.081	0.006	0.109	0.086
Uranium (calculated)	µg/L	0	9	9	0.05	0.189	0.092	0.3	0.249
Uranium (measured)	µg/L	0	2	2	0.215	0.218	–	0.22	–
Gross Alpha	pCi/L	0	6	9	0.248	0.756	0.231	1.97	0.941
Gross Beta	pCi/L	0	7	9	3.37	5.76	0.158	9.09	5.88
Gross Gamma	pCi/L	0	7	10	53.3	76.8	1.67	138	78.1

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier on Table F–1 includes data from Canyon Alluvial Wells (Table F–15) and Canyon Alluvial Springs (Table F–16).

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–17 Radiochemical Statistical Analysis of Groundwater – Intermediate Perched Wells

Measured Radiochemical		2001 through 2005							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Intermediate Perched Wells [a] Composite									
Americium-241	pCi/L	0	12	77	0.012	0.02	0.005	0.033	0.023
Cesium-137	pCi/L	2	11	77	0.395	6.11	2.06	7.39	7.33
Cobalt-60	pCi/L	0	10	60	1.22	3.31	1.88	6.48	4.48
Iodine-129	pCi/L	0	1	8	–	0.818	–	–	–
Neptunium-237	pCi/L	0	12	50	5.79	13.9	1.14	30.1	14.6
Plutonium-238	pCi/L	1	8	77	0.0	0.024	0.027	0.111	0.043
Plutonium-239, Plutonium-240	pCi/L	2	8	77	0.014	0.333	0.611	3.65	0.756
Potassium-40	pCi/L	5	51	60	1.26	289	353	19,000	386
Radium-226	pCi/L	10	21	31	0.137	0.743	0.608	3.28	1
Sodium-22	pCi/L	0	3	60	1.2	5.62	5.57	9.56	11.9
Strontium-90	pCi/L	2	14	78	0.091	0.776	1.28	10.3	1.45
Technetium-99	pCi/L	9	11	22	2.34	4.26	1.61	7.86	5.21
Tritium	pCi/L	15	24	61	78.7	2,650	4,340	23,500	4,380
Uranium-234	pCi/L	1	55	73	0.046	8.22	15.6	1,210	12.3
Uranium-235, Uranium-236	pCi/L	2	32	75	0.017	0.791	1.49	53.3	1.31
Uranium-238	pCi/L	1	55	75	0.031	8.45	16.4	1,210	12.8
Uranium (calculated)	µg/L	0	69	73	0.0	0.543	0.356	6.9	0.627
Uranium (measured)	µg/L	0	41	41	0.02	0.54	0.015	2.97	0.545

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Gross Alpha	pCi/L	0	26	67	0.574	1.48	0.423	4.04	1.64
Gross Beta	pCi/L	3	51	67	0.829	4.78	2.59	42.6	5.49
Gross Gamma	pCi/L	0	26	63	45.6	121	73.8	1,560	149
Los Alamos Canyon [b]									
Americium-241	pCi/L	0	2	21	0.022	0.023	–	0.024	–
Cesium-137	pCi/L	2	6	22	1.29	5.95	2.5	7.39	7.95
Cobalt-60	pCi/L	0	3	17	2.43	4.09	2.34	6.48	6.73
Iodine-129	pCi/L	0	1	4	–	0.818	–	–	–
Neptunium-237	pCi/L	0	3	11	13	19.3	8.2	25.1	28.6
Plutonium-238	pCi/L	0	2	20	0.012	0.012	–	0.012	–
Plutonium-239, Plutonium-240	pCi/L	0	2	20	0.04	1.85	–	3.65	–
Potassium-40	pCi/L	2	16	17	1.68	970	1,340	19,000	1,630
Radium-226	pCi/L	4	7	10	0.143	0.453	0.197	0.592	0.599
Sodium-22	pCi/L	0	1	17	–	9.56	–	–	–
Strontium-90	pCi/L	2	6	22	0.091	1.82	2.93	10.3	4.16
Technetium-99	pCi/L	1	1	7	–	2.34	–	–	–
Tritium	pCi/L	4	11	15	117	186	7.04	348	190
Uranium-234	pCi/L	1	16	20	0.048	40.8	70.4	1,210	75.3
Uranium-235, Uranium-236	pCi/L	2	12	20	0.018	3.01	5.16	53.3	5.93
Uranium-238	pCi/L	1	15	20	0.09	45.2	78.1	1,210	84.8
Uranium (calculated)	µg/L	0	15	17	0.019	1.012	1.21	6.9	1.62
Uranium (measured)	µg/L	0	12	12	0.02	0.322	0.075	0.785	0.365
Gross Alpha	pCi/L	0	6	16	0.735	1.55	1.11	4.04	2.44
Gross Beta	pCi/L	1	12	16	2.8	5.89	1.91	23.9	6.97
Gross Gamma	pCi/L	0	6	16	45.6	84.5	34.6	146	112
Mortandad Canyon [b]									
Americium-241	pCi/L	0	1	16	–	0.033	–	–	–
Cesium-137	pCi/L	0	2	16	0.395	1.19	–	1.99	–
Cobalt-60	pCi/L	0	5	16	1.22	1.82	0.634	2.8	2.38
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	3	16	8.91	12.9	3.53	15.6	16.9
Plutonium-238	pCi/L	0	0	16	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	16	–	–	–	–	–
Potassium-40	pCi/L	1	14	16	3.48	22.9	13.1	47.8	29.7
Radium-226	pCi/L	4	6	8	0.302	1.43	1.36	3.28	2.51
Sodium-22	pCi/L	0	1	16	–	2.17	–	–	–
Strontium-90	pCi/L	0	1	16	–	0.22	–	–	–
Technetium-99	pCi/L	8	10	11	2.63	4.45	1.56	7.86	5.42
Tritium	pCi/L	9	9	9	4,310	12,000	5,610	23,500	15,700
Uranium-234	pCi/L	0	16	16	0.096	0.26	0.142	0.441	0.33

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Uranium-235, Uranium-236	pCi/L	0	8	16	0.028	0.043	0.015	0.069	0.054
Uranium-238	pCi/L	0	16	16	0.032	0.114	0.065	0.219	0.146
Uranium (calculated)	µg/L	0	8	8	0.12	0.33	0.157	0.5	0.438
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	3	16	1.12	1.81	0.599	2.2	2.49
Gross Beta	pCi/L	0	15	16	1.01	4.8	4.25	14.7	6.95
Gross Gamma	pCi/L	0	5	16	57.9	86.5	37.7	151	120
Pajarito Canyon [b]									
Americium-241	pCi/L	0	0	4	–	–	–	–	–
Cesium-137	pCi/L	0	1	4	–	2.89	–	–	–
Cobalt-60	pCi/L	0	1	4	–	2.34	–	–	–
Iodine-129	pCi/L	0	0	4	–	–	–	–	–
Neptunium-237	pCi/L	0	0	0	–	–	–	–	–
Plutonium-238	pCi/L	0	0	4	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	4	–	–	–	–	–
Potassium-40	pCi/L	0	3	4	15.7	41.6	27.9	71.1	73.2
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	4	–	–	–	–	–
Strontium-90	pCi/L	0	1	4	–	0.176	–	–	–
Technetium-99	pCi/L	0	0	4	–	–	–	–	–
Tritium	pCi/L	0	0	0	–	–	–	–	–
Uranium-234	pCi/L	0	3	4	0.233	0.248	0.013	0.257	0.262
Uranium-235, Uranium-236	pCi/L	0	1	4	–	0.050	–	–	–
Uranium-238	pCi/L	0	3	4	0.108	0.13	0.021	0.15	0.154
Uranium (calculated)	µg/L	0	7	7	0.05	0.294	0.11	0.36	0.376
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	0	0	–	–	–	–	–
Gross Beta	pCi/L	0	0	0	–	–	–	–	–
Gross Gamma	pCi/L	0	0	0	–	–	–	–	–
Potrillo Canyon [b]									
Americium-241	pCi/L	0	0	3	–	–	–	–	–
Cesium-137	pCi/L	0	0	3	–	–	–	–	–
Cobalt-60	pCi/L	0	1	3	–	2.44	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	3	–	–	–	–	–
Plutonium-238	pCi/L	0	0	3	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	3	–	–	–	–	–
Potassium-40	pCi/L	0	2	3	10.6	24.8	-	38.9	-
Radium-226	pCi/L	0	0	1	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Sodium-22	pCi/L	0	0	3	–	–	–	–	–
Strontium-90	pCi/L	0	0	3	–	–	–	–	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	2	–	–	–	–	–
Uranium-234	pCi/L	0	3	3	0.228	0.276	0.068	0.332	0.353
Uranium-235, Uranium-236	pCi/L	0	2	3	0.021	0.057	–	0.093	–
Uranium-238	pCi/L	0	3	3	0.105	0.124	0.027	0.171	0.154
Uranium (calculated)	µg/L	0	3	3	0.24	0.284	0.055	0.322	0.346
Uranium (measured)	µg/L	0	3	3	0.027	0.204	0.098	0.273	0.314
Gross Alpha	pCi/L	0	1	3	–	3.51	–	–	–
Gross Beta	pCi/L	0	1	3	–	0.829	–	–	–
Gross Gamma	pCi/L	0	0	3	–	–	–	–	–
Pueblo Canyon [b]									
Americium-241	pCi/L	0	4	9	0.015	0.022	0.007	0.029	0.029
Cesium-137	pCi/L	0	2	8	6.58	6.84	–	7.1	–
Cobalt-60	pCi/L	0	0	4	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	4	–	–	–	–	–
Plutonium-238	pCi/L	1	4	10	0.0	0.026	0.034	0.111	0.059
Plutonium-239, Plutonium-240	pCi/L	1	2	10	0.033	0.036	–	0.039	–
Potassium-40	pCi/L	0	3	4	45.5	57.8	17	69.8	77
Radium-226	pCi/L	1	3	4	0.23	0.364	0.188	0.765	0.577
Sodium-22	pCi/L	0	0	4	–	–	–	–	–
Strontium-90	pCi/L	0	2	9	0.093	0.178	–	0.263	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	2	3	13	78.7	711	554	1,110	1,340
Uranium-234	pCi/L	0	7	8	0.046	0.936	0.453	1.83	1.27
Uranium-235, Uranium-236	pCi/L	0	5	8	0.019	0.105	0.045	0.153	0.144
Uranium-238	pCi/L	0	6	8	0.034	0.688	0.234	1.12	0.875
Uranium (calculated)	µg/L	0	6	6	0.0	1.41	1.23	3.08	2.4
Uranium (measured)	µg/L	0	5	5	0.02	2.3	0.455	2.97	2.7
Gross Alpha	pCi/L	0	3	8	2.3	2.67	0.473	3.2	3.2
Gross Beta	pCi/L	0	6	8	1.45	8.53	1.76	12.6	9.93
Gross Gamma	pCi/L	0	3	6	79	89.1	17.2	109	109
Sandia Canyon [b]									
Americium-241	pCi/L	0	0	13	–	–	–	–	–
Cesium-137	pCi/L	0	0	13	–	–	–	–	–
Cobalt-60	pCi/L	0	0	8	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	4	8	8.16	14.4	10.5	30.1	24.7

		2001 through 2005							
Measured Radiochemical		**Detected per ESR**	**Used In This SWEIS**	**Analyzed**	**Minimum**	**Mean**	**Standard Deviation**	**Maximum**	**95 Percent UCL**
Plutonium-238	pCi/L	0	0	13	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	13	–	–	–	–	–
Potassium-40	pCi/L	1	6	8	10	45.6	16.5	103	58.8
Radium-226	pCi/L	0	5	6	0.137	0.239	0.061	0.288	0.292
Sodium-22	pCi/L	0	0	8	–	–	–	–	–
Strontium-90	pCi/L	0	1	13	–	0.099	–	–	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	1	13	–	170	–	–	–
Uranium-234	pCi/L	0	2	13	0.306	0.306	–	0.306	–
Uranium-235, Uranium-236	pCi/L	0	1	13	–	0.031	–	–	–
Uranium-238	pCi/L	0	3	13	0.052	0.125	0.035	0.15	0.165
Uranium (calculated)	µg/L	0	11	13	0.006	0.109	0.051	0.446	0.14
Uranium (measured)	µg/L	0	11	11	0.026	0.195	0.022	0.557	0.208
Gross Alpha	pCi/L	0	4	13	0.627	0.986	0.076	1.17	1.06
Gross Beta	pCi/L	0	8	13	1.47	2.27	0.185	3.49	2.4
Gross Gamma	pCi/L	0	10	13	46.3	323	430	1,560	590
Water Canyon [b]									
Americium-241	pCi/L	0	5	11	0.012	0.018	0.003	0.022	0.021
Cesium-137	pCi/L	0	0	11	–	–	–	–	–
Cobalt-60	pCi/L	0	0	8	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	8	5.79	9.45	–	13.1	–
Plutonium-238	pCi/L	0	2	11	0.007	0.012	–	0.018	–
Plutonium-239, Plutonium-240	pCi/L	1	4	11	0.014	0.032	0.024	0.059	0.055
Potassium-40	pCi/L	1	7	8	1.26	33.1	7.35	53.9	38.5
Radium-226	pCi/L	0	0	2	–	–	–	–	–
Sodium-22	pCi/L	0	1	8	–	1.2	–	–	–
Strontium-90	pCi/L	0	3	11	0.134	0.158	0.033	0.183	0.195
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	9	–	–	–	–	–
Uranium-234	pCi/L	0	8	9	0.052	0.263	0.155	0.733	0.370
Uranium-235, Uranium-236	pCi/L	0	3	11	0.017	0.055	0.045	0.086	0.105
Uranium-238	pCi/L	0	9	11	0.031	0.143	0.128	0.455	0.227
Uranium (calculated)	µg/L	0	19	19	0.05	0.28	0.201	0.74	0.37
Uranium (measured)	µg/L	0	10	10	0.02	0.425	0.013	0.706	0.434
Gross Alpha	pCi/L	0	9	11	0.574	1.41	0.547	3.09	1.77

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Gross Beta	pCi/L	2	9	11	1.05	7.05	9.85	42.6	13.5
Gross Gamma	pCi/L	0	2	9	71.2	92.1	–	113	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier on Table F–1 includes data from Intermediate Perched Wells (Table F–17) and Intermediate Perched Springs (Table F–18).

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–18 Radiochemical Statistical Analysis of Groundwater – Intermediate Perched Springs

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Intermediate Perched Springs [a] Composite									
Americium-241	pCi/L	0	9	30	0.012	0.023	0.006	0.034	0.027
Cesium-137	pCi/L	0	4	31	0.847	2.72	1.64	4.25	4.32
Cobalt-60	pCi/L	0	1	22	–	2.45	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	5	22	6.33	14.4	5.79	33.4	19.5
Plutonium-238	pCi/L	1	2	30	0.003	0.03	–	0.058	–
Plutonium-239, Plutonium-240	pCi/L	2	4	30	0.018	0.034	0.013	0.045	0.047
Potassium-40	pCi/L	3	18	22	4.34	24.8	1.29	56.6	25.4
Radium-226	pCi/L	4	8	10	0.154	0.563	0.403	1.31	0.843
Sodium-22	pCi/L	0	1	22	–	2.89	–	–	–
Strontium-90	pCi/L	3	11	33	0.066	0.313	0.213	0.611	0.438
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	3	22	70	93.6	14.7	104	110
Uranium-234	pCi/L	0	23	31	0.031	0.328	0.23	0.673	0.422
Uranium-235, Uranium-236	pCi/L	0	9	31	0.011	0.045	0.039	0.113	0.071
Uranium-238	pCi/L	0	19	31	0.022	0.22	0.136	0.425	0.281
Uranium (calculated)	µg/L	0	69	69	0.023	0.559	0.439	1.31	0.663
Uranium (measured)	µg/L	0	10	10	0.02	0.626	0.364	1.4	0.852
Gross Alpha	pCi/L	0	15	31	0.595	1.23	0.725	2.51	1.59
Gross Beta	pCi/L	0	28	31	0.796	7.04	5.23	15.7	8.98
Gross Gamma	pCi/L	0	11	29	61.7	99	15.3	293	108
Los Alamos Canyon [b]									
Americium-241	pCi/L	0	4	9	0.014	0.026	0.007	0.034	0.033
Cesium-137	pCi/L	0	2	9	1.13	2.02	–	2.91	–
Cobalt-60	pCi/L	0	1	3	–	2.45	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Neptunium-237	pCi/L	0	0	3	–	–	–	–	–
Plutonium-238	pCi/L	1	2	9	0.003	0.03	–	0.058	–
Plutonium-239, Plutonium-240	pCi/L	2	4	9	0.018	0.034	0.013	0.045	0.047
Potassium-40	pCi/L	0	3	3	9.04	24.8	13.7	34.5	40.3
Radium-226	pCi/L	0	2	3	0.154	0.216	–	0.278	–
Sodium-22	pCi/L	0	1	3	–	2.89	–	–	–
Strontium-90	pCi/L	2	4	10	0.119	0.340	0.221	0.611	0.556
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	8	–	–	–	–	–
Uranium-234	pCi/L	0	8	10	0.237	0.442	0.197	0.673	0.579
Uranium-235, Uranium-236	pCi/L	0	5	10	0.016	0.054	0.039	0.113	0.089
Uranium-238	pCi/L	0	8	10	0.148	0.283	0.126	0.425	0.371
Uranium (calculated)	µg/L	0	8	8	0.023	0.794	0.372	1.31	1.05
Uranium (measured)	µg/L	0	3	3	0.02	0.883	0.748	1.34	1.73
Gross Alpha	pCi/L	0	5	9	0.628	1.37	0.784	2.51	2.05
Gross Beta	pCi/L	0	8	9	1.43	8.33	5.05	15.7	11.8
Gross Gamma	pCi/L	0	4	8	61.7	81.7	12.1	93.3	93.6
Pajarito Canyon [b]									
Americium-241	pCi/L	0	4	18	0.012	0.02	0.001	0.025	0.021
Cesium-137	pCi/L	0	1	19	–	0.847	–	–	–
Cobalt-60	pCi/L	0	0	19	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	5	19	6.33	14.4	5.79	33.4	19.5
Plutonium-238	pCi/L	0	0	18	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	18	–	–	–	–	–
Potassium-40	pCi/L	3	15	19	4.34	25.3	1.15	56.6	25.9
Radium-226	pCi/L	4	6	7	0.374	0.964	0.367	1.31	1.26
Sodium-22	pCi/L	0	0	19	–	–	–	–	–
Strontium-90	pCi/L	0	5	19	0.066	0.154	0.07	0.252	0.215
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	3	12	70	93.6	14.7	104	110
Uranium-234	pCi/L	0	12	18	0.05	0.099	0.022	0.191	0.111
Uranium-235, Uranium-236	pCi/L	0	2	18	0.017	0.029	–	0.041	–
Uranium-238	pCi/L	0	9	18	0.032	0.076	0.011	0.141	0.083
Uranium (calculated)	µg/L	0	18	18	0.028	0.14	0.059	0.428	0.168
Uranium (measured)	µg/L	0	7	7	0.058	0.368	0.478	1.4	0.722
Gross Alpha	pCi/L	0	10	19	0.595	0.907	0.023	1.25	0.922
Gross Beta	pCi/L	0	18	19	0.796	3.31	0.341	5.1	3.47

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Gross Gamma	pCi/L	0	6	18	64.3	136	90	293	208
Water Canyon [b]									
Americium-241	pCi/L	0	1	3	–	0.02	–	–	–
Cesium-137	pCi/L	0	1	3	–	4.25	–	–	–
Cobalt-60	pCi/L	0	0	0	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	0	–	–	–	–	–
Plutonium-238	pCi/L	0	0	3	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	3	–	–	–	–	–
Potassium-40	pCi/L	0	0	0	–	–	–	–	–
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	0	–	–	–	–	–
Strontium-90	pCi/L	1	2	4	0.166	0.279	–	0.392	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	2	–	–	–	–	–
Uranium-234	pCi/L	0	3	3	0.031	0.056	0.028	0.087	0.088
Uranium-235, Uranium-236	pCi/L	0	2	3	0.011	0.018	–	0.026	–
Uranium-238	pCi/L	0	2	3	0.022	0.025	–	0.028	–
Uranium (calculated)	µg/L	0	43	43	0.023	0.192	0.186	0.65	0.248
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	0	3	–	–	–	–	–
Gross Beta	pCi/L	0	2	3	1.99	2.24	–	2.49	–
Gross Gamma	pCi/L	0	1	3	–	101	–	–	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier on Table F–1 includes data from Intermediate Perched Wells (Table F–17) and Intermediate Perched Springs (Table F–18).

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–19 Radiochemical Statistical Analysis of Groundwater – San Ildefonso Pueblo Water Supply Wells [a]

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Americium-241	pCi/L	1	11	46	0.005	0.022	0.009	0.034	0.027
Cesium-137	pCi/L	1	6	46	0.575	2.22	2.11	6.4	3.91
Cobalt-60	pCi/L	0	3	17	1.62	2.11	0.427	2.42	2.59
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	17	9.11	11.2	–	13.3	–
Plutonium-238	pCi/L	0	17	62	0.0	0.023	0.029	0.044	0.037

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Plutonium-239, Plutonium-240	pCi/L	0	14	62	0.0	0.01	0.009	0.017	0.015
Potassium-40	pCi/L	2	14	17	0.971	29.1	3.11	63.3	30.7
Radium-226	pCi/L	4	10	16	0.14	0.737	0.567	2.18	1.09
Sodium-22	pCi/L	0	3	17	2.7	3.26	0.788	4.86	4.15
Strontium-90	pCi/L	6	20	59	0.051	0.247	0.121	1.69	0.3
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	4	44	52.8	88.9	24.3	116	113
Uranium-234	pCi/L	18	38	43	0.022	5.342	0.815	13	5.6
Uranium-235, Uranium-236	pCi/L	0	33	44	0.021	0.297	0.110	0.909	0.335
Uranium-238	pCi/L	6	36	44	0.087	3.11	0.557	8.23	3.29
Uranium (calculated)	µg/L	0	33	35	0.017	8.67	1.66	24.8	9.23
Uranium (measured)	µg/L	0	12	12	0.02	8.35	0.526	24.3	8.65
Gross Alpha	pCi/L	20	33	44	0.324	7.47	3.23	19.7	8.58
Gross Beta	pCi/L	0	34	44	1.47	5.34	2	18.4	6.01
Gross Gamma	pCi/L	0	8	37	50.2	97.9	45.9	184	130

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] The corresponding data set identifier is indicated in Table F–1.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–20 Radiochemical Statistical Analysis of Groundwater – Santa Fe Water Supply Wells [a]

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Americium-241	pCi/L	0	1	18	–	0.011	–	–	–
Cesium-137	pCi/L	0	14	28	0.018	7.03	6.77	14.2	10.6
Cobalt-60	pCi/L	0	2	6	1.41	1.64	–	1.87	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	3	6	9.84	10.4	0.057	10.8	10.4
Plutonium-238	pCi/L	0	1	18	–	0.004	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	2	18	0.0	0.005	–	0.009	–
Potassium-40	pCi/L	2	5	6	12	30.6	7.05	61.1	36.8
Radium-226	pCi/L	5	6	8	0.557	2.3	0.842	3.96	2.97
Sodium-22	pCi/L	0	1	6	–	1.59	–	–	–
Strontium-90	pCi/L	0	10	35	0.081	0.147	0.047	0.226	0.176
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	5	17	0.125	71.5	51.5	123	117
Uranium-234	pCi/L	21	46	47	0.005	20.6	18.2	97.2	25.9

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Uranium-235, Uranium-236	pCi/L	1	37	40	0.003	1.44	1.26	7.79	1.85
Uranium-238	pCi/L	12	24	26	2.03	21.3	18.7	84.8	28.8
Uranium (calculated)	µg/L	0	21	22	0.0	70.3	53	255	93
Uranium (measured)	µg/L	0	4	4	6.41	14.3	5.36	18.4	19.5
Gross Alpha	pCi/L	16	16	17	6.31	33.3	33.2	192	49.5
Gross Beta	pCi/L	3	16	17	0.167	11.3	4.94	51.5	13.7
Gross Gamma	pCi/L	0	0	16	–	–	–	–	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] The corresponding data set identifier is indicated in Table F–1.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–21 Radiochemical Statistical Analysis of Sediment from 2001 through 2005

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Regional Stations									
Americium-241	pCi/g	0	41	91	0.002	0.015	0.005	0.116	0.017
Cesium-137	pCi/g	7	86	88	0.015	0.196	0.084	1.09	0.213
Cobalt-60	pCi/g	0	6	25	0.018	0.054	0.033	0.087	0.08
Neptunium-237	pCi/g	0	24	25	0.096	0.703	0.186	1.21	0.777
Plutonium-238	pCi/g	1	25	92	0.0	0.021	0.023	0.118	0.03
Plutonium-239, Plutonium-240	pCi/g	3	43	92	0.0	0.045	0.032	0.450	0.055
Potassium-40	pCi/g	0	25	25	13.8	19.7	0.94	32.9	20
Sodium-22	pCi/g	0	0	25	–	–	–	–	–
Strontium-90	pCi/g	2	27	93	0.043	0.122	0.02	0.247	0.13
Tritium	pCi/L	1	4	15	80.6	160	113	465	271
Tritium	pCi/g	0	12	35	0.032	0.081	0.027	0.135	0.097
Uranium-234	pCi/g	0	91	91	0.282	0.863	0.106	1.74	0.885
Uranium-235, Uranium-236	pCi/g	0	79	91	0.022	0.075	0.01	0.174	0.077
Uranium-238	pCi/g	0	91	91	0.295	0.858	0.128	1.65	0.884
Uranium (calculated)	µg/g	0	51	51	0.1	1.48	1.15	4.48	1.79
Gross Alpha	pCi/g	13	90	90	2.85	13.5	1.3	30.9	13.8
Gross Beta	pCi/g	13	90	90	12.2	24.2	0.838	36.7	24.3
Gross Gamma	pCi/g	0	55	56	3.87	7.96	1.61	25.8	8.39
Perimeter Stations									
Americium-241	pCi/g	15	115	225	0.0	0.104	0.079	3.08	0.118
Cesium-137	pCi/g	8	211	228	0.0	0.237	0.172	3.16	0.26
Cobalt-60	pCi/g	0	5	86	0.02	0.036	0.002	0.056	0.038

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Neptunium-237	pCi/g	0	86	86	0.091	0.606	0.008	2.04	0.608
Plutonium-238	pCi/g	4	80	224	0.0	0.016	0.007	0.325	0.018
Plutonium-239, Plutonium-240	pCi/g	34	120	224	0.0	0.774	0.377	12.5	0.841
Potassium-40	pCi/g	0	86	86	13.7	26.8	1.57	35	27.1
Sodium-22	pCi/g	0	11	85	0.013	0.035	0.008	0.106	0.039
Strontium-90	pCi/g	0	89	223	0.031	0.21	0.080	3.24	0.226
Tritium	pCi/L	4	27	52	0.0	804	189	2,300	875
Tritium	pCi/g	0	42	169	0.0	14.1	27.4	145	22.4
Uranium-234	pCi/g	2	227	227	0.05	0.903	0.068	2.71	0.912
Uranium-235, Uranium-236	pCi/g	0	185	227	0.0	0.078	0.02	0.414	0.08
Uranium-238	pCi/g	0	227	227	0.056	0.878	0.072	2.66	0.887
Uranium (calculated)	µg/g	0	148	148	0.09	1.95	1.46	7.51	2.19
Gross Alpha	pCi/g	13	230	230	2	13.1	1.44	38.2	13.2
Gross Beta	pCi/g	22	230	230	15.2	32.8	3.04	63.3	33.2
Gross Gamma	pCi/g	0	181	182	1.46	9.2	2.13	145	9.51
Onsite Stations									
Americium-241	pCi/g	117	197	288	0.004	1.07	0.231	13.7	1.1
Cesium-137	pCi/g	67	273	280	0.005	1.54	0.625	28.6	1.61
Cobalt-60	pCi/g	0	11	89	0.021	0.055	0.008	0.137	0.06
Neptunium-237	pCi/g	0	89	89	0.157	0.659	0.039	1.61	0.667
Plutonium-238	pCi/g	72	141	285	0.0	0.638	0.25	11.5	0.679
Plutonium-239, Plutonium-240	pCi/g	175	200	285	0.003	0.919	0.223	13.4	0.95
Potassium-40	pCi/g	0	89	89	18.1	28	0.448	33.8	28.1
Sodium-22	pCi/g	0	6	89	0.022	0.055	0.038	0.082	0.086
Strontium-90	pCi/g	31	115	286	0.024	0.414	0.056	2.64	0.425
Tritium	pCi/L	71	74	81	82.5	1,450	430	9,930	1,550
Tritium	pCi/g	11	74	194	0.0	0.719	0.472	5.1	0.826
Uranium-234	pCi/g	21	281	281	0.042	0.874	0.081	1.91	0.883
Uranium-235, Uranium-236	pCi/g	4	244	281	0.011	0.081	0.03	0.214	0.084
Uranium-238	pCi/g	1	281	281	0.037	0.901	0.083	2.16	0.911
Uranium (calculated)	µg/g	0	188	188	0.11	1.99	1.5	6.51	2.2
Gross Alpha	pCi/g	154	274	275	1.7	16.7	2.43	59.3	17
Gross Beta	pCi/g	268	276	276	6.64	37.6	2.91	74.3	37.9
Gross Gamma	pCi/g	0	199	202	1.48	10.5	1.5	36.6	10.7
Ancho Canyon [a]									
Americium-241	pCi/g	7	21	50	0.0	0.042	0.039	0.239	0.059
Cesium-137	pCi/g	6	47	47	0.013	0.175	0.086	0.724	0.2
Cobalt-60	pCi/g	0	1	21	–	0.021	–	–	–

Measured Radiochemical		**2001 through 2005**							
		Detected per ESR	**Used In This SWEIS**	**Analyzed**	**Minimum**	**Mean**	**Standard Deviation**	**Maximum**	**95 Percent UCL**
Neptunium-237	pCi/g	0	21	21	0.157	0.502	0.294	1.33	0.628
Plutonium-238	pCi/g	2	9	48	0.001	0.009	0.007	0.019	0.013
Plutonium-239, Plutonium-240	pCi/g	16	22	48	0.006	0.064	0.06	0.665	0.089
Potassium-40	pCi/g	0	21	21	18.1	26.7	1.88	31.4	27.5
Sodium-22	pCi/g	0	1	21	–	0.022	–	–	–
Strontium-90	pCi/g	5	20	50	0.054	0.149	0.022	0.375	0.158
Tritium	pCi/L	3	5	7	85.6	368	399	1,610	718
Tritium	pCi/g	1	17	41	0.0	12.4	22.7	134	23.2
Uranium-234	pCi/g	0	47	47	0.281	0.758	0.144	1.59	0.799
Uranium-235, Uranium-236	pCi/g	0	40	47	0.017	0.066	0.024	0.147	0.073
Uranium-238	pCi/g	0	47	47	0.225	0.845	0.204	2.01	0.903
Uranium (calculated)	µg/g	0	37	37	0.09	2.03	1.53	6.04	2.52
Gross Alpha	pCi/g	15	47	47	1.7	11	3.18	22.5	11.9
Gross Beta	pCi/g	37	47	47	12.4	29.3	6.3	42	31.1
Gross Gamma	pCi/g	0	42	43	4.88	7.84	1.2	16.7	8.2
Bayo Canyon [b]									
Americium-241	pCi/g	0	4	11	0.007	0.018	0.013	0.049	0.031
Cesium-137	pCi/g	0	9	11	0.012	0.038	0.011	0.09	0.046
Cobalt-60	pCi/g	0	0	4	–	–	–	–	–
Neptunium-237	pCi/g	0	4	4	0.383	0.525	0.083	0.583	0.606
Plutonium-238	pCi/g	0	2	11	0.0	0.01	-	0.02	-
Plutonium-239, Plutonium-240	pCi/g	0	0	11	–	–	–	–	–
Potassium-40	pCi/g	0	4	4	24.5	25.6	0.66	28.3	26.2
Sodium-22	pCi/g	0	2	4	0.013	0.019	–	0.024	–
Strontium-90	pCi/g	0	0	10	–	–	–	–	–
Tritium	pCi/L	1	2	2	139	325	–	510	–
Tritium	pCi/g	0	1	7	–	0.003	–	–	–
Uranium-234	pCi/g	0	11	11	0.625	0.959	0.24	1.3	1.1
Uranium-235, Uranium-236	pCi/g	0	11	11	0.031	0.084	0.043	0.144	0.11
Uranium-238	pCi/g	0	11	11	0.597	0.989	0.262	1.41	1.14
Uranium (calculated)	µg/g	0	8	8	0.22	2.27	1.81	4.23	3.52
Gross Alpha	pCi/g	2	10	10	5.78	10.7	3.03	16.8	12.6
Gross Beta	pCi/g	2	10	10	23	30.3	4.42	36.5	33.1
Gross Gamma	pCi/g	0	10	10	5.96	8.39	2.3	13.6	9.82
Cañada del Buey Canyon [c]									
Americium-241	pCi/g	2	6	11	0.018	0.035	0.013	0.083	0.045
Cesium-137	pCi/g	0	12	12	0.017	0.094	0.052	0.293	0.123
Cobalt-60	pCi/g	0	0	5	–	–	–	–	–

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Neptunium-237	pCi/g	0	5	5	0.163	0.432	0.302	0.879	0.697
Plutonium-238	pCi/g	0	6	11	0.0	0.059	0.057	0.140	0.105
Plutonium-239, Plutonium-240	pCi/g	1	8	11	0.013	0.04	0.009	0.075	0.047
Potassium-40	pCi/g	0	5	5	26.5	28.6	0.271	31.5	28.9
Sodium-22	pCi/g	0	0	5	–	–	–	–	–
Strontium-90	pCi/g	0	2	12	0.057	0.077	–	0.096	–
Tritium	pCi/L	2	2	2	943	977	–	1,010	–
Tritium	pCi/g	0	7	9	0.0	0.025	0.02	0.053	0.04
Uranium-234	pCi/g	0	11	11	0.675	0.977	0.115	1.39	1.05
Uranium-235, Uranium-236	pCi/g	0	9	11	0.027	0.096	0.09	0.414	0.155
Uranium-238	pCi/g	0	11	11	0.59	0.928	0.096	1.44	0.984
Uranium (calculated)	µg/g	0	6	6	0.27	1.89	1.41	2.97	3.02
Gross Alpha	pCi/g	1	12	12	10	17.7	2.81	24.1	19.3
Gross Beta	pCi/g	2	12	12	15.8	39	10.8	63.3	45.1
Gross Gamma	pCi/g	0	9	9	6.2	8.25	1.39	10.7	9.16
Chaquehui Canyon [b]									
Americium-241	pCi/g	0	2	4	0.003	0.008	–	0.013	–
Cesium-137	pCi/g	1	4	4	0.128	0.312	0.291	0.746	0.597
Cobalt-60	pCi/g	0	0	2	–	–	–	–	–
Neptunium-237	pCi/g	0	2	2	0.635	0.796	–	0.956	–
Plutonium-238	pCi/g	0	1	4	–	0.009	–	–	–
Plutonium-239, Plutonium-240	pCi/g	1	3	4	0.008	0.015	0.006	0.02	0.021
Potassium-40	pCi/g	0	2	2	13.7	17.5	–	21.3	–
Sodium-22	pCi/g	0	0	2	–	–	–	–	–
Strontium-90	pCi/g	0	3	4	0.113	0.195	0.08	0.272	0.285
Tritium	pCi/L	1	1	1	–	2,300	–	–	–
Tritium	pCi/g	0	0	3	–	–	–	–	–
Uranium-234	pCi/g	1	4	4	1.03	1.55	0.761	2.67	2.29
Uranium-235, Uranium-236	pCi/g	0	4	4	0.058	0.086	0.035	0.135	0.12
Uranium-238	pCi/g	0	4	4	0.884	1.35	0.517	2.07	1.85
Uranium (calculated)	µg/g	0	3	3	0.34	3.27	2.94	6.211	6.6
Gross Alpha	pCi/g	2	4	4	7.19	17.8	8.87	26.1	26.5
Gross Beta	pCi/g	2	4	4	23.7	32	8.17	42.9	40
Gross Gamma	pCi/g	0	3	3	7.16	8.01	1	9.11	9.14
Fence Canyon [c]									
Americium-241	pCi/g	1	4	8	0.014	0.018	0.005	0.032	0.023
Cesium-137	pCi/g	1	8	8	0.044	0.208	0.209	0.574	0.353
Cobalt-60	pCi/g	0	1	4	–	0.026	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/g	0	4	4	0.6	0.928	0.229	1.09	1.15
Plutonium-238	pCi/g	0	1	8	–	0.003	–	–	–
Plutonium-239, Plutonium-240	pCi/g	1	2	8	0.016	0.023	–	0.03	–
Potassium-40	pCi/g	0	4	4	25.7	26.3	0.801	27.1	27.1
Sodium-22	pCi/g	0	0	4	–	–	–	–	–
Strontium-90	pCi/g	0	2	8	0.163	0.174	–	0.185	–
Tritium	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/g	0	2	6	1.46	3.28	–	5.1	–
Uranium-234	pCi/g	0	8	8	0.683	0.98	0.062	1.12	1.02
Uranium-235, Uranium-236	pCi/g	0	8	8	0.055	0.09	0.04	0.199	0.118
Uranium-238	pCi/g	0	8	8	0.743	1.023	0.059	1.27	1.06
Uranium (calculated)	µg/g	0	6	6	0.32	2.14	1.57	3.8	3.4
Gross Alpha	pCi/g	0	8	8	4.86	18.6	8.71	28.1	24.6
Gross Beta	pCi/g	2	8	8	20.7	35.1	9.97	46.3	42
Gross Gamma	pCi/g	0	6	7	7.9	10.4	1.2	11.4	11.4
Frijoles Canyon [a]									
Americium-241	pCi/g	2	5	16	0.016	0.022	0.005	0.026	0.027
Cesium-137	pCi/g	1	16	16	0.057	0.224	0.147	0.685	0.296
Cobalt-60	pCi/g	0	0	3	–	–	–	–	–
Neptunium-237	pCi/g	0	3	3	0.266	0.433	0.237	0.889	0.701
Plutonium-238	pCi/g	0	3	15	0.0	0.008	0.01	0.019	0.02
Plutonium-239, Plutonium-240	pCi/g	5	7	15	0.009	0.024	0.004	0.053	0.026
Potassium-40	pCi/g	0	3	3	17.6	27.6	5.94	31.8	34.3
Sodium-22	pCi/g	0	1	3	–	0.024	–	–	–
Strontium-90	pCi/g	0	7	15	0.059	0.138	0.002	0.223	0.14
Tritium	pCi/L	0	1	5	–	92.3	–	–	–
Tritium	pCi/g	1	2	11	0.031	72.5	–	145	–
Uranium-234	pCi/g	0	16	16	0.376	1.11	0.297	2.1	1.25
Uranium-235, Uranium-236	pCi/g	0	15	16	0.02	0.072	0.018	0.13	0.081
Uranium-238	pCi/g	0	16	16	0.43	1.08	0.259	2.14	1.21
Uranium (calculated)	µg/g	0	10	10	0.18	2.24	2	6.42	3.48
Gross Alpha	pCi/g	9	17	17	9.44	14.3	2.27	21.7	15.4
Gross Beta	pCi/g	15	17	17	18.4	31.9	4.86	42.6	34.2
Gross Gamma	pCi/g	0	12	12	1.46	8.71	1.84	13.2	9.75
Guaje Canyon [b]									
Americium-241	pCi/g	0	9	17	0.006	0.018	0.009	0.039	0.023
Cesium-137	pCi/g	3	14	18	0.013	0.27	0.232	0.883	0.392
Cobalt-60	pCi/g	0	0	9	–	–	–	–	–

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Neptunium-237	pCi/g	0	9	9	0.175	0.657	0.129	1.12	0.741
Plutonium-238	pCi/g	0	4	17	0.003	0.012	0.006	0.021	0.018
Plutonium-239, Plutonium-240	pCi/g	6	9	17	0.005	0.027	0.019	0.055	0.039
Potassium-40	pCi/g	0	9	9	24.3	28.2	1.39	33.1	29.2
Sodium-22	pCi/g	0	1	8	–	0.106	–	–	–
Strontium-90	pCi/g	0	6	18	0.13	0.207	0.07	0.396	0.263
Tritium	pCi/L	1	1	3	–	797	–	–	–
Tritium	pCi/g	0	2	9	0.014	0.019	–	0.024	–
Uranium-234	pCi/g	1	17	17	0.563	1.15	0.262	2.01	1.27
Uranium-235, Uranium-236	pCi/g	0	13	17	0.047	0.113	0.045	0.338	0.137
Uranium-238	pCi/g	0	17	17	0.623	1.14	0.207	1.75	1.24
Uranium (calculated)	µg/g	0	10	10	0.23	2.2	1.65	3.8	3.22
Gross Alpha	pCi/g	6	17	17	6.24	14	2.78	23	15.5
Gross Beta	pCi/g	9	17	17	24.1	33.2	5.03	53	35.6
Gross Gamma	pCi/g	0	15	15	6.29	9.85	1.63	15.7	10.7
Indio Canyon [c]									
Americium-241	pCi/g	0	2	5	0.011	0.019	–	0.027	–
Cesium-137	pCi/g	0	5	5	0.085	0.151	0.063	0.235	0.206
Cobalt-60	pCi/g	0	0	2	–	–	–	–	–
Neptunium-237	pCi/g	0	2	2	0.277	0.299	–	0.321	–
Plutonium-238	pCi/g	0	0	5	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/g	0	4	5	0.012	0.02	0.006	0.025	0.025
Potassium-40	pCi/g	0	2	2	25.2	28.1	–	31	–
Sodium-22	pCi/g	0	1	2	–	0.082	–	–	–
Strontium-90	pCi/g	0	1	6	–	0.18	–	–	–
Tritium	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/g	0	0	4	–	–	–	–	–
Uranium-234	pCi/g	0	5	5	0.517	0.896	0.282	1.22	1.14
Uranium-235, Uranium-236	pCi/g	0	5	5	0.036	0.081	0.051	0.155	0.125
Uranium-238	pCi/g	0	5	5	0.501	0.925	0.303	1.27	1.19
Uranium (calculated)	µg/g	0	3	3	0.24	1.64	1.47	3.17	3.3
Gross Alpha	pCi/g	1	5	5	3.76	12.6	7.04	18.7	18.7
Gross Beta	pCi/g	2	5	5	18.5	33.3	9.31	43.2	41.5
Gross Gamma	pCi/g	0	4	4	5.7	7.44	1.77	9.9	9.17
Los Alamos Canyon [a]									
Americium-241	pCi/g	31	37	57	0.01	0.133	0.059	0.376	0.152
Cesium-137	pCi/g	14	55	55	0.023	0.484	0.165	1.96	0.528
Cobalt-60	pCi/g	0	1	18	–	0.02	–	–	–

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Neptunium-237	pCi/g	0	18	18	0.321	0.589	0.124	1.15	0.647
Plutonium-238	pCi/g	5	22	57	0.0	0.02	0.007	0.053	0.023
Plutonium-239, Plutonium-240	pCi/g	47	48	57	0.013	0.212	0.067	1.26	0.231
Potassium-40	pCi/g	0	18	18	22.7	27.3	0.636	31.3	27.6
Sodium-22	pCi/g	0	0	18	–	–	–	–	–
Strontium-90	pCi/g	3	23	58	0.066	0.622	0.237	3.24	0.719
Tritium	pCi/L	7	12	16	0.0	426	603	3,030	767
Tritium	pCi/g	4	19	41	0.002	1.94	3.04	6.46	3.3
Uranium-234	pCi/g	0	56	56	0.334	0.822	0.1	1.39	0.849
Uranium-235, Uranium-236	pCi/g	0	49	56	0.018	0.07	0.036	0.152	0.08
Uranium-238	pCi/g	0	56	56	0.338	0.785	0.092	1.48	0.809
Uranium (calculated)	µg/g	0	38	38	0.16	1.56	1.12	4.29	1.92
Gross Alpha	pCi/g	24	57	57	4.05	12.1	2.15	29.9	12.7
Gross Beta	pCi/g	51	57	57	16.9	34.3	3.68	49.5	35.2
Gross Gamma	pCi/g	0	41	42	2.09	8.41	0.408	17	8.53
Mortandad Canyon [a]									
Americium-241	pCi/g	46	56	76	0.002	3.32	0.605	13.7	3.48
Cesium-137	pCi/g	28	65	73	0.005	5.22	2.57	28.6	5.84
Cobalt-60	pCi/g	0	7	24	0.023	0.07	0.006	0.137	0.074
Neptunium-237	pCi/g	0	24	24	0.162	0.71	0.12	1.57	0.758
Plutonium-238	pCi/g	47	53	74	0.002	1.61	0.597	11.5	1.77
Plutonium-239, Plutonium-240	pCi/g	42	53	74	0.003	2.85	0.694	13.4	3.03
Potassium-40	pCi/g	0	24	24	21.7	28.9	0.11	33.8	29
Sodium-22	pCi/g	0	5	24	0.02	0.027	0.005	0.032	0.031
Strontium-90	pCi/g	15	47	72	0.024	0.625	0.238	2.64	0.693
Tritium	pCi/L	14	18	21	226	1,860	317	5,940	2,000
Tritium	pCi/g	3	18	49	0.0	6.62	12.8	96.1	12.5
Uranium-234	pCi/g	16	75	75	0.042	0.857	0.233	1.91	0.91
Uranium-235, Uranium-236	pCi/g	2	61	75	0.019	0.081	0.033	0.214	0.09
Uranium-238	pCi/g	0	75	75	0.037	0.868	0.231	2.16	0.921
Uranium (calculated)	µg/g	0	48	48	0.11	1.98	1.55	6.51	2.42
Gross Alpha	pCi/g	44	71	71	2.18	21.5	4.49	59.3	22.5
Gross Beta	pCi/g	65	71	71	21.4	43.4	3.29	74.3	44.1
Gross Gamma	pCi/g	0	55	56	5.12	16.5	6.96	145	18.4
Pajarito Canyon [a]									
Americium-241	pCi/g	26	73	95	0.0	0.149	0.096	3.08	0.171
Cesium-137	pCi/g	7	94	96	0.005	0.521	0.29	5.87	0.579
Cobalt-60	pCi/g	0	2	33	0.049	0.052	–	0.054	–

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Neptunium-237	pCi/g	0	33	33	0.252	0.803	0.151	1.61	0.855
Plutonium-238	pCi/g	15	57	96	0.0	0.12	0.047	1.31	0.132
Plutonium-239, Plutonium-240	pCi/g	50	74	96	0.002	0.299	0.147	3.81	0.333
Potassium-40	pCi/g	0	33	33	20.5	27.7	0.742	35	28
Sodium-22	pCi/g	0	1	33	–	0.043	–	–	–
Strontium-90	pCi/g	6	28	97	0.031	0.299	0.148	1.14	0.354
Tritium	pCi/L	27	27	32	197	2,070	530	9,930	2,270
Tritium	pCi/g	1	32	61	0.003	7.0	11.8	103	11.1
Uranium-234	pCi/g	4	95	95	0.31	0.921	0.077	1.69	0.937
Uranium-235, Uranium-236	pCi/g	1	85	95	0.0	0.079	0.029	0.196	0.085
Uranium-238	pCi/g	0	95	95	0.221	0.915	0.087	1.86	0.933
Uranium (calculated)	µg/g	0	61	61	0.13	2.12	1.62	5.53	2.53
Gross Alpha	pCi/g	31	95	95	2.37	16.8	1.7	34.4	17.2
Gross Beta	pCi/g	46	95	95	17.9	38.5	2.69	62.3	39.1
Gross Gamma	pCi/g	0	62	62	4.73	9.99	0.778	19.1	10.2
Potrillo Canyon [c]									
Americium-241	pCi/g	0	2	7	0.012	0.013	–	0.014	–
Cesium-137	pCi/g	0	7	7	0.024	0.111	0.069	0.207	0.162
Cobalt-60	pCi/g	0	0	3	–	–	–	–	–
Neptunium-237	pCi/g	0	3	3	0.368	0.508	0.198	0.755	0.732
Plutonium-238	pCi/g	0	1	7	–	0.016	–	–	–
Plutonium-239, Plutonium-240	pCi/g	0	1	7	–	0.027	–	–	–
Potassium-40	pCi/g	0	3	3	25.3	27.3	2.76	30.1	30.4
Sodium-22	pCi/g	0	0	3	–	–	–	–	–
Strontium-90	pCi/g	0	2	6	0.107	0.112	–	0.116	–
Tritium	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/g	0	1	6	–	2.18	–	–	–
Uranium-234	pCi/g	0	7	7	0.364	0.766	0.256	1.09	0.956
Uranium-235, Uranium-236	pCi/g	0	7	7	0.033	0.084	0.05	0.153	0.121
Uranium-238	pCi/g	0	7	7	0.419	0.833	0.257	1.1	1.02
Uranium (calculated)	µg/g	0	5	5	0.33	1.41	1.12	2.61	2.39
Gross Alpha	pCi/g	1	6	6	3.59	12.1	5	16.3	16.1
Gross Beta	pCi/g	1	7	7	18.2	33.1	10.7	45.2	41
Gross Gamma	pCi/g	0	6	6	1.48	6.46	1.57	8.43	7.71
Pueblo Canyon [a]									
Americium-241	pCi/g	15	29	35	0.011	0.184	0.18	1.32	0.25
Cesium-137	pCi/g	4	36	37	0.0	0.378	0.348	2.11	0.491
Cobalt-60	pCi/g	0	0	13	–	–	–	–	–

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Neptunium-237	pCi/g	0	13	13	0.261	0.709	0.032	1.51	0.726
Plutonium-238	pCi/g	4	18	35	0.005	0.018	0.01	0.046	0.022
Plutonium-239, Plutonium-240	pCi/g	27	30	35	0.015	2.7	1.37	12.5	3.19
Potassium-40	pCi/g	0	13	13	26	29.1	0.493	33.1	29.4
Sodium-22	pCi/g	0	1	13	–	0.021	–	–	–
Strontium-90	pCi/g	0	23	34	0.051	0.175	0.056	0.386	0.199
Tritium	pCi/L	1	6	7	160	325	–	544	–
Tritium	pCi/g	0	3	27	0.006	0.254	0.351	0.818	0.65
Uranium-234	pCi/g	0	35	35	0.343	1.08	0.245	2.32	1.16
Uranium-235, Uranium-236	pCi/g	0	29	35	0.012	0.086	0.021	0.149	0.093
Uranium-238	pCi/g	0	35	35	0.391	0.993	0.126	2.03	1.04
Uranium (calculated)	µg/g	0	23	23	0.13	1.93	1.39	4.47	2.5
Gross Alpha	pCi/g	3	36	36	3.13	15.4	3.54	28.3	16.6
Gross Beta	pCi/g	9	36	36	23.5	33.7	4.41	46	35.1
Gross Gamma	pCi/g	0	29	29	5.17	9.35	1.01	12.9	9.72
Sandia Canyon [a]									
Americium-241	pCi/g	0	11	30	0.002	0.015	0.005	0.022	0.018
Cesium-137	pCi/g	0	22	29	0.004	0.056	0.004	0.139	0.057
Cobalt-60	pCi/g	0	3	10	0.024	0.028	0.001	0.031	0.029
Neptunium-237	pCi/g	0	10	10	0.223	0.826	0.178	2.04	0.937
Plutonium-238	pCi/g	3	10	30	0.0	0.015	0.006	0.044	0.019
Plutonium-239, Plutonium-240	pCi/g	2	11	30	0.0	0.025	0.012	0.043	0.032
Potassium-40	pCi/g	0	10	10	21.4	27.6	0.707	34.8	28
Sodium-22	pCi/g	0	1	10	–	0.023	–	–	–
Strontium-90	pCi/g	0	6	27	0.042	0.074	0.027	0.111	0.096
Tritium	pCi/L	2	4	6	108	543	596	1,270	1,130
Tritium	pCi/g	0	2	24	0.053	0.374	–	0.696	–
Uranium-234	pCi/g	1	30	30	0.05	0.952	0.46	2.71	1.12
Uranium-235, Uranium-236	pCi/g	1	23	30	0.012	0.084	0.045	0.246	0.103
Uranium-238	pCi/g	1	30	30	0.056	0.933	0.479	2.66	1.11
Uranium (calculated)	µg/g	0	19	19	0.14	2.16	1.7	7.51	2.92
Gross Alpha	pCi/g	7	26	27	4.26	12.9	4.11	25.9	14.5
Gross Beta	pCi/g	15	27	27	6.64	33.4	4.56	52.9	35.1
Gross Gamma	pCi/g	0	26	26	5.08	9	0.758	17.3	9.3
Water Canyon [a]									
Americium-241	pCi/g	2	42	68	0.004	0.033	0.016	0.155	0.038
Cesium-137	pCi/g	10	66	66	0.007	0.22	0.102	1.14	0.245
Cobalt-60	pCi/g	0	1	16	–	0.056	–	–	–

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Neptunium-237	pCi/g	0	16	16	0.091	0.455	0.159	0.955	0.533
Plutonium-238	pCi/g	0	23	68	0.0	0.018	0.023	0.166	0.027
Plutonium-239, Plutonium-240	pCi/g	11	39	68	0.003	0.057	0.041	0.721	0.07
Potassium-40	pCi/g	0	16	16	24.5	28.3	0.725	32.9	28.7
Sodium-22	pCi/g	0	3	16	0.022	0.03	0.011	0.04	0.042
Strontium-90	pCi/g	2	30	68	0.044	0.12	0.034	0.285	0.133
Tritium	pCi/L	17	22	24	82.5	217	172	541	289
Tritium	pCi/g	1	8	68	0.0	2.13	2.20	6.59	3.66
Uranium-234	pCi/g	0	68	48	0.314	0.742	0.045	1.31	0.752
Uranium-235, Uranium-236	pCi/g	0	53	68	0.016	0.071	0.016	0.17	0.075
Uranium-238	pCi/g	0	68	68	0.273	0.786	0.09	1.74	0.808
Uranium (calculated)	µg/g	0	39	39	0.11	1.77	1.29	4.58	2.18
Gross Alpha	pCi/g	21	69	69	2.53	12.2	2.72	26.9	12.9
Gross Beta	pCi/g	32	69	69	8.22	33.1	2.62	50.5	33.7
Gross Gamma	pCi/g	0	42	42	5.45	7.98	0.94	12	8.27

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, pCi/g = picocuries per gram, µg/L = micrograms per liter.

[a] Canyon sampling stations are at both onsite and perimeter locations.

[b] Perimeter Stations. Canyon sampling stations are at perimeter locations.

[c] Canyon sampling stations are at onsite locations.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–22 Radiochemical Statistical Analysis of Runoff from 2001 through 2005

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Regional Stations									
Americium-241	pCi/L	0	6	34	0.003	0.043	0.045	0.116	0.08
Cesium-137	pCi/L	0	5	31	0.54	2.44	1.28	3.75	3.56
Cobalt-60	pCi/L	0	2	19	1.25	1.28	–	1.3	–
Neptunium-237	pCi/L	0	0	19	–	–	–	–	–
Plutonium-238	pCi/L	0	3	35	0.018	0.029	0.017	0.049	0.049
Plutonium-239, Plutonium-240	pCi/L	0	12	35	0.0	0.267	0.368	1.0	0.475
Potassium-40	pCi/L	0	16	19	7.19	42.5	27.5	90.2	56
Radium-226	pCi/L	0	3	5	0.245	1.77	2.56	4.72	4.66
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	1	19	–	2.51	–	–	–
Strontium-90	pCi/L	0	14	34	0.093	0.227	0.171	0.694	0.316
Tritium	pCi/L	0	5	24	74.8	118	21.5	199	137
Uranium-234	pCi/L	0	36	36	0.271	7.97	13.9	108	12.5

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Uranium-235, Uranium-236	pCi/L	0	33	36	0.025	0.689	1.26	9.55	1.12
Uranium-238	pCi/L	0	36	36	0.173	7.85	14.5	111	12.6
Uranium (calculated)	µg/L	0	26	26	0.0	2.43	2.24	12.5	3.29
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	4	31	34	0.736	17.6	26.9	235	27.1
Gross Beta	pCi/L	0	34	34	1.34	32.3	51.9	298	49.7
Gross Gamma	pCi/L	0	10	29	59.3	201	202	499	326
Perimeter Stations									
Americium-241	pCi/L	25	139	215	0.005	1.05	0.378	11.6	1.11
Cesium-137	pCi/L	3	81	207	0.0	7.95	1.9	68.1	8.36
Cobalt-60	pCi/L	0	36	149	0.517	3.6	3.09	13.5	4.61
Neptunium-237	pCi/L	0	44	149	0.141	11.2	6	28.8	13
Plutonium-238	pCi/L	3	84	214	0.0	0.231	0.098	2.84	0.252
Plutonium-239, Plutonium-240	pCi/L	23	144	214	0.0	5.65	3.81	106	6.27
Potassium-40	pCi/L	0	137	148	1	69.4	67.3	327	80.7
Radium-226	pCi/L	0	10	15	0.161	0.365	0.069	0.6	0.407
Radium-228	pCi/L	0	1	2	–	0.481	–	–	–
Sodium-22	pCi/L	0	8	149	0.216	2.37	0.347	3.56	2.61
Strontium-90	pCi/L	14	151	208	0.062	4.32	1.66	35.1	4.59
Tritium	pCi/L	2	90	182	50.9	179	58.1	1,410	191
Uranium-234	pCi/L	10	188	211	0.038	8.14	5.45	88.9	8.92
Uranium-235, Uranium-236	pCi/L	1	155	211	0.008	0.732	0.337	7.28	0.785
Uranium-238	pCi/L	8	188	211	0.022	8.37	5.46	91.9	9.15
Uranium (calculated)	µg/L	0	171	172	0.0	5.9	4.79	135	6.62
Uranium (measured)	µg/L	0	89	89	0.03	2.05	3.5	13.5	2.78
Gross Alpha	pCi/L	9	167	212	0.548	189	124	3,070	208
Gross Beta	pCi/L	8	201	212	0.636	251	189	4,630	278
Gross Gamma	pCi/L	0	16	61	57.6	186	148	1,110	259
Onsite Stations									
Americium-241	pCi/L	38	356	542	0.0	13.1	24.8	583	15.7
Cesium-137	pCi/L	3	188	498	0.0	12	5.81	104	12.9
Cobalt-60	pCi/L	0	66	289	0.033	4	3.54	10.7	4.84
Neptunium-237	pCi/L	0	75	287	1.96	12.1	7.75	40.3	13.9
Plutonium-238	pCi/L	20	240	531	0.0	13.7	28.5	685	17.3
Plutonium-239, Plutonium-240	pCi/L	55	330	531	0.0	11.1	17	775	13
Potassium-40	pCi/L	0	266	288	0.0	78.4	112	709	91.8
Radium-226	pCi/L	0	28	36	0.123	0.349	0.302	1.45	0.461

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Radium-228	pCi/L	0	5	6	0.537	1.55	0.994	2.83	2.42
Sodium-22	pCi/L	0	13	289	0.814	2.84	1.11	4.32	3.44
Strontium-90	pCi/L	31	355	502	0.052	3.95	1.28	78.8	4.08
Tritium	pCi/L	13	209	370	54.4	326	139	12,900	345
Uranium-234	pCi/L	27	472	506	0.013	10.6	3.67	354	10.9
Uranium-235, Uranium-236	pCi/L	2	360	513	0.0	0.947	0.218	65.5	0.97
Uranium-238	pCi/L	26	485	515	0.015	13.8	6.85	2,220	14.4
Uranium (calculated)	µg/L	0	465	465	0.0	7.62	8.54	249	8.4
Uranium (measured)	µg/L	0	212	212	0.025	7.05	22.8	238	10.1
Gross Alpha	pCi/L	26	411	495	0.193	162	91.4	2,600	171
Gross Beta	pCi/L	20	469	488	0.809	199	129	5,370	211
Gross Gamma	pCi/L	0	74	175	55	180	74.8	1,990	197
Ancho Canyon [b]									
Americium-241	pCi/L	0	2	7	0.017	0.019	–	0.021	–
Cesium-137	pCi/L	0	2	6	2.47	2.7	–	2.93	–
Cobalt-60	pCi/L	0	1	5	–	2.42	–	–	–
Neptunium-237	pCi/L	0	1	5	–	13.9	–	–	–
Plutonium-238	pCi/L	0	1	7	–	0.01	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	7	–	–	–	–	–
Potassium-40	pCi/L	0	2	5	15.8	29.5	–	43.2	–
Radium-226	pCi/L	0	0	1	–	–	–	–	–
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	5	–	–	–	–	–
Strontium-90	pCi/L	0	0	6	–	–	–	–	–
Tritium	pCi/L	0	1	5	–	112	–	–	–
Uranium-234	pCi/L	0	7	7	0.061	0.117	0.034	0.171	0.142
Uranium-235, Uranium-236	pCi/L	0	0	7	–	–	–	–	–
Uranium-238	pCi/L	0	6	7	0.037	0.054	0.008	0.103	0.06
Uranium (calculated)	µg/L	0	8	8	0.09	9.48	16.1	33.5	20.7
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	1	7	–	1.19	–	–	–
Gross Beta	pCi/L	0	3	7	1.11	1.89	0.392	2.12	2.34
Gross Gamma	pCi/L	0	1	6	–	78.3	–	–	–
Frijoles Canyon [b]									
Americium-241	pCi/L	0	5	16	0.018	0.095	0.098	0.542	0.181
Cesium-137	pCi/L	0	2	15	1.5	2.45	–	3.39	–
Cobalt-60	pCi/L	0	3	11	1.46	1.83	0.53	2.44	2.43
Neptunium-237	pCi/L	0	4	11	12.1	12.6	5.33	22.2	17.82
Plutonium-238	pCi/L	0	2	16	0.046	0.052	–	0.057	–

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Plutonium-239, Plutonium-240	pCi/L	0	4	16	0.0	0.467	0.87	1.77	1.32
Potassium-40	pCi/L	0	8	11	2.49	22.3	15.3	43.2	32.8
Radium-226	pCi/L	0	1	3	–	0.161	–	–	–
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	11	–	–	–	–	–
Strontium-90	pCi/L	1	4	16	0.062	0.726	0.939	3.63	1.65
Tritium	pCi/L	0	7	16	58.3	118	47.3	219	153
Uranium-234	pCi/L	0	12	15	0.038	0.207	0.187	1.37	0.313
Uranium-235, Uranium-236	pCi/L	0	4	15	0.046	0.07	0.027	0.098	0.096
Uranium-238	pCi/L	0	12	15	0.027	0.166	0.219	1.39	0.29
Uranium (calculated)	µg/L	0	10	10	0.057	0.119	0.048	0.19	0.149
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	7	16	0.548	10	14.6	47.3	20.8
Gross Beta	pCi/L	0	15	16	0.636	9.91	13.1	128	16.6
Gross Gamma	pCi/L	0	3	13	57.6	68.5	15.3	92.6	85.8
Guaje Canyon [a]									
Americium-241	pCi/L	6	20	32	0.018	0.361	0.239	1.52	0.466
Cesium-137	pCi/L	3	20	30	0.0	6.98	3.2	15.8	8.39
Cobalt-60	pCi/L	0	0	4	–	–	–	–	–
Neptunium-237	pCi/L	0	0	4	–	–	–	–	–
Plutonium-238	pCi/L	0	8	32	0.065	0.361	0.011	0.699	0.369
Plutonium-239, Plutonium-240	pCi/L	7	18	32	0.012	1.2	1.32	3.93	1.81
Potassium-40	pCi/L	0	3	4	30.6	65.1	55.4	178	128
Radium-226	pCi/L	0	2	2	0.486	0.543	–	0.6	–
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	4	–	–	–	–	–
Strontium-90	pCi/L	12	28	31	0.212	7.84	5.14	26.8	9.74
Tritium	pCi/L	2	6	16	84.3	151	24.2	268	171
Uranium-234	pCi/L	8	31	34	0.039	30.9	26.4	354	40.2
Uranium-235, Uranium-236	pCi/L	1	27	33	0.0	1.82	1.28	15.2	2.3
Uranium-238	pCi/L	7	30	33	0.033	27.2	25.1	334	36.2
Uranium (calculated)	µg/L	0	28	28	0.059	13.3	17.4	137	19.7
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	7	25	31	0.9	343	385	3,070	494
Gross Beta	pCi/L	6	30	30	2.29	446	576	5,370	652
Gross Gamma	pCi/L	0	7	19	85.2	334	546	1,110	739

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Los Alamos Canyon [b]									
Americium-241	pCi/L	9	92	121	0.0	1.26	1.1	16.1	1.48
Cesium-137	pCi/L	0	51	115	0.685	9.43	2.86	68.1	10.2
Cobalt-60	pCi/L	0	22	80	0.033	2.97	1.46	5.87	3.58
Neptunium-237	pCi/L	0	27	80	3.41	11.6	5.79	26.7	13.8
Plutonium-238	pCi/L	2	62	117	0.0	0.212	0.09	1.4	0.235
Plutonium-239, Plutonium-240	pCi/L	23	90	117	0.002	2.87	0.592	19.6	2.99
Potassium-40	pCi/L	0	77	80	0.0	69.8	67.5	277	84.9
Radium-226	pCi/L	0	7	8	0.205	0.35	0.084	0.542	0.412
Radium-228	pCi/L	0	1	2	–	0.481	–	–	–
Sodium-22	pCi/L	0	4	80	2.45	3.09	0.363	3.56	3.45
Strontium-90	pCi/L	0	92	113	0.115	6.55	4.37	78.8	7.44
Tritium	pCi/L	0	60	102	50.9	144	49.4	400	156
Uranium-234	pCi/L	2	104	115	0.048	6.09	4.87	149	7.03
Uranium-235, Uranium-236	pCi/L	0	92	115	0.017	0.567	0.216	6.04	0.611
Uranium-238	pCi/L	0	104	115	0.022	6.09	4.89	147	7.03
Uranium (calculated)	µg/L	0	122	122	0.02	8.23	5.63	102	9.23
Uranium (measured)	µg/L	0	66	66	0.03	2.71	4.43	21.6	3.78
Gross Alpha	pCi/L	2	94	114	0.575	120	107	848	142
Gross Beta	pCi/L	0	108	114	1.58	130	132	1,140	155
Gross Gamma	pCi/L	0	6	13	70.8	226	428	814	568
Mortandad Canyon [b]									
Americium-241	pCi/L	17	94	137	0.009	28.9	48.3	583	38.7
Cesium-137	pCi/L	3	53	125	0.22	27.5	24.2	104	34
Cobalt-60	pCi/L	0	22	98	1.13	1.88	1.92	7.99	2.68
Neptunium-237	pCi/L	0	32	98	1.98	12.1	8.2	40.3	14.9
Plutonium-238	pCi/L	11	84	132	0.0	32.4	64.5	685	46.2
Plutonium-239, Plutonium-240	pCi/L	19	89	133	0.0	22.5	44.3	608	31.7
Potassium-40	pCi/L	0	86	98	0.055	72.9	88.5	630	91.6
Radium-226	pCi/L	0	17	20	0.167	0.285	0.229	1.45	0.394
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	6	98	0.814	2.35	0.913	4.13	3.09
Strontium-90	pCi/L	9	87	128	0.1	2.5	2.42	43.9	3
Tritium	pCi/L	3	52	80	78	1,090	1,042	12,900	1,370
Uranium-234	pCi/L	4	118	124	0.03	3.76	4.74	55	4.62
Uranium-235, Uranium-236	pCi/L	0	95	124	0.0	0.354	0.484	4.6	0.451
Uranium-238	pCi/L	2	119	125	0.015	4	5.18	67.2	4.93
Uranium (calculated)	µg/L	0	64	64	0.018	3.93	4.32	45.8	4.99

Measured Radiochemical		2001 through 2005							
		Detected per ESR	**Used In This SWEIS**	**Analyzed**	**Minimum**	**Mean**	**Standard Deviation**	**Maximum**	**95 Percent UCL**
Uranium (measured)	µg/L	0	35	35	0.079	3.46	8.45	48.3	6.25
Gross Alpha	pCi/L	4	107	125	0.605	148	150	2,290	176
Gross Beta	pCi/L	2	119	123	1.6	120	109	2,210	139
Gross Gamma	pCi/L	0	20	54	58.4	335	266	1,990	451
Pajarito Canyon [b]									
Americium-241	pCi/L	9	134	214	0.004	0.479	0.425	10.1	0.551
Cesium-137	pCi/L	0	61	192	1.21	6.62	3.1	46.8	7.4
Cobalt-60	pCi/L	0	24	104	0.495	4.34	3.9	10.7	5.9
Neptunium-237	pCi/L	0	26	102	2.42	11.3	8.83	28	14.6
Plutonium-238	pCi/L	5	85	212	0.0	0.167	0.116	0.985	0.192
Plutonium-239, Plutonium-240	pCi/L	11	123	212	0.002	0.931	0.931	7.65	1.1
Potassium-40	pCi/L	0	97	103	4.31	79.2	117	709	102
Radium-226	pCi/L	0	5	8	0.14	0.312	0.16	0.566	0.453
Radium-228	pCi/L	0	4	4	0.537	1.68	1.1	2.83	2.76
Sodium-22	pCi/L	0	7	104	1.87	3	1.24	4.32	3.92
Strontium-90	pCi/L	11	133	197	0.052	2.37	1.71	71.9	2.66
Tritium	pCi/L	6	93	160	62.9	238	45.9	1,980	248
Uranium-234	pCi/L	14	181	198	0.013	9.5	5.05	331	10.2
Uranium-235, Uranium-236	pCi/L	2	129	206	0.0	1.16	0.878	65.5	1.31
Uranium-238	pCi/L	17	195	207	0.02	20.8	29	2,220	24.9
Uranium (calculated)	µg/L	0	170	170	0.0	6.24	9.65	249	7.69
Uranium (measured)	µg/L	0	88	88	0.03	7.75	29	238	13.8
Gross Alpha	pCi/L	10	158	194	0.193	121	73.5	1,630	132
Gross Beta	pCi/L	9	180	190	0.809	145	102	3,160	160
Gross Gamma	pCi/L	0	29	55	55	118	51.8	430	137
Pueblo Canyon [b]									
Americium-241	pCi/L	19	75	102	0.013	1.30	0.951	67.3	1.52
Cesium-137	pCi/L	0	42	97	0.0	5.1	3.17	28.3	6.06
Cobalt-60	pCi/L	0	13	66	2.21	5.44	5.08	13.5	8.2
Neptunium-237	pCi/L	0	15	66	0.141	10.5	4.01	24.5	12.6
Plutonium-238	pCi/L	3	43	99	0.0	0.282	0.31	5.55	0.375
Plutonium-239, Plutonium-240	pCi/L	16	84	99	0.009	12.5	11.55	775	15
Potassium-40	pCi/L	0	65	65	3.67	81	78	343	99.9
Radium-226	pCi/L	0	4	5	0.274	0.31	0.004	0.352	0.314
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	2	66	0.216	0.938	–	1.66	–
Strontium-90	pCi/L	2	82	96	0.086	2.88	3.12	21.3	3.56
Tritium	pCi/L	0	38	74	57.4	183	112	1,410	219
Uranium-234	pCi/L	2	93	97	0.038	8.86	9.64	88.9	10.8

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Uranium-235, Uranium-236	pCi/L	0	85	97	0.008	0.621	0.623	7.28	0.754
Uranium-238	pCi/L	1	93	97	0.066	8.68	9.8	91.9	10.7
Uranium (calculated)	µg/L	0	46	47	0.004	12.6	10.5	81.8	15.7
Uranium (measured)	µg/L	0	27	27	0.03	2.24	3.66	11.5	3.62
Gross Alpha	pCi/L	2	88	97	0.61	163	180	1,800	201
Gross Beta	pCi/L	2	96	97	1.54	267	320	3,010	331
Gross Gamma	pCi/L	0	9	25	58.4	152	137	820	241
Sandia Canyon [b]									
Americium-241	pCi/L	0	20	56	0.01	0.041	0.014	0.111	0.047
Cesium-137	pCi/L	0	10	57	1.62	3.74	1.71	9.61	4.8
Cobalt-60	pCi/L	0	9	39	1.04	3.39	1.38	5.63	4.29
Neptunium-237	pCi/L	0	11	39	1.96	13.7	0.387	22.9	13.9
Plutonium-238	pCi/L	0	9	57	0.025	0.051	0.011	0.097	0.058
Plutonium-239, Plutonium-240	pCi/L	0	20	57	0.005	0.083	0.034	0.331	0.097
Potassium-40	pCi/L	0	37	39	1.32	58.6	88.5	420	87.1
Radium-226	pCi/L	0	1	2	–	0.176	–	–	–
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	2	39	2.1	2.22	–	2.33	–
Strontium-90	pCi/L	0	24	55	0.09	0.227	0.091	0.831	0.264
Tritium	pCi/L	2	26	49	54.4	132	49.4	533	151
Uranium-234	pCi/L	1	55	57	0.022	2.24	1.71	69.1	2.69
Uranium-235, Uranium-236	pCi/L	0	39	57	0.019	0.201	0.17	4.83	0.254
Uranium-238	pCi/L	1	51	57	0.045	2.36	1.79	70.9	2.85
Uranium (calculated)	µg/L	0	65	65	0.018	1.55	1.39	17.7	1.89
Uranium (measured)	µg/L	0	39	39	0.04	0.998	1.23	4	1.38
Gross Alpha	pCi/L	2	44	55	0.428	52.2	64.8	877	71.3
Gross Beta	pCi/L	1	54	55	3.41	43.3	27.9	524	50.8
Gross Gamma	pCi/L	0	7	27	82.8	139	65.7	343	188
Water Canyon [b]									
Americium-241	pCi/L	3	53	72	0.0	0.101	0.079	1.18	0.122
Cesium-137	pCi/L	0	27	65	0.0	4.92	2.57	15	5.89
Cobalt-60	pCi/L	0	8	28	0.857	3	1.52	8.3	4.05
Neptunium-237	pCi/L	0	3	28	7.05	12.1	4.54	15.9	17.2
Plutonium-238	pCi/L	2	28	69	0.0	0.111	0.038	0.549	0.125
Plutonium-239, Plutonium-240	pCi/L	2	43	69	0.0	0.323	0.281	3.15	0.407
Potassium-40	pCi/L	0	25	28	1.26	105	197	511	183
Radium-226	pCi/L	0	1	1	–	0.245	–	–	–
Radium-228	pCi/L	0	1	2	–	1.06	–	–	–

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Sodium-22	pCi/L	0	0	28	–	–	–	–	–
Strontium-90	pCi/L	10	54	65	0.14	2.32	1.99	16.9	2.85
Tritium	pCi/L	2	15	49	88.4	148	24.9	231	161
Uranium-234	pCi/L	6	56	67	0.049	13.6	9.4	79	16
Uranium-235, Uranium-236	pCi/L	0	42	67	0.009	0.934	0.583	4.86	1.11
Uranium-238	pCi/L	6	60	67	0.019	16.4	13.8	82.1	19.9
Uranium (calculated)	µg/L	0	123	123	0.0	14.5	20	190	18
Uranium (measured)	µg/L	0	46	46	0.025	13	25.9	93.4	20.5
Gross Alpha	pCi/L	8	51	65	0.463	150	105	1,660	179
Gross Beta	pCi/L	8	62	65	1.26	234	173	2,990	278
Gross Gamma	pCi/L	0	8	23	93.1	300	228	496	455

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Canyon sampling stations are at perimeter locations.

[b] Canyon sampling stations are at both onsite and perimeter locations.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–23 Radiochemical Statistical Analysis of Soils from 2001 through 2003

Measured Radiochemical		*2001 through 2003*						
		Detected per ESR	*Used In This SWEIS*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Regional Stations								
Americium-241	pCi/g	10	10	0.0	0.004	0.002	0.009	0.005
Cesium-137	pCi/g	10	10	0.06	0.257	0.105	0.65	0.322
Plutonium-238	pCi/g	5	5	0.0	0.002	0.002	0.004	0.004
Plutonium-239, Plutonium-240	pCi/g	10	10	0.001	0.01	0.005	0.029	0.013
Strontium-90	pCi/g	10	10	0.05	0.156	0.041	0.26	0.181
Tritium	pCi/mL	10	10	0.0	0.273	0.237	0.94	0.419
Uranium-234	pCi/g	7	7	0.55	0.729	0.246	1.2	0.911
Uranium-235	pCi/g	7	7	0.033	0.056	0.022	0.077	0.073
Uranium-238	pCi/g	7	7	0.59	0.74	0.263	1.2	0.935
Uranium (calculated)	pCi/g	6	6	1.7	2.2	0.240	2.7	2.39
Gross Alpha	pCi/g	6	6	3.7	4.48	1.1	6.1	5.37
Gross Beta	pCi/g	6	6	3.7	4.55	0.436	5.01	4.9
Gross Gamma	pCi/g	6	6	6	7.33	1	8	8.13
Perimeter Stations								
Americium-241	pCi/g	29	29	0.001	0.012	0.003	0.058	0.013
Cesium-137	pCi/g	30	30	0.09	0.337	0.023	0.84	0.346
Plutonium-238	pCi/g	24	24	0.0	0.003	0.001	0.011	0.004
Plutonium-239, Plutonium-240	pCi/g	30	30	0.008	0.059	0.023	0.53	0.067

Measured Radiochemical		*2001 through 2003*						
		Detected per ESR	*Used In This SWEIS*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Strontium-90	pCi/g	29	29	0.01	0.174	0.008	0.45	0.177
Tritium	pCi/mL	25	25	0.01	0.822	0.551	3	1.04
Uranium-234	pCi/g	20	20	0.6	1.12	0.439	2.25	1.31
Uranium-235	pCi/g	20	20	0.033	0.081	0.041	0.188	0.099
Uranium-238	pCi/g	20	20	0.54	1.12	0.454	2.32	1.32
Uranium (calculated)	pCi/g	20	20	2.1	3.93	1.36	9.3	4.53
Gross Alpha	pCi/g	20	20	1.93	5.41	1.97	7.9	6.27
Gross Beta	pCi/g	20	20	2.38	4.91	1.83	7.7	5.71
Gross Gamma	pCi/g	20	20	9	11.3	3.17	20	12.7
Onsite Stations								
Americium-241	pCi/g	36	36	0.002	0.015	0.008	0.2	0.018
Cesium-137	pCi/g	36	36	0.03	0.345	0.061	0.9	0.365
Plutonium-238	pCi/g	32	32	0.0	0.002	0.0	0.006	0.002
Plutonium-239, Plutonium-240	pCi/g	36	36	0.002	0.056	0.032	0.8	0.067
Strontium-90	pCi/g	34	34	0.0	0.142	0.038	0.38	0.154
Tritium	pCi/mL	36	36	0.1	0.907	0.724	4	1.14
Uranium-234	pCi/g	24	24	0.75	1.08	0.345	1.8	1.22
Uranium-235	pCi/g	24	24	0.044	0.069	0.03	0.152	0.081
Uranium-238	pCi/g	24	24	0.77	1.15	0.364	1.87	1.3
Uranium (calculated)	pCi/g	24	24	2.41	3.51	0.997	6	3.91
Gross Alpha	pCi/g	24	24	3.59	5.54	1.32	8.1	6.07
Gross Beta	pCi/g	24	24	2.9	4.7	1.39	8.1	5.26
Gross Gamma	pCi/g	24	24	10	11.6	1.54	14	12.2

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/mL = picocuries per milliliter, pCi/g = picocuries per gram.
Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–24 presents EPA and EPA-equivalent maximum contaminant levels (MCLs) (Title 40 *Code of Federal Regulations* [CFR], Part 141) for comparison between the groundwater, surface water or stormwater runoff concentrations presented in the above tables. The regulations at 40 CFR Part 141 only apply to drinking water systems.

Table F–24 Benchmark Concentrations for Analyzed Radionuclides for Groundwater, Surface Water, or Stormwater Runoff [a]

Constituent	*Benchmark Concentration*	
Americium-241	picocuries per liter	15 [b]
Cesium-137	picocuries per liter	93 [c]
Cobalt-60	picocuries per liter	173 [c]
Neptunium-237	picocuries per liter	15 [b]
Plutonium-238	picocuries per liter	15 [b]
Plutonium-239	picocuries per liter	15 [b]
Plutonium-240	picocuries per liter	15 [b]

Constituent	Benchmark Concentration	
Potassium-40	picocuries per liter	251 [c]
Radium-226, Radium-228	picocuries per liter	5 [b]
Sodium-22	picocuries per liter	407 [c]
Strontium-90	picocuries per liter	8 [b]
Tritium	picocuries per liter	20000 [b]
Uranium-234	micrograms per liter	30 [b]
Uranium-235	micrograms per liter	30 [b]
Uranium-236	micrograms per liter	30 [b]
Uranium-238	micrograms per liter	30 [b]
Uranium Total	picocuries per liter	10 [d]
Gross Alpha	picocuries per liter	15 [b]
Gross Beta	millirem per year	4 [b]
Gross Gamma	millirem per year	4 [b]

[a] Similar values are available for soils and sediments, but this would require more detailed analysis of agricultural and recreational use at a particular location.
[b] EPA maximum contaminant levels (40 CFR Part 141).
[c] EPA-equivalent maximum contaminant levels. Published value calculated to yield an annual dose equivalent of 4 millirem per year to the total body using Federal Guidance Report 11 dose factors.
[d] Calculated using sum of fractions rule and isotopic distribution for naturally occurring uranium.

The LANL environmental surveillance program also includes chemicals and elements, that are periodically measured at Regional, Perimeter, and Onsite stations. Samples of soil, sediment, surface water and groundwater were all measured for these chemicals and elements which are listed in **Tables F–25 and F–26** (LANL 2002, 2004a, 2004b, 2005, 2006b).

Table F–25 Chemicals Measured in the Los Alamos National Laboratory Environmental Surveillance Program

Chemical	Chemical	Chemical
Acenaphthene	2-Chloronaphthalene	Isophorone
Acenaphthylene	2-Chlorophenol	Isopropylbenzene
Acetone	Chrysene	4-Isopropyltoluene
4-Amino-2,6-dinitrotoluene	2,4-D	Methylene Chloride
2-Amino-4,6-dinitrotoluene	2,4-DB	2-Methylnaphthalene
Aniline	4,4'-DDD	2-Methylphenol
Anthracene	4,4'-DDE	4-Methylphenol
Aroclor-1016 (PCB)	4,4'-DDT	Naphthalene
Aroclor-1242 (PCB)	Dibenzofuran	3-Nitroaniline
Aroclor-1254 (PCB)	1,2-Dichlorobenzene	4-Nitroaniline
Aroclor-1260 (PCB)	1,3-Dichlorobenzene	Nitrobenzene
Azobenzene	1,4-Dichlorobenzene	N-Nitrosodimethylamine
Benzo(a)anthracene	3,3’-Dichlorobenzidine	N-Nitroso-di-n-propylamine
Benzo(a)pyrene	Dieldrin	1,2,3,4,6,7,8,9-Octachlorodibenzodioxin
Benzo(b)fluoranthene	Diethylphthalate	Pentachlorophenol
Benzo(g,h,i)perylene	Dimethyl Phthalate	Perchlorate
Benzo(k)fluoranthene	Di-n-butylphthalate	Phenanthrene
Benzoic Acid	Di-n-octylphthalate	Phenol
Benzyl Alcohol	2,4-Dinitrotoluene	Pyrene

Chemical	***Chemical***	***Chemical***
delta-BHC	1,4-Dioxane	Pyridine
Bis(2-chloroethoxy)methane	Endrin	RDX
Bis(2-ethylhexyl)phthalate	Ethylbenzene	Styrene
Bromodichloromethane	Fluoranthene	2,3,7,8-Tetrachlorodibenzofuran
Bromoform	Fluorene	Tetrachloroethene
2-Butanone	Heptachlor	Toluene
Butylbenzylphthalate	Heptachlor Epoxide	Trichloroethene
Carbazole	1,2,3,4,6,7,8-Heptachlorodibenzodioxin	1,1,1-Trichloroethane
4-Chloroaniline	Hexachlorobenzene	2,4,6-Trichlorophenol
Chlorodibromomethane	2-Hexanone	1,3,5-Trinitrobenzene
Chloroform	HMX	2,4,6-Trinitrotoluene
Chloromethane	Indeno(1,2,3-cd)pyrene	

PCB = polychlorinated biphenyls.

Table F–26 Elements Measured in the Los Alamos National Laboratory Environmental Surveillance Program

Element	***Element***	***Element***
Silver	Chromium	Antimony
Aluminum	Copper	Selenium
Arsenic	Iron	Tin
Boron	Mercury	Strontium
Barium	Manganese	Thallium
Beryllium	Molybdenum	Vanadium
Cadmium	Nickel	Zinc
Cobalt	Lead	

Measured environmental concentrations of the chemicals and elements listed in Tables F–25 and F–26 did not exceed EPA or New Mexico Environment Department standards with the following exceptions of perchlorate, hexavalent chromium, polychlorinated biphenyls (PCBs), and 1,4-dioxane. The number of "Detected per ESR" and "Used in This SWEIS" data points for these four chemicals are identical because the ESR source for these chemicals only reported data that were considered detected.

Perchlorate is a chemical of particular interest that has a high propensity to enter the groundwater. Perchlorate is used in rocket solid propellant, fireworks, lubricating oils, paint production, explosives, fabrics, and dye fixers. Perchlorate is formed naturally in the upper atmosphere and may also be created from fertilizers, mineral weathering, or electrochemical reactions. Perchlorate is soluble in water and has been shown to disrupt thyroid function and influence thyroid tumor formation if ingested in sufficient quantities. There is no Federal EPA MCL or MCL goal for perchlorate in drinking water. The EPA, however, has established a No Observed Effect Level (NOEL) of 23 parts per billion or 23 micrograms per liter for perchlorate, based on a daily oral exposure of 0.0007 milligram per kilogram per day for a 154-pound (70-kilogram) adult consuming 0.53 gallons (2 liters) of water per day. The EPA Drinking Water

Equivalent Level is 24.5 Micrograms per liter. The State of New Mexico has established an interim groundwater screening level of 1 part per billion or 1 microgram per liter. Between 2002 and 2005, 903 detectable sample measurements of perchlorate were made in groundwater samples at the environmental monitoring stations. A statistical analysis of these measurements is presented in **Table F–27**. Measured mean values of perchlorate at most LANL locations were below both the EPA NOEL and New Mexico screening limit. Only Mortandad and Pueblo Canyons exceeded the New Mexico limit, and only Mortandad Canyon exceeded the EPA NOEL (USACHPPM 2006, EPA 2006a, LANL 2006b, NAS 2005, NMAC 2006).

Hexavalent chromium, also known as chromium (VI), is one of three forms of the element chromium that occurs naturally, but can also be artificially produced. Hexavalent chromium is also a chemical of particular interest that is soluble in water and therefore has a high propensity to enter groundwater. Hexavalent chromium has been shown to damage or irritate the respiratory system and is identified by the EPA as a known carcinogen if inhaled in sufficient quantities. The EPA MCL for hexavalent chromium in drinking water is 100 micrograms per liter. The State of New Mexico has established a groundwater standard of 50 micrograms per liter for hexavalent chromium. Both the EPA and State of New Mexico hexavalent chromium water concentration limits are based on the measurement of filtered groundwater samples.

Table F–27 Statistical Analysis of Perchlorate in Groundwater (micrograms per liter)

Measured Radiochemical	*2002 to 2005*						
	Detected per ESR	*Used In This SWEIS*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Ancho Canyon	16	16	0.05	0.431	0.457	0.958	0.654
Guaje Canyon	32	32	0.05	0.623	0.552	1.45	0.814
Los Alamos	92	92	0.05	0.953	0.693	13.8	1.1
Mortandad Canyon	273	273	0.05	32.8	5.74	256	33.4
Pajarito Canyon	81	81	0.05	0.561	0.594	1.45	0.691
Pueblo Canyon	76	76	0.05	1.95	0.571	5.02	2.07
Sandia Canyon	63	63	0.05	0.642	0.471	2.17	0.759
Water Canyon	106	106	0.05	0.724	0.633	1.45	0.845
White Rock Canyon	164	164	0.05	0.751	0.762	12	0.868

ESR = Environmental Surveillance Reports, UCL = upper confidence limit.

Measured hexavalent chromium concentrations in groundwater samples in and around LANL were significantly higher for unfiltered water than for filtered water. This has been attributed to drilling equipment and well-casing materials, which are composed of steel compounds that contain hexavalent chromium and to the presence of chromium-bearing minerals in aquifer materials. Between 2001 and 2005, 1,020 detectable sample measurements of hexavalent chromium were made in groundwater at the environmental monitoring stations. A statistical analysis of these filtered sample measurements is presented in **Table F–28**. Measured mean values for hexavalent chromium at all LANL locations from 2001 through 2005 were below both the EPA MCL and the New Mexico standard (EPA 2006b, LANL 2006b, NMAC 2006).

Table F–28 Statistical Analysis of Hexavalent Chromium in Filtered Groundwater Samples (micrograms per liter)

Measured Radiochemical	*2001 to 2005*						
	Detected per ESR	*Used In This SWEIS*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Ancho Canyon	8	8	1	1.75	0.542	2.4	2.13
Guaje Canyon	0	0	–	–	–	–	–
Los Alamos	63	63	0.503	2.25	0.243	16.7	2.31
Mortandad Canyon	92	92	0.503	7.04	11.9	404	9.48
Pajarito Canyon	46	46	0.503	1.21	0.444	3.7	1.34
Pueblo Canyon	18	18	0.503	1.08	1.07	4.9	1.57
Sandia Canyon	8	8	1	13.1	9.18	21.2	19.4
Water Canyon	89	89	0.52	1.53	0.699	10.5	1.67
White Rock Canyon	82	82	0.503	2.86	0.338	5.01	2.93
San Ildefonso	0	0	–	–	–	–	–
Santa Fe	0	0	–	–	–	–	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit.

In 2005, chromium concentrations between 375 and 404 micrograms per liter were detected in Well R-28 in the regional aquifer below Mortandad Canyon. Additional sampling in 2006 indicated that chromium contamination was found in the regional aquifer in a limited area beneath Sandia and Mortandad Canyons and in perched groundwater beneath Mortandad Canyon. Chromium contamination was not detected in water supply wells. In recognition of these results, the LANL contractor has prepared an *Interim Measures Work Plan for Chromium Contamination in Groundwater* in 2006 (LANL 2006a). The goals of the Work Plan were to:

- Determine the primary sources of chromium contamination and the nature of operations associated with the releases;
- Characterize the present-day spatial distribution of chromium and related constituents;
- Collect data to evaluate the geochemical, physical, and hydrologic processes that govern chromium transport; and
- Collect and evaluate data to help guide subsequent investigations and remedy selection.

These activities were conducted and completed in the summer and fall of 2006 and the results were summarized in an interim measures investigation report to provide a basis for follow-on work (LANL 2006c). This report found that the main source of hexavalent chromium was chromium-treated cooling water from a TA-3 power plant at the head of Sandia Canyon during its operations between 1956 and 1972. Other sources of chromium were identified as past facility discharges into Mortandad Canyon and Los Alamos Canyon. Sampling data from one regional groundwater well in Sandia Canyon and one regional groundwater well in Mortandad Canyon contain clear evidence of LANL-derived chromium contamination. Additional data collection from other regional groundwater monitoring wells is needed to further assess the extent of LANL-derived chromium contamination. Recommendations included additional data collection on chromium and other chemicals for use in risk assessments and the selection of corrective action remedies.

PCBs are a family of 209 chlorinated hydrocarbon compounds that were produced in the U.S. until 1997. PCBs are chemicals of particular interest because they decompose slowly and can exist and cycle between air, water, and soil. PCBs were at one time used in flame retardants, inks, adhesives, dyes, paints, fluorescent lighting fixtures, electrical transformers, electrical capacitors, and other electrical equipment. PCBs have a strong affinity for airborne particles, sediments, and soil, but do not typically migrate to groundwater. PCBs also have the potential to accumulate in fish and animals. PCBs have been shown to cause skin conditions and damage the liver and have been identified by the EPA as a known carcinogen if inhaled or ingested in sufficient quantities. The EPA MCL for PCBs in drinking water is 0.5 micrograms per liter. The State of New Mexico has established a groundwater standard of 1 microgram per liter for PCBs.

Between 2004 and 2005, four detectable sample measurements of PCBs were made in groundwater at these stations. These measurements are presented in **Table F–29**. The PCB contamination was detected only once in each of four sampling stations; no PCBs were detected in any other groundwater samples collected from the four stations. These single occurrences may indicate that the samples in which PCBs were detected are not representative of the groundwater. Despite the detection of PCBs in stormwater runoff within the LANL site boundaries, available data show no discernible impacts on PCB concentrations in the Rio Grande. Three independent types of measures showed that PCB concentrations downstream of LANL to the Cochiti Reservoir were indistinguishable from concentrations upstream of LANL. Mean total PCB concentrations in fish from Abiquiu reservoir were statistically similar to mean total PCB concentrations in fish from the Cochiti Reservoir. The statistical similarity in PCBs upstream and downstream of LANL has also been shown for dissolved water concentrations. Additionally, sampling of Rio Grande surface water by the New Mexico Environment Department and LANL showed whole water concentrations of PCBs were similar upstream and downstream of LANL. These results indicated that there are other sources of PCBs in the Rio Grande. A preliminary analysis indicated that PCB concentrations greater than 0.1 nanogram per liter can be ascribed to background fallout levels of PCBs. This is within the magnitude of some values measured in the Rio Grande water column. Measured mean value of PCBs at LANL locations was below both the EPA MCL and the New Mexico standard (EPA 2006d, LANL 2006b, NMAC 2006).

Table F–29 Statistical Analysis of Polychlorinated Biphenyl in Groundwater (micrograms per liter)

Measured Radiochemical	*2004 to 2005*						
	Detected per ESR	*Used In This SWEIS*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Ancho Canyon	1	1	–	0.44	–	–	–
Los Alamos Canyon	2	2	0.059	0.061	–	0.063	–
White Rock Canyon	1	1	–	0.17	–	–	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit.

1,4-Dioxane, also known as diethylene oxide and glycol ethylene ether is the name of an industrial solvent used in paints, varnishes, lacquers, cleaning and detergent preparations. It is of particular interest because it mixes readily with water and migrates rapidly in soil. It does not degrade and can exist and cycle between air, water, and soil. 1,4-Dioxane has been shown to damage the liver and kidneys and has been identified by the EPA as a probable carcinogen if inhaled or ingested in sufficient quantities. There is no EPA MCL for 1,4-dioxane in drinking water; however, the EPA Region 6 cancer risk level of 1 in 100,000 for 1,4-dioxane is 61 micrograms per liter and is applicable to LANL groundwater measurements in accordance with the Consent Order. In 2005, a total of seven detectable sample measurements of 1,4-dioxane were made in groundwater at Mortandad Canyon stations. A statistical analysis of these measurements was collated and is presented in **Table F–30**. Measured mean values of 1,4-dioxane at these LANL locations were above the EPA 1 in 100,000 cancer risk level (EPA 2006c, HHS 2006, LANL 2006b, NMAC 2006).

Table F–30 Statistical Analysis of 1,4-Dioxane in Groundwater (micrograms per liter)

Measured Radiochemical	*2004 to 2005*						
	Detected per ESR	*Used In This SWEIS*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Mortandad Canyon	7	7	21.6	40.3	16.1	56.4	52.3

ESR = Environmental Surveillance Reports, UCL = upper confidence limit.

F.4 References

ANL (Argonne National Laboratory), 2005a, “Human Health Fact Sheet, Americium,” Environmental Science Division, Argonne, Illinois, August.

ANL (Argonne National Laboratory), 2005b, “Human Health Fact Sheet, Plutonium,” Environmental Science Division, Argonne, Illinois, August.

ANL (Argonne National Laboratory), 2005c, “Human Health Fact Sheet, Cesium,” Environmental Science Division, Argonne, Illinois, August.

ANL (Argonne National Laboratory), 2005d, “Human Health Fact Sheet, Strontium,” Environmental Science Division, Argonne, Illinois, August.

ANL (Argonne National Laboratory), 2005e, “Human Health Fact Sheet, Tritium (Hydrogen-3),” Environmental Science Division, Argonne, Illinois, August.

DOE (U.S. Department of Energy), 1999, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

EPA (U.S. Environmental Protection Agency), 2006a, “Integrated Risk Information System” *Perchlorate and Perchlorate Salts*, Office of Research and Development, National Center for Environmental Assessment, Washington, DC, (http://www.epa.gov/iris/subst/1007.htm), February 13.

EPA (U.S. Environmental Protection Agency), 2006b, “Integrated Risk Information System,” *Chromium (VI) (CASRN 18540-29-9)*, Office of Research and Development, National Center for Environmental Assessment, Washington, DC, (http://www.epa.gov/iris/subst/0144.htm), November 30.

EPA (U.S. Environmental Protection Agency), 2006c, “Integrated Risk Information System,” *1,4-Dioxane (CASRN 123-91-1),* Office of Research and Development, National Center for Environmental Assessment, Washington, DC, (http://www.epa.gov/iris/subst/0326.htm), November 30.

EPA (U.S. Environmental Protection Agency), 2006d, “Integrated Risk Information System,” *Polychlorinated biphenyls (PCBs) (CASRN 1336-36-3)*, Office of Research and Development, National Center for Environmental Assessment, Washington, DC, (http://www.epa.gov/iris/subst/0294.htm), November 30.

HHS (U.S. Department of Health and Human Services), 2006, *Toxicological Profile for 1,4-Dioxane*, Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine/Toxicology Branch, Atlanta, Georgia, July.

LANL (Los Alamos National Laboratory), 2001, *Derivation and Use of Radionuclide Screening Action Levels*, LA-UR-01-990, Environmental Restoration Project, Los Alamos, New Mexico, March 29.

LANL (Los Alamos National Laboratory), 2002, *Environmental Surveillance at Los Alamos during 2001*, LA-13979-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004a, *Environmental Surveillance at Los Alamos during 2002*, LA-14085-ENV, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2004b, *Environmental Surveillance at Los Alamos during 2003*, LA-14162-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005, *Environmental Surveillance at Los Alamos during 2004*, LA-14239-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006a, *Interim Measures Work Plan for Chromium Contamination in Groundwater*, LA-UR-06-1961, Environmental Stewardship Division, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2006b, *Environmental Surveillance at Los Alamos during 2005*, LA-14304-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006c, *Interim Measures Investigation Report for Chromium Contamination in Groundwater*, LA-UR-06-8372, Los Alamos, New Mexico, November.

NAS (National Academy of Sciences), 2005, "Report Assesses Health Implications of Perchlorate Exposure," Available at http://www4.nationalacademies.org/news.nsf/isbn/0309095689?OpenDocument, January 10.

NMAC (New Mexico Administrative Code), 2006, "Title 20 Environmental Protection, Chapter 6 Water Quality, Part 2 Ground and Surface Water Protection," Water Quality Control Commission, November 8.

USACHPPM (U.S. Army Center for Health Promotion and Preventive Medicine), 2006, "Perchlorate in Drinking Water," Publication No. 31-003-0502, *Readiness thru Health*, Aberdeen Proving Ground, Maryland, Available at http://chppm-www.apgea.army.mil/dwater, February 13.

APPENDIX G

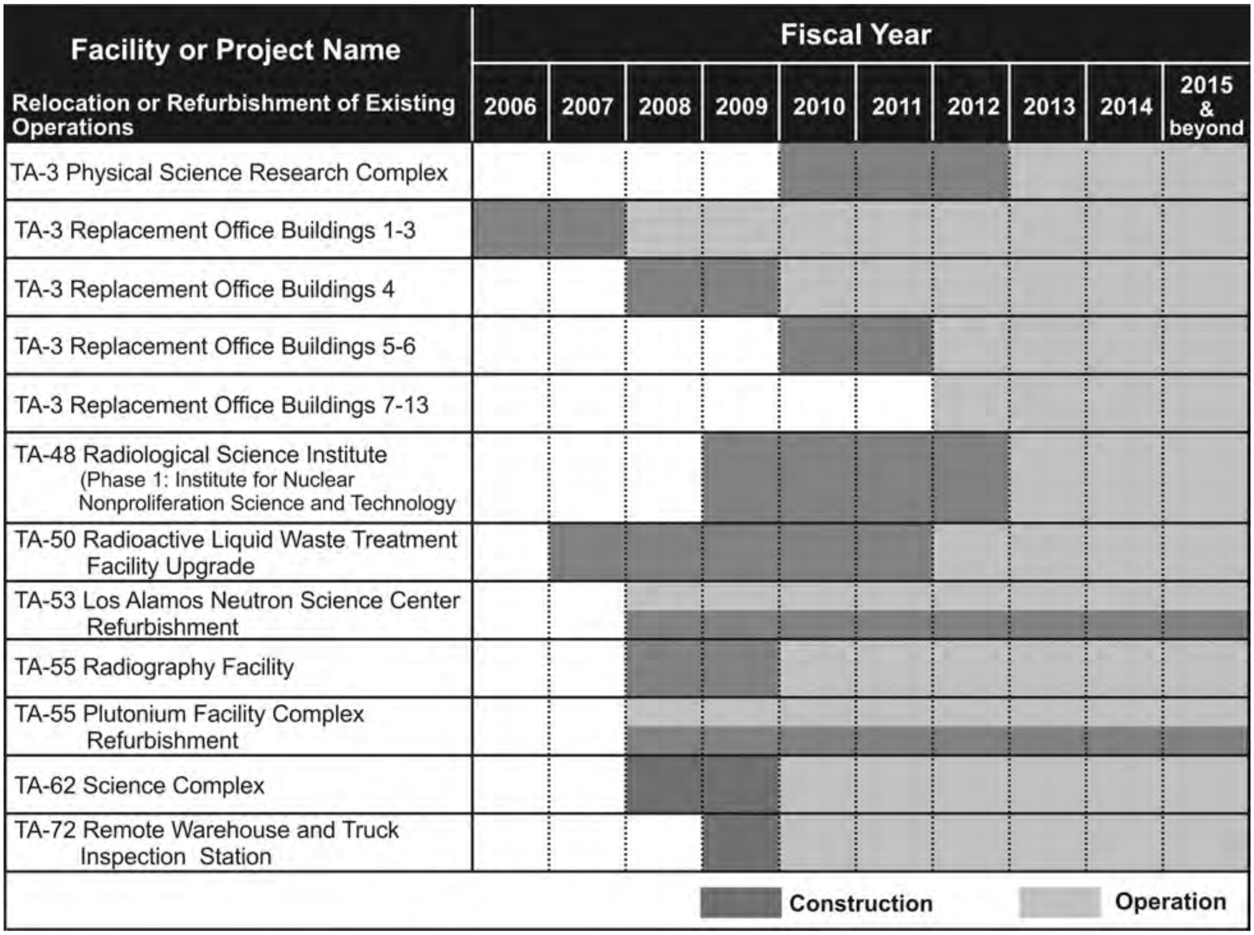
IMPACTS ANALYSES OF PROJECTS TO MAINTAIN EXISTING LOS ALAMOS NATIONAL LABORATORY OPERATIONS AND CAPABILITIES

APPENDIX G
IMPACTS ANALYSES OF PROJECTS TO MAINTAIN EXISTING LOS ALAMOS NATIONAL LABORATORY OPERATIONS AND CAPABILITIES

The projects discussed in this appendix are elements of the Expanded Operations Alternative as described in Chapter 3 of this *Final Site-Wide Environmental Impact Statement for the Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (SWEIS). The Expanded Operations Alternative reflects proposals that would expand the overall operations level at Los Alamos National Laboratory (LANL) above those established for the No Action Alternative. Additionally, the Expanded Operations Alternative includes a number of new projects whose purpose is not to expand the operations level, but to update existing facilities or provide new buildings in which to continue existing operations and capabilities. In some cases, the projects to maintain existing operations and capabilities have the potential to impact land use at LANL. However, not all new projects would affect land use, as many would involve actions within or modifications to existing structures or construction of new facilities within previously developed areas of LANL. This appendix presents the project-specific analyses for nine proposed construction or refurbishment projects that would be implemented or for which implementation decisions are needed within the timeframe under consideration in this SWEIS.

- Technical Area 3 (TA-3) Physical Science Research Complex (formerly the Center for Weapons Physics Research) (Section G.1)
- TA-3 Replacement Office Buildings (Section G.2)
- TA-48 Radiological Sciences Institute, including Phase I – The Institute for Nuclear Nonproliferation Science and Technology (Section G.3)
- TA-50 Radioactive Liquid Waste Treatment Facility Upgrade (Section G.4)
- TA-53 Los Alamos Neutron Science Center (LANSCE) Refurbishment (Section G.5)
- TA-55 Radiography Facility (Section G.6)
- TA-55 Plutonium Facility Complex Refurbishment (Section G.7)
- TA-62 (TA-3) Science Complex (Section G.8)
- TA-72 Remote Warehouse and Truck Inspection Station (Section G.9)

Collectively, the nine projects presented in this appendix represent one component of the National Nuclear Security Administration's (NNSA's) ongoing effort to replace much of the older workspace and physical infrastructure at LANL with corresponding modern equivalents, consolidate certain operations, and eliminate underutilized and redundant structures and buildings. To support this effort, NNSA has identified distinct areas to be addressed to ensure infrastructure sustainability. These include initiatives to reduce structure footprints and operating costs, and to improve safety, security, environmental protection, scientific interactions, and productivity. The proposed timeframes associated with construction or refurbishment and operation of the proposed facilities are depicted in **Figure G–1**.



Facility or Project Name	Fiscal Year									
Relocation or Refurbishment of Existing Operations	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015 & beyond
TA-3 Physical Science Research Complex					▓	▓	▓	░	░	░
TA-3 Replacement Office Buildings 1-3	▓	▓	░	░	░	░	░	░	░	░
TA-3 Replacement Office Buildings 4			▓	▓	░	░	░	░	░	░
TA-3 Replacement Office Buildings 5-6					▓	▓	░	░	░	░
TA-3 Replacement Office Buildings 7-13							░	░	░	░
TA-48 Radiological Science Institute (Phase 1: Institute for Nuclear Nonproliferation Science and Technology				▓	▓	▓	▓	░	░	░
TA-50 Radioactive Liquid Waste Treatment Facility Upgrade		▓	▓	▓	▓	▓	░	░	░	░
TA-53 Los Alamos Neutron Science Center Refurbishment			░ ▓	░ ▓	░ ▓	░ ▓	░ ▓	░ ▓	░ ▓	░ ▓
TA-55 Radiography Facility			▓	▓	░	░	░	░	░	░
TA-55 Plutonium Facility Complex Refurbishment			░ ▓	░ ▓	░ ▓	░ ▓	░ ▓	░ ▓	░ ▓	░ ▓
TA-62 Science Complex			▓	▓	░	░	░	░	░	░
TA-72 Remote Warehouse and Truck Inspection Station				▓	░	░	░	░	░	░

▓ Construction ░ Operation

Figure G–1 Proposed Timeframes for Construction and Operation of Projects to Maintain Existing Los Alamos National Laboratory Operations and Capabilities

The projects included in this appendix are categorized into two broad groups: (1) those that would relocate existing operations to a completely new facility, with the former facility(ies) undergoing decontamination, decommissioning, and demolition (DD&D); and (2) those that would renovate or refurbish an existing facility to prolong its capabilities and bring it up to current standards. In keeping with congressional "one for one" space requirements, all proposed new building construction projects discussed in this appendix also include the DD&D of a comparable amount of space in older buildings or transportable structures that are no longer needed or that are unsuitable for future use. Standard construction practices applicable to all construction projects at LANL are described in the text box on the following page. The general process for DD&D of the structures is described in Appendix H.

Detailed project-specific work plans for DD&D of the structures would be developed and approved by NNSA before any actual work began. The plans would include those required for environmental compliance (such as stormwater pollution prevention plans) and monitoring activities (such as using real-time radiation monitors); all necessary legal and regulatory requirements in effect at the time would be undertaken before any DD&D activities were conducted.

Construction Work Elements

Design and Operation Standards: All new structures at LANL would be designed and constructed in compliance with applicable DOE Orders, requirements, and governing standards that have been established to protect public and worker health and the environment. DOE Order 420.1B (DOE 2005) requires that nuclear and nonnuclear facilities be designed, constructed, and operated so that the public, workers, and environment are protected from adverse impacts of natural phenomena hazards, including earthquakes. DOE Standard 1020-2002 (DOE 2002a) implements DOE Order 420.1B and provides criteria for the design of new structures, systems, and components and for evaluation, modification, or upgrade of existing structures, systems, and components so that DOE facilities safely withstand the effects of natural phenomena hazards, such as earthquakes. The criteria specifically reflect adoption of the seismic design and construction provisions of the International Building Code for DOE Performance Category 1 and 2 facilities. Prior to construction of any new facilities, an estimate of the seismic hazard at the proposed site would be conducted using the most current seismic information. The new facilities would also be designed to meet safety and engineering criteria specified in the *LANL Engineering Standards Manual*, OST220-03-01-ESM (LANL 2004b), and would meet current code requirements for electrical, plumbing, fire protection, and other utilities.

Facilities would be constructed according to Leadership in Energy and Environmental Design (LEED) standards (USGBC 2006). LEED for New Construction and Major Renovations is a green building rating system designed to guide and distinguish high-performance commercial and institutional projects, with a focus on office buildings. The standards used for new LANL buildings would increase energy use efficiency and probably achieve net reductions in energy use. LEED emphasizes state-of-the-art strategies for sustainable site development, water savings, energy efficiency, material selection, and indoor environmental quality. Under LEED standards, older, less-efficient buildings would be removed, and, in general, their former locations would be used for parking and open space.

Construction Safety and Health Plan: The work would be planned, managed, and performed to ensure that standard worker safety goals are met and that work would be performed in accordance with good management practices, regulations promulgated by the Occupational Safety and Health Administration, and LANL resource management plans. To prevent serious injuries, all site workers (including contractors, subcontractors, lessees and permit or easement holders or their contractors and subcontractors) would be required to submit and adhere to an approved construction safety and health plan.

Environmental Management: NNSA's goal for the construction of new facilities is to retain as much of the natural setting, vegetation, and overall environmental integrity of the site as practical. The site surrounding new buildings and parking would be professionally landscaped within the guidelines of the LANL Site and Architectural Design Principles (LANL 2002a) and LANL Sustainable Design Guide (LANL 2002b). Disturbance and removal of vegetation at the construction site would be limited to those areas necessary to accommodate building, roadway, parking, parking structure footprint, and work areas. Total tree removal would be allowed within only 50 feet (15 meters) of building footprints and 5 feet (1.5 meters) of parking and roadways. Trees greater than 10 inches (25.4 centimeters) in diameter measured 4.5 feet (1.35 meters) from the ground surface would not normally be cut and removed from areas with a slope less than 20 degrees at distances greater than 20 feet (6 meters) from building footprints or 10 feet (3 meters) from parking lots and roadways. No tree cutting or other disturbance would occur in areas with greater than 20 percent slope, except as periodically needed for wildland fire management purposes. Wildfire management planning is currently being developed in the *Los Alamos National Laboratory Wildland Fire Management Plan*, LA-UR-05-0286 (LANL 2005d). Management activities, such as tree thinning, could be put into effect at the proposed facilities. Tree thinning procedures would include incorporation of best management practices to prevent soil erosion and use of manual timber cutting on the steep slopes rather than mechanical methods.

National Pollutant Discharge Elimination System: No construction would be conducted within floodplains or wetlands. As appropriate, engineered best management practices for each building, parking structure, or roadway site would be implemented as part of a site stormwater pollution prevention plan executed under a National Pollutant Discharge Elimination System construction permit. Best management practices may include the use of hay bales, straw wattles, and silt fences. Prior to construction, topsoil from the site would be removed and stockpiled for later use in land restoration efforts at either this site or other sites. Soil stockpiles would be seeded and protected with silt fences to prevent erosion and impact on nearby drainages. Following construction, areas surrounding the buildings would be restored to enhance site drainage and stormwater capture for passive irrigation of landscaping. Recontoured areas would then be reseeded with a native grass mix to stabilize the site and planted with landscape vegetation closer to the buildings. Permanent site engineered controls for stormwater runoff may include stormwater retention ponds, curbing, permeable asphalt, or use of timber or stone as riprap to slow waterflow runoff. Vehicle fueling would not occur within drainages or floodplain areas.

Excavation and Dust Suppression: Dozers, backhoes, or graders may be used to remove tree stumps and rocks and to smooth the surface. Clearing or excavation activities during site construction would have the potential to generate dust. Standard dust suppression methods (such as water spraying or soil tackifiers) would be used to minimize dust generation during construction activities.

Cultural resources: If cultural remains were encountered during construction, activities would cease until their significance was determined and appropriate subsequent actions taken.

Ultimate disposition of the facilities constructed by the projects in this appendix would be considered at the end of their operations, usually several decades after construction. Facilities that would support missions involving radioactive and hazardous materials are required to be designed with consideration of the entire lifecycle of the facilities; this includes incorporating features into the design that would facilitate eventual facility DD&D. The impacts from the eventual disposition of the newly constructed facilities would be similar to or less than the impacts from the disposition of the facilities that they replace.

Purpose and Need

LANL's primary mission is to support national security. Nuclear technology and the associated radiological facilities at LANL are vital to this mission. The mission includes programs such as defense nuclear nonproliferation, emergency operations, domestic safeguards, and corresponding training operations and encompasses activities related to nuclear weapons, nuclear nonproliferation and arms control, homeland security, nuclear energy, radioactive waste management, environmental management, nuclear regulation, health and safety, nuclear medicine, and advanced materials science.

LANL has consistently applied state-of-the-art basic and applied scientific research in solving complex problems of national importance. The same attention to the state of infrastructure and facilities has not kept pace over the years. As a result, LANL's infrastructure is deteriorating to the point of jeopardizing its long-term ability to fulfill its stockpile stewardship mission. Many of the current structures in use at LANL are from 20 to 50 years old. A large percentage of the LANL workforce is located in facilities that are in marginal condition and frequently overcrowded. Buildings and structures built and occupied at LANL since the late 1940s are often incorrectly sized to effectively accommodate modern operations. The demands on the services, utilities, and communications were not anticipated when the buildings were designed. Current activities are conducted in scattered, old structures, many of which are obsolete and increasingly expensive to operate. Today, LANL has the oldest facilities and the greatest number of old facilities among the three national security laboratories and the Nevada Test Site. Approximately half of LANL's facilities are in poor or fair condition.

The liability and cost of aging infrastructure is an escalating problem throughout the U.S. Department of Energy (DOE) complex. Because the cost of operations and maintenance for aging LANL facilities is significant and growing, leaving this problem unaddressed would impact LANL's ability to carry out NNSA's stockpile stewardship mission. In the past, preventive facility maintenance has been deferred for higher priorities. The current DOE budgeting process allocates 5 to 8 percent less for infrastructure and repair than the industrial average. Over time, this practice has resulted in a backlog of repairs that threatens to overtake LANL's ability to effectively address these problems while pursuing research activities critical to NNSA's Defense Program mission. The majority of LANL facilities are reaching the end of their useful lives and would require major upgrade investments to meet future mission needs and ensure the health and safety of LANL employees. Even after such investment in upgrading aging facilities, the functionality of these buildings would remain marginal. These buildings and structures were neither built to current structural (including seismic), health, safety, and security standards, nor can they be easily or economically retrofitted to meet these standards or to accommodate present day office electronics, communications equipment, or heating and cooling systems. If these buildings are not replaced, they would eventually need to be shut down for safety reasons, and their missions would be compromised.

Employee safety would be improved by providing modern, well-designed workspaces. Current structures are poorly suited to today's demanding security needs. Many safety controls can be deployed by only new building design and construction. In addition, NNSA's purpose is to: (1) improve the quality of the facilities to carry out current and future anticipated research programs in support of NNSA's missions, (2) decrease and control operational and maintenance costs for LANL facilities, and (3) consolidate peer groups that need to interact frequently and provide a working environment that encourages collaboration, creative innovation, and efficiency.

Three of the projects proposed in this appendix are part of a TA-3 Revitalization Plan, which specifically addresses changes to one of LANL's most populated TAs; these include the Physical Science Research Complex in TA-3, construction and operation of Replacement Office Buildings in TA-3, and the Remote Warehouse and Truck Inspection Station in TA-72. Other projects address consolidation of LANL radiochemistry and nuclear nonproliferation capabilities in a new complex at TA-48, replacement of radioactive liquid waste treatment capabilities at TA-50, refurbishment of the LANSCE at TA-53, relocation of nondestructive examinations into a radiography facility at TA-55, refurbishment of the Plutonium Facility Complex in TA-55, and construction of a new Science Complex in either TA-62 or TA-3. Additional discussion of the purpose and need for the Radioactive Liquid Waste Treatment Facility Upgrade Project, TA-55 Radiography Facility Project, and Remote Warehouse and Truck Inspection Station Project are described below. The remaining projects are encompassed by the general purpose and need discussion above.

Purpose and Need for the Radioactive Liquid Waste Treatment Facility Upgrade Project

NNSA needs to provide reliable means for treating LANL-generated radioactive liquid wastes in compliance with DOE and other applicable regulatory requirements. Capability is needed for the treatment of liquid low-level radioactive waste, acidic transuranic waste, caustic transuranic waste, and small amounts of industrial wastewater that are generated in support of mission-critical and other work performed at LANL. Specifically, the ability to manage radioactive liquid waste is necessary for the continued performance of Stockpile Stewardship Program work in the Plutonium Complex and the Chemistry and Metallurgy Research Building. The current facility is over 40 years old and has liquid effluent discharges and air emissions resulting from liquid waste treatment that must meet current regulatory requirements. NNSA needs to provide for the ability to modify or expand treatment components as necessary to meet future regulatory requirements that may be more stringent than those currently in effect.

Purpose and Need for the Technical Area 55 Radiography Facility Project

Examination of nuclear items and components through radiography is a key process in U.S. nuclear weapons stockpile safety and reliability verification. Use of high-energy radiography capability formerly located at TA-8 required nuclear items and components to be temporarily moved out of TA-55 where the items and components are fabricated and stored. Transportation and examination at TA-8 required significant security resources. Movement of these nuclear items and components has become difficult. In addition, TA-8 facilities require extensive renovations to meet current requirements for a nuclear facility. High-energy radiography capability for nuclear materials is limited, affecting mission milestones and deadlines. NNSA needs to provide a more efficient high-energy radiography capability that eliminates the need for transporting nuclear items and components outside the security perimeter of TA-55.

Purpose and Need for the Remote Warehouse and Truck Station

The current warehouse facility is over 50 years old and has become cramped as LANL and NNSA have increased materials holding time requirements for materials in order to meet quality control inspection and chain-of-custody protocols. Additionally, LANL programs and activities have been expanding, resulting in increases in the amount of material processed at the current TA-3 warehouse facility. The current TA-3 warehouse facility is not properly equipped or constructed to meet current security requirements, including the need to segregate incoming vendor vehicles from government warehouse vehicles. Furthermore, the current location of the TA-3 warehouse facility requires offsite vehicles to travel through the densely populated TA-3 areas.

Overview of Projects

A brief introduction to each project is presented below, with detailed analysis of the environmental impacts associated with each project presented in the following sections. Chapter 4 of this SWEIS provides a detailed description of the affected environment at LANL. Therefore, the affected environment discussion is minimal in this appendix unless unique characteristics of the project or project area require further discussion.

Physical Science Research Complex (Technical Area 3)

Approximately 750 scientists from various divisions and disciplines located across LANL would be consolidated and collocated in this new facility, which would facilitate the science required for nuclear weapons stockpile stewardship and certification. The Physical Science Research Complex would be constructed in a developed area of TA-3 that currently has several existing structures in it; these structures would be demolished to accommodate the new facility.

Replacement Office Buildings (Technical Area 3)

The TA-3 Replacement Office Buildings would consolidate staff currently located in temporary structures or aging permanent buildings throughout TA-3 or from other parts of LANL. The complex would consist of 12 new buildings and related parking infrastructure. The replacement offices would include a Los Alamos Site Office Building. The number of staff housed in the overall Replacement Office Buildings would total approximately 900.

Radiological Sciences Institute, including Phase I – The Institute for Nuclear Nonproliferation Science and Technology (Technical Area 48)

NNSA proposes to build a new consolidated and integrated Radiological Sciences Institute. This project would serve two purposes: (1) modernization of LANL radiochemistry capabilities, and

(2) assumption of capabilities that could potentially be lost from LANL due to changes in other facilities (such as hot cell capabilities from the Chemistry and Metallurgy Research Building). The new institute would be constructed over 20 years, in a phased approach. Construction of the first phase, the Institute for Nuclear Nonproliferation for Science and Technology, is proposed to begin during the timeframe analyzed in this SWEIS. The Institute for Nuclear Nonproliferation Science and Technology would ultimately include a Security Category I and II training facility with a Security Category I vault, several Security Category III and IV laboratories, a field security test laboratory, a secure radiochemistry facility, and associated office support facilities. Further, Security Category III and IV material and capabilities from TA-18 that would remain at LANL would be relocated to the Institute for Nuclear Nonproliferation Science and Technology.

Radioactive Liquid Waste Treatment Facility Upgrade (Technical Area 50)

NNSA proposes to construct a new treatment facility adjacent to the existing Radioactive Liquid Waste Treatment Facility to ensure that LANL can maintain the capability to treat radioactive liquid waste safely, reliably, and effectively for the next 50 years with normal maintenance. The main building of the existing Radioactive Liquid Waste Treatment Facility would be retained; the three annexes that do not meet current seismic or wind-loading standards would undergo DD&D. The new structure would house equipment for treating liquid low-level radioactive waste and liquid transuranic waste and would provide flexibility to accommodate new technology that may be required in the upcoming years to meet more stringent discharge standards.

Los Alamos Neutron Science Center Refurbishment (Technical Area 53)

Since the LANSCE linear accelerator first accelerated protons in 1972, the facility mission has evolved considerably. However, investment in the physical infrastructure and technology has not been adequate to ensure long-term sustainable operation at high reliability. The LANSCE Refurbishment Project proposes to sustain reliable facility operations well into the next decade. The LANSCE Refurbishment Project would address the following priorities: (1) replacing facility equipment where necessary to address code compliance or end-of life issues that could severely impact facility operations; (2) enhancing cost-effectiveness by system refurbishments or improvements that stabilize decreasing facility reliability and maintainability; (3) stabilizing the overall beam availability and reliability in a manner that is sustainable over the longer term; and (4) accomplishing the above with minimal disruption to scheduled user programs.

Radiography Facility (Technical Area 55)

This project would enhance the safety and ease the logistics of LANL's stockpile management procedures. Nondestructive examinations using dye penetrant testing, ultrasonic testing, and x-ray radiography of nuclear items and weapons components are necessary elements of LANL's mission for stockpile management. Many steps of this process occur in TA-55, but final radiography was performed in TA-8. This required that the nuclear components and items be shipped between TA-55 and TA-8, a distance of 4.5 miles (7.2 kilometers), for this single step of the examination process. A rolling roadblock was required when the materials were transported, and a temporary material accountability area needed to be set up in TA-8 while the nondestructive examination procedures took place. These steps required significant security resources, making the process expensive, logistically difficult, and inefficient. NNSA proposes to construct a new high-energy nondestructive examination facility at TA-55 to eliminate the need for transporting these nuclear items to different locations at LANL during the examination process.

Plutonium Facility Complex Refurbishment (Technical Area 55)

The TA-55 Plutonium Facility Complex was constructed in the mid-1970s and has been in operation for approximately 30 years. Although systems in this complex function as designed, many are near the end of their design lives and have become increasingly difficult and expensive to maintain. NNSA has determined that an investment is needed in the near term to upgrade electrical, mechanical, safety, and other selected facility-related systems that are approaching the end of life. The proposed project comprises a number of subprojects considered for execution within the timeframe analyzed in this SWEIS.

Technical Area 62 (Technical Area 3) Science Complex

The Science Complex would consist of two buildings and one supporting parking structure that would be constructed in TA-3 or north of TA-3 in TA-62. This new complex would provide approximately 400,200 square feet (37,180 square meters) of office and light laboratory space in support of basic and applied scientific research and technology. One of the buildings would provide facilities for many of the bioscience activities currently conducted in the former Health Research Laboratory, now known as the Bioscience Facilities, located adjacent to the Los Alamos townsite.

Technical Area 72 Remote Warehouse and Truck Inspection Station

The current warehouse located at TA-3 provides centralized shipping, receiving, distribution, packaging, and transportation compliance and mail services for all LANL organizations. The facility is over 50 years old and has become cramped as LANL and NNSA have increased materials holding time requirements for purposes of quality control inspection and chain-of-custody protocols. The facility does not meet current security requirements. NNSA proposes construction of a consolidated warehouse facility and truck inspection complex in TA-72 to replace the current warehouse facility and LANL’s temporary truck inspection station.

G.1 Physical Science Research Complex Construction and Operation Impact Assessment

This section provides an impact assessment for the construction and operation of a Physical Science Research Complex in TA-3 at LANL. Section G.1.1 provides background information on the construction project and a physical description of the Physical Science Research Complex. Section G.1.2 provides a description of the proposed project to construct and operate a Physical Science Research Complex in TA-3. Section G.1.3 provides an analysis of environmental consequences of the proposed project and the No Action Alternative.

G.1.1 Introduction

Over the past 3 years, a detailed analysis of the cost of operating and maintaining LANL facilities and a prioritization system to fund facilities and infrastructure upgrades have been developed. NNSA has been evaluating and implementing methods to reduce facility costs and has identified distinct areas that must be addressed to ensure future infrastructure sustainability. These areas include facility consolidation and cost reduction initiatives to reduce facility footprints and operating costs, as well as the improvement of safety, security, environmental protection, scientific interactions, and productivity. A TA-3 Revitalization Plan has been developed to address the upgrade of LANL's most populated area. The proposed construction and operation of the Physical Science Research Complex in TA-3 is one such consolidation and strategic planning effort being considered at LANL.

Theoretical and computational weapons physics research requires the use of delicate equipment and highly sensitive computers in carefully regulated laboratory environments. However, many such activities at LANL are currently conducted in scattered, 20- to 50-year-old facilities, many of which are obsolete and increasingly expensive to operate. The lack of adequate building infrastructure has resulted in experiments being conducted in spaces never intended to serve as laboratories. The space that has been made available to conduct this research is spread across TA-3, TA-35, and TA-53, rather than being consolidated in a single facility resulting in inefficiencies among the staff. Recent and ongoing construction actions have been undertaken to correct these deficiencies and address the modernization of several such facilities in TA-3, including the Nonproliferation and International Security Center, the Nicholas C. Metropolis Center for Simulation and Modeling, and the National Security Science Building. The Physical Science Research Complex would complete the theoretical and computational research core in TA-3. The project would consolidate and relocate critical operations necessary for continued support of the stockpile stewardship mission. The proposed Physical Science Research Complex would be located in TA-3, just west of the Nonproliferation and International Security Center.

G.1.2 Options Considered

The two options identified for the Physical Science Research Complex are the No Action Option and the proposed project option.

G.1.2.1 No Action Option

Under the No Action Option, LANL stockpile stewardship mission staff would continue to operate at current levels at existing geographically dispersed facilities at TA-3, TA-35, and TA-53. Corrective maintenance and actions would continue to be performed as facility infrastructure failures occur. Staff consolidation in a state-of-the-art research center would not occur, nor would the proposed DD&D of vacated older buildings and structures.

G.1.2.2 Proposed Project

The proposed project is the construction and operation of a new Physical Science Research Complex in a currently developed area of TA-3 (see **Figure G–2**). The Physical Science Research Complex would provide a new, modern facility and would consolidate staff currently located throughout TA-3, in TA-35, and in TA-53 in temporary structures or aging permanent buildings in failing and poor condition. Approximately 750 upper-level management, technical, and administrative staff whose work directly supports the Stockpile Stewardship Program would be consolidated in this facility. Currently, these individuals are located in outdated buildings or transportables (office trailers) in TA-3, TA-35, and TA-53 (LANL 2006a). The Physical Science

Research Complex would consist of up to four buildings, providing approximately 350,000 square feet (32,500 square meters) of space to house offices, light laboratories, computer rooms, analytical facilities, and support and common areas. Each building would be four stories tall; three of the four buildings would be designated as classified buildings and require security controls and fencing (LANL 2006a). In total, the facility would have a combined footprint of approximately 128,000 square feet (11,900 square meters). Approximately 30 percent of the total floor space would be composed of light-to-medium experimental laboratories, consisting primarily of laser laboratories (LANL 2006a). The Physical Science Research Complex would be sited south of the National Security Science Building where the Administration Building parking lot, guard station, Integrated Management Building and associated transportables, and part of the Administration Building A wing are located today.

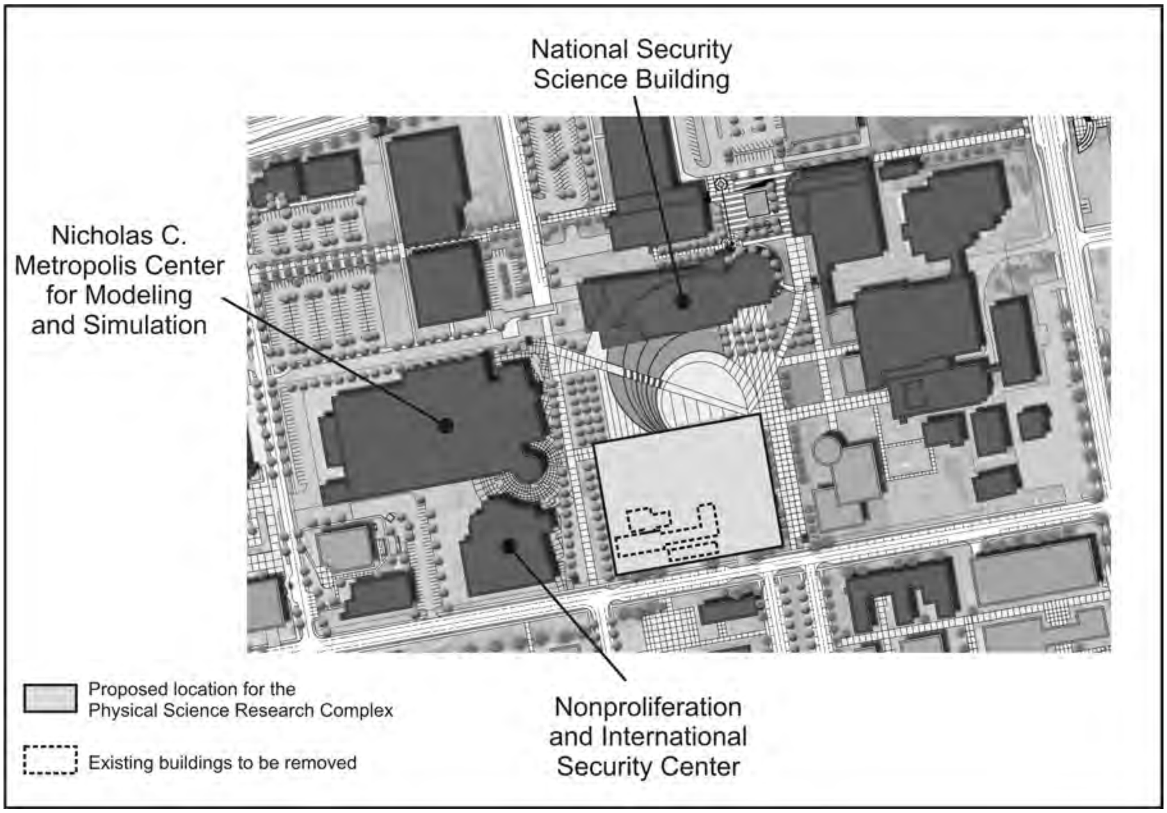


Figure G–2 Proposed Location for the Physical Science Research Complex

The light laboratories would have an efficient heating, ventilating, and air conditioning system with an ability to control temperature within 2 to 3 degrees; specialized flooring to limit vibration; extensive electrical grounding; and pressurized air, helium, and nitrogen gas available for use. No wet chemistry is expected to be conducted in the Physical Science Research Complex. The complex would include a clean room and vault space for classified weapons designers and would require a substantial amount of electricity (LANL 2006a). Common areas would include three auditoriums of different sizes, various-sized conference rooms, a 20,000-square-foot (1,900-square-meter) computer room with access floor, a computer equipment room, a vault-type room for offices, a computer machine room, a kitchen, and equipment storage rooms (LANL 2006a).

As shown in Figure G–2, construction and operation of the Physical Science Research Complex would occur at a location in TA-3 that includes approximately 74,000 square feet (6,900 square meters) of existing structures. These structures (TA-03-0028, -0142, -0510, -1559, -1566, and 1663) would undergo DD&D to accommodate construction of the proposed new facility. Once constructed, the Physical Science Research Complex would also house staff and capabilities from approximately 22 other LANL structures. In total, about 30 buildings and structures located across TA-3, TA-35, and TA-53 comprising about 867,000 square feet (80,550 square meters) would be removed under the proposed project. Physical Science Research Complex construction is scheduled to begin in 2010 and take approximately 2 years to complete. The associated DD&D of buildings within the proposed footprint of the Physical Science Research Complex would occur at the beginning of this timeframe, with subsequent DD&D of other buildings in TA-3, TA-35, and TA-53 occurring after their respective staff have relocated to the Physical Science Research Complex. At this time, project-specific work plans have not been prepared that would define the actual methods, timing, or workforce to be used for DD&D of these structures. Typical processes and methods for DD&D as discussed in Appendix H would be used for this proposed project.

G.1.3 Affected Environment and Environmental Consequences

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Land Resources* – The proposed site is in an already-developed area of TA-3 and the proposed land use is consistent with land use plans. Only the visual environment is included in the impacts discussion.

- *Water Resources* – The proposed site is located in an already-developed area of TA-3, and operations would not result in new discharges.

- *Ecological Resource*s – The proposed project is located in an already-developed area of TA-3; in general, wildlife is expected only around the periphery of TA-3.

- *Socioeconomics and Infrastructure* – No new employment is expected. Construction and DD&D workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.

- *Environmental Justice* – The proposed project is confined to an already-developed area of TA-3, with no disproportionate human health impacts to low-income or minority populations expected.

- *Facility Accidents* – The proposed project would not implement new activities associated with radiological materials; only industrial accidents may occur.

This impact assessment focuses on those areas of the affected environment where potential impacts would occur: visual environment, geology and soils, air quality and noise, human health, cultural resources, site infrastructure, waste management, and transportation.

G.1.3.1 No Action Option

Under the No Action Option, NNSA would not construct the Physical Science Research Complex at TA-3 and LANL stockpile stewardship mission staff would continue to occupy existing structures spread among three TAs at the site. Benefits that would result from consolidating personnel in a modern facility would not occur. Outdated structures and temporary buildings that presently accommodate personnel would continue to contribute adversely to the visual character of TA-3 and other areas. Benefits in the areas of resource efficiency and conservation that would be realized by vacating currently occupied energy-inefficient structures would not take place. Expenses for repairs and replacement of aging heating, ventilation, and air conditioning systems and other building components would increase. As building systems and other components fail and cannot be replaced or repaired, affected buildings would be partially or completely closed and the staff relocated. No disturbance of existing TA-3 land or building sites would occur. The proposed vacating and DD&D of outdated facilities and temporary buildings would not occur, and no construction or DD&D waste requiring disposal would be generated.

G.1.3.2 Proposed Project

Land Resources—Visual Environment

Construction Impacts—Impacts on visual resources resulting from construction of the Physical Science Research Complex would be temporary in nature and could include increased levels of dust from heavy equipment.

Operations Impacts—The existing buildings are part of the "dense mixed development" within TA-3 that constitutes an adverse visual impact because it contains unusually discordant structures (NNSA 2001). The proposed Physical Science Research Complex would be visually compatible with nearby office and computing structures and would enhance the overall architectural character of the Core Development Area.

DD&D Impacts—Impacts on visual resources resulting from DD&D of vacated buildings under the proposed project would be temporary in nature and could include increased levels of dust from heavy equipment. Once these activities are completed, the general appearance of TA-3, TA-35, and TA-53 should benefit from the removal of outdated and vacated structures.

Geology and Soils

The site for the Physical Science Research Complex lies within a part of the Pajarito Fault system characterized by subsidiary or distributed fault ruptures; two small, closely spaced faults are located below TA-3. The annual probability of surface rupture in areas beyond the principal or main trace of the Pajarito Fault, such as at the Physical Science Research Complex site, is less than 1 in 10,000 (LANL 2004c). To account for seismic risk, the Physical Science Research Complex would be designed and constructed in accordance with current DOE seismic standards and applicable building codes.

Construction Impacts—Approximately 499,000 cubic yards (381,000 cubic meters) of soil would be disturbed during building excavation within areas already disturbed by previous facility construction; there would be no impact on undisturbed LANL soils. Construction of the new buildings would require removal of soils as well as new excavation of shallow bedrock in some areas. As a result, construction and DD&D activities would generate excess soil and excavated bedrock that may be suitable for use as backfill. This uncontaminated backfill material would be stockpiled at an approved material management area at LANL for future use. Best management practices would be implemented to prevent erosion and migration of disturbed materials from the site caused by stormwater or other water discharges or wind.

DD&D Impacts—DD&D activities associated with existing facilities would have a negligible additional impact on geologic and soil resources at LANL, as the affected facility areas are developed and adjacent soils are already disturbed. Additional ground disturbance would be necessary to establish laydown yards and waste management areas in the vicinity of the facilities to be razed. Available paved surfaces, such as parking lots in the vicinity of the facilities to be demolished, would be used to the extent possible.

The major indirect impact on geologic and soil resources at the DD&D locations would be associated with the need to excavate any contaminated tuff and soil from beneath and around facility foundations. Borrow material (such as crushed tuff and soil) would be required to fill the excavations to grade, but such resources would be available from onsite borrow areas (see Section 5.2) and in the vicinity of LANL. LANL staff would survey potentially affected areas to determine the extent and nature of any contamination and required remediation in accordance with established procedures. All excavated contaminated media would be characterized and managed according to waste type and all applicable LANL procedures and regulatory requirements.

Air Quality and Noise

Construction Impacts—Construction of new facilities at TA-3 would result in temporary increases in air quality impacts from construction equipment, trucks, and employee vehicles. Criteria pollutant concentrations were modeled for the site work and erection construction phases of the TA-3 Physical Science Research Complex’s largest new facilities and compared to the most stringent standards. Construction modeling considered particulate emissions from activity in the construction area and emissions from various earthmoving and material-handling equipment. The maximum ground-level pollutant concentrations off site and along the perimeter road to which the public has regular access would be below the ambient air quality standards, except for possible short-term concentrations of nitrogen oxides and carbon monoxide. Estimated concentrations for particulate matter with an aerodynamic diameter less than or equal to 10 micrometers (PM_{10}) would be greatest for the site work phase. Estimated maximum PM_{10} concentrations are an annual average of 3.5 micrograms per cubic meter and a 24-hour average of 72.1 micrograms per cubic meter. The maximum annual and short-term concentrations for construction would occur at the site boundary or roadway north-to-northeast of TA-3. Soil disturbance during construction could result in small radiological air emissions, but would be controlled by best management practices, thereby resulting in no impacts on workers or the public.

Construction of the new Physical Science Research Complex at TA-3 would result in a temporary increase in noise levels from construction equipment and activities. Some disturbance of wildlife near the area may occur as a result of construction equipment operation. There would be no change in noise impacts on the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from construction employee vehicles and materials and debris shipments. Noise sources associated with construction at TA-3 are not expected to include loud impulsive sources such as blasting.

Operations Impacts—Criteria and toxic air pollutants could be generated from the operation and testing of an emergency generator, if an additional one is necessary. Also, the use of various chemicals in laboratories and other activities would result in criteria and toxic air pollutant emissions. Emissions from the diesel generator would occur during periodic testing and would result in little change in air pollutant concentrations, and expected air quality impacts on the public would be minor.

Little or no change in toxic pollutant emissions or air pollutant concentrations at LANL is expected under this option. Toxic pollutants released from laboratories would vary by year with the activities performed and are expected to be similar to the current combined emissions from the existing buildings and capabilities that would be consolidated at TA-3. The emissions would continue to be small and below Screening-Level Emission Values (see Appendix B). Therefore, the air quality impacts on the public would be minor. Additionally, operations would have no significant radiological air emissions.

Noise impacts of operating the new Physical Science Research Complex at TA-3 are expected to be similar to those of existing operations at TA-3. Although there would be small changes in traffic and equipment noise (for example, new heating and cooling systems) near the area, there would be little change in noise impacts on wildlife and no change in noise impacts on the public outside of LANL as a result of operating these new facilities.

DD&D Impacts—DD&D of buildings being replaced by the Physical Science Research Complex would result in temporary increases in air quality impacts of construction equipment, trucks, and employee vehicles. Criteria pollutant concentrations were not modeled for the DD&D of buildings at TA-3, but would be less than those from construction of the new facilities. DD&D of buildings at other TAs would be similar to DD&D activities taking place at various areas at LANL. Concentrations off site and along the roads to which the public has regular access would be below ambient air quality standards. Soil disturbance during demolition could result in small radiological air emissions, but would be controlled by best management practices, thereby resulting in no impacts on workers or the public.

DD&D of excessed buildings and structures in TA-3, TA-35, and TA-53 would result in some temporary increase in noise levels near the area from construction equipment and DD&D activities. Some disturbance of wildlife near the area may occur as a result of construction equipment operation. There would be no change in noise impacts on the public outside of LANL as a result of DD&D activities, except for a small increase in traffic noise levels from DD&D employee vehicles and materials and debris shipments.

Human Health

Construction Impacts—Potentially serious exposures to various hazards or injuries would be possible during the construction and DD&D phases of the proposed project. Adverse effects could range from relatively minor (such as lung irritation, cuts, or sprains) to major (such as lung damage, broken bones, or fatalities) (DOE 2004, BLS 2003). The potential for industrial accidents is based on both DOE and Bureau of Labor Statistics data on construction injuries and fatalities. Based on an estimated 1.99 million person-hours to construct the new facilities, no fatal accidents are expected to occur. Nonfatal injuries are estimated to be between 23 (DOE 2004) and 84 (BLS 2003).

To prevent serious exposures and injuries, all site construction contractors would be required to submit and adhere to a Construction Safety and Health Plan and undergo site-specific hazard training. No potential offsite human health effects of construction hazards are expected.

Operations Impacts—Physical Science Research Complex operation is expected to have a beneficial effect on the LANL staff working environment, as working conditions would be improved by use of proper lighting, heating, ventilation, and air conditioning, and ergonomic equipment and furniture. Office, administrative, and light laboratory activities would constitute most of the Physical Science Research Complex operations, and applicable safety and health training and worksite criteria would be required for these workers.

DD&D Impacts—A potential source of impacts on noninvolved workers and members of the public would be associated with the release of radiological contaminants during the DD&D process. Any emissions of contaminated particulates would be reduced by the use of plastic draping and enclosures, coupled with high-efficiency particulate air (HEPA) filters. Construction and demolition workers would be actively involved in potentially hazardous activities such as heavy-equipment operations; soil excavations; and handling, assembly, or DD&D of various building materials. Potentially serious exposures to various hazards or injuries are possible during the DD&D phase of the proposed project. Adverse effects could range from relatively minor (such as lung irritation, cuts, or sprains) to major (such as lung damage, broken bones, or fatalities). The potential for industrial accidents is based on both DOE and the Bureau of Labor Statistics data on construction injuries and fatalities. Based on an estimated 286,000 person-hours to demolish the new facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be approximately 3 (DOE 2004) to 12 (BLS 2003).

To prevent serious exposures and injuries, all site construction contractors would be required to submit and adhere to a Construction Safety and Health Plan and undergo site-specific hazard training. Appropriate personal protection measures, such as personal protection device use (gloves, hardhats, steel-toed boots, eyeshields, and earplugs or ear covers) would be a routine part of construction activities. The proposed project is not expected to have an effect on the health of any demolition workers under normal operations conditions.

DD&D of certain buildings and structures in TA-3 would involve removal of some asbestos-contaminated material, which would be conducted according to existing asbestos management programs at LANL which are in compliance with strict asbestos abatement guidelines. Workers would be protected by personal protective equipment and other engineered and administrative controls. As a result of the controls that would be established, no asbestos would be released that could be inhaled by members of the public.

Cultural Resources

DD&D Impacts—The proposed site of the Physical Science Research Complex is in an already-developed area of TA-3. However, TA-03-0028 is a potentially significant historic building that would be removed. Prior to its demolition it would be assessed for inclusion in the National Register of Historic Places. The current Administration Building (TA-03-0043) has been formally declared as eligible for the National Register of Historic Places and a Memorandum of Agreement has been signed regarding required documentation prior to its removal.

Socioeconomics and Infrastructure

Construction Impacts—Utility infrastructure resources would be required for Physical Science Research Complex construction. Standard construction practice dictates that electric power needed to operate portable construction and supporting equipment be supplied by portable diesel-fired generators. Therefore, no electrical energy consumption would be directly associated with construction. A variety of heavy equipment, motor vehicles, and trucks would be used, requiring diesel fuel, gasoline, and propane for operation. Liquid fuels would be brought to the site as needed from offsite sources and, therefore, would not be limited resources. Water would be needed primarily to provide dust control, aid in soil compaction at the construction site, and possibly for equipment washdown. Water would not be required for concrete mixing, as ready-mix concrete is typically procured from offsite resources. Portable sanitary facilities would be provided to meet the workday sanitary needs of project personnel on the site. Water needed for construction would typically be trucked to the point of use, rather than provided by a temporary service connection. Construction is estimated to require 2.6 million gallons (10 million liters) of liquid fuels and 14.4 million gallons (54 million liters) of water for the entire project.

The existing LANL infrastructure would be capable of supporting requirements for new facility construction without exceeding site capacities, resulting in a negligible impact on site utility infrastructure. Utility lines are located adjacent to the proposed building sites and would require minimal trenching to connect them to the new structures. Minor repairs to existing underground sewer or water lines may be necessary (NNSA 2001).

Operations Impacts— Physical Science Research Complex operations would result in estimated annual electrical and water requirements of 45,000 megawatt-hours and 9.6 million gallons (36 million liters), respectively (LANL 2006a). This power and water use would be similar to or less than the facilities that are being replaced. Although LANL does not meter water or electrical use at most buildings, nor does it track waste generated at individual buildings, the Physical Science Research Complex is expected to operate with more energy-efficient utility systems than the current structures. Water consumption is also expected to decrease with the DD&D of existing resource-inefficient structures currently in operation. As such, Physical Science Research Complex operation is expected to have no or negligible incremental impact on utility infrastructure capacities at LANL.

DD&D Impacts—Activities associated with DD&D of facilities to be replaced by the Physical Science Research Complex are projected to require 129,000 gallons (488,000 liters) of liquid fuels and 4.1 million gallons (16 million liters) of water. DD&D activities would be staggered over an extended period of time. As a result, impacts of these activities on LANL's utility infrastructure are expected to be very minor on an annualized basis. Standard practice dictates that utility systems serving individual facilities be shut down as they are no longer needed. As DD&D activities progress, interior spaces, including associated equipment, piping, and wiring, would be removed prior to final demolition. Thus, existing utility infrastructure would be used to the extent possible and would then be supplemented or replaced by portable equipment and facilities as DD&D activities proceed.

Waste Management

Construction Impacts—Physical Science Research Complex construction would result in approximately 1,600 cubic yards (1,200 cubic meters) of waste, consisting primarily of debris such as gypsum board, pallets, and wire generated in the course of normal construction. Waste types and quantities generated by removal of the structures would be within the capacity of the existing waste management system and would not result in a substantial impact on existing waste management disposal operations.

No known potential release sites are present within the proposed footprint of the Physical Science Research Complex site (LANL 2006a). Should any potential release site be disclosed during subsurface construction work, LANL's environmental restoration project staff would review the site, stipulate procedures for working within that site area, and perform remediation as needed consistent with DOE and the Compliance Order on Consent (Consent Order) (NMED 2005) requirements.

Operations Impacts—Solid waste generated during Physical Science Research Complex operations would be disposed of at the Los Alamos County Landfill or other appropriate solid waste landfill. The amount of waste generated during Physical Science Research Complex operations would not increase substantially from current volumes generated at the existing structures. Sanitary waste would be removed from the facility via sanitary wastewater lines to the Sanitary Wastewater Systems Plant.

DD&D Impacts—DD&D of associated buildings would produce approximately 195,000 cubic yards (149,000 cubic meters) of waste, including low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, sanitary waste, and nonhazardous solid waste. DD&D would also generate about 314,000 pounds (142,000 kilograms) of chemical waste and 311 cubic yards (238 cubic meters) of asbestos waste. This waste would be packaged according to applicable requirements and sent to the LANL asbestos transfer station for shipment off site to a permitted asbestos disposal facility along with other asbestos waste generated at LANL. The anticipated amount of waste would not be beyond the disposal capacity of existing on and offsite disposal facilities. **Table G–1** summarizes waste types and volumes expected to be generated during DD&D activities. Although excessed LANL transportables are usually donated to the public, it has been assumed for purposes of analysis that they would also be dispositioned as demolition debris. About 8.9 percent of waste produced during DD&D activities is bulk low-level radioactive wastes. For purposes of analysis, NNSA has evaluated both the on and offsite disposal of low-level radioactive waste to ensure that the environmental consequences of either waste management option were considered. Potential available offsite disposal sites include the Nevada Test Site near Mercury, Nevada, and a commercial facility.

Table G–1 Estimated Waste Volumes from Physical Science Research Complex Decontamination, Decommissioning, and Demolition Activities (cubic yards)

Low-Level Radioactive Waste	*Mixed Low-Level Radioactive Waste*	*Solid* [a]	*Hazardous*	*Asbestos*
17,400	< 1	177,000	3	311

[a] Includes demolition and sanitary waste.

Note: To convert cubic yards to cubic meters, multiply by 0.76455.

For disposal of generated low-level radioactive waste, two capability scenarios were evaluated. Low-level radioactive waste could be disposed of on site or shipped off site, with the selected disposal path determined based on TA-54 disposal capacity and disposal priorities.

Scenario 1. Under this scenario, NNSA would pursue offsite disposal of the low-level radioactive waste resulting from DD&D of the buildings and structures, including concrete, soil, steel, and personal protective equipment. Among other possible offsite disposal locations, both the Nevada Test Site, a DOE waste disposal facility, and a commercial facility have the capacity to accept these quantities of waste.

Scenario 2. Under this scenario, low-level radioactive waste would be disposed of on site in TA-54. The current disposal site footprint has limited waste capacity, although expansion into Zone 4 is planned. Onsite disposal capacity is expected to be adequate for the amount of low-level radioactive waste that would be generated by the DD&D activities.

All other wastes generated by the DD&D activities would be handled, managed, packaged, and disposed of in the same manner as the same wastes generated by other activities at LANL. Most mixed low-level radioactive waste generated at LANL is sent off site to other DOE or commercial facilities for treatment and disposal. The estimated volume of mixed low-level radioactive waste generated is small, and offsite disposal capacity is adequate.

Small amounts of hazardous waste would also be generated during DD&D activities. These wastes would be handled, packaged, and disposed of according to LANL's hazardous waste management program and are within its capacity.

Demolition debris and sanitary waste would be managed at the Los Alamos County Landfill or transported to an offsite landfill. For the purposes of analysis, it was assumed that these wastes would be disposed of at an offsite location. DD&D would generate nonradiological asbestos waste. This waste would be packaged according to applicable requirements and sent to the LANL asbestos transfer station for shipment off site to a permitted asbestos disposal facility along with other asbestos waste generated at LANL. Offsite disposal capacity would be adequate.

Transportation

Construction Impacts—Construction personnel would park on site and at remote designated parking areas. Truck traffic volumes carrying waste material to local or regional landfill sites would increase during these periods.

Operations Impacts—Once construction is completed, operation of the Physical Science Research Complex would account for the relocation of approximately 250 personnel from TAs other than TA-3. Using a ratio of 0.45 vehicles per employee, approximately 113 more vehicles may be added to TA-3 roadways and parking areas as a result of Physical Science Research Complex personnel relocation (DOE 1998).

DD&D Impacts—The generated DD&D wastes would need to be transported to storage or disposal sites using over-the-road truck transportation. These sites could be at LANL TA-54 or an offsite location. Transportation has potential risks to workers and the public from incident-free transport, such as radiation exposure as the waste packages are transported along the routes and highways. There is also increased risk from traffic accidents (without release of radioactive material) and radiological accidents (in which radioactive material is released).

The effects of incident-free transportation of construction and DD&D wastes on the worker population and general public are presented in **Table G–2**. Effects are presented in terms of the collective dose in person-rem resulting in excess latent cancer fatalities (LCFs) in Table G–1. Excess LCFs are the number of cancer fatalities that may be attributable to the proposed project and estimated to occur in the exposed population over the lifetimes of the individuals. If the number of LCFs is less than one, the subject population is not expected to incur any LCFs resulting from the actions being analyzed. The risk for development of excess LCFs is highest for workers under the offsite disposition option. This is because the dose is proportional to the duration of transport, which in turn is proportional to travel distance. As shown in Table G–2, disposal of low-level radioactive waste at Nevada Test Site, which is located farthest from LANL, would lead to the highest dose and risk, although the dose and risk are low for all disposal options.

Table G–2 Incident-Free Transportation Impacts – Physical Science Research Complex

Disposal Option	*Low-Level Radioactive Waste Disposal Location*	*Crew*		*Public*	
		Collective Dose (person-rem)	*Risk (LCF)*	*Collective Dose (person-rem)*	*Risk (LCF)*
Onsite disposal	LANL TA-54	0.037	2.2×10^{-5}	0.01	6.0×10^{-6}
Offsite disposition	Nevada Test Site	4.65	0.0028	1.35	0.00081
	Commercial facility	4.51	0.0027	1.32	0.00079

LCF = latent cancer fatality, TA = technical area.

Table G–3 presents the impacts of traffic and radiological accidents. This table provides population risks in terms of fatalities due to traffic accidents from both the collisions themselves and from excess LCFs from exposure to releases of radioactivity. The analyses assumed that all nonradiological wastes would be transported to offsite disposal facilities.

The results in Tables G–2 and G–3 indicate that no traffic fatalities and no excess LCFs are expected from the transportation of generated waste derived from the DD&D of excessed buildings and structures at TA-3, TA-35, and TA-53.

Table G–3 Transportation Accident Impacts – Physical Science Research Complex

Low-Level Radioactive Waste Disposal Location [a]	*Number of Shipments* [b]	*Distance Traveled (10^6 kilometers)*	*Accident Risks*	
			Radiological (excess LCFs)	*Traffic (fatalities)*
LANL TA-54	10,897	4.16	Not analyzed [c]	0.0013
Nevada Test Site	10,897	6.76	1.2×10^{-8}	0.0036
Commercial facility	10,897	6.50	9.6×10^{-9}	0.0033

LCF = latent cancer fatality, TA = technical area.

[a] All nonradiological wastes would be transported off site.

[b] Approximately 10 percent of shipments are radioactive wastes. Others include 90 percent industrial and sanitary waste and about 0.1 percent asbestos and hazardous wastes.

[c] No traffic accident leading to releases of radioactivity for onsite transportation is hypothesized.

Note: To convert kilometers to miles, multiply by 0.6214.

G.2 Replacement Office Buildings Impact Assessment

This section provides an assessment of environmental impacts for the proposed Replacement Office Buildings at TA-3. Section G.2.1 provides background information on the proposed project to build a Replacement Office Building Complex and two parking structures and to DD&D two structures. Section G.2.2 provides a brief description of the proposed options for the replacement offices. Section G.2.3 presents the environmental consequences of the No Action Option and the proposed project (construction and operation of the proposed Replacement Office Buildings at TA–3).

G.2.1 Introduction

NNSA is working to reduce the number of substandard structures across LANL and to relocate staff and activities into more efficient and safe structures. Staff currently occupies trailers and other temporary structures that have exceeded their intended lifespan. NNSA has a congressional mandate to remove facilities at the same rate as new construction. NNSA is in the process of reducing non-office and inefficient office space, focusing on increased use and replacement of inefficient structures.

Over the past 3 years, a detailed analysis of the cost of operating and maintaining LANL facilities and a prioritization system to fund structural and infrastructure upgrades were developed. NNSA evaluated and implemented methods to reduce facility costs and identified distinct areas to be addressed to ensure infrastructure sustainability. These areas include structure consolidation and cost reduction initiatives to reduce structure footprints and operating costs as well as improve safety, security, environmental protection, scientific interactions, and productivity. A TA-3 Revitalization Plan, developed to address the upgrade of LANL's most populated areas and the construction of Replacement Office Buildings in TA-3, is one such consolidation and strategic planning effort being considered at LANL.

G.2.2 Options Considered

The two options identified for the Replacement Office Buildings are the No Action Option and proposed project option.

G.2.2.1 No Action Option

Under the No Action Option, no action would be taken. The site would not be changed and no Replacement Office Buildings or parking structures would be constructed. No DD&D activities would occur. Employees intended for the proposed office buildings would remain at their current locations throughout TA-3, and no consolidation would occur.

G.2.2.2 Proposed Project

The proposed project would be located partially on undeveloped land south of West Jemez Road and partially in the area of the existing Wellness Center and would consist of 12 new buildings (1 would be available to house NNSA's Los Alamos Site Office) and two new parking structures, one north of Mercury Road and one to the south of West Jemez Road. The Wellness Center and a warehouse would be demolished to accommodate this project. The current Los Alamos Site Office Building would also be demolished. Impacts of the Los Alamos Site Office Building DD&D were analyzed in the *Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico* (DOE 1999c). Three office buildings that were proposed before the larger project was envisioned were categorically excluded from further National Environmental Policy Act (NEPA) evaluation under DOE's NEPA implementing regulations. However, these three buildings are integral to this office complex and are included in the impacts analysis. The complex would provide new, modern structures and would consolidate staff located primarily throughout TA-3 in temporary structures or aging permanent buildings in failing and poor condition. LANL staff located in other TAs may also be housed in the new Replacement Office Buildings. The surface parking area near Mercury Road would become a parking structure in the distant future. **Figure G–3** shows the currently proposed layout of the Replacement Office Building complex.

The buildings would be sited partially on undeveloped land south of West Jemez Road and partially in the area of the existing Wellness Center. The Replacement Office Buildings would include construction of a 45,000-square-foot (4,200-square-meter) Los Alamos Site Office Building, which would house approximately 150 staff. Construction of the Los Alamos Site Office Building has begun. The remaining office buildings would consist of two-story structures, each with a footprint of 8,000 to 9,000 square feet (740 to 840 square meters). These new buildings would provide approximately 15,000 to 17,500 gross square feet (1,400 to 1,600 square meters) of office space and house approximately 50 to 70 staff each. The number of administrative staff housed in the overall Replacement Office Buildings would total approximately 900. This staff would migrate from other offices in various locations throughout LANL and would not constitute new hires.

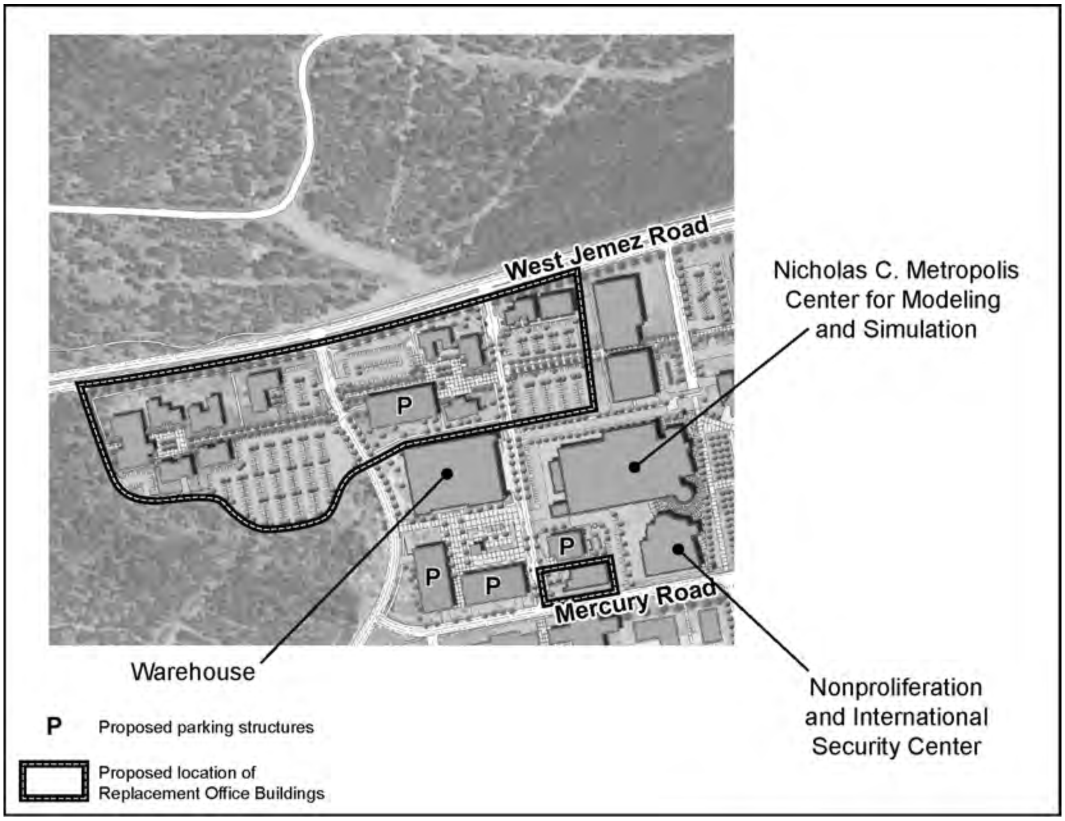


Figure G–3 Replacement Office Building Complex Proposed Layout

G.2.3 Affected Environment and Environmental Consequences

For the Replacement Office Buildings, the affected environment descriptions include only those resource areas that would be impacted. The analysis of environmental consequences relies on the affected environment descriptions in Chapter 4 of this SWEIS. Where information specific to the TA-3 affected environment is available and aids understanding potential impacts of constructing and operating the Replacement Office Buildings, it is included.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Socioeconomics and Infrastructure* – No new employment is expected. Construction and DD&D workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.

- *Environmental Justice* – The proposed project is mainly confined to already-developed areas of TA-3, with no disproportionate human health impacts to low-income or minority populations expected.

- *Facility Accidents* – The proposed project would not implement new activities associated with radiological materials; only industrial accidents may occur.

This impact assessment focuses on those areas of the affected environment where potential impacts would occur: land resources, geology and soils, water resources, air quality and noise, ecological resources, human health, cultural resources, site infrastructure, waste management, and transportation.

G.2.3.1 No Action Option

Under the No Action Option, LANL administrative staff would continue to operate at existing scattered LANL locations. The Replacement Office Buildings would not be constructed at TA-3, nor would the Wellness Center or the Warehouse undergo DD&D. Poor quality office space and the effectiveness of current staff to recruit and retain qualified employees would remain a problem. Current DOE seismic standards or applicable building codes would not be met, and use of the buildings would be phased out over time as commercial lease space or space within LANL became available or trailers could be brought on site. Outdated structures and temporary buildings that presently accommodate personnel would continue to contribute adversely to the visual character of the TA-3 area. No disturbance of existing TA-3 land or building sites would occur. There would be no construction or building removal debris to require disposal. Utility usage would remain the same as existing usage in the near future. Continued expenses for repairs and replacement of aging heating, ventilation, and air conditioning systems and other building components would increase. As building systems and other components fail and cannot be replaced or repaired, affected buildings would be partially or completely closed and the staff relocated. Benefits that would result from consolidating personnel in a modern facility that fosters better communication and collaboration between scientists and administrative personnel would not occur. Likewise, benefits would not result in the areas of resource efficiency and conservation by vacating currently occupied energy-inefficient structures.

G.2.3.2 Proposed Project

The Replacement Office Buildings Project also includes DD&D of the existing Wellness Center and warehouse located in the northwest section of TA-3. The following discussion summarizes potential impacts during construction, operations, and DD&D, as appropriate.

Land Resources—Land Use

Construction Impacts—Construction of the Replacement Office Building Complex, including parking lots and construction laydown areas, would require 13 acres (5.3 hectares) of previously undisturbed land within TA-3 that is presently designated as Reserve.

Operations Impacts—Additional acreage would be required within previously disturbed portions of the TA that are designated as Physical and Technical Support. Future land use plans have designated the proposed site area in the undeveloped portion of TA-3 as Physical and Technical Support. Thus, placement of the Replacement Office Buildings and a parking lot within the western part of TA-3 would be consistent with these plans.

Land Resources—Visual Resources

Construction Impacts—Impacts on visual resources resulting from construction of the Replacement Office Building Complex would result in short-term impacts on the visual environment, including increased dust generation due to construction activities.

Operations Impacts—Once complete, the project would result in a change in both near and distant views of TA-3. The project site is partially located within a forested area along West Jemez Road, which would be replaced with buildings and a parking lot. Although landscaping along West Jemez Road could help mitigate views, the new buildings and parking lot would be readily visible from the road and nearby areas. Views from Pajarito Road would also change; however, this would impact primarily employees, as the road is restricted from public use. Also, because the size of developed portions of TA-3 would increase and the area of woodland decrease, distant views of the TA would change as a result of construction of the Replacement Office Building Complex. However, the overall effect would be minimal due to the present highly developed nature of that part of LANL.

Geology and Soils

The Replacement Office Buildings site lies within a part of the Pajarito Fault system characterized by subsidiary or distributed fault ruptures; two small, closely spaced faults are located in TA-3. The annual probability of surface rupture in areas beyond the principal or main trace of the Pajarito Fault, such as at the Replacement Office Buildings site, is less than 1 in 10,000 (LANL 2004c). This probability is less than the required performance goal for the facility and in accordance with DOE standards. Additionally, the Replacement Office Buildings would be designed and constructed in accordance with current DOE seismic standards and applicable building codes.

The proposed area for the facility includes both disturbed and undisturbed soils. The undisturbed soils maintain the present vegetative cover. They are arid soils consisting largely of sandy loam material alluvially deposited from tuff units on higher slopes to the west and eroded from underlying geologic units. In general, the soils are poorly developed, with relatively little horizon differentiation and organic matter accumulation. These factors, combined with the dry moisture regime of the area, result in only a limited number of plant species being able to subsist on the soil medium, which, in turn, supports a very limited number of wildlife species.

Construction Impacts—Construction of the Replacement Office Buildings would include both areas already disturbed by previous facility construction and areas not previously disturbed. The impact on LANL undisturbed (native) soils would be proportional to the total area of new construction. Approximately 369,000 cubic yards (282,000 cubic meters) of soil and rock would be excavated for building construction. As a result, construction activities would generate excess soil and excavated bedrock that may be suitable for use as backfill. Uncontaminated backfill material would be stockpiled at an approved material management area at LANL for future use. Best management practices would be implemented to prevent erosion and migration of disturbed materials from the site caused by stormwater or other water discharges or wind.

Operations impacts—Office building operations would not result in additional impacts on geologic and soil resources at LANL.

DD&D Impacts—DD&D activities associated with existing facilities would have a negligible additional impact on geologic and native soil resources at LANL, as the affected facility areas are already developed and adjacent soils are already disturbed. Additional ground disturbance would be necessary to establish laydown yards and waste management areas in the vicinity of the facilities to be razed. Available paved surfaces, such as parking lots in the vicinity of the facilities to be demolished, would be used to the extent possible.

The major indirect impact on geologic and soil resources at the DD&D locations would be associated with the need to excavate any contaminated tuff and soil from beneath and around facility foundations. Borrow material (such as crushed tuff and soil) would be required to fill the excavations to grade, but such resources are available from onsite borrow areas (see Chapter 5, Section 5.2) and in the vicinity of LANL. LANL staff would survey potentially affected contaminated areas to determine the extent and nature of any contamination and required remediation in accordance with LANL procedures. All excavated material would be characterized before removing it for disposal.

Water Resources

The proposed site is predominantly flat, with a slight slope toward the adjacent steep-sided canyon to the southwest. During storm events, unchanneled stormwater runoff from the mesa drains into the canyon.

Construction Impacts—Little or no effect on surface water resources is anticipated during construction of the Replacement Office Buildings. The proposed project would not result in disturbance of watercourses or generation of liquid effluents that would be released to the surrounding environment.

Under the current U.S. Environmental Protection Agency (EPA) Construction General Permit Program, permits are required for all LANL construction activities or other projects that disturb 1 or more acres (0.4 or more hectares) of land. Conditions of the permit require the development and implementation of a stormwater pollution prevention plan. Silt fences, hay bales, or other appropriate best management practices would be employed to minimize stormwater transport of fine particulates (disturbed during construction) into surface water in the vicinity of TA-3.

Operations Impacts—There would be an increase in stormwater runoff associated with the new office building because of the increase in impervious areas of buildings and parking lots. The replacement of buildings should not change the stormwater runoff from these TAs significantly.

Air Quality and Noise

Construction Impacts—Construction of new facilities at TA-3 would result in temporary increases in air quality impacts of construction equipment, trucks, and employee vehicles. Criteria pollutant concentrations were modeled for the site work and erection construction phases of TA-3’s largest new facilities and compared to the most stringent standards. The maximum ground-level concentrations off site and along the perimeter road to which the public has regular access would be below the ambient air quality standards, except for possible short-term concentrations of nitrogen oxides and carbon monoxide. Estimated concentrations for PM_{10} would be greatest for the site work phase. Estimated maximum PM_{10} concentrations are an annual average of 3.8 micrograms per cubic meter and a 24-hour average of 78.5 micrograms per cubic meter. The maximum annual and short-term concentrations for construction would occur at the site boundary or roadway north-to-northeast of TA-3. Modeling considered particulate emissions from activity in the construction area and emissions from various earthmoving and material-handling equipment.

Construction of new office facilities at TA-3 would result in some temporary increase in noise levels from construction equipment and activities. Some disturbance of wildlife near the area may occur as a result of construction equipment operation. There would be no change in noise impacts on the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from construction employees' vehicles and materials shipments. Noise sources associated with construction at TA-3 are not expected to include loud impulsive sources such as blasting.

Operations Impacts—Operation of the Replacement Office Buildings at TA-3 would not result in an increase of criteria pollutant emissions above the existing level because the total number of employee trips to LANL would remain the same.

Noise impacts of operating the new office complex at TA-3 are expected to be similar to those from overall existing operations at TA-3. Although there would be a small change in traffic and equipment noise (for example, new heating and cooling systems) near the area, there would be little change in noise impacts on wildlife and no change in noise impacts on the public outside of LANL as a result of operating these new structures.

DD&D Impacts—DD&D of buildings being replaced by new facilities would result in temporary increases in air quality impacts of construction equipment, trucks, and employee vehicles. Maximum ground-level concentrations offsite and along the perimeter road to which the public has regular access would be below the ambient air quality standards, except for short-term concentrations of nitrogen oxides, carbon monoxide, and PM_{10}.

Demolition of the Wellness Center and warehouse would result in some temporary increase in noise levels from construction equipment and activities. Some disturbance of wildlife near the area may occur as a result of construction equipment operation. There would be no change in noise impacts on the public outside of LANL as a result of demolition activities, except for a small increase in traffic noise levels from construction employees' vehicles and materials shipments.

Ecological Resources

Construction Impacts—Construction of the Replacement Office Building Complex would involve clearing and grading 13 acres (5.3 hectares) of ponderosa pine and mixed conifer forest within TA-3. This would result in loss of less-mobile wildlife, such as reptiles and small mammals, and cause more-mobile species, such as birds or large mammals, to be displaced. The success of displaced animals would depend on the carrying capacity of the area into which they moved. If the area were at its carrying capacity, displaced animals would not be likely to survive. Indirect impacts of construction, such as noise or human disturbance, could also impact wildlife living adjacent to the construction zone. Such disturbance would span the construction period. These impacts could be mitigated by clearly marking the construction zone to prevent equipment and workers from disturbing adjacent habitat and by properly maintaining equipment. Construction of the new buildings and parking lot would not impact wetlands, as none are located in or near the construction zone.

The northern portion of TA-3 falls within the Los Alamos Canyon Mexican spotted owl (*Strix occidentalis lucida*) Area of Environmental Interest. Potential impacts to the Mexican spotted owl were evaluated in a biological assessment prepared by DOE. This assessment noted that although 11.2 acres (4.5 hectares) of buffer habitat would be disturbed, spotted owls have been not been detected in Los Alamos Canyon in recent years. The report concluded that if all reasonable and prudent alternatives are taken, actions associated with the construction of the Replacement Office Building Complex may affect, but are not likely to adversely affect, the Mexican spotted owl. Reasonable and prudent alternatives include ensuring that all lighting complies with the New Mexico Night Sky Protection Act, appropriate erosion and runoff controls be employed, unnecessary disturbance to vegetation be avoided, and all exposed soils be revegetated as soon as feasible (LANL 2006b). The U.S. Fish and Wildlife Service (USFWS) has concurred with this assessment (see Chapter 6, Section 6.5.2).

Areas of Environmental Interest for the bald eagle (*Haliaeetus leucocephalus*) and southwestern willow flycatcher (*Empidonax traillii extimus*) do not include any part of TA-3. However, recognizing that the bald eagle forages over all of LANL and that some habitat degradation is associated with the Replacement Office Building Complex project, the biological assessment concluded that provided appropriate reasonable and prudent alternatives are implemented to protect adjacent foraging habitat, the project may affect, but is not likely to adversely affect, the bald eagle. In addition to the reasonable and prudent alternatives noted above for the Mexican spotted owl, those for the bald eagle could include not disturbing winter roosting trees, monitoring the presence or absence of eagles during project activities, and keeping noise and disturbance to a minimum. Since the nearest southwestern willow flycatcher Area of Environmental Interest is more than 4.6 miles (7.4 kilometers) from the project site, the biological assessment concluded that the proposed project would have no effect on this species (LANL 2006b). The USFWS has concurred with the biological assessment as it relates to the bald eagle and southeastern willow flycatcher (see Chapter 6, Section 6.5.2).

Operations Impacts—Operation of the Replacement Office Building Complex would have minimal impact on terrestrial resources within or adjacent to TA-3. Because the wildlife residing in the area has already adapted to levels of noise and human activity associated with current operation, it is unlikely that it would be adversely affected by similar types of activity involved with operation of the new buildings. Areas not permanently disturbed (for example, construction laydown areas) would be landscaped; however, this would provide little habitat to native wildlife.

Human Health

Construction Impacts—During construction of the Replacement Office Buildings, some construction-related accidents would potentially occur. The potential for industrial accidents is based on both DOE and Bureau of Labor Statistics data on construction injuries and fatalities (DOE 2004, BLS 2003). Based on an estimated 1.35 million person-hours to construct the new facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be approximately 15 (DOE 2004) to 57 (BLS 2003).

DD&D Impacts—Health and safety impacts of demolition activities would be similar to those expected during construction activities. Based on an estimated 7,600 person-hours for DD&D of the existing facilities (including the current Los Alamos Site Office Building), no fatal accidents would occur, and nonfatal injuries are not expected (DOE 2004, BLS 2003).

Cultural Resources

A total of eight archaeological sites have been located within TA-3. Sites include lithic scatters, trails and stairs, and a wagon road. Two archaeological sites are eligible for listing on the National Register of Historic Places, four are of unknown eligibility, and two are not eligible. There are no National Register of Historic Places-eligible archaeological resources located in the vicinity of the proposed Replacement Office Building Complex; however, one site of undetermined status, a historical trail, is located to the south of the parking lot. Although three National Register of Historic Places-eligible buildings are located in TA-3, none are situated near the proposed new complex. One traditional cultural property is present within TA-3.

Construction Impacts—There are no cultural resource sites eligible for the National Register of Historic Places within the vicinity of the Replacement Office Buildings. However, the historic trail located to the south of the parking lot must be managed as a National Register of Historic Places-eligible site until formally determined otherwise. Due to its proximity to the proposed project, there could be potential adverse effects of construction. As noted above, one traditional cultural property is located within TA-3. However, it would not be affected by construction or operation of the Replacement Office Building Complex.

Operations Impacts—Operation of the Replacement Office Buildings and associated parking lots would not impact any cultural resources.

Socioeconomics and Infrastructure

Construction Impacts—Utility infrastructure resources would be required for Replacement Office Buildings construction. Standard construction practice dictates that electric power needed to operate portable construction and supporting equipment be supplied by portable diesel-fired generators. Therefore, no electrical energy consumption would be directly associated with construction. A variety of heavy equipment, motor vehicles, and trucks would be used, requiring diesel fuel, gasoline, and propane for operation. Liquid fuels would be brought to the site as needed from offsite sources and, therefore, would not be limited resources. Water would be needed primarily to provide dust control, aid soil compaction at the construction site, and possibly for equipment washdown. Water would not be required for concrete mixing, as ready-mix concrete is typically procured from offsite resources. Portable sanitary facilities would be provided to meet the workday sanitary needs of project personnel on the site. Water needed for construction would typically be trucked to the point of use, rather than provided by a temporary service connection.

For Replacement Office Buildings construction, total liquid fuel consumption is estimated to be 1.8 million gallons (6.8 million liters). Total water consumption is estimated to be 9.6 million gallons (36 million liters). The existing LANL infrastructure would be capable of supporting the requirements for new facility construction without exceeding site capacities, resulting in negligible impact on site utility infrastructure.

Operations Impacts—In general, utility infrastructure requirements for operation of the new office structures would be limited to building connections, and no upgrades to existing utilities would be required. Usage in the proposed structures would be equivalent to or less than that of the replaced structures because contemporary building design includes water and energy conservation features. As such, Replacement Office Buildings operation is expected to have no or negligible incremental impact on utility infrastructure capacities at LANL.

DD&D Impacts—Activities associated with DD&D of facilities to be replaced by the Replacement Office Buildings are projected to require 356,000 gallons (1.35 million liters) of liquid fuels and 11.3 million gallons (43 million liters) of water. DD&D activities would be staggered over an extended period of time. As a result, impacts of these activities on LANL's utility infrastructure are expected to be very minor on an annualized basis. Standard practice dictates that utility systems serving individual facilities be shut down as they are no longer needed. As DD&D activities progress, interior spaces, including associated equipment, piping, and wiring, would be removed prior to final demolition. Thus, existing utility infrastructure would be used to the extent possible and would then be supplemented or replaced by portable equipment and facilities as DD&D activities proceed.

Waste Management

Construction Impacts—Replacement Office Building Complex construction would generate approximately 1,700 cubic yards (1,300 cubic meters) of construction waste, primarily construction debris and associated solid waste. Construction debris is not hazardous and may be disposed of in a solid waste landfill. A substantial portion of construction debris at LANL is routinely recycled; in 2003, approximately 89 percent of the uncontaminated construction and demolition waste was recycled, and those rates are expected to continue (LANL 2004d).

Operations Impacts—Operations at the new Replacement Office Building Complex would generate sanitary wastes. However, because the offices are a replacement for existing office space, no increase in waste is expected.

DD&D Impacts—Demolition activities would generate approximately 6,900 cubic yards (5,300 cubic meters) of demolition debris and sanitary waste. The demolition debris would be transferred to appropriate offsite recycling or disposal facilities. As with construction debris, as much as 89 percent of the demolition debris could potentially be recycled. Although no radiological waste is anticipated as a result of the demolition activities of the Wellness Center and warehouse, 31 cubic yards (24 cubic meters) of low-level radioactive waste was estimated in case contaminated materials were encountered during the demolition activities. This waste would be disposed of at TA-54. Because the estimated volume is small, no impacts on disposal capacity are expected.

Transportation

Construction Impacts—Construction personnel would park onsite and at remote designated parking areas. Truck traffic volume carrying construction materials to LANL and waste to local and regional landfill sites would increase. This increase in traffic would not have any significant impact on the adjacent road systems, including West Jemez Road. As stated earlier, a substantial portion of construction debris at LANL is routinely recycled.

DD&D Impacts—Demolition activities would generate a small amount of low-level radioactive wastes that would be disposed of onsite or shipped offsite. The demolition debris would be transported to offsite recycling or disposal facilities. As with construction debris, a majority of demotion debris could potentially be recycled.

G.3 Radiological Sciences Institute, Including Phase I – The Institute for Nuclear Nonproliferation Science and Technology Impact Assessment

This section provides an assessment of environmental impacts for the proposed Radiological Sciences Institute at LANL’s TA-48. Section G.3.1 provides background information on the proposed project to replace deteriorated structures scattered over six TAs with the Radiological Sciences Institute. Section G.3.2 provides a description of the proposed options for the Radiological Sciences Institute. Section G.3.3 presents environmental consequences of the No Action Option and the proposed project (construction and operation of the proposed Radiological Sciences Institute at TA-48 and DD&D of the replaced facilities).

G.3.1 Introduction

The proposed project site is located in TA- 48, approximately 1 mile (1.6 kilometers) southeast of TA-3 along Pajarito Road and also includes a small portion of the western edge of TA-55. The Radiological Sciences Institute would provide state-of-the-art facilities for wet chemistry, metallurgy, safeguards (domestic and international), material protection control and accountability, machining and manufacturing, training schools, and underground storage of special nuclear material (LANL 2006a). This project would also involve DD&D of 52 deteriorating structures (80 percent of LANL’s radiological facilities) (LANL 2006a). The project would consolidate radiological laboratories and working spaces to a significantly smaller footprint of modern, flexible facilities in up to 13 buildings located at TA-48.

The missions proposed for relocation to the Radiological Sciences Institute include (but are not limited to) support for weapons manufacturing, material property evaluations for stockpile stewardship, support for domestic and international safeguards, training for International Atomic Energy Agency inspectors, training and support for national emergency response to threats involving radioactive sources, biological research, detection and sensor technologies, various chemistry and chemical engineering missions, radioisotope production and distribution, and basic energy science. New and developing projects that require radiological facilities include missions such as homeland security, advanced fuel cycle initiatives, separation processes for commercial-reactor spent fuel, production capability for nuclear fuels for space missions, powder metallurgy for space and medical applications, nonproliferation, threat reduction, nuclear material control and accountability, alternative energy systems, advanced fusion, and nuclear-weapons-related research.

Much of the radiological infrastructure at LANL is 40 to 60 years old, and the ability to continue critical national missions is threatened. Current facilities are rapidly approaching obsolescence, with operation and maintenance costs associated with increased safety, security, regulatory, and operating requirements becoming prohibitive. Radiological competence and mission commitments need to be met at LANL (LANL 2006a). The existing radiological facilities were built in accordance with building codes and safety and security requirements that are now outdated (LANL 2006a). NNSA needs to replace aging structures with modern buildings designed to meet usage needs.

Table G–4 shows the types of buildings currently in use by different programs that would be replaced by the Radiological Sciences Institute Project, including their building numbers, approximate age, facility condition, and existing floor space. **Table G–5** lists the names and functions of the 30 permanent structures that would be replaced by the Radiological Sciences Institute.

Table G–4 Summary of Los Alamos National Laboratory Radiological Buildings Proposed for Decontamination, Decommissioning, and Demolition Radiological Sciences Institute Project

Program	*Structure*	*Building Numbers* [a]	*Area (gross square feet)*	*Predominant Condition*	*Predominant Building Age (years)*
Chemistry	10 permanent buildings 8 transportable 2 trailers	46-24, 46-31, 46-158, 46-200, 46-250, 48-1, 48-8, 48-17, 48-26, 59-1 48-27, 48-29, 48-33, 48-34, 48-46, 48-47, 48-208, 48-214 48-149, 48-154	167,409	Poor to failing	40-59
Materials Science and Technology	5 permanent buildings 2 trailers	3-29, 3-35, 3-169, 3-66, 3-451 3-1524, 3-1525	258,922	Poor to failing	40-59
Nuclear Nonproliferation	13 permanent buildings 1 transportable 8 trailers 3 other	18-1, 18-28, 18-30, 18-129, 18-141, 18-147, 18-227, 18-297, 3-66, 35-2, 35-27, 35-115, 35-347 35-253 18-288, 18-300, 18-301, 35-239, 35-261, 35-262, 35-263, 35-382 18-256, 18-257, 18-258	180,099	Poor to failing	40-59
Radiological Machining and Inspection	1 permanent building	3-102	29,365	Adequate	40-59
Totals	52 structures		635,795		

[a] 100 percent of most building functions would be moved to the Radiological Sciences Institute. Buildings whose functions would be only partially replaced by the Radiological Sciences Institute and the corresponding percentages are: 3-29, 7 percent (the hot cells); 35-2, 33 percent; 46-24, 50 percent; 46-31, 25 percent; 46-158, 15 percent; 46-200, 50 percent; 59-1, 25 percent.

Notes: Facilities associated with the Institute for Nuclear Nonproliferation Science and Technology Phase I DD&D include the International Atomic Energy Agency schoolhouse portion of 3-66; Buildings 35-2 (33 percent), 35-27, 35-115, 35-247; and all TA-18 buildings. DD&D of these facilities is not part of the Institute for Nuclear Nonproliferation Science and Technology and would be handled separately.

To convert square feet to square meters, multiply by 0.092903.

Source: LANL 2006a.

Table G–5 Name, Function, and Number of Employees of Permanent Buildings Proposed for Decontamination, Decommissioning, and Demolition by the Radiological Sciences Institute Project

Technical Area Building [a]	*Name*	*Current Use*	*Employees* [b]
46-24 (50%)	Laboratory and Office Building	Optics laboratories	24
46-31 (25%)	Test Building No. 2	Optics laboratories	3
46-158 (15%)	Laser-Induced Chemistry Laboratory	Optics laboratories	1
46-200 (50%)	Chemistry and Laser Laboratory	Chemistry laboratory	2
46-250	Analytical Chemistry	Chemistry laboratory	7
48-1	Radiochemistry Building	Chemical laboratory (nuclear)	149
48-8	Isotope Separator Building	Machine shops	2
48-17	Assembly Checkout Building	Assembly facilities	3
48-26	Office Building	Office	2
59-1 (25%)	Occupational Health Laboratory	Radiation effects laboratory	46
3-29 (7%)	Chemistry and Metallurgy Research Laboratory (Hot Cells)	Nuclear laboratory	24
3-169 [c]	Warehouse (Sigma)	General storage	125
3-66 [c]	Sigma Building	Laboratories (nuclear)	125
3-451	Micro Machining Facility	Physics laboratory	8
3-1524	Laboratory and Office Building	Laboratories (nuclear)	2
35-2 [c]	Laboratory and Office Building (Nuclear Safeguards Research)	Laboratories (nuclear)	93
35-27 [c]	Nuclear Safeguard Laboratory	Laboratories (nuclear)	72
35-115	Solvent Storage Shed	Hazardous and flammable storage	0
35-347	Garage	General storage	0
18-1 [d]	Staging Area	Fabrication facility	1
18-28	Warehouse	Programmatic general storage	1
18-30	Main Building	Office	222
18-129	Reactor Sub-Assay Building	Nuclear physics laboratory	10
18-141	Ultra-Sonic Cleaning Building	Nuclear physics laboratory	0
18-147	Office Building	Office	6
18-227	Accelerator Device Laboratory	Accelerator building	0
18-256	Butler Building	Applied physics laboratory	0
18-297	Storage Building	General storage	0
3-102 [c]	Technical Shops Addition (Radiological Machine Shop)	Nuclear contaminated storage	0
Total			1,074 [e]

[a] Unless noted by a percentage shown in parentheses, 100 percent of the floor space and building function would be moved to the Radiological Sciences Institute.

[b] One hundred percent of employees currently located at each building are listed, except for those buildings where only a portion of the function is to be transferred to the Radiological Sciences Institute. In those instances, the number of employees that would move to the Radiological Sciences Institute was assumed to be proportional to the percentage of floor space in the building that the Radiological Sciences Institute would replace.

[c] Identified as a radiological facility in the *SWEIS Yearbook – 2003* (LANL 2004d).

[d] All TA-18 functions from the Pajarito Site, except the Solution High-Energy Burst Assembly (SHEBA), would be moved to the Radiological Sciences Institute.

[e] Total includes permanent buildings listed in this table and 146 employees located in transportables and trailers not included in the table.

Source: LANL 2006a.

G.3.2 Options Considered

The two options identified for the Radiological Sciences Institute are the No Action Option and the proposed project option.

G.3.2.1 No Action Option

Under the No Action Option, the current use of existing radiological facilities throughout LANL would continue. At least two facilities are currently planned for DD&D under other actions: the TA-18 and Chemistry and Metallurgy Research Buildings. The facilities have exceeded their design life and are rapidly becoming obsolete and seriously deteriorating; corrective maintenance actions would continue as failures occur. Maintenance cost would continue to escalate to support the aging facilities until they must be shut down. Upgrade costs to meet currently applicable building codes and safety and security requirements are prohibitive and would provide only a limited lifespan to existing facilities. LANL would systematically lose radiological competence, and mission commitments would not be met. Failures of the existing facilities and equipment would delay programmatic work, possibly damage equipment, and possibly pose a risk to personnel safety, campaigns, critical experiments, and related activities. Because nearly 70 percent of all LANL radiological facilities are 40 to 60 years old, they would experience more and more severe failures over time, until corrective maintenance is no longer possible and the facilities would have to be shut down if unreliability adversely impacts safety or the environment.

G.3.2.2 Proposed Project

Under the proposed project, the Radiological Sciences Institute would be constructed and 52 obsolete structures scattered over six TAs would undergo DD&D. This analysis assumes the Radiological Sciences Institute would consist of up to 13 facilities. Phase I of the Radiological Sciences Institute Project would include 5 buildings associated with the Institute for Nuclear Nonproliferation Science and Technology, for which construction would begin in 2009, with an estimated occupancy in fiscal year 2012. New construction for the Institute for Nuclear Nonproliferation Science and Technology would include a Security Category I and II laboratory with a Security Category I vault, several Security Category III and IV laboratories, a field test laboratory, a secure radiochemistry facility, and associated office support facilities, further described below.

- *Security Category I and II Facility* – a small Nuclear Hazard Category 2 laboratory located within a security Isolation Zone and within the Perimeter Intrusion Detection and Assessment System (PIDAS) adjacent to TA-55 but physically isolated from the programmatic activities and personnel inside TA-55. The facility would provide the ability to utilize and store Security Category I and II quantities of materials (including rollup of various numbers of Security Category III and IV quantities).

- *Security Category III and IV Laboratories* – an independent radiological facility incorporating both open and secured laboratories, used for research and development, testing, and evaluation of technology directly applied to nuclear nonproliferation programs.

- *Secure Radiochemistry Facility* – a secure, low-background-dissolving and radiochemistry capability for the receipt and processing of classified samples to meet the requirements of current and future national security programs. The building would be a vault-type room.

- *Field Test Laboratory* – an outdoor vehicle portal and long-standoff nuclear material monitoring and detection field laboratory to be used to develop and demonstrate advanced nuclear detection technology suitable for deployment in border-protection situations and in other environments requiring long-distance monitoring.

- *Office Support Facility* – an office complex sized to accommodate the staff in the Institute for Nuclear Nonproliferation Science and Technology, to include both open and secured office space, and mechanical, electrical, and software design, fabrication, and assembly facilities for building prototype instruments and supporting research and development needs.

The Radiological Sciences Institute would consolidate radiological activities in an optimally designed, efficient, safe, and secure set of buildings. Facilities would be included for wet chemistry, metallurgy, safeguards (domestic and international), material protection control and accountability, machining and manufacturing, and nonproliferation training schools. The complex would also include a Security Category I underground vault for storage of special nuclear material, eliminating (through underground tunnels) routine material transport on public roads. Also, the complex would be designed to accommodate multiple concurrent radiological activities and Security Categories (III and IV) and temporary Security Category II International Atomic Energy Agency training schools. A Nuclear Hazard Category 3 operations building for specific co-located actinide chemistry operations and safeguards would also be included. In addition to the programs and functions listed above, others that would be moved to the Radiological Sciences Institute and have measurable quantities of emissions or waste include those of the Sigma Complex (Buildings TA-3-66, -35, and -169), the Pajarito Site (TA-18 buildings, except the Solution High-Energy Burst Assembly (SHEBA Project), the Radiological Machine Shop at TA-3 (TA-3-102), the Chemistry and Metallurgy Research hot cells (located at TA-3-29), and the Radiochemistry Facility currently located in TA-48.

This project would also involve DD&D of 52 obsolete structures (80 percent of LANL's radiological facilities), accounting for approximately 636,000 gross square feet (59,100 square meters) of building space located in six TAs (TA-3, TA-18, TA-35, TA-46, TA-48, and TA-59) (LANL 2006a). There are about 1,074 employees located in buildings that would be replaced by the Radiological Sciences Institute (see Table G–5). Of that total, 293 are in existing buildings at TA-48 slated for replacement (193 in permanent structures and 100 in transportables or trailers). Phase I of the Radiological Sciences Institute (the Institute for Nuclear Nonproliferation Science and Technology) would occupy approximately 145,000 net square feet (13,500 square meters), a reduction of about 50,000 net square feet (4,600 square meters) relative to the facilities to be replaced, and would house approximately 450 to 500 technical and support staff (LANL 2006a).

G.3.3 Affected Environment and Environmental Consequences

For Radiological Sciences Institute construction and operation, the affected environment is primarily TA-48, although the region of influence for each resource evaluated may extend beyond TA-48 and LANL. For DD&D of buildings replaced by the Radiological Sciences Institute, the affected environment is primarily TA-3, TA-35, TA-46, TA-48, and TA-59. DD&D of buildings in TA-18 is not part of the impacts evaluation for the Radiological Sciences Institute, but rather is included as part of the TA-18 Closure, Including Remaining Operations Relocation, and Structure DD&D Impacts Assessment (see Appendix H). Also, the DD&D impacts for the Chemistry and Metallurgy Research Building hot cells (Wing 9 of Building 3-29) are not part of the Radiological Sciences Institute evaluation, but are included as part of the proposed project analyzed in the *Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory* (DOE 2003). The impacts of TA-18 operations and the hot cells that would be moved to the Radiological Sciences Institute are included in the affected environment baseline for comparison with the impacts of the new Radiological Sciences Institute.

The analysis of environmental consequences relies on the affected environment descriptions in Chapter 4 of this SWEIS. Where information specific to TA-48 (or the TAs impacted by DD&D activities) is available and aids understanding the Radiological Sciences Institute affected environment, it is included here. An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Socioeconomics and Infrastructure* – No new employment is expected. Construction and DD&D workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.

- *Environmental Justice* – The proposed project is mainly confined to already-developed areas, with no disproportionate human health impacts to low-income or minority populations expected.

This impact assessment focuses on those areas of the affected environment where potential impacts would occur: land resources, geology and soils, water resources, air quality and noise, ecological resources, human health, cultural resources, site infrastructure, waste management, transportation, and facility accidents.

G.3.3.1 No Action Option

Under the No Action Option, LANL radiochemistry capabilities would not be modernized and would not take on capabilities that could potentially be lost from LANL due to changes in other facilities (the Chemistry and Metallurgy Research and Pajarito Site). No disturbance of existing land or building sites would occur. There would be no construction or building removal debris to require disposal. Utility use would remain essentially the same as the present use. Continued expenses for repairs and replacement of aging heating, ventilation, and air conditioning systems and other building components would increase. As building systems and other components fail and cannot be replaced or repaired, affected buildings would be partially or completely closed and the staff relocated. Personnel would remain scattered throughout LANL, and collaboration between scientists and administrative personnel would be hindered. Under the No Action Option, the inefficiencies of using outmoded and deteriorating buildings would continue.

No changes in emissions or air pollutant concentrations are expected under the No Action Option. Under this option, radiological air emissions would continue to be generated from operations at the Sigma Complex (TA-3-66), Machine Shops (TA-3-102), Radiochemistry (TA-48), and hot cells (Wing 9) at the Chemistry and Metallurgy Research Building. No increases in emissions or additional radionuclides are expected under the No Action Option.

Human Health

The consequences of continued operations at facilities that release radiological air emissions, and would be consolidated in the proposed Radiological Sciences Institute (Sigma Complex [TA-3-66], Machine Shops [TA-3-102], and Radiochemistry [TA-48]), on public and worker health under the No Action Option are presented below. A discussion of the terminology used in the human health evaluation and basic radiological health effects and the methodologies used to evaluate consequences can be found in Appendix C of this SWEIS.

Public Health—The collective dose to the public from all airborne radioactive emissions from these three facilities was estimated to a 50-mile (80-kilometer) radius from each facility. The total population dose from all three facilities, shown in **Table G–6**, is estimated to be 0.18 person-rem per year, which is a small part of the total population dose (30 person-rem) from all Key Facilities at LANL. This population dose would result in no additional fatalities in the 50-mile (80 kilometer) radius population of close to 300,000.

Table G–6 Annual Radiological Impacts on the Public from Operations under the Radiological Sciences Institute Project No Action Option

	Population Dose within 50 Miles (80 kilometers)	*Facility-Specific MEI Dose*	*MEI Location (feet)*
Sigma (TA-3-66)	0.16 person-rem	0.026 millirem	N 3,560 LANL boundary
Machine Shops (TA-3-102)	0.013 person-rem	0.0023 millirem	N 3,380 LANL boundary
Radiochemistry (TA-48)	0.0065 person-rem	0.0019 millirem	NNE 2,920 Royal Crest Trailer Park
Total dose	0.18 person-rem	Not applicable	
Cancer fatality risk	0.00011	1.6×10^{-8} (Sigma)	
Regulatory dose limit [a]	Not applicable	10 millirem	
Background radiation dose [b]	120,000 person-rem	400 millirem	

MEI = maximally exposed individual, TA = technical area.

[a] Title 40 of the *Code of Federal Regulations*, Part 61, establishes an annual limit of 10 millirem via the air pathway to any member of the public from DOE operations. There is no standard for a population dose.

[b] The annual individual dose from background radiation at LANL ranges from a low of about 300 millirem to a high of about 500 millirem (see this SWEIS, Appendix C). The population living within 50 miles (80 kilometers) of TA-48 was estimated to be 299,508 in 2000.

Note: To convert feet to meters, multiply by 0.3048.

Sources: Chapter 5 and Appendix C of this SWEIS.

A maximally exposed individual (MEI) is a hypothetical member of the public residing at the LANL site boundary who would receive the maximum dose from facility emissions. Each facility has a different location for its MEI, based on many factors, including the climate, distance, type and amount of radiological air emissions, and physical form of the radionuclides. The location and estimated dose for each of the three facilities that have radiological air emissions are listed in Table G–6; these doses do not include exposures from other sources at LANL. The highest of the three MEI doses is from emissions at the Sigma Complex. This MEI would receive an estimated annual dose of 0.026 millirem from operations as compared to the LANL site-wide MEI, who would receive 7.8 millirem per year from emissions from all LANL facilities. To put these doses into perspective, comparisons with doses from natural background radiation and the regulatory limit of 10 millirem established in Title 40 *Code of Federal Regulations* [CFR] Part 61 are included in the table.

In general, collective total effective dose equivalent by Key Facility or TA is difficult to determine because these data are assigned to the individual worker, not to a specific TA or building. In addition, members of many groups and organizations receive doses at several locations. Under the No Action Option, the average worker doses expected at the Sigma Complex, Machine Shops, and Radiochemistry would be similar to those in the 6-year period from 1999 through 2004.

Hazardous Chemical Impacts—No chemical-related health impacts would be associated with this option. As stated in Chapter 5, Section 5.6, of this SWEIS, the quantities of chemicals that could be released to the atmosphere during routine normal operations are minor and would be below screening levels used to determine the need for additional analysis. Under normal operating conditions, workers would be protected from hazardous chemicals by adherence to Occupational Safety and Health Administration and EPA occupational standards that limit concentrations of potentially hazardous chemicals in the workplace.

Waste Management

The impacts of managing waste from continued operations at the Radiochemistry Facility, Sigma Complex, Pajarito Site (TA-18), and Machine Shops (Building 03-102 only) would be the same as those currently experienced at these facilities because the same types and quantities of waste would be generated and subsequently managed.

Some gains in waste management efficiencies are expected over the next few years, and these gains would be realized under both the No Action Option and the proposed project (that is, whether or not the Radiological Sciences Institute is constructed and operated). Significant reductions in the volume of radioactive liquid discharges are expected over the next few years as improvements are made to the beryllium laundry operations, electroplate bath condensate system, and perchloric acid exhaust duct washdown process. Based on historical data and planned improvements, the projected discharge volume of radioactive liquids is 845,000 gallons (3.2 million liters) per year (LANL 2006a).

Chemical waste generation rates are expected to be 31,000 pounds (14,000 kilograms) per year. Low-level radioactive waste generation rates are estimated to be 157 cubic yards (120 cubic meters) per year. Mixed low-level radioactive waste and transuranic waste generation rates are expected to be very low, approximately 1.3 cubic yards (1 cubic meter) per year for each category. No mixed transuranic waste is expected to be generated (LANL 2006a).

Facility Accidents

Potential accidents under the No Action Option estimated to have the highest impacts would involve radiological operations and materials associated with Chemistry and Metallurgy Research Wing 9 hot cell operations. Five accident scenarios were selected to represent the bounding impacts of accidents. Information used to estimate the impacts of these accidents is shown in **Table G–7**. The material at risk in a hot cell is estimated to be 10.6 ounces (300 grams) of plutonium-238 equivalent and an additional 28.7 pounds (13 kilograms) of plutonium-238 equivalent in iridium cans inside two layers of textured graphite (general purpose heat source modules).

Table G–7 Bounding Radiological Accident Scenarios under the Radiological Sciences Institute Project No Action Option

Accident	*Source Term* [a] *(curies)*	*Release Energy (watts)*	*Annual Frequency*
Hot cell fire involving plutonium-238 in general purpose heat source modules	5.13 plutonium-238	2.04×10^{6}	1.0×10^{-4}
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules	22.572 plutonium-238 1.386 plutonium-239	2.04×10^{6}	2.4×10^{-4}
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules	5.13 plutonium-238 0.315 plutonium-239	0	2.4×10^{-3}
Spill of plutonium-238 residue from 0.5-gallon (2-liter) bottles outside of hot cell	0.001283 plutonium-238	0	0.1
Hot cell plutonium-238 spill with no confinement	0.4104 plutonium-238	0	0.01

[a] A release height of 4.9 feet (1.5 meters) is assumed for all accidents. Specific activity is 0.063 curies per gram for plutonium-239 and 17.1 curies per gram for plutonium-238.

Assuming that an accident occurred, estimated consequences for a noninvolved worker located 330 feet (100 meters) from the accident, the onsite worker population, the MEI located at West Jemez Road, and the offsite population are shown in **Tables G–8** through **G–10**. Estimated risks that take accident frequency into account to these same receptors are shown in Table G–10.

The hypothetical accidents with the highest radiological impacts would be the seismic-induced building collapse with no fire and the seismic-induced building collapse with a fire involving plutonium-238 in general purpose heat source modules. If either of these accidents were to occur, the consequences are estimated to be 2.9 or 8.6 increased LCFs for the offsite population, 0.047 or 0.052 increased risk of an LCF for the MEI, and 0.21 or 0.18 increased risk of an LCF for a noninvolved worker located at a distance of 330 feet (100 meters) from the accident, respectively. After taking into account the frequency (or probability) of each accident, the seismic-induced building collapse with no fire is estimated to have the highest risks. For this accident, the annual risks are estimated to be 0.0069 LCFs for the offsite population, 0.00011 increased risk of LCFs for the MEI, and 0.00049 increased risk of an LCF for a noninvolved worker located at a distance of 330 feet (100 meters) from the accident.

Table G–8 Radiological Accident Offsite Population Consequences under the Radiological Sciences Institute Project No Action Option

Accident	*MEI*		*Population to 50 Miles (80 kilometers)*	
	Dose (rem)	*LCF* [a]	*Dose (person-rem)*	*LCF* [b, c]
Hot cell fire involving plutonium-238 in general purpose heat source modules	9.18	0.0055	3,060	1.84
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules	43	0.052	14,400	8.64
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules	39	0.047	4,770	2.86
Spill of plutonium-238 residue from (0.5-gallon (2-liter) bottles outside of hot cell	0.012	7.4×10^{-6}	1.12	0.00067
Hot cell plutonium-238 spill with no confinement	3.96	0.0024	359	0.22

MEI = maximally exposed individual, LCF = latent cancer fatality.

[a] Increased risk of an LCF to an individual, assuming the accident occurs.

[b] Increased number of LCFs for the offsite population, assuming the accident occurs.

[c] Offsite population size is approximately 300,000 persons.

Table G–9 Radiological Incident Onsite Worker Consequences under the Radiological Sciences Institute Project No Action Option

Accident	*Noninvolved Worker at 330 Feet (100 meters)*	
	Dose (rem)	*LCF* [a]
Hot cell fire involving plutonium-238 in general purpose heat source modules	32.5	0.039
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules	152	0.18
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules	171	0.21
Spill of plutonium-238 residue from 0.5-gallon (2-liter) bottles outside of hot cell	0.045	2.7×10^{-5}
Hot cell plutonium-238 spill with no confinement	14.3	0.0086

LCF = latent cancer fatality.

[a] Increased risk of an LCF to an individual, assuming the accident occurs.

The impacts of the other postulated accidents are shown in Tables G–8 through G–10. Comparing the seismic accident that includes a fire with one that does not include a fire, the former has higher offsite population and MEI impacts, while the latter has higher individual worker and worker population impacts. This is because the buoyant effects of a fire loft the radioactive plume over the onsite workers, while the greater releases associated with this scenario would impact the general population farther downwind. In contrast, the absence of a fire and its buoyant effects has a greater impact on close-in individuals like the noninvolved worker at 330 feet (100 meters) and the large worker population at the Chemistry and Metallurgy Research Building.

Table G–10 Radiological Accident Offsite Population and Worker Risks under the Radiological Sciences Institute Project No Action Option

Accident	*Onsite Worker (LCFs)*	*Offsite Population (LCFs)*	
	Noninvolved Worker (at 330 feet [100 meters]) [a]	*MEI* [a]	*Population to 50 Miles (80 kilometers)* [a, b]
Hot cell fire involving plutonium-238 in general purpose heat source modules	3.9×10^{-6}	5.5×10^{-7}	0.00018
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules [c]	4.4×10^{-5}	1.2×10^{-5}	0.0021
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules [c]	0.00049	1.1×10^{-4}	0.0069
Spill of plutonium-238 residue from 0.5-gallon (2-liter) bottles outside of hot cell	2.7×10^{-6}	7.4×10^{-7}	6.7×10^{-5}
Hot cell plutonium-238 spill with no confinement	8.6×10^{-5}	2.4×10^{-5}	0.0022

LCF = latent cancer fatality, MEI = maximally exposed individual.

[a] Increased risk of an LCF to an individual per year.

[b] Offsite population size is approximately 300,000 persons.

[c] An updated probabilistic seismic hazard analysis has been completed for LANL (LANL 2007), which results in higher peak horizontal ground acceleration values for the same annual probability of exceedance. In the seismic accident analyses for the Chemistry and Metallurgy Research Building, the radioactive source term was conservatively based on the assumption that all structures, systems, and components failed, therefore, the updated probabilistic seismic hazard analysis is not expected to change the accident consequences or risks.

G.3.3.2 Proposed Project

Land Resources—Land Use

Construction Impacts—Construction of the Radiological Sciences Institute, including parking lots and construction laydown areas, would require 33.6 acres (13.6 hectares) of land. Of the land area required for the Radiological Sciences Institute, approximately 12.6 acres (5.1 hectares) are undeveloped (LANL 2006a).

Operations Impacts—Upon project completion, 32 acres (13 hectares) would be occupied by permanent facilities. While the land use designation of much of the site would remain Reserve, some Reserve areas and the currently designated Experimental Science area would be redesignated in the future as Nuclear Materials Research and Development (LANL 2003b).

The Radiological Sciences Institute would be constructed in TA-48 and a small portion of TA-55 located within the Pajarito Corridor West Development Area. Construction of the Radiological Sciences Institute within TA-48 would take place in areas designated within that plan as available for Primary Development and Proposed Parking, as well as within the currently developed portion of the site which is identified as Potential Infill. Although the Radiological Sciences Institute would result in the use of previously undeveloped land and involve a change in land use designation in TA-48, its construction would be compatible with future land use plans. The small portion of the western edge of TA-55 that would be affected by the Radiological Sciences Institute is classified as Nuclear Materials and Research. Under this option, land use within this area would not change from its current land use designation of Nuclear Materials Research and Development.

DD&D Impacts—DD&D of buildings proposed for replacement is not expected to result in a change in land use at the respective TAs. These structures are within built-up areas that would continue to be used for other purposes. Once removed, the land upon which these buildings stood would be available for future development.

Land Resources—Visual Resources

The buildings that would be replaced by the Radiological Sciences Institute are all in currently developed areas consisting of industrial and office buildings, transportables, and trailers. The buildings are primarily located in TAs along Pajarito Road, except buildings in TA-3. As with TA-48, the views are industrial in nature and are viewed primarily by site personnel.

Construction Impacts—Construction of the Radiological Sciences Institute would result in a change in both near and distant views of TA-48 and the western edge of TA-55. Short-term impacts would include the construction activity itself as well as increased dust generation. Although landscaping is planned along Pajarito Road following construction, new buildings and parking lots would be more visible from the road than current facilities due to their increased number and size. Additionally, a number of buildings, as well as parking lots, would be located closer to the road than are the current Advanced Radiochemistry Diagnostics Building and associated facilities. These changes in the visual environment would mainly impact LANL employees. Additionally, new development of TA-48 would be visible at the entrance to the controlled access along Pajarito Road and to viewers in the southeast quadrant of TA-3.

Distant views from the higher elevations to the west of TA-48 (as well as the western edge of TA-55) would also change as a result of construction of the Radiological Sciences Institute, as the size of the developed area would increase as well as the number of buildings and parking lots. However, the overall effect on the view would be minimal due to the present nature of development on the mesa.

DD&D Impacts—Although removal of buildings that the Radiological Sciences Institute would replace would positively affect visual resources, the level of improvement would be small. Near views of LANL facilities along the mesa are seen mostly by LANL employees. From higher elevations to the west, the Pajarito Mesa presents the appearance of a mosaic of industrial buildings within a ponderosa pine forest. Removal of a limited number of buildings would not appreciably change the view.

Geology and Soils

The 9-mile-long (14-kilometer-long) Rendija Canyon Fault is located approximately 0.5 miles (0.8 kilometers) east of the Radiochemistry Laboratory at TA-48. Geologic mapping shows that there is no faulting in the near surface directly beneath TA-48. The closest fault is located about 300 feet (90 meters) southwest of the Radiochemistry Laboratory (LANL 2004c). This small fault trace exhibits only about 2 feet (0.6 meters) of offset. Most of these small faults have been inferred to represent ruptures subsidiary to the major faults, and, as such, their potential rupture hazard is very small (Gardner et al. 1999). Additionally, all buildings in the Radiological Sciences Institute would be designed in accordance with current DOE seismic standards and applicable building codes.

The proposed area for the facility includes undisturbed soils that maintain the present vegetative cover. They are arid soils consisting largely of sandy loam material alluvially deposited from tuff units on higher slopes to the west and eroded from underlying geologic units. In general, the soils are poorly developed with relatively little horizon differentiation and organic matter accumulation. These factors, combined with the dry moisture regime of the area, result in only a limited number of plant species being able to subsist on the soil medium, which, in turn, supports a very limited number of wildlife species.

Construction Impacts—Approximately 802,000 cubic yards (613,000 cubic meters) of soil would be disturbed during building excavation. These estimates are based on building footprints and do not include the impact of short-term construction support activities such as the use of equipment laydown yards. The impact of such support areas would be minimized by locating these facilities in developed areas such as parking lots.

Adherence to standard best management practices for soil erosion and sediment control, including watering, during construction would serve to minimize soil erosion. After construction, disturbed areas would lie within the footprint of the new buildings and roadway, with temporarily disturbed areas stabilized and revegetated, so they would not be subject to long-term soil erosion.

For construction of the Security Category I underground vault for special nuclear material storage and the associated tunnel, excavation depths of up to 45 feet (14 meters) into the mesa may be necessary. Excavation of welded tuff could necessitate blasting to speed construction. A site survey and foundation study would be conducted as necessary to confirm site geologic characteristics for facility engineering purposes. In addition, prior to commencing ground disturbance, NNSA would survey potentially affected contaminated areas to determine the extent and nature of any contamination and required remediation in accordance with LANL procedures.

Aggregate (sand, gravel, crushed stone) and other geologic resources would be required to support Radiological Sciences Institute construction activities at TA-48, but such resources are readily available from onsite borrow areas and otherwise abundant in the vicinity of Los Alamos County.

Operations Impacts—Radiological Sciences Institute operations would not result in additional impacts on geologic and soil resources at LANL. Any new facilities and uses within TA-48 would be evaluated, designed, and constructed in accordance with DOE Order 420.1B and sited to minimize risk from geologic hazards, including earthquakes.

DD&D Impacts—DD&D activities associated with existing radiological facilities would have a negligible additional impact on geologic and soil resources at LANL, as the affected facility areas are already developed and adjacent soils are already disturbed. Additional ground disturbance would be necessary to establish laydown yards and waste management areas in the vicinity of the facilities to be razed. Available paved surfaces, such as parking lots in the vicinity of the facilities to be demolished, would be used to the extent possible.

The major indirect impact on geologic and soil resources at DD&D locations would be associated with the need to excavate any contaminated tuff and soil from beneath and around facility foundations. Borrow material (such as crushed tuff and soil) would be required to fill the excavations to grade, but such resources are readily available from onsite borrow areas and otherwise abundant in the vicinity of Los Alamos County. LANL staff would survey potentially affected contaminated areas to determine the extent and nature of any contamination and required remediation in accordance with LANL procedures and the Consent Order. All excavated material would be characterized before removing it for disposal.

Water Resources

All radioactive liquid effluents are directed to the Radioactive Liquid Waste Treatment Facility in TA-50 and sanitary liquid effluents to the Sanitary Wastewater Systems Plant in TA-46. Any potential contamination sources, such as aboveground storage tanks, are controlled through a Spill Prevention Control and Countermeasures Plan.

For TAs that would be impacted by DD&D activities, there are currently two National Pollutant Discharge Elimination System (NPDES) outfalls (which discharged 3.81 million gallons [14.4 million liters] in 2005) associated with the Sigma Complex at TA-3 (LANL 2006f). There is also one NPDES outfall (which discharged 0.92 million gallons [3.48 million liters] in 2005) associated with the Chemistry and Metallurgy Research Building at TA-3, but it is not associated with the Wing 9 hot cells.

Construction Impacts—Little or no effect on surface water resources is anticipated during construction of the Radiological Sciences Institute. The proposed project would not result in disturbance of watercourses or generation of liquid effluents that would be released to the surrounding environment. Silt fences, hay bales, or other appropriate best management practices would be employed and specified in a stormwater pollution prevention plan to ensure that fine particulates created during construction would not be transported by stormwater into surface water features in the vicinity of TA-48.

Operations Impacts—The proposed project should produce minimal effects on surface water resources during operations. There are three NPDES outfalls associated with facilities moving to the Radiological Sciences Institute. The Sigma Complex currently has two NPDES outfalls (03A-022 and 03A-024) (LANL 2006a), and the Chemistry and Metallurgy Research Building has one NPDES outfall (03A-021) (LANL 2006a), but it is not associated with the Chemistry and Metallurgy Research Building hot cell operations that would be moved into the Radiological Sciences Institute.

There would be more stormwater runoff from the new facility because of the increase in impervious areas of buildings and parking lots. This may be offset by the decreased stormwater runoff from the demolished facilities.

Aboveground storage tanks may be added to the Radiological Sciences Institute, but the number would not exceed the current number of aboveground storage tanks associated with the operations slated to be moved to the Radiological Sciences Institute. Radioactive and sanitary liquid effluents from the Radiological Sciences Institute would continue to be discharged to the Radioactive Liquid Waste Treatment Facility and Sanitary Wastewater Systems Plant, respectively.

The proposed project should produce minimal effects on groundwater resources during operations. Potable and industrial water use during operation of the Radiological Sciences Institute would not vary significantly from current volumes used for operations at the various radiological facilities that would be incorporated at the Radiological Sciences Institute. The cooling tower at Building 48-1 and the Sigma Building 3-66 would be incorporated into a new cooling tower system for the Radiological Sciences Institute. The cooling tower cycle increase program would reduce the amount of water used by this new system. Groundwater quality should not be affected by the operation of the Radiological Sciences Institute, as no new potential contamination sources would be added.

DD&D Impacts—Although several of the NPDES outfalls at the facilities to be demolished have already been blocked off and no longer discharge industrial effluent to the environment, the possibility of accidental discharges through these drains would be eliminated when the buildings at TA-3-66, TA-18, and TA-35 are demolished (LANL 2006a). Elimination of the 14 buildings at TA-18 that would be replaced by the Radiological Sciences Institute also would eliminate a potential source of contamination in the Pajarito Canyon 100-year floodplain. As noted above, increased impervious areas at the Radiological Sciences Institute that would create more stormwater runoff may be offset by the decreased stormwater runoff from demolished buildings and parking lots.

Air Quality and Noise

Nonradiological air pollutant emission sources at TA-48 include three natural-gas-fired boilers and emissions from various toxic chemicals. Emissions from boilers for 2003 are reported in **Table G–11**. **Table G–12** shows emissions of other pollutants from the Machine Shop at TA-3 and activities at TA-18 that could be transferred to TA-48.

Table G–11 Nonradiological Air Pollutant Emissions at Technical Area 48 – 2003 (tons per year)

Pollutant	*Boiler BS-1*	*Boiler BS-2*	*Boiler BS-6*
Criteria Pollutants			
Carbon monoxide	0.455	0.455	0.609
Nitrogen oxides	0.542	0.542	0.725
Particulate matter	0.041	0.041	0.055
PM_{10}	0.041	0.041	0.055
$PM_{2.5}$	0.041	0.041	0.055
Sulfur oxides	0.003	0.003	0.004
Volatile organic compounds	0.030	0.030	0.040

PM_{10} and $PM_{2.5}$ = particulate matter with aerodynamic diameters of 10 and 2.5 micrometers, respectively, or less.
Source: LANL 2006e.

Table G–12 Nonradiological Air Pollutant Emissions at Technical Area 3 Machine Shops and Technical Area 18 – 2005 (tons per year)

Pollutant	*Machine Shop (TA-3)*	*TA-18 Pajarito Site*
Ethanol	0.012	0.0035
Kerosene	0.0012	0
Zinc chloride fume	0	0.00013

TA = technical area.
Source: LANL 2006f.

Radiological air emissions for 1999 – 2005 are presented in Chapter 4, Section 4.4.3.1. Doses associated with radiological emissions at LANL are discussed in the section on human health. Emissions from three facilities that are projected to be consolidated in the proposed Radiological Sciences Institute are, or have been, monitored for radiological air emissions. Both the Machine Shops at TA-3 and Radiochemistry Complex at TA-48 have monitored point sources. Monitoring at the Sigma Complex (TA-3) was discontinued in 2000; it was determined that because of sufficiently low emissions, stack monitoring was no longer necessary for compliance. There are radiological air emissions from TA-18, but because the source of those emissions, SHEBA, would not be moved to the Radiological Sciences Institute, those data are not included here.

Estimated emission rates for toxic air pollutants emitted at TA-48 were compared to screening-level emission values for the *Site-Wide Environmental Impact Statement for the Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS)* (DOE 1999a). A screening-level emission value was developed for each chemical. A screening level emission value is a theoretical maximum emission rate that, if emitted at that TA over a short-term (8-hour) or long-term (1-year) period, would not exceed a health-based guideline value. This screening-level emission value was compared to the emission rate that would result if all the chemicals purchased for use in the facilities at a TA over the course of 1 year were available to become airborne. At TA-48, chemicals have been emitted at levels below the screening levels identified.

Construction Impacts—Construction of new facilities at TA-48 would result in temporary increases in air quality impacts of construction equipment, trucks, and employee vehicles. Criteria pollutant concentrations were modeled for the site work and erection construction phases of the TA-48 Radiological Sciences Institute’s largest new facilities. Maximum ground-level concentrations off site and along the perimeter road to which the public has regular access would be below ambient air quality standards, and the air quality impacts on the public would be minimal. Estimated concentrations for PM_{10} would be greatest for the site work phase. Estimated maximum PM_{10} concentrations are an annual average of 2.3 micrograms per cubic meter and a 24-hour average of 31.9 micrograms per cubic meter. The maximum annual and short-term concentrations for construction would occur at the site boundary north of TA-48. Construction modeling considered particulate emissions from activity in the construction area and emissions from various earthmoving and material-handling equipment.

Although no radiological releases to the environment are expected in association with construction activities at TA-48, the potential exists for contaminated soils and possibly other media to be disturbed during excavation and other site activities. A large potential release site encircles all of TA-48-1 and TA-48-45 (LANL 2006a). To determine the extent and nature of any contamination, an assessment of the affected areas would be performed prior to commencing ground disturbance. As needed, any contamination found would be remediated before continuing, and appropriate personal protection equipment would be required for working in this area.

In addition, there are other potential release sites within TA-48 (LANL 2006a). These sites and others at LANL are being investigated and assessed consistent with DOE requirements and the Consent Order. If it is determined that the potential release sites pose an unacceptable risk to the public or to LANL workers, the sites would be cleaned up before proceeding.

Construction of the new Radiological Sciences Institute at TA-48 would result in some temporary increase in noise levels near the area from construction equipment and activities. Some disturbance of wildlife near the area may occur as a result of construction equipment operation. There would be no change in noise impacts on the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from construction employees' vehicles and materials shipments. Noise sources associated with construction at TA-48 may include loud impulsive sources such as blasting.

Operations Impacts—Under the proposed project, criteria and toxic air pollutants would be generated from the operation and testing of an emergency generator, use of various chemicals in laboratories, and other activities. Emissions from the diesel generator would occur during periodic testing resulting in little change in air pollutant concentrations. Air quality impacts on the public would be minor.

Little or no change in toxic pollutant emissions or air pollutant concentrations at LANL is expected under this option. For facilities that would be combined at TA-48, toxic pollutants released from laboratories would be similar to those from current uses as shown under the No Action Option and would vary by year with the activities performed. Emissions would continue to be below screening-level emission values, and air quality impacts on the public would be minor.

Projected annual radiological air emissions from the Radiological Sciences Institute were estimated to be the combined total of the projected emissions from the individual facilities whose functions would be moved to the Radiological Sciences Institute. The projected emissions are shown in **Table G–13**. The individual facility air emissions combined together in the Radiological Sciences Institute at TA-48 are described in detail in this SWEIS, Appendix C (Human Health). Impacts of radiological air emissions released during normal operations are discussed under Human Health.

Noise impacts of operation of the new Radiological Sciences Institute at TA-48 are expected to be similar to those from existing operations at TA-48. Although there would be a slight increase in traffic and equipment noise near the area (for example, new heating and cooling systems), there would be minimal change in noise impacts on wildlife and no change in noise impacts on the public outside of LANL as a result of operating these new facilities.

Table G–13 Radiological Air Emissions from the Radiological Sciences Institute

Radionuclide	*Emission Rate (curies per year)*
Arsenic-72	1.21×10^{-4}
Arsenic-73	2.55×10^{-3}
Arsenic-74	1.33×10^{-3}
Beryllium-7	1.65×10^{-5}
Bromine-77	9.35×10^{-4}
Germanium-68	8.97×10^{-3}
Krypton-85	1.00×10^{2}
Rubidium-86	3.08×10^{-7}
Selenium-75	3.85×10^{-4}
Xenon-131m	4.50×10^{1}
Xenon-133	1.50×10^{3}
Other activation products [a]	5.58×10^{-6}
Plutonium-239	1.21×10^{-5}
Uranium-234	6.60×10^{-5}
Uranium-235	4.84×10^{-7}
Uranium-238	1.95×10^{-3}
Mixed fission products [b]	1.54×10^{-4}

[a] Other activation products are a mixed group of activation products represented by strontium-90 and yttrium-90 in equilibrium.

[b] Mixed fission products are rep resented by strontium-90 and yttrium-90 in equilibrium.

Source: Appendix C of this SWEIS.

DD&D Impacts—DD&D of buildings at TA-3, TA-18, TA-35, TA-46, TA-48, and TA-59 would result in temporary increases in air quality impacts from construction equipment, trucks, and employee vehicles. Maximum ground-level concentrations at the site boundary would be below the ambient air quality standards, except for possible short-term concentrations of carbon monoxide. Concentrations off site and along the perimeter road to which the public has regular access would be below ambient air quality standards, and it is expected that air quality impacts on the public would be minor.

DD&D of buildings at TA-3, TA-35, and TA-48 would result in some release of radionuclides. The potential exists for contaminated soils, building debris, and possibly other media to be disturbed during demolition of these facilities. The release of radionuclides would be minimized by proper decontamination of buildings prior to demolition and the use of appropriate containment devices. Radiological air emissions would be comparable to or less than those emitted during normal operations. Impacts of these radiological air emissions released during DD&D of the buildings under the proposed project are discussed under Human Health.

DD&D of buildings at TA-3, TA-18, TA-35, TA-46, TA-48, and TA-59 would result in some temporary increase in noise levels near the area from construction equipment and activities. Some disturbance of wildlife near the area may occur as a result of demolition activity. There would be no change in noise impacts on the public outside of LANL as a result of these activities, except for a small increase in traffic noise levels from employee vehicles and debris shipments.

Ecological Resources

Effects of the Cerro Grande Fire within TA-48 varied from a burn severity of medium to low or unburned. Those portions of the TA in the vicinity of the Radiochemistry Building (Building 48-1) were categorized as being burned at the low or unburned severity level (DOE 2000). The buildings that would be replaced by the Radiological Sciences Institute are all located in currently developed industrial and office areas. While buildings situated in TA-3, TA-35, TA-46, TA-48, and TA-59 are located within the ponderosa pine forest vegetation zone and those in TA-18 are in the pinyon (*Pinus edulis* Engelm.)- juniper (*Juniperus monosperma* [Engelm.] Sarg.) woodland vegetation zone, wildlife use of the areas in the immediate vicinity of the buildings would be limited. Due to the presence of people, activity, and security fencing, no large animals are usually found within developed areas.

Four wetlands occur in TA-48, three of which are located within Mortandad Canyon between TA-48 and TA-60. These wetlands, which total about 1.1 acres (0.4 hectares), are characterized by coyote willow (*Salix exigua* Nutt.), Baltic rush (*Juncus balticus* Willd.), cattail (*Typha* spp.), and wooly sedge (*Carex lanuginose* Michx.). The fourth wetland is located between TA-48 and TA-55; cattail is the dominant plant. This wetland is less than 0.1 acre (0.04 hectares) in size (ACE 2005).

Surface water flow within that portion of Mortandad Canyon on the northern boundary of TA-48 is ephemeral. Thus, there are no fish or other permanent aquatic resources present within TA-48. Further, there are no permanent water bodies in any of the TAs within which buildings are to be removed.

Although there are no threatened or endangered species in the TA-48 area (LANL 2006a), portions of the TA are located within both the core habitat and buffer zone of the Mexican spotted owl for the Sandia-Mortandad Canyon Area of Environmental Interest. However, the buffer and core areas encompass only the eastern portion of the TA. They do not include developed areas (or areas adjacent to developed areas) on the mesa. Additionally, a small portion of the southeast corner of TA-48 and the western edge of TA-55 fall within the buffer zone of the Pajarito Canyon Mexican spotted owl Area of Environmental Interest. Areas of Environmental Interest are established under the *LANL Threatened and Endangered Species Habitat Management Plan* to protect important breeding or wintering habitat for certain sensitive species. Areas of Environmental Interest for the bald eagle and southwestern willow flycatcher do not include any part of TA-48 (LANL 1998).

Of those TAs where buildings are to be demolished in connection with the new Radiological Sciences Institute (TA-3, TA-18, TA-35, TA-46, and TA-59), only TA-3 and TA-35 fall within the core areas of the Los Alamos Canyon and Sandia-Mortandad Canyon Areas of Environmental Interest, respectively, of the Mexican spotted owl. However, only those buildings to be removed at TA-35 are within developed core habitat. None of these TAs falls within Areas of Environmental Interest for the bald eagle or southwestern willow flycatcher (LANL 1998).

Construction Impacts—Although construction of some of the new facilities associated with the Radiological Sciences Institute would involve previously disturbed land, about 12.6 acres (5.1 hectares) of ponderosa pine forest at TA-48 and within the small area of TA-55 would be cleared (LANL 2006a). This would result in decreased less-mobile wildlife such as reptiles and small mammals, and cause more-mobile species, such as birds or large mammals, to be displaced. The success of displaced animals would depend on the carrying capacity of the area into which they move. If the area were at its carrying capacity, displaced animals would not likely survive. Indirect impacts of construction, such as noise or human disturbance, could also impact wildlife living adjacent to the construction zone. Such disturbance would span the construction period. The work area would be clearly marked to prevent construction equipment and workers from disturbing adjacent natural habitat.

Construction of the Radiological Sciences Institute would not directly impact wetlands located in Mortandad Canyon or the small wetland situated between TA-48 and TA-55. Best management practices would reduce the potential for indirect impacts to wetlands at TA-48.

While there are no threatened or endangered species in the TA-48 area, portions of the TA are located within both the core and buffer zones of the Sandia-Mortandad Canyon and Pajarito Canyon Mexican spotted owl Areas of Environmental Interest. However, only a small portion of the Radiological Sciences Institute may be built within buffer habitat; most new structures would not be in core or buffer zones. Thus, the biological assessment prepared by DOE concluded that with the application of reasonable and prudent alternatives such as reseeding and erosion protection, the project may affect, but is not likely to adversely affect, the Mexican spotted owl (LANL 2006b). The USFWS has concurred with this assessment (see Chapter 6, Section 6.5.2).

Areas of Environmental Interest for the bald eagle and southwestern willow flycatcher do not include any part of TA-48 or TA 55. Recognizing that the bald eagle forages over all of LANL and that some habitat degradation is associated with construction of the Radiological Sciences Institute, the DOE biological assessment concluded that with appropriate reasonable and prudent alternatives (see Section G.2.3.2) the project may affect, but is not likely to adversely affect, the bald eagle. Since the nearest southwestern willow flycatcher Area of Environmental Interest is over 3 miles (4.8 kilometers) from the project site it was determined that there would be no effect on this species (LANL 2006b). The USFWS has concurred with the biological assessment as it relates to bald eagle and southeastern willow flycatcher (see Chapter 6, Section 6.5.2).

Operations Impacts—Operation of the Radiological Sciences Institute would have minimal impact on terrestrial resources within or adjacent to TA-48. Because the wildlife residing in the area has already adjusted to current levels of noise and human activity associated with current operation, it would not likely be adversely affected by similar types of activity involved with operation of the new facility. Areas not permanently disturbed by the new facility (for example, construction laydown areas) would be landscaped. While these areas would provide some habitat for wildlife, species composition and density would differ from preconstruction conditions.

DD&D Impacts—Removal of existing structures that the Radiological Sciences Institute is to replace would generate increased noise and levels of human disturbance. However, impacts would be temporary and would have minimal effect on wildlife, as these structures exist within disturbed areas and wildlife in adjacent areas is accustomed to human activity. Upon demolition of the buildings, the land would be revegetated and could be available for other uses. Because revegetation would primarily be for purposes of soil stabilization, there would be little benefit for wildlife. Also, if the land were redeveloped, there would be little change in its value as wildlife habitat; however, if development did not take place and native species were used in the revegetation effort, wildlife could benefit. Specific effects would depend on the nearness of existing development and natural habitat.

Since wetlands do not exist in the immediate area of any of the buildings to be removed in association with the new Radiological Sciences Institute, there would be no direct impacts on this resource. The use of best management practices would prevent erosion and subsequent sedimentation of any wetlands located in the canyons.

As noted above, of the buildings to be demolished in connection with the Radiological Sciences Institute, only those located in TA-35 occur within developed core habitat for the Mexican spotted owl. The removal of these buildings could produce noise greater than 6 decibels A-weighted (dB[A]) above background levels in undeveloped core habitat to the north in Mortandad Canyon. However, provided that reasonable and prudent alternatives are followed, the biological assessment concluded that demolition may affect, but is not likely to adversely affect, the Mexican spotted owl. Reasonable and prudent alternatives include muted back-up indicators on heavy equipment and reseeding and erosion protection. Also, activities involving heavy equipment would not be permitted to take place between March 1 and May 15, or until the completion of surveys for spotted owls. If owls were determined to be present, work restrictions would be extended until August 31. Potential impacts from DD&D activities to the bald eagle and southwestern willow flycatcher would not be expected (LANL 2006b). The USFWS has concurred with the biological assessment as it relates to impacts to the Mexican spotted owl, bald eagle and southeastern willow flycatcher from building demolition (see Chapter 6, Section 6.5.2).

Human Health

Construction Impacts—No radiological risks would be incurred by members of the public from construction activities. Construction workers would be at a small risk for construction-related accidents and radiological exposures. They could receive doses above natural background radiation levels from exposure to radiation from other past or present activities at the site. Any contamination that might be present in the soil would have been determined during site characterization and cleaned up accordingly. Workers would be protected through appropriate training, monitoring, and management controls. Their exposure would be limited to ensure that doses were kept as low as reasonably achievable (ALARA).

The potential for industrial accidents is based on both DOE and Bureau of Labor Statistics data on construction injuries and fatalities. Based on an estimated 3.12 million person-hours to construct the new facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be 35 (DOE 2004) to 132 (BLS 2003).

Operations Impacts—Radiological Sciences Institute operations would not exceed the combined current operational limits. **Table G–14** shows that the annual collective dose to the population living within a 50-mile (80-kilometer) radius of the new Radiological Sciences Institute at TA-48 would be 0.26 person-rem, far less than the total population dose (30 person-rem) from all Key Facilities at LANL. This population dose would result in no additional fatalities in the population.

Table G–14 Annual Radiological Impacts on the Public from Radiological Sciences Institute Operations [a]

	Population Dose within 50 Miles (80 kilometers)	*MEI Dose*	*MEI Location (feet)*
Dose	0.26 person-rem	0.077 millirem	NNE 2,920 Royal Crest Trailer Park
Cancer fatality risk [b]	0.00016	4.6×10^{-8}	–
Regulatory dose limit [c]	Not applicable	10 millirem	–
Background radiation dose [d]	120,000 person-rem	400 millirem	–

MEI = maximally exposed individual.

[a] The stack parameters were conservative estimates used for the purpose of calculating a dose. A stack height of 10 meters, diameter of 1 meter, and exit velocity of 1 meter per second were used.

[b] Based on a risk estimate of 0.0006 LCFs per person-rem (see Appendix C of this SWEIS).

[c] 40 CFR Part 61 establishes an annual dose limit of 10 millirem via the air pathway to any member of the public from DOE operations. There is no standard for a population dose.

[d] The annual individual dose from background radiation at LANL ranges from a low of about 300 millirem to a high of about 500 millirem (see Appendix C of this SWEIS). The population living within 50 miles (80 kilometers) of TA-48 was estimated to be 299,508 in 2000.

Note: To convert feet to meters, multiply by 0.3048.

An MEI is a hypothetical member of the public residing at the LANL site boundary who would receive the maximum dose. The MEI, located at the Royal Crest Trailer Park, would receive an estimated annual dose of 0.077 millirem from Radiological Sciences Institute operations, as shown in Table G–14. This dose corresponds to an increased annual risk of developing a fatal cancer of 4.6×10^{-8}, or about 1 chance in 22 million for each year of operation.

Depending on the new facility layouts and consolidation of activities, the worker doses may vary from those at the existing facilities. Worker doses would be similar to those under the No Action Option or potentially less due to the improved facility design.

Neither additional chemicals nor an increase in chemical inventories is expected over those associated with current operating levels at the proposed new facility. Therefore, there would be no chemical-related health impacts on workers or the public expected under this option. The quantities of most chemicals that could be released to the atmosphere during routine normal operations are minor and would be below screening levels used to determine the need for additional analysis.

DD&D Impacts—Nonradiological DD&D health impacts could include construction-type injuries and possible fatalities. Based on an estimated 1 million person-hours for DD&D of the existing facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be 12 (DOE 2004) to 45 (BLS 2003).

Demolition of the buildings might also involve removal of some asbestos-contaminated material. Removal of this material would be conducted according to existing asbestos management programs at LANL in compliance with strict asbestos abatement guidelines. Workers would be protected by personal protective equipment and other engineered and administrative controls, and no asbestos would be released that could be inhaled by members of the public.

Potential radiological DD&D health impacts were evaluated for members of the public and workers. The main radiological impacts would result from DD&D of the Sigma Complex (TA-3-66), Machine Shop (Building TA-3-102), and Radiochemistry site (TA-48). Quantitative information has not been presented, as project-specific work plans have not been prepared nor have the buildings in question been completely characterized with regard to types and locations of contamination. The Chemistry and Metallurgy Research Building Wing 9 was not included in the DD&D analysis, as it has previously been considered in a prior NEPA compliance document (DOE 2003). In addition, DD&D impacts of other partial buildings were not included. In addition to those listed above, several other buildings were reviewed with regard to health impacts because they were monitored for radiological air emissions in the past, currently house radiological sources, or have potential for radiological air emissions based on past functions. The review indicated that there would be no health impacts of their DD&D on members of the public or workers.

During early DD&D stages, when interior equipment is being removed from the buildings in question, doses to the public would be comparable to or less than those estimated for normal operation (see Table G–6). The building structures would be intact, with operating filtering systems for the stacks, while the decontamination and decommissioning were taking place. No additional nuclides would be introduced during these stages. Worker doses during decontamination and equipment removal may be higher than during normal operations but would be managed to remain under the DOE Administrative Control Level of 2,000 millirem per year and ALARA (DOE 1999b).

The primary source of potential consequences to workers and members of the public would be associated with the release of radiological air emissions during the demolition stage. Any radiological air emissions would be reduced by plastic draping and an enclosure, coupled with HEPA filters. Potential releases of radioactive particulates from disposition activities are expected to be lower than releases from past normal operations.

Cultural Resources

Surveys have identified two archaeological resource sites within TA-48, both of which are eligible for the National Register of Historic Places. The prehistoric site is a one- to three-room structure, whereas the historic site is a rock and wood enclosure. Additionally, the Radiochemistry Building and a number of other buildings have been determined to be potentially significant historic buildings. However, none of the buildings or structures have been formally evaluated for National Register of Historic Places eligibility status, and are, therefore, considered eligible and managed as such until a formal assessment determination has been made. There are no cultural resource sites in the small area of TA-55 that could be affected by the proposed Radiological Sciences Complex.

Four of the five TAs where structures would be removed as a part of the proposed project contain cultural resource sites. These are briefly summarized in **Table G–15**.

Table G–15 Affected Cultural Resource Sites – Radiological Sciences Institute

Technical Area	*Number of Cultural Resource Sites*	*Types of Resources Present*	*National Register of Historic Places Eligibility* [a]
3	8	Lithic scatter; trail and stairs; wagon road	3/2
18	3	Cavates; historic structure; rock shelter	3/0
35	0		
46	19	Pueblo roomblocks; lithic and ceramic scatters, one- to three-room structures, wagon road, cavates	9/2
59	1	Wagon road	0/0

[a] Number of sites that are eligible (the first number) or undetermined eligibility (the second number).

Traditional cultural properties are properties that are eligible for the National Register of Historic Places because of their association with cultural practices or beliefs of a living community that are (1) rooted in that community's history, and (2) important in maintaining its cultural identity. Consultations to identify traditional cultural properties were conducted with 19 American Indian tribes and 2 Hispanic communities in connection with the preparation of the *1999 SWEIS* (DOE 1999a). As noted in Section 4.7.3 of this SWEIS, traditional cultural properties are present throughout LANL and adjacent lands; however, to protect such sites specific features or locations are not identified (Knight and Masse 2001). Traditional cultural properties are not expected in developed areas of any TA involved in the Radiological Sciences Institute Project.

Construction Impacts—New construction in the area of the prehistoric or historic sites would require that the site boundaries be marked and fenced. Fencing would prevent accidental intrusion and disturbance to the site(s). If either of the two National Register of Historic Places-eligible prehistoric or historic sites could not be avoided by the proposed construction activities and protected by fencing, then a data recovery plan would need to be prepared and site excavation conducted prior to construction.

Radiological Sciences Institute construction and operation impacts on traditional cultural properties are unlikely, as most development would take place within previously disturbed portions of TA-48. Also, because the site would remain developed, potential views of TA-48 from any traditional cultural properties located in the vicinity would remain largely unchanged.

DD&D Impacts—Before demolition could begin on parts of the Radiochemistry Building or structures within TA-3, TA-18, TA-35, TA-46, and TA-59, a cultural resources assessment would be performed, as well as any subsequent compliance requiring documentation. NNSA, in conjunction with the State Historic Preservation Office, would implement documentation measures such as preparing a detailed report containing the history and description of the affected properties. These measures would be incorporated into a formal memorandum of agreement between NNSA and the New Mexico Historic Preservation Division to resolve adverse effects on eligible properties. The Advisory Council on Historic Preservation would be notified of the memorandum of agreement and would have an opportunity to comment. DD&D of buildings to be replaced by the new Radiological Sciences Institute would not impact traditional cultural properties, as all are located within developed portions of LANL.

Socioeconomics and Infrastructure

Construction Impacts—Utility infrastructure resources would be required for construction of the new Radiological Sciences Institute. Standard construction practice dictates that electric power needed to operate portable construction and supporting equipment be supplied by portable diesel-fired generators. Therefore, no electrical energy consumption would be directly associated with construction. A variety of heavy equipment, motor vehicles, and trucks would be used, requiring diesel fuel, gasoline, and propane for operation. Liquid fuels would be brought to the site as needed from offsite sources and, therefore, would not be a limited resource. Water would be needed primarily to provide dust control, aid in soil compaction at the construction site, and possibly for equipment washdown. Water would not be required for concrete mixing, as ready-mix concrete is typically procured from offsite resources. Portable sanitary facilities would be provided to meet the workday sanitary needs of project personnel on the site. Water needed for construction would be trucked to the point of use, rather than provided by a temporary service connection.

For construction of all 13 buildings, total liquid fuel consumption is estimated to be 4.2 million gallons (16 million liters). Total water consumption is estimated to be 22.4 million gallons (85 million liters). The existing LANL infrastructure would be capable of supporting requirements for new facility construction without exceeding site capacities, resulting in a negligible impact on site utility infrastructure.

Operations Impacts—No net increase in utility infrastructure demands for operation of the new Radiological Sciences Institute is expected, as its operational demands with more resource-efficient utility systems would be equal to or less than those of the facilities that the new Radiological Sciences Institute would replace. As such, operation of the Radiological Sciences Institute is expected to have no or negligible incremental impact on utility infrastructure capacities at LANL.

DD&D Impacts—Activities associated with DD&D of facilities to be replaced by the Radiological Sciences Institute are projected to require 101,000 gallons (384,000 liters) of liquid fuels and 3.1 million gallons (12 million liters) of water. DD&D activities would be staggered over an extended period of time. As a result, annual impacts of these activities on LANL's utility infrastructure would be minimal. Standard practice dictates that utility systems serving individual facilities be shut down as they are no longer needed. As DD&D activities progress, interior spaces, including associated equipment, piping, and wiring, would be removed prior to final demolition. Thus, existing utility infrastructure would be used to the extent possible and would then be supplemented or replaced by portable equipment and facilities as DD&D activities proceed, as previously discussed for construction activities.

Waste Management

The Radiochemistry Facility at TA-48 currently generates sanitary wastes, liquid radioactive wastes, and solid radioactive (low-level and transuranic) and chemical wastes, including mixed wastes. Sanitary wastes are delivered by a dedicated pipeline to the sanitary wastewater systems plant at TA-46. Radioactive liquid wastes are transported via dedicated piping to the Radioactive Liquid Waste Treatment Facility at TA-50. Low-level radioactive wastes are disposed of at

TA-54; all other radioactive, chemical, and mixed wastes are sent off site for treatment or disposal. Historical chemical and radioactive waste generation information is provided in **Table G–16** for TA-48. Table G–16 also includes historical waste generation information for the Sigma Complex, the Machine Shops, and those activities at the Pajarito Site that may be transferred to TA-48.

Table G–16 Waste Generation for the Radiochemistry Facility, Pajarito Site, Sigma Complex, and Machine Shops at Technical Area 3 (1998 to 2003)

		Radiochemistry Facility TA-48	*Pajarito Site TA-18* [a]	*Sigma Complex TA-3*	*Machine Shops TA-3* [b]
Transuranic waste (cubic yards)	Range	0 to 2	0 to 0	0 to 0	0 to 0
	Average	less than 1	0	0	0
Low-level radioactive waste (cubic yards)	Range	23 to 102	0 to 41	less than 1 to 264	20 to 535
	Average	58	13	94	127
Mixed low-level radioactive waste (cubic yards)	Range	less than 1 to 8	0 to 10	0 to 7	0 to less than 1
	Average	3	1	1	less than 1
Chemical waste (pounds)	Range	3,340 to 410,350	0 to 3,760	1,940 to 71,420	340 to 58,370
	Average	80,020	650	26,120	10,800

TA = technical area.

[a] TA-18 waste data include data for SHEBA which would not be moved to the Radiological Sciences Institute. Therefore, data presented for TA-18 are conservative (high) estimates of waste quantities.

[b] The Machine Shops data were compiled jointly for two buildings, the Nonhazardous Materials Machine Shop (Building 03-39) and the Radiological Hazardous Materials Machine Shop (Building 03-102). Only activities from Building 03-102 would be transferred to the Radiological Sciences Institute. Therefore, the values shown are conservative estimates of waste management impacts on the affected environment.

Note: To convert cubic yards to cubic meters, multiply by 0.76455; pounds to kilograms, by 0.4536.

Sources: LANL 2003b, 2004d, 2005c, 2006f.

Construction Impacts—Radiological Sciences Institute construction would generate approximately 2,800 cubic yards (2,100 cubic meters) of waste, primarily construction debris and associated solid waste. Construction debris is not hazardous and may be disposed of in a solid waste landfill. Recent LANL tracking and projection efforts have identified construction and demolition debris as a separate category of nonroutine sanitary (solid) waste. A substantial portion of construction debris at LANL is routinely recycled; in 2003, approximately 89 percent of the uncontaminated construction and demolition debris was recycled, and those rates are expected to continue (LANL 2004d).

Operations Impacts—Radiological Sciences Institute operations are expected to generate sanitary wastes, liquid radioactive wastes, and solid radioactive (low-level and transuranic) and chemical wastes, including mixed wastes. Because the Radiological Sciences Institute would be a new facility, design features would minimize wastes through enhanced processing, avoidance of cross-contamination, and nonhazardous product substitutions. Sanitary wastes would be delivered by dedicated pipeline to the Sanitary Wastewater Systems Plant at TA-46. Radioactive liquid wastes would be transported via dedicated piping to the Radioactive Liquid Waste Treatment Facility at TA-50. Other radioactive and chemical wastes would be managed at the waste management facilities or to a centralized waste storage facility within the Radiological Sciences Institute, where wastes may be stored for less than 90 days. Low-level radioactive wastes would be disposed of at TA-54 or at an offsite facility; all other radioactive and chemical wastes would be sent off site for treatment or disposal.

Because the Radiological Sciences Institute would consolidate operations already under way at the Radiochemistry Facility, Sigma Complex, Pajarito Site (TA-18), and Machine Shops (Building 03-102 only), the same general level of waste generation is expected to continue. Estimates of future waste generation rates were calculated based on historical rates and planned process improvements.

Projected discharge volumes of radioactive liquids are 845,000 gallons (3.2 million liters) per year (LANL 2006a). Chemical waste generation rates are expected to be 31,000 pounds (14,000 kilograms) per year. Low-level radioactive waste generation rates are estimated to be 157 cubic yards (120 cubic meters) per year. Mixed low-level and transuranic waste, including mixed transuranic waste; generation rates are expected to be very low, approximately 1.3 cubic yards (1 cubic meter) per year for each category (LANL 2006a).

DD&D Impacts—DD&D activities are expected to generate significant quantities of debris, including some radioactively contaminated debris. With the exception of low-level radioactive waste, most DD&D waste would be transferred to appropriate offsite treatment, recycling, or disposal facilities. **Table G–17** lists potential DD&D waste volumes from facilities that would be replaced by the Radiological Sciences Institute. Uncontaminated demolition debris may be recycled at on or offsite facilities. Chemical and radioactive wastes generated through decontamination processes would be managed at the waste management facilities. The large quantity of low-level radioactive waste may be disposed of on site or sent to an offsite facility. Solid wastes would be transferred to a permitted municipal landfill.

Table G–17 Decontamination, Decommissioning, and Demolition Waste Volumes for Buildings to be Replaced by the Radiological Sciences Institute

DD&D Waste Type	***Cubic Yards***
Low-level radioactive waste [a]	95,700
Mixed low-level radioactive waste	1,020
Remote-handled low-level radioactive waste	479
Contact-handled transuranic waste	1,130
Remote-handled transuranic waste	11
Demolition debris [b]	76,800
Hazardous waste with asbestos	605
Solid hazardous waste with organics	9
Solid hazardous waste with metals	373

DD&D = decontamination, decommissioning, and demolition.

[a] Consists of 71,800 cubic yards (54,900 cubic meters) of bulk waste, 23,500 cubic yards (18,000 cubic meters) of packaged waste, and 479 cubic yards (366 cubic meters) of remote-handled waste.

[b] Demolition waste includes solid and sanitary wastes.

Note: To convert cubic yards to cubic meters, multiply by 0.76455.

Transportation

Pajarito Road would provide access to the Radiological Sciences Institute.

Construction Impacts—Traffic on Pajarito Road could be disrupted due to temporary increases during construction.

Operations Impacts—Under the proposed project, interstate waste transportation would decrease over the long term. However, local traffic would increase.

DD&D Impacts—The large amounts of waste generated by Radiological Sciences Institute DD&D activities would have to be transported to storage or disposal sites using over-the-road truck transportation. These sites could be LANL TA-54 or an offsite location. Transportation has potential risks to workers and the public from incident-free transport, such as radiation exposure as the waste packages are transported along the routes and highways. Traffic accidents could result both in injuries or deaths from collisions and in an additional radiological dose to the public from radioactivity that may be released during the accident.

The effects of incident-free transportation of construction and DD&D wastes on the worker population and general public are presented in **Table G–18**. Effects are presented in terms of the collective dose in person-rem resulting in excess LCFs. Excess LCFs are the number of cancer fatalities that may be attributable to the proposed project, estimated to occur in the exposed population over the lifetimes of the individuals. If the number of LCFs is less than one, the subject population is not expected to incur any LCFs resulting from the actions being analyzed.

Table G–18 Incident-Free Transportation Impacts – Radiological Sciences Institute

Disposal Option	*Low-Level Radioactive Waste Disposal Location* [a]	*Crew*		*Public*	
		Collective Dose (person-rem)	*Risk (LCF)*	*Collective Dose (person-rem)*	*Risk (LCF)*
Onsite disposal	LANL TA-54	3.56	0.0021	1.06	0.00064
Offsite disposition	Nevada Test Site	31.34	0.0188	8.90	0.0053
	Commercial Facility	30.0	0.018	8.62	0.0052

LCF = latent cancer fatality, TA = technical area.

[a] Transuranic wastes would be disposed of at the Waste Isolation Pilot Plant (WIPP).

The risk of development of excess LCFs is highest for the workers under the offsite disposition option. This is because the dose is proportional to the duration of transport, which in turn is proportional to travel distance. As shown in Table G–18, disposal of low-level radioactive waste at the Nevada Test Site, which is located farthest from LANL, would lead to the highest dose and risk, although the dose and risk are low for all disposal options. **Table G–19** presents the impacts of traffic and radiological accidents. This table provides population risks in terms of fatalities due to traffic accidents from both the collisions themselves and from excess LCFs from exposure to releases of radioactivity. The analyses assumed that all transuranic and nonradioactive wastes would be transported to offsite disposal facilities.

Because all estimated LCFs and traffic fatalities, as shown in Tables G–18 and G–19, are much less than 1.0, the analysis indicates that no excess fatal cancers would result from this activity, either from dose received from packaged waste on trucks or potentially received from traffic collisions and accidental release.

Table G–19 Transportation Accident Impacts – Radiological Sciences Institute

Low-Level Radioactive Waste Disposal Location [a, b]	*Number of Shipments* [c]	*Distance Traveled (million kilometers)*	*Accident Risks*	
			Radiological (excess LCFs)	*Traffic (fatalities)*
LANL TA-54	10,469	2.20	4.2×10^{-9}	0.027
Nevada Test Site	10,469	17.03	5.1×10^{-6}	0.174
Commercial facility	10,469	15.54	4.9×10^{-6}	0.158

LCF = latent cancer fatality, TA = technical area.

[a] All nonradiological wastes would be transported offsite.

[b] Transuranic wastes would be disposed of at WIPP.

[c] Approximately 58.7 percent of shipments are radioactive wastes. Others include 41 percent industrial and sanitary waste and about 0.6 percent asbestos and hazardous wastes.

Note: To convert kilometers to miles, multiply by 0.6214.

Facility Accidents

Operations Impacts—Potential accidents that might occur at the proposed Radiological Sciences Institute that are estimated to have the highest impacts would involve radiological operations and materials that were transferred from Chemistry and Metallurgy Research Wing 9 hot cell operations. Six accident scenarios were selected to represent the bounding impacts of accidents at the Radiological Sciences Institute. Information used to estimate the impacts of these accidents is shown in **Table G–20**. The material at risk in a hot cell is estimated to be 10.6 ounces (300 grams) of plutonium-238 equivalent and an additional 2.2 pounds (1 kilogram) of plutonium-239. The new Radiological Sciences Institute vault is assumed to contain this same entire inventory.

Table G–20 Bounding Radiological Accident Scenarios – Radiological Sciences Institute

Accident	*Source Term* [a] *(plutonium-238 curies)*	*Release Energy (watts)*	*Annual Frequency*
Hot cell fire involving plutonium-238 in general purpose heat source modules	5.13 plutonium-238	2.04×10^{6}	0.0001
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules	22.572 plutonium-238 1.386 plutonium-239	2.04×10^{6}	2.4×10^{-5}
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules	5.13 plutonium-238 0.315 plutonium-239	0	0.00024
Spill of plutonium-238 residue from 0.5-gallon (2-liter) bottles outside of hot cell	0.001283 plutonium-238	0	0.1
Hot cell plutonium-238 spill with no confinement	0.4104	0	0.01
Main vault fire	10.26 plutonium-238 0.126 plutonium-239	2.04×10^{6}	$<1 \times 10^{-6}$

[a.] A release height of 4.9 feet (1.5 meters) is assumed for all accidents. Specific activity is 0.063 curies per gram for plutonium-239 and 17.1 curies per gram for plutonium-238.

Assuming that an accident occurred, estimated consequences for a noninvolved worker located 330 feet (100 meters) from the accident, the MEI located at the trailer park, and the offsite population are shown in **Tables G–21** and **G–22**. Estimated risks that take accident frequency into account to these same receptors are shown in **Table G–23**.

Table G–21 Radiological Accident Offsite Consequences – Radiological Sciences Institute

Accident	*MEI*		*Population to 50 Miles (80 kilometers)* [b, c]	
	Dose (rem)	*LCF* [a]	*Dose (person-rem)*	*LCF*
Hot cell fire involving plutonium-238 in general purpose heat source modules	6.31	0.0038	2,770	1.7
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules	29.6	0.036	13,000	7.8
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules	19.4	0.012	4,650	2.8
Spill of plutonium-238 residue from 0.5-gallon (2-liter) bottles outside of hot cell	0.0066	4.0×10^{-6}	1.1	0.00065
Hot cell plutonium-238 spill with no confinement	2.12	0.0013	350	0.21
Main vault fire	12.8	0.0077	5,620	3.4

MEI = maximally exposed individual, LCF = latent cancer fatality.

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs for the offsite population per year.

[c] Offsite population size is approximately 300,000 persons located within a 50-mile (80-kilometer) radius.

Table G–22 Radiological Accident Onsite Worker Consequences – Radiological Sciences Institute

Accident	*Noninvolved Worker at 330 Feet (100 meters)*	
	Dose (rem)	*LCF* [a]
Hot cell fire involving plutonium-238 in general purpose heat source modules	32.5	0.039
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules	152	0.18
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules	171	0.21
Spill of plutonium-238 residue from 0.5-gallon (2-liter) bottles outside of hot cell	0.045	2.7×10^{-5}
Hot cell plutonium-238 spill with no confinement	14.3	0.0086
Main vault fire	65.9	0.079

LCF = latent cancer fatality.

[a] Increased risk of an LCF to an individual, assuming the accident occurs.

The accident scenarios with the potential for the highest radiological impacts to the MEI are the seismic-induced building collapse with no fire and the seismic-induced building collapse with a fire involving plutonium-238 in general purpose heat source modules. If either of these accidents were to occur, the consequences are estimated to be 2.8 or 7.8 increased LCFs for the offsite population, 0.012 or 0.036 increased risk of LCFs for the MEI, and 0.21 or 0.18 increased risk of an LCF for a noninvolved worker located at a distance of 330 feet (100 meters) from the accident, respectively. After taking into account the frequency (or probability) of each accident, the hot cell plutonium-238 spill with no confinement is estimated to have the highest risks. For this accident, the annual risks are estimated to be 0.0021 LCFs (1 chance in 480) for the offsite population, 1.3×10^{-5} increased risk (1 chance in 77,000) of LCFs for the MEI, and 8.6×10^{-5} increased risk (1 chance in 12,000) of an LCF for a noninvolved worker located at a distance of 330 feet (100 meters) from the accident.

Table G–23 Radiological Accident Offsite Population and Worker Risks – Radiological Sciences Institute

Accident	*Onsite Worker (LCFs)*	*Offsite Population (LCFs)*	
	Noninvolved Worker at 330 Feet (100 meters) [a]	*MEI* [a]	*Population to 50 Miles (80 kilometers)* [b, c]
Hot cell fire involving plutonium-238 in general purpose heat source modules	3.9×10^{-6}	3.8×10^{-7}	0.00017
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules [d]	4.4×10^{-6}	8.5×10^{-7}	0.00019
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules [d]	4.9×10^{-5}	2.8×10^{-6}	0.00067
Spill of plutonium-238 residue from 0.5-gallon (2-liter) bottles outside of hot cell	2.7×10^{-6}	4.0×10^{-7}	6.5×10^{-5}
Hot cell plutonium-238 spill with no confinement	8.6×10^{-5}	1.3×10^{-5}	0.0021
Main vault fire	$< 7.9 \times 10^{-8}$	$< 7.7 \times 10^{-9}$	$< 3.4 \times 10^{-6}$

LCF = latent cancer fatality, MEI = maximally exposed individual.

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs for the offsite population per year.

[c] Offsite population size is approximately 300,000 persons located within a 50-mile (80-kilometer) radius.

[c] An updated probabilistic seismic hazard analysis has been completed for LANL (LANL 2007), which results in higher peak horizontal ground acceleration values for the same annual probability of exceedance. In the seismic accident analyses for the Radiological Sciences Institute, the radioactive source term was conservatively based on the assumption that all structures, systems, and components failed, therefore, the updated probabilistic seismic hazard analysis is not expected to change the accident consequences or risks.

Seismic accidents considered for the proposed Radiological Sciences Institute are estimated to have a probability of release of 0.1 (the same as at the Chemistry and Metallurgy Research Building); the Radiological Sciences Institute would be designed to withstand the evaluation-basis earthquake. In comparing a seismic accident scenario that includes a fire with one that does not include a fire, both located within the Radiological Sciences Institute, the former has higher potential for causing offsite population and MEI impacts, while the latter has higher individual worker impacts. This is because the buoyant effects of a fire loft the radioactive plume over the onsite workers, while the greater releases associated with this scenario would impact the general population farther downwind. In contrast, the absence of a fire and its buoyant effects has a greater impact on close-in individuals like the noninvolved worker at 330 feet (100 meters) and the nearby worker population.

G.4 Radioactive Liquid Waste Treatment Facility Upgrade Impact Assessment

This section provides an assessment of environmental impacts for the proposed Radioactive Liquid Waste Treatment Facility Upgrade. Section G.4.1 provides background information on the proposed project. Section G.4.2 provides a description of the proposed options for the Radioactive Liquid Waste Treatment Facility Upgrade. Section G.4.3 presents environmental consequences of the No Action Option and project options for the Radioactive Liquid Waste Treatment Facility Upgrade. The main volume of this SWEIS contains information about the general environmental setting of LANL and environmental impacts associated with continued operations of the site.

G.4.1 Introduction

The Radioactive Liquid Waste Treatment Facility treats radioactive liquid wastes generated at other LANL facilities and houses analytical laboratories supporting waste treatment operations. The principal capabilities and activities conducted at the Radioactive Liquid Waste Treatment Facility include: (1) waste characterization and packaging, including identification and quantification of constituents of concern in waste streams and packaging and labeling waste according to U.S. Department of Transportation regulations; (2) waste transportation including inspection and cross-checking for acceptance; (3) liquid and solid chemical materials and radioactive waste storage; (4) waste pretreatment; (5) radiological liquid waste treatment using a number of treatment processes, including ultrafiltration and reverse osmosis; and (6) secondary waste treatment.

The original Radioactive Liquid Waste Treatment Facility (Building 50-1) as shown in **Figure G–4** was constructed in 1963. Between 1963 and 1986, three annexes were attached to the north, south, and east sides of the original building. With the addition of these annexes, the current facility has a total floor area of approximately 42,300 square feet (3,900 square meters). The North Annex has a footprint of about 5,000 square feet (450 square meters); the East Annex has a footprint of about 7,000 square feet (630 square meters); and the South Annex has a footprint of about 7,500 (700 square meters).

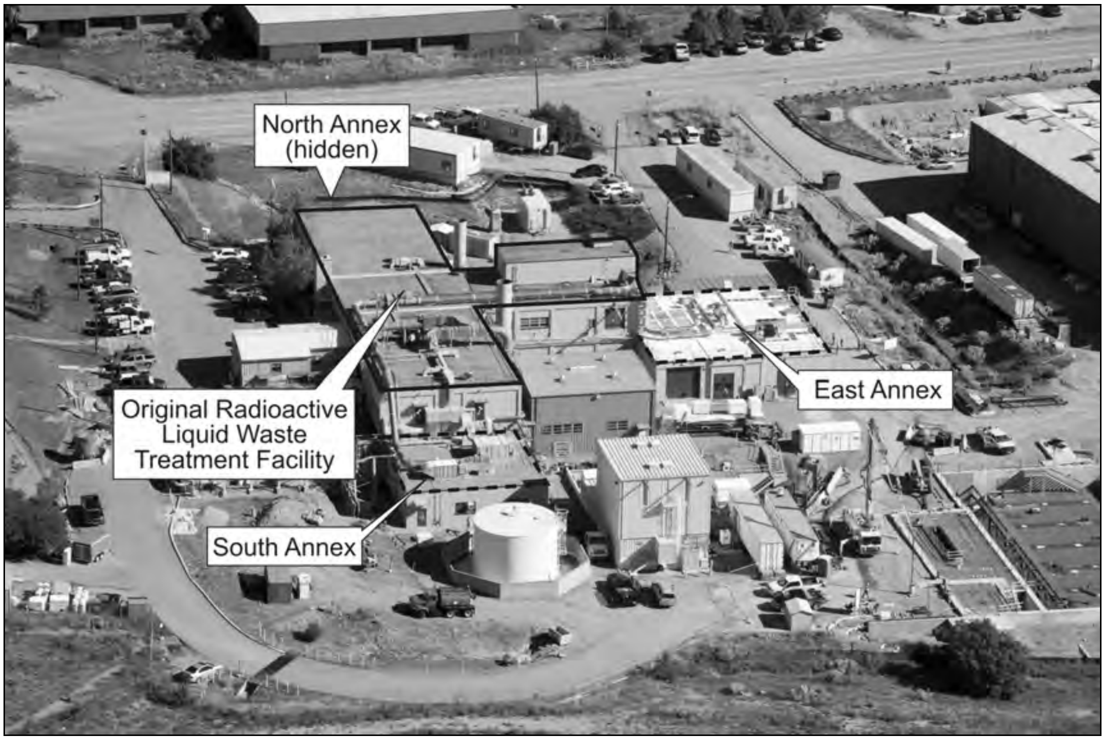


Figure G–4 Existing Radioactive Liquid Waste Treatment Facility

The Radioactive Liquid Waste Treatment Facility is the only facility available at LANL to treat a broad range of transuranic liquid wastes and low-level radioactive liquid waste. However, the ability of this facility to operate reliably is becoming increasingly uncertain. The original building is over 40 years old and has exceeded its design life. Similarly, the clarifiers, rotary vacuum filter, and heating, ventilation, and air conditioning systems, installed in 1963, are also over 40 years old. The infrastructure and treatment equipment require increasing maintenance attention to keep them operational, and replacement parts are increasingly difficult to acquire; replacement components for some older systems are no longer commercially produced. Corrosion of pipes and tanks has resulted in leaks. Radioactive Liquid Waste Treatment Facility materials and components are failing with increased frequency, and key systems could potentially fail within the next 5 to 10 years.

The current Radioactive Liquid Waste Treatment Facility treats all liquid radioactive waste generated at LANL except for that generated at TA-53 and occasionally that from TA-21. A system of pipes collects radioactive wastewater from various facilities, such as the Plutonium Facility at TA-55 and the Chemistry and Metallurgy Research Facility at TA-3, and transfers the wastewater to influent tanks at the Radioactive Liquid Waste Treatment Facility. In a few cases, trucks bring radioactive wastewater from other facilities to the Radioactive Liquid Waste Treatment Facility.

The influent waste stream contains two types of radioactive components: (1) tritiated water, and (2) radioactive solids that are either dissolved or suspended in the liquid. The existing and the proposed Radioactive Liquid Waste Treatment Facility treatment processes are designed to treat the dissolved or suspended solids, but are not able to extract tritiated water. Tritiated wastewater is discharged via a permitted outfall if it meets discharge criteria or is trucked to TA-53's evaporation ponds if it exceeds discharge criteria. Tritiated wastewater has not been trucked to the TA-53 evaporation ponds since 2003.

Although the treatment processes cannot remove tritiated water, they do extract suspended and dissolved radioactive solids from the liquid waste and concentrate the solids by removing additional liquid. The treated liquid is either returned to the low-level radioactive waste influent tank or released to a permitted outfall in Mortandad Canyon. Solid radioactive waste is placed in 55-gallon (208-liter) drums. Drums of solids that meet the waste acceptance criterion regarding liquid content are trucked to TA-54 for storage or disposal. Concentrated liquids resulting from the evaporator portion of the treatment process are sent by truck to a permitted commercial treatment facility in Tennessee for drying, a trip of about 1,400 miles (2,700 kilometers). Typically, about six shipments are made each year. The treatment facility returns the dried solids to TA-54. Drums of solidified transuranic waste from liquid treatment are stored at TA-54 pending preparation for shipment to WIPP near Carlsbad, New Mexico; low-level radioactive waste is disposed of in TA-54.

Future preparation of transuranic waste for shipment is expected to occur in a new TRU (Transuranic) Waste Facility in TA-54 (Appendix H, Section H.3.2.2.2). Some of the functions needed for preparation of transuranic waste from the Radioactive Liquid Waste Treatment Facility may be optionally duplicated in a separate structure co-located with the Radioactive Liquid Waste Treatment Facility. The environmental analysis conducted for the TRU Waste Facility bounds this possibility.

Because many treatment processes work best with water that contains certain ranges of minerals and chemicals and with certain quantities of water, design of the new facility would consider historical usage and future mission requirements. The lower-bound waste volumes assume the generators of radioactive wastewater implement various waste minimization and pollution prevention projects. Calculations of the upper-bound waste volumes assume these waste minimization and pollution prevention projects do not occur and changes in LANL's mission (in particular an increase in pit production up to 80 pits per year) would result in generation of more radioactive wastewater. **Table G–24** shows the quantities of wastewater that the new facilities would be designed to process annually. Upper-bound quantities would be about twice as large.

Table G–24 Design Basis Influent Volumes – Radioactive Liquid Waste Treatment Facility Upgrade

Influent	*Lower Bound (gallons per year)*
Low-level radioactive waste	2,507,000
Acidic transuranic waste	3,700
Caustic transuranic waste	2,600

Note: To convert gallons to liters, multiply by 3.7854.

G.4.2 Options Considered

For the Radioactive Liquid Waste Treatment Facility Upgrade, one No Action Option (see Section G.4.2.1) and three action options (see Sections G.4.2.2, G.4.2.3, and G.4.2.4) are proposed to address facility needs. Additionally, two auxiliary actions to reduce or eliminate the discharge are also proposed (see Section G.4.2.5). The auxiliary actions (evaporation tanks or mechanical evaporation) may be incorporated as part of the No Action Option or any of the three action options. Section G.4.2.6 presents options considered, but dismissed.

G.4.2.1 No Action Option

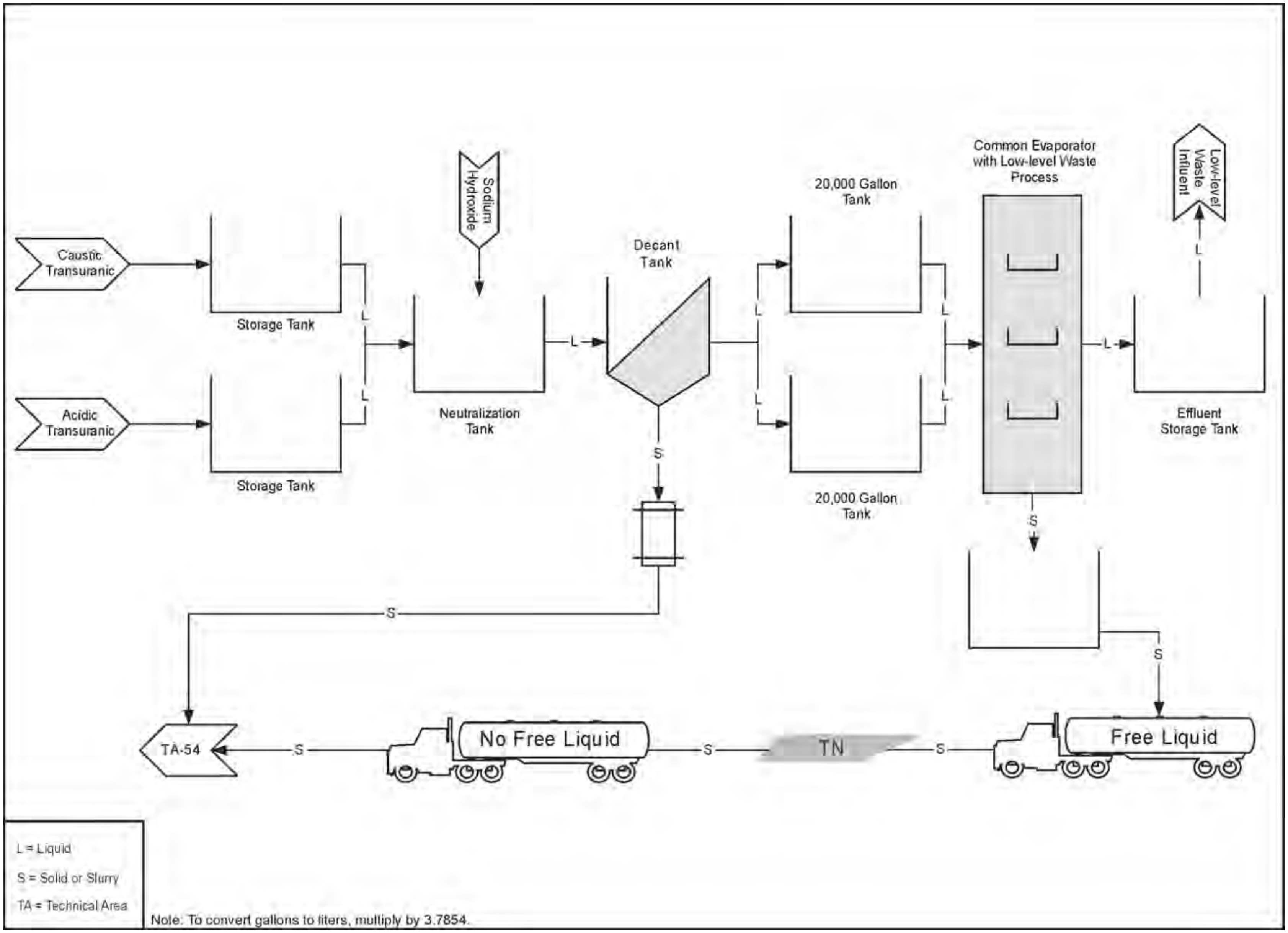
Under the No Action Option, the Radioactive Liquid Waste Treatment Facility would continue to process transuranic and low-level radioactive wastewater in the existing building. No new construction would occur. The annexes to the original Radioactive Liquid Waste Treatment Facility, which do not meet seismic and wind-loading standards, would not be removed. No existing contaminated materials would be removed. Existing processes would continue to treat liquid transuranic waste and liquid low-level radioactive wastes separately. Treatment processes would result in generation of transuranic sludge, low-level radioactive waste sludge, solid low-level radioactive waste, secondary liquid low-level radioactive wastes (evaporator bottoms), and treated effluent. The transuranic sludge would be solidified (cemented), then transported to TA-54 for storage, characterization, and shipment to WIPP for disposal. The low-level radioactive waste sludge would be dewatered, packaged, and shipped to TA-54 for disposal. Solid low-level radioactive wastes would be packaged and shipped to TA-54 for disposal. Secondary liquid low-level radioactive wastes would be transported by truck to an offsite treatment plant where it would be dried, and the resultant solids would be returned to LANL for disposal at TA-54 as solid low-level radioactive wastes, if it meets waste acceptance criteria. Optionally, effluent from the existing facility could be evaporated as discussed in Section G.4.2.5. The existing treatment processes for transuranic waste are shown in **Figure G–5**.

Under the No Action Option, LANL staff would continue to perform routine repairs, safety improvements, and replacement-in-kind of equipment on an as-needed basis. LANL would continue to meet current discharge standards, but may not be able to meet future discharge standards if they become more stringent and the auxiliary actions are not implemented. The existing Radioactive Liquid Waste Treatment Facility would continue to process radioactive liquid wastes until key systems irreparably fail or until the facility can no longer meet discharge standards. System failure or failure to meet discharge standards is estimated to occur sometime within the next 10 years. Therefore, this No Action Option does not meet NNSA's purpose and need to maintain treatment capability at LANL for 50 years.

G.4.2.2 Option 1: Single Liquid Waste Treatment Building Option – Proposed Project

Under the proposed project, NNSA would construct new low-level radioactive waste and transuranic liquid waste treatment facilities to achieve greater reliability, redundancy, and flexibility. A new waste treatment building would have a footprint of about 10,800 square feet (1,000 square meters). The building would consist of a partially below-grade basement, a main floor, and a mezzanine for a total area of 20,700 square feet (1,923 square meters), and would be accompanied by a new central utilities building. NNSA would also modify low-level radioactive and transuranic waste processes to become more effective and better able to incorporate future technology. Portions of the existing Radioactive Liquid Waste Treatment Facility, as described below, would be demolished. The existing facility would not be renovated but would continue to be used for offices and chemical analyses. New equipment would be purchased; some existing equipment may be used to supplement the new equipment and to provide redundancy. Additionally, either one of the auxiliary actions (evaporation tanks or mechanical evaporation) described in Section G.4.2.5 may be added to this option.

The proposed location of the single new low-level radioactive waste and transuranic facility is west of the existing Radioactive Liquid Waste Treatment Facility in an existing parking area (see **Figure G–6**). The building would be sited near the point where transuranic waste lines enter TA-50 to minimize the distance this wastewater must flow to reach the treatment facility. NNSA would conduct DD&D of the East Annex. The existing transuranic storage tank vault (TA-50-66) and the transformer on the north side of the existing Radioactive Liquid Waste Treatment Facility would also be demolished. Some wastewater collection pipes and utilities in the immediate vicinity of the Radioactive Liquid Waste Treatment Facility may be rerouted. Some remediation of contaminated soils would be required.



Note: To convert gallons to liters, multiply by 3.7854.

Figure G–5 Existing Treatment Processes for Transuranic Waste

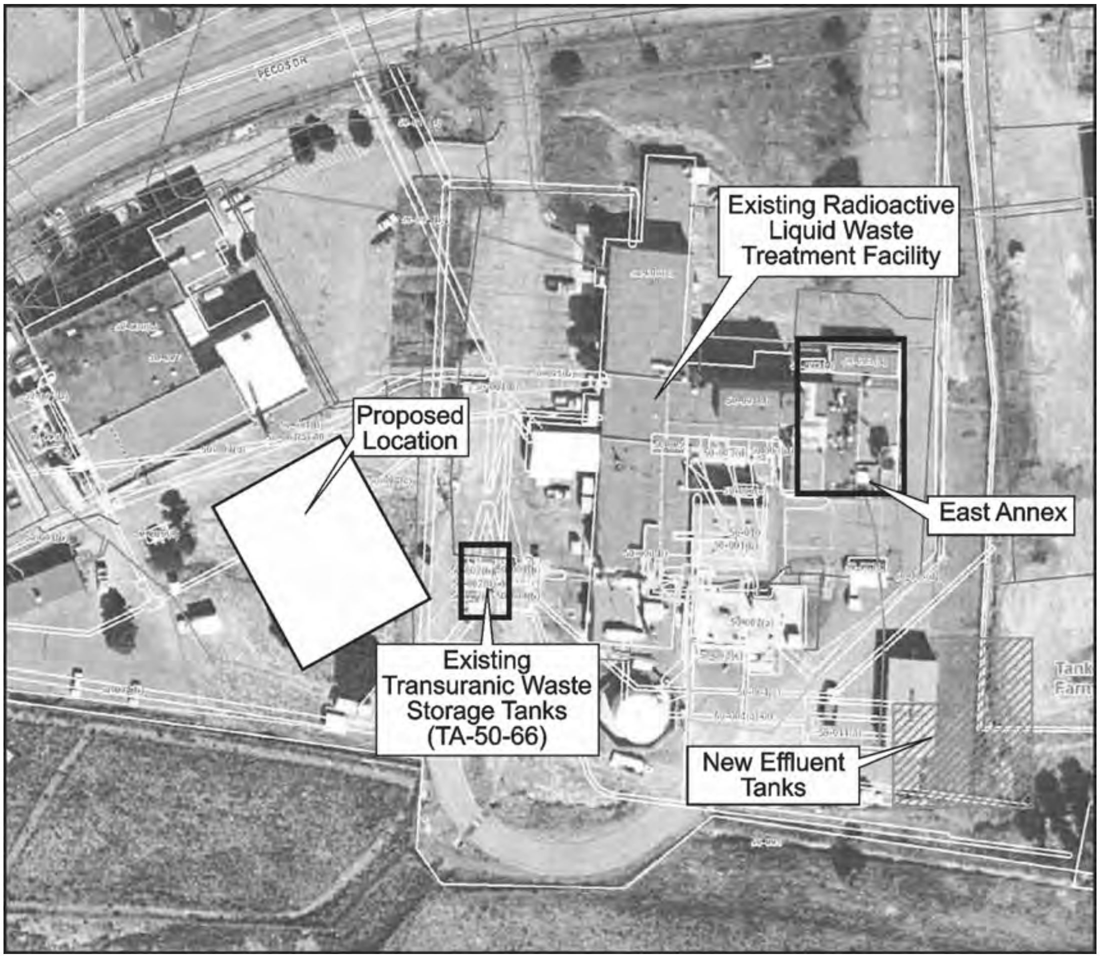
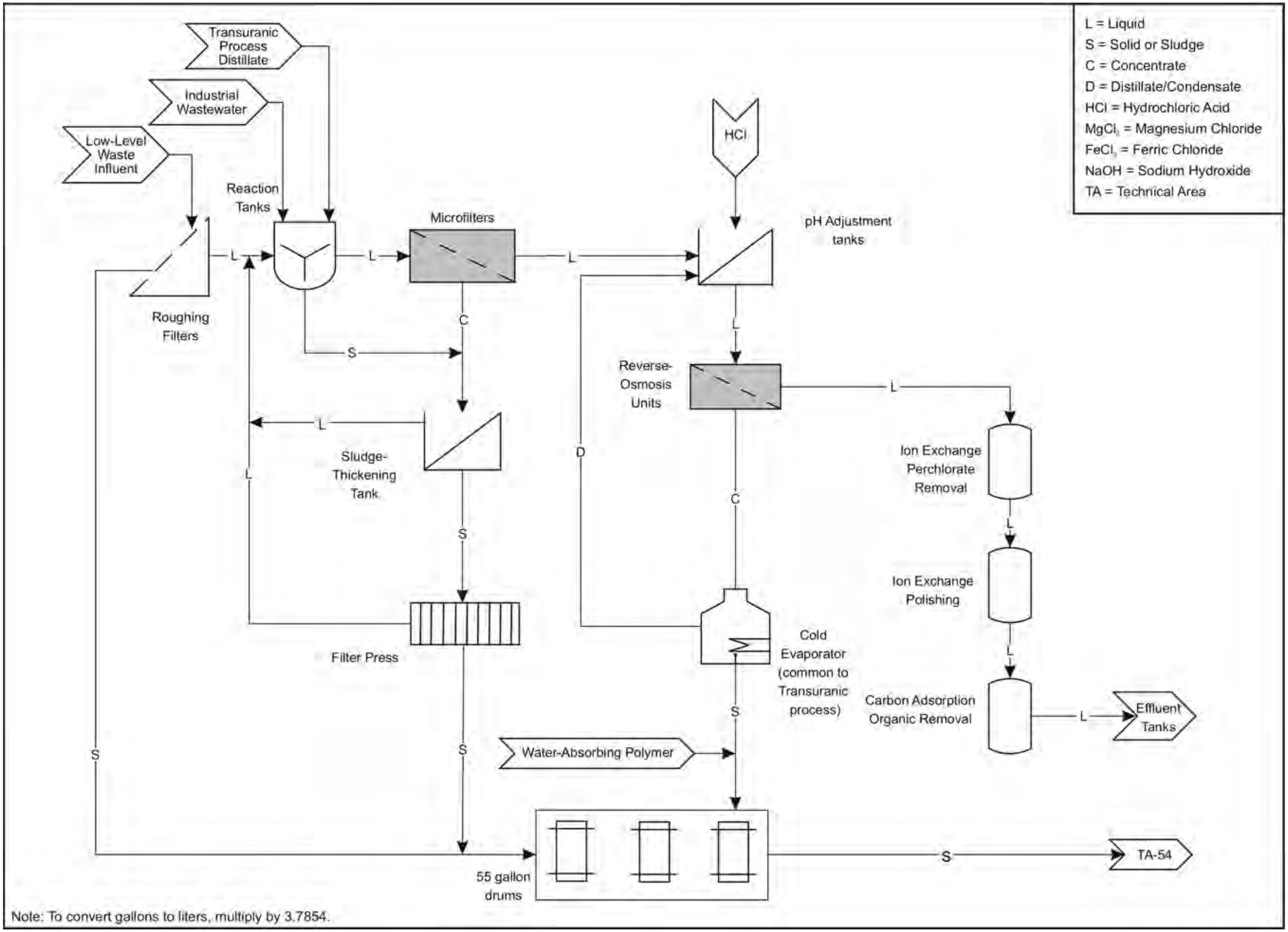


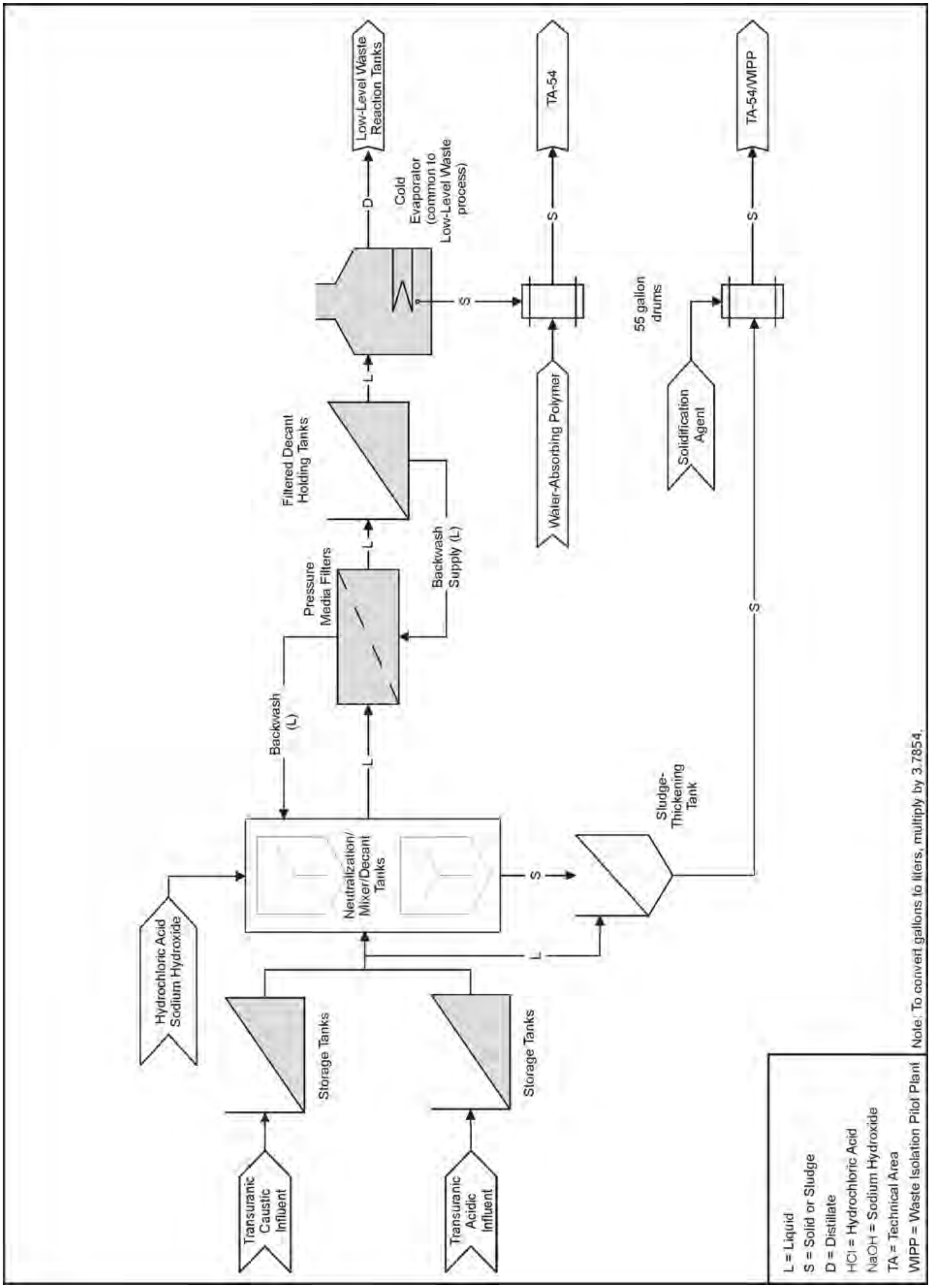
Figure G–6 Proposed Project Location

The proposed low-level radioactive waste treatment process consists of removing suspended and dissolved solids from the liquid waste stream, concentrating the solid waste stream by removing additional liquid, packaging the resulting solid radioactive waste, and ultimately releasing the remaining liquids to a permitted outfall or to evaporative processes. **Figure G–7** shows the proposed low-level radioactive waste treatment process. This process would receive waste via pipeline from the low-level radioactive waste influent tanks and distillate from the transuranic waste treatment process. Some industrial wastewater that cannot be treated by other LANL wastewater treatment systems may also be treated (LANL 2005e). In a typical year, the system could receive approximately 2.5 million gallons (9.5 million liters) of liquid low-level radioactive waste, although the upper bound influent volume may be up to 5 million gallons (20 million liters). The proposed transuranic waste treatment process is shown in **Figure G–8**. The transuranic influent tanks can store approximately 25,000 gallons (96,000 liters) per year of transuranic acid wastewater and 9,000 gallons (34,000 liters) per year of transuranic caustic wastewater. Redundant tanks would handle overflows and drainage.



Note: To convert gallons to liters, multiply by 3.7854.

Figure G–7 Proposed Low-Level Radioactive Waste Treatment Process



Note: To convert gallons to liters, multiply by 3.7854.

Figure G–8 Proposed Transuranic Waste Treatment Process

G.4.2.3 Option 2: Two Liquid Waste Treatment Buildings Option

This option would involve construction and operation of two new treatment facilities: one for low-level radioactive waste and one for transuranic waste (see **Figure G–9**). A central utilities building would also be constructed. The new low-level radioactive waste facility would have a footprint between 25,000 and 35,000 square feet (2,323 to 3,150 square meters) and would be located on the north side of the Radioactive Liquid Waste Treatment Facility. The transuranic waste facility would be located close to the point where transuranic waste lines enter TA-50, southwest of the existing Radioactive Liquid Waste Treatment Facility, to minimize the distance this wastewater must flow to reach the treatment facility. The transuranic waste facility would require approximately 15,000 square feet (1,350 square meters) of floor space. Like the low-level radioactive waste facility, it would contain processing areas, mechanical rooms, a control room, and access control areas. Additionally, either one of the auxiliary actions (evaporation tanks or mechanical evaporation) described in Section G.4.2.5 may be added to this option.

Locating the new low-level radioactive waste facility north of the existing Radioactive Liquid Waste Treatment Facility would necessitate demolition of the North Annex, in addition to the East Annex, as well as a transformer located on the north side of the existing facility. The existing transuranic waste storage tank vault (TA-50-66) would be demolished. Some remediation of contaminated soils would be required. The new facilities would use the same treatment process as that described for the proposed project. All other aspects of this option are the same as those of the proposed project (Option 1).

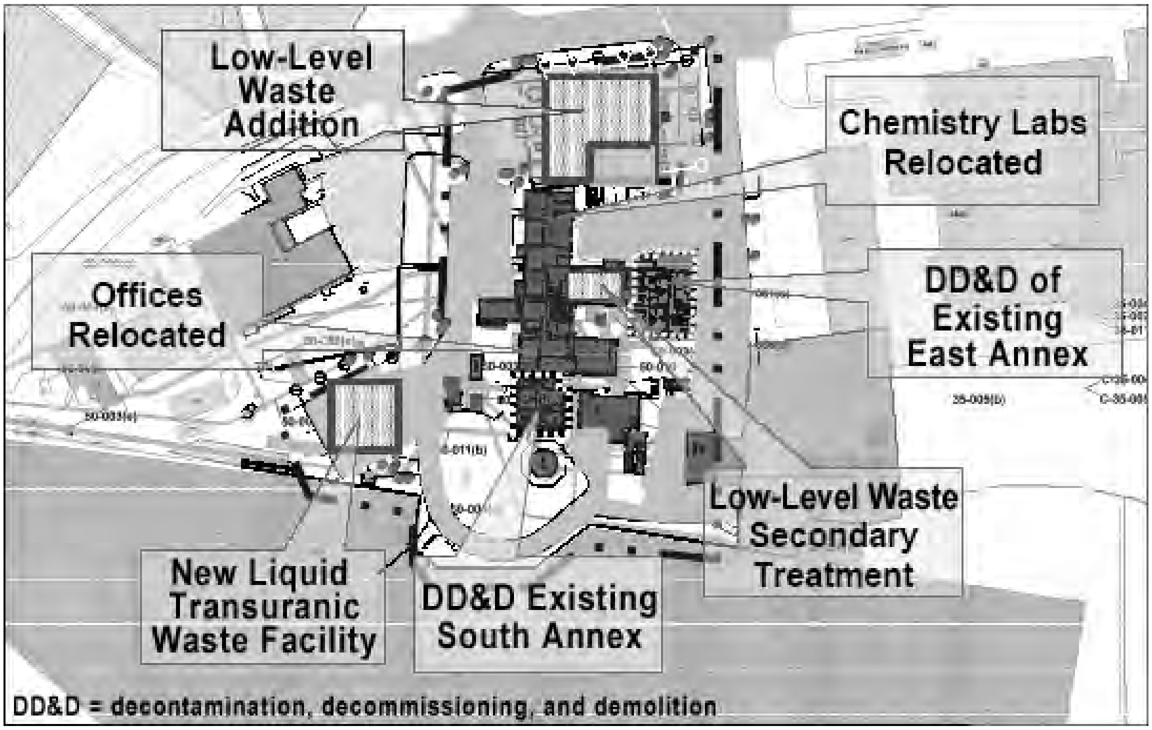


Figure G–9 Proposed Layout under the Two Liquid Waste Treatment Buildings Option

As a variation on this option, treatment functions to be housed in two facilities may be housed in multiple facilities in addition to the central utilities building. For example, separate structures may be constructed for portions of the transuranic waste treatment train rather than being consolidated into one structure.

G.4.2.4 Option 3: Two Liquid Waste Treatment Buildings and Renovation Option

Under Option 3, new buildings would be constructed to house the low-level radioactive waste and transuranic waste treatment processes, as in Option 2. As for Option 2, two new treatment buildings are envisioned, in addition to a central utilities building, although separate functions of the liquid waste treatment trains may be optionally housed in separate structures. In addition, the existing Radioactive Liquid Waste Treatment Facility would be renovated and reused for offices, chemistry laboratories, and drying of various solid residues (secondary waste) from the low-level radioactive waste treatment system.

Upon completion of the new facilities, the low-level radioactive waste and transuranic waste processes would be established in the new facilities and renovation of the existing facility would begin. When renovation is completed, equipment needed to dry the solid residues would be installed and operated in the renovated facility. In the interim, solid wastes would continue to be shipped off site for dewatering. The wastewater streams would be treated in the same way as under the proposed project (Option 1), and the treated effluent would similarly be discharged into Mortandad Canyon, reused, or evaporated. One of the auxiliary actions (evaporation tanks or mechanical evaporation) described in Section G.4.2.5 may be added to this option.

This Two Liquid Waste Treatment Buildings and Renovation Option (Option 3) would entail major structural and infrastructure changes to the existing Radioactive Liquid Waste Treatment Facility. Existing external walls would be removed and replaced with seismically appropriate materials and construction as required to meet LANL engineering standards for Hazard Category 2 facilities. Electrical and plumbing systems that do not meet current building codes would be replaced. Piping that does not conform to spill control requirements would also be replaced. The North, South, and East Annexes would be demolished, as they do not meet seismic requirements; failure of these structures could have a detrimental effect on existing and new construction. Under this option, the process of characterizing, demolishing, and removing contaminated materials would be the same as that under the proposed project (Option 1).

G.4.2.5 Auxiliary Actions

For the Radioactive Liquid Waste Treatment Facility Upgrade, two auxiliary actions are proposed to reduce or eliminate this discharge. The auxiliary actions could be applied to the No Action Option or any of the action options.

The first auxiliary action consists of constructing evaporation tanks and allowing the wastewater to evaporate using passive solar energy. The tanks would consist of up to three individual tanks constructed of lined, self-supporting concrete structures having walls approximately 4 feet high. Each tank would be open on top and have a surface area for evaporation of about an acre, with a total surface tank area of about 3 acres (1.2 hectares). The tanks would be surrounded by a security fence slatted with inserts to provide a wind screen. Except for periodic cleaning to eliminate the buildup of dissolved solids in the water, the tanks would be managed to always retain a minimum level of water. During cleaning, salt (and blown-in dirt) on the floor and sidewalls of the tanks would be flushed to a sump for solids removal, and the filtrate from solids removal returned to the evaporation tanks. The evaporation tanks could be constructed at a site in TA-52, located about a mile east of the Radioactive Liquid Waste Treatment Facility. A pipeline would be constructed to transport effluent from the Radioactive Liquid Waste Treatment Facility to the evaporation tanks.

The second auxiliary action option consists of the use of mechanical evaporation. Evaporative equipment would be purchased and installed at or near the proposed low-level radioactive waste treatment building.

G.4.2.6 Options Considered but Dismissed

Two additional action options were considered but dismissed from further evaluation. The first of these would be to construct the new radioactive liquid waste treatment facilities in another location. This site option was dismissed because the collection system, which is already in place to deliver wastewater to the current Radioactive Liquid Waste Treatment Facility, would need to be rebuilt in new locations. Constructing a new collection system has the potential for negative impacts on a number of resources without a benefit over the options being considered. The existing facility is in reasonable proximity to the source of most of the transuranic wastewater. Any other location would entail additional collection infrastructure and a longer distance over which wastewater would be transferred. In addition, the current facility has an existing NPDES permit to discharge at its current location.

The second option considered but dismissed from further evaluation would be to renovate the existing Radioactive Liquid Waste Treatment Facility to house the new transuranic waste and low-level radioactive waste treatment processes. This option is not feasible, as the capability to treat radioactive liquid wastewater must be maintained so that LANL missions are not impacted. Engineering and process reviews have determined that it is not feasible to install additional treatment equipment in the existing facility while the current treatment process is operating due to lack of space. The existing treatment processes must be maintained with no more than 10 days of downtime to ensure that mission-critical activities in facilities that generate liquid radioactive waste can be maintained. The time required to renovate the existing facility would far exceed 10 days.

G.4.3 Affected Environment and Environmental Consequences

This section presents an analysis of environmental consequences for each of the four options presented in Section G.4.2. Affected environment descriptions are also included where information is available that is specific to the project site and has not been included in Chapter 4 of this SWEIS. Detailed information about the LANL environment is presented in the main volume of this SWEIS. The auxiliary actions (see Section G.4.2.5) are not evaluated separately, but are largely evaluated as part of each of the action options (Options 1, 2, and 3). These auxiliary action evaluations would be also applicable to the No Action Option.

Proposed sites for the new transuranic and low-level radioactive waste buildings are within the developed area of TA-50, adjacent to the existing Radioactive Liquid Waste Treatment Facility. The area has been designated as an industrial area focused on Nuclear Materials Research and Development in *LANL's Comprehensive Site Plan*. Mortandad Canyon, which lies north of the proposed project, is largely undeveloped.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary.

- *Noise* – Would be managed with standard worker protective measures; no impact on the public due to location.
- *Socioeconomics and Infrastructure* – No new employment is expected. Construction and DD&D workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.
- *Environmental Justice* – The proposed project is mainly confined to already-developed areas of TA-50, with no disproportionate human health impacts to low-income or minority populations expected.
- *Facility Accidents* – Potential facility accidents associated with this proposed project are addressed as part of the No Action Alternative of this SWEIS.

Resource areas examined in this analysis include: land resources, geology and soils, water resources, air quality, ecological resources, human health, cultural resources, site infrastructure, waste management, and transportation.

G.4.3.1 No Action Option

No changes in air emissions or biological resources are expected under the No Action Option. Although the Radioactive Liquid Waste Treatment Facility is currently able to meet existing discharge standards, the facility may not meet more stringent discharge standards in the future. Implementation of the auxiliary action options would greatly reduce or eliminate liquid effluent discharges and therefore beneficially effect water quality. Construction impacts from particulate or radioactive emissions would not occur. There would be no effects on land resources, cultural resources, human health, transportation, traffic, or infrastructure under the No Action Option.

Between 1998 and 2004, the Radioactive Liquid Waste Treatment Facility received a range of about 2.2 million to 5.9 million gallons (8.4 million to 22.3 million liters) of low-level radioactive waste influent per year (LANL 2005e). During that same period, solid low-level radioactive waste volumes ranged from 173 to 510 cubic yards (132 to 390 cubic meters) per year (LANL 2003b, 2004d, 2006a).

During 2005, the facility treated and discharged about 1.8 million gallons (6.8 million liters) of effluent to a permitted outfall. Also during 2005, 339 cubic yards (259 cubic meters) of solid low-level radioactive waste, very small quantities of mixed low-level radioactive waste, and

15.9 pounds (7.2 kilograms) of chemical waste were generated. About 75 cubic yards (57.5 cubic meters) of the low-level radioactive waste was construction soil and debris from installing influent storage tanks for the Cerro Grande Rehabilitation Project (LANL 2006f).

Under the No Action Option, low-level radioactive waste volumes are expected to be similar to the past few years of Radioactive Liquid Waste Treatment Facility operation, when more-efficient treatment equipment was brought online and radioactive solids were more effectively removed than in previous years. Because the treatment process would not be improved under the No Action Option, the amount of solid low-level radioactive waste to be generated would be largely a product of the influent volume and contamination concentrations. The average influent volume for 2003–2004 was 2.7 million gallons (10.3 million liters), while average low-level radioactive waste generation was 488 cubic yards (373 cubic meters) (LANL 2003b, 2004d, 2006a). Influent and waste generation levels were smaller than those averages in 2005 (LANL 2006f). If all pollution prevention measures and mission changes are implemented as scheduled, low-level radioactive waste influent volumes are expected to decrease slightly from current levels by about the year 2014 (LANL 2005e). Solid low-level radioactive waste volumes are expected to decrease slightly as well.

Similarly, because the treatment process would not be improved under the No Action Option, transuranic waste quantities would be a function of the influent volume and influent contamination concentrations. For the years 1998-2002, the Radioactive Liquid Waste Treatment Facility received on average 1,412 gallons (5,346 liters) of caustic transuranic and 8,792 gallons (33,276 liters) of acid transuranic influent per year. In that same period, the Radioactive Liquid Waste Treatment Facility produced approximately about 6.5 to 7.8 cubic yards (5 to 6 cubic meters) of solid transuranic and mixed transuranic waste annually. Under the No Action Option, the transuranic waste influent would approximately double if mission changes and pollution prevention measures are implemented. The amount of transuranic solid waste generated by treatment of the influent is likely to increase in a similar way.

Construction and operation of the evaporation tanks would have the same impacts as those detailed for Options 1, 2, and 3 in Section G.4.3.2.

G.4.3.2 Option 1: Single Liquid Waste Treatment Building Option – Proposed Project

Land Resources—Land Use

Land in TA-50 where the new building would be constructed is in the immediate vicinity of the Radioactive Liquid Waste Treatment Facility, a highly developed area with a land use designation of Waste Management (see Section 4.1 for a land use map and description). If evaporation tanks were constructed, the pipeline to them would be routed east through TA-63 and TA-52 in areas with current land use designations of Physical and Technical Support, Experimental Science, and Reserve. The proposed location of the evaporation tanks near the border of TA-52 and TA-5 is designated Reserve (LANL 2003b).

Construction Impacts—Construction of the new liquid waste management building would occur in a developed area and result in no changes to current or future land use designations. If the option to construct evaporation tanks is implemented, the land use designation for the tank areas and along a portion of the pipeline would likely change from Reserve to Waste Management. The tanks themselves could occupy approximately 3 acres (1.2 hectares), but a somewhat larger area (up to 4 acres [1.6 hectares]) would undergo a change in land use designation. Removing this land from the Reserve designation was not previously accounted for in land use plans (LANL 2004d).

Land Resources—Visual Resources

As noted previously in the land use discussion, the area in which the treatment buildings would be constructed is a highly developed area. This area currently has an industrial look, with a mix of buildings of different design. The area proposed for construction of the tanks is currently undeveloped and wooded.

Construction Impacts—There would be temporary local visual impacts associated with construction of the new treatment building, and during excavation from the use of construction equipment. The current natural setting in the area of the evaporation tanks, and a portion of the pipeline, would be disrupted by removal of vegetation, establishment of a construction staging area, and construction activities. Construction would entail excavation of soils to construct the tanks and pipeline, and possibly the temporary establishment of a soil pile. Excess soils would be removed and used or stockpiled elsewhere.

Operations Impacts—The new treatment building would not result in a change to the overall visual character of the area within TA-50. The facility would be a maximum of two stories and constructed in accordance with site guidelines, which establish acceptable color schemes for building exteriors. Establishment of evaporation tanks would result in a permanent change to the visual environment in the area near the border of TA-52 and TA-5. Although this change would result in a noticeable break in the forest cover when seen from higher elevations to the west of LANL, due to their low profile and the presence of nearby forest vegetation, the tanks would not likely be visible from the east. Additionally, the tanks would be surrounded by a fence that would be colored to blend with the surrounding environment. Following regrowth of vegetation, the area disturbed for pipeline construction would not be noticeable.

DD&D Impacts—Removal of the East Annex and TA-50-66 would result in temporary local visual impacts in the form of construction equipment and the presence of partially demolished buildings. Long-term effects would be a slightly improved local visual environment, once the annex and TA-50-66 are removed.

Geology and Soils

The existing Radioactive Liquid Waste Treatment Facility is categorized as a potential release site; other potential release sites representing possible historic spills, polychlorinated biphenyls, or leakage of radioactive wastewater are present in the vicinity of the proposed construction at TA-50. A large radioactive waste material disposal area (MDA), designated MDA C, is immediately south of the existing Radioactive Liquid Waste Treatment Facility. NNSA is implementing environmental investigation and remediation measures for MDA C and other potential release sites at TA-50 in accordance with DOE requirements and the Consent Order.

TA-50 is approximately 0.8 miles (1.25 kilometers) east of the nearest mapped fault, a subsidiary of the Rendija Canyon Fault (see Section 4.2 of this SWEIS). However, previous study indicates that the level of seismic risk is low and is manageable through facility design. Any new facilities would be designed in accordance with current DOE seismic standards and applicable building codes.

Because building construction would occur within areas already disturbed by previous facility construction, there would be no impact on native soils. Construction of the new facilities would require removal of facility soils as well as new excavation of shallow bedrock in some areas. As a result, construction activities would generate excess soil and excavated bedrock that may be suitable for use as backfill. Uncontaminated backfill would be stockpiled at an approved material management area at LANL for future use. Best management practices would be implemented to prevent erosion and migration of disturbed materials from the site caused by stormwater, other water discharges, or wind.

Construction Impacts—Approximately 36,000 cubic yards (28,000 cubic meters) of soil and rock would be disturbed during building excavation. If construction of the evaporation tanks and associated pipeline also occurs, an additional 69,000 cubic yards (53,000 cubic meters) of excavation work would be required. Nevertheless, the proposed project would initiate removal of contaminated areas adjacent to the Radioactive Liquid Waste Treatment Facility and would have a positive effect. The East Annex and TA-50-66 would also be demolished, and remediation of associated potential release sites would be initiated.

Operations Impacts—There would be minimal operations impacts on geology and soils. Evaporation of liquid effluent would eliminate addition of contaminants to soil and sediment below the existing permitted outfall. As noted above, construction activities may remove contaminated media, resulting in a reduced potential for contamination spread from past releases.

DD&D Impacts—Contaminated material would be removed from the areas affected by demolition and construction, and would be managed according to waste type and LANL procedures.

Water Resources

The Radioactive Liquid Waste Treatment Facility currently releases treated effluent to Mortandad Canyon at a permitted outfall. Other industrial outfalls and stormwater also discharge into Mortandad Canyon, both upstream and downstream from the Radioactive Liquid Waste Treatment Facility. Mortandad Canyon crosses lands belonging to the Pueblo of San Ildefonso before discharging into the Rio Grande. Existing contaminants are known to be present in Mortandad Canyon. A permeable reactive membrane barrier designed to trap contaminants and to prevent their movement downstream toward the Pueblo of San Ildefonso is located downstream from TA-50.

Construction Impacts—Construction could result in movement of contaminated and uncontaminated materials. The effects of construction would be mitigated by implementation of a stormwater pollution prevention plan to contain sediments and prevent erosion.

Operations Impacts—The overall effect of implementing the proposed project is expected to be positive. This option would ensure that both current and projected future discharge requirements could be met. During operations, effluent water quality is expected to improve due to improved processing and potentially more-stringent discharge requirements. If discharges are eliminated or greatly decreased through recycling or evaporation, movement of contaminants in groundwater and surface water in Mortandad Canyon is expected to decrease. If liquid discharge is not reduced or completely eliminated by recycling or evaporation, the permeable reactive membrane barrier is expected to mitigate the downstream movement of contaminants. The potential for spills of contaminated water would be greatly reduced by replacing single-walled piping with double-walled pipes and by use of secondary containment structures.

DD&D Impacts—Demolition could result in mobilization of particulates that could be entrained in offsite sediments. However, erosion control measures specified in a stormwater pollution prevention plan would be implemented. Movement of contaminated or uncontaminated materials is, therefore, expected to be negligible.

Air Quality

The Radioactive Liquid Waste Treatment Facility contributes less than 1 microcurie of radioactive emissions to LANL’s total radioactive emissions. Likewise, Radioactive Liquid Waste Treatment Facility emissions of criteria air pollutants (nitrogen oxides, sulfur oxides, particulate matter, carbon monoxide, and volatile organic compounds) and other hazardous air pollutants are small relative to LANL’s overall emissions.

Construction Impacts—Construction and demolition would result in temporary increases in particulate emissions.

Operations Impacts—Sufficient information to assess emissions and doses from a new treatment building is not yet available. The effect of the proposed project on air quality is expected to be minimal. During operations, radioactive air emissions are expected to be within an order of magnitude of current air emissions. Because current radioactive air emissions are very low, radioactive emissions from the processes to be implemented under any of the new construction options would likely not be major contributors to the total LANL radioactive emissions. Stack monitoring requirements would be adjusted as necessary based on the final design. New combustion equipment installed as part of any of the new construction options would be low-nitrogen-oxide emitters compared to existing equipment. Radiological and nonradiological emissions associated with solar evaporation of effluent are expected to be small, and dominated by evaporation of water containing tritium.

DD&D Impacts—Demolition of the East Annex and the transuranic waste influent storage tanks (TA-50-66) would likely produce radioactive or hazardous emissions. These emissions would be temporary, but released particulates could be dispersed to other areas. Because of the presence of contaminated soils and structural materials, there is potential to release radioactive or other hazardous constituents. Standard measures for controlling fugitive emissions would be employed.

Ecological Resources

The Radioactive Liquid Waste Treatment Facility is located within a highly developed industrial area of TA-50 and contains no important biological resources. However, the evaporation ponds would be located in an open field containing scattered trees. Mortandad Canyon contains breeding and foraging habitat for the Mexican spotted owl. The industrial area where the Radioactive Liquid Waste Treatment Facility is located is within developed Mexican spotted owl core habitat and its developed buffer zone. The area where the evaporation tanks would be located is also within the buffer and cores zones of the Sandia and Mortandad Canyon Area of Environmental Interest (LANL 2000).

Construction Impacts – Construction of the new Radioactive Liquid Waste Treatment Facility would not disturb any natural habitat. The biological assessment prepared by DOE, however, determined that constructing the evaporation tanks and pipeline would remove about 5.4 acres (2.2 hectares) of undeveloped core and buffer habitat of the Mexican spotted owl (LANL 2006b). It was also determined that construction of the Radioactive Liquid Waste Treatment Facility would likely result in noise levels greater than 6 dB(A) above background levels in the core zone; however, these levels should attenuate to below this level within 0.25 miles (0.4 kilometers) of the construction site. The biological assessment concluded that with the application of reasonable and prudent alternatives the project may affect, but is not likely to adversely affect, the Mexican spotted owl. Reasonable and prudent alternatives would include not permitting work to start between March 1 and the completion of surveys aimed at determining if owls were present in order to avoid a sudden increase in noise levels during the breeding season (LANL 2006b). Additional reasonable and prudent alternatives would be similar to those addressed in Section G.3.3.2. The USFWS has concurred with this assessment (see Chapter 6, Section 6.5.2).

The bald eagle Area of Environmental Interest is not located near the proposed project site. However, because the entire LANL site is considered potential bald eagle foraging area, there may be some habitat degradation associated with the project. Provided reasonable and prudent alternatives are implemented to protect adjacent foraging habitat from detrimental cumulative effects (see Section G.2.3.2), the DOE biological assessment concluded that construction of the Radioactive Liquid Waste Treatment Facility may affect, but is not likely to adversely affect, the bald eagle. Because the proposed project is not within or upstream of the southwestern willow flycatcher Area of Environmental Interest, the biological assessment determined that the project would not affect this species (LANL 2006b). The USFWS has concurred with the DOE biological assessment as it relates to the bald eagle and southeastern willow flycatcher (see Chapter 6, Section 6.5.2).

Operations and DD&D Impacts – No direct effects on sensitive species are expected from Radioactive Liquid Waste Treatment Facility Operations. However, a biological assessment prepared by DOE predicted that if water is evaporated and not discharged to Mortandad Canyon the reduction in flow would decrease the extent of perennial and intermittent stream reaches and associated wetland and riparian habitat. This could in turn reduce the abundance and diversity of prey species for the Mexican spotted owl. Thus, the biological assessment concluded that zero discharge may adversely affect the Mexican spotted owl (LANL 2006b). But after reviewing the assessment, the USFWS determined that the affects to the Mexican spotted owl would be insignificant and discountable, and would not result in adverse affects (see Chapter 6, Section 6.5.2).

DD&D effects are expected to be temporary and to have no direct impact on sensitive species.

Human Health

The Radioactive Liquid Waste Treatment Facility has very low radioactive emissions. These emissions do not have a distinguishable effect on the projected dose to the public. Current Radioactive Liquid Waste Treatment Facility operations are conducted with a commitment to maintaining radiological doses to workers at ALARA levels.

Construction Impacts—Construction would have potential for affecting only worker health. Based on an estimated 141,000 projected person-hours and accident rates for construction at DOE sites and for the general construction industry, 2 to 6 recordable injuries and no fatalities could be expected from construction of the new treatment buildings and associated structures. If the evaporation tanks and pipeline were built, an additional 420,000 person-hours would be required, with a possibility of 5 (DOE 2004) to 18 (BLS 2003) recordable injuries.

Operations Impacts—Emissions from operating the new treatment processes would remain very low, so there would be no distinguishable contribution to the dose to the public from all LANL activities. Emissions from effluent evaporation would be small and dominated by tritium, assuming operation of the evaporation tanks as described in Section G.4.2.5. The potential quantity of evaporated tritium would be minimal compared to the quantity of tritium emitted from other Key Facilities (for example, the Tritium Facility and the Plutonium Facility). The associated radiation dose would be small and enveloped by the impacts to the public discussed in Chapter 5, Section 5.6.1.

Worker health and safety at the facility would improve during operations under this option for two reasons: (1) the new buildings, equipment, and infrastructure would be more reliable and require less maintenance; and (2) because the buildings and process are being designed together (rather than retrofitting new equipment into an old building), when maintenance is needed, prolonged periods of time in zones with potential for radiation doses would be less than those in the current Radioactive Liquid Waste Treatment Facility. Maintenance of the evaporation tanks including periodic cleaning may cause occupational exposures to workers. However, radiation doses would be maintained to levels as low as reasonably achievable below DOE occupational dose limits in 10 CFR Part 835, and exposures to non-radioactive materials would be maintained well below established occupational exposure limits.

DD&D Impacts—Under this option, workers could be exposed to radiologically or chemically contaminated materials during demolition activities. Worker risks would be mitigated by use of personal protective equipment and pre-established safety procedures. Based on an estimated 56,000 person-hours and construction accident rates, 1 to 2 recordable injuries could be expected to occur from DD&D (DOE 2004, BLS 2003).

Cultural Resources

There are no archaeological remains within the developed area of TA-50. Archaeological sites in the vicinity of the proposed evaporation tanks and pipeline would be avoided. The existing Radioactive Liquid Waste Treatment Facility qualifies as a historic building. Any removal of process equipment or demolition of portions of the structure requires historic building documentation to mitigate any adverse effects.

Construction Impacts—Under Option 1, construction would not affect cultural resources. Changes in the Radioactive Liquid Waste Treatment Facility process area would require historic documentation before any equipment is removed from the building. Any mitigation plans would have to be implemented before or during project implementation.

The pipeline and tanks would be sited to avoid impacts on nearby archaeological sites to the extent practical. However, if the pipeline alignment or the tanks encroached on cultural sites, the sites would be fenced for avoidance or excavated.

Operations Impacts—Operations conducted under the proposed project would not affect historic buildings.

DD&D Impacts—Effects on historic buildings under this option are expected to be minimal. Removal of the East Annex is not likely to affect the original historic fabric of the Radioactive Liquid Waste Treatment Facility. Removal of both the East Annex and the transuranic waste influent storage vault (TA-50-66) would require historic documentation before the demolition process began.

Socioeconomics and Infrastructure

Major infrastructure (potable water, sewage, natural gas, and electricity) is available at TA-50. As necessary, utility infrastructure and capacity will be evaluated under a separate action to determine upgrade requirements due to demand from proposed new projects, including the Radioactive Liquid Waste Treatment Facility. Recently installed natural gas infrastructure would adequately accommodate the Radioactive Liquid Waste Treatment Facility. The radioactive liquid waste collection system, which pipes radioactive liquid waste to the Radioactive Liquid Waste Treatment Facility, requires improvements such as replacing manholes and installing monitoring equipment. Within the Radioactive Liquid Waste Treatment Facility, the piping is largely single-walled and has inadequate leak and spill protection. The electrical system within the existing facility does not meet current codes.

Construction—Utility infrastructure resources would be needed for Radioactive Liquid Waste Treatment Facility construction. Standard construction practice dictates that electric power needed to operate portable construction and supporting equipment be supplied by portable diesel-fired generators. Therefore, no electrical energy consumption would be directly associated with construction. A variety of heavy equipment, motor vehicles, and trucks would be used, requiring diesel fuel, gasoline, and propane for operation. Liquid fuels would be brought to the site as needed from offsite sources and, therefore, would not be limited resources. Water would be needed primarily to provide dust control, aid in soil compaction at the construction site, and possibly for equipment washdown. Water would not be required for concrete mixing, as ready-mix concrete is typically procured from offsite resources. Portable sanitary facilities would be provided to meet the workday sanitary needs of project personnel on the site. Water needed for construction would typically be trucked to the point of use, rather than provided by a temporary service connection. Construction is estimated to require 190,000 gallons (720,000 liters) of liquid fuels and 1.0 million gallons (3.8 million liters) of water.

If evaporation tanks and pipeline were constructed, an additional 850,000 gallons (3.2 million liters) of liquid fuels and 6.5 million gallons (25 million liters) of water would be required.

The existing LANL infrastructure would be capable of supporting requirements for new facility construction without exceeding site capacities, resulting in a negligible impact on site utility infrastructure.

Operations Impacts—Utility demands in TA-50 are expected to increase. Operations at both the new Chemistry and Metallurgy Research Building Replacement and the Radioactive Liquid Waste Treatment Facility would potentially require more natural gas and electric power over time. As stated previously, utility infrastructure needs are being separately evaluated. Nevertheless, the proposed project would be subject to an energy efficiency study as it reaches detailed design phases. The preliminary facility design limits energy use to some extent by the use of cold evaporators instead of more energy-consumptive driers or other evaporative equipment.

DD&D Impacts—Activities associated with DD&D of facilities to be replaced by the new facility would be staggered over an extended period of time. As a result, impacts of these activities on LANL's utility infrastructure are expected to be very minor on an annualized basis. Standard practice dictates that utility systems serving individual facilities are shut down as they are no longer needed. As DD&D activities progress, interior spaces, including associated equipment, piping, and wiring, would be removed prior to final demolition. Thus, existing utility infrastructure would be used to the extent possible and would then be supplemented or replaced by portable equipment and facilities as DD&D activities proceed, as previously discussed for construction activities. DD&D is estimated to require 1,700 gallons (6,500 liters) of liquid fuel and 52,000 gallons (197,000 liters) of water.

Waste Management

The existing Radioactive Liquid Waste Treatment Facility does not contain RCRA regulated treatment, storage, and disposal facilities. All RCRA-regulated waste is managed in less-than-90-day storage areas before being packaged and trucked to TA-54 for offsite treatment and disposal. In 2005, the Radioactive Liquid Waste Treatment Facility produced approximately 16 pounds (7.2 kilograms) (LANL 2006f) of chemical waste compared to about 4,850 pounds (2,200 kilograms) of chemical waste projected by the *1999 SWEIS* (DOE 1999a).

The Radioactive Liquid Waste Treatment Facility typically generated about 170 to 262 cubic yards (130 to 200 cubic meters) of solid low-level radioactive waste annually between 1998 and 2002 (LANL 2003b). In 2003, 510 cubic yards (390 cubic meters) of low-level radioactive waste were generated, in 2004, 464 cubic yards (355 cubic meters) were generated (LANL 2004d, 2005c), and in 2005, 339 cubic yards (259 cubic meters) were generated (LANL 2006f). Less than 4 percent of the low-level radioactive waste volume was mixed low-level radioactive waste (LANL 2003b, 2004d). Between 1998 and 2002, the Radioactive Liquid Waste Treatment Facility generated about 39 cubic yards (30 cubic meters) of transuranic or mixed transuranic solid waste, of which about one-third was mixed transuranic waste (LANL 2003b). Due to operational interruptions in 2003 and 2004, the Radioactive Liquid Waste Treatment Facility generated no transuranic waste and only 4 cubic yards (2.7 cubic meters) of mixed transuranic waste during those 2 years (LANL 2004d, 2005c). No transuranic or mixed transuranic waste was generated during 2005 (LANL 2006f).

Construction and DD&D Impacts – **Table G–25** lists the types and volumes of waste expected to be generated during construction and demolition of buildings under Option 1. Nearly 4,900 cubic yards (3,700 cubic meters) of low-level radioactive waste is projected to be soil and debris containing so little radioactive or hazardous material that it can be disposed in bulk using lift liners or similar disposal containers that are transported in reusable transport packages such as Intermodals. Packaged low-level radioactive waste would include small quantities of low-level radioactive waste from one-time transitioning from the existing Radioactive Liquid Waste Treatment Facility, and additional one-time waste from facility stand-down. This waste would include low-level radioactive waste sludges that would be drummed, solidified, and disposed of at TA-54 or any other authorized facility, as well as small quantities of used filters, membranes, and expendable supplies. A small amount of mixed low-level radioactive waste is expected to be generated from DD&D activities.

Table G–25 Construction and Decontamination, Decommissioning, and Demolition Waste Volumes – Single Waste Liquid Treatment Building Option

Waste Type	*Cubic Yards*
Low-level radioactive waste (bulk)	4,860
Low-level radioactive waste (packaged)	1,620
Mixed low-level radioactive waste	44
Transuranic waste (contact-handled)	94
Demolition debris [a]	820
Construction waste [b]	980
Hazardous waste with asbestos	200
Solid hazardous waste with organics	< 1
Solid hazardous waste with metals	< 1

[a] Includes solid sanitary wastes.

[b] Includes 427 tons (387 metric tons) of solid waste from constructing evaporation tanks with associated pipeline. Construction waste density is 2 cubic yards per ton.

Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Contact-handled transuranic waste would include small quantities of transuranic sludge that would be drummed, solidified, and transferred to TA-54 for eventual disposal at WIPP. DD&D may also generate waste from roofing materials that may contain asbestos and would require disposal at a permitted offsite facility, as well as possibly small quantities (less than 1 cubic yard [0.8 cubic meter]) of other wastes containing organics or metals. Otherwise, all potentially recyclable materials from construction or DD&D would be characterized; if contaminated with radioactive materials or chemicals, they would be disposed of at an appropriate permitted facility (LANL 2005f).

Facility construction, transitioning, and DD&D are expected to also generate small quantities of liquids that would be processed and disposed of in accordance with LANL requirements. Construction liquids are expected to include wash water from concrete trucks (less than 100 gallons [380 liters]). Transitioning liquids are expected to include 2,640 gallons (10,000 liters) of clean water used for testing the new process that would be processed through the existing Radioactive Liquid Waste Treatment Facility treatment system. Rinsing and flushing of the piping at the existing Radioactive Liquid Waste Treatment Facility would be treated at the new or the existing facility. Any remaining treated effluent would be evaporated assuming the auxiliary action options discussed in Section G.4.2.5 are implemented; otherwise the effluent would be released to the outfall in Mortandad Canyon.

Operations Impacts—Operations would generate liquid effluent, transuranic waste, and low-level radioactive waste. The volumes of waste generated would be a function of the level of operations occurring at LANL; these volumes are presented in Chapter 5, Section 5.9 of this SWEIS.

Transportation

Pecos Drive, a secondary road that intersects Pajarito Road, provides access to TA-55, TA-50, and TA-35. Traffic is restricted to the LANL workforce and official visitors. Sufficient parking is available to accommodate the existing workforce on the site.

Construction Impacts—Construction would result in some local adverse transportation effects. Construction traffic would increase temporarily. Parking would be eliminated by construction of the new facility.

Operations Impacts—Implementation of this option would eliminate the need to ship radioactive waste to Tennessee, thus reducing the risks of waste transportation off site.

DD&D Impacts—As with construction, traffic on Pecos Road and employee parking would be disrupted during demolition. Demolition traffic would increase temporarily.

The generated construction and DD&D wastes would be transported to disposal sites, either at LANL TA-54 or an offsite location. Transportation has potential risks to workers and the public from incident-free transport, such as radiation exposure as the waste packages are transported long the routes and highways. Traffic accidents could result both in injuries or deaths from collisions and in an additional radiological dose to the public from radioactivity that may be released during the accident.

The effects of incident-free transportation of construction and DD&D wastes on the worker population and general public is presented in **Table G–26**. Effects are presented in terms of the collective dose in person-rem resulting in excess LCFs. Excess LCFs are the number of cancer fatalities that may be attributable to the proposed project, estimated to occur in the exposed population over the lifetimes of the individuals. If the number of LCFs is smaller than one, the subject population is not expected to incur any LCFs resulting from the actions being analyzed.

The risk for development of excess LCFs is highest for the workers under the offsite disposition option. This is because the dose is proportional to the duration of transport, which in turn is proportional to travel distance. As shown in Table G–26, disposal of low-level radioactive waste at the Nevada Test Site, which is located farthest from LANL, would lead to the highest dose and risk, although the dose and risk are low for all disposal options.

Table G–26 Incident-Free Transportation – for Single Liquid Waste Treatment Building Option Impacts

Disposal Option	*Low-Level Radioactive Waste Disposal Location* [a]	*Crew*		*Public*	
		Collective Dose (person-rem)	*Risk (LCF)*	*Collective Dose (person-rem)*	*Risk (LCF)*
Onsite disposal	LANL TA-54	0.26	0.000155	0.082	0.000049
Offsite disposition	Nevada Test Site	2.02	0.0012	0.59	0.00036
	Commercial facility	1.96	0.0012	0.58	0.00035

LCF = latent cancer fatality, TA = technical area.

[a] Transuranic wastes would be disposed of at WIPP.

Table G–27 presents the impacts of traffic and radiological accidents. This table provides population risks in terms of fatalities due to traffic accidents from both the collisions themselves and from excess LCFs from exposure to releases of radioactivity. The analyses assumed that all transuranic and nonradioactive wastes would be transported to offsite disposal facilities.

Table G–27 Transportation Accident Impacts – for Single Liquid Waste Treatment Building Option

Low-Level Radioactive Waste Disposal Location [a, b]	*Number of Shipments* [c]	*Distance Traveled (million kilometers)*	*Accident Risks*	
			Radiological (excess LCFs)	*Traffic (fatalities)*
LANL TA-54	462	0.057	3.6×10^{-10}	0.00089
Nevada Test Site	462	1.04	5.2×10^{-8}	0.0106
Commercial facility	462	0.94	3.9×10^{-9}	0.0095

LCF = latent cancer fatality, TA = technical area.

[a] All nonradiological wastes would be transported off site.

[b] Transuranic wastes would be disposed of at WIPP.

[c] Approximately 87.7 percent of shipments are radioactive wastes. Others include 10 percent industrial and sanitary wastes and about 2.4 percent asbestos and hazardous wastes.

Note: To convert kilometers to miles, multiply by 0.6214.

Because all estimated LCFs and traffic fatalities, as shown in Tables G–26 and G–27, are much less than 1.0, the analysis indicates that no excess fatal cancers would result from this activity, either from dose received from packaged waste on trucks or potentially received from traffic collisions and accidental release.

G.4.3.3 Option 2: Two Liquid Waste Treatment Buildings Option

The overall effect of implementing this option would be positive. Effects on land use, cultural resources, ecological resources, human health, and infrastructure are expected to be similar to those under the proposed project (Option 1). Resource area impacts that would differ from the proposed project are discussed in detail below.

Land Resources—Visual Resources

As noted previously in the land use discussion, the area in which the treatment buildings would be constructed is highly developed. This area currently has an industrial look, with a mix of buildings of different design. The area proposed for construction of the tanks is currently undeveloped and wooded.

Construction Impacts—There would be temporary local visual impacts associated with construction of the new treatment buildings and during excavation from the use of construction equipment. The current natural setting, in the area of the evaporation tanks and a portion of the pipeline, would be disrupted by removal of vegetation, establishment of a construction staging area, and construction activities. Construction would entail excavation of soils to construct the tanks and pipeline, and possibly the temporary establishment of a soil pile. Excess soils would be removed and used or stockpiled elsewhere.

Operations Impacts—The new treatment buildings would not result in a change to the overall visual character of the area within TA-50. Buildings would be a maximum of two stories and constructed in accordance with site guidelines, which establish acceptable color schemes for building exteriors. Establishment of evaporation tanks would result in a permanent change to the visual environment in the area near the border of TA-52 and TA-5. Impacts would be similar to those described for Option 1 (see Section G.4.3.2). Following regrowth of vegetation, the area disturbed for pipeline construction would not be noticeable.

DD&D Impacts—Removal of the North and East Annexes and TA-50-66 would result in temporary local visual impacts in the form of construction equipment and the presence of partially demolished buildings. Long-term effects would be a slightly improved local visual environment, once the annexes and TA-50-66 are gone.

Geology and Soils

Construction Impacts—About 80,000 cubic yards (61,000 cubic meters) of soil and rock would be disturbed during building construction; installation of the evaporation tanks and pipeline would disturb the same quantities of soil and rock as those given for Option 1.

This option would initiate removal of some potential release sites and would have a positive effect. This option would be likely to affect more potential release sites than would the proposed project because of its larger footprint.

DD&D Impacts—The major indirect impact on geologic and soil resources at DD&D locations would be associated with the need to excavate any contaminated soil and tuff from beneath and around facility foundations. Under this option, the North and East Annexes and TA-50-66 would be demolished and remediation of associated potential release sites would be required. Borrow material such as crushed tuff and soil would be required to fill the excavations to grade, but such resources would be available from onsite borrow areas (see Chapter 5, Section 5.2 of this SWEIS). Potentially affected contaminated areas would be surveyed to determine the extent and nature of any contamination. All excavated contaminated media would be characterized and managed according to waste type and all LANL procedures and regulatory requirements.

Water Resources

DD&D Impacts—Effects on water quality could be larger under this option because more demolition is proposed under this option. However, erosion control measures specified in a stormwater pollution prevention plan would be implemented to mitigate impacts of sediment movement by stormwater. Water quality effects would be similar to those under Option 1.

Air Quality

DD&D Impacts—Nonradioactive emissions would be slightly larger under this option because the amount of demolition is greater. Other air quality impacts would be similar to those under Option 1.

Ecological Resources

Possible impacts would be the same as those for Option 1.

Human Health

Construction Impacts—Option 2 would result in somewhat larger worker hours and risks than would Option 1. Based on 317,000 worker hours, 4 to 13 recordable injuries could occur during construction (DOE 2004, BLS 2003). If the evaporation tanks and pipeline were built, an additional 420,000 person-hours would be required, with a possibility of 5 (DOE 2004) to 18 (BLS 2003) recordable injuries.

DD&D Impacts—Under this option, workers could potentially be exposed to radiologically or chemically contaminated materials during demolition activities. Worker risks would be mitigated by use of personal protective equipment and pre-established safety procedures. Based on an estimated 59,800 worker hours and construction accident rates, one to three recordable injuries could occur from DD&D (DOE 2004, BLS 2003).

Operations Impacts—Impacts would be the same as those for Option 1.

Cultural Resources

Construction Impacts—Under this option, effects of construction on cultural resources would be the same as those for Option 1.

Operations Impacts—This option would result in minimal effects on historic buildings. The original portion of the Radioactive Liquid Waste Treatment Facility would remain, but would undergo internal changes such as process equipment removal. As required by mitigation plans, documentation would occur before any equipment is removed from the building. Mitigation plans would have to be implemented before or during project implementation.

DD&D Impacts—Removal of the North and East Annexes to the Radioactive Liquid Waste Treatment Facility and TA-50-66 under this option should not affect the original historic fabric of the building, but would require historic documentation before the demolition process began.

Socioeconomics and Infrastructure

Construction Impacts—Construction of the new buildings would require more infrastructure resources than Option 1. Construction is estimated to require 420,000 gallons (1.6 million liters) of liquid fuels and 2.3 million gallons (8.7 million liters) of water. If the evaporation tanks and pipeline were constructed, then similar impacts to those described in Option 1 would occur. The existing LANL infrastructure would be capable of supporting Option 2 without exceeding site capacities.

Operations Impacts—Electricity and natural gas requirements would be slightly more than Option 1 since additional new buildings would be operating. This would increase the use of utilities for lighting and heating as compared to Option 1.

DD&D Impacts—Activities associated with facilities to be replaced by the new facilities in Option 2 would be similar to those described in Option 1. However, the infrastructure needs for Option 2 would be somewhat higher than for Option 1 because one additional annex would be removed. DD&D is estimated to require quantities of liquid fuel and water similar to those in Option 1.

Waste Management

Waste types are expected to be similar to those under the proposed project. **Table G–28** provides the types and volumes of wastes generated during construction, transition, and demolition of buildings. Uncontaminated construction waste volumes would be larger than those under the proposed project because two or more new treatment facilities would be built. Transition and standdown wastes would be identical to those under the proposed project (Option 1). Volumes of demolition wastes would be greater than those under the proposed project because of the additional demolition of the North Annex. Operational waste is expected to be similar to that under the proposed project. Chemical and radioactive wastes generated through decontamination processes would be managed within the LANL waste management system. The low-level radioactive waste may be disposed of onsite or sent to an offsite facility, depending upon onsite capacities and waste acceptance priorities at TA-54 Area G. Solid wastes would be transferred to a permitted municipal landfill.

Operations Impacts—Operations would generate liquid effluent, transuranic waste, and low-level radioactive waste. The volumes of waste generated would be a function of the level of operations occurring at LANL; these volumes are presented in Chapter 5, Section 5.9, of this SWEIS.

Transportation

Pecos Drive, a secondary road that intersects Pajarito Road, provides access to TA-55, TA-50, and TA-35. Traffic is currently restricted to the LANL workforce and official visitors along Pecos Drive. Sufficient parking is available to accommodate the existing workforce in the area.

Construction Impacts—Traffic on Pecos Road and employee parking would be disrupted during construction. Pecos Road would be realigned slightly near the new low-level radioactive waste treatment buildings, but would not alter traffic flow over the long term. Traffic associated with construction would cause a temporary increase in local traffic.

Table G–28 Construction and Decontamination, Decommissioning, and Demolition Waste Volumes – Two Liquid Waste Treatment Buildings Option

DD&D Waste Type	*Cubic Yards*
Low-level radioactive waste (bulk)	5,250
Low-level radioactive waste (packaged)	1,750
Mixed low-level radioactive waste	44
Transuranic waste (contact-handled)	94
Demolition debris [a]	1,650
Construction waste [b]	1,110
Hazardous waste with asbestos	210
Solid hazardous waste with organics	< 1
Solid hazardous waste with metals	< 1

DD&D = decontamination, decommissioning, and demolition.

[a] Includes solid sanitary wastes.

[b] Includes 427 tons (387 metric tons) of solid waste from constructing evaporation tanks. Construction waste density is 2 cubic yards per ton (1.4 cubic meters per metric ton).

Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Operations Impacts—Under this option, there would be no change in local traffic. Implementation of the proposed treatment technologies would eliminate the need to ship radioactive waste to and receive residues back from Tennessee, thus reducing the risks of offsite waste transportation.

The waste generated by construction and DD&D activities would have to be moved to a different location for disposal, mostly using over-the-road truck transportation. Effects of incident-free and accident conditions of transporting construction and DD&D wastes to disposal locations on or off site are presented in **Tables G–29** and **G–30**. All nonradiological and transuranic wastes would be transported to offsite facilities. The results in these two tables indicate that no traffic fatalities or excess LCFs are expected from transportation of generated wastes.

Table G–29 Incident-Free Transportation Impacts – Two Liquid Waste Treatment Buildings Option

Disposal Option	*Low-Level Radioactive Waste Disposal Location* [a]	*Crew*		*Public*	
		Collective Dose (person-rem)	*Risk (LCF)*	*Collective Dose (person-rem)*	*Risk (LCF)*
Onsite disposal	LANL TA-54	0.26	0.000156	0.082	0.000049
Offsite disposal	Nevada Test Site	2.16	0.0013	0.63	0.00038
	Commercial facility	2.10	0.00126	0.62	0.00037

LCF = latent cancer fatality, TA = technical area.

[a] Transuranic waste would be disposed of at WIPP.

Table G–30 Transportation Incident Impacts – Two Liquid Waste Treatment Building Option

Low-Level Radioactive Waste Disposal Location [a, b]	*Number of Shipments* [c]	*Distance Traveled (10^6 kilometers)*	*Accident Risks*	
			Radiological (excess LCFs)	*Traffic (fatalities)*
LANL [b]	540	0.076	3.6×10^{-10}	0.0011
Nevada Test Site	540	1.14	5.6×10^{-8}	0.0117
Commercial facility	540	1.03	4.2×10^{-9}	0.0105

LCF = latent cancer fatality.

[a] All nonradiological wastes would be transported offsite.

[b] Transuranic waste would be disposed of at WIPP.

[c] Approximately 81 percent of these are radioactive. Others include 17 percent industrial and sanitary waste and about 2 percent asbestos and hazardous waste.

Note: To convert kilometers to miles, multiply by 0.6214.

G.4.3.4 Option 3: Two Liquid Waste Treatment Buildings and Renovation Option

Under this option, the effects on ecological resources would be similar to those under the proposed project (Option 1). Resource area impacts that would differ from the proposed project are discussed in detail below.

Land Resources – Visual Resources

Activities in this option would be the same as those conducted in Option 2, with the additional renovation of a portion of the existing facilities. The renovated structure would have new external walls that would have color schemes that would match the new structures built as part of Option 2. Local visual impacts would therefore be similar to those described for Option 2.

Geology and Soils

About 95,000 cubic yards (73,000 cubic meters) of soil would be disturbed during building construction. Installation of the evaporation tanks and pipeline would disturb the same quantities of soil and rock as those given for Option 1.

This option would have a long-term positive effect by removing contaminated materials. More demolition would occur under this option than under Options 1 or 2, and a larger area of the associated potential release sites could be disturbed. More contaminated materials would be removed under this option. Contaminated material from demolition and construction would be managed according to waste type and LANL procedures. The long-term potential for spread of air- and waterborne contamination would be reduced.

Water Resources

Effects on water quality could be larger than those under Option 1 because more demolition is proposed under this option. However, implementing sediment and erosion control measures is expected to control possible consequences. Other water quality effects would be similar to those under Option 1.

Air Quality

Radioactive and nonradioactive emissions would be slightly greater under this option than under the proposed project because the amount of demolition would be greater. Other air quality impacts would be similar to those under Option 1.

Ecological Resources

Possible impacts on ecological resources would be the same as those for Option 1.

Human Health

Construction Impacts—Option 3 would result in somewhat larger worker hours and risks than would Option 2. Based on 377,000 worker hours, 4 to 16 recordable injuries could occur from construction (DOE 2004, BLS 2003). If the evaporation tanks and pipeline were built, an additional 420,000 person-hours would be required, with a possibility of 5 (DOE 2004) to 18 (BLS 2003) recordable injuries.

DD&D Impacts—Potential for worker exposure to radiological and hazardous material (such as asbestos) contamination would be greater under this option than under Option 2 due to the increased amount of demolition and the renovation in the existing facility. This greater potential exposure would result in very small increases in worker risk. DD&D activities would require 108,000 person-hours resulting in the possibility of 1 to 5 recordable injuries (DOE 2004, BLS 2003).

Operation Impacts—Impacts would be the same as those under Option 1.

Cultural Resources

Under this option, additional adverse effects on cultural resources are expected. In addition to impacts addressed under Option 2, changes to the structure of the existing Radioactive Liquid Waste Treatment Facility would alter the original appearance of the historic building. Removal of equipment, modification to the building, and demolition of the annexes would require documentation and consultation with the New Mexico Historic Preservation Office. Any mitigation plans would be implemented before DD&D began.

Socioeconomics and Infrastructure

Construction Impacts—Option 3 would require more infrastructure resources than Options 1 and 2 because Option 3 includes Option 2 plus renovating the existing facilities. Construction is estimated to require 500,000 gallons (1.9 million liters) of liquid fuels and 2.7 million gallons (10 million liters) of water. If the evaporation tanks and pipeline were constructed, then similar impacts to those described in Option 1 would occur. The existing LANL infrastructure would be capable of supporting Option 3 without exceeding site capacities.

Operations Impacts—Electricity and natural gas requirements would be slightly more than Options 1 and 2 since two new buildings would be constructed and existing facilities would be reused.

DD&D Impacts—Activities associated with facilities to be replaced by the new facilities in Option 3 would be similar to those described for Options 2. As in Option 2, a second annex would be removed. Option 3 would require quantities of liquid fuel and water similar to those for Option 1.

Waste Management

Construction, transition, and standdown waste volumes would be similar to those under Option 2. Under this option, contaminated wastes from demolition and renovation would exceed those of Options 1 and 2, as the South Annex would be demolished in addition to the East and North annexes. Existing external walls would be removed and replaced with seismically appropriate materials and construction as required to meet the LANL's standard for Hazard Category 2 facilities. In addition, electrical and plumbing systems that do not meet the current building codes would be replaced. Operational waste would be similar to that of the proposed project. All wastes would be managed in accordance with LANL procedures and the project's waste management plan. **Table G–31** provides the types and volumes of wastes generated during construction (contaminated soil and rubble volumes), transition, and demolition of buildings.

Table G–31 Construction and Decontamination, Decommissioning, and Demolition Waste Volumes – Two Liquid Waste Treatment Buildings and Renovation Option

DD&D Waste Type	*Cubic Yards*
Low-level radioactive waste (bulk)	7,720
Low-level radioactive waste (packaged)	2,570
Mixed low-level radioactive waste	153
Transuranic waste (contact-handled)	228
Demolition debris [a]	1,810
Construction waste [b]	1,150
Hazardous waste with asbestos	211
Solid hazardous with organics	< 1
Solid hazardous with metals	1

DD&D = decontamination, decommissioning, and demolition.

[a] Includes solid sanitary waste.

[b] Includes 427 tons (387 metric tons) of solid waste from constructing evaporation tanks. Construction waste density is 2 cubic yards per ton (1.4 cubic meters per metric ton).

Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Transportation

Traffic effects would be the same as those for Option 1, except that the disruption would be longer in duration due to the extended renovation and demolition activities.

The large amounts of waste generated by construction and DD&D activities would have to be moved to a different location for disposal, mostly using over-the-road truck transportation. The effects from incident-free transportation and accident conditions of transporting the construction and DD&D wastes to disposal locations on or off site are presented in **Tables G–32** and **G–33**. All nonradiological and transuranic wastes would be transported to offsite facilities.

Table G–32 Incident-Free Transportation Impacts – Two Liquid Waste Treatment Buildings and Renovation Option

Disposal Option	*Low-Level Radioactive Waste Disposal Location* [a]	*Crew*		*Public*	
		Collective Dose (person-rem)	*Risk (LCF)*	*Collective Dose (person-rem)*	*Risk (LCF)*
Onsite	LANL TA-54	0.58	0.00035	0.185	0.00011
Offsite	Nevada Test Site	3.46	0.0021	1.02	0.00061
	Commercial facility	3.35	0.0020	1.00	0.00060

LCF = latent cancer fatality, TA = technical area.

[a] Transuranic waste would be disposed of at WIPP.

Table G–33 Transportation Incident Impacts – Two Liquid Waste Treatment Building and Renovation Option

Low-Level Radioactive Waste Disposal Location [a, b]	*Number of Shipments* [c]	*Distance Traveled (10^6 kilometers)*	*Accident Risks*	
			Radiological (excess LCF)	*Traffic (fatalities)*
LANL [b]	771	0.100	8.3×10^{-10}	0.0014
Nevada Test Site	771	1.68	8.3×10^{-8}	0.017
Commercial facility	771	1.52	6.2×10^{-9}	0.015

LCF = latent cancer fatality.

[a] All nonradiological wastes would be transported offsite.

[b] Transuranic waste is disposed of at WIPP.

[c] Approximately 85 percent of these are radioactive. Others include 13 percent industrial and sanitary wastes, and about 2 percent asbestos and hazardous wastes.

The results in these two tables indicate that no traffic fatalities or excess LCFs would be expected from transportation of generated wastes.

G.5 Los Alamos Neutron Science Center (LANSCE) Refurbishment Impacts Assessment

This section provides an impact assessment for activities to be taken to refurbish LANSCE. Section G.5.1 provides background information on the proposed project. Section G.5.2 provides a brief description of the proposed options for LANSCE. Section G.5.3 presents the environmental consequences of the No Action Option and the proposed project.

G.5.1 Introduction

In the late 1960s and early 1970s, the Los Alamos Meson Physics Facility was constructed as a world-class medium-energy physics machine with the primary mission of studying production of subatomic particles called pions and their interaction with nuclei. At that time, the nuclear weapons program needed an intense source of neutrons that the new machine could provide. As a result, an accelerator was designed and constructed to have an extraordinarily flexible beam structure capable of accelerating both positive and negative hydrogen ions and delivering those beams to multiple experimental areas simultaneously. In 1996, the Los Alamos Meson Physics Facility was renamed the Los Alamos Neutron Science Center (LANSCE) (LANL 2004a).

Since the LANSCE linear accelerator first accelerated protons in 1972, the facility mission has evolved considerably. However, investment in the physical infrastructure has not kept pace with that required for long-term sustainable operation at high reliability. NNSA now needs to make repairs to the facility and its operating systems and equipment to address its continued use. In addition, the refurbishment would eliminate the following sources of operational inefficiencies that could improve operational effectiveness: single-point failures with an estimated time to repair of greater than 30 days; equipment beyond its predicted end of life that could severely impact facility operations; obsolete equipment with no available spare parts; and environmental, safety, and health or code compliance issues necessary to continue safe operation.

G.5.2 Options Considered

Two options identified for LANSCE Refurbishment are the No Action Option and proposed project option.

G.5.2.1 No Action Option

Under the No Action Option, no action to refurbish the facility would be taken. The existing programs would be operated as they are today, and there would be limitations on the full expanded use of the facility; corrective maintenance and actions would continue to be performed as failures occur or certain activities would cease. If systems proposed for replacement on this project are neither modified nor upgraded, they are expected to fail. Based on currently available information, the nature, timing, or type of all failures cannot be predicted. However, many failures would delay programmatic work, campaigns, critical experiments, and their activities. All of this would result in higher program costs and lengthier schedules. Because the facility is over 30 years old, it would experience more and more severe failures over time, until either equipment would have to be replaced on a piecemeal basis through corrective maintenance (resulting in increased operating costs) or the facility would have to be shut down if unreliability adversely impacts safety. If this No Action Option is selected, there is a high probability that the research and development for the Stockpile Stewardship Program and radioactive isotope production would be shut down in 4 to 5 years.

G.5.2.2 Proposed Project

NNSA has identified a series of refurbishment activities that would ensure reliable facility operations well into the next decade. Refurbishment would prevent long nonoperational periods and costly emergency expenditures. This proposed project would entail replacing facility equipment, enhancing cost-effectiveness, and stabilizing the overall beam availability reliability, while imposing minimal disruption to user programs.

NNSA proposes to: (1) replace facility equipment where necessary to address code compliance or end-of-life issues that could severely impact facility operations, (2) enhance cost-effectiveness by system refurbishments or improvements that stabilize decreasing facility reliability and maintainability, (3) stabilize the overall beam availability and reliability in a manner that is sustainable over the longer term, and (4) accomplish the above with minimal disruption to scheduled user programs.

Achieving the above requires undertaking the following activities (LANL 2005b):

- Replacing a minimum set of klystrons, transmitters, high-voltage power systems, and ancillary hardware with new and modern equivalents to achieve high reliability of the 805-megahertz radiofrequency system
- Replacing the power amplifier, intermediate power amplifier, and ancillary hardware with a modern system to maintain and improve reliability of the 201-megahertz radiofrequency system
- Replacing antiquated hardware and software in the accelerator control, data acquisition, and timing systems that have become virtually nonmaintainable because of obsolescence
- Refurbishing and replacing vacuum and cooling systems and magnet power supplies for the accelerator and beam-transfer lines to substantially reduce the increasing amount of beam downtime due to these systems
- Refurbishing and improving beam-diagnostics systems to provide much-needed efficient beam-tuning capabilities to maintain reliability
- Replacing injector components to increase the negative-hydrogen beam intensity by a factor of two (LANL 2005b).

There is substantial evidence that many components needed to sustain reliable operation are near the end of life, are so obsolete that replacement parts can no longer be found, need replacement to comply with Federal law, or could have single-point failures with long lead time replacements (LANL 2004a).

All refurbishment and upgrade work for the LANSCE Refurbishment Project would be performed within the existing complex at TA-53. The activities proposed constitute a refurbishment of existing, operating facilities that would provide the same basic operational conditions that currently exist. The proposed project would be limited to the Accelerator Complex and experimental facilities. The proposed schedule has overall design beginning in fiscal year 2007, with refurbishment activities completed in fiscal year 2014. Under this schedule, an extended outage in the 2010 to 2012 timeframe may be required; however, work would be performed during these outages to minimize disruption to operations and would be conducted over the course of about 7 years (LANL 2005b). The project is not expected to result in material changes to the permitting basis (for example, air and water emissions), and the subprojects would fall within the bounds of existing permits.

Specifically, LANSCE Refurbishment would enhance cost-effectiveness by system refurbishments or improvements that reduce operating costs, improve decreasing facility reliability by replacing systems that have an impact of 15 percent or greater on reliability for those systems, and increase the negative-hydrogen beam intensity for improved proton radiography data (LANL 2005b).

G.5.2.3 Options Considered but Dismissed

Move the mission to another facility

Moving the mission from LANL to another location would reduce the amount of capital that must be invested at LANL; however, LANSCE continues to be the major LANL experimental-science facility and is a critical feature of LANL's science-based mission. The LANSCE facility is unique to LANL, and there is no foreseeable future substitute for this capability. A list of other DOE facilities that could be possible sites for portions of the mission need was identified by capability type. Technical capabilities for evaluation included: proton radiography, fast-burst neutron sources, neutron irradiation of weapons components, fast-neutron nuclear science, low-energy neutron nuclear science, and neutron scattering in support of weapons materials science. No one DOE facility was identified that could fulfill the entire mission of LANSCE, and no combination of facilities was identified that could complete the required missions without a new investment several times the cost of LANSCE refurbishment (LANL 2005b). Therefore, this action was dismissed from further consideration.

Construct a new facility and demolish the existing TA-53 facility at the end of its life

Construction of a new LANSCE facility at LANL or elsewhere would require more resources and is not a viable fiscal option at this time. Therefore, this option was dismissed from further consideration.

G.5.3 Affected Environment and Environmental Consequences

The LANSCE complex is located in TA-53 (see **Figure G–10**). NNSA proposes activities that constitute a refurbishment of an existing, operating facility that would provide the same basic operational conditions that currently exist (LANL 2006a). Therefore, the affected environment is TA-53, although the region of influence for each resource evaluated may extend beyond TA-53 and LANL.

The analysis of environmental consequences relies heavily on the affected environment descriptions in Chapter 4 of the main volume of this SWEIS, and care has been taken not to repeat this information. Resource areas or disciplines not expected to be affected by the LANSCE Refurbishment Project or that would not directly or indirectly affect project implementation have not been included. Otherwise, where information specific to TA-53 and LANSCE is available and aids understanding the TA-53 affected environment and potential environmental consequences, it has been included.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Land Resources* – Refurbishment takes place within existing structures and would not change land use designations or visual resources.
- *Geology and Soils* – Refurbishment takes place within existing structures.

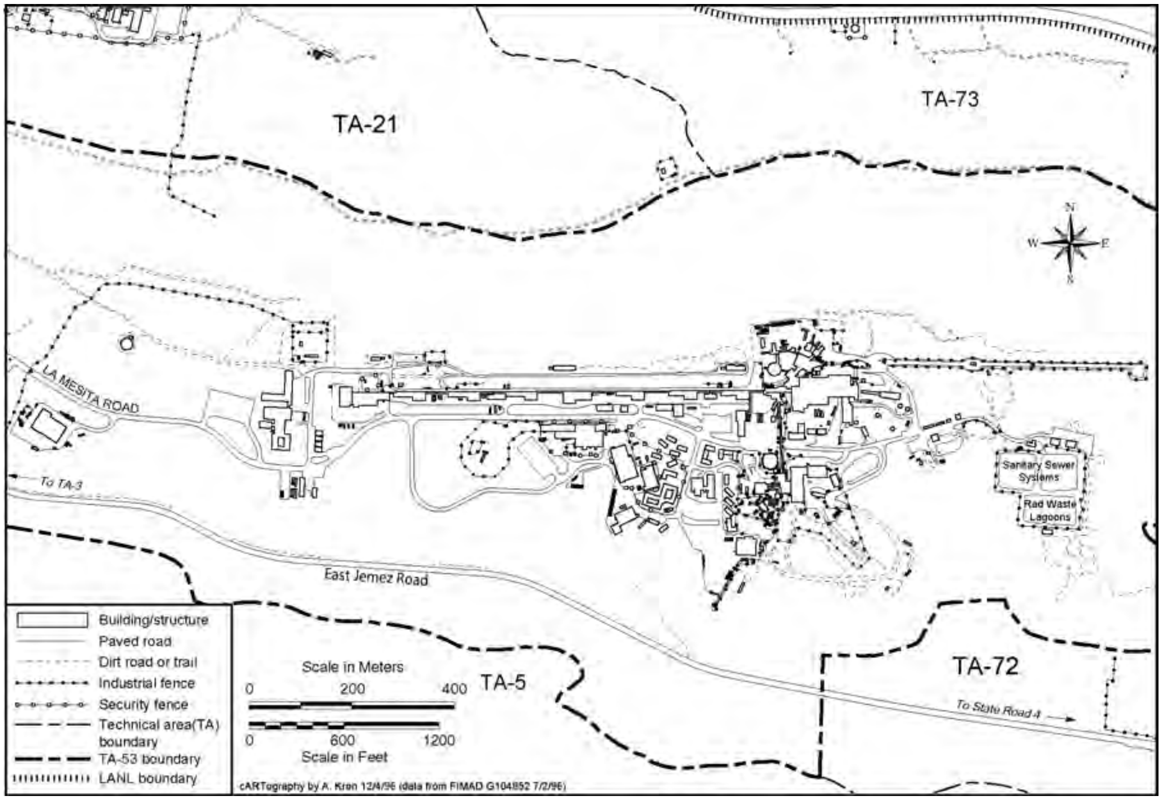


Figure G–10 Location of Los Alamos Neutron Science Center at Technical Area 53

- *Ecological Resources* – Refurbishment takes place within existing structures with no new land disturbed.

- *Socioeconomics and Infrastructure* – No new employment is expected. Construction and refurbishment workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.

- *Transportation* – Refurbishment takes place within existing structures with no additional traffic effects.

- *Environmental Justice* – The proposed project is confined to already-developed areas of TA-53, with no disproportionate human health impacts to low-income or minority populations expected.

- *Facility Accidents* – The proposed project would not implement new activities associated with radiological materials; only industrial accidents may occur.

This impact assessment focuses on those areas of the affected environment where potential impacts would occur: water resources, air quality and noise, human health, cultural resources, site infrastructure, and waste management.

G.5.3.1 No Action Option

Lack of investment in critical structural upgrades and replacements would delay programmatic work, campaigns, critical experiments, and their activities. Over time, this would result in higher program costs and lengthier schedules. Because no new buildings or facilities would be built under the No Action Option and operations would not change, there would be no impact on land use, water resources, human health, or transportation. Impacts of the No Action Option are included in the impacts of the No Action Alternative discussed in Chapter 5 of this SWEIS.

G.5.3.2 Proposed Project

All the refurbishment and upgrade work for the LANSCE Refurbishment Project would be performed inside the existing LANSCE complex at TA-53. The project is not expected to result in material changes to the permitting basis (air and water emissions), and the subprojects are assumed to fall within the bounds of existing permits.

Water Resources

Operations Impacts—While LANSCE Refurbishment Project activities are not intended to materially change LANSCE complex operations, project implementation may indirectly increase annual discharge of nonradiological cooling water effluent due to potential increased use of the accelerator facilities. However, discharge levels are still expected to remain below those that were forecast for the *1999 SWEIS* (DOE 1999a).

Air Quality and Noise

LANSCE operations have historically accounted for more than 90 percent of all radioactive air emissions and 95 percent of the total offsite dose from LANL (LANL 2005a, 2006a). These emissions have historically come predominantly from stacks ES-3 and ES-2. Stack ES-3 ventilates Building 53-003, the linear accelerator and adjacent experimental stations. Stack ES-2 exhausts the proton storage ring and experimental stations at the Manuel Lujan Neutron-Scattering Center and Weapons Neutron Research Facility buildings. However, the shutdown of beam operations in Area A in the 1998 timeframe resulted in decreased radiological air emissions from the ES-3 emission point. Air activation products from the LANSCE stacks contributed over 95 percent of the total LANL radiological air emissions during 2005 (LANL 2006d).

Construction Impacts—As LANSCE Refurbishment Project activities would primarily involve upgrades and repairs or replacements of existing structures, systems, and components, including electrical, electronic, and mechanical systems; most work would be performed using portable equipment and hand tools. There would be some emissions of criteria and toxic pollutants from fuels, solvents, acids, and epoxies associated with project activities. Because implementation of individual subprojects would be spread out over a period of 7 years and emissions would be small, any impacts on ambient air quality would be negligible to minor and of short duration. Minor impacts of vehicle emissions from transport of materials and construction workers would occur off site. No radiological releases to the environment are expected in association with LANSCE Refurbishment Project activities.

Project activities could result in a temporary increase in noise levels near the TA-53 complex and near specific work areas. There would be no change in noise impacts on the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from project workers' vehicles and materials shipments. Noise sources would not include loud impulsive sources such as blasting.

Operations Impacts—While LANSCE Refurbishment Project activities are not intended to materially change LANSCE complex operations, project implementation may indirectly increase air emissions due to increased use of the accelerator facilities as described in Chapter 5, Section 5.4.2, of this SWEIS. The dose to the MEI from these emissions would be limited by operational controls to 7.5 millirem per year.

The acoustic environment of the more intensely developed TAs such as TA-53, in which administrative, research and development, and various industrial processes are collocated, includes noise from mechanical equipment (such as cooling systems, vents, motors, and material-handling equipment), in addition to employee motor vehicle and truck traffic. This level of noise at LANSCE would not change from existing levels and does not generally pose a hazard to workers. In situations requiring workers to enter high-noise environments, appropriate hearing protection is provided. LANSCE operations do not result in impulse noises that would be distinguishable by the public.

Human Health

During LANSCE operations, short-lived positron emitters, and activation products such as carbon-11, nitrogen-13, and oxygen-15, are released from the stacks and diffuse from the buildings. These products would release photon radiation as they decay, producing a potential radiation dose. Based on atmospheric modeling of actual releases and dose calculations, the dose to the MEI (at East Gate) from LANSCE in 2005 was 6.31 millirem. The total dose from all LANL operations to an individual at East Gate was approximately 6.46 millirem. This dose is under the EPA limit of 10 millirem per year, and approximately 1 percent of the naturally occurring background radiation dose (LANL 2006d).

Construction Impacts—No radiological risks would be incurred by members of the public from proposed LANSCE Refurbishment Project activities. Project workers would be at a small risk for work-related accidents and radiological exposures. However, as the majority of the scoped work would be performed in areas outside of the beam line, doses to workers performing these tasks would be minimal (LANL 2006a). These workers would be protected through appropriate training, monitoring, and management controls. Their exposure would be limited to ensure that doses were kept ALARA.

Operations Impacts—While LANSCE Refurbishment Project activities are not intended to materially change LANSCE complex operations, project implementation may indirectly increase air emissions, including radiological emissions and consequential dose, due to increased use of the accelerator facilities. However, the dose would be limited by operational controls to 7.5 millirem per year.

Cultural Resources

The LANSCE Accelerator Building has been determined to be eligible for listing on the National Register of Historic Places. Although project-related modifications would not affect the external appearance of the structure, it would be necessary to make a determination of potential adverse effects and document existing conditions, as appropriate. Such documentation could include production of archival photographs and drawings. Additionally, any other significant historic buildings at TA-53 that could experience internal modifications would have to be evaluated for National Register of Historic Places eligibility status; these buildings must be considered potentially eligible until formally assessed.

Socioeconomics and Infrastructure

Utility infrastructure at the LANSCE complex encompasses the electrical power, natural gas, and water supply systems needed to support mission requirements. LANL's total electrical energy consumption was 421,413 megawatt-hours in fiscal year 2005, with LANSCE using 93,042 megawatt-hours. These values are well below the *1999 SWEIS* annual forecasts of 782,000 and 437,000 megawatt-hours, respectively. LANL's total electric peak demand was about 69.4 megawatts in fiscal year 2005 with LANSCE accounting for 21.9 megawatts of the total. Again, these values are well below the *1999 SWEIS* forecasts of 113 and 63 megawatts, respectively (LANL 2006f). Full-power operation of the 800-million electron volt linear accelerator alone requires 21 megawatts of power from the LANL electric grid. Natural gas is also consumed by boilers within TA-53 for space heating and also to operate and maintain the cooling water system (LANL 2003a, 2006a). LANSCE's boilers consumed approximately 65,283 decatherms (equivalent to about 65.3 million cubic feet [1.85 million cubic meters]) of natural gas in fiscal year 2005 (LANL 2006a). LANL's total natural gas consumption was 1,187,855 decatherms (equivalent to about 1.19 billion cubic feet [33.7 million cubic meters]) in fiscal year 2005. Site-wide natural gas consumption remained below the *1999 SWEIS* annual forecast of 1,840,000 decatherms (equivalent to about 1.84 billion cubic feet [52.1 million cubic meters]) (LANL 2006f). LANSCE's natural gas consumption was not individually forecast in the *1999 SWEIS*.

Cooling water requirements for accelerator operations drive total water demand at LANSCE. Operations have historically required about 77 million gallons (291 million liters) of water annually, or about 15 percent of the water consumption for all of LANL (LANL 2006a). LANL used about 359 million gallons (1.36 billion liters) of water in fiscal year 2005 (LANL 2006f); LANSCE's metered water use was approximately 54.8 million gallons (207 million liters) in 2005 (LANL 2006a). Nevertheless, recent LANL site-wide and historic LANSCE usages are well below the *1999 SWEIS* annual forecasts of 759 million gallons (2.87 billion liters) and 265 million gallons (1.0 billion liters), respectively (LANL 2006a, 2006f).

Overall, LANSCE demands for electric power and water have trended well below those forecast in the *1999 SWEIS* in part because those projections included operation of the Low-Energy Demonstration Accelerator. Operation of this facility was forecast to more than double LANSCE's electric peak load demand and its water demand for cooling tower operation (LANL 2006a). Nonetheless, this facility only operated from late 1998, and at lower power than originally proposed, until it was shut down in December 2001. The facility has been decommissioned and is being dismantled (LANL 2006f).

Construction Impacts—Requirements for utility infrastructure resources are expected to be negligible and well within the capacities of existing TA-53 utility systems (LANL 2006a). Although small quantities of gasoline and diesel fuel would be required for such uses as operation of vehicles associated with project activities and possibly for portable generators to power hand tools, spotlighting, and other construction equipment, fuel would be procured from offsite sources and, therefore, would not be a limited resource.

Operations Impacts—While LANSCE Refurbishment Project activities are not intended to materially change LANSCE complex operations, project implementation would likely indirectly increase utility demands over more recent levels due to increased use of the accelerator facilities as analyzed and described in Chapter 5, Section 5.8.2.3, of this SWEIS. However, levels are still expected to remain below those forecast in the *1999 SWEIS* (DOE 1999a).

Waste Management

LANL generates chemical and radioactive wastes as a result of research, production, maintenance, construction, and remediation service activities. For 2005, waste quantities generated from operations at the key facilities were below *1999 SWEIS* projections for all waste types (LANL 2006f). At LANSCE, low-level radioactive liquid waste is collected and allowed to decay in three process tanks, located in Building 53-945, prior to discharge to two lined evaporation tanks. Sanitary wastewater is collected and sent to the Sanitary Wastewater Systems Plant at TA-46. Chemical wastes include hazardous, toxic, and special wastes. Small quantities of hazardous wastes such as liquid solvents, solvents on wipes, lead, and solder are produced from accelerator maintenance and development (LANL 2006a). **Table G–34** presents the latest available waste generation data for LANSCE operations.

Table G–34 Waste Generation from Existing Los Alamos Neutron Science Center Operations at Technical Area 53

Waste Type	*1999 SWEIS ROD Projection*	*2005 Generation*
Low-level radioactive waste (cubic yards per year)	1,420	67
Mixed low-level radioactive waste (cubic yards per year)	1	< 1
Chemical (pounds per year)	36,600	1,980

ROD = Record of Decision.
Note: To convert pounds to kilograms, multiply by 0.45359; cubic yards to cubic meters, multiply by 0.76456.
Source: LANL 2006f.

Construction Impacts—LANSCE Refurbishment Project activities are expected to generate small quantities of low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, and nonhazardous solid wastes. In particular, low-level and mixed low-level radioactive wastes would be generated from refurbishment of beam-line components, but operating experience would be combined with recognized waste minimization techniques to eliminate or reduce all waste streams (LANL 2004a). All wastes would be managed and disposed of in a fully compliant method that minimizes volume while minimizing exposure to workers. Liquid low-level radioactive waste would be processed directly through LANSCE's Radioactive Liquid

Waste Treatment Facility. Greater than 75 percent of all nonhazardous solid waste generated, including steel, wire and piping, and packing materials (such as pallets and packing crates), would be recycled (LANL 2006a).

Operations Impacts—While LANSCE Refurbishment Project activities are not intended to materially change LANSCE complex operations, project implementation may indirectly increase air emissions, including radiological emissions and consequential dose, due to enhanced operational availability of the accelerator facilities. However, levels are still expected to remain below applicable standards and levels that were forecast in the *1999 SWEIS*. In addition, an increase in LANSCE operations may result in generation of additional volumes of wastes, but quantities are expected to remain within the *1999 SWEIS* projections.

G.6 Technical Area 55 Radiography Facility Impacts Assessment

This section provides an assessment of environmental impacts for the proposed TA-55 Radiography Facility. Section G.6.1 provides background information on radiography facilities throughout LANL. Section G.6.2 provides a description of the TA-55 Radiography Facility proposed options. Section G.6.3 presents environmental consequences of the No Action Option and the new Radiography Building Option.

G.6.1 Introduction

The NNSA proposes to relocate high-energy x-ray radiography[1] (radiography) of nuclear items and components from the former location at TA-8 to facilities within restricted access areas of TA-55. This would involve an incremental development of the capability within TA-55.

In the ROD (61 *Federal Register* [FR] 68014) for the *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE 1996), LANL was assigned responsibility for ensuring the safety and reliability of weapons systems in the stockpile for the foreseeable future, in the absence of underground testing. LANL was also assigned responsibility for stockpile management, which addresses NNSA’s production and maintenance of nuclear weapons, including component production and weapon disassembly, as well as stockpile surveillance and process development. Nondestructive examination of nuclear weapons components using dye penetrant testing, ultrasonic testing, and radiography of nuclear items and weapons components is a necessary piece of these responsibilities.

Many of the facilities for carrying out stockpile stewardship and management are located within the PIDAS at TA-55. Access to this area is highly restricted by physical barriers and security personnel. Research and development of nuclear weapons items and components are carried out in the Plutonium Facility, Building 55-4.

Radiography on nuclear items and components has been performed at Building 8-23 within TA-8 at LANL. This radiography facility has several types of radiographic equipment that provide extensive and flexible capabilities for nondestructively examining a wide range of materials and assembly configurations. Nuclear components and items were shipped by truck from TA-55 to

---

[1] *X-ray radiography is a nondestructive test method that uses penetrating radiation to probe the volume of an item or component. Different materials and thicknesses of the item or component require x-rays of different energies.*

radiography facilities at TA-8, a distance of approximately 4.5 miles (7.2 kilometers). A rolling roadblock was used when the materials were transported, and a temporary material accountability area was set up at TA-8 while the nondestructive examination procedures took place. These procedures required that security personnel accompany the transportation vehicles and be in place for the duration of the examinations; thus, significant security resources were required. This process was expensive, inconvenient, and logistically difficult. Since the events of September 11, 2001, there have been increased demands on security personnel, and adequate resources were not always readily available to safeguard the transportation and examinations. In addition, Building 8-23 required extensive renovation to continue to function as a nuclear facility. LANL ceased the movement of nuclear items and components out of TA-55 to TA-8, and radiography at LANL for these materials was stopped. This has prevented NNSA from effectively carrying out part of its mission for stockpile stewardship and management.

NNSA has developed a strategy for incremental development of the capability within the TA-55 PIDAS from low to high energy over a period of years. Under this strategy, NNSA has ceased radiography of nuclear items and components at TA-8, although radiography capability to support high-explosives operations remains at that location. The nuclear radiography capability is being relocated to TA-55 from TA-8 using near-term, interim, and long-term phases. The near-term phase utilizes low-energy radiography for nuclear items and components and uses destructive testing and other nondestructive examination information in lieu of high-energy radiography. This low-energy radiography capability is being developed in Building 55-4. The interim phase locates a mid-energy range capability (two 6 million electron volt machines) in a previously unused tunnel between Buildings 55-4 and the old 55-41. The long-term phase (the proposed project) would be to install a high-energy (up to 20 million electron volt) pit radiography capability. This document addresses the environmental impacts of locating the high-energy radiography capability at TA-55.

G.6.2 Options Considered

The two options identified for the TA-55 Radiography Facility are the No Action Option and the construction of a new facility within TA-55. Under the No Action Option, LANL would no longer be able to perform high-energy radiography. The new facility option would implement the strategy for developing high-energy radiography capability within the PIDAS at TA-55. NNSA would construct a new radiography facility at TA-55 to accommodate high-energy radiography and other nondestructive examination activities. Under both options, demolition activities within the TA-55 PIDAS that have no impact to the public, workers, or environment, and that have been categorically excluded, would continue.

G.6.2.1 No Action Option

Under the No Action Option, there would be no high-energy radiography capability for nuclear items and components at LANL. Some low-energy radiography would continue at Building 55-4, and the mid-energy radiography would take place in the tunnel adjacent to Building 55-4. No new structure would be built at TA-55 for high-energy radiography.

G.6.2.2 New Radiography Building Option

Under the New Radiography Building Option, NNSA would construct and operate a new facility within TA-55 in the area of Building PF-41; Building PF-41 is scheduled for demolition (see **Figure G–11**). The new facility would have 5,000 square feet (460 square meters) of available floor space. The New Radiography Building Option would include construction of a 400-square-foot (37-square-meter) accessory structure, which would contain the boiler for the facility. The new radiography building would be no more than two stories high, with one floor below ground level.

Figure G–11 Location of Building 55-41 Relative to Building 55-4 at Technical Area 55

G.6.2.3 Options Considered but Dismissed

A series of options for locating radiography capability were evaluated. The following sections describe options that were not further analyzed in this document because they do not meet the need for a more-efficient capability of nondestructive radiography of nuclear components and items as described in Section G.6.1.

Use of the TA-18 Radiography Facilities

Certain radiography capabilities exist at TA-18. However, use of these radiography facilities would require that nuclear items and components be transported approximately 2.5 miles (4 kilometers) to TA-18. Conducting the full suite of proposed radiography examinations at TA-18 would require installation of additional shielding materials and would conflict with existing space requirements for current TA-18 operations. In the *Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the*

Los Alamos National Laboratory (DOE 2002c) and ROD (67 FR 79906), NNSA stated its decision that many of the TA-18 capabilities would be relocated to the Nevada Test Site. Relocation of materials from TA-18 has taken place, and TA-18 no longer meets the requirements of a Security Category I nuclear facility. This option does not meet NNSA's purpose and need for a permanent, secure, and cost-effective radiography capability at TA-55.

Construct New Radiography Facility within Tunnels at TA-55

Another option was to construct a new high-energy radiography facility within or adjacent to the underground tunnel between Buildings 55-4 and 54-41. However, space within the tunnels is not large enough to accommodate high-energy radiography, access to and from the tunnels is restricted, and costs for conversion of tunnel space into a radiography facility would be excessive. Due to these limitations, this option was dismissed from further consideration.

Establish a Radiography Capability at the Chemistry and Metallurgy Research Building

The possibility of establishing a radiography capability at the Chemistry and Metallurgy Research Building was also investigated. This option would require transportation of nuclear items and components to and from the Chemistry and Metallurgy Research Building. In addition, the amount of nuclear material that can be located within the Chemistry and Metallurgy Research Building is highly restricted and the process of radiographic examination of nuclear items would exceed these limits (DOE 2003). In the *Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE 2003) and ROD (69 FR 6967), NNSA stated its decision to relocate the analytical chemistry and materials characterization capabilities to a new facility at TA-55; however, the new facility does not include radiography capabilities or space to establish these capabilities. Due to these limitations, this option does not meet the purpose and need and was dismissed from further consideration.

Use of Building TA-55-41

Two options originally considered for a Radiography Facility would have used parts of Building TA-55-41, which was originally designed and constructed for storage of nuclear material. The options were to renovate the building or to demolish part of the building and construct a new radiography facility within the original high bay. However, the decision was made to totally demolish Building TA-55-41 and these options are not further considered.

G.6.3 Affected Environment and Environmental Consequences

Chapter 4 of this SWEIS describes the natural and human environment that could be affected by the options described. TA-55 is located on Pajarito Road, which is restricted to LANL-badged personnel. Building 55-4 is located within the PIDAS. Nuclear components are manufactured and nuclear research and development is conducted in Building 55-4.

Based on the option descriptions, environmental resources that may potentially be affected as a result of implementing the action options have been considered. An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Land Resources* – Land use and visual resources would not be affected, as construction would take place within an existing and previously disturbed industrial area.
- *Water Resources* – There would be no effect on water quality. Operation of the radiography facility would not result in any effluent discharges.
- *Ecological Resources* – The action option would be located within previously disturbed and developed land or adjacent to disturbed areas within an industrialized area of LANL. Facilities under the action options would not be located in a floodplain or wetland.
- *Socioeconomics and Infrastructure* – No new employment is expected. Construction workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.
- *Cultural Resources* – Because the proposed New Radiography Building Option would be constructed on previously disturbed land, no impacts to cultural resources are expected.
- *Environmental Justice* – The proposed project is confined to already-developed areas of TA-55, with no disproportionate human health impacts to low-income or minority populations expected.

Resource areas examined in detail in this analysis include: geology and soils, air quality and noise, human health, site infrastructure, waste management, transportation, and facility accidents.

G.6.3.1 No Action Option

Under the No Action Option, the high-energy radiography capability would not be located in a new building at TA-55. Facilities at TA-8 and TA-55 could continue to be used in their current fashion. Under this option, there would be no construction activities.

There would be no change in ambient air quality effects associated with implementing the No Action Option. Ambient noise levels would remain unchanged in the vicinity of TA-55. Potential noise from construction and operational activities associated with the New Radiography Building Option would not occur.

There would be no potential for injuries to construction workers from activities planned under the action option. Potential radiation doses to radiography and nuclear material handlers would diminish because high-energy radiography of nuclear items and components would be discontinued.

The No Action Option would require no modification of existing utilities and infrastructure in TA-55. There would be no construction wastes generated and shipment of construction waste to landfills or recycling centers would not occur. There would be no additional effects to consider.

G.6.3.2 New Radiography Building Option

Geology and Soils

The 9-mile-long (14-kilometer-long) Rendija Canyon Fault is located approximately 0.8 miles (1.3 kilometers) west of Building 55-41 (see Section 4.2 of this SWEIS). Most of the small faults observed in the area have been inferred to represent ruptures subsidiary to the major faults, and as such their potential rupture hazard is very small (Gardner et al. 1999). Any new facilities would be designed in accordance with current DOE seismic standards and applicable building codes.

Construction Impacts—Construction of the new buildings would require excavation of up to 8,000 cubic yards (6,100 cubic meters) of soils as well as shallow bedrock in some areas. As a result, construction would generate excess soil and excavated bedrock that may be suitable for use as backfill. Uncontaminated backfill would be stockpiled at an approved material management area at LANL for future use. Best management practices would be implemented to prevent erosion and migration of disturbed materials from the site caused by stormwater, other water discharges, or wind.

Operations Impacts—Facility operations would not result in additional impacts on geologic and soil resources at LANL.

Air Quality and Noise

Construction Impacts—Construction activities as a result of implementing the new Radiography Building Option could result in temporary, localized emissions associated with vehicle and equipment exhaust as well as particulate (dust) emissions from excavation and construction activities. Effects on air quality would be temporary and localized. There would be no long-term degradation of regional air quality. Air emissions are not expected to exceed either National Ambient Air Quality Standards or New Mexico Ambient Air Quality Standards. Effects of the proposed project on air quality would be negligible compared to potential annual air pollutant emissions from LANL as a whole.

Implementing appropriate control measures would mitigate fugitive dust. Frequent watering with watering trucks would be used to control fugitive dust emissions. Emissions from diesel engine combustion products could result from construction activities involving heavy equipment. Air pollutant emissions associated with construction equipment operation would not result in exceedances of ambient air quality standards.

Implementation of the New Radiography Building Option would result in limited short-term increases in noise levels associated with various construction activities. Following completion of these activities, noise levels would return to preexisting levels. Noise generated by the New Radiography Building Option is not expected to have an adverse effect on LANL workers, members of the public, or the environment. New construction would require the use of heavy equipment for moving materials and for removal of debris and soil. Truck traffic would occur infrequently but would generally produce noise levels below that of the heavy equipment. Personal protective equipment would be required to protect workers’ hearing if site-specific work produced noise levels above the LANL action level of 82 dB(A) on average. Noise from these construction activities should not be noticeable to most members of the public and should not disturb most local wildlife.

Operations Impacts—In general, radiography operations do not require hearing protection. When actual radiography work is being conducted, x-ray machines or devices are used to generate radiographs (or pictures) of objects. Cooling water circulators for x-ray machines can generate elevated noise levels, but employees are not located in the direct vicinity of these machines when they are in operation.

The proposed new radiography capability at TA-55 would include equipment that generates noise at levels well below the LANL action level of 82 dB(A) on average. Noise levels that exceed the action level would typically trigger implementation of a hearing conservation program for workers. However, this is not expected to be required for workers under the New Radiography Building Option.

Traffic noise from commuting workers is not expected to noticeably increase over present traffic noise level on roads at LANL. Worker vehicles would remain parked during the day and would not contribute to background noise levels except during rush hour. Therefore, noise levels from commuter traffic are not expected to change.

Human Health

The health of construction workers and LANL project staff is considered in this analysis because they would be involved in either facility construction or high-energy radiography equipment operation under the New Radiography Building Option. The radiography operations would take place in rooms protected by shielding, so that there would be no offsite radiation doses to the public under normal operations. Members of the general public are not affected because access to Pajarito Road, and thence to buildings within TA-55, is restricted. Unescorted, untrained members of the public are not routinely admitted to TA-55.

The health of LANL workers is routinely monitored depending upon the type of work they perform. Health monitoring programs for LANL workers consider a wide range of potential concerns, including exposure to radioactive materials, hazardous chemicals, physical or environmental hazards, and routine workplace hazards. In addition, LANL workers involved in hazardous operations are protected by various engineering or process controls and are required to wear appropriate personal protective equipment. Training is also required to identify and avoid or correct potential hazards typically found in the work environment and to respond to emergency situations. Workers with the potential to be exposed to radiation, such as radiography workers or nuclear material handlers, are monitored through the use of personnel radiation dosimeters. Because of the various health monitoring programs, requirements for personal protective equipment, and routine health and safety training, LANL workers are generally considered a healthy workforce, with a below-average incidence of work-related injuries and illnesses.

Construction Impacts—The most common hazards associated with construction activities are falls, heavy-equipment hazards, being struck or caught by objects or equipment, and transportation incidents. Potential fatalities can be considered by comparing national statistics on construction with project worker information for the New Radiography Building Option. Potentially serious exposures to various hazards or injuries are possible during the construction phases of the proposed project. Adverse effects could range from relatively minor (such as lung irritation, cuts, or sprains) to major (such as lung damage, broken bones, or fatalities). The potential for industrial accidents is based on both DOE and Bureau of Labor Statistics data on construction injuries and fatalities. Based on an estimated 32,400 person-hours to construct the new facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be none (DOE 2004) to less than two (BLS 2003).

The New Radiography Building Option is not expected to result in adverse long-term effects on the health of construction workers; however, construction workers would be actively involved in potentially hazardous activities under this option. Construction activities would involve the use of heavy equipment (such as bulldozers and front-end loaders). Potentially serious exposures to various physical hazards or injuries are possible during the construction phases. To prevent serious injuries, all construction workers would be required to adhere to a contractor safety plan for construction activities. Adherence to an approved plan, use of personal protective equipment and engineered controls, and completion of appropriate hazards training would aid in prevention of adverse long-term health effects on construction workers.

Operations Impacts—Routine operation and maintenance of the proposed new radiography capability would be performed in accordance with standard practices used at LANL for conducting work with radiation-generating machines, such as Laboratory Implementation Requirement 402-700, *Occupational Radiation Protection Requirements*. Operation of the proposed new facility would pose potentially serious worker health hazards, such as high-radiation fields, when operating. To avoid potentially serious worker doses, radiography operations would be designed and constructed so that workers would not be exposed to high-radiation fields. This would be accomplished by use of warning alarms, mandatory evacuation of certain work areas or establishment of exclusion areas in and around the building, closed-circuit television monitors of high-radiation areas, and interlocks on all doors that would prevent inadvertent entry by staff but would allow workers to exit an area if they failed to respond to warning alarms. Occupied work areas, such as the control room, would be shielded, and radiation alarm monitors would be appropriately located to alert workers to high-radiation fields produced during routine operations. Workers would also be issued personnel radiation dosimeters and would utilize ALARA principles in their work.

Radiation levels at the target can cause injury or death; no workers would be in the vicinity of the target when x-ray machines are operating. Radiation dose levels would be greatly reduced in adjacent rooms and throughout the rest of the building. Work areas would be designed to shield workers in adjacent rooms to ensure that exposures are kept to less than 20 millirem per week, and routine radiography operations would result in worker radiation doses much less than 20 millirem per week for all site workers.

In addition to potential radiation doses from radiography operations, workers could also be exposed to radiation from handling, transporting, and testing various items containing nuclear materials. Engineering and administrative controls would be developed to keep worker doses as low as reasonably achievable. In addition, the amount of nuclear material allowed in the radiography room and adjacent test areas would be kept to a minimum, and no materials would be stored in the building.

Radiography workers and nuclear material handlers supporting the proposed project would be drawn from workers that currently perform these duties at LANL. Therefore, the dose to workers from the nondestructive examination operations would not be additive to doses typically received by these workers, nor would operations expose a new population of workers to radiological doses. The dose to individual workers and to the pool of workers that perform these tasks is not expected to change if the New Radiography Building Option is implemented.

Socioeconomics and Infrastructure

Utility infrastructure at the TA-55 Complex encompasses the electrical power, natural gas, steam, and water supply systems needed to support mission requirements. TA-55 used approximately 15,715 megawatt-hours of electricity in fiscal year 2005. TA-55 also uses natural gas to fire boilers for facility heating and other uses that are housed in Building 55-6. Natural gas consumption totaled 20,427 decatherms (equivalent to about 20.4 million cubic feet [0.58 million cubic meters]) in fiscal year 2005. TA-55 water usage is not metered (LANL 2006a). TA-55's electric power and natural gas consumption represented about 4 percent and 2 percent, respectively, of LANL's site-wide consumption in fiscal year 2005.

Construction—Utility infrastructure resources would be needed for construction of the new facility. Standard construction practice dictates that electric power needed to operate portable construction and supporting equipment be supplied by portable diesel-fired generators. Therefore, no electrical energy consumption would be directly associated with construction. A variety of heavy equipment, motor vehicles, and trucks would be used, requiring diesel fuel, gasoline, and propane for operation. Liquid fuels would be brought to the site as needed from offsite sources and, therefore, would not be limited resources. Water would be needed primarily to provide dust control, aid in soil compaction at the construction site, and possibly for equipment washdown. Water would not be required for concrete mixing, as ready-mix concrete is typically procured from offsite resources. Portable sanitary facilities would be provided to meet the workday sanitary needs of project personnel on the site. Water needed for construction would typically be trucked to the point of use, rather than provided by a temporary service connection. Construction is estimated to require 42,000 gallons (159,000 liters) of liquid fuels and 234,000 gallons (886,000 liters) of water.

Operations Impacts—Utility infrastructure requirements for operation of the new Radiography Building would be limited to building connections, and no upgrades to existing utilities would be required. Usage in the new facility would be equivalent to or less than that of the former radiography facilities because contemporary building design includes water and energy conservation features. As such, operation of the new facility is expected to have no or negligible incremental impact on utility infrastructure capacities at LANL.

Waste Management

About 24 cubic yards (18 cubic meters) of solid waste would be generated during construction of the new building. Construction and installation of the radiography facility would incorporate, to the extent practical, recommendations that would be provided in the pollution prevention design assessment for this project. Construction debris would be minimized through recycling, reuse, or reselling, if the cost benefits, resources, and available technologies permit. Material that cannot be recycled would be disposed of at the Los Alamos County Landfill or other New Mexico solid waste landfills. Recyclable material would be transported directly to an appropriate recycling facility or would be staged at the Los Alamos County Landfill for recycling. No potential release sites are known to be present at the proposed construction sites. The radiography project, in consultation with the environmental restoration activities, would perform characterization and confirmatory sampling to determine the soil disposition.

Transportation

Operations Impacts—Under the New Radiography Building Option, nuclear items and components would be transported within the PIDAS at TA-55. Radioactive materials and items would not be transported for radiography on LANL or public roads, and traffic would not be affected by road closures. Under the New Radiography Building Option, there would be reduced trips of nuclear components to TA-8. Fewer trips would result in less traffic and fewer potential roadway accidents.

Facility Accidents

Operations Impacts—In preparing this SWEIS, a large suite of accident scenarios was identified and grouped by material at risk. Accident types and initiators that could produce an accident with a frequency in excess of 10^{-7} (1 in 10 million) per year when realistically estimated or in excess of 10^{-6} (1 in a million) per year when conservatively estimated were treated as “credible” and “reasonably foreseeable.” Rigorous evaluations were performed for the potentially risk-dominant scenarios, meaning those that were credible and led to offsite consequences beyond insignificant.

Under the New Radiography Building Option, radiographic capability would be moved from the High-Energy Processing Key Facility at TA-8 to TA-55. These radiographic procedures were evaluated for potential accidents for this SWEIS, and any potential accident is bounded by other accidents.

The New Radiography Building Option would not result in additional nuclear material at TA-55. Under the current procedure, nuclear items and components are stored and worked on at Building 55-4 and moved to TA-8 on a temporary basis for nondestructive examination. Thus, these nuclear items and components are part of the inventory at TA-55 that was used in the accident screening analysis.

G.7 Plutonium Facility Complex Refurbishment Project Impact Assessment

This section provides an impact assessment for the Plutonium Facility Complex Refurbishment Project in TA-55. Section G.7.1 provides background information on the refurbishment project and the proposed project to modernize and upgrade facility and infrastructure portions of the TA-55 Complex. Section G.7.2 provides a description of the proposed options for modernizing and upgrading the facility infrastructure at TA-55. Section G.7.3 presents the environmental consequences of the proposed infrastructure modernization and upgrade activities at TA-55.

G.7.1 Introduction

The TA-55 Plutonium Facility Complex (TA-55 Complex) encompasses about 40 acres (16 hectares) and is located about 1 mile (1.6 kilometers) southeast of TA-3. Most of TA-55 is situated inside a restricted area surrounded by a double security fence. The main complex has five connected buildings: the Administration Building, Support Office Building, Support Building, Plutonium Facility, and Warehouse. The Nuclear Materials Storage Facility (Building 55-41, discussed in the previous section) is separate from the main complex. Various other support, storage, security, and training structures are located throughout the complex.

To address the threats of the 21st century, the U.S. nuclear deterrent strategy requires a safe, secure, and reliable capability to design and manufacture replacement plutonium weapons components. This capability is provided through the Stockpile Stewardship Program. The TA-55 Complex is needed to support the Stockpile Stewardship Program and other nuclear programs. It must continue to operate to achieve its programmatic milestones, safely and cost-effectively, for at least the next 25 years. The Plutonium Facility Complex Refurbishment Project would enable an extension of the facility's lifetime by recapitalizing selected major facility systems to help ensure the facility's continuing capability and reliability to support NNSA's missions. In this project, major (also referred to as "critical") systems are defined as those facility and infrastructure systems whose loss of functionality or reliability due to an emergent disability could disrupt TA-55 Complex operations for an unacceptably long duration pending repair.

The TA-55 Complex, constructed in the mid-1970s, is the primary nuclear facility in the Nation for plutonium research and development. It consists of a Security Category I special nuclear materials laboratory and processing facility as well as support systems and structures. It is the most modern and well-equipped nuclear facility at LANL; however, it is aging, and critical systems are beginning to require excessive maintenance. The goal of this project is to support the Stockpile Stewardship Program and other efforts delineated in DOE and NNSA strategic plans for the next 25 years. An investment is necessary in the near term (the next 10 years or so) to upgrade electrical, mechanical, safety, security, facility control, and other selected facility-related systems.

The scope of the overall project is to modernize and upgrade facility and infrastructure portions of the TA-55 Complex that are approaching the end of life. This project is part of a comprehensive, long-term strategy to extend the life of TA-55 so that it can operate safely, securely, and effectively for at least another 25 years (LANL 2006a).

The project would be executed through a series of subprojects. The subprojects focus on priority facility systems and components that would improve overall facility reliability and that are critical to facility and program operations. Subproject sequencing would minimize disruptions to operations. The process of subproject sequencing requires consideration of a number of factors that have direct bearing on the way this project would be accomplished. Factors considered in prioritization of subprojects include:

- *Regulatory Requirements*: Is there a regulatory mandate or driver, law, policy, or order that would be satisfied by completion of the subproject?
- *Environmental Impact and Minimize Waste*: Will completion of the subproject reduce the possibility of an adverse environmental impact or reduce current waste generation?
- *Personnel Safety*: Will completion of the subproject result in improvement of personnel safety?
- *Mission*: Will completion of the subproject improve the facility's ability to support mission requirements?
- *Security*: Will completion of the subproject lead to an improvement in security?
- *Maintainability*: Will completion of the subproject lead to an improvement in maintainability?
- *Reliability*: Will the equipment or system be more reliable after completion of the subproject?
- *Availability*: Will completion of the subproject lead to an improvement in facility availability?
- *Maintain Authorization Basis*: Is the item classified as Safety, Structures, Systems and Components and will completion of the subproject strengthen the Facility Authorization Basis?
- *Condition Assessment System Status*: If the system is listed in the Condition Assessment System, will completion of the subproject improve its condition assessment?

G.7.2 Options Considered

The two options identified for the Plutonium Facility Complex Refurbishment are the No Action Option and the proposed project option.

G.7.2.1 No Action Option

Under the No Action Option, operations at TA-55 would continue at the level they are today. There would be no renovations or remodeling to improve reliability of pit production or actinide processing. Corrective maintenance and actions would continue to be performed as failures occur. However, maintenance cost would increase to support the aging systems until the systems must be shut down or replaced. If systems proposed for replacement on this project are neither modified nor upgraded, they are expected to fail in the next 10 to 15 years. Based on available information, it is not possible to predict the nature, timing, or type of failures. However, many failures would delay programmatic work, possibly damage equipment, and possibly pose a risk to personnel safety, campaigns, critical experiments, and other activities where plutonium analysis and capabilities are required. Because the facilities are over 25 years old, they would experience more and more severe system failures over time, until either the systems would have to be replaced on a piecemeal basis through corrective maintenance (resulting in increased operating costs) or the facility would have to be shut down.

G.7.2.2 Proposed Project

Existing facilities would be renovated for purposes of life extension rather than just maintenance. This option would entail renovating building systems in the Plutonium Facility or systems supporting the Plutonium Facility. The approach of this project is to renovate or refurbish only systems most in need of upgrading. However, renovations would have to be conducted in an operating nuclear facility, with the attendant programmatic impact and reduction of construction efficiency. Contamination control and safeguards and security issues would not be trivial and would have to be addressed.

All work would be performed inside the existing TA-55 Complex. Most of the work would be inside existing structures or would entail modifications to existing structures that are relatively minor in scope. The proposed project would be limited to the TA-55 Complex and is organized as follows:

- Inside the Plutonium Facility
- Exterior to the Plutonium Facility, including closely related support work (for example, the Plutonium Facility roof)

This section lists a series of upgrades that would compose Phase 1 of the TA-55 Refurbishment Project based on current planning assumptions. Although the list may change based on future planning decisions, and subprojects currently scheduled for a later phase may be moved up in priority, the impacts of the current Phase I upgrades would be similar.

- Heating and cooling systems (preheat coils in intake stacks)
- Heating, ventilation, and air conditioning plenums and associated Zone 1 plenums
- Roof (membrane) for the Plutonium Facility
- Confinement doors in the Plutonium Facility
- Heating, ventilation, and air conditioning ductwork Zone 1
- Criticality alarm system
- Fire water sprinkler piping
- Vault water tanks
- Air dryers
- Stack upgrade and replacement
- Fire alarm panel and wiring
- Fire alarm devices – buildings
- Fire alarm devices – gloveboxes
- Heating, ventilation, and air conditioning plenums (non-safety class portions)

- Glovebox stands
- Chiller replacement
- Replacement of cooling towers
- Elevator
- Waste transfer system
- Uninterruptible power supply replacement

This section lists the types of upgrades that are scheduled for later phases of the Plutonium Facility Complex Refurbishment Project, based on current planning assumptions. Depending on mission requirements and funding availability, any of the following subprojects could be reprioritized for earlier completion.

- Heating and cooling systems (except preheat coils in intake stacks)
- Non-plutonium-facility heating, ventilation, and air conditioning
- Heating, ventilation, and air conditioning plenums
- Heating, ventilation, and air conditioning ductwork intakes, bleed-off, exhaust
- Heating, ventilation, and air conditioning fans and motors
- Facility control system
- Nonprocess cooling water system
- Fire suppression system
- Fire suppression – halon system
- Fire doors electrical distribution system
- 13.2-kilovolt distribution
- Paging system
- Process air
- Continuous air monitoring systems
- Fixed-head air sampler blower system
- Steam system
- Positive pressure chilled water
- Bubbler bypass features
- Chlorine gas delivery system
- Remove selected gloveboxes from throughout the building
- Hot water system
- Utility gas systems
- Industrial gas systems (trailers)

- Radiation protection systems
- Wet vacuum
- Acid distribution
- Water storage tank exteriors
- Sanitary waste
- Site drainage
- Material control and accounting systems
- Tie in Facility Improvement Technical Support (FITS) Building (TA-55) and Manufacturing Technology Support Facility (protocol) to classified local area network
- Communications capacity
- Roofs
- Structure (confinement system)
- Lockers and change facilities
- Operations Center
- Attic
- Laboratories – doors
- Vault racks and shelving, Kardex Unit, and special nuclear material storage drawers
- Trolley systems
- Perimeter road and site paving
- Upgrade tunnel – Plutonium Facility to Building 55-41
- Facilities for site support service contractor
- Warehouse capability
- Cafeteria
- Training Center and mockup for TA-55
- Equipment and glovebox mockup and assembly area

The subprojects would be designed and installed so that any changes in operation would be consistent with approved environmental permits issued by the EPA and the State of New Mexico. The subprojects would not materially change any aspect of LANL's ability to comply with permits. While the new structures, systems, or components may not function in precisely the same way as the existing ones and may be constructed, fabricated, and operated in a different manner, they would fulfill the same function and provide at least the same level of protection and monitoring as the existing ones. One exception is the stack upgrade and replacement subproject for the Plutonium Facility. The proposed modifications are in part in anticipation of more stringent stack release requirements. These modifications would result in stacks that are different in size and would have better performance parameters than the existing stacks.

All proposed work would be performed inside or adjacent to the existing TA-55 Complex. Most of the work would be inside existing structures or would entail modifications to existing structures, systems, or components that would result in relatively minor changes to their operational performance.

G.7.2.3 Options Considered but Dismissed

Move the Stockpile Stewardship Program to another location

DOE prepared the *Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE 1996) to analyze mission assignments. In its ROD (61 FR 68014), DOE assigned pit production and associated activities to support stockpile stewardship and management to LANL. Thus, the option of moving the Stockpile Stewardship Program to another location within the nuclear weapons complex was already considered and dismissed from further consideration.

G.7.3 Affected Environment and Environmental Consequences

In the case of the proposed project, it is difficult to upgrade an operating nuclear facility with high levels of security because of the organizational, programmatic, safety, and security constraints involved. The constraints and requirements are necessarily much more formal and detailed than those for an office building, for example. The proposed project involves existing, required assets. As such, it must be constructed at TA-55 within the existing systems and infrastructure; there are no other options as to location. Therefore, the affected environment is TA-55, although the region of influence for each resource evaluated may extend beyond TA-55 and LANL.

The analysis of environmental consequences relies heavily on the affected environment descriptions in Chapter 4 of this SWEIS, and care has been taken not to repeat this information. Resource areas or disciplines not expected to be affected by the Plutonium Facility Complex Refurbishment Project, or that would not directly or indirectly affect project implementation, have not been included. Otherwise, where information specific to TA-55 is available and aids understanding the TA-55 affected environment and potential environmental consequences, it has been included.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Land Resources-Visual* – Visual resources would not be affected because subprojects would occur indoors or in a previously disturbed industrial area.

- *Ecological Resources* – The project would occur in an already-developed area of TA-55. No parts of the project would be located in a floodplain or wetland.

- *Cultural Resources* – The proposed upgrades to the main TA-55 Plutonium Facility Complex buildings are likely exempt under the Programmatic Agreement between the

State Historic Preservation Office and NNSA and, therefore, would not require any formal compliance consultation.

- *Socioeconomics and Infrastructure* – No new employment is expected. Construction and DD&D (refurbishment) workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.

- *Environmental Justice* – The proposed project is confined to already-developed areas of TA-55, with no disproportionate human health impacts to low-income or minority populations expected.

- *Facility Accidents* – Potential facility accidents associated with this proposed project are addressed as part of the No Action Alternative of this SWEIS.

This impact assessment focuses on those areas of the affected environment where potential impacts would occur: land use, geology and soils, water resources, air quality and noise, human health, site infrastructure, waste management, and transportation.

G.7.3.1 No Action Option

Under the No Action Option, the project to refurbish systems in the Plutonium Facility Complex would not be implemented, necessitating a continued high level of maintenance activity to keep the facility operating safely. The overall environmental impacts of the Plutonium Facility Complex would be as described under the No Action Alternative in Chapter 5 of this SWEIS. However, as systems continue to require replacement and maintenance, there would be collateral impacts. The two Plutonium Facility stacks are corroded, and surveillance and sampling is becoming problematic, which could degrade regulatory compliance. In addition, the stacks no longer meet American National Standards Institute stack requirements or New Mexico State requirements. Although utility demand would reflect continuation of current activities, as existing radiological facilities age and associated utility systems deteriorate, utility usage would increase as utility system efficiency decreases over time. No changes in waste types are expected in the short term under the No Action Option. As systems and equipment age and the level of required maintenance increases, there could be a commensurate increase in the amount of waste generated. Waste generation rates are expected to remain within LANL waste management infrastructure capabilities.

G.7.3.2 Proposed Project

Under the Plutonium Facility Complex Refurbishment Project, work related to the subprojects would be performed primarily within or around existing structures at TA-55.

Land Resources – Land Use

TA-55 is situated in the west-central portion of LANL along Pajarito Road between Twomile and Pajarito Canyons approximately 1.1 miles (1.8 kilometers) south of the Los Alamos townsite. The Plutonium Facility Complex within TA-55 encompasses 40 acres (16.2 hectares) of land, 43 percent of which is developed (DOE 2003). Existing land uses within TA-55 are designated

Nuclear Materials Research and Development and Reserve (LANL 2003c). TA-55 falls within the Pajarito Corridor West Development Area. In general, the plan designates land use north of Pajarito Road as Infill (the area around existing structures), Primary Development (to the west and south of developed areas), or Parking (to the southeast of developed areas) (LANL 2001).

Construction Impacts—Implementation of several subprojects to the existing project scope would involve varying degrees of land-disturbing activities ranging from grading work and roadway replacement to construction of accessory structures or additions to existing structures within the TA-55 Complex. These subprojects would collectively have a negligible-to-minor incremental impact on land resources at LANL and would be consistent with prevailing land uses of the TA-55 Complex.

Operations Impacts—Following completion of Plutonium Facility Complex Refurbishment Project activities, facility operations would not result in additional impacts on land resources at LANL.

Geology and Soils

The 9-mile-long (14-kilometer-long) Rendija Canyon Fault is located approximately 0.8 miles (1.3 kilometers) west of the Plutonium Facility at TA-55 (see Section 4.2 of this SWEIS). Most of the small faults observed in the area have been inferred to represent ruptures subsidiary to the major faults, and as such their potential rupture hazard is very small (Gardner et al. 1999). Proposed new and upgraded structures, systems, or components would be designed, constructed, and operated in compliance with applicable DOE orders, requirements, and governing standards established to protect public and worker health and the environment.

Construction Impacts—Refurbishment project activities at TA-55 would have no or negligible direct impact on geologic and soil resources, as all work would be performed inside and adjacent to existing TA-55 facilities. Potential release sites that could be impacted by refurbishment project activities at TA-55 would be addressed in accordance with DOE requirements and the Consent Order. That is, prior to commencing ground disturbance, potentially affected contaminated areas would be surveyed to determine the extent and nature of any contamination and required remediation in accordance with procedures established for environmental remediation. Other buried objects would be surveyed and removed as appropriate.

Operations Impacts—Following completion of Plutonium Facility Complex Refurbishment Project activities, facility operations would not result in any additional impacts on geologic and soil resources at LANL. The structural integrity and seismic safety basis of TA-55 facilities would be improved because a number of the proposed project subprojects would involve structural upgrades that specifically include installation of seismic bracing to meet current performance category standards.

Water Resources

TA-55 is located on a narrow mesa (Mesita del Buey). The mesa is flanked by Mortandad Canyon to the north and Twomile Canyon to the south. TA-55 is primarily a heavily developed facility complex, with surface drainage occurring primarily as sheet-flow runoff from the impervious surfaces within the complex. No developed portions of the complex are located within a delineated floodplain. One TA-55 facility discharges cooling-tower blowdown directly to Mortandad Canyon (via National Pollutant Discharge Elimination System Outfall 03A-181) (DOE 2003). In 2005, discharges through this outfall totaled 2.40 million gallons (9.08 million liters) (LANL 2006f).

Construction Impacts—Impacts on water resources would be negligible under this option, as there are no natural surface water drainages in the TA-55 Complex vicinity and ground-disturbing activities would be minor. Appropriate soil erosion and sediment control measures (sediment fences, stacked hay bales, and mulching disturbed areas) and spill prevention practices would be employed to minimize suspended sediment and material transport and potential water quality impacts. No onsite discharge of sanitary wastewater is planned, nor impact on surface water expected.

Operations Impacts—Following completion of Plutonium Facility Complex Refurbishment Project activities, facility operations would result in no additional impacts on water resources at LANL. The proposed refurbishment activities are not intended to materially change TA-55 operations, and no measurable increase in effluent discharge is expected (LANL 2006a).

Air Quality and Noise

Estimates for selected toxic and hazardous air pollutant emissions from key LANL facilities were made in the *1999 SWEIS* (DOE 1999a) based on chemical use at LANL and assumed stack and building parameters. Chemical purchasing records for these key facilities have been reviewed each year and estimated emissions reported in the annual *SWEIS Yearbooks* (LANL 2003b, 2004d, 2005c, 2006f). **Table G–35** presents estimated toxic and hazardous air pollutant emissions for 2005 based on chemical usage at TA-55.

Table G–35 Toxic and Hazardous Pollutant Air Emissions from Existing Operations at Technical Area 55

Chemical and Form	*2005 Air Emissions (kilograms)*
Acetone	4.56
Acetylene	0.00
Ammonium Chloride (Fume)	0.28
Ethanol	82.07
Hydrogen Chloride	9.14
Hydrogen Peroxide	0.18
Magnesium Oxide Fume	0.35
Methyl Alcohol	0.28
Nitric Acid	9.35
Oxalic Acid	0.53
Potassium Hydroxide	0.18
Propane	0.00
Tributyl Phosphate	1.36

Note: To convert kilograms to pounds, multiply by 2.2046.
Source: LANL 2006f.

Radiological air emissions from operations at TA-55 in 2005 are described in Chapter 4, Section 4.4.3.1, Radiological Monitoring. TA-55 typically produces a minimal amount (less than 3 percent) of the total LANL air emissions.

Construction Impacts—As execution of the higher-priority subprojects would primarily involve upgrades to and repairs or replacements of existing structures, systems, and components, including electrical, electronic, plumbing, and mechanical systems, most work would be performed using portable equipment and hand tools. There would be some criteria and toxic pollutant emissions from fuels, solvents, acids, and epoxies associated with subproject work. Because implementation of individual subprojects would be spread out over a number of years rather than performed concurrently, any impacts on ambient air quality would be negligible to minor and of short duration.

Construction activities would result in a temporary increase in emissions from construction equipment, trucks, and, to a lesser degree, employee vehicles. Incremental increases in toxic air pollutants would be small and would have a negligible-to-minor short-term impact on local ambient air quality.

Although no radiological releases to the environment are expected in association with construction activities at TA-55, the potential exists for contaminated soils and possibly other media to be disturbed during excavation and other site activities. Potential release sites at TA-55 that could be impacted during site activities would be addressed in accordance with DOE requirements and the Consent Order. To determine the extent and nature of any contamination, an assessment of the affected areas would be performed prior to commencing ground disturbance. If the contamination poses an unacceptable risk to the public or LANL workers, the sites would be cleaned up before proceeding.

Refurbishment project activities and new facility construction would result in some temporary increase in noise levels near the TA-55 Complex and near specific subproject work areas. There would be no change in noise impacts on the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from project workers' vehicles and materials shipments. Noise sources associated with the proposed subprojects are not expected to include loud impulsive sources such as blasting.

Operations Impacts—Following completion of Plutonium Facility Complex Refurbishment Project activities, facility operations would not result in any measurable increase in air emissions. Implementation of the stack upgrade and replacement subproject would provide for improved in-stack mixing and emissions monitoring.

Further, implementation of the chiller replacement subproject would have a positive impact on environmental quality by removing ozone-depleting substances, and one subproject (steam system) would directly reduce emissions of criteria pollutants by replacing natural-gas-fired boilers with electric units.

Following completion of Plutonium Facility Complex Refurbishment Project activities, facility operations would not result in any measurable increase in noise levels.

Human Health

LANL workers receive the same dose as the general public from background radiation, but they also receive an additional radiation dose from working in facilities with nuclear materials, such as at TA-55. However, occupational radiation exposures for workers at LANL remain well below those projected for the *1999 SWEIS* ROD. The majority of the LANL offsite maximum exposed individual dose in 2005 (6.46 millirem) resulted from emissions from LANSCE stacks. The portion of that dose attributed to operations at TA-55 is minimal (less than 1 percent) (LANL 2005a). All worker doses in 2005 were below the 5-rem-per-year standard set by DOE (LANL 2006f). Further details can be found in Section 4.6.2.1 of this SWEIS.

No radiological risks would be incurred by members of the public from proposed project activities. Project workers would be at a small risk for work-related accidents and radiological exposures. They could receive doses above natural background radiation levels from exposure to radiation from other past or present activities at the site as well as from work in contaminated areas and encountering contaminated materials during subproject execution. However, these workers would be protected through appropriate training, monitoring, and management controls. Their exposure would be limited to ensure that doses were kept ALARA. The individual dose to involved workers would be less than 500 millirem per year for any subproject (LANL 2006a).

Operations Impacts—Following completion of Plutonium Facility Complex Refurbishment Project activities, there would be no increase in radiological releases to the atmosphere from normal operations, as the proposed upgrades are not intended to materially change TA-55 Complex operations. Similarly, there would be no change in the basis for postulated accidents and resulting consequences from implementation of this option, as upgrades would not materially change facility operations and materials at risk would not be affected. A number of the higher-priority subprojects involve upgrades that would substantially improve the safety basis of the TA-55 Complex and the Plutonium Facility in particular. In addition, implementation of the stack upgrade and replacement subproject, as previously discussed, would provide for improved in-stack mixing and emissions monitoring in support of improved regulatory compliance.

Socioeconomics and Infrastructure

Utility infrastructure at the TA-55 Complex encompasses the electrical power, natural gas, steam, and water supply systems needed to support mission requirements. TA-55 used approximately 15,715 megawatt-hours of electricity in fiscal year 2005. TA-55 also uses natural gas to fire boilers for facility heating and other uses that are housed in Building 55-6. Natural gas consumption totaled 20,427 decatherms (equivalent to about 20.4 million cubic feet [0.58 million cubic meters]) in fiscal year 2005. TA-55 water usage is not metered (LANL 2006a). TA-55's electric power and natural gas consumption represented about 4 percent and 2 percent, respectively, of LANL's site-wide consumption in fiscal year 2005.

Construction Impacts—Requirements for utility infrastructure resources, including electricity, fuels, and water, are expected to be negligible for most subprojects and activities would be staggered over an extended period of time. Existing TA-55 utility systems would easily be capable of supporting project activities (LANL 2006a). Small quantities of gasoline and diesel fuel would be required for such uses as operation of construction vehicles and possibly for portable generators to power hand tools, spotlighting, and other construction equipment. This fuel would be procured from offsite sources and, therefore, would not be a limited resource.

Operations Impacts—The proposed refurbishment activities are not intended to materially change TA-55 operations. No net increase in utility infrastructure demands is expected that would be directly related to implementation of the proposed project.

Waste Management

LANL generates chemical and radioactive wastes as a result of research, production, maintenance, construction, and remediation service activities. For 2005, waste quantities generated from operations at the key facilities were generally below *1999 SWEIS* ROD projections for nearly all waste types (LANL 2006f). **Table G–36** presents the latest available waste generation data for TA-55 operations.

Table G–36 Waste Generation from Existing Operations at Technical Area 55

Waste Type	*1999 SWEIS ROD Projection*	*2005 Generation*
Low-level radioactive waste (cubic yards per year)	986	380
Mixed low-level radioactive waste (cubic yards per year)	17	17
Transuranic waste (cubic yards per year)	310	62
Mixed transuranic waste (cubic yards per year)	133	125
Chemical (pounds per year)	18,500	2,840

ROD = Record of Decision.
Note: To convert cubic yards to cubic meters, multiply by 0.76455; pounds to kilograms, by 0.4536.
Source: LANL 2006f.

The Plutonium Facility has capabilities to treat, package, store, and transport the radioactive waste produced by TA-55 operations. Liquid wastes are converted to solids or are piped to the TA-50 Radioactive Liquid Waste Treatment Facility. Some transuranic wastes are immobilized with cement in 55-gallon (208-liter) drums. Other transuranic waste is consolidated in 55-gallon (108-liter) drums or is packaged in waste boxes. Low-level radioactive wastes also are packaged in the Plutonium Facility, where care is taken to avoid combining hazardous waste with radioactive waste to form mixed waste. Solid wastes of all types are stored temporarily at TA-55 until they are shipped to onsite waste storage or disposal locations, primarily in TA-54 (LANL 2006a).

Construction Impacts—Refurbishment project activities are expected to generate transuranic waste, low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, and nonhazardous solid and sanitary wastes from removal of equipment being replaced and construction activities. Projected waste volumes, for those wastes where estimates have been made, are provided in **Table G–37**.

Table G–37 Total Waste Generation from Implementation of the Plutonium Facility Complex Refurbishment Project at Technical Area 55

Waste Type	*Projected Generation*
Low-level radioactive waste (cubic yards)	1,290 [a]
Mixed low-level radioactive waste (cubic yards)	216
Transuranic waste (cubic yards)	196
Mixed transuranic waste (cubic yards)	144
Chemical waste (pounds)	2,000
Nonhazardous solid waste (cubic yards)	2,740 [b]

[a] Includes 970 cubic yards (740 cubic meters) of bulk low-level radioactive waste and 320 cubic yards (240 cubic meters) of packaged low-level radioactive waste.

[b] Includes about 2,060 cubic yards (1,570 cubic meters) of demolition debris and 685 cubic yards (524 cubic meters) of construction waste.

Note: To convert cubic yards to cubic meters, multiply by 0.7644; pounds to kilograms, multiply by 0.4536.

Source: LANL 2006a.

Low-level radioactive waste would consist mainly of construction debris removed from radiological control areas. Chemical waste could include various materials removed from inside TA-55 facilities as part of the upgrades, including electronic components, wiring, batteries, and other materials (LANL 2006a). Chemical wastes may also include spent chemical wastes or leftover materials that could not otherwise be recycled, such as solvents or acids. Construction debris and miscellaneous removed equipment (water tanks, pumping units, heating and ventilating equipment, and roofing material) would be characterized to determine the appropriate waste classification. All wastes would be managed and disposed of in a fully compliant method that minimizes volume while minimizing exposure to workers. Subprojects would be designed and constructed to incorporate pollution prevention and waste minimization features. For some subprojects, DD&D would be performed after the new systems are in place; for others, DD&D would be part of the critical path. Waste volume estimates would be refined through conceptual design report activities. A waste management plan would be developed by the project as part of the conceptual design report. The existing LANL waste management infrastructure is adequate for management of the waste types and quantities generated by the Plutonium Facility Complex Refurbishment activities.

Operations Impacts—Following completion of Plutonium Facility Complex Refurbishment Project activities, there would be no increase in TA-55 waste generation rates, as the proposed upgrades are not intended to materially change TA-55 Complex operations.

Transportation

Construction Impacts—Traffic on Pajarito Road could be disrupted due to temporary increases during construction.

Operations Impacts—Under the proposed project, interstate waste transportation would decrease over the long term. However, local traffic would increase.

Waste generated during refurbishment activities would have to be transported for disposal at either LANL TA-54 or an offsite location, using over-the-road truck transportation. Transportation has potential risks to workers and the public from incident-free transport, such as radiation exposure as the waste packages are transported along the highways. There is also increased risk from traffic accidents (without release of radioactive material) and radiological accidents (in which radioactive material is released).

The effects of accident-free transportation of wastes on the worker population and general public are presented in **Table G–38**. The effects are presented in terms of the collective dose in person-rem resulting in excess LCFs. Excess LCFs are the number of cancer fatalities that may be attributable to the proposed project and estimated to occur in the exposed population over the lifetimes of the individuals. If the number of LCFs is less than one, the subject population is not expected to incur any LCFs resulting from the actions being analyzed. The risks of developing excess LCFs are highest for workers under the offsite disposition option because the dose is proportional to the duration of transport, which in turn is proportional to travel distance. As shown in Table G–38, disposal of low-level radioactive waste at Nevada Test Site, which is farthest from LANL, would lead to the highest dose and risk, although the dose and risk are low under all disposal options.

Table G–38 Incident-Free Transportation Impacts – Plutonium Facility Complex Refurbishment

Disposal Option	*Low-Level Radioactive Waste Disposal Location* [a]	*Crew*		*Public*	
		Collective Dose (person-rem)	*Risk (LCF)*	*Collective Dose (person-rem)*	*Risk (LCF)*
Onsite disposal	LANL TA-54	0.85	0.00051	0.27	0.00016
Offsite disposal	Nevada Test Site	1.38	0.00083	0.43	0.00026
	Commercial Facility	1.34	0.00081	0.42	0.00025

LCF = latent cancer fatality, TA = technical area.

[a] Transuranic waste would be disposed of at WIPP.

Table G–39 presents the impacts of traffic and radiological accidents. This table provides population risks from traffic accidents in terms of LCFs caused by exposure to releases of radioactivity, and of fatalities caused by the collisions themselves. The analyses assumed that, all transuranic and nonradioactive wastes generated by refurbishment activities would be transported to offsite disposal facilities.

Table G–39 Transportation Incident Impacts – Plutonium Facility Complex Refurbishment

Low-Level Radioactive Waste Disposal Location [a, b]	*Number of Shipments* [c]	*Distance Traveled (10^6 kilometers)*	*Accident Risks*	
			Radiological (excess LCFs)	*Traffic (fatalities)*
LANL TA-54	285	0.11	1.2×10^{-9}	0.0013
Nevada Test Site	285	0.34	1.2×10^{-8}	0.0036
Commercial facility	285	0.32	9.1×10^{-9}	0.0034

LCF = latent cancer fatality, TA = technical area.

[a] Transuranic waste would be disposed of at WIPP.

[b] All nonradiological wastes would be transported off site.

[c] Approximately 46 percent of these are radioactive. Others include 54 percent industrial and sanitary and about 0.4 percent asbestos and hazardous.

Note: To convert kilometers to miles, multiply by 0.6214.

The results in these two tables indicate that no traffic fatalities or excess LCFs are expected from transportation of generated wastes.

Because all of the LCFs estimated, as shown in Tables G–37 and Table G–38, are much less than 1.0, the analysis indicates that no excess fatal cancers would result from this activity, either from dose received from packaged waste on trucks or potentially received from accidental release. Likewise, no fatalities are expected from traffic accidents.

G.8 Science Complex Impact Assessment

This section provides an assessment of environmental impacts for the proposed project consisting of the construction and operation of the Science Complex at several alternate LANL sites. The Science Complex would be constructed within the timeframe under consideration in this SWEIS. More general descriptions of the affected environment at LANL are located in Chapter 4 of this SWEIS, while this appendix focuses on project-specific analyses of those resources that would be impacted by the Science Complex Project. The proposed Science Complex Project is categorized as one that would relocate existing operations to a completely new facility, and then conduct DD&D of an equivalent square footage of existing LANL facilities. Section G.8.1 provides background information and rationale for the proposed project to build the Science Complex, while Section G.8.2 provides descriptions of the location options for the Science Complex. Section G.8.3 describes the affected environment and impacts of the No Action Option and the proposed project (construction and operation of the proposed Science Complex) at all of the location options.

G.8.1 Introduction

NNSA and DOE are proposing to construct two buildings and one supporting parking structure. This facility, collectively referred to as the Science Complex, would aid NNSA in fulfilling its primary Defense Program Stockpile Stewardship mission, while supporting basic and applied scientific research and technology to be conducted on DOE-administered land that could be custodially transferred from one Federal agency to another or by long-term ground lease or government-approved land transfer. The Science Complex would replace 402,000 gross square feet (37,300 square meters) of LANL's 5,800,000-square-foot (538,800-square-meter) of outdated and inefficient occupied space.

The Science Complex would be used for light laboratories and offices. It would be a state-of-the-art, multi-disciplinary facility that would enable the performance of mission-related scientific research. Low hazard work would be conducted in the laboratories. Work would be nonradiological except for the use of ionizing radiation producing equipment (such as x-ray machines) and sealed sources (radioactive sources engineered to meet Department of Transportation special form testing at 49 CFR 173.469 or the American National Standards Institute N45.6 testing for Sealed Radioactive Sources, Categorization). Biological research laboratories would be designed and operated in accordance with applicable standards for work with Biosafety Level 1 agents (see Appendix C for a discussion of Biosafety Levels).

G.8.2 Options Considered

The four options identified for the Science Complex Project are the No Action Option and three action options. Option 1, the Northwest Technical Area 62 Site Option, has been identified as the Preferred Option for the Science Complex Project.

G.8.2.1 No Action Option

Under the No Action Option, the Science Complex would not be constructed. Operations and activities proposed for the Science Complex would continue at dispersed locations across LANL in aging facilities that are reaching the end of their useful lives and require major upgrades to meet future mission objectives.

G.8.2.2 Option 1: Northwest Technical Area 62 Site Option (Preferred Option)

The Science Complex would be constructed on a site in Northwest TA-62, located west of the Research Park area. The Northwest TA-62 site is bounded to the south by West Jemez Road, to the east by West Road, to the west by forested land, and to the north by a utility corridor unpaved access road with forested land beyond. Note that the "Northwest" name is a historical site name that has since been combined with the TA nomenclature and does not refer to the northwest portion of TA-62. The utility corridor access road may be paved in the future to provide all-weather access to areas of the Santa Fe National Forest and a local recreational ski facility.

The relatively undeveloped site is situated on slightly sloping terrain above the south rim of Los Alamos Canyon and is vegetated primarily with native grass, ponderosa pine, and some pinyon-juniper. The Science Complex would consist of two buildings: a four-story secured building of approximately 110,000 gross square feet (10,200 square meters), and a four-story unclassified work building, including an auditorium, of approximately 292,000 gross square feet (27,100 square meters) (LANL 2006a). In addition to these two buildings, a new six-story, 504,000-gross-square-foot (47,000-square-meters) parking structure would be constructed on site. A maximum area of 15.6 acres (6.3 hectares) would be required for the project, which includes an area of about 5 acres (2 hectares) for new construction and staging. General roadway improvements would include construction of a site access road to the Science Complex and a parking structure. Also, to mitigate non-construction-related traffic increases, east- and westbound right- and left-turn deceleration lanes could be constructed on West Jemez Road approaching the site access. **Figure G–12** illustrates the conceptual layout of the Science Complex at the Northwest TA-62 site.

G.8.2.3 Option 2: Research Park Site Option

Under the Research Park Site Option, the Science Complex would be constructed at the Los Alamos Research Park site, located in the northwest portion of TA-3. The Research Park site is bounded to the west by West Road, to the south by West Jemez Road, to the east by the existing Research Park Buildings, and to the north by Los Alamos Canyon. Approximately 100 feet (30.5 meters) to the east lie the existing Los Alamos County Research Park Buildings and Los Alamos County Fire Station. The Los Alamos community access road may be developed in the future to provide all-weather access to areas in the Santa Fe National Forest and a local recreational ski facility. To mitigate non-construction-related traffic increases, the four-lane cross section of West Jemez Road east of the proposed site access could be extended to the site access. Also, east- and westbound right- and left-turn deceleration lanes could be constructed on West Jemez Road approaching the site access.

The relatively undeveloped site is situated on slightly sloping terrain above the south rim of Los Alamos Canyon and is vegetated primarily with native grass, ponderosa pine, and some pinyon-juniper.

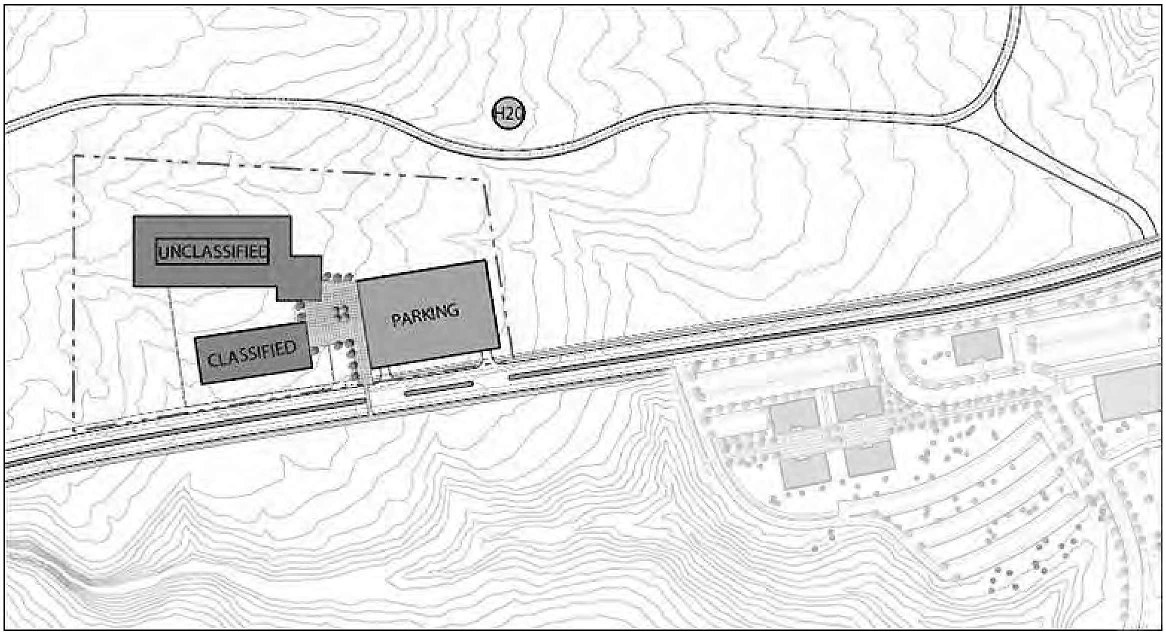


Figure G–12 Conceptual Layout of the Science Complex at the Northwest Technical Area 62 Site

G.8.2.4 Option 3: South Technical Area 3 Site Option

Under the South TA-3 Site Option, the Science Complex would be constructed on a site in the southeast portion of TA-3. The South TA-3 site is bounded to the south by Pajarito Road and to the west by Diamond Drive. The site is partially developed, with an existing parking lot situated in the center of the site, which is accessed from Diamond Drive. The eastern edge of the parking lot is constructed on fill material, which slopes downward to the east. At the toe of the slope lies a poorly defined drainage. South of the parking lot, between Pajarito Road and the parking lot, the area is relatively undeveloped. The undeveloped areas to the east and south of the parking lot are characterized by slightly sloping terrain and vegetated primarily with native grass, ponderosa pine, and some pinyon-juniper. To mitigate non-construction-related traffic, it would be necessary to construct south- and northbound left- and right-turn deceleration lanes on Diamond Drive approaching the site access.

G.8.2.5 Options Considered but Dismissed

Consistent with the Council on Environmental Quality and DOE NEPA regulations (40 CFR Part 1500 and 10 CFR Part 1021, respectively), several options were analyzed for comparison of potential effects with those options listed above. Two options were analyzed from a land use planning perspective, primarily based on location, which considered land use, traffic circulation, infrastructure, environmental compliance, security, safety, space consolidation opportunities and proximities, and work environment quality. The site options were located at the Gateway site, on the southeast corner of West Jemez Road and Diamond Drive, and on Twomile Mesa in TA-58. As a consequence of the planned Security Perimeter Road, access to both of these sites was made impractical. Therefore, both of these previously considered sites were eliminated from further consideration.

G.8.3 Affected Environment and Environmental Consequences

For construction and operation of the Science Complex at either the Northwest TA-62 or the Research Park sites, the affected environment would primarily be TA-62 and TA-3. For construction and operation of the Science Complex at the South TA-3 Site Option, the affected environment would primarily be TA-3.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Socioeconomics and Infrastructure* – No new employment is expected. Construction and DD&D workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussions.

- *Environmental Justice* – The proposed project would entail no disproportionate human health impacts to low-income or minority populations.

Resource areas examined in this analysis include: land resources, geology and soils, water resources, air quality and noise, ecological resources, human health, cultural resources, site infrastructure, waste management, transportation, and facility accidents.

G.8.3.1 No Action Option

Under the No Action Option, the Science Complex would not be constructed at any of the location options. Under the No Action Option, new land tracts would not be developed at this time. The tracts could remain undeveloped or could be developed sometime in the future by NNSA for some as-yet-undetermined use. Potential effects associated with development and use of this land would not occur. No construction waste would be generated. However, the potential for increased efficiency due to more-modern construction and collocation would also not occur. Open space from DD&D of old, less-efficient structures would not be created.

G.8.3.2 Option 1: Northwest Technical Area 62 Site Option (Preferred Option)

Land Resources—Land Use

Under the Northwest TA-62 Site option a site located to the west of TA-3 would be used for construction of the Science Complex. Current land use within the entire 245-acre (99-hectare)

TA is classified as Reserve and land use should not change in the future (LANL 2003b). The Science Complex would disturb 5 acres (2 hectares) of undeveloped land and would result in a change in future land use from Reserve to Experimental Science.

Land Resources—Visual Resources

The southern rim of Los Alamos Canyon is relatively undeveloped, and the area possesses desirable aesthetic qualities that contribute to the natural viewshed. From West Jemez Road, the view north to the forest canopy at the site is unobstructed. From the site, the views west, north, and east, to Los Alamos Canyon below and to the mountains and valleys beyond Los Alamos, are relatively unobstructed. The principal manmade features that contrast with the existing natural environment are West Jemez Road and the TA-3 facilities to the south and the Los Alamos Canyon bridge and community buildings to the east and north, these being at a lower elevation than the site.

The Science Complex would encompass 5 acres (2 hectares) on the site and would consist of two four-story buildings and a six-story parking structure, as well as related supporting structures and utilities. Buildings of this size would be visible from neighboring properties and roadways. Although the Science Complex at this site would be near existing industrial compounds at TA-3, and the area of existing development at TA-3 has already impacted the landscape, the addition of the Science Complex would result in an impact on visual resources in this area because views from the site, or from West Jemez Road, to the west, north, and east would be obstructed. Currently, LANL structures are largely contained on the south side of West Jemez Road. However, with the Science Complex construction on the north side of this road, the natural forested buffer area between LANL and Los Alamos Canyon at this site would be lost.

Because there is little nighttime activity at LANL, nighttime light sources would generally be security lighting. The sodium vapor lights used for this purpose can be distinguished from the lights of the nearby Los Alamos community by their slightly yellow color. At a distance across the viewshed, however, the color variation in light sources becomes negligible, and any nighttime distinction between LANL and the community is not apparent to the observer. Light sources for the proposed Science Complex would be associated primarily with security lighting. However, the security lighting near the north edge of the site may illuminate some portion of the south and north canyon walls of Los Alamos Canyon adjacent to the site. This increased illumination may impact nighttime movement of wildlife in the area, including the Mexican spotted owl, and Mexican spotted owl habitat.

Construction of new facilities would affect this viewshed. Preservation of existing vegetation and use of building design sand colors that complement the natural environment would mitigate viewshed degradation. In addition, limiting use of bright security lights on the north edge of the site and using directed lighting and shielded fixtures would limit illumination to the adjacent Los Alamos Canyon walls. To mitigate the visual impact of lighting, the project would conform to the New Mexico Night Sky Protection Act per architectural and design guidelines.

Geology and Soils

Data from geological studies indicate that TA-62 is located in a fault zone. In general, the density of seismic features increases to the west at LANL, and a number of faults are mapped in the TA-62 area (see Section 4.2 of this SWEIS). A probabilistic analysis of potential surface rupture was performed to evaluate the Chemistry and Metallurgy Research Building site in TA-3. TA-3 is located adjacent to and east of TA-62 (DOE 2003). The analysis indicates that the annual probability of surface rupture in TA-3 is less than 1 in 10,000, which is less than the required performance goal for the Chemistry and Metallurgy Research Building and is in accordance with DOE standards. If located in TA-62, an estimate of the seismic hazard at the site would be conducted, and the Science Complex would be designed in accordance with current DOE seismic standards and applicable building codes.

Soil resources in the area of the proposed location for the Science Complex are undisturbed and maintain natural vegetative cover. The arid soils in this area are largely sandy loam material alluvially deposited from tuff units on the slopes to the west and eroded from underlying geologic units. Soils in the proposed construction area are primarily classified as Typic Eutroboralfs, while there are smaller areas at the site where soils are classified as Typic Ustorthents. Both of these soil types are poorly developed with relatively little horizon differentiation and organic matter accumulation. These factors, combined with the dry moisture regime of the area, result in only a limited number of plant species able to subsist on the soil medium, which, in turn, supports a very limited number of wildlife species.

Construction Impacts—Construction of the Science Complex at the Northwest TA-62 site is expected to impact soil resources over several acres. Soil resources in this area, as well as the habitat it supports, would be irretrievably lost as a result of the construction. To mitigate this loss, valuable surface soil in this area would be scraped off of the building sites and stockpiled prior to beginning construction activities. In addition, some underlying rock (consisting of Bandelier tuff) would be excavated for building foundations. An estimated 840,000 cubic yards (640,000 cubic meters) of soil and rock would be excavated and stockpiled. The stockpiled soil and rock could then be used at other locations at LANL for site restoration following remediation. If soil and rock stockpiles were to be stored for longer than a few weeks, the stockpiles would be seeded or managed as appropriate to prevent stockpile erosion and impact on nearby drainages. In addition, care would be taken to employ all necessary erosion control best management practices during and following construction to limit impact on soil resources adjacent to the construction and building sites.

Water Resources

There are no natural surface water resources at the Northwest TA-62 Project site. An existing water tank is currently located on the site, approximately 50 feet (15 meters) north of one of the proposed structures. Regional groundwater occurs approximately 6,150 feet (1,875 meters) below ground surface at the site, and no groundwater pumping or monitoring wells exist at the site. Two existing, natural drainage swales transect the western half of the site.

Construction Impacts—No long-term effects on surface water quality would be likely. Vegetation reduction could expose soils due to excavation and heavy construction equipment.

Best management practices for runoff control, such as silt barriers and straw bales, would be used. The potential for downstream siltation would be minor and temporary in nature. A stormwater pollution prevention plan would be developed and implemented, including placement of best management practices to prevent erosion of disturbed soil by stormwater runoff or other water discharges.

Under the current conceptual site layout plan (see Figure G–12) some modification of the site's natural drainage patterns would be necessary. This would involve a consultation with the U.S. Army Corps of Engineers to determine if a Clean Water Act Section 404 Dredge and Fill Permit, and a State of New Mexico Section 401 Water Quality Certification are required.

Operations Impacts—The addition of new impermeable surfaces would increase stormwater runoff and would decrease surface water infiltration. While decreased infiltration is not expected to have an adverse effect on groundwater quality, the increased amount of runoff from impervious surfaces may have a slight effect on surface water quality and on residual contaminant transport within canyon sediments. Best management practices integrated as part of the site design would minimize the potential for sediment and residual contaminant transport.

Air Quality and Noise

Construction Impacts—Construction of the proposed Science Complex would result in temporary, localized emissions associated with vehicle and equipment exhaust as well as particulate (dust) emissions from excavation and construction activities. Emissions from gasoline and diesel engines would result from excavation and construction activities. Air emissions associated with excavation and construction equipment operation would not result in exceedances of ambient air quality standards, except for possible short-term concentrations of carbon monoxide and nitrogen oxides. Estimated concentrations for PM_{10} would be greatest for the site work phase. The maximum estimated ground-level concentration for PM_{10} would be an annual average of 4.5 micrograms per cubic meter and a 24-hour average of 92.2 micrograms per cubic meter offsite or along the perimeter road to which the public has regular access.

Soil disturbance during construction would result in small air emissions, but would be controlled by best management practices and would not exceed ambient air quality standards, thereby resulting in no impacts on workers or the public.

The proposed project would result in limited short-term increases in noise levels associated with construction activities and increased long-term noise levels associated with operation of the proposed Science Complex. Noise generated by the proposed project is not expected to have an adverse effect on either construction workers or workers at the new facility once it is operating.

Sound levels would dissipate to background levels before reaching publicly accessible areas or undisturbed wildlife habitats, and they would not be noticeable to nearby workers or members of the public, nor would they disturb local wildlife. Traffic noise from construction workers or operations would not increase the present traffic noise level on West Jemez Road.

Operations Impacts—In terms of Science Complex operation, as existing LANL capabilities and organizations are consolidated at the Science Complex, there could be fewer emissions resulting from individuals driving to various points at LANL throughout the day for meetings and other purposes.

Ecological Resources

Areas in the region of TA-62 burned in the Cerro Grande Fire, including a portion of the area contained within the Northwest TA-62 Option. There are no wetlands or aquatic resources within the Northwest TA-62 Option area, although wetlands are located to the north in Los Alamos Canyon. A portion of the project area falls within the core and buffer zone of the Los Alamos Canyon Area of Environmental Interest for the Mexican spotted owl. Areas of environmental interest for the bald eagle and southwestern willow flycatcher are not located near the project site (LANL 2006b).

Construction Impacts—Science Complex construction would involve clearing and grading approximately 5 acres (2 hectares) of ponderosa pine forest within TA-62. This would result in loss of less-mobile wildlife, such as reptiles and small mammals, and cause more-mobile species, such as birds or large mammals, to be displaced. The success of displaced animals would depend on the carrying capacity of the area into which they moved. If the area were at its carrying capacity, displaced animals would not likely survive. Indirect impacts of construction, such as noise, light, or human disturbance, could also impact wildlife living adjacent to the construction zone. Such disturbance would span the construction period. These impacts could be mitigated by clearly marking the construction zone to prevent equipment and workers from disturbing adjacent habitat, including the Mexican spotted owl habitat, and properly maintaining equipment. Construction of the new buildings and parking structure would not impact wetlands, as none are located in or near the construction zone.

The Science Complex would remove areas of undeveloped core and buffer habitat within the Los Alamos Canyon Mexican spotted owl Area of Environmental Interest. Further, noise from the project would potentially exceed 6 dB(A) above background in the core zone; however, this level would drop below that level within 450 feet (135 meters) from the construction zone. The biological assessment prepared by DOE noted that it is unlikely that the Mexican spotted owl would be denied access to adequate nesting and foraging habitat as a result of the project. Thus, provided all reasonable and prudent alternatives are implemented (see Section G.2.3.2), the project may affect, but is not likely to adversely affect, the Mexican spotted owl (LANL 2006b). The USFWS has concurred with this assessment (see Chapter 6, Section 6.5.2).

Areas of Environmental Interest for the bald eagle and southwestern willow flycatcher are not located near the proposed Science Complex. However, recognizing that the bald eagle forages over all of LANL and that some habitat degradation would be associated with the project, the DOE biological assessment concluded that with appropriate reasonable and prudent alternatives (see Section G.2.3.2), the project may affect, but is not likely to adversely affect, the bald eagle. Since the nearest southwestern willow flycatcher Area of Environmental Interest is not within or downstream of the project site there would be no effect on this species (LANL 2006b). The USFWS has concurred with the biological assessment as it relates to the bald eagle and southwestern willow flycatcher (see Chapter 6, Section 6.5.2).

Operations Impacts—Science Complex operation would have minimal impact on terrestrial resources within or adjacent to TA-62. Because the wildlife residing in the area has already adapted to levels of noise and human activity associated with development in the area surrounding the project area, it would not likely be adversely affected by similar types of activity involved with operation of the new buildings.

Human Health

Construction Impacts—During Science Complex construction, some construction-related accidents would potentially occur. The potential for industrial accidents is based on both DOE and Bureau of Labor Statistics data on construction injuries and fatalities. Based on an estimated 3.2 million person-hours to construct the new facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be approximately 36 (DOE 2004) to 135 (BLS 2003).

Cultural Resources

Three archaeological sites are situated in the vicinity of the proposed Northwest TA-62 location, and each site has been determined to be eligible for the National Register of Historic Places. Two of these prehistoric sites are listed as nonstructural, and both traverse the proposed project area. One site is a 1-acre (0.4-hectare) prehistoric artifact scatter. The second site is about 0.6 acres (0.2 hectares) in size and is a prehistoric artifact site comprised of a dense lithic scatter. The third site is a cavate.

Construction Impacts—The three prehistoric archaeological sites are at risk of either direct or indirect impact by the proposed construction of Northwest TA-62. Construction activity, traffic, and ground disturbance could damage portions of these sites. If buried cultural deposits are encountered during construction, activities would cease and procedures as set forth in *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico* (LANL 2006c) would be implemented. Those buildings to be replaced by the two Science Complex Buildings have not been evaluated for their historic importance; thus, an eligibility assessment would have to be conducted prior to their demolition.

Socioeconomics and Infrastructure

The site is currently developed with aboveground electrical distribution lines, a water tower, underground water transmission lines with valves and pumps, and communication lines. Electrical and communication lines are located in a utility corridor along the water tower access road near the north boundary of the proposed site. A gas line is located approximately 250 feet (76 meters) from the southeast corner of the site. There are no sanitary sewer lines within 300 feet (91 meters) of the site boundary.

Construction Impacts—Utility infrastructure resources would be required for Science Complex construction. Standard construction practice dictates that electric power needed to operate portable construction and supporting equipment be supplied by portable diesel-fired generators. Therefore, no electrical energy consumption would be directly associated with construction. A variety of heavy equipment, motor vehicles, and trucks would be used, requiring diesel fuel, gasoline, and propane for operation. Liquid fuels would be brought to the site as needed from offsite sources and, therefore, would not be limited resources. Water would be needed primarily to provide dust control, aid soil compaction at the construction site, and possibly for equipment washdown. Water would not be required for concrete mixing, as ready-mix concrete is typically procured from offsite resources. Portable sanitary facilities would be provided to meet the workday sanitary needs of project personnel on the site. Water needed for construction would typically be trucked to the point of use, rather than provided by a temporary service connection.

For Science Complex construction, total liquid fuel consumption is estimated to be 4.3 million gallons (16 million liters) and total water consumption is estimated to be 23 million gallons (86 million liters) over the 2-year construction phase. Development of the proposed Science Complex Project would require addition of a natural gas line. The conceptual plan includes extending a new gas line approximately 500 feet (150 meters) east along the utility corridor to connect with existing lines. Local electrical and data or communication lines would be accessed through the utility corridor. In addition, the Science Complex Building must be connected to existing sewer lines. Primary vehicle access to the site would be from a signalized intersection along West Jemez Road. However, the existing LANL infrastructure would be capable of supporting requirements for new facility construction without exceeding site capacities, resulting in negligible impact on site utility infrastructure.

Operations Impacts—Utility resource usage in the proposed structures would be equivalent to or less than the usage of the replaced structures. This is due to contemporary building design, which includes water and energy conservation features. As such, Science Complex operation is expected to have no or negligible incremental impact on utility infrastructure capacities at LANL.

Waste Management

There are currently no LANL operations located at the site, and therefore no waste volumes are produced. However, the activities that would be relocated to the Science Complex currently produce waste at other LANL locations. There would be no change to overall waste types or volumes.

Construction Impacts—The proposed project would generate solid waste from construction that would be disposed of at the Los Alamos County Landfill or other New Mexico solid waste landfills. Based on the total gross square footage of newly constructed office and light laboratory space for the Science Complex, approximately 3,320 cubic yards (2,540 cubic meters) of waste would be generated during construction. This estimate would be refined as additional information becomes available during project design development.

Operations Impacts—Regulated wastes from site development, facility operations, and DD&D of other structures as a result of the new Science Complex would be handled through existing waste management programs at LANL and carried out in accordance with applicable laws, regulations, and DOE orders.

Transportation

Site development would primarily affect traffic on West Jemez Road. Level of service is a quantitative measurement indicating the level of delay and congestion at an intersection, ranging from A to F (where level of service A indicates very little congestion or delay, and level of service F indicates a high level of congestion or delay). West Jemez Road currently operates at level of service A during morning and afternoon peak hours.

Construction Impacts—Traffic generated by Science Complex construction would have only minor impacts on the adjacent roadway system, including West Jemez Road. No mitigation measures would be necessary to accommodate construction-related traffic.

Operations Impacts—To evaluate Science Complex impacts on traffic at LANL and in Los Alamos, a traffic analysis was conducted for the Science Complex at the Northwest TA-62 site. The analysis evaluated short- and long-term impacts on traffic resulting from an estimated 1,600 employees at the Science Complex. Short-term background traffic volumes are the sum of existing traffic volumes (counted in the fall of 2004) plus the traffic volumes estimated to be generated by the Wellness Center and adjacent development. Long-term background traffic volumes assumed a 20 percent increase in traffic volumes on West Jemez Road. The study estimated that the Science Complex would generate about 5,790 vehicle trips on the average weekday (2,895 vehicles entering and exiting in a 24-hour period) (LSC 2005b). To mitigate non-construction related traffic increases, the four-lane cross section of West Jemez Road east of the proposed site access could be extended to the site access. Also, east- and westbound right- and left-turn deceleration lanes could be constructed on West Jemez Road approaching the site access.

Facility Accidents

Operations Impacts—As an office building and light laboratory, the Science Complex is not considered a credible threat to the health and safety of personnel outside of the complex in the event of an accident. If the Science Complex is not fully used by LANL site employees, it is possible that some or all of this space could be occupied by a commercial company. Therefore, an analysis of the potential risk to an occupant of this building from an accident in another LANL facility was evaluated. From the list of accidents analyzed in the Appendix D of this SWEIS, the accident at the Chemistry and Metallurgy Research Building in TA-3 would be the most likely to impact the occupants at the Science Complex. The accident is identified as a HEPA filter fire with a likelihood of occurrence of one in 100 years (see Appendix D). If such an accident were to occur, the dose to an occupant of the Science Complex, which is about 6,600 feet (2,000 meters) northwest of the Chemistry and Metallurgy Research Building, would be 0.30 rem or less, with a risk of less than 1.8×10^{-4} (1 in 5,600) that an exposed individual would develop an LCF. Taking into account the likelihood of occurrence of such an accident, the risk of an LCF would be 1.8×10^{-6} (1 chance in 560,000) per year of occupancy. DD&D of the Chemistry and Metallurgy Research Building would reduce this radiological risk.

G.8.3.3 Option 2: Research Park Site Option

The effects on air quality and noise, human health, and waste management are expected to be similar to those of the proposed project (Option 1). Resource area impacts or conditions that would differ from the proposed project are discussed below.

Land Resources—Land Use

Under the Research Park Site option, the Science Complex would be built in TA-3 just to the west of the Los Alamos County Research Park. TA-3, which is located in the northwestern portion of LANL, encompasses 359 acres (145 hectares), most of which is occupied by buildings and other structures. It contains the director's office, administrative offices, support facilities, and a number of laboratories (DOE 1999a). As with the Northwest TA-62 Site option, the new Science Complex would occupy 5 acres (2 hectares) of undeveloped land. Currently land use in this area is classified as Reserve and future land use was predicted to remain unchanged (LANL 2003b). However, if this option is selected, future land use would change from Reserve to Experimental Science.

Land Resources—Visual Resources

The principal manmade features that contrast with the existing natural environment are West Jemez Road and the TA-3 facilities to the south, the existing Research Park Building to the east, and the Los Alamos Canyon bridge and community buildings to the east and north, these being at a lower elevation than the site.

Operations Impacts—The Science Complex would consist of two four-story buildings and a six-story parking structure, as well as related supporting structures and utilities. Buildings of this size would be visible from neighboring properties and roadways. Although the Science Complex at this site would be near and adjacent to existing industrial compounds at the Research Park and TA-3, and the area of existing development at TA-3 has already impacted the landscape, the addition of the Science Complex would result in a significant impact on visual resources in this area because views from the site, or from West Jemez Road, to the west, north, and east would be obstructed. With the Science Complex construction on the north side of West Jemez Road, the natural forested buffer area between LANL and Los Alamos Canyon would be further reduced. Impacts of the Research Park Site Option would be similar to those of the proposed project.

Construction of new facilities would further affect this viewshed. Impacts of the Research Park Site Option would be similar to those of the proposed project (Option 1). In addition, limiting use of bright security lights on the north edge of the site and using directed lighting and shielded fixtures would limit illumination to the adjacent Los Alamos Canyon walls. To mitigate the visual impact of lighting, the project would conform to the New Mexico Night Sky Protection Act architectural and design guidelines.

Geology and Soils

The site for the Science Complex at TA-3 lies within a part of the Pajarito Fault system characterized by subsidiary or distributed fault ruptures. Probabilistic analysis of potential surface rupture indicates that the annual probability of surface rupture in areas beyond the principal or main trace of the Pajarito Fault, such as at the Science Complex TA-3 site, is less than 1 in 10,000 (LANL 2004c). This probability is a less than the required performance goal for the facility and in accordance with DOE standards. Additionally, the Science Complex would be designed in accordance with current DOE seismic standards and applicable building codes.

Construction Impacts—Impacts on geology and soils associated with Science Complex construction at the Research Park Site in TA-3 would be similar to those discussed under the Northwest TA-62 Site Option (Option 1).

DD&D Impacts—The Research Park Site Option includes DD&D activities of unspecified facilities with a footprint equivalent to new facility construction. The impacts associated with DD&D of existing facilities would be the same as those discussed under the Northwest TA-62 Site Option (Option 1).

Water Resources

There are no surface water resources at the Research Park site, nor are there any significant surface water drainage features at the proposed project site, though the site does drain toward Los Alamos Canyon to the north. Regional groundwater occurs approximately 6,100 feet (1,859 meters) below ground surface at the site, and no groundwater pumping or monitoring wells exist at the site.

Construction Impacts—Because no watercourses would be directly impacted by construction, a Clean Water Act Section 404 Dredge and Fill Permit and a State of New Mexico Section 401 Water Quality Certification would not be required. All vehicles and equipment used for construction purposes would be inspected for leaks before arrival at the construction site to avoid inadvertent surface contamination from hydrocarbon fuel products.

Operations Impacts—Research Park Site Option operations impacts would be the same as those discussed under the Northwest TA-62 Site Option (Option 1).

Ecological Resources

The project area for the Research Park Site Option is not within an Area of Environmental Interest delineated for protection of the Mexican spotted owl, southwestern willow flycatcher, or the bald eagle. Other state-listed special status species would have a low probability of occurrence within the project area. The Research Park Site Option is situated within ponderosa pine forest and is adjacent to Los Alamos Canyon located to the north. Industrial development from LANL facilities is located to the south. There are no wetlands or aquatic resources within the proposed project area for this option, although wetlands are located beyond TA-62 to the north in Los Alamos Canyon (LANL 2006b).

Construction Impacts—The Research Park Site Option would result in clearing and grading approximately 5 acres (2 hectares) of ponderosa pine forest to construct the Science Complex. The area to the south and east is either already heavily developed or is planned for development. Impacts of construction on wildlife would be similar to those described for the proposed project (Option 1).

Operations Impacts—Under the Research Park Site Option, operation of the proposed Science Complex would not be likely to pose significant adverse effects on most wildlife. Activities would be restricted to within the facility grounds; therefore, most area wildlife would likely continue to use the area around the facility for foraging and migration after construction was complete. In addition, the site currently experiences human impact of the surrounding development; therefore, increased activity from the Science Complex under the Research Park Site Option is expected to cause minimal effects on area wildlife.

Human Health

Human health impacts would be the same as those for Option 1.

Cultural Resources

No archaeological sites are located within the boundaries of the leased Research Park tract. However, there is one National Register of Historic Places-eligible site located in the vicinity of the proposed Science Complex. It is situated to the immediate north of the Research Park on nonleased land.

Construction Impacts—Construction of the planned Research Park Site Option, including the access road, would not affect any recorded prehistoric or historic archaeological sites. If any buried material or cultural remains are encountered during construction, activities would cease until appropriate local authorities or a qualified professional is consulted. The buildings to be replaced by the new Science Complex have not been evaluated for their historic significance; thus, an eligibility assessment would be completed prior to demolition activities.

Socioeconomics and Infrastructure

Existing aboveground electrical distribution and communications lines, underground water transmission lines, storm drains, and buried gas lines transect portions of the proposed Research Park site. There are no identified sanitary sewer lines within 400 feet (120 meters) of the site. Roads in the vicinity of the proposed Research Park location include West Jemez Road and West Road.

Construction Impacts—Utility infrastructure resources required for Science Complex construction at the Research Park site location would be similar to those described for the Northwest TA-62 Site Option (Option 1).

Operations Impacts—Development of the proposed Science Complex at the Research Park location would likely require rerouting of many utilities currently located on the site, and rerouting may also be necessary outside the project area. A sanitary sewer trunk line would need to be extended from buildings to the south or from the existing building in the eastern portion of the Research Park. Primary vehicle access to the site would be from a signalized intersection along West Jemez Road.

Waste Management

Waste management impacts would be the same as those for Option 1.

Transportation

Site development would primarily affect traffic on West Jemez Road. West Jemez Road currently operates at level of service A during morning and afternoon peak hours.

Construction Impacts—Traffic generated by Science Complex construction would not have any significant impacts on the adjacent roadway system, including West Jemez Road. No mitigation measures would be necessary to accommodate construction-related traffic volumes.

Operations Impacts—To evaluate Science Complex impacts on traffic at LANL and in Los Alamos, a traffic analysis was conducted for the Science Complex at the Northwest TA-62 site (LSC 2005b). The proposed Research Park site is located adjacent to the Northwest TA-62 site and would also have primary access along West Jemez Road. Therefore, a signalized intersection would likely be used for access to West Jemez Road, and traffic impacts would be similar to those resulting from development at the Northwest TA-62 site. To mitigate non-construction-related traffic increases, the four-lane cross section of West Jemez Road east of the proposed site access could be extended to the site access. Also, east- and westbound right- and left-turn deceleration lanes could be constructed on West Jemez Road approaching the site access.

Facility Accidents

Operations Impacts—Under this option, Science Complex would be located about 3,400 feet (1,000 meters) meters to the north of the Chemistry and Metallurgy Research Building. Similar to the situation discussed under Option 1, the HEPA filter fire accident at the Chemistry and Metallurgy Research Building would be the most likely event to impact the occupants at the Science Complex. This accident would lead to an occupant dose of about 0.7 rem, or a risk of 4.2×10^{-4} (1 in 2,400) of developing an LCF. Taking into account the likelihood of the accident occurring, the risk of an LCF would be 4.2×10^{-6} (1 chance in 240,000) per year of occupancy. Again, DD&D of the Chemistry and Metallurgy Research Building would reduce this radiological risk.

G.8.3.4 Option 3: South TA-3 Site Option

The effects on air quality and noise, human health, and waste management are expected to be similar to those of the proposed project (Option 1). Resource area impacts or conditions that would differ from the proposed project are discussed below.

Land Resources—Land Use

Under this option, the Science Complex would be constructed in the southern part of TA-3 and would require 5 acres (2 hectares) of land. TA-3, which is located in the northwestern portion of LANL, encompasses 359 acres (145 hectares), most of which is occupied by buildings and other structures. It contains the Director's office, administrative offices, support facilities, and a number of laboratories (DOE 1999a). The portion of the TA within which the Science Complex would be located is presently classified as Experimental Science. This area is predicted to remain Experimental Science in the future; thus, construction of the new complex would not result in a change in land use (LANL 2003b).

Land Resources—Visual Resources

The South TA-3 site is located at the northeast corner of Diamond Drive and Pajarito Road, near the top of Mortandad Canyon within TA-3. The viewshed at this site is relatively developed, as it is located at the southeastern corner of heavily developed TA-3 and is adjacent to nearby TA's with parking lots and structures. The view from the South TA-3 site to the west is of Chemistry and Metallurgy Research Building parking lots, of multistory buildings to the north, buildings and parking lots across Pajarito Road to the south, and of a forested drainage, which lies at a lower elevation from the site to the east and leads down to Mortandad Canyon. The South TA-3 site is partially covered with a 1.5-acre (0.6-hectare) parking lot currently used by LANL employees. Currently, the viewshed from this site is impacted due to existing LANL structures.

Operations Impacts—The Science Complex would encompass the majority of the site and would consist of two four-story buildings and a six-story parking structure, as well as related supporting structures and utilities. Buildings of this size would be visible from neighboring properties and roadways. The Science Complex at this site would be near existing industrial buildings at TA-3, and the area of existing development at TA-3 has already impacted the landscape. If the existing small parcels of forested land to the south and east of the South TA-3 site remain undisturbed, Science Complex development at this site would retain the landscape's primary aesthetic attributes.

As there is little nighttime activity at LANL, nighttime light sources would generally be security lighting. Because this site is located in an area already developed with other LANL facilities and structures, the presence of lights at the Science Complex would not likely adversely impact visual resources of the surrounding area, nor are lights expected to impact nighttime movement of wildlife in the area.

Construction Impacts—Construction of new facilities at this site would not significantly affect the viewshed. Preservation of existing vegetation and use of building design sand colors that complement the natural environment would mitigate potential viewshed degradation. Because of the level of LANL development surrounding the site, Science Complex lighting at the site is not expected to adversely impact the surrounding area visual resources.

Geology and Soils

The probability of surface rupture for the South TA-3 site is the same as that for the other options. Soil resources in the area of the proposed location for the Science Complex are relatively disturbed, and only adjacent undisturbed areas maintain vegetative cover. The South TA-3 site is partially occupied by a parking lot that is partially built up on fill material. The fill material came from the site in the process of grading or was brought in from another area. The arid soils in this area, and presumably underlying the parking lot, are largely sandy loam material alluvially deposited from tuff units on the higher slopes to the west and eroded from underlying geologic units. Soils in the proposed Science Complex area at this site are classified as Typic Eutroboralfs. This soil type is poorly developed with relatively little horizon differentiation and organic matter accumulation. These factors, combined with the dry moisture regime of the area, result in only a limited number of plant species able to subsist on the soil medium, which, in turn, supports a very limited number of wildlife species.

Construction Impacts—Science Complex construction at the South TA-3 site would result in the same construction impacts as those discussed under the Northwest TA-62 Site Option (Option 1).

DD&D Impacts—Activities and impacts associated with DD&D of existing facilities would be the same as those discussed under the Northwest TA-62 Site Option (Option 1).

Water Resources

Because the South TA-3 site is located at the headwaters of Mortandad Canyon, there would be surface water considerations with Science Complex development. Regional groundwater occurs approximately 6,050 feet (1,844 meters) below ground surface at the site, and no regional groundwater pumping or monitoring wells exist at the site.

Construction Impacts—Science Complex construction at the South TA-3 site would have similar impacts as those discussed under the Northwest TA-62 Site Option. Additionally, if the adjacent drainage leading to Mortandad Canyon were affected by fill material or excavation during construction, a Clean Water Act Section 404 Dredge and Fill Permit and a State of New Mexico Section 401 Water Quality Certification would be required.

Operations Impacts—Science Complex operation at the South TA-3 site would have the same impacts as those discussed under the Northwest TA-62 Site Option.

Ecological Resources

The project area for the South TA-3 Site Option is partially developed and is not within an Area of Environmental Interest delineated for protection of the Mexican spotted owl, southwestern willow flycatcher, or the bald eagle. Other state-listed special status species would have a low probability of occurrence within the project area (LANL 2006a).

The South TA-3 site is generally located in a developed part of TA-3 but does contain areas of native grass, ponderosa pine, and some pinyon-juniper. There are no wetlands or aquatic resources within the proposed project area for this option. There are however, wetlands in upper Mortandad Canyon. The area is not within any areas of environmental interest for any federally listed threatened or endangered species (LANL 2006a).

Construction Impacts—Science Complex construction under the South TA-3 Site Option would result in impacts generally similar to those addressed in Section G.8.3.2. The proposed project would result in clearing and grading less than 5 acres (2 hectares) of land to construct the Science Complex. Much of the area around the buildings would be paved. A biological assessment would be needed if tree removal affects more than 5 acres (2 hectares) (LANL 2006b).

Operations Impacts—Operation of the proposed the Science Complex would not pose significant adverse affects on most wildlife under this option. Activities would be restricted to within the facility grounds, therefore, most area wildlife would likely continue to use the area around the facility for foraging and migration after construction was complete.

Human Health

Human health impacts would be the same as those for Option 1.

Cultural Resources

No archaeological sites are located in the vicinity of the proposed South TA-3 location for the Science Complex. The entire proposed project area was previously surveyed for cultural resources.

Construction Impacts—Construction planned for South TA-3, including roads and areas for construction traffic and staging, would not affect any recorded prehistoric or historic archaeological sites. If any buried material or cultural remains are encountered during construction, activities would cease until appropriate local authorities or a qualified professional is consulted before work resumes. The buildings to be replaced by the new Science Complex have not been evaluated for historical significance; thus, an eligibility assessment would be completed prior to demolition activities.

Socioeconomics and Infrastructure

Existing aboveground electrical distribution lines, belowground communications lines, underground water transmission lines, storm drains, and buried gas lines run parallel to both Diamond Drive and Pajarito Road adjacent to the site. In addition, a new buried steam line is planned near the center of the site for construction of the Information Management Division Operations Facility. Existing sanitary sewer lines are located somewhat farther from the site, and sewer service could be brought to the site from the same side of Diamond Drive. Roads in the vicinity of the proposed South TA-3 alternate site include Diamond Drive and Pajarito Road.

Construction Impacts—Utility infrastructure resources required for Science Complex construction at the South TA-3 Site Option location would be similar to those described for the Northwest TA-62 Site Option (Option 1).

Operations Impacts—Development of the proposed Science Complex Project at the South TA-3 alternate site would require addition of a natural gas line, connected from either the west side of Diamond Drive or the north side of Pajarito Road. In addition, the Science Complex Building must be connected to existing sewer lines that lie both north of the site, serving the Biosafety Level 3 Facility, and southwest of the Diamond Drive-Pajarito Road intersection. Any trenching associated with bringing utility service to the site that could potentially impact adjacent drainages would be done using erosion control best management practices.

Waste Management

Waste management impacts would be the same as those for Option 1.

Transportation

According to the 2002 environmental assessment for the proposed construction and operation of the Biosafety Level 3 Facility at LANL, which is north of the South TA-3 alternate site, Pajarito Road had approximately 8,000 average vehicle trips, while West Jemez Road had approximately 6,000 per day (DOE 2002b). The environmental assessment also noted that the intersection of Diamond Drive and West Jemez Road exhibited considerable congestion during peak traffic periods. Pajarito Road traffic levels have decreased slightly since access to the road has been limited to LANL badge holders, resulting in an increase in traffic on West Jemez Road.

Construction Impacts—Though traffic generated by Science Complex construction at Northwest TA-62 was not projected to have any significant impacts on the adjacent roadway system, including West Jemez Road, in the 2005 study, there would be additional impacts on traffic resulting from Science Complex construction at the South TA-3 site.

Operations Impacts—To evaluate Science Complex impacts on traffic at LANL and in Los Alamos, a traffic analysis was conducted for the Science Complex at the Northwest TA-62 site in 2005 (LSC 2005b). The analysis evaluated short- and long-term impacts on traffic resulting from the 1,600-employee Science Complex at this site. Results of this traffic study for the Northwest TA-62 Site Option are applicable for traffic evaluation at the South TA-3 site because the proposed Science Complex is unchanged. However, because the South TA-3 site would be within the planned Security Perimeter Road and not as easily accessible due in part to proximity and higher traffic flows on Diamond Drive relative to those on West Jemez Road, traffic impacts of the Science Complex at the South TA-3 site would be greater than the study determined for the Northwest TA-62 site. In the study, short-term background traffic volumes are the sum of existing traffic volumes (counted in the fall of 2004) plus the traffic volumes estimated to be generated by the Wellness Center and adjacent development. Long-term background traffic volumes assumed a 20 percent increase in traffic volumes on West Jemez Road. The study estimated that the Science Complex would generate about 5,790 vehicle trips on the average weekday (2,895 vehicles entering and exiting in a 24-hour period). To mitigate non-construction-related traffic, it may be necessary to construct south- and northbound left- and right-turn deceleration lanes on Diamond Drive approaching the site access.

Facility Accidents

Operations Impacts—Under this option, the Science Complex would be located about 800 feet (240 meters) to the southeast of the Chemistry and Metallurgy Research Building. Similar to the situation discussed under Option 1, the HEPA filter fire accident at the Chemistry and Metallurgy Research Building would be the most likely event to impact the occupants at the Science Complex. This accident would lead to an occupant dose of 2.8 rem or less, or a risk of 1.7×10^{-3} (1 in 600) of developing an LCF. Taking into account the likelihood of the accident occurring, the risk of an LCF would be 1.7×10^{-5} (1 chance in 60,000) per year of occupancy. The DD&D of the Chemistry and Metallurgy Research Building would reduce this radiological risk.

G.9 Remote Warehouse and Truck Inspection Station Impact Assessment

This section presents an assessment of environmental impacts for the proposed construction and operation of the Remote Warehouse and Truck Inspection Station at TA-72. Under the proposed project, existing operations would be relocated to a completely new facility. The existing warehouse in TA-3 would be demolished or reused for some other purpose; the existing temporary truck inspection station on East Jemez Road would be demolished. Section G.9.1 provides background information on the proposed project to build the Remote Warehouse and Truck Inspection Station. Section G.9.2 provides a description of the options for the proposed project. Section G.9.3 provides information supplementing the affected environment description presented in Chapter 4 and describes the environmental impacts of the No Action Option and the proposed project to construct and operate the Remote Warehouse and Truck Inspection Station at TA-72.

G.9.1 Introduction

The current warehouse located at TA-3 provides centralized shipping, receiving, distribution, packaging and transportation compliance, and mail services for all LANL organizations. Personnel at the current warehouse facility are responsible for part of the institutional physical handling, identification, acceptance of goods or materials, and distribution of these materials for LANL. Over 500,000 packages and shipments are received, processed, inspected, and delivered annually to 500 drop points at LANL. Nearly 4,000 radioactive or hazardous and classified shipments are received and delivered annually. The mail distribution function currently delivers 14,000,000 pieces annually to 620 LANL mail stops and processes over 500,000 pieces for external mailing. Approximately 18,000 outbound classified documents are handled annually. The volume of material received and shipped and the Federal administrative requirements for handling these shipments continue to increase. There are also approximately 80 daily commercial deliveries to the TA-3 warehouse location. Trucks accessing the TA-3 warehouse currently represent approximately 50 to 60 percent of the truck traffic volume for TA-3. The current TA-3 warehouse facility location requires offsite vehicles to travel through densely populated TA-3 areas (LANL 2006a).

G.9.2 Options Considered

The two options identified for the Remote Warehouse and Truck Inspection Station are the No Action Option and the proposed project option.

G.9.2.1 No Action Option

Under the No Action Option, the Remote Warehouse and Truck Inspection Station would not be constructed. Incoming commercial trucks would continue to be inspected at the temporary inspection station on East Jemez Road prior to continuing farther onto the LANL site. Receiving, warehousing, and mailing activities would continue to be conducted at the current TA-3 warehouse facility. Under the No Action Option, operational and security issues associated with operating the current TA-3 warehouse facility would not be resolved.

G.9.2.2 Proposed Project

The Remote Warehouse and Truck Inspection Station Project would relocate shipment receiving, warehousing, and distribution functions from TA-3 to a site in TA-72. In addition, the truck inspection station would be relocated from its current location on the northwest corner of New Mexico State Route 4 (NM 4) and East Jemez Road to the new Remote Warehouse and Truck Inspection Station site. The proposed site is located in Santa Fe County on the south side of East Jemez Road, about 1 mile (1.6 kilometers) west of NM 4 and 0.5 miles (0.8 kilometers) east of the Protective Technology Los Alamos shooting range, which is located north of East Jemez Road. The proposed location is not far from lands belonging to San Ildefonso Pueblo and is about 1 mile (1.6 kilometers) from the Tsankawi Unit of Bandelier National Monument. The proposed site is situated on gently sloping terrain in Sandia Canyon that is covered with pinyon-juniper and some ponderosa pine.

There would be an 85,000-square-foot (7,900-square-meter) warehouse, a 12,000-square-foot (1,100-square-meter) office building, a 400-square-foot (37-square-meter) truckers' rest lounge, a dog kennel, and a 600-square-foot (55-square-meter) guardhouse. In addition to the building footprints, the truck inspection station would comprise approximately 50,000 square feet (4,600 square meters) of paved area. Upon completion of the proposed project, the location of the current truck inspection station on the north side of East Jemez Road would be returned to a natural condition. **Figure G–13** illustrates the conceptual layout of the Remote Warehouse and Truck Inspection Station at the TA-72 site.

The area affected by Remote Warehouse and Truck Inspection Station Project construction would be about 4 acres (1.6 hectares) and would include the actual facilities, parking, staging areas, and perimeter fencing. There would also be modifications made along East Jemez Road to accommodate safety and access improvements.

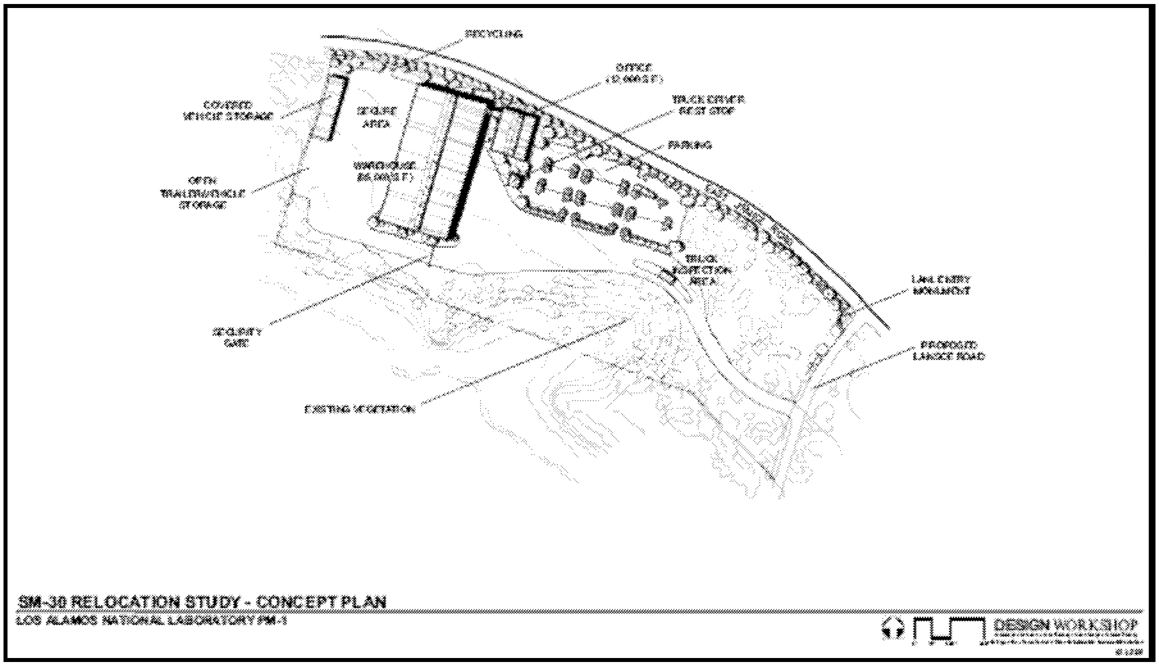


Figure G–13 Technical Area 72 Remote Warehouse and Truck Inspection Station Conceptual Layout

The warehouse facility would include loading docks, leveling ramps, conveyor belts, and a security vault. The facility would have areas for mail sorting, packaging, and storage of general mail, as well as shipments of hazardous chemicals and radioactive materials. There would also be a customer service desk and offices for shipping and receiving, postage, classified documents, mail room supervision, dispatcher, large-freight receiving, and warehouse supervision. The office building would house approximately 125 people involved with activities supporting consolidated warehouse and truck inspection functions.

The Remote Warehouse and Truck Inspection Station would accommodate the projected growth and changes in LANL materials management and provide adequate quality inspection and holding areas (cages) for chain-of-custody materials. The warehouse would enhance and support safety and security requirements by providing for greater separation between radioactive and hazardous materials and the majority of other materials shipping and receiving operations. The current plan is to have uncleared commercial trucks enter the warehouse area to unload and, after inspection, have smaller government trucks and vans with cleared drivers distribute the goods throughout LANL. At the Remote Warehouse and Truck Inspection Station, vendor vehicles and personnel would be separated from government vehicles and personnel. Materials being sent to secure areas and those being sent to the rest of LANL would also be segregated.

G.9.2.3 Options Considered but Dismissed

Ten location options for the Remote Warehouse and Truck Inspection Station were analyzed in a February 2004 siting study (Booth 2004). Many of these sites were not acceptable because of operational or environmental considerations, while other sites were eliminated due to security considerations. Specifically, one of the primary security objectives for the Remote Warehouse and Truck Inspection Station Project is to restrict large private trucks from TA-3 and adjacent areas. Therefore, options that did not achieve this objective were eliminated based on security and efficiency of operations. The TA-72 site (identified as the East Jemez and NM 4 site in the study) ranked highest for development of the Remote Warehouse and Truck Inspection Station, according to results of a model that accounted for all pertinent selection criteria, including environmental and physical, social and political, safety, operations, and economic factors. As a result of the siting study, all other sites previously identified were eliminated from further consideration.

G.9.3 Affected Environment and Environmental Consequences

The affected environment descriptions in this section provide the context for understanding the environmental consequences discussed in the impact assessments. They serve as a baseline from which any environmental changes brought about by implementing the proposed project can be evaluated; the baseline conditions are the currently existing conditions. For construction and operation of the Remote Warehouse and Truck Inspection Station at the proposed location on East Jemez Road, the affected environment would primarily be TA-72.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Socioeconomics and Infrastructure* – No new employment is expected. Construction workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussions.

- *Environmental Justice* – The proposed Remote Warehouse and Truck Inspection Station would entail no disproportionate impacts to low-income or minority populations.

Resource areas examined in this analysis include: land resources, geology and soils, water resources, air quality and noise, ecological resources, human health, cultural resources, site infrastructure, waste management, transportation, and facility accidents.

G.9.3.1 No Action Option

Under the No Action Option, the Remote Warehouse and Truck Inspection Station would not be constructed at the East Jemez Road site, and LANL would continue to operate its warehouse and distribution operations from outdated facilities. As a result, there would not be any land disturbances or additional impacts on environmental resources at TA-72. Under the No Action Option, the objective of removing private commercial vehicles from TA-3 would not be met.

G.9.3.2 Proposed Project

Land Resources—Land Use

TA-72 is 1,189 acres (481 hectares) in size and is located in the northeastern portion of LANL. Current land designation within most of the TA is Reserve, except for a small area north of East Jemez Road categorized as Physical and Technical Support. Future land use was not projected to change prior to this project being proposed (LANL 2003b).

Construction Impacts—Remote Warehouse and Truck Inspection Station construction along the south side of East Jemez Road would require clearing about 4 acres (1.6 hectares) of land. Site development would represent a change in both current and projected land use from Reserve to Physical and Technical Support.

Land Resources—Visual Resources

Along East Jemez Road between NM 4 and the shooting range, Sandia Canyon is relatively undeveloped, and the area possesses desirable aesthetic qualities. There is a forest canopy, and certain spots along East Jemez Road afford views of the surrounding mesas and more distant mountains. The principal manmade features that contrast with the existing natural environment are East Jemez Road, the existing truck inspection station, and the shooting range.

Construction Impacts—During the construction phase, heavy equipment, hauling operations, staging areas, and site preparation activities would create local temporary adverse visual effects through disturbance of soil resources and subsequent release of airborne dust locally.

Operations Impacts—Impacts of site development, which would involve clearing approximately 4 acres (1.6 hectares), would be visible to passing travelers on East Jemez Road. The area proposed for the Remote Warehouse and Truck Inspection Station would be visible to motorists along East Jemez Road because the project would require clearing trees, and the resulting buildings would be taller than most remaining trees. Some screening would be possible by selectively cutting trees closest to East Jemez Road and by placement of buildings on the site with regard to its topographic features. Nighttime lighting would be required in a location that was previously unlit. Although the Remote Warehouse and Truck Inspection Station would not be visible from the trails or parking lot at the Tsankawi Unit of Bandelier National Monument, the nighttime sky glow from Remote Warehouse and Truck Inspection Station lighting could be visible from Tsankawi under normal conditions. However, the trails at Tsankawi are closed to the public after dusk. Installed lighting would comply with the New Mexico Night Sky Protection Act to the extent it does not compromise security.

Geology and Soils

Only small faults at the western periphery of the area have been identified in TA-72, so the seismic hazard would be minimal. Soil resources in the area of the Remote Warehouse and Truck Inspection Station proposed location are undisturbed and maintain the present vegetative cover.

Construction Impacts—Construction of the Remote Warehouse and Truck Inspection Station in TA-72 is expected to require excavation of approximately 90,000 cubic yards (69,000 cubic meters) of soil and underlying Bandelier tuff. Soil resources that are excess to project needs would be stockpiled in approved areas. These soil and rock stockpiles could then be used at other locations at LANL for site restoration following remediation. If soil and rock stockpiles are to be stored for longer than a few weeks, the stockpiles would be seeded or managed as appropriate to prevent erosion and loss of the resource. In addition, care would be taken to employ all necessary erosion control best management practices during and following construction to limit impact on soil resources adjacent to the construction site.

Water Resources

The proposed Remote Warehouse and Truck Inspection Station location is approximately 1,500 feet (460 meters) east (downgradient) of Los Alamos County water supply well PM-3, and 3,100 feet (950 meters) west of water supply well PM-1. Both wells are located on the north side of East Jemez Road, along with the ephemeral streambed in Sandia Canyon. Both wells tap the regional aquifer. Regional groundwater occurs at approximately 900 feet (270 meters) below ground surface. Intermediate, perched groundwater occurs in portions of Sandia Canyon at a depth of approximately 450 feet (140 meters) below ground surface, but is not used as a resource.

Construction Impacts—No long-term effects on surface water quality would be likely. Best management practices for runoff control, such as silt barriers and straw bales, would be used during construction. The potential for downstream siltation would be minor and temporary in nature. A stormwater pollution prevention plan would be developed and implemented, including best management practices to prevent erosion of disturbed soil by stormwater runoff or other water discharges. All Remote Warehouse and Truck Inspection Station construction would occur on the south side of East Jemez Road. Therefore, there would be no impact on the Sandia Canyon floodplain and ephemeral watercourse, located on the north side of the road.

Operations Impacts—The addition of new impermeable surfaces would increase stormwater runoff and would decrease surface water infiltration. While decreased infiltration is not expected to have an adverse effect on groundwater quality, the increased amount of runoff from paved surfaces may have a slight effect on surface water quality and on residual contaminant transport within canyon sediments. Best management practices integrated as part of the site design would minimize the potential for sediment and residual contaminant transport. Removal of paved surfaces at the existing truck inspection station would help offset potential increases in runoff in Sandia Canyon due to proposed Remote Warehouse and Truck Inspection Station development.

Air Quality and Noise

Construction Impacts—Construction of the proposed Remote Warehouse and Truck Inspection Station would result in temporary, localized emissions associated with vehicle and equipment exhaust, as well as particulate (dust) emissions from excavation and construction activities. Total emissions of criteria pollutants and other air emissions associated with heavy-equipment operation for excavation and construction activities would be greater than for other vehicles due to the types of engines and their respective emission factors. Air emissions associated with excavation and construction equipment operation would not exceed ambient air quality standards. Emissions resulting from soil disturbance during construction would be controlled by best management practices, thereby causing no impacts on workers or the public.

The proposed project would result in limited short-term increases in noise levels associated with construction activities. Noise generated would not have an adverse effect on construction workers. Sound levels are expected to dissipate to background levels before reaching the Tsankawi parking lot at the intersection of NM 4 and East Jemez Road.

Operations Impacts—Effects of Remote Warehouse and Truck Inspection Station operations on air quality would be negligible compared to potential annual air pollutant emissions from LANL as a whole. Remote Warehouse and Truck Inspection Station operation could result in fewer emissions by consolidating delivery trucks and trips going to various points at LANL throughout the day. Operations would not cause any radiological air emissions.

The project would result in increased long-term noise levels associated with the proposed Remote Warehouse and Truck Inspection Station operation. Noise generated by the proposed project would not have an adverse effect on workers at the new facility once it is operating. Operational sound levels are expected to dissipate to background levels before reaching the Tsankawi parking lot at the intersection of NM 4 and East Jemez Road. Noise from the facility may be noticeable to the public on East Jemez Road; however, undisturbed wildlife habitats in the surrounding area would not be adversely impacted by the increased noise.

Ecological Resources

The proposed project site is situated within a mixed pinyon-juniper woodland and ponderosa pine forest due to its elevation and orientation that includes north-facing slopes. The area is not within an Area of Environmental Interest delineated for protection of the Mexican spotted owl, southwestern willow flycatcher, or the bald eagle. Other state-listed special status species would have a low probability of occurrence within the project area (LANL 2006a). Furthermore, there are no wetlands or aquatic resources within the project area (ACE 2005).

Construction Impacts—The proposed project would result in clearing and grading approximately 4 acres (1.6 hectares) of ponderosa pine forest and pinyon-juniper woodland. Much of the area around buildings would be paved, and an industrial security fence would be installed at the perimeter. The project area contains large-diameter trees (greater than 8 inches

[20 centimeters]), primarily ponderosa pines, that would potentially require removal for the proposed project construction.

Remote Warehouse and Truck Inspection Station construction would also result in loss of less-mobile wildlife, such as reptiles and small mammals, and cause more-mobile species, such as birds or large mammals, to be displaced. The success of displaced animals would depend on the carrying capacity of the area into which they moved. If the area were at its carrying capacity, displaced animals would not likely survive. Indirect impacts of construction, such as noise or human disturbance, could also impact wildlife living adjacent to the construction zone. Such disturbance would span the construction period. These impacts would be mitigated by clearly marking the construction zone to prevent equipment and workers from disturbing adjacent habitat.

As noted above, the site of the Remote Warehouse and Truck Inspection Station would not be located within Areas of Environmental Interest for the Mexican spotted owl, bald eagle, or southwestern willow flycatcher. However, recognizing that the bald eagle forages over all of LANL and that some habitat degradation is associated with the proposed project, the biological assessment prepared by DOE concluded that if appropriate reasonable and prudent alternatives are followed to protect adjacent foraging habitat (see Section G.2.3.2), the project may affect, but is not likely to adversely affect, the bald eagle. The biological assessment further concluded that the project would not effect the Mexican spotted owl or southwestern willow flycatcher (LANL 2006b). The USFWS has concurred with this assessment (see Chapter 6, Section 6.5.2).

Operations Impacts—Operation of the proposed Remote Warehouse and Truck Inspection Station would not likely pose significant adverse effects on most wildlife in this portion of Sandia Canyon. Activities would be restricted to within the facility grounds; therefore, most area wildlife would likely continue to use the area around the facility for foraging and migration after construction was complete.

Human Health

Construction Impacts—During Remote Warehouse and Truck Inspection Station construction, some construction-related accidents could potentially occur. The rate of occurrence for industrial accidents is based on both DOE and Bureau of Labor Statistics data on construction injuries and fatalities. Based on an estimated 281,000 person-hours to construct the new facilities, no fatal accidents would occur. The number of nonfatal injuries would be between 3 and 12 (DOE 2004, BLS 2003).

Cultural Resources

Three archaeological sites are situated in the vicinity of the proposed Remote Warehouse and Truck Inspection Station location. These sites include two rock rings and a lithic scatter. Each site was recommended by LANL for a determination of eligibility for the National Register of Historic Places.

In addition to the above-mentioned sites, two nearby National Historic Landmarks are located outside of the proposed project boundary. They include the Mortandad Cave Kiva National

Historic Landmark, accessed by the Mortandad Trail, and the Sandia Canyon Cave Kiva National Historic Landmark. There are no historic structures in the project area.

Construction Impacts—The planned East Jemez Road Remote Warehouse and Truck Inspection Station could impact the recorded prehistoric archaeological sites at the proposed location. Additional consultation would be required to ensure the sites are clearly marked such that the sites are avoided and that construction activity, traffic, and ground disturbances would not result in damage to the sites. If buried cultural deposits are encountered during construction, activities would cease, and procedures as set forth in *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico* would be implemented (LANL 2006c).

The Mortandad Trail, located east of the proposed project site, leads to the Mortandad Cave Kiva National Historic Landmark and is closed to public access except for organized tours. Although the proposed project would not affect normal access to the trail, it would incorporate fencing around the perimeter of the Remote Warehouse and Truck Inspection Station to protect sensitive areas, including the Mortandad Cave Kiva National Historic Landmark, from unauthorized increased visitation.

Socioeconomics and Infrastructure

Currently, there are no NNSA facilities at the site. In the vicinity of the proposed project area, there are no utilities on the north side of East Jemez Road. However, there are existing aboveground electrical distribution lines, underground water transmission lines (and water pumping wells), and underground telecommunications along the north side of East Jemez Road in the vicinity of the proposed Remote Warehouse and Truck Inspection Station.

Construction—Utility infrastructure resources would be needed for Remote Warehouse and Truck Inspection Station construction. Standard construction practice dictates that electric power needed to operate portable construction and supporting equipment be supplied by portable diesel-fired generators. Therefore, no electrical energy consumption would be directly associated with construction. A variety of heavy equipment, motor vehicles, and trucks would be used requiring diesel fuel, gasoline, and propane for operation. Liquid fuels would be brought to the site as needed from offsite sources and, therefore, would not be limited resources. Water would be needed primarily to provide dust control, aid in soil compaction at the construction site, and possibly for equipment washdown. Water would not be required for concrete mixing, as ready-mix concrete is typically procured from offsite resources. Portable sanitary facilities would be provided to meet the workday sanitary needs of project personnel on the site. Water needed for construction would typically be trucked to the point of use, rather than provided by a temporary service connection. Construction is estimated to require 420,000 gallons (1.6 million liters) of liquid fuels and approximately 2 million gallons (7.6 million liters) of water.

The existing LANL infrastructure would be capable of supporting the requirements for new facility construction without exceeding site capacities, resulting in a negligible impact on site utility infrastructure.

Operations Impacts—Development of the proposed Remote Warehouse and Truck Inspection Station Project would require addition of a natural gas line, extended from the intersection of

East Jemez Road and NM 4, east of the proposed site. In addition, a means of sanitary sewer treatment, conveyance, and disposal would be required for the proposed facility. Onsite disposal of sanitary wastes in this area would be intensive if a conventional leach field is used. Onsite disposal would require an New Mexico Environment Department groundwater discharge permit to ensure local groundwater resources are not adversely impacted. An option of local treatment with surface discharge to the Sandia Canyon watercourse would require modification to the LANL NPDES permit.

Waste Management

There are currently no LANL operations located at the site, and therefore no waste volumes are produced. However, the activities that would be relocated to the Remote Warehouse and Truck Inspection Station currently produce waste at other LANL locations. There would be no change to overall waste types or volumes.

Construction Impacts—Based on the scope of the proposed project and historical projects at LANL, it is estimated that approximately 610 cubic yards (470 cubic meters) of solid waste would be generated during construction. The solid waste from construction would be recycled or disposed of at a permitted solid waste landfill.

Operations Impacts—Wastes from operations that would be moved to the new warehouse site under the proposed project would generally be of the same types and quantities as those generated at the current warehouse, TA-3-30. No new radioactive or other wastewater or hazardous waste streams would be generated.

Under the proposed project, sanitary waste from the existing warehouse site (SM-30) would no longer be discharged to the Sanitary Wastewater System Plant (TA-46). Due to the Remote Warehouse and Truck Inspection Station location, sanitary sewage from the facility may require onsite treatment, which could result in permitted discharges from a new treatment system. The total volume of sanitary waste generated, treated, and disposed of at LANL would remain unchanged.

Transportation

The TA-3 area where the warehouse functions are presently located is accessed from Pajarito Road, East and West Jemez Roads, and Diamond Drive. Trucks going to LANL must use East Jemez Road and stop at the current truck inspection station at the NM 4 intersection.
Los Alamos County peak period traffic volumes and resulting congestion are greatly influenced by LANL (as it is the main employer in Los Alamos County), existing roadway network constraints, the Pajarito Plateau topography, and operational access restrictions. A traffic study was conducted in support of the proposed Remote Warehouse and Truck Inspection Station (LSC 2005a). The study reports existing average weekday peak-hour traffic along East Jemez Road in the proposed project area to be about 175 eastbound and 995 westbound vehicle trips in the morning and about 1,260 eastbound and 205 westbound vehicle trips in the afternoon.

East Jemez Road lies within the LANL site boundary and is under NNSA control. It serves as the primary public access road between LANL and White Rock and to locations west of

Los Alamos County. An access control station would be built on East Jemez Road close to Diamond Drive to screen all vehicles entering LANL from these roads. The only access to TA-53 (LANSCE) is along East Jemez Road. The Los Alamos County Landfill and proposed future waste transfer station and Royal Crest Trailer Park are also accessed by East Jemez Road. There are no sidewalks or improved bicycle lanes along East Jemez Road. Long-range transportation plans for TA-53 propose a secondary access road descending from the mesa, with an intersection across from the general proposed project area.

Operations Impacts—The traffic study evaluated the impact of the 125-employee Remote Warehouse and Truck Inspection Station on traffic along East Jemez Road for two different scenarios: a two-lane and a four-lane East Jemez Road (LSC 2005a). Traffic impact was evaluated in terms of level of service, a quantitative measurement indicative of the level of delay and congestion at an intersection, ranging from A to F (level of service A being very little congestion or delay, while level of service F is a high level of congestion or delay). The Remote Warehouse and Truck Inspection Station is projected to generate nearly 540 vehicle trips on the average weekday, with about 270 vehicles entering and 270 exiting in a 24-hour period. These vehicle trips would be moved from the existing access (to the east) to the proposed Remote Warehouse and Truck Inspection Station access. The shooting range is expected to generate about 100 vehicle trips on the average weekday, with about 50 vehicles entering and 50 exiting in a 24-hour period.

Under the two-lane East Jemez Road scenario, with shooting-range-site-generated traffic and the addition of the Remote Warehouse and Truck Inspection Station, the East Jemez Road and site access intersection (without a traffic signal) is projected to operate at a failing level of service (level of service F) for east- and westbound traffic during the afternoon peak hour. The entrance to the shooting range would also potentially become a part of the intersection, with the warehouse entrance and the estimated number of vehicles entering and exiting taken into account in estimating potential traffic impacts. Under the four-lane East Jemez Road scenario, with the addition of the distribution center to existing shooting-range-site-generated traffic, the East Jemez Road and site access intersection (without a traffic signal) would operate at an acceptable level of service during short-term peak hours (LSC 2005a).

The traffic study concluded that changes to roadway geometry, to include left-turn lanes and acceleration lanes for east- and westbound traffic on East Jemez Road, would be required to achieve an acceptable level of service for vehicles on East Jemez Road and vehicles entering the road from the proposed combined access intersection. Although truck and other traffic would increase at TA-72 relative to current levels, the proposed project could result in reduced traffic in and around TA-3 because deliveries would be consolidated for specific sites at LANL.

Facility Accidents

Operations Impacts—The Remote Warehouse and Truck Inspection Station would process and distribute all types of deliveries to LANL, including conventional mail and packages and some hazardous, biological, and radioactive materials. Locating the facilities along East Jemez Road in Sandia Canyon would isolate them from any residential or work areas in the event of an accidental release. East Jemez Road is the designated truck route for Los Alamos County and LANL.

The operational hazards of the proposed project have been previously assessed in the *1999 SWEIS* (DOE 1999a) at the current locations of those operations. Most operations proposed for the Remote Warehouse and Truck Inspection Station were eliminated from further analysis in the SWEIS on the basis of hazard categorization; it was determined that no hazards existed beyond those routinely encountered in an office or standard industrial laboratory environment. Because there would be no substantial changes (such as in quantities of hazardous materials at risk) in operations from implementing the proposed project, potential outcomes of accidents involving operations-related hazards would be bounded by the operational hazard analyses in the SWEIS.

G.10 References

ACE (U.S. Army Corps of Engineers) 2005, *Wetlands Delineation Report, Los Alamos National Laboratory, Los Alamos, New Mexico*, Albuquerque, District, Albuquerque, New Mexico, October.

BLS (Bureau of Labor Statistics), 2003, *Incidence Rates of Nonfatal Occupational Injuries and Illnesses in 2003*, U.S. Department of Labor, Washington, DC.

Booth, S., 2004, *Site Options Study for New Warehouse at Los Alamos National Laboratory*, LA-UR-04-1283, Los Alamos National Laboratory, Los Alamos, New Mexico, February.

DOE (U.S. Department of Energy), 1996, *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*, DOE/EIS-0236, September.

DOE (U.S. Department of Energy), 1998, *Environmental Assessment for the Proposed Strategic Computing Complex, Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1250, Los Alamos Area Office, Los Alamos, New Mexico, December 18.

DOE (U.S. Department of Energy), 1999a, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 1999b, *DOE Standard, Radiological Control*, DOE-STD-1098-99, Washington, DC, July.

DOE (U.S. Department of Energy), 1999c, *Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico*, DOE/EIS-0293, Los Alamos Area Office, Los Alamos, New Mexico, October.

DOE (U.S. Department of Energy), 2000, *Special Environmental Analysis for the Department of Energy, National Nuclear Security Administration, Actions Taken in Response to the Cerro Grande Fire at Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/SEA-03, Los Alamos Area Office, Los Alamos, New Mexico, September.

DOE (U.S. Department of Energy), 2002a, *DOE Standard, Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, DOE-STD-1020-2002 (January), supersedes DOE-STD-1020-94 (April 1994), Washington, DC, January.

DOE (U.S. Department of Energy), 2002b, *Environmental Assessment for the Proposed Construction and Operation of a Biosafety Level 3 Facility at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1364, National Nuclear Security Administration, Office of Los Alamos Site Operations, February 26.

DOE (U.S. Department of Energy), 2002c, *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory*, DOE/EIS-0319, National Nuclear Security Administration, Washington, DC, August.

DOE (U.S. Department of Energy), 2003, *Final Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0350, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, November.

DOE (U.S. Department of Energy), 2004, *DOE and Contractor Facility Incident Rates,* Office of Environment, Safety, and Health, Washington, DC.

DOE (U.S. Department of Energy), 2005, *DOE Order 420.1B, Facility Safety*, Office of Environment, Safety and Health, Washington, DC, December 22.

Gardner, J. N, A. Lavine, G. WoldeGabriel, D. Krier, D. Vaniman, F. Caporuscio, C. Lewis, P. Reneau, E. Kluk, and M. J. Snow, 1999, *Structural Geology of the Northwestern Portion of Los Alamos National Laboratory, Rio Grande Rift, New Mexico: Implications for Seismic Surface Rupture Potential from TA-3 to TA-55*, LA-13589-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, March.

Knight, Terry, and W. Bruce Masse, 2001, *Identification and Management of Native American Traditional Cultural Properties at Los Alamos National Laboratory*, LA-UR-01-1354, Los Alamos, New Mexico, available at http://www.esh.lanl.gov/~esh20/pdfs/MasseKnight.pdf.

LANL (Los Alamos National Laboratory), 1998, *Threatened and Endangered Species Habitat Management Plan Overview*, LA-LP-98-112, ESH-20, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 2000, *Threatened and Endangered Species Habitat Management Plan, Site Plans*, LA-UR-00-4747, Los Alamos, New Mexico, April.

LANL (Los Alamos National Laboratory), 2001, *Comprehensive Site Plan 2001*, LA-UR-01-1838, Los Alamos, New Mexico, April 13.

LANL (Los Alamos National Laboratory), 2002a, *Site + Architectural Design Principles*, LA-UR-01-5383, Site Planning and Development Group, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2002b, *LANL Sustainable Design Guide*, LA-UR-02-6914, Site and Project Planning Group, Los Alamos, New Mexico, December.

LANL (Los Alamos National Laboratory), 2003a, *Facility-Wide Air Quality Impact Analysis*, LA-UR-03-3983, Meteorology and Air Quality Group, Environmental Stewardship Division, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2003b, *SWEIS Yearbook—2002, Comparison of 1998 to 2002 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-03-5862, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2003c, *Physics Facility Strategic Plan*, LA-UR-03-8251, Physics Division, Los Alamos, New Mexico, November 5.

LANL (Los Alamos National Laboratory), 2004a, *Statement of Mission Need and Project Description for Refurbishment of the Los Alamos Neutron Science Center (LANSCE-R)*, LA-UR-04-1350, May 21.

LANL (Los Alamos National Laboratory), 2004b, "Section G10 Site Preparation," *Engineering Standards Manual*, OST220-03-01-ESM, Revision 1, Los Alamos, New Mexico, August 16.

LANL (Los Alamos National Laboratory), 2004c, *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement (DOE/EIS-0238)*, LA-UR-04-5631, Ecology Group, Los Alamos, New Mexico, August 17.

LANL (Los Alamos National Laboratory), 2004d, *SWEIS Yearbook—2003, Comparison of 2003 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-04-6024, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005a, *2004 LANL Radionuclide Air Emissions*, LA-14233, Los Alamos Site Office, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2005b, *LANSCE Refurbishment Project: Mission Need Statement, Non-Major System Acquisition Project*, LA-UR-05-4040, Los Alamos, New Mexico, June 1.

LANL (Los Alamos National Laboratory), 2005c, *SWEIS Yearbook—2004, Comparison of 2004 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-05-6627, Ecology Group, Environmental Stewardship Division, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2005d, *Los Alamos National Laboratory Wildland Fire Management Plan, Management Review Draft*, LA-UR-05-0286, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005e, *Pollution Prevention Project, Radioactive Liquid Waste Treatment Facility (RLWTF), Influent Boundary Condition Assessment,* Revision 2.0, LA-UR-05-9001, Los Alamos, New Mexico, November.

LANL (Los Alamos National Laboratory), 2005f, Conceptual Design Report for the TA-50 Radioactive Liquid Waste Treatment Facility Upgrade Project (90%), *Final Waste Management Plan*, Prepared by DJMJ Holmes and Narver.

LANL (Los Alamos National Laboratory), 2006a, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document*, Data Call Materials, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006b, *Biological Assessment of the Continued Operation of Los Alamos National Laboratory on Federally Listed Threatened and Endangered Species*, LA-UR-06-6679, Ecology and Air Quality Group (ENV-EAQ), Los Alamos Site Office, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006c, *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico*, LA-UR-04-8964, Ecology Group, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2006d, *Environmental Surveillance at Los Alamos during 2005*, LA-14304-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006e, *Emissions Inventory Report Summary for Los Alamos National Laboratory for Calendar Year 2005*, LA-14309-SR, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory) 2006f, *SWEIS Yearbook—2005, Comparison of 2005 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-06-6020, Risk Reduction Office, Environmental Protection Division, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2007, *Update of the Probabilistic Seismic Hazard Analysis and Development of Seismic Design Ground Motions at the Los Alamos National Laboratory*, LA-UR-07-3965, Los Alamos, New Mexico, May.

LSC (LSC Transportation Consultants, Inc.), 2005a, *LANL Distribution Center Traffic Impact and Access Analysis*, Colorado Springs, Colorado, November 15.

LSC (LSC Transportation Consultants Inc.), 2005b, *LANL Science Center Traffic Impact and Access Analysis*, Colorado Springs, Colorado, November 15.

NMED (New Mexico Environment Department), 2005, Compliance Order on Consent Proceeding Under the New Mexico Hazardous Waste Act Section 74-4-10 and the New Mexico Solid Waste Act Section 74-9-36(D), March 1.

NNSA (National Nuclear Security Administration), 2001, *Environmental Assessment for Construction and Operation of a New Office Building and Related Structures within TA-3 at Los Alamos National Laboratory, Los Alamos, New Mexico*, NNSA/EA-1375, Los Alamos Area Office, Los Alamos, New Mexico, July 26.

USGBC (U.S. Green Building Council), 2006, "LEED for New Construction," Available at http://www.usgbc.org/LEED, Accessed April 10.

APPENDIX H

IMPACTS ANALYSES OF CLOSURE AND REMEDIATION ACTIONS

APPENDIX H
IMPACTS ANALYSES OF CLOSURE AND REMEDIATION ACTIONS

Appendix H presents project-specific analyses for three proposed projects related to closure and remediation that would be initiated within the timeframe under consideration in the *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (SWEIS):

- Technical Area (TA) 18 Closure, including remaining Operations Relocation, and Structure Decontamination, Decommissioning, and Demolition (DD&D);
- TA-21 Structure Decontamination, Decommissioning, and Demolition; and
- Waste Management Facilities Transition.

Each of these proposed projects would either: (1) generate potentially large volumes of wastes from exhumations or DD&D activities; or (2) require the installation of closure covers and subsequent long-term monitoring of areas at Los Alamos National Laboratory (LANL) where it is proposed that waste be left in place. Additionally, one project would also provide facilities necessary for the safe management of newly generated waste. The proposed timeframes associated with construction, DD&D, and closure activities for these projects are depicted in **Figure H–1**. Analyses in this appendix consider projects proposed for the period 2007 through 2011, but would equally apply to actions beyond 2011 as long as the actions are bounded by the analyses in the appendix.

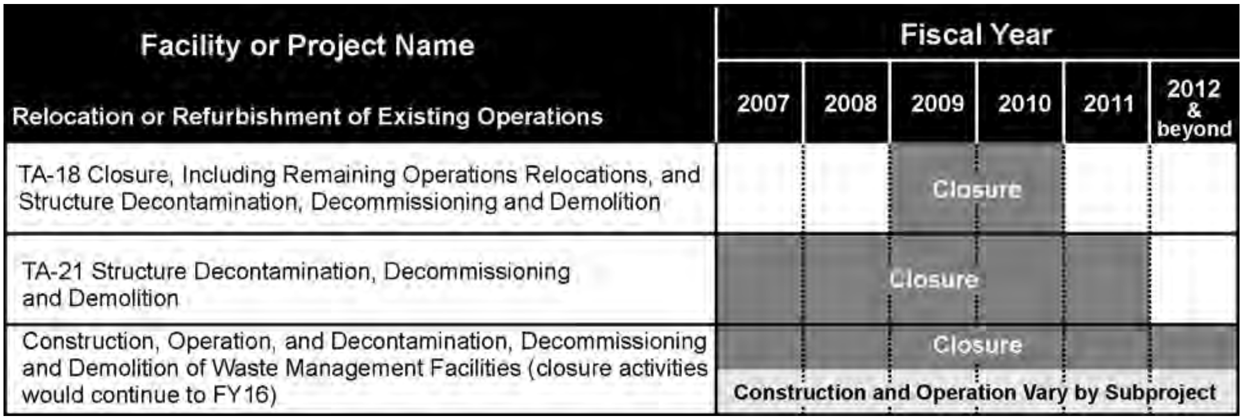


Figure H–1 Proposed Timeframes for Construction and Operation of Closure and Remediation Actions

DD&D activities are governed by a series of guidelines and procedures specified in U.S. Department of Energy (DOE) implementation guides DOE G-430.1-2, -3, -4, and -5, and by DOE-STD-1120-2005, that addresses integration of safety and health into disposition of facilities. LANL staff carefully plan all work to ensure compliance with established state and Federal laws and regulations (such as National Emissions Standards for Hazardous Air Pollutants [NESHAP]), DOE Orders, and Compliance Agreements, and in accordance with LANL procedures and best management practices. Depending on the project, LANL staff may choose to perform the DD&D work with site personnel or subcontract all or portions of the project. For the purpose of this description, both LANL and subcontractor personnel are considered DD&D workers. The National Nuclear Security Administration (NNSA) develops detailed project-specific work plans for the DD&D of structures before any actual work can begin.

Management and support activities associated with DD&D projects that parallel these elements include overall project management, DD&D work planning and engineering, characterization, authorization basis, radiological and safety technical support, waste and traffic management, cost and schedule management, program waste management planning, utilities and infrastructure management, and building surveillance and maintenance prior to and during DD&D. In particular, planning activities include preparation of implementation plans, safety documents, waste management plans, and procedures; engineering reviews and evaluations; readiness reviews and verification; and closure surveys and reports. LANL staff implement activity planning to support work control and worker safety using the Integrated Safety Management process, and limits exposure to workers based on an administrative control level of 500 millirem per year and as low as reasonably achievable (ALARA) principles.

Every DD&D project shares several common stages described in the following text box. The project-specific DD&D information related to each of the three proposed projects are detailed in subsequent sections of this appendix.

The ultimate disposition of the facilities constructed by the projects in this appendix would be considered at the end of their operations, usually several decades after their construction. The designs for the facilities that would support missions involving radioactive and hazardous materials are required to consider life-cycle features including eventual facility DD&D. It is anticipated that the impacts from the eventual disposition of the newly-constructed facilities would be similar or less than the impacts resulting from the disposition of the facilities that they replace.

Waste Management and Pollution Prevention Techniques. Waste management and pollution prevention techniques that could be implemented during the DD&D of the buildings and structures would include:

- Conducting routine briefings of workers.
- Segregating wastes at the point of generation to avoid mixing and cross-contamination.
- Decontaminating and reusing equipment and supplies.
- Removing surface contamination from items before discarding.
- Avoiding use of organic solvents during decontamination.
- Using drip, spray, squirt bottles or portable tanks for decontamination rinses.
- Using impermeable materials such as plastic liners or mats and drip pallets to prevent the spread of contamination.

Decommission, Decontamination and Demolition Work Elements

Deactivation (a preliminary step to DD&D): Materials and equipment to be reused would be relocated, and accountable materials would be collected and transferred to other locations for storage. Additional actions could be draining liquids from tanks and removing high levels of contamination. The structure may be placed in a surveillance and maintenance status. After deactivation, the structure may undergo DD&D or be reused.

Removal of Process Equipment (a preliminary step to DD&D): Equipment would be cut up or removed. This may include ventilation systems and process lines. The process equipment would either be reused or packaged for disposal.

Characterization, Segregation of Work Areas, and Structural Evaluation: Walls, floors, ceilings, roof, equipment, ductwork, plumbing and other components within each building and site element would be tested to determine the type and extent of contamination present. The buildings and structures would then be segregated into areas of contamination and no contamination. Contaminated areas would be further subdivided by the type of contamination: radioactive materials, hazardous materials, toxic materials including asbestos, and any other Resource Conservation and Recovery Act listed or characteristic contamination. As part of the characterization and segregation of work areas, consideration would also be given to the structural integrity. Some areas could require demolition work prior to decontamination.

Removal of Contamination: Workers would remove or stabilize contamination according to the type and condition of materials. If the surface of a floor or wall were found to be contaminated, it might be physically stripped off. If contamination were found within a wall, a surface coating might be applied to keep the wall from releasing contaminated dust during dismantlement and to keep the surface intact.

Demolition of the Structures, Foundation, and Parking Lot: After contaminated materials have been removed, wherever possible and practical, the demolition of all or portions of the structure would begin. Demolition could involve simply knocking down the structure and breaking up any large pieces. Knocking down portions of the building, foundation, and parking lot could require the use of backhoes, front-end loaders, bulldozers, wrecking balls, shears, sledge and mechanized jack hammers, cutting torches, saws, and drills. If not contaminated, demolition material could be reused onsite at LANL or disposed of as construction waste onsite or offsite. Asphalt would be placed in containers and trucked to established storage sites within LANL, at TA-59 on Sigma Mesa.

Segregating, Packaging, and Transport of Debris: Demolition debris from the structures would be segregated and characterized by size, type of contamination, and ultimate disposition. Debris that is still radiologically contaminated would be segregated as low-level radioactive waste if no hazardous[1] contamination were present. Other types of debris that would be segregated include mixed low-level radioactive waste,[2] noncontaminated construction debris, and debris requiring special handling. Segregation activities could be conducted on a gross scale using heavy machinery or could be performed on a smaller scale using hand-held tools. Segregated waste would be packaged as appropriate and stored temporarily pending transport to an appropriate onsite or offsite disposal facility.

Debris would be packaged for transport and disposal according to waste type, characterization, ultimate disposition, and U.S. Department of Transportation (DOT) or DOE transportation requirements. Uncontaminated construction debris could be sent unpackaged to the local landfill by truck. Demolition debris would also be recycled or reused to the extent practicable. Debris would be disposed of either on or offsite depending on the available capacity of existing disposal facilities. Offsite disposal would involve greater transportation requirements depending on the type of waste, packaging, acceptance criteria, and location of the receiving facility.

Testing and Cleanup of Soil and Contouring and Seeding: The soils beneath the buildings would be sampled and tested for contamination. Any contaminated soil would undergo cleanup per applicable environmental regulations and permit requirements and would be packaged and transported to the appropriate disposal facility depending on the type and concentration of contamination. After clean fill and soil were brought to the site as needed, the site would be contoured. Contouring would be designed to minimize erosion and replicate or blend in with the surrounding environment. Subsequent seeding activities would use native plant seeds and the seeds of non-native cereal grains selected to hold the soil in place until native vegetation becomes stabilized.

[1] *Hazardous waste is a category of waste regulated under the Resource Conservation and Recovery Act (RCRA). Hazardous RCRA waste must be solid and exhibit at least one of four characteristics described in 40 Code of Federal Regulations (CFR) 261.20 through 40 CFR 261.24 (ignitability, corrosivity, reactivity, or toxicity) or be specifically listed by the U.S. Environmental Protection Agency in 40 CFR 261.31 through 40 CFR 261.33.*

[2] *Mixed low-level radioactive waste contains both hazardous RCRA waste and source, special nuclear, or byproduct material subject to the Atomic Energy Act.*

- Avoiding areas of contamination until they are due for decontamination.
- Reducing waste volumes (by such methods as compaction).
- Engaging in the use of recycling actions (materials such as lead, scrap metals, and stainless steel could be recycled to the extent practical).

Some of the wastes generated from the DD&D of the buildings would be considered residual radioactive material. DOE Order 5400.5 establishes guidelines, procedures, and requirements to enable the reuse, recycling, or release of materials that are below established limits. Materials that are below these limits are acceptable for use without restrictions. The residual radioactive material that would be generated by DD&D would include uncontaminated concrete, soil, steel, lead, roofing material, wood, and fiberglass. The concrete material could be crushed and used as backfill at LANL. Soil could also be used as backfill or as topsoil cover, depending on its characteristics. Steel and lead could be stored and reused or recycled at LANL. Wood, fiberglass, and roofing materials would be disposed of at the Los Alamos County Landfill or other available landfills.

H.1 Technical Area 18 Closure, Including Remaining Operations Relocation, and Structure Decontamination, Decommissioning, and Demolition Impacts Assessment

This section provides an impacts assessment for the closure of TA-18, including the disposition of the remaining TA-18 Security Category III and IV capabilities and materials[1], a decision that was deferred in the Record of Decision (ROD) (67 *Federal Register* [FR] 79906) for the *Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory* (DOE/EIS-0319) (*TA-18 Relocation EIS*), and the DD&D of the buildings and structures at TA-18. Section H.1.1 provides background information and the purpose and need for the relocation of TA-18 Security Category III and IV capabilities and materials, the proposed actions for the disposition of the remaining Security Category III and IV operations and materials, and DD&D activities. Section H.1.2 provides a brief description of the proposed options for the disposition of the remaining Security Category III and IV capabilities and materials. Section H.1.3 describes the affected environment and presents an impacts assessment for both the disposition of the remaining Security Category III and IV capabilities and materials and for the DD&D of buildings at TA-18. Chapter 4 of this SWEIS presents a description of the affected environment at LANL and TA-18. Any unique characteristics of LANL and TA-18 not covered in Chapter 4 that would be affected by the proposed TA-18 closure, relocation of remaining TA-18 operations and subsequent DD&D of TA-18 buildings, are presented here.

Descriptions and impact analyses in this section are based on the status of TA-18 facilities and activities as of approximately the end of 2005. Facility status continues to change at TA-18 as NNSA implements the decisions made in the ROD for the *TA-18 Relocation EIS* (DOE/EIS-0319). Activities that could affect the descriptions included in this section include the following:

---

[1] *This Security Category description refers to the required level of safeguards and security as established in DOE Order 470.4 and its manual, DOE M 470.4-6.*

- transitioning of radiation sources to TA-55,
- removing special nuclear fuel from criticality machines and undertaking activities to prepare the machines for transfer to the Nevada Test Site Device Assembly Facility,
- removing and relocating materials from TA-18 storage areas, and
- removing accelerators and related sources and support equipment.

Performance of these activities does not affect the environmental impacts analysis presented in Section H.1.3.

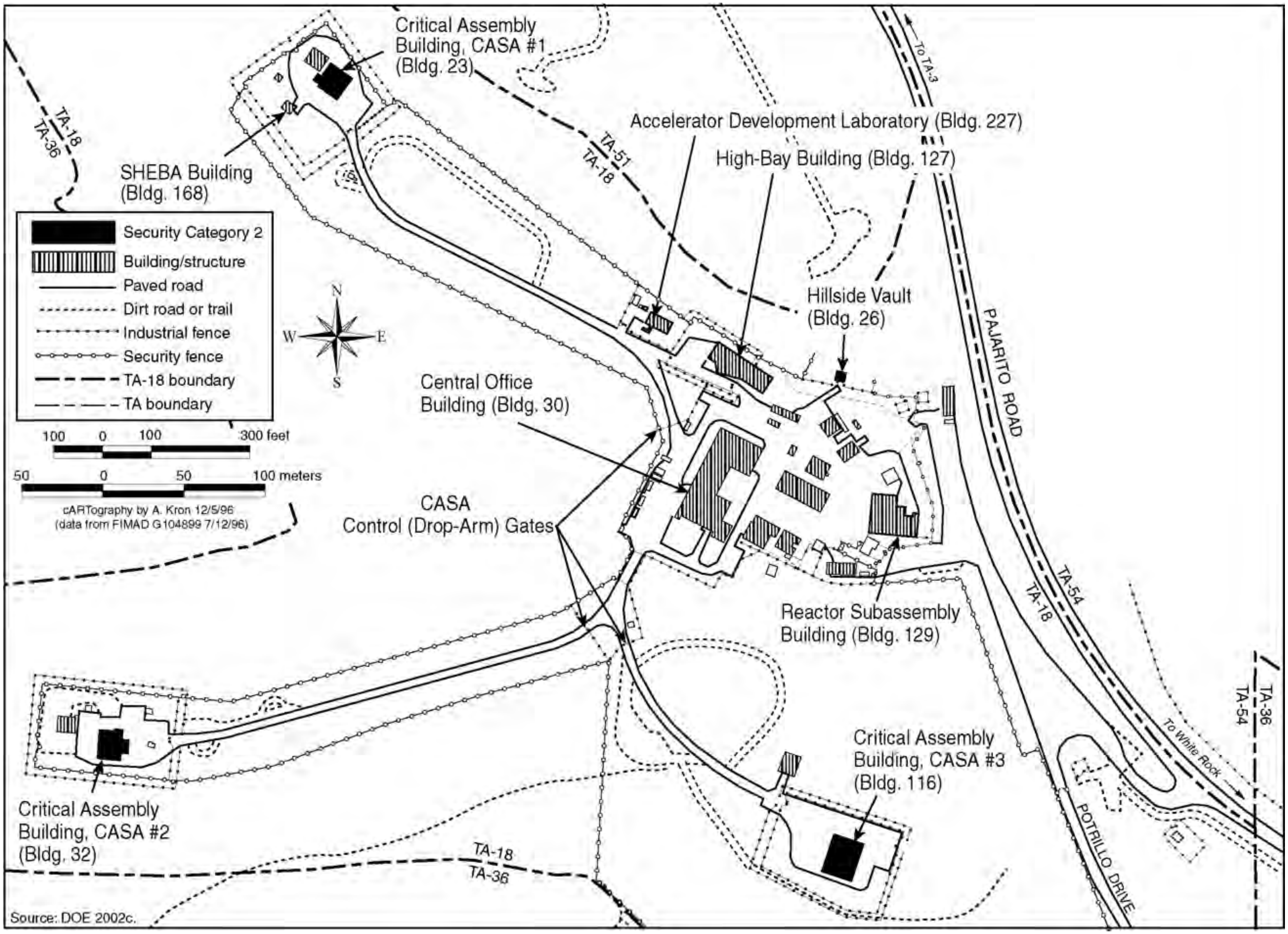
H.1.1 Introduction and Purpose and Need for Agency Action

This section provides background information on the relocation of TA-18 Security Category I, II, III, and IV capabilities and materials, the proposed actions for the disposition of the remaining Security Category III and IV operations and materials, and DD&D activities.

Background

NNSA is responsible for providing the Nation with nuclear weapons, ensuring the safety and reliability of those nuclear weapons, and supporting programs that reduce global nuclear proliferation (LANL 2005f). One of the major training facilities supporting these missions is located at TA-18. The principal TA-18 operation has been research in the design, development, construction, and application of nuclear criticality experiments. The operations at TA-18 enable DOE personnel to gain knowledge and expertise in advanced nuclear technologies that support the following: (1) nuclear materials management and criticality safety; (2) emergency response in support of counterterrorism activities; (3) safeguards and arms control in support of domestic and international programs to control excess nuclear materials; and (4) criticality experiments in support of Stockpile Stewardship and other programs.

TA-18 is located at the Pajarito Site and contains about 60 structures totaling about 80,000 square feet (7,432 square meters) (see **Figure H–2**). The TA-18 buildings and infrastructure, some of which have been operational since 1946, range from 30 to more than 50 years of age and are increasingly expensive to maintain and operate. NNSA prepared an environmental impact statement (EIS) for relocating the TA-18 capabilities and materials in 2002. In its December 31, 2002 ROD (67 FR 79906) for the *TA-18 Relocation EIS*, NNSA decided to relocate Security Category I and II capabilities and related materials to the Device Assembly Facility at the Nevada Test Site (DOE 2002b). This alternative included transportation of special nuclear materials and equipment required to support Security Category I and II capabilities. NNSA did not issue a decision regarding the future location of TA-18 Security Category III and IV capabilities and materials within the LANL site, or the disposition of the TA-18 facilities.



Source: DOE 2002c.

Figure H–2 Technical Area 18 Pajarito Site

SPECIAL NUCLEAR MATERIALS SAFEGUARDS AND SECURITY

(DOE Manual 470.4-6)

Special nuclear materials are defined in the Atomic Energy Act of 1954 as (1) plutonium, uranium enriched in the isotope 233 or 235, or any other material designated as special nuclear material; or (2) any material artificially enriched by any of the above.

DOE's policy is to protect national security and the health and safety of DOE and contractor employees, the public, and the environment by protecting and controlling special nuclear material. This is accomplished by designing specific safeguards and security strategies to prevent or minimize both unauthorized access to special nuclear material and unauthorized disclosure, loss, destruction, modification, theft, compromise, or misuse of special nuclear material as a result of terrorism, sabotage, or events such as disasters and civil disorders.

DOE uses a cost-effective, graded approach to providing special nuclear material safeguards and security. Quantities of special nuclear material stored at each DOE site are categorized into Security Categories I, II, III, and IV, with the greatest quantities included under Security Category I and lesser quantities included in descending order under Security Categories II through IV. Types and compositions of special nuclear material are further categorized by their "attractiveness," that is, the relative ease of the processing and handling activities required to convert such materials into a nuclear explosive device. For example, assembled weapons and test devices fall under Attractiveness Level A. Pure products (metal items that can be used for weapons production in their existing form or after simple mechanical processing) are categorized under Attractiveness Level B. High-grade special nuclear material (high-grade chemical compounds, mixtures, or metal alloys that require relatively little processing to convert them for weapons use) and low-grade special nuclear material (bulk and low-purity materials that require extensive or complex processing efforts to convert them to metal or high-grade form) are categorized as Levels C and D, respectively. All other special nuclear material (highly radioactive special nuclear material not included under another attractiveness level, solutions containing very small amounts of special nuclear material, uranium enriched to less than 20 percent uranium-235, etc.) fall under Level E. This alphanumeric system results in overall categories ranging from Security Category IA (weapons and test devices in any quantities) to Security Category IV (reportable quantities of special nuclear material not included in other categories).

Implementation of the ROD to relocate Security Category I and II capabilities and materials was initiated in 2004. In October 2005, TA-18 was de-inventoried below Security Category I and II levels. More than half of the programmatic special nuclear material was transported to the Device Assembly Facility at the Nevada Test Site. The remaining portion was transferred to TA-55 for temporary storage and excess special nuclear material was sent to Y-12 for disposition. The planning assumptions for this SWEIS are:

- TA-18 would continue to support limited Security Category III and IV capabilities through September 2008.
- TA-18 operations would cease by the end of September 2008, and the facility would be turned over for disposition.

Until closed, the major programs using TA-18 facilities would be the Defense Nuclear Nonproliferation and the Nuclear Criticality Safety Programs. Defense Nuclear Nonproliferation Program elements include International Atomic Energy Agency and second line of defense training support. After 2006, the International Atomic Energy Agency training program would be performed at other LANL facilities. The Defense Nuclear Nonproliferation Program would continue to conduct experiments to support second line of defense and nuclear nonproliferation research and development testing at TA-18 until other locations within LANL become available.

After the removal of Security Category I and II equipment and material, the only critical assembly that remains operational at TA-18 would be the Solution High-Energy Burst Assembly (SHEBA) in its Security Category III configuration. The Nuclear Criticality Safety Program would continue to operate SHEBA at TA-18 to maintain the capabilities for training and criticality experiments. NNSA will analyze, through separate National Environmental Policy Act (NEPA) action, the relocation of SHEBA from TA-18 to another site.

TA-18 has also been used to store sealed radiation sources returned to the NNSA under the Global Threat Reduction Initiative until they can be disposed of at the Waste Isolation Pilot Plant (WIPP) in New Mexico. LANL would continue to store radiation sources at TA-18, but over time would transition the staging to an area at TA-55 or other LANL locations (for example, at TA-54) for temporary storage pending disposition at WIPP.

NNSA plans to relocate some capabilities and materials from TA-18 to the Nonproliferation and International Security Center in TA-3, which currently houses personnel that support Defense Nuclear Nonproliferation Program activities. This facility can accept Security Category IV material.

The main facilities consist of three remote-controlled Critical Assembly Storage Areas, or CASAs, (Buildings 23, 32, and 116) and a separate weatherproof shelter near Building 23 that houses SHEBA (Building 168). These buildings are located some distance from the main laboratory (Building 30) that houses individual control rooms for the remote-controlled critical assemblies. A security fence surrounds each CASA. The following text describes the primary buildings addressed in this project-specific analysis (DOE 2002b).

Building 23 (CASA 1)

CASA 1 was built in 1947. The CASA 1 experimental operations area is best described as cuboid. The interior dimensions are 30 feet (9.1 meters) wide by 48 feet (14.6 meters) long by 26 feet (7.9 meters) high. The walls of CASA 1 are constructed with standard hollow 8-inch (20.3-centimeter) by 8-inch (20.3-centimeter) by 46-inch (116.8-centimeter) concrete masonry blocks. The concrete masonry block walls are reinforced with 0.375-inch- (0.95-centimeter-) diameter reinforcing steel placed at 24 inches (61 centimeters) on center in both the vertical and horizontal directions. At a height of 16 feet (4.9 meters), the concrete blocks are replaced with glass block panels. These panels are constructed from regular 7.75-inch (19.7-centimeter) by 7.75-inch (19.7-centimeter) by 3.875-inch (9.84-centimeter) glass blocks. The west and east walls have one centrally located panel approximately 8 by 22 feet (2.4 by 6.7 meters), while the north and south wall each have three panels approximately 7.42 feet by 15.33 feet (2.3 meters by 4.7 meters). The roof is a 4-inch- (10.2-centimeter-) thick concrete slab. The floor is an 8-inch- (20.3-centimeter-) thick concrete slab with a 6-inch- (15.2-centimeter-) square reinforcing mesh of number 6 wires. The eastern wall has a 12 by 14 foot (3.7 by 4.3 meter) electrically operated ballistic-steel door.

In addition, four 3 foot (0.9 meter) by 7 foot (2.1 meter) personnel doors penetrate the CASA 1 experimental area walls (two in the south wall and one each in the east and west wall). CASA 1 houses a general-purpose criticality experiment remote critical assembly machine. This machine does not contain permanently mounted nuclear fuel, and will remain in this building until relocation to the Device Assembly Facility at the Nevada Test Site.

Building 32 (CASA 2)

CASA 2 was built in 1952. It is a single-bay laboratory constructed of reinforced concrete walls and reinforced concrete slab and beam construction at the roof. The walls are 9 inches (22.9 centimeters) thick with a single mat of reinforcing, and 15 to 39 inches (38.1 to

99.1 centimeters) thick around the bay with double mat reinforcing. CASA 2 walls are like CASA 1 walls and afford only nominal shielding. The critical assemblies housed in CASA 2 are Flattop and Comet. These machines do not contain permanently mounted nuclear fuel, and will remain in this building until their relocation to the Device Assembly Facility at the Nevada Test Site.

Building 116 (CASA 3)

CASA 3 was built in 1962. It is a single-story structure with a high-bay laboratory. It has no windows, and no glass blocks were used in its construction. The main structure is constructed of reinforcing concrete shear walls and reinforced concrete slab and beam construction at the roof. Reinforced concrete masonry block walls surround the entrance, machine section, and equipment areas. CASA 3, with its 18-inch- (45.7-centimeter-) thick concrete walls and ceiling, is the only CASA that has significant shielding.

CASA 3 construction provides reasonable confinement in case of a relatively severe criticality accident. The one entrance to the main room is designed like a tunnel to minimize radiation scattering outside of the building, and it is oriented so that the entrance does not open toward the areas most frequently occupied by personnel or members of the public.

CASA 3 houses the Godiva critical assembly. This machine does not contain permanently mounted nuclear fuel, and will remain in this building until its relocation to the Device Assembly Facility at the Nevada Test Site.

Building 168 (SHEBA Building)

Located approximately 60 feet (18.3 meters) southwest of CASA 1 is the SHEBA Experiments Building 168. The building is an all metal double-wall construction with rigid frames anchored to a concrete pad. All walls and the ceiling are fiberglass insulated. For high-radiation experiments, SHEBA is lowered into a pit in the floor of the building which provides shielding during the experiments and provides containment of any liquid release from SHEBA. The current planning basis includes removal of SHEBA in 2009 and reconstituting it at another DOE Site, pending a NEPA review.

The SHEBA Building provides only a weatherproof shelter for the SHEBA critical assembly. No radiation shielding is provided by the structure. This is intentional, as radiation dose measurements and radiation instrumentation can be fielded around critical assemblies in the SHEBA Building without the presence of shielding or building scatter.

Building 30 (Central Office Building)

The main offices of the operating group are located in Building 30. These include the offices of the group management, staff, and several counting laboratories and electronic assembly areas. In addition, Building 30 houses the main TA-18 machine shop. The CASA 1, 2, and 3 control rooms are located on the south side of the building. Building 30 is a single-story building constructed of reinforced concrete with a basement.

Building 26 (Hillside Vault)

The Hillside Vault is located in the canyon wall at the northeast side of the TA-18 site. Materials and components are stored in sealed storage containers at designated locations. Containers are transported to other locations at TA-18 for use in experiments or radiation measurements. The vault is normally maintained to be free of detectable contamination and is subject to a very low occupancy factor.

Building 127 (High Bay)

Building 127, also known as the High Bay, is located next to the canyon wall at the north side of the site. It consists of a large room and a basement with an office complex. The experimental bay features a false floor and light walls to provide low scatter. This feature led to the use of the facility for measurements that require a "clean" radiation environment. A two-story-high shield wall separates the experimental bay from the rest of the site.

Activities on the main floor include portable radiography and detector development for passive and active surveillance of fissile material. There is currently a linear accelerator as well as a Kaman neutron generator in the basement. Both the linear accelerator and the neutron generator are connected to a scram system and a series of interlocks that allow their operation from the main-floor control room.

Building 129 (Reactor Subassembly Building)

Building 129 is located at the northeast end of the site. It is a concrete structure in which portal monitors and detection systems are developed and tested. It consists of one large room and several compartmentalized office and laboratory spaces. Both neutron and gamma-ray sources are used for detector development and calibration procedures. Fissionable material in Building 129 is limited to Security Category III special nuclear material.

Building 227 (Accelerator Development Laboratory)

Radiography operations are conducted in Building 227. Building 227, the Accelerator Development Laboratory, is a concrete structure housing a radiofrequency quadruple accelerator in the main level and a tomographic gamma scanner and a radioactive waste drum counter in the basement. Both of these devices use small sources (the tomographic gamma scanner uses cesium and barium sources and the drum counter uses a shielded pulsed neutron generator), or up to Security Category III special nuclear material inserted in matrices inside the drums to be used. A shielded control room is situated in the basement adjoining the laboratory space. The shielding is provided by a combination of both concrete and earth.

Purpose and Need

The purpose of this project is to remove all operations from TA-18 for security and safety reasons, primarily because it is located at the bottom of a canyon. The NNSA must make a decision regarding the future location of TA-18 Security Category III and IV capabilities and materials.

Consistent with its decision to relocate the Security Category I and II materials and operations to the Nevada Test Site or another site, NNSA plans to close TA-18 and relocate associated Security Category III and IV mission operations elsewhere at LANL. Therefore, NNSA needs to identify a suitable location, or locations, for relocating the remaining TA-18 capabilities and materials. In conjunction with that action, NNSA also needs to DD&D TA-18 facilities and disposition surplus Category III and IV materials.

H.1.2 Options Description

This section provides a description of the options for the disposition of the remaining Security Category III and IV capabilities and materials. It also identifies potential disposition options for TA-18 facilities.

H.1.2.1 Disposition of Remaining Security Category III and IV Capabilities and Materials

The following summarizes the options considered for the disposition of the remaining Security Category III and IV capabilities and materials:

Option 1. Relocate the capabilities and materials within LANL. This option would have three approaches to accommodate the capabilities and materials:
Option 1a) construct a new facility at TA-55; Option 1b) construct a new facility elsewhere at LANL (for example at TA-48); or Option 1c) distribute the activities among selected facilities.

Option 2. Relocate, or reconstitute, the capabilities and materials at a site other than LANL. This option would have two approaches: Option 2a) relocate the capabilities and materials to a facility near the Device Assembly Facility at the Nevada Test Site; or Option 2b) relocate to other facilities at another DOE site.

Option 3. Keep the capabilities and materials at TA-18. This option is encompassed by the No Action Alternative, and would continue to use some TA-18 buildings and structures.

The *TA-18 Relocation EIS* considered and evaluated the consequences of constructing new facilities and relocating Security Category III and IV capabilities and materials to other locations within LANL. The consequences, as presented in the *TA-18 Relocation EIS*, would envelop those associated with the activities for Options 1a and 1c, and for Option 3. Option 1b is being considered as part of an integrated Radiological Sciences Institute Project and is evaluated in Appendix G, Section G.3, of this SWEIS. Options 2a and 2b would reconstitute the operation at the Nevada Test Site or at facilities at another DOE site and therefore are not evaluated in this SWEIS.

The SHEBA critical experiment machine would not be relocated with other Security Category III and IV capabilities and materials from TA-18 to another location at LANL. The SHEBA criticality experiment machine, because of its minimal shielding, has to be located in an isolated area away from population centers. NNSA will analyze, through a separate NEPA action, the relocation and reconstitution of SHEBA from TA-18 to the Nevada Test Site.

NNSA is routinely exchanging and transferring equipment and materials between the various TAs. Therefore, transferring some of the Security Category IV materials to the Nonproliferation and International Security Center or TA-35 is considered to be part of the requirements for the normal operation and would not require any project-specific NEPA documentation. Both of these facilities are authorized to accept, store, and handle special nuclear material Security Category IV materials. Movements of Security Category III and IV materials between TA-18 and TA-55 are also considered routine operations activities at LANL.

The impacts of keeping the capabilities and materials at TA-18 within LANL would be similar to, or smaller than, those evaluated in Chapter 5 of this SWEIS under the No Action Alternative.

H.1.2.2 Disposition of Technical Area 18 Facilities

Disposition options considered for the TA-18 building and structures include:

Option 1. DD&D all building and structures;

Option 2. Continue to use some buildings and structures for continued operation of Security Category III and IV activities; and

Option 3. No Action, (no DD&D), keep the buildings and structures for other uses.

Over the past 60 years of operations, certain areas within some of the buildings and structures at TA-18 have become contaminated with radioactive material. At this time, the existing structures have not been completely characterized with regard to types and locations of contamination. In addition, project-specific work plans have not been prepared that would define the actual methods, timing, or workforce to be used for the DD&D of the structures.

The general processes that would be used to DD&D the structures at TA-18 would be the same as those described in the introduction of Appendix H. The contaminated areas within the TA-18 buildings comprise about 500 square feet (46 square meters) (DOE 2002b). There are also small amounts of activation products in the concrete and metals within the walls of the critical assembly structures. Some of the disposition work could involve technologies and equipment that have been used in similar operations, and some could use newly developed technologies and equipment.

All demolition debris would be sent to disposal locations onsite or offsite. Demolition of the uncontaminated structures would be performed using standard industry practices. The TA-18 structures are not expected to be technically difficult to demolish and waste debris would be handled, transported, and disposed of in accordance with standard LANL procedures. A post-demolition site survey would be performed in accordance with the requirements of the MARSSIM (MARSSIM 2000).

H.1.3 Affected Environment and Environmental Consequences

The following discussions present the potential environmental consequences from:
(1) disposition of the remaining Security Category III and IV and capabilities and materials; and
(2) disposition of TA-18 buildings and structures. Detailed information about the LANL affected

environment is presented in the main body of the SWEIS. An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for environmental justice, a determination was made that no further analysis was necessary because no disproportionate impacts to low-income or minority populations would be expected.

H.1.3.1 Disposition of Remaining Security Category III and IV Capabilities and Materials

The environmental consequences of Security Category III and IV activities under Option 3 (No Action) are similar to, or bounded by, those associated with the current activities at TA-18. Option 3 is incorporated into the No Action Alternative described in Chapter 3. Both this SWEIS and the *TA-18 Relocation EIS* provide the bounding consequences associated with the No Action Alternative. Relocation of the Security Category III and IV capabilities and materials to a facility near the Device Assembly Facility at the Nevada Test Site under Option 2 could provide a synergy between these capabilities and the Security Category I and II missions being relocated to the Nevada Test Site. NNSA is also considering relocating, or reconstituting, the SHEBA critical assembly to another DOE site. These actions, as well as the option of relocating Security Category III and IV capabilities and materials to another DOE site, would result in environmental consequences outside the LANL site and are therefore not evaluated in this SWEIS.

The environmental consequences of actions under Options 1a or 1c, would be similar to, or bounded by, the consequences of relocating Security Category III and IV capabilities and materials evaluated in the *TA-18 Relocation EIS*. That EIS evaluated the consequences of relocating Security Category III and IV capabilities and materials, except for the SHEBA, to a new facility south of TA-55. Under Option 1a, a similar building would need to be constructed in a comparable location, leading to similar environmental consequences. Under Option 1c, capabilities and materials would be distributed among selected facilities, including the Nonproliferation and International Security Center and TA-35 laboratories for Security Category IV missions and materials, and the Chemistry and Metallurgy Research and TA-55 facilities for Security Category III and IV capabilities. Acceptance of Security Category III and IV materials would require capabilities and materials with minimal or no modification to these facilities. The movement of materials between the building and technical areas is considered to be part of the routine, day-to-day, operations at LANL. Therefore, the environmental consequences of actions under Option 1c would be nil, or bounded by those of Option 1a. The environmental consequences of actions under Option 1b are analyzed as part of the Radiological Sciences Institute at TA-48 (see Appendix G). Option 1 is incorporated into the Expanded Operations Alternative described in Chapter 3.

H.1.3.2 Disposition of Technical Area 18 Buildings and Structures

This section describes the potential environmental consequences of the disposition of TA-18 facilities. This evaluation is based on the use of general industry DD&D methods and known practices that could be used for TA-18 buildings and structures.

Under Option 1, all TA-18 structures and buildings would undergo DD&D. Under Option 2, the excess buildings and structures would undergo DD&D. Option 3 is the No Action Option for the

DD&D process. For Option 3, the buildings and structures would either remain under surveillance and maintenance or would be occupied by other users. For the purposes of this analysis, only the potential impacts of Option 1 are discussed, because the activities associated with this option would have the greatest potential impacts, including generating the largest volume of waste materials, and therefore bound Options 2 and 3.

The environmental impacts from demolition of buildings and structures are discussed qualitatively for land resources, air quality and noise, ecological resources, cultural resources, and human health. Quantitative impacts are presented for waste generation and its transport to local and offsite disposal sites. For purposes of analysis, it was assumed that low-level radioactive waste could be disposed of onsite, or transported to offsite disposal facilities, such as a commercial facility in Utah. Disposition of industrial waste and uncontaminated materials could be performed onsite or sent to local landfills.

Land Resources

Land resources include land use and visual resources.

Land Use

Facilities at TA-18 are located on a 131-acre (53-hectare) site that is situated 3 miles (4.8 kilometers) from the nearest residential area, White Rock. Approximately 20 percent of the site has been developed. Site facilities are located at the bottom of a canyon near the confluence of Pajarito Canyon and Threemile Canyon. TA-18 structures include a main building, three outlying remote-controlled critical assembly buildings known as CASAs, and several smaller laboratory, nuclear material storage, and support buildings. A security fence to aid in physical safeguarding of special nuclear material bounds the entire site. The Cerro Grande Fire threatened structures at TA-18; however, no permanent buildings were damaged or destroyed (DOE 2002b).

The generalized land use categories within which TA-18 is located are depicted in Chapter 4, Figure 4–4 and include the Nuclear Materials Research and Development and Reserve (LANL 2003d). According to the *Comprehensive Site Plan* for 2001, TA-18 falls within the Pajarito Corridor East Development Area (LANL 2001a). The Plan indicates that much of TA-18 (including all developed portions) is designated as a No Development Zone (Hazard).

DD&D Impacts—DD&D of TA-18 buildings and structures could result in an overall change in the land use designation of the area. Although not shown on future land use maps of the site (LANL 2003d), the Nuclear Materials Research and Development designation could be changed such that the entire area would be designated as Reserve. Since the area would not be redeveloped following DD&D, there would be no conflict with the Pajarito Corridor East Development Area designation of much of the site.

Visual Environment

Since surrounding canyon walls rise approximately 200 feet (61 meters) above the site, TA-18 is not visible from any offsite location (DOE 2002b).

DD&D Impacts—DD&D activities could have short-term adverse impacts on visual resources due to the presence of heavy equipment and an increase in dust. Since TA-18 is located on the bottom of the Pajarito Canyon and the surrounding canyon walls essentially mask the buildings, no offsite visual impacts are expected. Once buildings and structures are removed and the site restored, including grading and planting of native species, the canyon bottom would present a natural appearance and, given time, would blend with previously undisturbed portions of the TA.

Geology and Soils

DD&D of the TA-18 facilities would result in disturbance of approximately 6.7 acres (2.7 hectares) and excavation of approximately 223,000 cubic yards (170,000 cubic meters) of soil. Because the soil was previously disturbed for facility construction, there would be no impact to native LANL soils. If uncontaminated, the excavated soils would be stockpiled for use as backfill either at TA-18 or elsewhere at LANL. If the soil is to be stockpiled for longer than a few weeks, the stockpiles should be seeded or managed as appropriate to prevent erosion and loss of the resource. In addition, care would be taken to employ all necessary erosion control best management practices during and following DD&D to limit impact on soil resources adjacent to the building sites. If contaminated, the soil would be disposed of as appropriate.

Water Resources

TA-18 facilities use domestic and industrial water, but the effluent from these sources has been pumped to the TA-46 Sanitary Wastewater Systems Plant and the TA-50 Radioactive Liquid Waste Treatment Facility, as appropriate. There has been no effluent discharged from TA-18 directly to the environment. Water usage at TA-18 has not been metered, but is expected to be average for laboratory and office facilities. Stormwater from the TA-18 buildings, roads, and parking lots drains into or falls within Pajarito Canyon. There are no underground or above-ground fuel storage tanks at the facility (DOE 2002b).

Parts of TA-18 lie within the 100-year floodplain for Pajarito Canyon. The building that houses SHEBA is partially within the floodplain boundary, although that assembly is only located at the facility during experiments. After the Cerro Grande Fire, high volumes of stormwater flow were expected through Pajarito Canyon, so a flood retention structure and a steel diversion wall were constructed upstream of TA-18 to minimize the possibility of flooding. When the watershed that drains into Pajarito Canyon returns to more stable conditions, these structures may be removed (DOE 2002c).

DD&D Impacts—DD&D activities would have little or no effect on water use or resources. Water use would be transferred to the other locations at LANL where TA-18 operations would be relocated. Most structures at TA-18 would be removed, which would remove potential contamination sources from an area where they could possibly be flooded. This would include removal of the steel diversion wall installed after the Cerro Grande Fire. Although the possibility of floodwater mobilizing contaminants from the buildings is remote, complete removal of this potential contaminant source would enhance protection of surface water quality.

DD&D activities would not result in the disturbance of watercourses or generation of liquid effluents that would be released to the surrounding environment. A Stormwater Pollution

Prevention Plan using best management practices, such as silt fences and hay bales, would be used during the DD&D project to ensure that fine particulates would not be transported by stormwater into surface water channels in the Pajarito Canyon. Potable water use at the site would be limited to that necessary for equipment washdown, dust control, and sanitary facilities for workers. Impacts of DD&D activities on groundwater should be minimal, because surface water would be collected and properly disposed of.

Air Quality and Noise

Air Quality

Nonradiological air pollutant emissions from TA-18 include criteria pollutants from various small fuel-burning sources and toxic chemicals. Use of toxic pollutants has been reduced in recent years and, in 2003, chemical use was limited to propane (LANL 2004c). Actual emissions vary by year with the amounts of chemicals used. The use of toxic chemicals at TA-18 has not been shown to have an adverse impact on air quality.

The primary radiological emissions from TA-18 Security Category III and IV activities would be the radioactive noble gas activation (argon-41) generated during SHEBA operations. After removal of the SHEBA critical assembly (in 2009), no gaseous radionuclide would be present or generated at TA-18.

DD&D Impacts—DD&D of the buildings and structures would result in emissions associated with vehicle and equipment exhausts, as well as radiological and particulate (dust) emissions from demolition activities. These air pollutant emissions would not be expected to result in exceedances of ambient air quality standards, although they could result in elevated concentrations of particulate matter near the demolition site for short periods.

No releases of gaseous radionuclides are anticipated from DD&D. DD&D would generate very small amounts of particulate air emissions (dust) from size reduction of metal and concrete within the buildings. The dust could include lead, asbestos, and a small amount of radionuclides, primarily radioactive cobalt-60 isotopes from activation. Any emissions of contaminated particulates would be reduced by the use of plastic draping and contaminant containment coupled with high-efficiency particulate air filters. The location of TA-18 in the canyon bottom limits the transport of, and promotes the deposition of, airborne particulates, thus reducing the concentration of airborne particulates at the site boundary.

Noise

Noise sources from TA-18 operations include heat ventilation and air conditioning equipment, and vehicles. Noise impacts on the public from the operations in this area are limited to employee and other traffic.

DD&D Impacts—Construction noise at LANL is common, and noise levels during demolition activities would be consistent with those typical of construction activities. As appropriate, workers would be required to wear hearing protection to avoid adverse effects on hearing. Noninvolved workers at the edges of the mesas above TA-18 could hear the activities below; however, the level of noise would not be distracting. Some wildlife species may avoid the immediate vicinity of TA-18 as demolition proceeds due to noise; however, any effects on wildlife resulting from noise associated with demolition activities would be temporary. Upon completion of DD&D, there would be a minor reduction in noise.

Ecological Resources

This section addresses the ecological setting (terrestrial resources, wetlands, aquatic resources, and protected and sensitive species) of TA-18. Ecological resources of LANL as a whole are described in Section 4.5 in this SWEIS, and the vegetation zones are depicted in Figure 4–25.

TA-18 is located in the Pinyon (*Pinus edulis* Engelm.)-Juniper (*Juniperus monosperma* [Engelm.] Sarg.) Woodland vegetation zone, although Ponderosa Pine (*Pinus ponderosa* P. & C. Lawson) forest is present along north-facing canyon walls. Approximately 20 percent of the TA is developed. Due to the presence of security fencing, no large animals would be found within developed portions of TA-18 (DOE 2002b); however, elk (*Cerus elaphus*) have been seen within other parts of the TA. The more northwesterly portions of TA-18 were burned at a low or unburned severity level as a result of the Cerro Grande Fire. At this level, seed sources should remain viable (DOE 2000).

There are no wetlands located within TA-18; however, nine wetlands have been delineated within Pajarito Canyon (TA-36) just to the east (ACE 2005). These wetlands total 15.2 acres (6.2 hectares). Plants found within these wetlands include coyote willow (*Salix exigua* Nutt.), Baltic rush (*Juncus balticus* Wildl.), sedges (*Carex* spp.), common spike rush (*Eleocharis palustris* (L.) Roemer & Schultes), American speedwell (*Veronica americana* Schwein. ex Benth), and cattail (*Typha* spp,). There are no aquatic resources located within TA-18 (DOE 2002b).

TA-18 falls within portions of the Threemile Canyon and Pajarito Canyon Mexican spotted owl (*Strix occidentalis lucida*) Areas of Environmental Interest. However, none of the TA-18 structures are in core habitat, and only CASAs 1 and 2 are in buffer habitat for the Threemile Canyon Area of Environmental Interest. TA-18 does not fall within Areas of Environmental Interest for the bald eagle (*Haliaeetus leucocephalus*) or southwestern willow flycatcher (*Empidonax traillii extimus*) (LANL 2000b). However, the project is located 890 feet (267 meters) upstream from the southwestern willow flycatcher Area of Environmental Interest (LANL 2006b).

DD&D Impacts—All DD&D activities would take place within the previously fenced and developed area of TA-18 that contains little wildlife habitat. Wildlife in canyon lands adjacent to TA-18 could be intermittently disturbed by construction activity and noise during the demolition period when heavy equipment would be used to raze structures, remove building foundations and buried utilities, excavate contaminated soil, and transport wastes to disposal sites. Species most likely to be affected are those commonly associated with the Pinyon-Juniper Woodland community within which TA-18 is located. Due to the presence of wetlands downstream from TA-18, a Floodplain-Wetlands Assessment would need to be performed prior to DD&D activities taking place. Implementation of best management practices during the demolition phase would prevent potentially sediment-laden runoff from reaching the wetlands. Ultimately, the canyon habitat could be restored using native species (which would have a beneficial effect on area wildlife) if the site were not used for other LANL-related purposes.

Potential impacts to the Mexican spotted owl were evaluated in a biological assessment prepared by DOE. This assessment noted that although CASA 1 and 2 are 980 feet (294 meters) and 680 feet (204 meters), respectively, from the nearest core boundary, noise levels in the core habitat would be elevated somewhat more than 6 decibels (A-weighted) [dB(A)] above background levels. However the report concluded that DD&D activities may affect, but are not likely to adversely affect, the Mexican spotted owl provided reasonable and prudent alternatives are implemented. Reasonable and prudent alternatives include muting all trucks and heavy equipment, reseeding and erosion protection, and not removing trees with a diameter at breast height greater than 8 inches (20 centimeters) without approval (LANL 2006b). The U.S. Fish and Wildlife Service has concurred with this assessment (see Chapter 6, Section 6.5.2).

With respect to the bald eagle, the DOE biological assessment noted that DD&D of TA-18 facilities would have no effect since the project would not remove any bald eagle foraging habitat. As noted above, the project would take place upstream from the southwestern willow flycatcher Area of Environmental Interest. Provided that reasonable and prudent alternatives are implemented, the biological assessment concluded that the proposed project may affect, but is not likely to adversely affect, the southwestern willow flycatcher. Reasonable and prudent alternatives would include the use of appropriate soil erosion best management practices to ensure that sedimentation of downstream wetlands does not occur (LANL 2006b). The U.S. Fish and Wildlife Service has concurred with the biological assessment as it relates to the bald eagle and southeastern willow flycatcher (see Chapter 6, Section 6.5.2).

Human Health

DD&D Impacts—The primary source of potential consequences to workers and members of the public would be associated with the release of radiological contaminants during the demolition process. The only radiological effect on noninvolved workers or members of the public would be from radiological particulate air emissions. Any emissions of contaminated particulates would be reduced by the use of plastic draping and contaminant containment coupled with high-efficiency particulate air filters. Contaminant releases of radioactive particulates from disposition activities are expected to be lower than releases from past TA-18 operations.

Because of their age, it is anticipated that the demolition of the TA-18 buildings and structures would involve removal of some asbestos-contaminated material. Removal of asbestos-contaminated material would be conducted according to existing asbestos management programs at LANL in compliance with strict asbestos abatement guidelines. Workers would be protected by personal protective equipment and other engineered and administrative controls, and no asbestos would likely be released that could be inhaled by members of the public.

DD&D is estimated to require 43,330 person-hours. The DOE and LANL limit for the annual worker exposure is 5 rem (Title 10 *Code of Federal Regulations* [CFR] Part 835), with an administrative control level of 2 rem (DOE 1999c). The worker dose during DD&D would be less than that of normal operations, or less than 100 millirem per person, annually.

For nonradiological impacts, based on the expected labor hours and DOE and national construction safety statistics, the DD&D of the TA-18 structures could result in an estimated two recordable injuries. No construction fatalities would be expected. Potential impacts from hazardous and toxic chemicals would continue to be prevented through the use of administrative controls and equipment.

Cultural Resources

Archeological Resources and Historic Buildings and Structures. TA-18 contains three types of archaeological cultural resource sites that have been determined to be eligible for the National Register of Historic Places. These include approximately 40 cavates, a rock shelter, and a historic structure of the Homestead Period (the Ashley Pond cabin). All of these sites have been determined to be eligible for listing on the National Register of Historic Places. Extensive erosion and stormwater control efforts initiated after the Cerro Grande Fire have had beneficial effects on the historic Ashley Pond cabin. This structure was surrounded by concrete barriers and sandbags to prevent damage from debris carried by stormwater runoff. Construction of a flood retention structure upstream also provides the Ashley Pond cabin additional protection from flooding (DOE 2002b).

TA-18 contains 60 buildings and structures dating to the Manhattan Project through the early Cold War period. Three of these buildings have been identified as eligible for listing on the National Register of Historic Places, including the Slotin Building (TA-18-1) and two other buildings (TA-18-2 and TA-18-5).

DD&D Impacts—Three archaeological resources sites found at TA-18 (a rock shelter, a cavate complex, and the Ashley Pond cabin) have been determined to be eligible for listing on the National Register of Historic Places. These resources are currently protected from disturbance and would continue to be protected during DD&D; thus, there would be no impact to archaeological resources. Only three LANL-associated buildings within TA-18 have been identified as National Register of Historic Places-eligible. However, there are other potentially significant historic buildings within TA-18 that have yet to be assessed for National Register of Historic Places eligibility status. A formal eligibility assessment of these buildings must be conducted prior to any demolition activities. Additionally, prior to any demolition activities, DOE, in conjunction with the New Mexico State Historic Preservation Office, would implement documentation measures such as preparing a detailed report containing the history and description of the affected properties. These measures would be incorporated into a formal Memorandum of Agreement between DOE and the New Mexico Historic Preservation Division in order to resolve adverse effects to eligible properties. The Advisory Council on Historic Preservation would be notified of the Memorandum of Agreement and would have an opportunity to comment.

Traditional Cultural Properties. Consultations to identify Traditional Cultural Properties were conducted with 19 American Indian tribes and two Hispanic communities in connection with the preparation of the *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS)* (DOE 1999a). As noted in Section 4.8.3 of the *1999 SWEIS*, Traditional Cultural Properties are present throughout LANL and adjacent lands. While specific features or locations are not identified in order to protect such sites, no Traditional Cultural Properties would be expected within developed areas of TA-18.

DD&D Impacts—Impacts on Traditional Cultural Properties would not be expected since such resources do not occur within developed portions of TA-18. However, the removal of structures at the TA could have a positive impact on any such resources located nearby since the area would present a less disturbed appearance than is presently the case.

Socioeconomics and Infrastructure

Major utility infrastructure (electric power, natural gas, and water) is available at TA-18 to provide service to existing facilities. The cessation of activities within TA-18 and the DD&D of TA-18 buildings and structures would include the removal or abandonment of existing utility corridors that serve the affected facilities. TA-18 operations have historically required about 2,840 megawatt-hours of electricity, 7 decatherms (equivalent to about 7,000 cubic feet [200 cubic meters]) of natural gas, and 3.9 million gallons (15 million liters) of water annually (DOE 2002b).

DD&D Impacts—Activities associated with DD&D of TA-18 facilities are expected to require 273,000 gallons (1.03 million liters) of liquid fuels and 8.4 million gallons (32 million liters) of water. DD&D activities would be staggered over an extended period of time. As a result, impacts of these activities on LANL's utility infrastructure are expected to be minor on an annualized basis. Standard practice dictates that utility systems serving individual facilities are shut down as they are no longer needed. As DD&D activities progress, interior spaces, including associated equipment, piping, and wiring, would be removed prior to final demolition. Thus, existing utility infrastructure would be used to the extent possible and would then be supplemented or replaced by portable equipment and facilities as DD&D activities proceed, as previously discussed for construction activities.

Waste Management

The total amount of waste generated from the disposition of the buildings and structures is estimated to be 21,900 cubic yards (16,700 cubic meters). This estimate does not include the amount of waste generated by the demolition of the parking lot or by soil removal. Waste types and quantities generated by removal of the structures would be within the capacity of existing waste management systems, and would not result in substantial impact to existing waste management disposal operations. **Table H–1** summarizes the waste types and volumes expected to be generated during demolition activities. About 21 percent of the waste produced during DD&D activities would be bulk low-level radioactive wastes, all of which could be transported offsite for disposal. For the purpose of analysis, this SWEIS evaluates both the onsite and offsite disposal options for low-level radioactive waste to ensure that the potential environmental consequences of potential waste management options have been bounded.

Table H–1 Estimated Waste Volumes (cubic yards)

Low Specific Activity Waste	*Mixed Low-Level Waste*	*Solid* [a]	*Hazardous*	*Asbestos*
4,700	5	17,100	20	55

[a] Includes construction, demolition, and sanitary waste.
Note: To convert waste volumes to cubic meters, multiply by 0.76456.

- **Option 1**. Under this option, NNSA would pursue offsite disposal of low-level radioactive waste resulting from DD&D of the buildings and structures including concrete, soil, steel, and personal protective equipment. Both the Nevada Test Site facilities for waste disposal and an existing commercial facility at Clive, Utah, have the capacity to accept the anticipated amount of these types of waste. Under this option, there would be little reduction of LANL's remaining low-level radioactive waste disposal capacity at TA-54 Area G.

- **Option 2**. Under this option for waste disposal, low-level radioactive waste would be disposed of onsite at LANL at TA-54 Area G. The current footprint is expected to be adequate for the amount of low-level radioactive waste that would be generated by these DD&D activities, but implementing this option would reduce the remaining capacity at Area G.

All other wastes generated by DD&D activities would be handled, managed, packaged, and disposed of in the same manner as the same wastes generated by other activities at LANL. Most mixed low-level radioactive waste generated at LANL is sent offsite to other DOE or commercial facilities for treatment and disposal.

Small amounts of hazardous waste would also be generated during DD&D activities. These wastes would be handled, packaged, and disposed of according to LANL's hazardous waste management program. This amount of waste is within the capacity of LANL's hazardous waste management program.

TA-18 uses lead shielding and beryllium metal in their experiments. These metals are expected to move with the experiments to new locations. It is expected that some of the materials would be categorized as excess inventory requiring disposal. If that is the case, the volume of this excess and potentially contaminated metal would be within the storage capacity at LANL, and would be managed and disposed of consistent with LANL's hazardous waste management program.

The generated solid waste could also be managed at the Los Alamos County landfill or could be transported to an offsite landfill. For the purposes of analysis, it was assumed that these wastes would be disposed of at an offsite location.

DD&D would generate about 55 cubic yards (41 cubic meters) of nonradiological asbestos waste. This waste would be packaged according to applicable requirements and sent to the LANL asbestos transfer station for shipment offsite to a permitted asbestos disposal facility along with other asbestos waste generated at LANL. It is not expected that the anticipated amount of waste would be beyond the disposal capacity of existing disposal facilities.

The *TA-18 Relocation EIS* (DOE 2002b) identified about 9 tons (8.5 metric tons) of natural uranium, depleted uranium and thorium that would not be relocated with the critical experiment machines to the Nevada Test Site. During DD&D of TA-18, LANL staff would relocate those materials that are required to support LANL operational capabilities to another part of LANL, or re-classify the materials as waste and dispose of them accordingly. No materials (depleted or natural uranium, thorium, or other bulk materials) would remain at TA-18.

Transportation

DD&D wastes would need to be transported to storage or disposal sites. These sites could be at LANL or an offsite location. Based upon this analysis, no excess fatal cancers are likely to result from this activity. Transportation has potential risks to workers and the public from incident-free transport, such as radiation exposure, because the waste packages are transported along the highways. There is also increased risk from traffic accidents (without release of radioactive material) and radiological accidents (in which radioactive material is released).

The effects from incident-free transportation of demolition wastes under both waste options for the worker population and the general public are presented as collective dose in person-rem resulting in excess latent cancer fatalities (LCFs) in **Table H–2**. Based on this table, the risk for development of excess LCFs is highest for workers and the public under the offsite disposition option. This is because the dose is proportional to the duration of transport, which in turn is proportional to travel distance. This would lead to a highest dose and risk from disposal at the Nevada Test Site, which is the farthest from TA-18.

Table H–2 Incident-Free Transportation Impacts – Technical Area 18 Decontamination, Decommissioning, and Demolition

Disposal Option	*Low-level Radioactive Waste Disposal Location*	*Crew*		*Public*	
		Collective Dose (person-rem)	*Risk (LCFs)*	*Collective Dose (person-rem)*	*Risk (LCFs)*
Onsite disposal	LANL TA-54	0.001	6×10^{-7}	0.0002	1×10^{-7}
Offsite disposal	Nevada Test Site	0.40	2×10^{-4}	0.08	5×10^{-5}
	Commercial Facility	0.35	2×10^{-4}	0.07	4×10^{-5}

LCF = latent cancer fatality, TA = technical area.

Accidents could occur in all phases of activities during DD&D, including onsite and offsite transportation, deactivation, disassembly, characterization, and packaging of waste for disposal. Once materials and equipment were removed, there would be no potential for any radiological accident release. Any potential for a radiological accident during equipment removal would be bounded by those of operational accidents analyzed in this SWEIS (see Chapter 5) and the *TA-18 Relocation EIS* (DOE 2002b). Two sets of accidents were analyzed: industrial and transportation accidents.

Two types of transportation accidents were evaluated: traffic-related accidents without release of radioactive wastes, and cargo-related accidents in which radioactive wastes would be released. Traffic accident risks were evaluated in terms of traffic fatalities, and the cargo or radiological accident risks were presented in terms of excess LCF from exposure to radioactive materials. The analysis assumed that all generated nonradiological wastes would be transported to offsite disposal facilities.

Table H–3 presents the impacts from traffic and radiological accidents. The results indicate that no traffic fatalities and no excess LCFs would likely occur from the activities during DD&D of TA-18.

Table H–3 Transportation Accident Impacts – Technical Area 18 Decontamination, Decommissioning, and Demolition

Low-level Radioactive Waste Disposal Location [a]	*Number of Shipments* [b]	*Distance Traveled (million kilometers)*	*Accident Risks*	
			Radiological (excess LCF)	*Traffic (fatalities)*
LANL TA-54	1,234	0.41	Not applicable [c]	0.0049
Nevada Test Site	1,234	1.1	5.0×10^{-8}	0.012
Commercial Facility	1,234	1.0	3.7×10^{-8}	0.011

LCF = latent cancer fatality, TA = technical area.

[a] All nonradiological wastes would be transported offsite.

[b] Only 22 percent of shipments are radioactive wastes, others include 77.5 percent for industrial and sanitary waste, and about 0.05 percent for asbestos and hazardous wastes.

[c] No traffic accident leading to releases of radioactivity for onsite transportation is hypothesized.

Note: To convert kilometers to miles, multiply by 0.621.

H.2 Technical Area 21 Structure Decontamination, Decommissioning, and Demolition Project Impact Assessment

This section provides information on the environmental effects of the proposed DD&D of TA-21 buildings at LANL. Section H.2.1 provides background information on TA-21 and its buildings, and describes the purpose and need for TA-21 DD&D, an action that would reduce ongoing surveillance and maintenance costs and allow investigation of potential release sites[2] located beneath the buildings. Section H.2.2 provides a description of the options to address the TA-21 buildings. Section H.2.3 describes the affected environment at TA-21 and presents an impacts assessment for the options to DD&D, as well as the No Action Option. Chapter 4 of this SWEIS

---

[2] *For this SWEIS, a potential release site means a site suspected of releasing or having the potential to release contaminants (radioactive, chemical, or both). Potential release site is a general term that includes solid waste management units and areas of concern that are cited and defined in the Compliance Order on Consent (Consent Order) that was entered into on March 1, 2005, by DOE, the management and operating contractor for LANL, and the State of New Mexico.*

presents an overall description of the affected environment at LANL and TA-21. Any unique characteristics of LANL and TA-21 not covered in Chapter 4 that would be affected by the proposed DD&D of TA-21 buildings are presented here.

As DD&D and remediation of potential release sites progresses in TA-21, the status of buildings, utilities, and contaminated sites will evolve. The analysis of impacts in this section is based on the status as of approximately the end of 2005. As of the issuance of this SWEIS, conditions may have changed with respect to building occupancy, building status, and availability of utilities. For example, operating facilities may have been placed in surveillance and maintenance status, personnel may have been moved out of buildings to another location at LANL, and utilities may have been terminated to certain buildings.

H.2.1 Introduction and Purpose and Need for Agency Action

The purpose of this project-specific analysis is to provide an assessment of impacts from the DD&D of TA-21 buildings and structures. This section provides background information on the DD&D activities, the purpose and need of the action, and a summary of related NEPA actions.

Background

TA-21 covers about 312 acres (126 hectares) at the northern portion of LANL adjacent to the Los Alamos Airport, principally on the DP Mesa. It contains a total of about 65 buildings and structures with a cumulative area of 239,000 square feet (22,200 square meters) (LANL 1999). The central area of TA-21 consists of groups of buildings and support facilities divided into two areas known as the DP West and DP East sites (sometimes collectively referred to as the "DP Site"). **Figure H–3** and **Figure H–4** show the locations of buildings and potential release sites in DP West and DP East, respectively.

The DP Site was built late in the Manhattan Project, in 1945, as the principal location for the LANL Plutonium Processing Facility. Buildings at DP West were used for plutonium recovery, precipitation, conversion, purification, reduction, metal casting and machining, and liquid radioactive waste treatment. Later, the buildings were converted for research on uranium hydride, enriched uranium fuel elements, and plutonium fuels service and development. During the 1970s, LANL transferred the process activities from DP West to facilities at TA-55, and removed the remaining process equipment. In 1996, large portions of two of the buildings, 21-0003 and 21-0004, were demolished.

The DP West buildings center on a core group of buildings running west to east: Buildings 21-0210, 21-0002, 21-0003, 21-0004, 21-0005, and 21-0150. Planning for DD&D is in process for Building 21-0210. The remainder of these structures were process buildings designed for work with uranium and transuranic materials. The buildings have below-grade unlined concrete "troughs" that contain waste and process piping. The older buildings are pre-engineered steel frame metal lath and plaster buildings with metal exterior sidings and roofs. Building 21-0150 is concrete column construction with exterior walls of concrete masonry unit construction (LANL 1999).

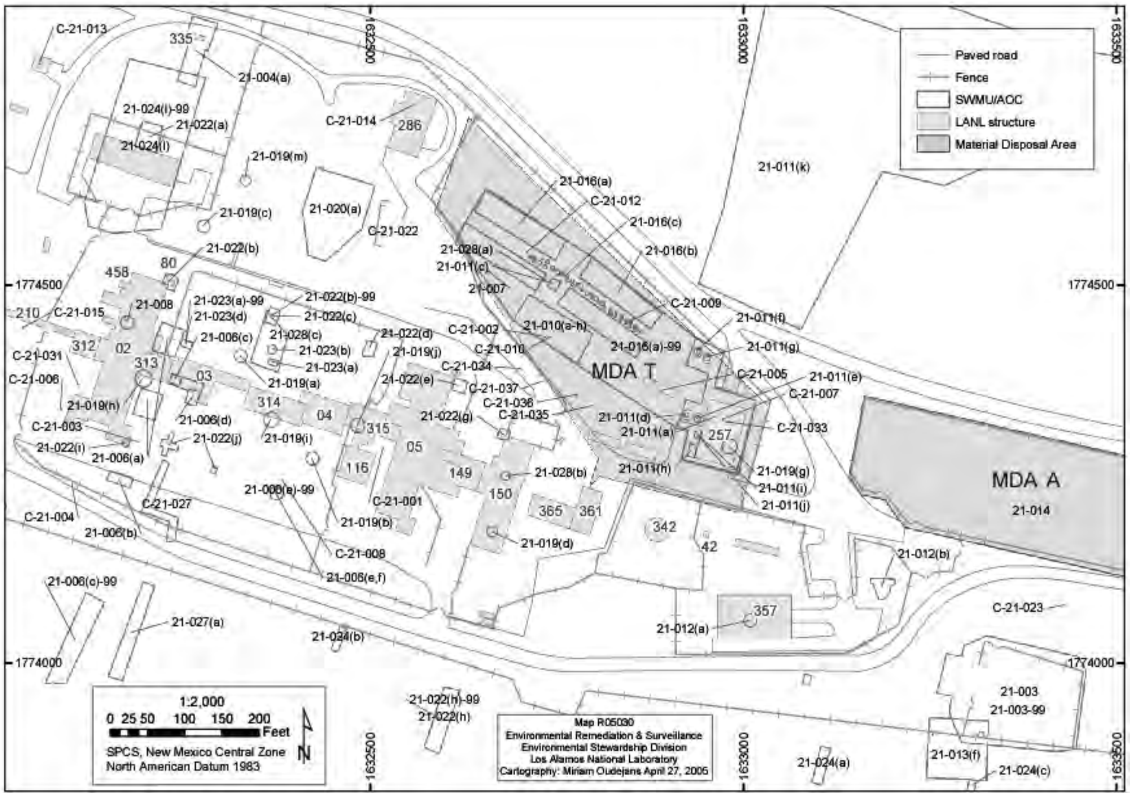


Figure H–3 Technical Area 21 Map of DP West Buildings and Potential Release Sites

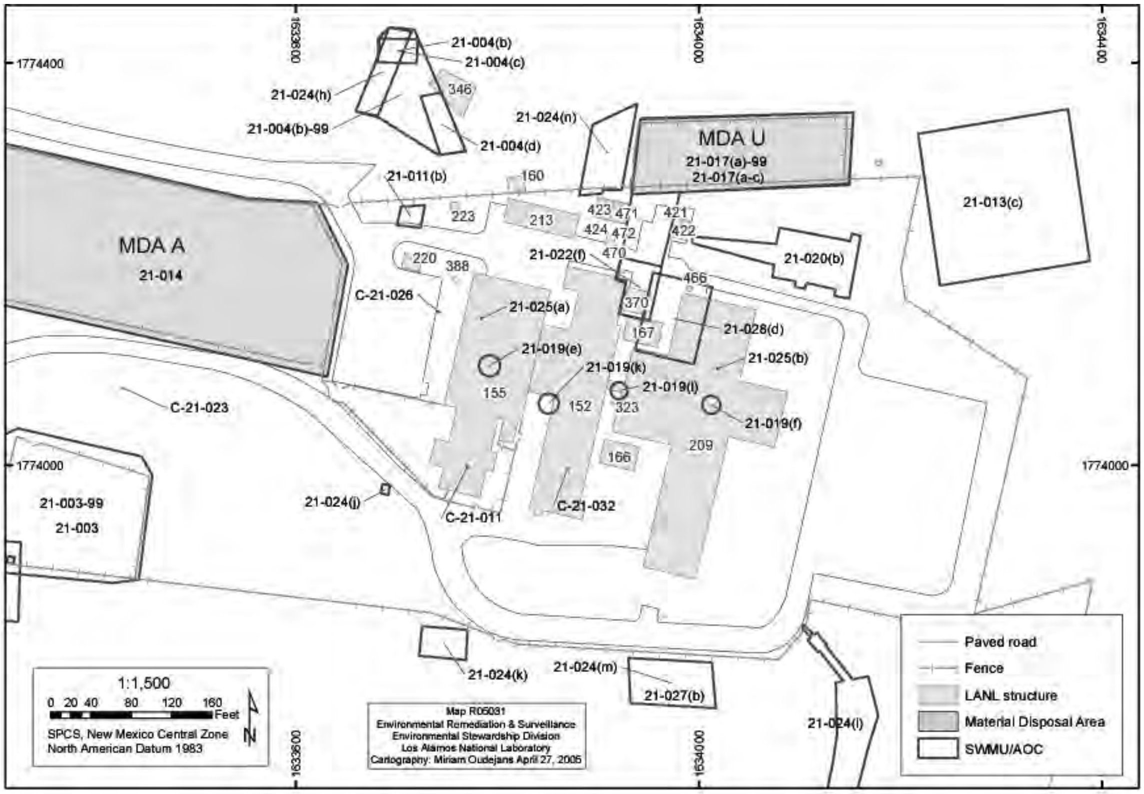


Figure H–4 Technical Area 21 Map of DP East Buildings and Potential Release Sites

Although most of the highly contaminated process equipment such as gloveboxes, glovebox ducts and filter plenums, and process tanks have been removed, small amounts of equipment such as fume hoods, waste tanks, sections of duct, and air filtration equipment remain. A small quantity of highly contaminated process piping remains, particularly in the troughs. This piping is likely contaminated with transuranic nuclides. The buildings are being operated at a minimum surveillance and maintenance level, involving only those actions that are necessary to prevent environmental releases or hazards to surveillance workers. In practice this means that the heat and ventilation services are shutdown and the lights, electrical power, and fire suppression systems remain active. Maintenance is insufficient to prevent slow deterioration of the structure and deterioration of protective coatings (paint) applied to contaminated building surfaces. NNSA maintains radiological and access controls for the buildings consistent with the presence of high levels of fixed contamination.[3] Previous DD&D projects demolished most of Buildings 21-0003 and 21-0004 in the 1990s, with the only portions remaining being the central corridor areas. A number of lesser structures directly supported the larger buildings, mostly by providing utility services and corridor access between buildings (LANL 1999).

Two other DP West buildings, 21-0257 and the 21-0286 slab, are located within or adjacent to Material Disposal Area (MDA) T, and the DD&D approach for those structures would be closely coordinated with the remediation approach for that MDA. Building 21-0286 was a former storage vault and warehouse, and the slab is minimally contaminated. Building 21-0257, the TA-21 Liquid Radioactive Waste Treatment Facility, provided pretreatment of liquid radioactive wastes prior to their transfer to the TA-50 Liquid Radioactive Waste Treatment Facility for final treatment. During 2001, the two-mile long, single-walled transfer line, dedicated to the transfer of radioactive liquid wastes from the TA-21 tritium facilities to the TA-50 Liquid Radioactive Waste Treatment Facility, was taken out of service, flushed, drained, and capped. The small volumes of liquid waste pretreated at the TA-21 Liquid Radioactive Waste Treatment Facility were transported from TA-21 to TA-50 or TA-53 by truck for final treatment and disposal (LANL 2004c). The disposition of any contaminated effluent piping would be addressed as an environmental remediation activity.

DP East buildings historically supported polonium and actinium initiator work and research on coatings of reactor fuels for the Rover Program. Since 1977, the buildings have been used for tritium handling, processing, and storage to support the Tritium Key Facility tritium research and technology mission. The remainder of TA-21 surrounds the DP East and DP West sites and includes various infrastructure and support buildings and structures.

Figure H–5 provides an aerial view of DP East and DP West and their relationship to the western portion of TA-21 and the Los Alamos townsite.

The DP East process buildings are 21-0155, 21-0152, and 21-0209. Buildings 21-0155 and 21-0152, the Tritium Systems Test Assembly Buildings, were originally used for polonium-210 initiator research, and were converted for use in the tritium program in 1977. They are primarily production facilities with presses, furnaces, and tritium trapping equipment (LANL 1999). Beryllium was used in Building 21-0152 in conjunction with polonium for the Initiator Research

---

[3] *"Fixed contamination" refers to residual radioactive materials that are not easily removed from a surface. In many cases, the contamination may be "fixed" in place with paint.*

Development Project. Building 21-209, the Tritium Science and Fabrication Facility, holds some process equipment, but also contains gloveboxes, laboratory equipment, change rooms, and administrative areas; it was never used for processing transuranic materials (LANL 1999). A number of support structures, the largest being Buildings 21-0166, 21-0167, 21-0213, and 21-0370, provide mechanical equipment, exhaust filtration, and warehouse support.

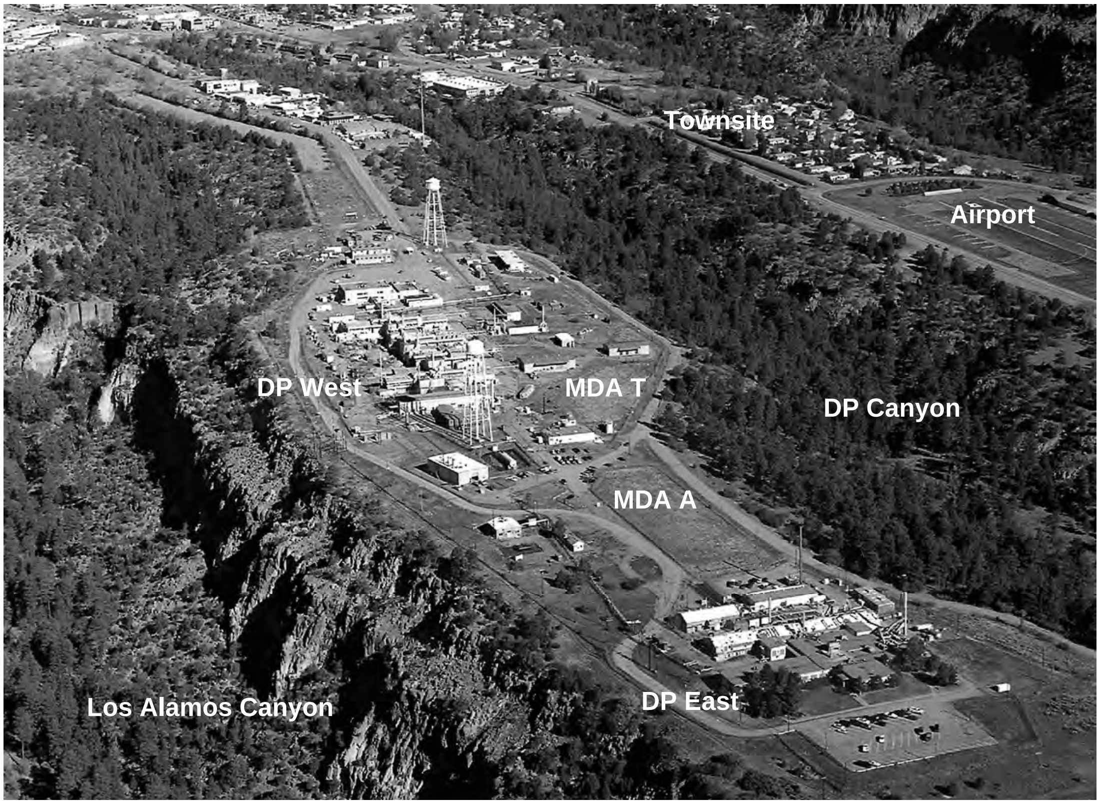


Figure H–5 Aerial Photograph of the DP East and DP West Sites, Looking West (1995)

Building 21-0152 and portions of Building 21-0155 are 1945-era pre-engineered steel frame, metal lath and plaster buildings with metal exterior siding and roofs. Buildings 21-0155 and 21-0209 contain concrete columns with concrete masonry units and brick exterior walls, and built-up roofing (LANL 1999). The equipment in these two buildings contained accountable quantities of radioactive material that is assumed to be removed in the deactivation operations prior to DD&D.

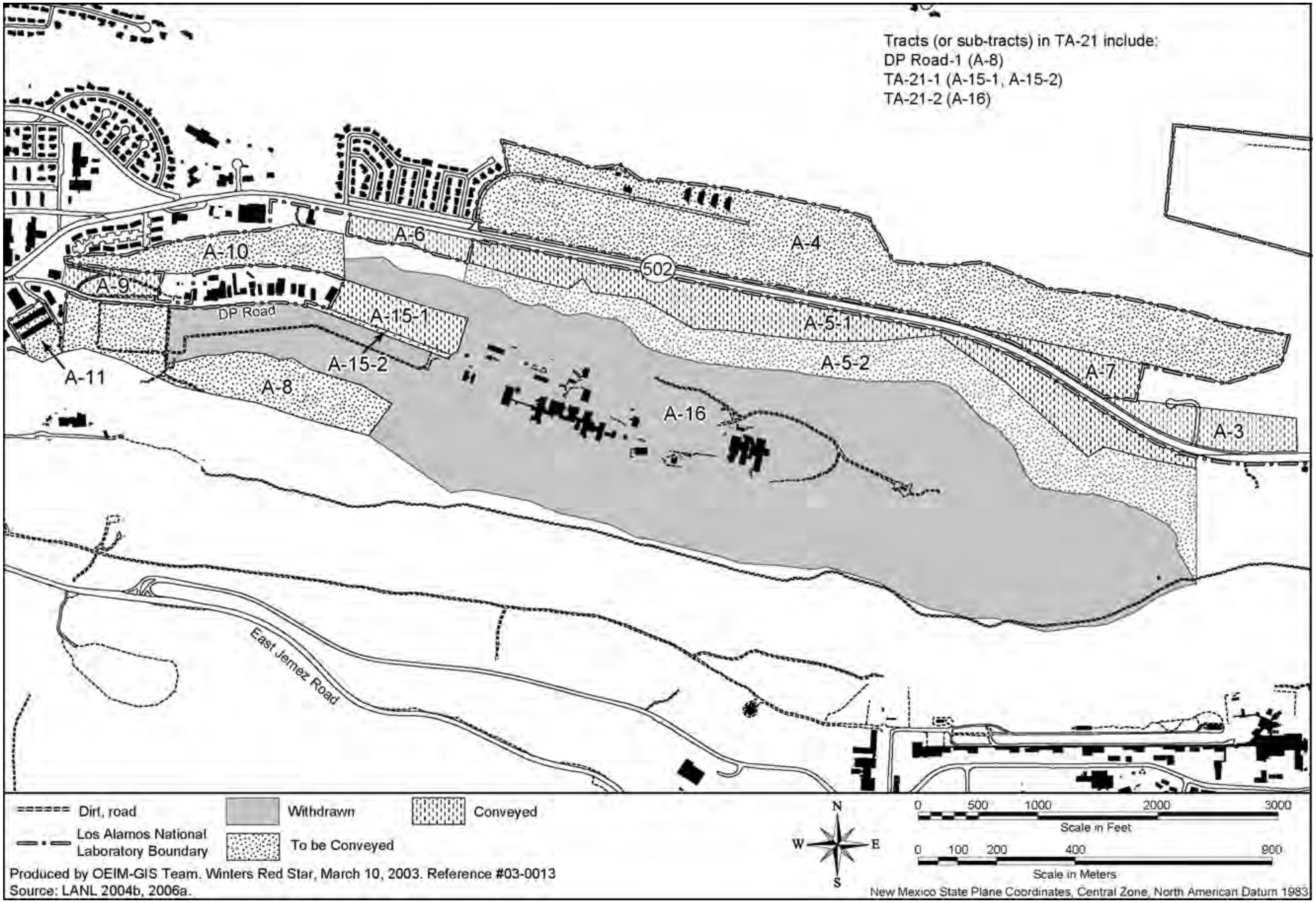
LANL staff has essentially completed the transfer of the tritium handling and storage mission from the DP East process buildings. Many of the remaining TA-21 buildings have been used for administrative or logistics support (such as general offices, warehouses and maintenance shops). There are numerous inactive buildings and structures that are largely unused and awaiting DD&D. Particularly prominent items include two water towers and water supply pumps and equipment that support the domestic water system. There are a number of warehouse facilities, sludge drying beds adjacent to the now unused sewage treatment plant, a steam plant that supplies heat to process and office facilities within the TA-21 area, electrical substations, chemical tanks and piping, security buildings, and additional miscellaneous utilities. There are also other nonbuilding “structures” such as roads and parking lots, various types of fences and security systems, utility poles, light poles, steam lines, and other miscellaneous features (LANL 1999). A natural gas pipeline currently supplies the steam plant and furnace facilities of DP East and serves as a secondary supply of natural gas to TA-53.

Access to the TA-21 facilities is via DP Road, which connects with New Mexico (NM) 502 at the edge of the Los Alamos business district. Access from TA-21 to the remainder of the LANL facility is either west along NM 502 (Trinity Drive) and Diamond Drive to TA-3, or east on NM 502 to NM 4. The route east on NM 502 is steep and curved and not recommended for truck traffic.

The Consent Order issued on March 1, 2005, establishes requirements for the investigation and cleanup of environmental contamination at LANL (NMED 2005a). TA-21 contains five MDAs, and over 60 potential release sites, many related to TA-21 buildings. For example, the Liquid Radioactive Waste Treatment Facility in 21-0257 contains many treatment and holding tanks that are designated as solid waste management units under the Consent Order and is included in the area specified for MDA T corrective action. The process buildings were originally constructed with below-grade waste piping contained in concrete troughs; these troughs are being investigated as potential release sites. There are additional known or suspected contaminant release sites next to or underneath the process buildings that are subject to investigation and corrective actions as part of the NNSA response to the Consent Order.

To allow a thorough and complete investigation of existing TA-21 potential release sites, NNSA would remove a number of the larger remaining TA-21 structures to allow reasonable access to nearby potential release sites and areas that are currently obstructed. Utility infrastructure also would need to be removed to allow access to additional areas. Schedules and activities for investigating each impacted potential release site would need to be integrated with the DD&D schedules of the obstructing buildings. The current schedule for the Consent Order requires that DOE complete all corrective actions within the Los Alamos and Pueblo watershed by August 2011. Building 21-0257 is collocated with MDA T, where a remedy completion report is required by February 19, 2010 (LANL 2006a, NMED 2005a).

Areas in TA-21 are also designated for potential reutilization under Public Law 105-119. Section 632 of that law directed DOE to convey land at or in the vicinity of LANL to the County of Los Alamos or transfer land to the U.S. Department of the Interior in trust for the Pueblo of San Ildefonso. DOE identified a number of tracts and subtracts of land for potential conveyance or transfer, including three subtracts within TA-21 as shown in **Figure H–6**. Section 4.1.1 includes additional information about the conveyance and transfer of TA-21 and other LANL tracts (DOE 1999d). TA-21 “subtracts” include DP Road-1 (A-8), TA-21-1 (A-15-1 and A-15-2), and TA-21-2 (A-16). The DP Road-1 subtract (25 acres [10.1 hectares]) and 8.7 acres (3.5 hectares) of the TA-21 tract have been, or are expected to be, conveyed to Los Alamos County. The remaining portion of the TA-21 tract (referred to as subtract A-16), about 252 acres (102 hectares), contains the majority of the areas within TA-21 that would need to be remediated under the Consent Order. This area has been withdrawn from the conveyance process.



Produced by OEIM-GIS Team. Winters Red Star, March 10, 2003. Reference #03-0013
Source: LANL 2004b, 2006a.

Figure H–6 Land Transfer Activities in Technical Area 21

In the midst of the DP Road and TA-21 tracts there is a land parcel of approximately 10 acres (4 hectares) of private land that is currently occupied by private commercial and light industrial businesses not directly associated with LANL contracts. This land is surrounded on the west and north by portions of the DP Road tract, and bounded on the south and east by portions of the TA-21 tract. MDA B is located directly across DP Road from these businesses.

Three buildings are in the DP Road-4 subtract which has yet to be conveyed. These consist of two National Register of Historic Places-eligible buildings (the LANL archives and warehouse), and a portable guardhouse that has been determined not eligible for listing on the National Register of Historic Places. Final characterization for radioactivity and hazardous materials contamination is incomplete and a determination of whether the structures need to be demolished prior to conveyance has yet to be made (LANL 2005a).

Although the TA-21-2 subtract is currently "withdrawn" from conveyance to Los Alamos County because of legacy contamination and as a buffer zone for TA-53 operations, portions of it may still be considered for conveyance after the remediation process is complete. The subtract is potentially attractive to businesses due to its proximity to the Los Alamos townsite, which suffers from a lack of land available for commercial development. Conversely, the remediation option selected for TA-21 might include significant quantities of radioactive materials remaining in place in a capped disposal site. This would result in significant areas being maintained under perpetual institutional control, making the remaining adjacent portions less desirable for development.

One possibility is removal of all buildings within subtract TA-21-2, and the subsequent evaluation of the resultant brownfield sites for potential reuse. Other possibilities include allowing the building foundations to remain, with or without application of a cap. Geophysical and radiological surveys have been conducted, potential release sites and boundaries identified, buried waste lines and structures located, and the nature and extent of geophysical and radiological anomalies determined (LANL 2005a). Based on this information, LANL staff can continue evaluating the reuse of portions of subtract TA-21-2 for industrial development and potential conveyance to Los Alamos County.

A number of previous NEPA determinations have been made that affect the proposed DD&D of TA-21. In 1995, DOE prepared the *Environmental Assessment of the Relocation of Neutron Tube Target Loading Operations*, DOE/EA-1131 (DOE 1995). The Proposed Action considered in that environmental assessment was the relocation of Neutron Tube Target Loading operations from TA-21 Building 21-0209 to Weapons Engineering Tritium Facility at TA-16 and associated upgrading of the building. Neutron Tube Target Loading involves the transfer of radioactive tritium gas onto metal target disks that are then assembled into neutron tubes. These neutron tubes are ultimately assembled into neutron generators that are used as nuclear weapons components. This environmental assessment specifically excludes consideration of the DD&D of Building 21-0209, but in addressing the relocation of these tritium activities, includes the subsequent deactivation of Building 21-0209. This Proposed Action was overtaken by the decision to relocate Neutron Tube Target Loading operations to Sandia National Laboratories (DOE 2005a).

DOE prepared the *Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the DOE and Located at LANL, Los Alamos and Santa Fe Counties, New Mexico (Conveyance and Transfer ElS)*, DOE/EIS-0293 (DOE 1999d) to examine potential environmental impacts associated with the conveyance or transfer of each of the land tracts tentatively identified in the DOE's Land Transfer Report to the Congress under Public Law 105-119. The transfer of TA-21 areas is considered under the *Conveyance and Transfer EIS*, including the DP Road tract and TA-21-1 subtract identified for transfer and development for commercial and industrial uses, and the TA-21-2 subtract that has been withdrawn from the conveyance process. This development would bring additional members of the public into the vicinity of the DP West and DP East Sites.

The Environmental Assessment for the Proposed Issuance of an Easement to Public Service Company of New Mexico for the Construction and Operation of a 12-inch Natural Gas Pipeline within Los Alamos National Laboratory, Los Alamos, New Mexico, DOE/EA-1409 (DOE 2002a) analyzes the construction of a gas line to provide natural gas to TA-53 and other LANL areas. The new line provides a more reliable source of natural gas for the areas currently supplied by the line that crosses TA-21 near DP East, in the necessary quantity, reliability, and redundancy necessary to allow the TA-21 line to be used as a secondary or emergency source of natural gas to these areas. Although the TA-21 natural gas requirements would end if the TA-21 steam plant is shut down, maintenance of the cross-mesa line as a secondary feeder to TA-53 would require modifications to allow remediation activities at MDA A and MDA T.

In 2005, DOE completed the *Environmental Assessment for the Proposed Consolidation of Neutron Generator Tritium Target Loading Production*, DOE/EA-1532 (DOE 2005a). This environmental assessment evaluates the potential impacts of relocating certain tritium handling operations from TA-21 and TA-16 to Sandia National Laboratories. This document and the associated finding of no significant impact provide NEPA analysis of installation of the neutron tube target loading process equipment in Building 870 at Sandia National Laboratories and subsequent target loading operations, but do not address the disposition of LANL tritium facilities.

Purpose and Need

There are numerous aging process and support buildings in TA-21 that are surplus to future LANL needs. Since the *1999 SWEIS* ROD, all activities associated with the NNSA missions have been relocated to other buildings at LANL, offsite locations, or have been discontinued. With their missions consolidated elsewhere, these buildings have been prioritized within the queue of buildings awaiting DD&D as part of LANL's program to reduce the surveillance and maintenance cost necessary to protect workers, the public, and the environment. The *1999 SWEIS* section on decommissioning includes a discussion but no formal consideration of the impacts of the DD&D of the DP West buildings (DOE 1999a). The movement among tritium facilities was discussed in general in the *1999 SWEIS*, and addressed specifically in the *Environmental Assessment of the Relocation of Neutron Tube Target Loading Operations* (DOE 1995). Thus, although the deactivation of all TA-21 process facilities has been the subject of NEPA analysis and is included in the No Action Alternative, NNSA has yet to formally consider the DD&D of the DP West and East Sites and of the remainder of TA-21 structures.

In addition to the general need to eliminate inactive legacy buildings and their associated overhead and maintenance costs, NNSA must remove many of these buildings to support the investigations of solid waste management units identified under the Consent Order. Some of these solid waste management units lie underneath buildings and slabs or are associated with past activities at the buildings. In addition, the TA-21 Liquid Radioactive Waste Treatment Facility is within the boundary of MDA T, and NNSA must remediate and manage the land associated with the building as part of that corrective action. The current schedule for the Consent Order requires that all corrective actions within the Los Alamos and Pueblo watershed be completed by August 2011 (LANL 2006a).

Finally, TA-21 is an area with potential for reuse under Public Law 105-119, and 54 acres (21.9 hectares) have been designated for conveyance to Los Alamos County. However, a large portion of the area (see Figure H–6) has been withdrawn from the conveyance process. Portions of this area could be considered as brownfield sites in the future.

H.2.2 Options Description

This section provides descriptions of the three options – the No Action Option; the Compliance Support Option, which removes structures only as necessary to support the environmental restoration activities; and TA-21 Complete DD&D Option of all structures within TA-21. The TA-21 Complete DD&D Option and the Compliance Support Option support the Expanded Operations Alternative within the overall SWEIS (Chapter 3 of this SWEIS). The TA-21 Complete DD&D Option is the preferred option.

As it continues to match missions to buildings, LANL staff identify buildings that are excess to its needs based on age, building condition, and current mission requirements. For decades, the DP West and DP East sites, which include buildings from the 1940s and 1950s that have hosted several radiological missions, have been identified for eventual DD&D. The *1999 SWEIS* projected that the DD&D of DP West would be completed by 2004, and identified the potential for (but did not analyze) the consolidation of TA-21 tritium operations to TA-16 (DOE 1999a). As part of a long-term plan to eventually DD&D these sites and allow for their environmental remediation and possible reuse, NNSA has not located any new missions at TA-21, and has relocated all TA-21 mission activities to buildings at other locations that are more structurally sound or operationally efficient. With the completion of the tritium mission in DP East, the NNSA planning process considers all of the TA-21 process buildings excess, with some in DP West already demolished.

The options identified for DD&D of the TA-21 buildings are generally consistent with the plan to DD&D the DP East and DP West Sites, and differ only in schedule and scope. All options begin with the DP East tritium buildings having completed deactivation.

H.2.2.1 No Action Option

The No Action Option assumes that the DP Site facilities would remain in their current status through 2011, the period analyzed by this SWEIS, and that there would be no additional DD&D during that period. All process facilities would be maintained under a surveillance and maintenance status, all administrative and logistics facilities would remain occupied or in their current service, and Building 21-0257 would maintain its capability to process liquid radioactive waste. Certain portions of the investigations and corrective actions for the DP Site under the Consent Order could be undertaken, but those that would be obstructed by existing buildings, and particularly Building 21-0257, would be postponed indefinitely. There would be continued surveillance and maintenance costs, minor emissions, and failure to achieve Consent Order milestones. All of the radioactively contaminated facilities in TA-21 must eventually undergo some level of decontamination and decommissioning; the No Action Option defers the actions and extends the public health liabilities for TA-21 radioactive facilities to an indeterminate future time.

H.2.2.2 Technical Area 21 Complete Decontamination, Decommissioning, and Demolition Option

Under this option all structures located within the boundaries of TA-21, including process buildings, administrative and logistics buildings, and support facilities would undergo DD&D. This would include the DD&D of infrastructure such as gas, water, and waste piping, electrical and communication lines, fences, and similar materials and equipment. NNSA would schedule DD&D activities to support the investigation and corrective actions required under the Consent Order. However, below-grade remediation activity not directly associated with structural foundations is not part of this scope and would be addressed separately as part of the Consent Order actions. The DD&D of buildings and structures with a possible interim use, such as the steam plant and piping and administrative and logistics facilities, could be deferred.

The TA-21 Complete DD&D Option would remove approximately 126 buildings and structures totaling approximately 271,000 square feet (25,177 square meters) (LANL 2006a). It would generate approximately 34,000 cubic yards (26,000 cubic meters) of radioactive waste and 48,000 cubic yards (37,000 cubic meters) of nonradioactive waste, and would require on the order of 256,000 person-hours of DD&D effort. Combined with the associated remediation activities, this option would directly affect the entire mesa top from the end of the mesa on the east to MDA B on the west, plus canyon areas for the access road. Contractor facilities would be required, including a waste management area to load and ship waste and a clean soil stockpile area to accept incoming and excavated clean soils.

The current status of TA-21, as described in the beginning of Section H.2.2, would be the starting point for the initiation of activities under this option. Activities under this option would include the characterization of the DP West process facilities, removal of any remaining process piping and interior process and nonprocess equipment, surface decontamination and facility demolition. The TA-21 Liquid Radioactive Waste Treatment Facility (Building 21-0257) would be deactivated, and all process equipment would be removed from it and from the tritium facilities in DP East. These facilities would also proceed through the remaining elements of DD&D discussed in the beginning of Appendix H. The remaining TA-21 nonprocess buildings and structures would then be characterized and demolished, with waste disposal dependent on facility characterization information. The DD&D projects under this option would be coordinated with Consent Order remediation activities to support timely completion of Consent Order milestones. Activity scope would be coordinated to avoid duplication of efforts such as soil and below-grade pipe removal, area excavation, and revegetation. Detailed DD&D plans are currently being prepared for the contaminated facilities. Since initial planning and characterization is not complete, specific work plans, methods, schedules, and resources are not available. Therefore, the impact analysis has used the general methods identified above to provide a bounding case.

H.2.2.3 Compliance Support Option – Partial Decontamination, Decommissioning, and Demolition to Allow Consent Order Compliance

Under the Compliance Support Option, LANL workers would DD&D only those structures that cover or would interfere with activities to investigate and remediate MDAs and other potential release sites where releases of contamination to the environment are suspected. The DD&D of TA-21 would be initiated based on the DP Site Decontamination and Decommission Project as currently defined, because the scope of that project is to DD&D those facilities that inhibit or preclude the cleanup of potential release sites. Under this option, there would be no further DD&D scope for TA-21 subsequent to this work, including any removal of buildings or structures to reduce surveillance and maintenance costs or support reutilization or conveyance under Public Law 105-119.

The Compliance Support Option would remove approximately 25 buildings and structures totaling approximately 200,000 square feet (18,580 square meters). It would generate approximately 34,000 cubic yards (26,000 cubic meters) of radioactive waste, 19,000 cubic yards (14,000 cubic meters) of nonradioactive waste, and would require on the order of 230,000 person-hours of DD&D effort (LANL 2006a). It would directly affect an area of approximately 14 acres (5.7 hectares) in TA-21, including grading and revegetation, although this would overlap with areas remediated as part of the Consent Order. **Table H–4** shows the TA-21 structures that would undergo DD&D in conjunction with the Compliance Support Option.

In practice, the initial actions of this option would be the same as the TA-21 Complete DD&D Option. LANL workers would characterize the DP West process facilities, remove any remaining process piping and interior nonprocess equipment, decontaminate surfaces, and demolish the facilities. Similarly, the TA-21 Liquid Radioactive Waste Treatment Facility (Building 21-0257) would be deactivated, and all process equipment removed from it and from the tritium facilities in DP East. These facilities would also proceed through the elements of characterization, decontamination, and demolition, which would result in removing most of the contaminated facilities from TA-21. The Compliance Support Option would also remove approximately seven additional buildings and structures that are largely uncontaminated but would obstruct remediation actions necessary to comply with the Consent Order. Various portions of the utilities infrastructure including gas, steam, water, sewage, and electrical lines and water towers would need to be removed to facilitate the investigation and remediation of MDAs and other potential release sites in both this and the TA-21 Complete DD&D Option. After removal of this infrastructure, an additional effort would be required to reroute or compensate for these interrupted services to the buildings that remain occupied after completion of Compliance Support Option DD&D activities.

Table H–4 Technical Area 21 Buildings to Undergo Decontamination, Decommissioning, and Demolition for the Compliance Support Option

Property Identification	*Description*
21-0002	Wet laboratory north + south
21-0002	Wet laboratory north + south mezzanine
21-0003	Remaining structure + adjacent asphalt
21-0004	Remaining structure + adjacent asphalt
21-0005	Laboratory north + south
21-0005	Laboratory north + south - mezzanine and attic
21-0005	Laboratory basement
21-0021	Building slab only
21-0046	Warehouse
21-0089	Pressure relief valve
21-0116	Hot tool room, including basement
21-0144	Utility/passageway
21-0149	Corridor
21-0150	Basement
21-0150	Mezzanine
21-0150	Molecular chemistry
21-0152	Laboratory building
21-0155	1st floor
21-0155	External mezzanine
21-0209	1st floor
21-0209	Basement
21-0228	Warehouse-slab only
21-0230	Sludge drying bed
21-0257	Liquid Radioactive Waste Treatment Plant
21-0257	Underground piping
21-0258	West water tower
21-0286	Warehouse - radioactive
21-0312	Corridor
21-0313	Corridor
21-0314	Corridor
21-0315	Corridor
21-0342	East water tower
RW Lines	Radioactive waste lines at Technical Area 21

Source: LANL 2006a.

H.2.3 Affected Environment and Environmental Consequences

This section describes the natural and human environment that could be impacted during the DD&D of TA-21 buildings and structures and provides the context for understanding any associated environmental consequences. The analysis of environmental consequences relies on the affected environment descriptions in Chapter 4 of this SWEIS. Where information specific to TA-21 is available and adds to the understanding of the affected environment, it is included here. The affected environment descriptions in this section serve as a baseline from which any environmental changes brought about by implementing one of the options can be evaluated; the baseline conditions are the existing conditions.

The definition of existing conditions is complicated by the evolution of TA-21 activities. Over the past several years, TA-21 tritium operations have been discontinued and there have been limited DD&D activities – equipment has been removed from several buildings and other buildings have been demolished. As a result, TA-21 characteristics may show variations independent of any action considered in this document. This is discussed in more detail in the individual resource sections.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for environmental justice, a determination was made that no further analysis was necessary because no disproportionate impacts to low-income or minority populations would be expected.

H.2.3.1 No Action Option

The No Action Option assumes that the administrative, logistics, and office activities currently occurring at TA-21 would continue. As there would be no additional DD&D at TA-21, the western portion of the area (that is, the 8.7-acre [3.5-hectare] TA-21-1 [West] Parcel) would be conveyed to Los Alamos County in the condition planned, with structures and infrastructure intact. The remainder of the TA would remain a part of LANL in an ongoing state of surveillance and maintenance. The No Action Option would have little or no additional effect on water resources except for the elimination of the National Pollutant Discharge Elimination System (NPDES) outfall associated with the deactivation of the Tritium Science and Fabrication Facility. Similarly, no changes to current radiological and nonradiological emissions or air pollutant concentrations are expected under the No Action Option, except those resulting from the deactivation of the TA-21 tritium facilities. Tritium emissions should diminish through 2011 even without DD&D, especially if ventilation at DP East could be terminated. (Emissions from stacks at TA-21 were stopped in September 2006 as one of TA-21 shutdown activities.) Ecological and cultural characteristics of TA-21 would remain largely unchanged from existing conditions, whereas public and worker dose resulting from radiological emissions from TA-21 would be expected to be consistent with, and less than, historical values. The No Action Option would eliminate the generation of waste that would otherwise be generated from DD&D and environmental restoration projects under the TA-21 Complete DD&D Option and Compliance Support Option.

H.2.3.2 Technical Area 21 Complete Decontamination, Decommissioning, and Demolition Option

Land Resources

Land Use

TA-21 consists of about 312 acres (126 hectares) at the eastern end of DP Mesa, near the central business district of the Los Alamos Townsite. The airport is located immediately north of TA-21, across DP Canyon. About 20 percent of the TA has been developed with the west-central portion of the tract containing the majority of development; remaining portions of the TA consist of sloped areas, some of which would likely not accommodate development. Access to the site is via DP Road (LANL 1999). As noted in Section H.2.1, facilities at TA-21 have until recently supported tritium research.

TA-21 is one of a number of TAs identified for conveyance to Los Alamos County under Section 632 of Public Law 105-119 (see SWEIS Chapter 4, Section 4.1.1). This TA has been divided into four subtracts for purposes of the land conveyance: DP Road-1, TA-21-1 (West) that consists of two units, and TA-21-2 (East). These subtracts have also been designated as A-8, A-15-1, A-15-2, and A-16, respectively (see Figure H–6). Subtracts A-8, A-15-1, and A-15-2 total 33.7 acres (13.6 hectares) in size and either have been or are slated to be conveyed to the county. Parcel TA-21-2 (East) is 252.1 acres (102 hectares); however, its conveyance has been deferred.

Land use within TA-21 has, until recently, included Waste Management; Administration, Service, and Support; Nuclear Materials Research and Development; and Reserve (see Chapter 4, Figure 4–4). According to the *Comprehensive Site Plan* for 2001, TA-21 falls within the Omega West Planning Area. The *Comprehensive Site Plan* indicates that all TAs within the planning area would eventually be decommissioned (LANL 2001a). Two areas within TA-21 are noted as No Development Zones (Hazard). TA-21 also includes five MDAs and numerous other potential release sites that will have to be addressed and potentially remediated in support of the Consent Order.

DD&D Impacts—Following DD&D of the buildings and structures within that part of TA-21 that has been withdrawn from conveyance to Los Alamos County (the 252-acre [102-hectare] TA-21-2 [East] Parcel), portions of the area could be considered as brownfield sites for potential reuse. Pending a decision relating to reuse, the redesignation of portions of the TA-21 from Waste Management, Service and Support, and Nuclear Materials Research and Development to Reserve is in keeping with the present designation of the remaining land within TA-21, as well as adjacent TAs (LANL 2003d).

Visual Environment

Facilities at TA-21 are situated on DP Mesa, which is located between Los Alamos Canyon to the south and DP Canyon to the north. Developed portions of the TA present an industrial appearance. Undeveloped portions of the mesa remain moderately vegetated with native grasses, shrubs, and small trees. The canyons are wooded. The site, particularly the water tower, can be seen from locations along NM 502. Developed portions of TA-21 are visible from higher elevations to the west. An analysis of the visual quality of the site determined that both developed and undeveloped areas of the site had low public value for visual resources (DOE 1999d).

DD&D Impacts—DD&D activities would have short-term adverse impacts on visual resources due to the presence of heavy equipment and an increase in dust. Following removal of buildings and structures within TA-21, the area would be contoured and revegetated, as appropriate, resulting in an improved visual environment. Since the area could be developed in the future, these efforts would be aimed primarily at soil stabilization and not at recreating a more natural environment. With future redevelopment possible, the view of the TA from NM 502 and from higher elevations to the west could remain commercial and industrial in nature. Nevertheless, with proper planning, the view would be of modern architecturally compatible buildings rather than the current mix of 50-year-old structures.

Geology and Soils

The TA-21 buildings and structures are subject to the same general geology and seismic conditions as the entire LANL site. As discussed in this SWEIS, Chapter 4, Section 4.2.2, geologic mapping and related field and laboratory investigations that included TA-21 revealed only small faults that have little potential for seismic rupture.

The LANL soil-monitoring program conducts annual sampling of soils for contaminants in and around the LANL facility. The program has identified TA-21 soils and soil samples from an adjacent area near the airport as the only LANL areas routinely exceeding Regional Statistical Reference Levels for plutonium, although the levels remain below levels that would require active remediation. The elevated contaminant levels are the result of actinide processing activity conducted at the DP West facility prior to its transfer to the TA-55 facility in the 1970s. There was no impact on the TA-21 soils from the Cerro Grande Fire.

DD&D Impacts—Under all options, the impact of a seismic event has been reduced by the deactivation of the DP East facilities and removal of a majority of the source material present. Since no new facilities would be constructed under the TA-21 Complete DD&D Option, there would be no new potential seismic impact. The TA-21 Complete DD&D Option would have a minor impact on the geologic and soils resources at LANL as the affected facility areas are already developed and adjacent soils are already disturbed. The DD&D activities would introduce some additional ground disturbance in excavating foundations and establishing laydown yards and waste management areas near the facilities to be demolished. However, the impacts would be temporary and available paved surfaces, such as adjacent parking lots, would be used to mitigate any impact. The degree of soil disturbance from this option is expected to be much smaller than that resulting from major remediation activities under the Consent Order. The primary indirect impact would be associated with the need to excavate any contaminated tuff and soil not addressed by the Consent Order from beneath and around facility foundations. Borrow material (such as crushed tuff and soil) would be required to fill the excavations to grade. Such resources are available from onsite borrow areas (see Chapter 5 of this SWEIS, Section 5.2) and in the vicinity of LANL.

Water Resources

Since the DP West and DP East buildings were constructed in 1945, they have used domestic and industrial water and have discharged cooling water to the DP Canyon. Building 21-0227 originally treated TA-21 sewage and industrial wastewater effluents prior to discharge to the DP Canyon. In 1999, this waste stream was rerouted to the TA-46 Sanitary Wastewater Systems Plant. Past soil contamination could impact surface water contamination levels in runoff, contamination migration through the soil, and contamination levels that may be present in the groundwater.

TA-21 water usage has historically averaged about 25 million gallons (95 million liters) per year representing about 5 percent of LANL usage (LANL 2006a). As the tritium mission at DP East is completed, the need for process and cooling water is expected to continue to decrease, leaving domestic usage and building ventilation (steam heat and cooling water) as the only major continuing uses.

There are two NPDES outfalls into the DP Canyon, which is considered part of the Los Alamos Canyon watershed. **Table H–5** provides the actual annual flows of these outfalls for the TA-21 facilities, the Steam Plant and the Tritium Science and Fabrication Facility (LANL 2006f).

Table H–5 Volume of Technical Area 21 National Pollutant Discharge Elimination System Outfalls (millions of gallons per year)

Facility Mission	*NPDES Outfall Designation*	*Source Building*	*Building/Process Description*	*2005 SWEIS Yearbook Actual Flow*
Tritium	02A-129	155N, 357	Steam Plant	32.6 [a]
Tritium	03A-158	209	Tritium Science and Fabrication Facility	0.39

NPDES = National Pollutant Discharge Elimination System.

[a] Discharge is estimated from flow measurements made at the time of sampling assuming a constant discharge rate. Contributing flows such as boiler blowdown are not metered. Thus, the reported discharge is overestimated based on metered water use at the steam plant.

Note: To convert gallons to liters, multiply by 3.785.

Source: LANL 2006f.

Most of the TA-21 site is sloped so that stormwater from the buildings and parking lots drain into either the DP or Los Alamos Canyons. TA-21 is located on a mesa top and not within the 100-year or 500-year floodplain boundaries. TA-21 currently contains four active aboveground fuel storage tanks and one active underground fuel storage tank, some of which are empty in anticipation of closure or DD&D.

DD&D Impacts—The TA-21 Complete DD&D Option would result in little or no effect on overall LANL water use or resources. Water use and discharges associated with the use of TA-21 office and logistics facilities would be reduced. The outfalls from the Tritium Science and Fabrication Facility and the Steam Plant would be eliminated, which would have a minor effect on surface water quality in Los Alamos Canyon. These industrial effluents comprise less than 40 percent of the discharges into that canyon. Removal of these discharges would have little effect on surface water quality, as the majority of the effluent is boiler blowdown and cooling water, which contains fewer contaminants than wastewater. However, as organizational functions are transferred to other LANL buildings, there would be compensating increases in the water and steam uses by those buildings. If TA-21 actions are limited to those required by the Federal Facility Compliance Agreement, then there would be little impact on surface water quantity and quality in Los Alamos Canyon, as only the Tritium Science and Fabrication Facility outfall would be eliminated.

This option would not result in the disturbance of watercourses or generation of liquid effluents that would be released to the surrounding environment. Silt fences, hay bales, or other appropriate best management practices would be employed (as described in stormwater pollution prevention plans) to ensure that fine particulates are not transported by stormwater or water used in dust suppression into surface water features in the DP or Los Alamos Canyons. Potable water use at the site would be limited to that necessary for equipment washdown, dust control, and sanitary facilities for workers. Impacts of DD&D activities on groundwater should be minimal because of surface water collection practices, especially in comparison to the impact from environmental restoration activities being conducted to comply with the Consent Order. Any final contouring of industrial areas and subsequent soil stabilization would be in conjunction with remediation activities necessary for compliance with the Consent Order. Groundwater profiling and any actions required to remediate past spills would be undertaken as part of the TA-21 remediation activities.

Air Quality and Noise

This section discusses radioactive and nonradioactive air emissions specific to TA-21. Radiological doses are discussed under Human Health.

Air Quality

Emissions from TA-21 activities include pollutants that have the potential to impact co-located LANL workers and the surrounding community, including radiological emissions from operating facilities and facilities in a state of surveillance and maintenance, as well as radioactive and nonradiological emissions from buildings and DD&D projects. The proximity of TA-21 to the Los Alamos townsite and to the recently transferred "DP Road" tract places all TA-21 emission sources close to the LANL site boundary and the public. NNSA plans, executes, controls, and monitors new and established TA-21 building and activity emissions to ensure worker and public safety, and to verify pollutant levels are within established regulatory limits.

Nonradioactive Emissions. Activities generating nonradioactive air pollutants at TA-21 include the Steam Plant, vehicle exhaust, and minor emissions from activities in the maintenance facilities operated by the LANL maintenance contractor. Emissions from the TA-21 Steam Plant are shown in **Table H–6**. DD&D activities have produced small amounts of fugitive dust consistent with dust generation that would result from normal construction activities (LANL 2004d).

Table H–6 Calculated Actual Emissions for Regulated Pollutants Reported to the New Mexico Environment Department for 2005

Source	*Nitrogen Oxides*	*Sulfur Oxides*	*Particulate Matter (less than or equal to 10 micron)*	*Carbon Monoxide*	*Volatile Organic Compounds*	*Hazardous Air Pollutants*
TA-21 Steam Plant	1.6	0.016	0.12	1.33	0.09	0.03
All Other LANL	48.9	1.9	4.9	33.8	14.5	6.5
Total	50.5	1.9	5.0	35.1	14.6	6.5
Percent TA-21 Steam Plant	3.1	0.8	2.4	3.8	0.6	0.5

TA = technical area.
Note: Air emissions in tons per year (LANL 2006e).

As part of the Title V operating permit application, the New Mexico Environment Department requested that LANL provide a facility-wide air quality impacts analysis. The analysis included emissions from the TA-21 boilers and demonstrated that simultaneous operation of all regulated air emission units described in the Title V permit application, being operated at their maximum requested permit limits, would not result in any ambient air quality standards being exceeded (LANL 2003c).

The limited amount of ambient air sampling that has been performed for nonradioactive air pollutants within the LANL region is discussed in Chapter 4 of this SWEIS. Although past activities at TA-21 facilities have involved handling of beryllium materials none of the TA-21 buildings is on the NESHAP permit for beryllium emissions, and TA-21 has no current operations that would result in beryllium emissions (LANL 2005e).

The NESHAP for asbestos requires that NNSA provide advance notice to the New Mexico Environment Department for large renovation jobs that involve asbestos and for all demolition projects such as at TA-21. The asbestos NESHAP further requires that all activities involving asbestos be conducted in a manner that mitigates visible airborne emissions and that all asbestos-containing wastes be packaged and disposed of properly. To ensure compliance, the LANL contractor has established an Asbestos Report Project with internal requirements defined in its Quality Assurance Project Plan, and conducts internal inspections of job sites and asbestos packaging on approximately a monthly basis (LANL 2003a, 2005e).

DD&D Impacts—Under the TA-21 Complete DD&D Option, the operational emission sources would be relocated or cease as the activities are relocated and the buildings demolished. There would be temporary increases in vehicle exhaust and fugitive dust during the demolition. Initial air emissions from TA-21 would be similar to current emissions. The nonradioactive air pollutant emissions from the three natural gas fired boilers in Building 21-0357 would be eliminated. Vehicle exhaust and emissions from activities in the maintenance and support facilities would be expected to follow these functions to their new location within LANL. The emissions produced from the use of toxic chemicals in the laboratory and the Liquid Radioactive Waste Treatment Facility, already reduced during deactivation, would be eliminated, as the process buildings are placed into surveillance and maintenance status and subsequently demolished.

Demolition and removal of radiological and nonradiological buildings and structures would result in temporary air quality impacts from construction equipment, truck, and employee vehicle exhaust. Criteria pollutant concentrations were not modeled for demolition of buildings at TA-21, but would be less than for construction of new facilities occurring concurrently at LANL. Concentrations offsite and along the perimeter road to which the public has regular access would be below the ambient air quality standards. Building demolition would also result in particulate (fugitive dust) emissions. The dust could include small amounts of lead, asbestos, and other nonradioactive hazardous constituents despite methods and controls used to mitigate such contaminants and ensure DD&D worker and co-located employee safety during demolition. Although the DP Canyon separates the DP Mesa from the site boundary, the proximity to the public would require active measures to ensure dust suppression and control. This option would result in the DD&D of a greater number of buildings than the Compliance Support Option. If the dust generated by demolition is assumed to be roughly proportional to the demolition waste volume, then the dust generated by the TA-21 Complete DD&D Option would be approximately 40 percent greater than that generated by the Compliance Support Option.

Radioactive Emissions. Radiological emissions from the TA-21 facilities are shown in **Table H–7**, and the ambient air sampling data at the center of TA-21 and at the East Gate (at the LANL perimeter across the DP Canyon north of TA-21) are shown in **Table H–8**.

Table H–7 Technical Area 21 Radiological Point Source Emissions

Location	*Emissions Point*	*7-Year Average (1999-2005) Radionuclide Emissions (curies per year)* [a]
21-155 (TSTA Stack)	21015505	264 (tritium) [b]
21-209 (TSFF Stack)	21020901	470 (tritium) [b]
Total		734 (tritium) [b]

TSTA = tritium systems test assembly, TSFF = Tritium Science and Fabrication Facility.

[a] Sources: LANL 2000c, 2001b, 2002c, 2003b, 2004a, 2005b, 2006d.

[b] Tritium gas and tritium oxide combined.

Table H–8 Technical Area 21 Ambient Air Monitoring

Radionuclide	*2005 Average Concentrations (curies per cubic feet)* [a]	
	Concentration at East Gate Location (north of LANL east of the airport)	*Concentration at TA-21 (central between DP East and DP West)*
Tritium	1.0×10^{-13}	1.2×10^{-13}
Americium-241	-1.2×10^{-20}	1.3×10^{-19}
Plutonium-238 [b]	-1.2×10^{-20}	6.7×10^{-21}
Plutonium-239 [b]	1.4×10^{-20}	1.3×10^{-18}
Uranium-234	2.2×10^{-19}	1.7×10^{-18}
Uranium-235 [b]	1.3×10^{-20}	1.3×10^{-19}
Uranium-238	2.6×10^{-19}	8.2×10^{-19}

TA = technical area.

[a] Source: LANL 2006e.

[b] Negative values are the result of analytical uncertainties due to the small quantity of material present in the sample, and from the adjustment to account for background radionuclide concentrations.

Note: To convert curies per cubic feet to curies per cubic meters, multiply by 0.028.

Tritium emissions from the Tritium Systems Test Assembly and the Tritium Science and Fabrication Facility exhaust ventilation stacks has decreased since 2003, in part due to the completion of active source removal activities at TA-21-155 and initiation of surveillance and maintenance status. Continued emissions from this facility, the result of off-gassing from contaminated equipment that remains in the building, requires continued monitoring until the potential emission levels from TA-21-155 are fully characterized. As TA-21-209 tritium-contaminated systems are dismantled and prepared for removal and disposal, increased emissions of tritium are expected. However, overall long-term emissions from these facilities would decrease following deactivation (LANL 2004d). There may be a short-term increase in tritium emissions from the Tritium Systems Test Assembly and the Tritium Science and Fabrication Facility during removal and relocation of tritium processing equipment, with emissions in the range of 1 to 7 curies per week from each facility. Since these increases should only be for limited periods, annual emissions would remain well below the facility 5-year averages.

Information on past building DD&D emissions at DP West was developed during the Building 3 and Building 4 South DD&D project. Stack monitors remained operational until the main ventilation systems were bypassed and capped in 1994 and 1995. For the first 3 years of the project (1991 through 1993) stack emissions were 9.2×10^{-5}, 5.1×10^{-5}, and 5.3×10^{-5} curies combined uranium and plutonium, respectively. This is comparable to routine emissions data for other LANL operating facilities as shown in Chapter 4, Section 4.4.3.1 of this SWEIS. Additionally, during the demolition of decontaminated buildings with areas of stabilized residual contamination, numerous air monitors placed at the perimeter of the controlled area detected no activity above background (LANL 1995).

Ambient air samples were analyzed for 10 radionuclides, and concentrations of the radionuclides that are relevant to activities at TA-21 are shown in Table H–8. The elevated tritium concentrations at TA-21 and the East Gate locations are likely to be at least partially the result of Tritium Systems Test Assembly and the Tritium Science and Fabrication Facility emissions, although ambient air sampling cannot unambiguously determine the sources of the radionuclides detected. The source of the uranium and transuranic air concentrations are less apparent, although some of these concentrations are near regional background levels.

DD&D Impacts—Even during surveillance and maintenance, radiological facilities could produce radiological emissions, depending upon the operational status of the building exhaust systems. During initial DD&D, there would be emissions during the removal of equipment and decontamination of structural surfaces. While the building shell is intact, emissions would result from building or temporary ventilation systems used for dust and contamination control. These systems would use high-efficiency particulate air filtration to reduce entrained airborne radioactivity prior to exhausting air from interior contaminated spaces to areas outside the building. Ventilation and other controls would be used to minimize worker inhalation and exposure to radioactivity and avoid recontamination of previously decontaminated areas. The result of the initial activities would be structural surfaces either decontaminated to unconditional-release levels or with selected contaminated surfaces stabilized to permit segregation of radioactively contaminated and uncontaminated debris after demolition.

The potential exists for contaminated soils, building debris, and possibly other media to be disturbed during building demolition. Release of radioactivity would be minimized by proper decontamination of buildings prior to demolition – if facilities are decontaminated to unconditional release levels as prescribed by the MARSSIM protocol, emissions would be similar to those from uncontaminated buildings. If residual levels of contamination remain after decontamination activities are complete, then small amounts of radioactivity would be emitted during demolition. The radionuclide concentrations resulting from demolition of contaminated facilities can be predicted based on the predemolition characterization of the building, and would be addressed in regulatory documents approved at that time. Such emissions typically would be of short duration, and would be minimized using dust suppression techniques and monitored along with the fugitive dust. This option would result in the DD&D of a greater number of buildings than the Compliance Support Option, but the number of radioactively contaminated buildings would be essentially the same.

Noise

The activities at TA-21 are similar to those of other office and laboratory areas at LANL. Operations noise sources include heating, ventilation, and cooling equipment, generators, and vehicles. DD&D and construction activities have also generated noise for limited periods. Minimal noise impacts are generated by current TA-21 activities.

DD&D Impacts—Noise levels during demolition activities would be consistent with those typical of construction activities. As appropriate, workers would be required to wear hearing protection to avoid adverse effects. Noninvolved workers at the edge of the demolition areas and members of the public on the perimeter road would be able to hear the activities; however, the level of noise would not be expected to result in increased annoyance. Construction noise at LANL is common. Some wildlife species might avoid the immediate vicinity of the TA-21 demolition sites as demolition proceeds due to noise; however, any effects on wildlife resulting from noise associated with the demolition activities would be expected to be temporary.

Ecological Resources

This section addresses the ecological setting (terrestrial resources, wetlands, aquatic resources, and protected and sensitive species) of TA-21. Ecological resources of LANL as a whole are described in Chapter 4, Section 4.5 of this SWEIS, and the vegetation zones are depicted in Figure 4–25.

While most of TA-21 is located within the Ponderosa Pine Forest vegetation zone, the more easterly portions of Los Alamos Canyon are within the Pinyon-Juniper Woodland vegetation zone. Also, mixed conifer forest occurs along north facing canyon walls (see Figure 4–25). About 20 percent of the area is developed as roadways, parking lots, and facilities with associated landscaping (DOE 1999d). Wildlife within undisturbed portions of the TA would be expected to be typical of those two communities. The Cerro Grande Fire (DOE 2000) did not directly affect TA-21. Wildlife use of developed portions of the site would be expected to be minimal, with large mammals being excluded from the area due to the presence of security fencing.

There are no wetlands within TA-21 (ACE 2005). Los Alamos Canyon contains a perennial water source flowing a few cubic feet per second during most of the year (DOE 1999d). Aquatic resources within the Los Alamos Canyon stream would be limited since no fish have been found in any LANL streams.

TA-21 falls within the Los Alamos Canyon Mexican spotted owl Area of Environmental Interest with the southern and eastern portions included within the core zone. TA-21 does not include any portion of the Areas of Environmental Interest for the bald eagle or southwestern willow flycatcher (LANL 2000b).

DD&D Impacts—All DD&D activities analyzed in this SWEIS would take place within the industrial area of TA-21, which contains little wildlife habitat. Wildlife in canyons adjacent to TA-21 could be intermittently disturbed by construction activity and noise over the demolition period when heavy equipment would be used to raze structures, remove building foundations and buried utilities, excavate contaminated soil, and transport wastes to disposal sites. Demolition related disturbances to wildlife are expected to be intermittent and localized. Upon DD&D of the buildings and structures within TA-21, the site would be contoured and revegetated. However, revegetation would have only relatively short-term benefits to wildlife since it is likely that the area could be developed in the future.

There are no wetlands located within TA-21. Thus, neither the elimination of two NPDES-permitted outfalls nor DD&D activities would affect this resource.

As noted above, TA-21 falls within the Los Alamos Canyon Mexican spotted owl Area of Environmental Interest. Since the TA-21 is highly disturbed no suitable foraging or nesting habitat would be lost as a result of DD&D activities and owls have not been identified in Los Alamos Canyon for the past 11 years. Noise levels may exceed background levels by more than 6 dB(A) as a result of demolition activities. The DOE biological assessment concluded that provided reasonable and prudent alternatives are implemented, DD&D activities may affect, but are not likely to adversely affect, the Mexican spotted owl. Reasonable and prudent alternatives include muted back-up indicators on heavy equipment, keeping disturbance and noise to a minimum, avoidance of unnecessary disturbance to vegetation including not removing trees with a diameter at breast height larger than 8 inches (20 centimeters), reseeding and erosion protection, and ensuring that any new lighting meet the requirements of the New Mexico Night Sky Protection Act. Also, activities involving heavy equipment would not be permitted to take place between March 1 and May 15, or until the completion of surveys for spotted owls. If owls were determined to be present work restrictions would be extended until August 31 (LANL 2006b). The U.S. Fish and Wildlife Service has concurred with this assessment (see Chapter 6, Section 6.5.2).

Since no bald eagle nesting or foraging habitat would be lost as a result of DD&D activities and the southwestern willow flycatcher Area of Environmental Interest is more than 2.6 miles (4.2 kilometers) from TA-21, the DOE biological assessment determined that the proposed project would have no effect on either species (LANL 2006b). The U.S. Fish and Wildlife Service has concurred with this assessment (see Chapter 6, Section 6.5.2).

Human Health

Routine operations and activities at TA-21 facilities result in LANL workers and the public receiving a radiation dose above background radiation levels, either through direct radiation exposure or through the inhalation or ingestion of radioactivity in the air or elsewhere in the environment. Subsections discuss TA-21 radiological doses to certain receptors, followed by the impact of those doses on the public and LANL workers. The “Worker Health” section also discusses the impacts from DD&D industrial accidents. Nonradiological air emissions and their effects are discussed in the “Air Quality” section and the effects of traffic accidents are discussed in the “Transportation” section in the following pages. The risk of facility accidents during the DD&D of TA-21 facilities was evaluated based on the radioactive material-at-risk estimated to remain in each individual process building after its deactivation or during surveillance and maintenance. On the basis of this evaluation, the environmental impacts for releases that could result from a facility accident at TA-21 are bounded by the impacts of previously evaluated accidents at the same location, and are not further addressed in this analysis.

NNSA evaluates the public impact of radionuclide emissions by direct monitoring of emission point sources and ambient air monitoring. The radiation doses calculated from the radiological emissions from TA-21 facilities are shown in **Table H–9**. Radiological doses determined from the ambient air sampling at TA-21 and the adjacent East Gate locations are shown in **Table H–10**.

Table H–9 Maximally Exposed Individual Average Radiological Doses from Technical Area 21 Point Source Emissions

Location	*7-Year Average Dose (1999-2005) (millirem per year)*	
	Dose to LANL MEI at East Gate	*Dose to Facility-Specific MEI*
21-155 (TSTA Stack)	0.0103	0.0103
21-209 (TSFF Stack)	0.00891	0.0200
Total	0.0192	0.0303

MEI = maximally exposed individual, TSTA = Tritium Systems Test Assembly, TSFF = Tritium Science and Fabrication Facility.
Sources: LANL 2000c, 2001b, 2002c, 2003b, 2004a, 2005b, 2006d.

Table H–10 Radiological Doses (above background) Measured at Technical Area 21 and the East Gate Locations, Based on Ambient Air Monitoring

Radionuclides	*7-Year Average Dose (1999-2005) (millirem per year)*	
	Annual Dose at the East Gate Location (north of LANL east of the airport)	*Annual Dose at TA-21 (central between DP East and DP West)*
Tritium	0.0401	0.0439
Americium-241	0.00157	0.00643
Plutonium-238	0.0	0.000429
Plutonium-239	0.000571	0.0424
Uranium-234	0.00629	0.0186
Uranium-235	0.00129	0.00257
Uranium-238	0.00786	0.0147
Total	0.0586	0.129

TA = technical area.
Sources: LANL 2000c, 2001b, 2002c, 2003b, 2004a, 2005b, 2006d.

Table H–9 provides the basis for assessing impact to the public from existing TA-21 operations. Radioactive material processing facilities in TA-21 collect, filter, and exhaust air from contaminated portions of the facility through ventilation exhaust stacks under normal operating conditions. Dispersion modeling techniques use the calculated radionuclide emissions data shown in Table H–7, along with other inputs to predict the radiological doses for hypothetical individuals at selected locations and for the collective population dose received by the surrounding community. The information in Table H–9 indicates the average annual radiological impact that the facilities within TA-21 have had on the surrounding community for the last 7 years. As deactivation activities are completed, the radiological dose attributable to tritium emissions should decrease independent of the options.

The radiological dose shown in Table H–10 is the average annual dose that a hypothetical individual would receive if they breathed air with the net airborne radionuclide concentration (sampled minus background) collected from the designated location. Although both radiological doses are low, the dose at the TA-21 location is higher, as might be expected closer to the tritium facility stacks and the DD&D of the moderately contaminated buildings removed during the sampling period. The radiological dose is derived in approximately equal parts from tritium, transuranic (plutonium and americium), and uranium isotopes. The East Gate location is common to both Table H–9 (emissions sampling and dose calculated by dispersion modeling) and Table H–10 (dose calculated using ambient air sampling data). The values given for tritium dose, the only radionuclide present in substantially elevated levels, shows reasonable agreement between the two tables for that location, given the difference in methods and the presence of other LANL emissions that could contribute to the hypothetical ambient dose.

Public Health

The LANL maximally exposed individual (MEI) is a hypothetical member of the public who, while not on LANL property, would receive the greatest dose from LANL operations (see Chapter 4 of this SWEIS, Section 4.6). The location of this MEI during most years of the analysis has been at the East Gate along NM 502, entering the east side of Los Alamos County. The 7-year (1999 through 2005) average dose the LANL MEI would have received is 1.9 millirem per year (based on emission sampling and dispersion modeling, not the ambient air monitoring value shown in Table H–10; see Chapter 5 of this SWEIS, Section 5.6), less than one percent of the naturally occurring background radiation dose (estimated to range from 300 to 500 millirem per year based on where the individual lives). Of the dose to the LANL MEI at the East Gate, the average portion attributed to the TA-21 facilities was minimal (0.0192 millirem per year).

In addition to the LANL MEI, each Key Facility has a facility-specific MEI, a hypothetical member of the public who, while at a location near that facility but not on LANL property, would receive the greatest dose from all Key Facilities. As shown in Table H–9, the average TA-21 facility-specific MEI is 0.0303 millirem per year.

The 7-year (1999 through 2005) average collective population dose attributable from all LANL operations to persons living within 50 miles (80 kilometers) of LANL was 1.22 person-rem. Tritium, from DP East as well as other Key Facilities, contributed to this population dose; however, most of this population dose resulted from the short-lived air activation products from the Los Alamos Neutron Science Center (LANSCE) (LANL 2006e).

DD&D Impacts—The DD&D process could cause temporary increases in radiological emissions that could be controlled within acceptable limits, but would result in the elimination of residual emissions from legacy structures. Removal of legacy structures also would permanently preclude any uncontrolled releases that would result from the failure of deteriorating structures or external factors such as wildfires. Environmental remediation activities that would follow DD&D perform a similar function for contaminated soil or environmental media, trading minimal temporary emissions for long-term risk reduction. There would be no direct radiation exposure to members of the public during this project due to the prohibition of public access to DD&D areas and the low levels of radiation present after deactivation.

Radiological emissions from TA-21 facilities under the TA-21 Complete DD&D Option would be divided into two phases. In the first phase, DD&D activities occurring within the building would take advantage of building integrity and certain building systems for contamination and emissions control. The second phase would be the short period during structural demolition for each building after decontamination is complete. A small fraction of any remaining radioactive contamination (and other hazards) could become airborne as the structure is demolished.

Estimating the dose received by the public from the in-building DD&D activities is difficult since there is little facility characterization or planning data available, including levels of radioactivity in equipment and how building and other contamination control systems would be used. Given the limited data, one approach to developing a bounding estimate radiation dose to the public is to assume that the emissions from in-building DD&D would be similar to the emissions from the building during operations. The types of radioactivity and controls would be similar, the building structure would be intact, and tritium trapping and filtration systems would be in place for ventilation exhaust during decontamination. The estimate would be conservative because, with the removal of accountable quantities of radioactive materials and cessation of process activities, levels of radioactivity present in the building would be orders of magnitude less than levels present during operation. Additionally, radioactivity would be continually reduced as equipment and materials are packaged as waste and removed. The 7-year average dose received by East Gate MEI from current emissions from the DP East tritium facilities is 0.0192 millirem per year (see Table H–9)

A second approach to estimating the dose received by the public is to compare it to emissions from similar previous DD&D projects. The Building 3 and Building 4 South DD&D project at DP West had stack emissions during in-building DD&D activities ranging from an initial high of 92 microcuries of uranium and plutonium the first year of the project to a low of 27 microcuries the final year of the project. A conservative calculation of the dose received from this emission suggests the East Gate MEI would receive less than 0.02 millirem per year. While it is difficult to accurately quantify the impact of in-building DD&D activities on the public, it is clear that the dose that would be received would be significantly less than one millirem per year.

Based on conservative estimates of residual levels of surface contamination and no mitigation on emissions during demolition from surface sealants or water spray, the dose that would be received by the East Gate MEI over the course of the whole TA-21 building demolition was estimated at 0.0002 millirem. Since many of the process buildings would be decontaminated to unconditional release levels, and dust suppression using water sprays also would be required to reduce fugitive dust, this dose is considered bounding. In examining previous projects, air sampling conducted during the Building 3 and Building 4 South demolitions detected no radioactivity above background that was attributable to decommissioning.

All of the options would have some ongoing emissions during the period considered under this SWEIS, with the impacts being bounded by those present during past DP East and DP West process operations. Tritium outgassing from deactivated equipment in DP East and some additional emissions from the DP West facilities in surveillance and maintenance status would continue under all options. The TA-21 Complete DD&D Option and the Compliance Support Option would remove radioactive materials from buildings; while that process might temporarily increase emissions, it would actively reduce emissions over time.

Worker Health

The 7-year average collective total effective dose equivalent for the LANL worker population is 161 person-rem (LANL 2003d, 2004c, 2005d, 2006f). In general, determining collective total effective dose equivalents for each TA is difficult because worker exposure data are collected at the group level, and members of many groups and organizations receive doses at several locations. The fraction of a group's collective total effective dose equivalent coming from a specific Key Facility or TA can only be estimated. For example, health physics personnel and maintenance workers are distributed over the entire site, and these two occupational groups account for a significant fraction of the LANL total effective dose equivalent. This would also be applicable to workers previously conducting work at DP West who also worked on other environmental restoration and DD&D activities. Thus, relevant historical worker exposure is not readily available from LANL data on an activity-by-activity basis.

Although data to support quantitative values of worker dose by facility are not readily available, the relative dose workers receive can be predicted based on the specific considerations at TA-21. Office workers receive only ambient radiation doses. The radiological dose received by workers engaged in surveillance and maintenance activities at DP East and DP West radioactive facilities is relatively low because the radiation source terms have been largely removed and the time spent in the contaminated areas has shortened. Doses received by workers associated with tritium activities, including the deactivation of these facilities, would not be applicable as a baseline for comparison of options. Thus non-DD&D workers receive low exposures.

Workers conducting DD&D activities in production facilities that are contaminated with uranium, tritium, and transuranic isotopes receive both external and internal dose. The external dose, in the form of gamma or beta exposure, is modest during the deactivation element and continues to decrease as the higher levels of radioactivity and more contaminated equipment is removed from the buildings. The internal dose, which is received when radioactive contamination is inhaled or ingested, can be reduced through ventilation controls, stabilization of loose contamination, and the use of personal protective equipment. DD&D projects in DP West reported worker internal radiation doses averaging 2 millirem over the project (LANL 1995).

DD&D activities involve work with tools, cutting equipment, and often large hydraulic and construction equipment, and workers are exposed to potential accident conditions similar to those found on construction sites. These include cutting and pinching, work at elevated locations and in trenches or enclosed spaces, rigging, and working near large construction equipment. Additionally, there are industrial hygiene hazards, particularly those associated with old buildings, such as exposure to asbestos and transite, lead and other heavy metals, polychlorinated biphenyls, solvents and hazardous constituents, and biological hazards (such as hantavirus from mouse droppings). National safety statistics are used in this analysis because they provide a more conservative estimate than would DOE safety statistics.

DD&D Impacts—The principal impacts on worker health would result from the radiation dose workers receive during the execution of DD&D, industrial hygiene impacts due to exposure to asbestos and hazardous materials, and industrial accidents similar to those associated with routine construction.

Potential worker dose during the decontamination of the buildings can only be estimated, as each facility would have to be characterized before work planning could begin. Planning would support maintaining worker doses at an ALARA level. The collective worker dose would be greater than that received at present because DD&D workers would receive a greater dose than workers performing surveillance and maintenance activities, and a greater number of workers would be required. However, under the No Action Option, the liability of the contaminated building remains, and addressing that liability would eventually require workers to incur similar radiological doses. Based on these projects, worker exposures from the DD&D of TA-21 should be less than the LANL radiation worker 7-year average of 161 person-rem per year.

The demolition of the TA-21 buildings might also involve the removal of asbestos contaminated materials. Removal of asbestos-contaminated materials would be conducted according to LANL asbestos management programs, in compliance with strict asbestos abatement guidelines, and is regulated by New Mexico Environment Department under the provisions of NESHAPS. Workers would use personal protective equipment and other engineered and administrative controls. Reviews of historical documentation and characterization of facilities would also provide information on areas in buildings where hazardous material spills have occurred, and conditions that present additional industrial hygiene hazards to workers. Industrial hygiene hazards may be present in facilities in which there is no radioactive contamination; however, nonradiological facilities may allow greater use of large construction equipment, resulting in less direct worker contact with hazardous locations.

Construction accidents are a substantial worker risk in DD&D activities, which require the use of cutting and shearing electrical, pneumatic, and hydraulic tooling. Workers must address issues of working at elevated locations, on scaffolding, below grade, and in confined or atmospherically suspect areas, and address issues of rigging large equipment and electrical safety. These issues are addressed at LANL through the Integrated Safety Management process, including job characterization, work planning, and worker training. Special care is also necessary in work around large pieces of construction equipment. Since there is no DD&D activity associated with the No Action Option, the risk of construction accidents resulting in worker injury or death is greater in the TA-21 Complete DD&D Option and the Compliance Support Option. Based on an expected 256,000 DD&D labor hours and DOE and national construction accident statistics, the DD&D of the TA-21 buildings could cause 3 to 11 recordable injuries. No construction fatalities would be expected using either of the statistical bases. Potential impacts from hazardous and toxic chemicals would continue to be prevented through the use of administrative controls and equipment.

Cultural Resources

The three general categories of cultural resources addressed in this section are archaeological, historic buildings and structures, and traditional cultural properties.

Archaeological and Historic Buildings and Structures. A cultural resource survey of TA-21 has identified 5 archaeological sites. These include a cavate, a rockshelter, trails and stairs, and a rock or wooden enclosure. The five sites are formally declared eligible or potentially eligible for listing on the National Register of Historic Places through consultation with the State Historic

Preservation Office. Additionally, surveys of buildings and structures at TA-21 have determined that 15 buildings are National Register of Historic Places-eligible.

Traditional Cultural Properties. Traditional cultural properties are properties that are eligible for the National Register of Historic Places because of their association with cultural practices or beliefs of a living community that are rooted in that community's history and are important in maintaining its cultural identity. There are no known traditional cultural properties located within TA-21; however, consultations with American Indian and Hispanic groups have not been conducted. Traditional cultural properties would not be anticipated in developed portions of the TA (DOE 1999d).

DD&D Impacts—DD&D of buildings and structures at TA-21 would not directly impact the five National Register of Historic Places-eligible or potentially eligible archaeological sites present within the area. DD&D of buildings and structures would have direct effects on 15 National Register of Historic Places-eligible historic buildings and structures that are associated with the Manhattan Project and Cold War years at LANL.

Prior to any demolition activities taking place, DOE in conjunction with the State Historic Preservation Office, would implement documentation measures such as preparing a detailed report containing the history and description of the affected properties. These measures would be incorporated into a formal Memorandum of Agreement between DOE and the New Mexico Historic Preservation Division to resolve adverse effects to eligible properties. The Advisory Council on Historic Preservation would be notified of the Memorandum of Agreement and would have an opportunity to comment.

Socioeconomics and Infrastructure

Socioeconomics

As of the end of 2005, approximately 130 personnel were located in TA-21 facilities, along with additional seasonal employees or summer students. These personnel supported environmental and other LANL programs and maintenance and warehousing functions for the LANL maintenance contractor.

DD&D Impacts—Socioeconomic impacts could result from the TA-21 DD&D action, including impacts on:

- LANL contractor and subcontractor employment;
- Potential employment from business using additional conveyed land (previously discussed in the *TA-21 Conveyance and Transfer EIS* [DOE 1999d]); and
- Private enterprises located on and adjacent to the DP Mesa.

Both the TA-21 Complete DD&D Option and the Compliance Support Option would remove most of the office space that these organizations currently use. However, since the programs and functions would still be required after the DD&D of TA-21, the majority of the personnel would be relocated to other buildings owned or leased by LANL, with little resulting effect to overall

LANL employment. The 30 personnel who support TA-21 tritium operations would be relocated regardless of the TA-21 DD&D option.

Any employment from DD&D activities would be modest and temporary, with a maximum onsite DD&D workforce of fewer than 100 workers. Additionally, LANL has an ongoing program to remove excess facilities; the intermittent DD&D activity at the DP West Site over the last several years was funded and managed as part of this program. Although the DD&D of TA-21 would require DD&D workers at TA-21, this would not necessarily increase the overall number of DD&D workers. Any DD&D funding not used for TA-21 buildings would be available for DD&D projects in other TAs. The impacts of TA-21 DD&D would not directly translate into increases or decreases in overall DD&D employment.

Several of the tracts at the western end of TA-21 adjacent to the land on DP Road currently in commercial use have been (or are anticipated to be) conveyed to Los Alamos County. These tracts provide undeveloped areas close to the Los Alamos townsite available for future development unencumbered by the issues associated with “brownfield” areas. Current plans allow for the possibility that portions of the largest tract (TA-21-2/A-16), which contains the DP East and DP West and most of the TA-21 areas, may be made available for industrial use after remediation. Given the current level of planning detail for both the DD&D and remediation approach and the remediation schedule showing completion of corrective actions within the Los Alamos and Pueblo watershed by August 2011, the socioeconomic impacts from associated future development cannot be accurately predicted and would likely occur after 2011.

Private businesses located on the DP Mesa and adjacent to DP Road could incur modest but not irreparable impacts from the TA-21 DD&D. Waste disposal DD&D activities would result in an average of fewer than 10 one-way trips (and 10 empty return trips) per day between 2006 and 2011 on DP Road and onto NM 502. This would not be a significant increase in traffic compared to current operations on either of these roads. The DD&D of contaminated facilities would take place at least 500 yards (457 meters) from the businesses, sufficient distance to mitigate any fugitive dust or project infrastructure impacts.

Infrastructure

Major utility infrastructure (electric power, natural gas, and water) is available at TA-21 to provide service to existing facilities. The TA-21 steam plant (TA-21-0357) is the central utility plant for DP Mesa facilities and a major consumer of utility resources, particularly natural gas to fire its three boilers as well as water for makeup and cooling. As such, it is the only TA-21 facility for which utility demands are specifically monitored (LANL 2003c, 2006a). The cessation of activities within TA-21 and the DD&D of TA-21 buildings and structures would include the removal or abandonment of existing utility corridors that serve the affected facilities. TA-21 steam plant operations have most recently required approximately 200 megawatt-hours of electricity, 27,000 decatherms (equivalent to about 27 million cubic feet [0.76 million cubic meters]) of natural gas, and 1.6 million gallons (6.1 million liters) of water annually (LANL 2006a).

DD&D Impacts—Activities associated with DD&D of all TA-21 facilities are expected to require 43,000 gallons (163,000 liters) of liquid fuels and 1.3 million gallons (4.9 million liters) of water. DD&D activities would be staggered over an extended period of time. As a result, impacts of these activities on LANL's utility infrastructure are expected to be minor on an annualized basis. Standard practice dictates that utility systems serving individual facilities are shut down as they are no longer needed. As DD&D activities progress, interior spaces, including associated equipment, piping, and wiring, would be removed prior to final demolition. Thus, existing utility infrastructure would be used to the extent possible and would then be supplemented or replaced by portable equipment and facilities as DD&D activities proceed, as previously discussed for construction activities.

Waste Management

LANL tracks its waste generation by "Key Facility" in the following categories: transuranic (including mixed transuranic), low-level radioactive waste, mixed low-level radioactive waste, and a category of chemical waste that includes hazardous and toxic waste and construction and demolition debris. Historical chemical and radioactive waste generation information is provided in **Table H–11** for TA-21.

Table H–11 Waste Generation Ranges and Annual Average Generation Rates from Technical Area 21 Facilities

		Tritium Facilities (annual rates)	*TA-21 Building 3 and Building 4 South Project, (1992-1995)*
Low-level Radioactive Waste (cubic yards)	Range	0 to 143	Not applicable
	Average	69	3,360
Mixed Low-level Radioactive Waste (cubic yards)	Range	0 to 2	Not applicable
	Average	0.9	Not applicable
Chemical Waste (pounds)	Range	20 to 11,390	Not applicable
	Average	2,483	1,790
Liquid Waste from TA-21-0257 (gallons)	Range	6,600 to 121,000	Not applicable
	Average	32,000	Not applicable

TA = technical area.

Notes: To convert pounds to kilograms, multiply by 0.45359; cubic yards to cubic meters, multiply by 0.76456; gallons to liters, multiply by 3.78533.

Sources: LANL 1995, 2003d, 2004c, 2005d, 2006f.

Due to its limited activity, TA-21 has generated relatively little operational waste over the past 5 years. The DP East buildings are considered part of the Tritium Key Facilities, as are the Weapons Engineering Tritium Facility and other facilities in TA-16. While the quantity of waste shown for the Tritium Facilities in Table H–11 is conservative because it includes contributions from both TA-16 and TA-21, it provides an indication of the waste types and a bounding limit on waste quantities. Sanitary (solid) waste, and uncontaminated construction and demolition debris generated at TA-21 was disposed of at the Los Alamos County Landfill. Recent environmental restoration activities in TA-21 have included investigation and source removal actions. For example, a corrective action at MDA V in 2006 resulted in removal of a large volume of waste. The only reported waste was 10.5 cubic yards (8 cubic meters) resulting from a removal action and site restoration conducted at Solid Waste Management Unit 21-024(f) (LANL 2004c). The wastes generated by the DD&D project to remove the south portions of Building 21-3 and Building 21-4 in the 1990s is shown in Table H–11 as an example of quantities and types of waste generated during a previous small DD&D project. The area of the buildings removed as part of this project represents between 6 percent and 9 percent of the area of the facilities that currently remain at TA-21.

Liquid sanitary wastes generated from all TA-21 facilities are treated at the TA-46 Sanitary Wastewater Systems Plant. Building 21-257, which has historically treated all liquid radioactive wastes generated by the DP West and DP East process facilities, is currently being maintained in a standby condition to allow pretreatment of any liquid radioactive wastes that would be generated from the deactivated facilities. After deactivation is complete, such waste is expected to be minimal, and it is unlikely that any DD&D-generated liquids would require processing in Building 21-257. Table H–11 provides the range and average liquid radioactive waste volumes pretreated at Building 21-257.

DD&D Impacts—The DD&D of TA-21 buildings and structures would generate a substantial volume of waste, and a principal project effort would be characterizing, packaging, handling, and disposing of waste materials. Initial planning efforts for the DP Site DD&D project have developed preliminary waste estimates. Dimensions of existing building components along with projections of contamination levels and packaging efficiencies were used to estimate waste volumes by waste type. As additional characterization data and planning information becomes available these estimates would be updated to refine the waste types and quantities, determine container types and quantities, and estimate levels of waste radioactivity. The waste estimate values for both of the TA-21 DD&D action options are provided in **Table H–12**.

Table H–12 Waste Generation under the Proposed Action and Compliance Response Alternatives

	Tritium Facilities (nominal average yearly generation)	*TA-21 Complete DD&D Option*	*Compliance Support Option*
Low-level Radioactive Waste	69 cubic yards	34,000 cubic yards	34,000 cubic yards
Bulk Low-level Radioactive Waste [a]	Not available	26,000 cubic yards	26,000 cubic yards
Packaged Low-level Radioactive Waste [a]	Not available	8,600 cubic yards	8,600 cubic yards
Mixed Low-level Radioactive Waste (RCRA/TSCA constituents; not radioactive asbestos is considered low-level waste)	0.9 cubic yards	65 cubic yards	65 cubic yards
Transuranic Waste [b]	0.0	1.3 cubic yards	1.3 cubic yards
Solid Waste (nonradioactive construction debris and sanitary waste)	Not available	47,000 cubic yards	18,000 cubic yards
Chemical Waste (asbestos and hazardous)	1.2 cubic yards	420 cubic yards	420 cubic yards
Liquid Waste Pretreated at TA-21-0257	32,000 gallons	8,000 gallons	5,700 gallons

TA = technical area; DD&D = decontamination, decommissioning, and demolition; RCRA = Resource Conservation and Recovery Act; TSCA = Toxic Substances Control Act.

[a] The low-level radioactive waste total has been subdivided into “bulk” and “packaged” components. The bulk waste is typically lower-activity radioactive building debris transported in intermodal containers and lift liners. The packaged waste is typically the higher-activity (>10 nanocuries per gram) materials and equipment packaged in “Type A” containers.

[b] Includes transuranic and mixed transuranic waste; all of the TA-21 transuranic waste would be “contact-handled” with no generation of transuranic “remote handled” waste.

Notes: To convert cubic yards to cubic meters, multiply by 0.76456; gallons to liters, multiply by 3.78533. All numbers rounded to two significant figures.

DOE has developed extensive liquid and solid waste management infrastructures at LANL with capabilities to characterize, process, package, store, and manage all of the waste types that would be generated during the DD&D of TA-21. NNSA has the capability to treat and dispose of some wastes onsite but in other cases uses permitted offsite facilities for treatment and disposal. The two largest-volume waste types expected to be generated by the DD&D of TA-21 are solid low-level radioactive waste and nonradioactive construction debris. NNSA plans on using a combination of onsite disposal and offsite disposal to disposition low-level radioactive waste to minimize the impact of the large volume of DD&D waste that this project, and other projects would generate.

The Los Alamos County Landfill is expected to cease operations in fall 2008. A new transfer station, operated by the County, will be used to sort and ship sanitary waste and uncontaminated debris to a landfill or recycling facilities outside the county. NNSA would also recycle as much of these materials as possible. Debris concrete may be crushed and used as fill material in lieu of importing clean fill soil and uncontaminated metal may be recycled as scrap. For the purposes of the analysis, Table H–12 conservatively assumes all of the debris is disposed of as waste.

All other wastes expected to be generated by the DD&D activities would be handled, managed, packaged, and disposed of in the same manner as the same wastes generated by other activities at LANL. Piping and other materials that are characterized as transuranic waste would be packaged in accordance with WIPP Waste Acceptance Criteria and the appropriate LANL procedures, transferred to Area G for storage, and ultimately shipped to the WIPP near Carlsbad, New Mexico. Any radioactive materials that are characterized as mixed low-level radioactive waste may be stored onsite at Area TA-54 pending identification of an offsite treatment and disposal facility. Most mixed low-level radioactive waste generated at LANL is sent offsite to other DOE or commercial facilities for treatment and disposal.

Asbestos contaminated with radioactive material could be disposed of in a disposal cell in Area G that is dedicated to the disposal of radioactively contaminated asbestos waste or alternatively packaged and disposed of offsite according to the receiving facility waste acceptance criteria. Asbestos waste that is not radioactively contaminated that is generated during the DD&D activities would be packaged according to applicable requirements and sent to the LANL asbestos transfer station for shipment offsite to a permitted asbestos disposal facility along with other asbestos waste generated at LANL.

Any hazardous waste generated during the TA-21 DD&D activities would be handled, packaged, and disposed of according to LANL's hazardous waste management program. These amounts are expected to be small and would be well within the capacity of LANL's hazardous waste management and disposal program.

Radioactive liquid waste would be transferred to the Radioactive Liquid Waste Treatment Facility in TA-50 at LANL for treatment. The liquid waste from the DD&D activities for TA-21 would be within the treatment and disposal capacity of the Radioactive Liquid Waste Treatment Facility. No effect on the Radioactive Liquid Waste Treatment Facility is anticipated.

The major difference between the TA-21 DD&D options is that the solid debris in the TA-21 Complete DD&D Option is about three times of the solid debris waste in the Compliance

Support Option due to the fewer buildings demolished. The asbestos waste would probably also be higher for complete DD&D; however, without characterization data on the buildings it is unclear which of the additional buildings would be expected to contain asbestos. The availability of asbestos removal contractors and asbestos disposal locations should not become a constraint.

Transportation

Several types of transportation impacts result from current TA-21 activities: automobile traffic on and off of the LANL facility, and truck traffic, particularly associated with maintenance and logistics activities. These vehicles need to pass through the Los Alamos townsite to reach other LANL TAs. This level of activity is consistent with an operating facility environment. There has historically been intermittent truck traffic associated with waste from DD&D of facilities at DP West.

DD&D Impacts—There are several types of temporary and permanent transportation impacts that could result from alternatives at TA-21. These include changes in automobile traffic patterns on and off of the LANL facility and changes in truck traffic patterns, particularly for transporting waste. While there might be minor changes in traffic patterns between options based on changes in number and locations of jobs and temporary increases in DD&D activities, the impact of a few hundred workers would be minor within the total LANL workforce.

Local traffic resulting from TA-21 DD&D activities, including worker commutes, equipment movement, and waste transportation, should not be appreciably greater than that which occurred during past operations. When combined with the traffic from concurrent remediation activities, the cumulative traffic would not result in local traffic exceeding normal volume for commercial areas, although there might be some intermittent periods of traffic congestion. The number of DD&D workers at TA-21 likely would be less than the current TA-21 staff. While the remediation option under the Consent Order for TA-21 has yet to be determined, even the most extensive remediation option would be less than 500 workers. The construction equipment may be staged at TA-21, so its movement along public roads would be mostly during project mobilization and demobilization. The traffic impacts from waste transportation would vary from about 1,000 to 1,500 trips per year from 2006 to 2010, an average of less than 20 one-way trips per day. Even remediation options that would result in several times greater truck traffic would still be consistent with acceptable commercial area traffic levels.

The effects from incident-free transportation of DD&D wastes under both the offsite disposal and onsite disposal options, for the worker population and the general public are presented in **Table H–13**. The effects are presented in terms of the collective dose in person-rem resulting in excess LCFs. Excess LCFs are the number of cancer fatalities that maybe attributable to the proposed project that are estimated to occur in the exposed population over the lifetime of the individuals. If the number of LCFs is less than one, the subject population is not expected to incur any LCFs resulting from the actions being analyzed. The risk for development of excess LCFs is highest for workers under the offsite disposition option because of the duration of exposure during transport.

Table H–13 Incident-Free Transportation Impacts – Technical Area 21 Decontamination, Decommissioning, and Demolition

Disposal Option	*Low-level Radioactive Waste Disposal Location* [a]	*Crew*		*Public*	
		Collective Dose (person-rem)	*Risk (LCFs)*	*Collective Dose (person-rem)*	*Risk (LCFs)*
Onsite Disposal	LANL TA-54	0.30	0.0002	0.06	0.00004
Offsite Disposal	Nevada Test Site	9.27	0.006	2.69	0.002
	Commercial Facility	8.98	0.005	2.62	0.002

LCF = latent cancer fatality, TA = technical area.

[a] Transuranic wastes are disposed of at WIPP.

The traffic accident impacts from transportation of DD&D wastes for both offsite disposal and onsite disposal are presented in **Table H–14** as traffic accidents, population dose due to accidental release of radioactivity, and fatalities due to traffic accidents from both the collisions and excess LCFs. The analysis assumed that all generated nonradiological wastes would be transported to offsite disposal facilities.

Table H–13 and Table H–14 indicate that no excess fatal cancers or fatalities would likely occur from DD&D activities in TA-21.

Table H–14 Transportation Accident Impacts – Technical Area 21 Decontamination, Decommissioning, and Demolition

Low-level Radioactive Waste Disposal Location [a, b]	*Number of Shipments* [c]	*Distance Traveled (million kilometers)*	*Accident Risks*	
			Radiological (excess LCF)	*Traffic (fatalities)*
LANL TA-54	4,742	1.19	1.7×10^{-11}	0.014
Nevada Test Site	4,742	6.33	2.8×10^{-7}	0.065
Commercial Facility	4,742	5.80	2.1×10^{-7}	0.060

LCF = latent cancer fatality, TA = technical area.

[a] All nonradiological wastes would be transported offsite

[b] Transuranic wastes are disposed of at WIPP.

[c] Only 22 percent of shipments are radioactive wastes, others include 77.5 percent for industrial and sanitary waste, and about 0.05 percent asbestos and hazardous wastes.

H.2.3.3 Compliance Support Option – Decontamination, Decommissioning, and Demolition to Support the Consent Order Activities

Land Resources

Land Use

Following DD&D of selected buildings and structures within TA-21, the site (except parcel A-15-1 which has been transferred to Los Alamos County) would remain under the control of DOE. Any potential development would have to address structure reuse or DD&D. Land use designations would remain unchanged.

Visual Environment

The more limited DD&D activities of this option would have short-term adverse impacts on visual resources due to the presence of heavy equipment and an increase in dust. Since many buildings would remain within TA-21, only limited areas would be contoured and revegetated. Although some of the larger buildings would be removed, the view of the TA from NM 502 and from higher elevations to the west would still include portions of the current mix of 50-year old structures.

Geology and Soils

Under all options, the impact of a seismic event has been reduced by the deactivation of the DP East facilities and removal of a majority of the source material present. Since no new facilities would be constructed under the Compliance Support Option, there would be no new potential seismic impact.

The Compliance Support Option would have a minor impact on the geologic and soils resources at LANL as the affected facility areas are already developed and adjacent soils are already disturbed. The DD&D activities would introduce some additional ground disturbance in excavating foundations and establishing laydown yards and waste management areas near the facilities to be demolished. However, the impacts would be temporary and available paved surfaces, such as adjacent parking lots, would be used to mitigate any impact. The degree of soil disturbance from the Compliance Support Option is expected to be much smaller than that resulting from major remediation activities under the Consent Order. The primary indirect impact would be associated with the need to excavate any contaminated tuff and soil not addressed by the Consent Order from beneath and around facility foundations. Borrow material (such as crushed tuff and soil) would be required to fill the excavations to grade. Such resources are available from onsite borrow areas (see Section 5.2).

Water Resources

Similar to the No Action Option, the Compliance Support Option would have a negligible impact on water resources, due to the elimination of the Tritium Science and Fabrication Facility outfall, which discharges less than three percent of the effluent in Los Alamos Canyon. The impact on water resources for dust suppression and decontamination is similar but less extensive in this option than in the TA-21 Complete DD&D Option; no significant effect on water resources is anticipated. The option would not result in the disturbance of watercourses or generation of liquid effluents that would be released to the surrounding environment. Relocation of office personnel would be minimal in comparison to complete DD&D, and best management practices would be used to control stormwater runoff and water used for dust suppression.

Air Quality and Noise

Air Quality

Nonradioactive Emissions. In the Compliance Support Option, similar to the TA-21 Complete DD&D Option, the operational emission sources would be relocated or cease as the activities are relocated and the buildings demolished. There would be temporary increases in vehicle exhaust and fugitive dust during the actual building demolition. Initially, air emissions from TA-21 would be similar to the current emissions. The emissions from the laboratory use of various toxic chemicals should be eliminated as the process buildings are placed into surveillance and maintenance status and subsequently demolished. However, the nonradioactive air pollutant emissions from the three natural gas-fired boilers in Building 21-0357 and the vehicle exhaust and emissions from activities in the maintenance facilities operated by the LANL maintenance contractor would remain.

Similar to the TA-21 Complete DD&D Option, the DD&D of the buildings and structures would result in temporary increases in air quality impacts from construction equipment, trucks, and employee vehicles. The relative quantities of the solid waste may be used to estimate the magnitude of demolition and hence the potential for dust generation. The Compliance Support Option would be expected to generate on the order of 78 percent as much dust as the TA-21 Complete DD&D Option.

Radioactive Emissions. The Compliance Support Option would have radiological emissions quantitatively similar to those of the TA-21 Complete DD&D Option, since all of the identified contaminated structures are within the scope of each option. Radiological emissions during surveillance and maintenance and initial DD&D would result from the exhaust of building or temporary ventilation systems used for dust and contamination control. Structural surfaces would be either decontaminated to unconditional release levels or with selected contaminated surfaces stabilized to permit segregation of radioactively contaminated and uncontaminated debris after demolition. Small quantities of radioactivity associated with the dust emissions would result from demolition activities. The potential exists for contaminated soils, building debris, and possibly other media to be disturbed during demolition of facilities. Release of radioactivity would be minimized by proper decontamination of buildings prior to demolition. Such emissions are typically of short duration and are monitored and addressed in regulatory documents. Doses to the public and workers are discussed in the section on human health.

Noise

Noise levels during demolition activities for both the Compliance Support Option and the TA-21 Complete DD&D Option would be consistent with those typical of construction activities. Impacts on the public and wildlife would be similar as well.

Ecological Resources

As in the TA-21 Complete DD&D Option, wildlife in canyons adjacent to TA-21 would be intermittently disturbed by construction activity and noise over the demolition period; however the impacts would be smaller and confined to more localized areas. The revegetation following the DD&D of buildings and structures within TA-21 would be more localized as would the redevelopment impact on wildlife. However, the impact from environmental restoration activities would be similar between options, and possibly larger than that of facility DD&D. The determination made in the DOE biological assessment for the Complete DD&D Option as it relates to the Mexican spotted owl, bald eagle, and southwestern willow flycatcher, and concurred with by the U.S. Fish and Wildlife Service, would also be applicable to this option (see Section H.2.3.2).

Since there are no wetlands in TA-21, DD&D activities would not affect this resource. One of the two NPDES-permitted outfalls associated with TA-21 operations would be eliminated, and the quantity of surface water discharged to the adjacent canyons from the Steam Plant outfall should be reduced from the present levels as a result of the relocation of tritium operations.

Human Health

The Compliance Support Option includes the DD&D of the buildings and structures at TA-21 necessary to support the environmental remediation activities. The primary human health impacts from the Compliance Support Option are those to the public due to radiological emissions and worker health and safety. Precautions taken to assure the protection of workers from industrial hygiene hazards (for example, asbestos removal) would ensure there would be minimal chemical or asbestos emission that could impact the public.

Public Health. The radiological emissions from the TA-21 facilities under the Compliance Support Option, as in the TA-21 Complete DD&D Option, include continued emissions from surveillance and maintenance buildings until in-building DD&D activities are complete and the short-term emissions that result from residual contamination becoming airborne during structural demolition. Since the identities of the radiological facilities and the methods and schedule to DD&D those facilities is similar to complete DD&D, the dose to the public should be bounded.

Worker Health. The principal impacts on worker health under the Compliance Support Option are similar to those in the TA-21 Complete DD&D Option. The impacts result from the radiation dose workers receive during the execution of DD&D, industrial hygiene impacts due to exposure to asbestos and hazardous materials, and industrial accidents similar to those associated with routine construction. As discussed above in reference to the public dose, since the DD&D facilities and methods are similar between options, the radiological dose received by the DD&D workers should also be similar.

The demolition of the above buildings might also involve the removal of some asbestos contaminated material. Additional industrial hygiene hazards and hazards from routine construction accidents occur in facilities in which there is no radioactive contamination; however, nonradiological facilities may allow greater use of large construction equipment, resulting in less direct worker contact with hazardous locations. The smaller number of facilities subject to DD&D under the Compliance Support Option suggests that the worker exposure to industrial and construction hazards would be reduced from those expected in the TA-21 Complete DD&D Option. Construction accidents and fatalities would be bounded by the values identified in the TA-21 Complete DD&D Option.

Cultural Resources

The DD&D of buildings and structures under the Compliance Support Option would not affect the five National Register of Historic Places-eligible archaeological sites at TA-21 but would have direct effects on 15 National Register of Historic Places-eligible historic buildings and structures that are associated with the Manhattan Project and Cold War years at LANL. Documentation measures would be implemented to reduce adverse effects to National Register of Historic Places-eligible properties at LANL and Memorandum of Agreement terms negotiated.

This would also apply to the requirements for historic preservation defined in 36 CFR Part 800 during the transfer of land under Public Law 105-119.

Socioeconomics and Infrastructure

Implementation of the Compliance Support Option would result in a substantial reduction in utility demands in TA-21 as major operational and support activities, such as the Tritium Science and Fabrication Facility, would be eliminated as under the Complete DD&D Option. However, the TA-21 steam plant would not be demolished and may still operate at least on an interim basis, but at substantially reduced levels and with comparable reductions in electric power, natural gas, and water consumption.

Fewer buildings would be fully demolished under this option. Therefore, utility demands for DD&D activities would be less than for the Complete DD&D option.

Socioeconomics

The principle impacts of the Compliance Support Option would not change from the TA-21 Complete DD&D Option. This is largely due to the removal of office space that is currently used. These programs and their functions would be relocated to other available buildings that are owned or leased by DOE, with little effects to the overall LANL personnel, since the programs are still required.

Waste Management

For the Compliance Support Option, as for the TA-21 Complete DD&D Option, the waste types and quantities generated by removal of the structures would be within the capacity of existing waste management systems, and would not by themselves result in substantial impact to existing waste disposal operations. The waste types and volumes expected to be generated during the Compliance Support Option DD&D activities under the two disposal alternatives are summarized in Table H–12.

The Compliance Support Option would generate about 60 percent less solid debris than the TA-21 Complete DD&D Option because it demolishes fewer buildings. The asbestos waste would probably also be lower in the Compliance Support Option.

Transportation

As in the TA-21 Complete DD&D Option, the wastes generated during the DD&D activities would need to be transported to storage or disposal sites. These sites could be either at LANL or at an offsite location, although the impacts to the public are larger when wastes are shipped for offsite disposal. The largest categories of waste that would be generated from DD&D activities are low-level radioactive waste and solid sanitary waste or debris. Solid sanitary waste or debris may often be recycled as fill on the LANL site, reducing the actual waste quantity; solid waste that cannot be recycled can be disposed of at a New Mexico Subtitle D landfill. Possible offsite low-level radioactive waste disposal sites, in contrast, are located at the Nevada Test Site and a commercial facility in Utah.

Since the quantities of radioactive waste are similar between the Compliance Support Option and the TA-21 Complete DD&D Option, the risks to the public from both radiation dose and traffic accidents as shown in Table H–13 and Table H–14 are assumed to be the same. The tables address both the option for disposal of low-level radioactive and sanitary waste at onsite and offsite disposal facilities. The only difference in the impacts between the TA-21 Complete DD&D Option and the Compliance Support Option is a slightly reduced risk of accidents due to the reduced number of truck trips to the sanitary waste disposal facility. The radiological impacts would be identical.

H.3 Waste Management Facilities Transition Impacts Assessment

Section H.3 provides an assessment of environmental impacts for alternatives to the management of solid low-level radioactive waste, mixed low-level radioactive waste, hazardous and chemical waste, and transuranic waste that take into consideration the closure of TA-54 Area L and MDA L, and TA-54 Area G and MDA G. In this appendix, closure of Area G refers to closure of the existing 63-acre portion of Area G shown in Appendix I, Figure I–15. Disposal operations at Area G will be expanded to Zones 4 and 6 of Area G (64 FR 50797). Closure of these areas is required by DOE Order 435.1 with corrective actions for certain units specified by the Consent Order (NMED 2005a) that was entered into by DOE, the University of California as the management and operating contractor, and the State of New Mexico, in March 2005. More detailed information regarding the Consent Order is presented in Chapter 2, Section 2.2.6. Section H.3.1 provides background information for the actions needed to remove, replace and re-locate existing facilities that are used to store and process these solid waste streams, as well as the purpose and need. Section H.3.2 provides a brief description of the No Action Option and other proposed options. Section H.3.3 describes the affected environment and environmental impacts at the LANL technical areas associated with the options (TA-50, TA-54, and TA-63). Chapter 4 of this SWEIS presents a description of the overall affected environment at LANL. Any unique characteristics of these TAs and LANL not covered in Chapter 4 that would be affected by the proposed transition of waste management facilities are presented here.

H.3.1 Introduction and Purpose and Need for Agency Action

TA-54 provides storage, processing and disposal capabilities for mixed low-level radioactive waste (Area L), chemical and hazardous waste (Areas J and L), low-level radioactive waste (Area G), and transuranic waste (Area G) that are generated by LANL programs. Due to the schedule for pending corrective actions at MDA L and MDA G per the requirements of the Consent Order, the following would need to occur by the end of 2015 and require NEPA analysis:

- Low-level radioactive waste support facilities currently located in Area G would need to undergo DD&D and be moved or replaced so that low-level radioactive waste disposal operations can continue at LANL.

- Applicable mixed low-level radioactive waste storage structures and hazardous and chemical waste storage structures and operations in Area L that would otherwise prevent closure of subsurface units in Area L and MDA L would need to be closed and relocated.

- Transuranic waste[4] retrievably stored in Area G would need to be retrieved, processed, and shipped for final disposal at WIPP. This action would require the relocation and addition of processing capabilities for preparing transuranic waste for shipment, addition of retrieval capabilities for remote-handled transuranic waste, and the construction and operation of a TRU (Transuranic) Waste Facility (previously called the Transuranic Waste Consolidation Facility) in a location other than Area G to process newly-generated waste.

Background

This section provides an overview of how low-level radioactive waste, mixed low-level radioactive waste, hazardous and chemical waste, and transuranic waste are currently managed. Some of these actions have been analyzed for environmental impacts in prior NEPA documentation, while other options need to be analyzed in this SWEIS. The overview of waste management practices that impact closure activities is divided into a discussion of legacy wastes, newly-generated wastes, and stored sealed-sources.

Legacy Waste. Legacy waste is waste that has been generated by past operations and has been in storage for many years. Mixed low-level radioactive legacy waste and hazardous and chemical legacy wastes are only temporarily stored in Area L for processing and shipment to offsite disposal facilities; therefore, the discussion of legacy waste in this appendix is specific to transuranic waste in Area G.

Legacy transuranic waste[5] is stored in fabric domes, trenches, pits and shafts at MDA G. NNSA expects to characterize and prepare about 379,000 cubic feet (10,700 cubic meters) of legacy contact-handled transuranic waste for shipment. About 296,650 cubic feet (8,400 cubic meters) of this waste is stored in above-ground storage units and about 82,500 cubic feet (2,340 cubic meters) is stored in subsurface storage units. Contact-handled transuranic waste is currently stored in the fabric domes, Trenches A-D, Pit 9, corrugated metal pipes on top of Pit 29, and Shafts 262-266. About 4,600 cubic feet (130 cubic meters) of remote-handled transuranic waste is stored in 55 shafts at Area G (LANL 2005c).

Some of the contact-handled transuranic waste in the fabric domes is currently being prepared for shipment to WIPP through the "Quick-to-WIPP" Program. In this program, approximately 2,000 high-wattage drums have been prioritized for accelerated characterization, certification, and shipment as they contain almost 60 percent of the radioactive material-at-risk at Area G (LANL 2005c).

Facilities that currently support the processing and shipment of contact-handled transuranic waste to WIPP include the following:

---

[4] *The term transuranic waste as used in Section H.3 includes mixed transuranic waste.*

[5] *Waste identified as legacy transuranic waste was originally placed into storage under the assumption that it met the definition of transuranic waste applicable at the time. All of this waste will be re-characterized to determine whether it meets the current definition of transuranic waste. It will be disposed of as transuranic waste or low-level radioactive waste based on the new characterization.*

- The Decontamination and Volume Reduction System. This system is located in Building 412 at Area G and provides processing capabilities to decontaminate large-sized storage packages and reduce the size of transuranic waste.

- Waste Characterization, Reduction, and Repackaging Facility. Located in TA-50, this facility receives waste transported by truck from Area G to be characterized (including equilibration and headspace gas analysis) and repackaged in a form suitable for eventual packaging into TRUPACT II containers. The repackaged containers are then transported by truck back to Area G for storage until shipment to WIPP (NNSA 2003).

- Radioassay and Nondestructive Testing Facility. Located in the western part of TA-54 (TA-54 West), this facility receives transuranic waste containers sent from Area G for configuring into payloads and loading into TRUPACT II containers, and shipping to WIPP (NNSA 2003).

To accelerate the processing of contact-handled transuranic waste from the fabric domes, DOE plans to install and operate three modular units at Area G perform waste characterization, reduction, and repackaging. The net result is that 16 drums could be readied for shipment to WIPP in the same time that current operations at TA-50 can produce only one drum for shipment (DOE 2002d).

Transuranic waste in below-ground storage is found in the following locations (LANL 2005c):

- Trenches A-D. These trenches contain approximately 11,850 cubic feet (335 cubic meters) of contact-handled transuranic waste packaged within 30-gallon (114 liter) metal drums placed within concrete lined casks.

- Pit 9. This pit contains approximately 55,100 cubic feet (1,560 cubic meters) of contact-handled transuranic waste packaged within 30-, 55-, and 85-gallon (114-, 208-, 322-liter, respectively) drums and fiberglass-reinforced plywood boxes.

- Corrugated metal pipes on Pit 29. 158 corrugated metal pipes contain approximately 15,600 cubic feet (442 cubic meters) of contact-handled transuranic waste consisting of concreted wastewater treatment sludge.

- Shafts 262-266. These shafts contain approximately 247 cubic feet (7 cubic meters) of tritium-contaminated contact-handled transuranic waste. Each shaft contains a single stainless steel containment vessel designed for this waste.

- Shafts 302-306. These shafts contain approximately 1,800 cubic feet (51 cubic meters) of remote-handled transuranic waste consisting of hot cell liner boxes (decommissioned gloveboxes from LANL hot cells). The gloveboxes are packaged in steel boxes.

- Shafts 235-243 and 246-253. Each of these shafts contains a single 35 cubic foot (1 cubic meter) canister of remote-handled transuranic waste. Twelve of the canisters contain 1.5-gallon (6-liter) cans of waste packaged into 55-gallon (208-liter) drums, while the remaining five canisters contain large debris items and hardware in 55-gallon (208-liter) drums.

- Shafts 200-232. These shafts contain the highest activity remote-handled transuranic waste. There are approximately 950 cubic feet (27 cubic meters) of remote-handled transuranic waste consisting of hot cell debris packaged into one-gallon (4-liter) cans that were placed into the shafts. The waste in these shafts would be the most difficult to retrieve because of the high activity and the configuration of the cans.

Structures and processes for shipping contact-handled transuranic waste stored in the above-ground fabric domes to WIPP have been analyzed through the NEPA process in the *1999 SWEIS* (DOE 1999a) and related Supplement Analysis (DOE 2002d) and the Environmental Assessment prepared for the Decontamination and Volume Reduction System (DOE 1999b); the impacts of the retrieval and processing of transuranic waste in below-ground storage are addressed in this SWEIS.

Newly-Generated Waste. Newly-generated waste is waste that has been generated since October 1998. Newly generated waste considered in this appendix primarily addresses hazardous and chemical waste and mixed low-level radioactive waste operations currently in Area L, and low-level radioactive waste and transuranic waste operations currently in Area G.

- *Transuranic Waste*—Transuranic waste continues to be generated as LANL carries out its research and production missions. NNSA would continue to store and process newly-generated transuranic waste using the processes described for dispositioning legacy wastes.

- *Low-level Radioactive Waste*—The *1999 SWEIS* analyzed the expansion of low-level radioactive waste disposal operations from currently operational portions of Area G to Zones 4 and 6 of TA-54. Zone 4 is located adjacent to, and west of, the current operational portion of Area G. An access control and monitoring building, a characterization and verification building, and a compactor located in Area G currently support these operations.

- *Mixed Low-level Radioactive Waste and Hazardous and Chemical Waste*—Storage structures are currently located in Area L for storage of mixed low-level radioactive waste and hazardous and chemical waste until this waste is shipped offsite for treatment and disposal. NNSA would continue to generate mixed low-level radioactive waste and hazardous and chemical waste.

- *Stored Sealed Sources*—A number of excess and unwanted sealed sources that, for reasons of public safety, have been collected by NNSA's Off-Site Source Recovery Project (see Appendix J, Section J.3) are stored within Area G. The sealed sources contain actinides and other radionuclides. Some of the stored sources are eligible for disposal as transuranic waste at WIPP, some may be disposed of as low-level radioactive waste at DOE facilities, and some may be disposed of pursuant to the Low-Level Radioactive Waste Policy Amendments Act of 1985 (Public Law 99-240). Capability for continued storage of some sealed sources may be needed after 2015.

Purpose and Need

The mission of LANL is to help ensure the safety and reliability of the nuclear weapons in the United States stockpile, prevent the spread of weapons of mass destruction and to protect the Nation from terrorist attacks (LANL 2005f). Activities associated with accomplishing these missions generate solid wastes that include low-level radioactive waste, mixed low-level radioactive waste, hazardous and chemical wastes, and transuranic waste. Facilities that are necessary to manage these waste streams encompass transportation, storage, processing and disposal. Most of these waste management operations are located in TA-54 Area L and Area G, where operations have been conducted since 1959 and 1957, respectively (LANL 2005c).

Operations in Area L currently involve storage of mixed low-level radioactive waste and hazardous and chemical wastes in container storage units, which are subject to RCRA permit or interim status requirements. Past operations include the subsurface disposal of non-radioactive liquid chemical waste in pits, shafts and impoundments. Operations in Area G currently consist of processing and disposal of low-level radioactive waste, storage of transuranic waste in above-ground fabric domes and below-ground trenches, pits and shafts, processing of the transuranic waste stored in the fabric domes, and shipment of this waste to a disposal site.

Some of the burial areas in Area L and Area G are subject to corrective action under the Consent Order, and some are disposal units subject to Resource Conservation and Recovery Act closure and post-closure care requirements. The current schedule for the Consent Order requires DOE submit remedy completion reports to the New Mexico Environment Department by July 9, 2011, for MDA L and by December 6, 2015, for MDA G (NMED 2005a, LANL 2005c, 2006a). The New Mexico Environment Department intends to simultaneously issue two hazardous waste permits that will include closure and post-closure requirements; one for active storage and treatment units and the second for interim status disposal units that are no longer active (NMED 2005b).

In Area L, NNSA needs to remove several container storage units for storage of mixed low-level radioactive waste and chemical and hazardous waste so that closure activities can be completed. LANL needs to determine the impacts associated with removing these container storage units and consolidating storage operations in Area L or other locations at LANL.

In Area G, NNSA needs to complete or move all storage operations and processing of transuranic waste for shipment to WIPP for disposal so that closure activities can be completed in compliance with the Consent Order. Impacts from processing and shipping transuranic waste currently stored in the fabric domes are analyzed in the *1999 SWEIS* and the 2002 *Supplement Analysis, Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Modification of Management Methods for Transuranic Waste Characterization at Los Alamos National Laboratory* (DOE 2002d). The impacts of retrieval and processing of the transuranic waste stored below-ground in trenches, pits and shafts, are analyzed in this SWEIS so that a preferred option can be selected. In addition, inspection, characterization and verification, and repackaging facilities and equipment are needed to accelerate the processing and shipment of transuranic waste stored above-ground, and to address the management of newly-generated transuranic waste once operations in Area G cease. A new facility is needed to store, process and disposition newly-generated transuranic waste that would be created in support of LANL's mission after Area G and MDA G are closed. In addition, NNSA needs to remove and replace low-level radioactive waste processing facilities located in Area G to allow closure activities to be completed and to allow continuation of low-level radioactive waste disposal in support of LANL's mission. NNSA may need to transition storage of sealed sources collected under the Off-Site Source Recovery Project to another LANL location.[6]

H.3.2 Options Description

The No Action Option and two other options are considered. The No Action Option is incorporated into the No Action Alternative as presented in Chapter 3. Two other options are presented that are incorporated into the Expanded Operations Alternative – Option 1: Accelerated Actions for Meeting the Consent Order, and Option 2: Interim Actions Necessary for Meeting the Consent Order. One of the latter two options will be selected to facilitate implementation of Consent Order activities.

H.3.2.1 No Action Option

Under the No Action Option operation of existing radiological and nonradiological processes would continue in Areas L and G based on NEPA coverage provided prior to the issuance of this SWEIS[7]. Specifically, the following would occur:

- Contact-handled transuranic waste stored at Area G in fabric domes would be retrieved and processed using existing facilities (Decontamination and Volume Reduction System, Waste Characterization, Reduction, and Repackaging Facility, and Radioassay and Nondestructive Testing Facility), and modular units.

- Transuranic waste stored in below-ground facilities would not be retrieved for processing and eventual shipment to WIPP.

- Newly-generated transuranic waste would continue to be stored, processed and shipped using current facilities in Area G, the modular units, the Waste Characterization, Reduction, and Repackaging Facility, and the Radioassay and Nondestructive Testing Facility.

- Low-level radioactive waste processing facilities and operations (an access and control monitoring building and entrances, a characterization and verification building, a compactor facility and disposal areas) currently located in Area G (including Zone 4) would continue to be used as part of low-level radioactive waste disposal operations.

---

[6] *Sealed sources in Area G are principally in Type B containers that are stored in domes. As needed, storage capacity could be transitioned to another LANL location, such as Zone 4 in TA-54 or the proposed TRU Waste Facility. Transition would be preceded by appropriate NEPA review. It is expected that the environmental impacts from storage of sealed sources in another LANL location would be similar to those for storage at Area G.*

[7] *The No Action Option is included in this appendix consistent with NEPA requirements; however, NNSA intends to comply with the Consent Order. NNSA plans to implement actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in this SWEIS.*

- All structures and processes currently located in Area L would remain with no changes to the footprint or operations.

H.3.2.2 Option 1: Accelerated Actions for Meeting the Consent Order

Under Option 1, NNSA would retrieve, process, and transport for disposal all wastes stored in facilities in Area L and MDA L, and Area G and MDA G, that need to be removed for closure activities; and remove, re-locate, and replace applicable facilities. Specific activities associated with Option 1 are described in Sections H.3.2.2.1 through H.3.2.2.5.

H.3.2.2.1 Remote-Handled Transuranic Waste Retrieval Facility

NNSA would construct and operate a remote-handled transuranic waste retrieval facility at Area G for the sole purpose of retrieving and processing remote-handled transuranic waste from Shafts 200-232, if a decision is made to retrieve some or all of this waste. This facility would provide remote capabilities to retrieve the remote-handled transuranic waste from the shafts.

A RCRA permit modification approval by the New Mexico Environment Department would be needed for the construction of this facility because mixed transuranic waste would be stored at the site. During the permit modification approval process, additional operating and safety procedures may be implemented based upon conditions added by the regulatory agency and from the public comment process.

NNSA would design this facility to Hazard Category 3 or Radiological Facility requirements and construct it in accordance with DOE and LANL standards, contingent upon nuclear safety analyses that would be performed. Construction of the facility would disturb about one-quarter acre (0.1 hectare) with the building taking up approximately 5,000 square feet (464 square meters), or about one-third of the floor space currently used for the Decontamination and Volume Reduction System (LANL 2006a).

The remote-handled transuranic waste retrieval facility would become operational by Fall 2011. It would be closed under the hazardous waste facility permit, and would undergo DD&D by 2015 upon completion of remote-handled transuranic waste removal from Area G. If permitted, the facility cannot undergo DD&D without completing closure by decontamination and removal of all wastes and waste residues. All empty shafts may be subsequently filled with low-level radioactive waste and incorporated into the Area G and MDA G closure.

H.3.2.2.2 TRU Waste Facility

Operations at LANL would continue to generate transuranic waste once Area G and MDA G are closed. LANL programs that currently generate transuranic waste include (Bachmeier 2005):

- Pit manufacturing and stockpile stewardship.
- Mixed oxide fuel research and development.
- Vault disposition programs.

- Plutonium-238 clean-up and stabilization.
- Actinide research and development.
- TA-18 inventory reduction.
- Off-Site Source Recovery Project.

A new TRU Waste Facility would therefore be needed to replace current capabilities at Area G for storing, processing, and shipping newly generated transuranic waste. Based on preconceptual design analysis, the TRU Waste Facility would be sized for a throughput of up to 1,500 drum equivalents per year. This capacity includes large items (such as size-reduced gloveboxes) and an additional contingency capacity of 500 drum equivalents per year to accommodate fluctuations throughout the waste management chain from LANL to WIPP. The facility would be composed of multiple buildings or a combination of buildings and domes, and would provide approximately 30,000 to 40,000 square feet (2,790 to 3,720 square meters) of space. A site of approximately 2.5 to 7 acres (1 to 2.8 hectares) would be required (LANL 2005h).

The facility would accommodate the following functions (LANL 2006a):

- Staging and Storage (10,000 to 15,000 square feet [930 to 1,390 square meters] for storage of up to 1,500 drums of transuranic waste).
- Characterization, certification, and repackaging consisting of approximately 3,000 square feet (280 square meters), either in new buildings or relocated mobile systems.
- Unpackaging, repackaging, decontamination and size reduction consisting of approximately 5,000 square feet (465 square meters), plus approximately 2,500 square feet (230 square meters) for change rooms.
- Utilities and support (including office and technical support space) consisting of approximately 5,000 square feet (465 square meters). The office space is considered optional, and may be satisfied by use of a nearby existing facility.
- Shipping (for example, TRUPACT II loading operations) consisting of approximately 5,000 square feet (465 square meters).

The nuclear portions of the facility (those areas or buildings where drum handling or waste processing occurs) would be designed and constructed to Hazard Category 2 and Performance Category 3 requirements. Other portions of the facility, such as office spaces, would be designed to more conventional standards and would be appropriately separated from nuclear functions. All facilities would be designed and constructed in accordance with applicable requirements and standards.

The TRU Waste Facility would use a Perma-Con® or similar confinement system (NFS 2005) to enclose facility functions. A comparable system for the new facility would include access ports, airlocks, the capability for supplying air to suited workers requiring access to the inner structure, and an overhead crane. Nuclear portions of the facility that require confinement ventilation systems would employ negative pressure and high-efficiency particulate air filtering systems for air treatment. Air would be discharged through a stack following high-efficiency particulate air filtration.

The floor would be constructed as a concrete pad covered with a material such as stainless steel or a sealant for contamination control. The pad would divert any liquids inadvertently introduced to the structure to a sump so that the liquids can be recovered, treated, and appropriately disposed.[8]

The facility would be connected to LANL site water, electricity, phone, and other utilities, and would be equipped with fire suppression, emergency communications, and other safety systems, including continuous air monitors, criticality monitors, fixed air samplers, a surrounding fence and controlled access.

A RCRA permit modification approval by the New Mexico Environment Department would be needed for the construction of this facility because mixed transuranic waste would be stored at the site. During the permit modification approval process, additional operating and safety procedures may be implemented based upon conditions added by the regulatory agency and from the public comment process.

A range of sites for constructing and operating the facility is being considered, with a preliminary site in TA-52 being identified. This site has a number of advantages including the fact that it is relatively close to TA-55, the primary waste generator for transuranic waste. Other sites will be reconsidered if there is reason to reject the location in TA-52 during the conceptual design phase. Because of the possibility that the location for this facility may change, this SWEIS evaluates locations where the facility would most likely be located that encompasses the following TAs in the Pajarito Road corridor: TA-35, TA-46, TA-48, TA-50, TA-51, TA-52, TA-54 West, TA-63 and TA-66. In addition, some of the functions to be conducted at the proposed TRU Waste Facility may be duplicated in a separate building co-located with the Radioactive Liquid Waste Treatment Facility in TA-50 to specifically treat any transuranic waste from this facility; however, the environmental analysis conducted for the TRU Waste Facility bounds this possibility.

Design of the TRU Waste Facility has begun. A RCRA permit modification request was submitted to the New Mexico Environment Department in 2007 and is pending (LANL 2006a). The facility would have a design life of 30 to 35 years. Facility operations are expected to occur after 2011.

H.3.2.2.3 Other Transuranic Waste Processing Needs

Additional equipment and facilities for accelerating the processing of contact-handled transuranic waste stored at Area G are needed. The additional equipment and facilities include the following (LANL 2005c):

---

[8] *It is assumed that waste acceptance criteria for the facility would include requirements to limit the quantities of free liquids that might be in received waste.*

- An IQ3 unit to replace the Fixed-Energy Response Function Analysis with Multiple Efficiency system and tomographic gamma scanner unit for performing quantitative assays to segregate low-level radioactive waste from the transuranic waste and determine plutonium isotopic characteristics and other transuranic isotope ratios.

- SuperHENC or multiple purpose crate counter to conduct standard waste box assays.

- An additional Perma-Con® containment system in Dome 224 for visual examinations, prohibited item disposition, and repackaging of drums.

- Mobile visual examination and repackaging for visual examinations, prohibited item disposition, and repackaging of drums.

- Modular repackaging unit for visual examinations, prohibited item disposition, and repackaging of drums.

- Decontamination and Volume Reduction System upgrades to a Hazard Category 2 facility to process oversize crates and fiberglass-reinforced plywood boxes, contingent on nuclear safety analyses to be performed.

- MART washers reinstallation in Dome 33.

- A diamond saw or similar type cutting system in the Decontamination and Volume Reduction System to cut corrugated metal pipe into lengths that can be packaged into standard waste boxes.

- A TRUPACT II loading and shipping area in Area G that would be used to load TRUPACT II containers for shipment to WIPP.

These additional equipment and facilities would allow the replacement of the Waste Characterization, Reduction, and Repackaging Facility and Radioassay and Nondestructive Testing Facility processing capabilities and eliminate shipments between Area G and these two facilities.

Different shafts store different forms of remote-handled transuranic waste, as described in Section H.3.1. NNSA would perform the following for the different transuranic waste forms by 2015 (LANL 2005c):[9]

- Shafts 302-306. NNSA would retrieve the steel boxes from each shaft using cranes or other available means and would place them in fabricated shielded containers. The containers would then be stored at Area G for future processing, repackaging, and characterization using currently available facilities. However, the Hazard Category and Performance Assessment would need to be upgraded to Hazard Category 2 and Performance Category 3 for the Decontamination and Volume Reduction System; Waste

---

[9] *After characterization, some of this transuranic waste could actually be determined to be low-level radioactive waste, which LANL staff would dispose of in onsite facilities in Area G.*

Characterization, Reduction, and Repackaging Facility; and modular units, contingent upon nuclear safety analyses to be performed.

- Shafts 235-243 and 246-253. Substantial and detailed historical information exists at LANL regarding the characterization and packaging of the transuranic waste contained in the canisters in these shafts. NNSA is in the process of preparing documentation that would meet acceptable knowledge requirements of the New Mexico Environment Department and complete the characterization process. Once the New Mexico Environment Department has approved a permit modification and determined that the documentation is sufficient for characterization of this remote-handled transuranic waste. This waste would be retrieved by readily-available means, placed into WIPP 72B casks, and sent to WIPP.

- Shafts 200-232. Approximately 950 cubic feet (27 cubic meters) of high-activity remote-handled transuranic waste in these shafts would be retrieved by the new, temporary remote-handled transuranic waste retrieval facility presented in Section H.3.2.2.1. The retrieved waste is assumed to be processed and repackaged at a LANL facility such as the Decontamination and Volume Reduction System in Area G.

H.3.2.2.4 Low-level Radioactive Waste Processing Facilities

To facilitate closure of Area G and MDA G, low-level radioactive waste processing facilities would need to undergo DD&D. DD&D of these buildings would be completed by 2011. These facilities include (LANL 2005c):

- An access control and monitoring building (Building 54-0156), called the Operations Center.

- A characterization and verification building (Building 54-0002).

- A compactor building (Building 54-0281).

NNSA would replace these buildings with similar buildings in Zone 4 to support continued low-level radioactive waste disposal operations. It is assumed that the size and functions of these structures and processes would be similar to the new structures and processes to be located in an expanded area of Zone 4.

Zone 4 is approximately 30 acres (12 hectares) located between, and adjacent to, the current operational areas in Area G and Area L. Access to Zone 4 and Area G is controlled by the gate at the western end of the waste management area. Mesita del Buey Road runs through Zone 4. The footprint of Zone 4 would need to expand westward into the current administrative area to accommodate the proposed low-level radioactive waste processing activities. The area south of Mesita del Buey Road would be the likely location of the processing activities. NNSA would also relocate the access gate, add a new access control structure, and remove or relocate several office trailers and storage sheds (LANL 2006a).

Access Control and Monitoring Building

The access control and monitoring building would provide a physical control point for access to Zone 4 and of Area G and a support area for radiological program needs. The building would consist of the following characteristics (LANL 2006a):

- A heating, ventilation and air conditioning system.
- An observation area with a large window to document entrance to and exit from Zone 4 and Area G.
- An administration area to support radiological control technicians and equipment.
- Separate entrances and exits for resident workers and non-resident workers (workers delivering waste packages).
- Restrooms and locker areas for donning and removing personal protective equipment and personnel radiological monitoring.
- A break area.
- Remote gate and portal and turnstile control.

The proposed access control and monitoring building would be approximately 1,200 to 1,500 square feet (110 to 140 square meters) in size and located near the entrance to Zone 4 and Area G. The building could be either a steel manufactured building or a portable or modular building. LANL would limit the radiological inventory for the building to check and calibration sources used for instrument maintenance and operational needs related to survey and smear sample analysis (LANL 2005c). The building would be operational by 2009.

Characterization and Verification Building

The characterization and verification building would house the assay equipment associated with identifying and verifying radiological characteristics of waste materials. Survey methods would consist of non-intrusive methods such as gamma spectroscopy, neutron counting, and handheld instrument techniques. The building would consist of the following (LANL 2006a):

- Central heating, ventilation, air conditioning, and dust control systems with a negative overpressure ventilation system.
- Processing areas for the characterization and verification equipment.
- A staging area for up to 15 55-gallon (210-liter) drums.
- Overhead rollup (coil) doors with ceiling clearance of at least 16 feet (5 meters) to provide for fork lift and lift truck access.
- A design floor load of 1,100 pounds per square foot (5,400 kilograms per square meter) to accommodate the concentrated floor loads of assay equipment that use lead shielding.

- Floors finished as smooth concrete with epoxy sealant for contamination control.
- Three-phase 480-volt power with a 200-amp panel with single-phase requirements being addressed with a step-down transformer, as appropriate.
- Building partitioning to address personnel monitoring and badge control, as well as a main restroom facility.

The proposed characterization and verification building would consist of a 2,500 to 3,000 square foot (230 to 300 square meter), single-story building. LANL staff would locate this facility in Zone 4 on the south side of Mesita del Buey Road. The building is anticipated to be designed to Hazard Category 3, Performance Category 2 standards (LANL 2006a). The building would be operational by 2010 (LANL 2005c).

Compactor Building

The compactor building would serve as a low-level radioactive waste volume reduction facility that would house a new hydraulic compactor with associated glove box train and a drum crusher. The compactor building would have the following characteristics (LANL 2006a):

- Sufficient space to operate both pieces of equipment. The compactor footprint is assumed to be 8 feet by 12 feet (2.4 meters by 3.7 meters), with access from at least two sides. The glove box dimensions would be 17 feet (5.2 meters) in length, 7 feet (2.1 meters) wide and 12 feet (3.7 meters) high with conveyor dimensions of 24 feet (7.3 meters) long, 8 feet (2.4 meters) wide and 20 feet (6.1 meters) high. The existing drum crusher footprint would be about 4 square feet (0.4 square meters) with access from at least one side.
- A waste package staging area of 300 to 500 square feet (28 to 46 square meters).
- A storage area of 300 square feet (28 square meters) for equipment, parts, and supplies.
- A ceiling clearance of about 28 feet (9 meters) for compactor maintenance access (a ceiling clearance for the drum crusher would be less than 16 feet, or 5 meters).
- Rollup (coil) doors to accommodate fork lift and lift truck access.
- A design floor load of 1,100 pounds per square foot (5,400 kilograms per square meter) to accommodate volume reduction equipment.
- Floors finished as smooth concrete with epoxy sealant for contamination control.
- Three-phase 480-volt power with a 200-amp panel with single-phase requirements being addressed with a step-down transformer, as appropriate.
- High-efficiency particulate air-filtered exhaust system for local contamination control.
- Centralized uninterruptible power supply backup for continuous air monitors and personal computers.

- Centralized vacuum system for air samplers.
- Negative overpressure air confinement (pending further safety analyses).

The compactor building would consist of a 3,000 to 5,000 square foot (280 to 460 square meter), single-story building near the administration building and characterization and verification building within the nuclear facility fenceline. The compactor building is anticipated to be designed to Hazard Category 3, Performance Category 2 standards (LANL 2006a). The compactor would be operational by 2011 (LANL 2005c).

In addition to the DD&D of the current low-level radioactive waste processing facilities in Area G, all other above-ground structures in Area G would undergo DD&D prior to the completion of closure activities.

H.3.2.2.5 Mixed Low-level Radioactive Waste and Hazardous and Chemical Waste Storage

The structures and container storage units to be removed for closure activities would depend on the results of ongoing investigations, the design of the final cover, and other regulatory and programmatic decisions. For the purpose of the analyses related to this option, NNSA assumes that a single closure cover would be used. The storage capacities of the container storage units in Area L are shown in **Table H–15**.

Table H–15 Area L Container Storage Units and Associated Storage Volumes

Facility Identification Number	*Container Storage Unit*	*Volume (cubic feet)*	*Drum Equivalent*
54-31	Waste storage shed	177	24
54-32	Hazardous waste storage with canopy	2,295	312
54-35 [a]	Waste storage pad	2,119	288
54-36 [a]	Perma-Con® waste storage pad	1,766	240
54-39	PCB waste storage facility	5,474	744
54-58 [a]	Waste storage pad	2,119	288
54-68	Waste/lab pack storage unit	237	32
54-69	Waste/lab pack storage unit	237	32
54-70	Waste/lab pack storage unit	237	32
54-215 [a]	Mixed low-level radioactive waste storage dome	34,926	4,752
54-216 [a]	Gas cylinder storage dome	4,944	672
	Total	54,526	7,416

PCB = polychlorinated biphenyls.

[a] Container storage units that would be removed under Option 1. All container storage units would be removed in Option 2.

Note: To convert cubic feet to cubic meters, multiply by 0.028317.

Source: LANL 2005c.

Using a single closure cover, NNSA would undertake the following actions (LANL 2005c):

- Remove container storage units 54-35, 54-58, 54-215 and 54-216 (and part of the Area L container storage unit, which is the paved area inside the Area L fenceline).
- Re-site container storage units 54-68 and 54-69.

- Close or re-locate container storage unit 54-36 (a Perma-con® unit used for sampling, repackaging, or consolidation).
- Decommission and remove Canopy 54-62.
- Re-site modular structures 54-50 and 54-1058.
- Modify the Area L fenceline.
- Remove office structures 54-37, 54-51, 54-60, 54-83, and 54-84.

Structures to be relocated to another location in Area L that is paved would be small enough to be moved with a fork lift or small crane. The mixed low-level radioactive waste storage dome would undergo DD&D. Other structures would undergo demolition using conventional means without the need for decontamination.

Mixed low-level radioactive waste storage operations would be consolidated at Area L using existing storage facilities that would not be impacted by closure activities. Only enough storage space for 530 to 5,830 cubic feet (15 to 165 cubic meters) of mixed low-level radioactive waste would be required, or approximately 72 to 793 drum-equivalents, which is as high as 17 percent of the current storage capacity in the mixed low-level radioactive waste dome (LANL 2005c). Future storage needs would therefore be approximately 2,600 square feet (242 square meters) (assuming the mixed low-level radioactive waste dome is 15,181 square feet [1,410 square meters] and the storage space required is proportional to the square footage).

LANL staff would manage hazardous and chemical wastes through other waste collection sites that may be established or removed based on need. These sites would be established and operated in compliance with all regulatory requirements. Container Storage Unit 54-32, which can store up to 312 drums, would remain in Area L and would continue to be used for the temporary storage of newly-generated hazardous and chemical wastes.

H.3.2.3 Option 2: Interim Actions Necessary for Meeting Consent Order and Other Options

Option 2 primarily considers variations of Option 1 if legacy and newly generated stored wastes cannot be removed from storage, processed, and shipped to disposal facilities on an accelerated schedule that would allow completion of closure activities in Area L and MDA L, and Area G and MDA G, as required by the Consent Order.

Option 2a: It is possible that schedule requirements, technical challenges, regulatory requirements, or other factors may prevent complete removal of transuranic waste from Area G and MDA G and shipment to WIPP in an accelerated timeframe that allows closure activities to begin. In this option, NNSA would move the remaining transuranic waste from Area G to another location outside of Area G to be stored until the waste could be processed and shipped. NNSA would construct two additional storage structures at the TRU Waste Facility or another location for storage of legacy transuranic wastes. This option considers that transuranic waste currently stored in Pit 9 and the shafts would require storage somewhere at the LANL site other than Area G. The transuranic waste in Pit 9 and the shafts would require approximately 7,986 drum equivalents of storage space. This would require shipments (and accompanying road closures) to be made. The number of shipments would be reduced if the storage location were combined with the TRU Waste Facility, since the TRU Waste Facility is assumed to ultimately process this waste under Option 2.

The two transuranic waste storage buildings would be similar in size to Dome 375, but with a different overhead confinement system. Each storage building would consist of approximately 30,000 square feet (2,787 square meters) that could hold up to a total of 8,000 drum equivalents (using Dome 375 as a baseline). The volume of these wastes would be approximately 7,190 drum equivalents (NNSA 2003). The Decontamination and Volume Reduction System would be used to perform size reduction of the crates and oversized boxes prior to storage in the two new storage buildings.

Option 2b: Under this option, the high activity remote-handled transuranic waste would be left in place in Shafts 200-232; the more easily-retrieved transuranic waste is assumed to be removed from underground storage areas. LANL staff would retrieve and store the other, more retrievable remote-handled transuranic waste in the two new storage buildings, as described in Option 2a. LANL staff would need to perform additional performance assessments for closure activities to upgrade closure activities to address this high-activity remote-handled transuranic waste, as described in Appendix I, Section I.3.3. Leaving the higher activity remote-handled transuranic waste in place may be contingent on environmental restoration decisions for MDA G to be made by the New Mexico Environment Department. DOE expects to submit a corrective measures evaluation report to the New Mexico Environment Department in September 2008.

Option 2c: In addition to either Option 2a or 2b, mixed low-level radioactive waste and hazardous and chemical waste would be stored at the TRU Waste Facility and the use of Area L would cease for these operations. LANL staff would continue to manage hazardous and chemical wastes through other sites and would obtain a RCRA permit for the TRU Waste Facility for storing hazardous wastes for periods greater than 90 days.

H.3.2.4 Options Considered but Eliminated

NNSA considered but eliminated one option associated with the management of transuranic wastes. The following presents this option and the reasons it was eliminated from further consideration.

Locate the TRU Waste Facility at a Major Generator Facility in an Existing Facility at TA-55

This option addresses newly generated transuranic waste that would be expected after waste management activities cease in TA-54, Area G. In this option, non-destructive analysis and real-time radiography activities would be conducted at TA-55 in existing facilities. The storage, loading, decontamination, and size reduction functions would be housed in an existing facility, such as the former Radioactive Materials Research, Operations and Demonstration Facility, which would require a RCRA permit (LANL 2005h).

This option was eliminated from further consideration because (LANL 2005h):

- The limited space in the Radioactive Materials Research, Operations and Demonstration Facility and the configuration of its floor space may not allow accommodation of all of the intended transuranic waste management functions.
- Road closures would be required to allow transfer of transuranic waste between TAs.

H.3.3 Affected Environment and Environmental Consequences

Detailed information about the LANL environment is presented in Chapter 4. Specific information relevant to the consequences of the proposed waste management facilities transition is addressed under each of the affected resource areas.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Socioeconomics and Infrastructure*—No new employment is expected. Construction and remediation workers would be drawn from the pool of worker employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.
- *Environmental Justice*—The proposed project would be largely confined to already developed areas and the new facilities would replace existing facilities with similar impacts. No disproportionate human health impacts on low-income or minority populations would be expected.

H.3.3.1 No Action Option

The No Action Option would result in continued operation as discussed in Section H.3.2.1. Processing of transuranic waste stored aboveground would continue as currently performed. All radioactive wastes stored belowground would remain. The current low-level radioactive waste processing facilities would remain in use. Hazardous and mixed radioactive waste storage operations in Area L would continue. The impacts related to the No Action Option are described in Chapter 5. If no action is taken, then NNSA would not be able to complete corrective actions and closure activities in Area L and MDA L, and Area G and MDA G, and would therefore not be in compliance with the Consent Order. Impacts to all resource areas would remain as currently observed with increased environmental contamination possible.

H.3.3.2 Option 1: Accelerated Actions for Meeting the Consent Order

Land Resources

Land Use

TA-54 (see Chapter 1, Figure 1–2) is where new low-level radioactive waste processing facilities, additional transuranic waste processing equipment and facilities, and DD&D activities would occur. TA-54 is one of the larger TAs at Los Alamos, measuring 943 acres (382 hectares) in size. The 3-mile (4.8 kilometer) northern border of the site forms the boundary between LANL and the Pueblo of San Ildefonso. The town of White Rock is located to the east of the TA. Land use within TA-54 is categorized as Experimental Science, Waste Management, and Reserve. Future land use is likely to remain similar, except that the area devoted to waste management is projected to expand such that it forms a continuous band along the TA's southern boundary (LANL 2003d). According to the *Comprehensive Site Plan* for 2001, TA-54 is within the Pajarito Corridor East Development Area. The area within which Area G and Area L fall is categorized as Potential Infill and Primary Development (LANL 2001a).

As noted in Section H.3.2.2.2, a location for the TRU Waste Facility has yet to be finalized. Thus, a generic area encompassing TA-35, TA-46, TA-48, TA-50, TA-51, TA-52, TA-54 West, TA-63, and TA-66 has been selected for analysis. For each TA, a generic site was selected within which the TRU Waste Facility could be constructed. The facility would be located on 2.5 to 7 acres (1 to 2.8 hectares) of land. **Table H–16** presents the current land use, planned future land use, and the development designation of each potential site.

Table H–16 Land Use and Development Designations for the TRU Waste Facility Site [a]

Technical Area	*Current Land Use*	*Planned Future Land Use*	*Comprehensive Site Plan Development Designation(s)*
35	Nuclear Materials Research and Development	Experimental Science	Primary Development, Potential Infill
46	Physical/Technical Support	Experimental Science	Primary Development
48	Experimental Science	Nuclear Materials Research and Development	Primary Development
50	Reserve	Reserve	Secondary Development
51	Experimental Science	Experimental Science	Potential Infill
52	Reserve	Reserve	Potential Infill
54 West	Experimental Science	Experimental Science	Potential Infill
63	Physical/Technical Support	Waste Management	Secondary Development
66	Reserve	Reserve	Secondary Development

[a] Many TAs have multiple land use designations; the listed land use is for the location in the TA most likely to be used for the TRU Waste Facility.

Sources: LANL 2001a, 2003d.

Construction, DD&D, and Operations Impacts—All actions within TA-54, including construction of a remote-handled transuranic waste retrieval facility; removal of the domes at MDA G; DD&D of most above-ground facilities in TA-54; construction of a TRUPACT II loading facility; relocation of transuranic waste processing equipment from outdoor areas to a transuranic waste storage dome; expansion into Zones 4 and 6 and construction of a low-level radioactive waste administration building, characterization and verification building, and compactor building; reconfiguration of storage facilities in Area L; and use of Dome 282 for hazardous waste storage would take place within previously disturbed parts of TA-54. These areas are currently designated Waste Management, a designation that would not change in the future; thus, there would be no impact on land use within TA-54 under this option.

The greatest potential impact to land use would occur at a generic site that is presently not developed. With the exception of TA-54 West, none of the generic sites contains buildings or structures. However, the potential facility sites are currently designated Primary Development, Secondary Development, or Potential Infill, indicating that they are suitable for development. Planned future land use at these sites, with the exception of TA-63, would need to change from current land use designations to Waste Management.

Visual Resources

Although a location for the TRU Waste Facility has yet to be finalized, a generic area encompassing TA-35, TA-46, TA-48, TA-50, TA-51, TA-52, TA-54 West, TA-63 and TA-66 has been selected for analysis. For each TA, a generic site was selected within which the new facility could be constructed. As noted in Section H.3.2.2.2, the TRU Waste Facility may be composed of multiple buildings or a combination of buildings, totaling approximately 30,000 to 40,000 square feet (2,790 to 3,720 square meters); it would require approximately 2.5 to 7 acres (1 to 2.8 hectares) of land. **Table H–17** indicates the development status of the generic sites and whether they would be visible from lands of the San Ildefonso Pueblo.

Table H–17 Potential Visibility of TRU Waste Facility

Technical Area	*TRU Waste Facility Within Undeveloped Site*	*TRU Waste Facility Visible from Lands of the San Ildefonso Pueblo*
35	Partially	No
46	Yes	No
48	Yes	No
50	Depends on location	No
51	Yes	Yes
52	Yes	Yes
54 West	No	Yes
63	Yes	No
66	Yes	No

TA-54 is at the eastern end of Pajarito Road and borders both the Pueblo of San Ildefonso and White Rock. While buildings and structures of the TA are visible from higher elevations to the west, near views of many elements of the TA are limited since Pajarito Road is closed to the public. However, the dominant feature of the site is the domes at MDA G, some of which are white-colored, in the eastern end of the TA. These domes contrast with the natural landscape and can be seen many miles away from areas in the Nambe-Española area and from areas in western and southern Santa Fe (LANL 2004b). They are also visible from the lands of the Pueblo of San Ildefonso.

Construction, DD&D, and Operations Impacts—Although a number of new buildings, including temporary and permanent structures, would be constructed within TA-54 under this option (including the remote-handled transuranic waste retrieval facility, low-level radioactive waste processing buildings, and relocation and addition of new equipment and a TRUPACT II loading area), all would be built within previously disturbed areas. Thus, construction would have minimal impact on visual resources under this option. However, removal of the domes at MDA G would have a beneficial impact on both near and distant views.

As noted from Table H–17, generic sites for the TRU Waste Facility, with the exception of TA-54 West and some areas of TA-50, are located within undeveloped areas. Thus, while construction of the new facility would have minimal visual impact within TA-54 West and portions of TA-50, it would create a change in the visual environment of the remaining sites. However construction would generally not be visible to the public since Pajarito Road is open only to laboratory personnel. Table H–17 also identifies TA-51, TA-52, and TA-54 West as areas where construction of the new facility would be visible from lands of the San Ildefonso Pueblo; however, construction within TA-54 West would be within a presently disturbed area. Regardless of where the TRU Waste Facility would be built, when viewed from higher elevations to the west it would add somewhat to the developed nature of LANL along Pajarito Road. DOE would mitigate the visual impacts from the TRU Waste Facility by following the design principles provided in the LANL architectural guide (LANL 2002a).

Proposed changes in Area L to remove and re-locate some mixed low-level radioactive waste and hazardous and chemical storage facilities would be conducted within previously disturbed areas to facilities not easily visible unless someone is traveling past Area L along Pajarito Road. Thus, any changes would have minimal impact on visual resources.

Geology and Soils

Geology, soils, and geological resources at LANL are addressed in Section 4.2 of this SWEIS. The generic area for the location of the proposed TRU Waste Facility is located along the eastern edge of the Pajarito Fault system, with TA-54 located further east. Specifically, the closest segment of the 9-mile (14-kilometer) long Rendija Canyon fault is located approximately 0.4 miles (0.6 kilometers) west of TA-50 and more than 3.7 miles (6 kilometers) northwest of TA-54. This fault exhibits as much as 130 feet (40 meters) of post-Bandelier Tuff displacement. Other small faults have been mapped in the area; they are generally subsidiary to the main fault and have limited displacement. Small fault traces have been mapped throughout central LANL; their potential rupture hazard is very small (LANL 1998). As noted in Chapter 4, Section 4.2.2.3, the seismic risk at LANL is considered very small.

Soils associated with the affected technical areas are generally thin and directly overlie the Bandelier Tuff. As discussed in Section 4.2.3 of this SWEIS, some soils have been affected by facility releases, but the majority of sites are well below contaminant screening levels.

Construction, DD&D, and Operations Impacts—Option 1 would include closure of MDA G and MDA L per the Consent Order (NMED 2005a). This action should reduce the potential for soil erosion that could occur through No Action based on the use of standard construction practices at LANL. Similarly, the use of standard practices in facility DD&D, as well as facility construction, should result in negligible impact to soils under Option 1.

Direct impacts on geology and soils under Option 1 would generally be proportional to the total area of land disturbed and earthwork necessitated for new construction (see Section 5.2), particularly the new waste management facilities in TA-54 and the new TRU Waste Facility to be constructed in the Pajarito Road corridor, and demolition and closure of appropriate container storage units in Area L and fabric domes in Area G. However, most of the work would be performed in areas where these resources already have been disturbed by existing or past activities.

Approximately 80,000 cubic yards (61,000 cubic meters) of earthwork would be required to implement Option 1. This estimate reflects the construction of the new low-level radioactive waste processing facilities to be constructed in Zone 4, the construction of the TRU Waste Facility, and the remote-handled transuranic waste retrieval facility, but it does not reflect the construction of a new TRUPACT II loading area since this would be placed inside an existing dome. Aside from earthmoving, excavation depths would generally be limited to 10 feet (3 meters) or less. In all instances, adherence to standard best management practices for soil erosion and sediment control, including watering during construction, would serve to minimize soil erosion and loss. After construction, disturbed areas that have not been paved would be stabilized and revegetated and would not be subject to long term soil erosion.

Potential release sites and potential release site-affected areas could be impacted by new facility construction. Prior to commencing any ground disturbance, potentially affected contaminated areas would be surveyed to determine the extent and nature of any contamination and required remediation in accordance with procedures established under the environmental restoration project. At areas where facilities would be removed or the facility footprint reduced, a decrease in the potential for contaminant releases would occur.

Geologic resource consumption would be negligible to small under Option 1 and would not be expected to deplete local sources or stockpiles of required materials. Approximately 4,900 cubic yards (3,746 cubic meters) of concrete including associated aggregate (sand and gravel) and Portland cement would be needed during construction. Component aggregate resources are readily available from onsite borrow areas and otherwise abundant in Los Alamos County, with the required concrete expected to be procured via an off-site supplier.

No mines, pits, or quarries are being operated along the Pajarito Road corridor so Option 1 would not impact geological resources (Stephens & Associates 2005). Prior to construction of any new facilities, an estimate of the seismic hazard to the proposed site would be conducted using the most current seismic information and in accordance with DOE seismic standards and applicable building codes.

It is anticipated that the new remote-handled transuranic waste retrieval facility and TRU Waste Facility would be Performance Category 3 facilities while the characterization and verification, and compactor buildings would be Performance Category 2 facilities, contingent upon nuclear safety analyses that would be performed prior to final design. Facility construction activities would adhere to standard best management practices for soil erosion and sediment control to minimize soil erosion and loss. This would minimize the potential for release of contaminants within the soil matrix. After construction, disturbed areas that have not been paved would be stabilized or revegetated and would not be subject to long term soil erosion.

Following the completion of Option 1, operations would not result in additional impacts on geologic and soil resources at LANL. As discussed above, new facilities would be evaluated, designed, and constructed in accordance with DOE Order 420.1B (DOE 2005b) and other governing DOE and LANL construction standards and sited to minimize the risk from geologic hazards, including earthquakes.

Water Resources

Hydrology and water resources are addressed in detail in Chapter 4, Section 4.3, and in Appendix E (Groundwater in the Vicinity of LANL) of this SWEIS. Appendix F of this SWEIS includes sample information pertaining to water resources. Appendix I, Section I.4.3, includes a discussion of water resources in TA-54, Area L and Area G.

TA-54 is one of the industrial sites at LANL covered by the Multi-Sector General Permit that has an individual stormwater pollution prevention plan. As a waste treatment, storage, or disposal facility, the stormwater pollution prevention plan includes stormwater controls, spill and leak procedures, maintenance procedures, and specific stormwater monitoring requirements (EPA 2000). Stormwater controls are inspected regularly as part of regular site inspections at the facility.

The technical areas along the Pajarito Road corridor are underlain by the Bandelier Tuff. The vadose zone, from the surface to the water table, at these locations is approximately 1,200 feet (366 meters) thick. Groundwater in the vadose zone cannot be produced in quantities that might be used for human or animal consumption. Moisture content of rock in the vadose zone is low and extraction in useful amounts is impractical using existing technology.

Construction and DD&D Impacts—Little or no effect on surface water resources is expected during removal or replacement of facilities required to close Area L and MDA L, and Area G and MDA G. Construction and eventual DD&D of the remote-handled transuranic waste retrieval facility would occur under the protection of a construction stormwater pollution prevention plan. Construction of the TRU Waste Facility would also require a construction stormwater pollution prevention plan. Construction of new low-level radioactive waste processing facilities in Zone 4 and DD&D of these facilities at MDA G would include construction stormwater pollution prevention plan controls. Another construction stormwater pollution prevention plan would be required for any structure removal and final cover installation at Area L and MDA L. All of the stormwater controls introduced for the construction and demolition projects would augment the controls already in place. Construction of a TRUPACT II loading facility and consolidating equipment in one of the fabric domes would not require any mitigative measures because they would be located inside an existing facility.

Infiltration rates at the surface are thought to be low, on the order of a few millimeters per year or less (Kwicklis et al. 2005). Construction and DD&D of the remote-handled transuranic waste retrieval facility, the TRU Waste Facility, and the current low-level radioactive waste buildings would likely result in surface disturbances which could result in increased infiltration rates (by up to about two orders of magnitude) as a result of rainfall events, snowmelt, or ponded water. It is difficult to estimate whether increased infiltration would change the rate of migration of any contaminants that may be situated under the disturbed areas, although near-surface contamination could be mobilized (or if currently mobile, transport could be accelerated over a small distance during periods of increased infiltration). Removal of waste, to the extent anticipated, would decrease the quantity of contaminants available for release to the environment, although increased infiltration could affect deeper contamination within the soil and tuff that is beyond the reach of the excavation. In any case, current rates of transport in the vadose zone overall are unlikely to change over the period addressed in this SWEIS, nor would groundwater resources be affected over this period. Consolidation of transuranic waste processes from outdoor areas to inside a dome would have minimal positive impacts.

Operations Impacts—Retrieval and processing of wastes should have little or no effect on surface water resources. Although remote-handled transuranic wastes that would be retrieved by the remote-handled transuranic waste retrieval facility should contain no liquids, processing areas would have shielded sumps to collect any liquids generated during processing. Similarly, although newly-generated contact-handled transuranic wastes should contain no free liquids, the floor of the TRU Waste Facility would direct any unexpected liquids to a sump for recovery, treatment, and proper disposal. Regardless of where the TRU Waste Facility is located, the site would be included in the Multi-Sector General Permit for industrial activities and would require an industrial stormwater pollution prevention plan.

Retrieval and processing of wastes, similar to construction activities, would entail disturbance of the surface and potentially increase infiltration to groundwater. Further, the handling of waste would run the risk of spill or loss; however, amounts would likely be small due to the small amount of liquid currently present and proper waste handling techniques.

Appropriately designed and constructed closure covers to be used for MDAs G and L should reduce the effects of stormwater infiltration that could mobilize contaminants and transport them to the groundwater.

Air Quality and Noise

Air Quality

Nonradiological air pollutant emission sources at the Solid Radioactive and Chemical Waste Management Key Facility include the use of various toxic chemicals. Emissions of toxic pollutants from the Solid Radioactive and Chemical Waste Management Key Facility are shown in **Table H–18** and are based on chemical usage. These emissions vary by year with the amounts of chemical being used but provide a basis for establishing baseline conditions.

Table H–18 Nonradiological Air Pollutant Emissions at Solid Radioactive and Chemical Waste Management Key Facility – 2005

Pollutant	*Tons per Year*
Ethanol	0.00198
Hydrogen chloride	0.45118
Potassium hydroxide	0.00117
Propane	0.00
Pyridine	0.00036
Sulfuric Acid	0.08431
Tetrahydrofuran	0.00032

Note: To convert tons to kilograms, multiply by 907.18.
Source: LANL 2006f.

A comparison of calculated maximum emission rate derived from health-based standards to the potential emission rate was made. A screening level emission value was developed for each chemical. A screening level emission value is a theoretical maximum emission rate that, if emitted at that TA over a short-term (8-hour) or long-term (1-year) period, would not exceed a health-based guideline value. This screening level emission value was compared to the emission rate that would result if all the chemicals purchased for use in the facilities at a TA over the course of one year were available to become airborne. At TA-54, chemicals would be emitted at levels below the screening levels identified.

Radiological air emissions, which contribute to the total radiological dose to a person, currently come from area sources and the Decontamination and Volume Reduction System at TA-54. Area source emissions include a) airborne soils from disturbing contaminated soils at TA-54, b) buried tritium-contaminated materials where tritium migrates to the surface and becomes airborne, and c) non-packaged waste as it is placed into the pits at Area G before it is covered. Appendix C of this SWEIS provides a breakdown of potential radiological air emissions from TA-54.

Construction and DD&D Impacts—Construction of new waste processing facilities under Option 1 (that is, the remote-handled transuranic waste retrieval facility, the TRU Waste Facility, the TRUPACT II loading facility, and the low-level radioactive waste processing buildings) would result in temporary increases in air quality impacts from construction equipment, trucks, and employee vehicles. Modeling of criteria pollutant concentrations for construction, with the possible exception of carbon monoxide, indicates that the maximum ground-level concentrations offsite would be below the ambient air quality standards and it is expected that the air quality impacts on the public would be minor. Most of the equipment that would be used for DD&D would be construction equipment. Vehicle emissions during DD&D would be similar to those during construction. Additional dust from the demolition of buildings and materials would also temporarily contribute to localized air quality impacts; however, these activities would not be expected to exceed ambient air quality standards.

For radiological emissions, during initial DD&D there would be emissions during the removal of equipment and decontamination of structural surfaces. While the building shell is intact, emissions would result from building or temporary ventilation systems used for dust and contamination control. These systems would use high-efficiency particulate air filtration prior to exhausting air from interior contaminated spaces to areas outside the building. Ventilation and other controls would be used to minimize worker inhalation and exposure to radioactivity and avoid recontamination of previously decontaminated areas. The result of the initial activities would be structural surfaces either decontaminated to unconditional-release levels or with selected contaminated surfaces stabilized to permit segregation of radioactively-contaminated and -uncontaminated debris after demolition.

The potential exists for contaminated soils, building debris, and possibly other media to be disturbed during building demolition. Release of radioactivity would be minimized by proper decontamination of buildings prior to demolition – if facilities are decontaminated to unconditional release levels as prescribed by the MARSSIM protocol (MARSSIM 2000), emissions would be similar to those from uncontaminated buildings. If residual levels of contamination remain after decontamination activities are complete, then small amounts of radioactivity would be emitted during demolition. The radionuclide concentrations resulting from demolition of contaminated facilities may be predicted based on the pre-demolition characterization of the building, and would be addressed in regulatory documents approved at that time. Such emissions are typically of short duration, and would be minimized using dust suppression techniques and monitored along with the fugitive dust.

Radiological air emissions from the Decontamination and Volume Reduction System would remain as currently observed until the facility undergoes DD&D in preparation for closure of Area G and MDA G. Two new facilities, the remote-handled transuranic waste retrieval facility and the TRU Waste Facility, would be assumed to emit radiological air emissions equivalent to the Decontamination and Volume Reduction System. **Table H–19** summarizes the annual air emissions to be expected from each of these three facilities.

Table H–19 Radiological Air Emissions from Each Waste Management Facility

Isotope	*Annual Air Emission Rate (curies per year)*
Americium-241	3.53×10^{-6}
Plutonium-238	1.76×10^{-5}
Plutonium-239	7.78×10^{-6}

Source: See Appendix C.

The radiological air emissions from the Decontamination and Volume Reduction System are assumed to continue until approximately 2015 (note however, that it must be decommissioned to allow for closure of MDA G in 2015.) The radiological air emissions from the remote-handled transuranic waste retrieval facility, to be located in TA-54 Area G, would occur from 2011 to 2015. The radiological air emissions from the TRU Waste Facility, would occur starting in 2012 and continue for the next 30 to 35 years.

Radiological air emissions from area sources in TA-54 are assumed to continue at current rates until closure of MDA G which is scheduled to be completed in 2015. The primary radionuclide in area air emissions is tritium, with approximately 60.9 curies per year projected to be released (see Appendix C, Table C–13).

Operations Impacts—During operations, toxic air pollutants would be generated from the use of various chemicals. Toxic pollutants released would be expected to be similar to current uses as shown in Table H–18 for the facilities at TA-54 and other locations associated with waste management operations. These emissions would vary by year with the activities performed. The emissions would be expected to be small and below the screening level emission values and it is expected that the air quality impacts on the public would be minor.

Noise

Operations noise sources from the Solid Radioactive and Chemical Waste Management Key Facility include heating, ventilation, and cooling equipment and vehicles. There are minimal noise impacts on the public from current waste management activities.

Construction and DD&D Impacts—Construction of new waste processing facilities under Option 1 would result in some temporary increase in noise levels near the area from construction equipment and activities. Some disturbance of wildlife near the area may occur as a result of operation of construction equipment. There would be no change in noise impacts on the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from construction employees' vehicles and materials shipment. Noise sources associated with construction of these facilities are not expected to include loud impulsive sources such as from blasting. DD&D activities may include blasting, but these events, if necessary, would only be for larger structures and the number of events would be small.

Operations Impacts—Noise impacts from operation of the waste processing facilities are expected to be similar to those from existing waste processing facilities at TA-50 and TA-54. Although there would be small changes in traffic and equipment noise (such as new heating and cooling systems) near the area, there would be little change in noise impacts on wildlife and no change in noise impacts on the public outside of LANL as a result of operating these new facilities.

Ecological Resources

TA-54 is largely located within the Pinyon-Juniper Woodland vegetation zone; however, the westernmost portion of the area falls within ponderosa pine forest. Wildlife using the TA would include species typical of both vegetation zones. Although most of the area was untouched by the Cerro Grande Fire, the northwestern portion of the site was burned at a low, unburned to medium severity level. At a medium severity level, seed stocks can be adversely affected and erosion can increase due to the removal of vegetation and ground cover (DOE 2000). Areas G and L are disturbed areas with minimal ground cover that are largely fenced; thus, wildlife use of these areas would be limited to small mammals, birds, and reptiles (Marsh 2001). There are no wetlands located within TA-54; however, a number of wetlands are located within Pajarito Canyon (TA-36) just to the south (see Section H.1.3.2) (ACE 2005).

A portion of TA-54 falls within the core and buffer zones of the southwestern willow flycatcher Area of Environmental Interest; however, the Area of Environmental Interest is restricted to the canyon and does not include any part of the Areas G and L. Areas of Environmental Interest for the Mexican spotted owl and bald eagle do not encompass any part of TA-54 (LANL 2000b).

Biological Resources

For the TRU Waste Facility, generic areas within TA-35, TA-46, TA-48, TA-50, TA-51, TA-52, TA-54 West, TA-63, and TA-66 have been selected for analysis. **Table H–20** indicates the type of vegetation present at the generic facility site, whether wetlands and aquatic resources are present, and if the facility would be within a Mexican Spotted Owl Area of Environmental Interest. None of the potential sites within the generic include Areas of Environmental Interest for the bald eagle or southwestern willow flycatcher.

Construction, DD&D and Operational Impacts—Under Option 1, all actions within TA-54, including new construction within Zone 4, DD&D activities, and removal of the white-colored domes, would take place within developed areas. Thus, there would be little to no direct impact on ecological resources. Although TA-54 includes a portion of the southwestern willow flycatcher Area of Environmental Interest, the area within which project-related activities would take place (TA-54 West) is about 450 feet (137 meters) from the core habitat. Thus, there would be no direct loss of foraging or nesting habitat. The biological assessment prepared by DOE determined that noise levels should not exceed 6 dB(A) above background levels in the core zone. Provided reasonable and prudent alternatives are implemented, the biological assessment concluded that the project may affect, but is not likely to adversely affect, the southwestern willow flycatcher. Reasonable and prudent alternatives would include designing all lighting so that it would be confined to the site, keeping disturbance and noise to a minimum, implementing appropriate erosion and runoff controls, avoiding unnecessary disturbance to vegetation (including wetland vegetation), revegetating with native plant species, and continuing to perform annual surveys adjacent to the project area before and during the action (LANL 2006b). The U.S. Fish and Wildlife Service has concurred with this assessment (see Chapter 6, Section 6.5.2).

Table H–20 Ecological Characteristics of the TRU Waste Facility Site

Technical Area	*Vegetation*	*Wetland/Aquatic Resources*	*Within Mexican Spotted Owl Area of Environmental Interest Core/Buffer Zone*
35	Partially disturbed and ponderosa pine	None	Yes/No
46	Ponderosa pine	None	Yes/Yes
48	Ponderosa pine	None	No/No
50	Open field with some ponderosa pine	None	Yes/Yes
51	Ponderosa pine	None	No/No
52	Ponderosa pine	None	Yes/Yes
54 West	Disturbed	None	No/No
63	Open field	None	No/Yes
66	Ponderosa pine	None	Yes/Yes

With respect to the bald eagle and Mexican spotted owl, the biological assessment determined that there would be no effect on either species as a result of implementing the proposed project. This is the case because the TA does not include any portion of Areas of Environmental Interest for these species, foraging habitat would not be disturbed, and noise levels would be less than 6 decibels (A-weighted) above background (LANL 2006b). The U.S. Fish and Wildlife Service has concurred with this assessment (see Chapter 6, Section 6.5.2).

Most generic sites for the TRU Waste Facility would disturb ponderosa pine forest, although at TA-50 and TA-63 the facility may be built within an area that is primarily open field. It is possible that it may be constructed in a developed area at TA-54 West or TA-50. No more than a maximum of 7 acres (2.8 hectares) of habitat would be disturbed with the loss or disturbance of associated wildlife. In no case would wetlands or aquatic resources be directly disturbed; best management practices would control erosion and sedimentation. At least some portion of either the core or buffer zone of Mexican spotted owl Areas of Environmental Interest would be affected by construction of the TRU Waste Facility within all TAs except TA-48, TA-51, and TA-54 West. For those generic sites where the new facility has the potential to affect the spotted owl, either directly or indirectly (for example, by excess noise or light), it would be necessary to conduct a biological assessment and initiate formal consultation with the U.S. Fish and Wildlife Service. None of the generic sites are within Areas of Environmental Interest for the bald eagle or southwestern willow flycatcher.

Human Health

This section summarizes the information on public and worker health affected by both nonradiological and radiological impacts that are currently observed in LANL operations. In particular, the focus is on those structures and processes in a generic area in the Pajarito Road corridor and TA-54 since the majority of waste management facilities are located in these two areas.

Nonradiological impacts include current occupational injury rates due to construction, operations, and DD&D, as well as toxic chemical and biological agent hazards. Radiological impacts are related to the amount of radiological dose that a member of the public and an on-site worker might receive due to radiological emissions and direct radiation in these technical areas. Section 4.6 generally describes off-site and on-site exposures due to LANL operations. This information cannot be assigned to specific areas within LANL, such as to TA-54.

Table H–21 summarizes the potential radiation dose to the facility-specific maximum exposed individual and population within 50 miles (80 kilometers) of waste management operations in TA-54. The facility-specific (TA-54) maximum exposed individual is assumed to be located approximately 394 yards (360 meters) northeast of TA-54. The primary isotopic contributor to the radiological dose to the maximum exposed individual shown in Table H–21 is tritium (71 percent of the 0.052 millirem per year). These radiological doses were calculated using the computer model CAP88-PC, which is described in Appendix C.

Table H–21 Potential Radiation Dose from Current Technical Area 54 Operations

Source	*Dose to the Facility-Specific Maximum Exposed Individual (millirem per year)*	*LCF Risk*
TA-54 Area Sources	0.045	2.7×10^{-8}
Decontamination and Volume Reduction System	0.0073	4.4×10^{-9}
Total	0.052	3.1×10^{-8}
	Dose to Population within 50 Miles (person-rem per year)	
TA-54 Area Sources	0.025	1.5×10^{-5}
Decontamination and Volume Reduction System	0.012	7.3×10^{-6}
Total	0.037	2.2×10^{-5}

TA = technical area, LCF = latent cancer fatality.

The 7-year average (1999 to 2005) collective total effective dose equivalent for the LANL worker population was 161 person-rem (LANL 2003d, 2006f). In general, determining the collective total effective dose equivalent for each Key Facility or technical area is difficult to determine because these data are collected at the group level, and members of many groups or organizations receive doses at several locations. The fraction of a group's collective total effective dose equivalent coming from a specific Key Facility or technical area can only be estimated. LANL staff report radiation exposure to waste management operations workers as an occupational group through DOE's Radiation Exposure Monitoring System database, but these workers may also perform other functions that do not support waste management activities.

The average measurable dose over the same 6-year period for waste management operations personnel at LANL was 141 millirem. Approximately 22 percent of the waste management operations personnel obtain measurable dose (DOE 2006). Waste management personnel primarily work in TA-50 and TA-54, but they may also periodically work in other TAs.

LANL staff currently monitor direct radiation (radiation from a source term, which can generally be correlated to an external dose) throughout the LANL site using thermoluminescent detectors.

LANL staff report these measurements through the LANL meteorology and air quality web site on a quarterly basis (LANL 2005g). The results include direct radiation contributions from natural background (that is, cosmic and terrestrial radiation). After subtracting out the approximate contribution of natural background radiation, it is found that LANL waste management operations in Area G contribute to direct radiation levels in the work environment outside the transuranic waste storage domes and the Decontamination and Volume Reduction System (direct radiation levels in TA-50 and TA-63 are within background levels) (LANL 2005g). These radiation levels contributed to a radiation dose ranging from 42 to 729 millirem per quarter from January 2003 through June 2005 and are a result of gamma and neutron exposures, depending on the location. These exposures reflect a worker who would be outside one of these locations 24 hours per day, 7 days per week (LANL 2005g).

Construction, DD&D and Operational Impacts—Compared to the No Action Option, additional point source radiological impacts can be expected due to the operation of the proposed remote-handled transuranic waste retrieval facility in TA-54 and the proposed TRU Waste Facility. It is assumed that the remote-handled transuranic waste retrieval facility and the TRU Waste Facility would be designed such that radiological releases would not exceed the releases that are documented from the Decontamination and Volume Reduction System.[10] The facility-specific maximum exposed individual dose associated with TA-54 from operation of the remote-handled transuranic waste retrieval facility would be the same as from the Decontamination and Volume Reduction System (0.0073 millirem per year) from 2011 to 2015. Both the remote-handled transuranic waste retrieval facility and the Decontamination and Volume Reduction System would cease operations in time to close MDA G in 2015. The TRU Waste Facility could potentially be located in one of several TAs on the Pajarito Road corridor: TA-35, TA-46, TA-48, TA-50, TA-51, TA-52, TA-54 West, TA-63 or TA-66. Taking into account the proximity of the Royal Crest Trailer park and LANL boundaries, the highest and therefore bounding potential dose to the facility-specific MEI resulting from emissions would be from a facility located at TA-51. This dose of approximately 0.0090 millirem per year would begin in 2012 and continue for about 30 to 35 years. The impact of the TRU Waste Facility, the remote-handled transuranic waste retrieval facility, and the Decontamination and Volume Reduction System on the LANL site-wide MEI (located approximately 800 meters north-northeast of LANSCE in the Expanded Operations Alternative) would be minor (an additional 0.0006 millirem per year) when compared to the dose from operations at LANSCE (7.5 millirem per year). Similarly, these additional waste management operations would add only 0.02 person-rem per year to the total dose (30 person-rem per year) the population would receive from normal operations at LANL under the Expanded Operations Alternative.

The 50-mile (80-kilometer) population radiological doses for emissions from the remote-handled transuranic waste retrieval facility would also be expected to be similar to the Decontamination and Volume Reduction System (0.012 person-rem per year) if these facilities are operated in TA-54. A potential location for the TRU Waste Facility is at the northwestern end of the Pajarito Road corridor in TA-48, which is in close proximity to the public at the Royal Crest Trailer park and the Los Alamos townsite. From this potential location, the TRU Waste Facility

---

[10] *The remote-handled transuranic waste retrieval and processing facility would be processing highly radioactive waste; thus, it is conceivable that its emissions could be higher than the Decontamination and Volume Reduction System. LANL staff would prepare a Documented Safety Analysis for this proposed facility to more accurately determine its potential emissions and resulting impacts.*

would contribute approximately 0.011 person-rem per year to the population, assuming emissions are the same as those from the Decontamination and Volume Reduction System. The population dose would be comparable or less if the facility were located in any of the other TAs being considered.

Population doses for area emissions at TA-54 were calculated to be 0.025 person-rem per year for the No Action Option. Area emissions should increase due to retrieval and DD&D activities.

In addition, an increase in the area sources related to soil disturbance during waste retrieval from trenches, pits and shafts and DD&D activities would occur. However, these increases would be offset by decreases in direct radiation associated with the transuranic waste stored in the domes as the above-grade waste inventory declines due to processing and shipping this waste to WIPP. It is therefore expected that direct radiation levels in Area G would stay relatively the same as transuranic waste is retrieved from below-ground storage and placed into above-ground storage in the storage domes. Retrieval would only occur as storage space becomes available in the storage domes. Direct radiation levels would ultimately decrease to close to background levels in Area G by 2016 once all transuranic waste is shipped offsite for disposal and DD&D activities are completed. In Area L, direct radiation levels would remain within background levels since mixed low-level radioactive waste storage volumes would not increase over current storage levels.

For the low-level radioactive waste processing facilities to be constructed in Zone 4, it is expected that direct radiation levels and radiological emissions associated with characterization, verification and compaction would remain at current levels since the only change in operations would be that the location of these activities would be different, and the new processing capabilities in Zone 4 would be similar to the current capabilities in Area G.

Worker exposures to direct radiation would be controlled ALARA using engineering design and administrative controls. The LANL performance goal is to maintain a worker’s whole body dose to less than 2 rem per year (LANL 2002b). Waste management workers would be expected to maintain current exposure levels because of these administrative controls.

For nonradiological impacts, approximately 2 to 9 recordable injuries may occur for performing DD&D activities in TA-54 (which includes Areas L and G) using DOE and national safety statistics for construction activities. These values represent DD&D of all structures and processes; although not all of the structures and processes in Area L would be removed under Option 1, these would represent a small percentage of the overall total and would not appreciably lower the values. Several facilities would also be constructed in this option. Using DOE and national safety statistics for LANL, approximately 4 to 13 recordable injuries may occur during construction of the low-level radioactive facilities, the TRU Waste Facility, and the remote-handled transuranic waste retrieval facility.

Note that installation of a new TRUPACT II loading area would result in lower occupational safety impacts than the construction of the other facilities because this loading area would go in an existing fabric dome and would not require significant construction activities. In addition, occupational safety impacts due to moving transuranic waste processing equipment from outdoors to inside one of the fabric domes would be minimal.

Potential impacts from hazardous and toxic chemicals would continue to be prevented through the use of administrative controls and equipment.

Cultural Resources

As noted in Section H.3.2.2.2, a location for the TRU Waste Facility has yet to be finalized. Thus, a generic area encompassing TA-35, TA-46, TA-48, TA-50, TA-51, TA-52, TA-54 West, TA-63, and TA-66 has been selected for analysis. For each TA, a generic site was selected within which the TRU Waste Facility could be constructed. The facility would be located on 2.5 to 7 acres (1 to 2.8 hectares) of land. **Table H–22** presents the number of archaeological resource sites identified within the vicinity of each generic TRU Waste Facility site, the number of the archaeological resources sites eligible or of undetermined status relative to listing on the National Register of Historic Places, and the number of eligible historic buildings and structures that could be affected.

Table H–22 Affected Cultural Resource Sites – TRU Waste Facility Site

Technical Area	*Archaeological Resource Sites Within Vicinity of TRU Waste Facility*	*NRHP Eligible/of Undetermined Status Sites Within Vicinity of TRU Waste Facility*	*NRHP Eligible Buildings and Structures Affected by TRU Waste Facility*
35	0	0/0	0
46	7	4/1	0
48	1	1/0	0
50	1	1/0	0
51	13	11/2	0
52	3	3/0	0
54 West	16	13/0	0
63	0	0/0	0
66	4	½	0

NRHP = National Register of Historic Places.

Due to its large size, TA-54 has many cultural resource sites; thus, only those resources within the TA that are in the vicinity of Area G and Area L are summarized in this section. There are 22 cultural resource sites near Area G and 10 in the vicinity of Area L and Zone 4. Of the 22 archeological sites located within Area G, 7 have been excavated within the MDA and 1 partially excavated with Zone 4. All identified cultural resource sites are prehistoric and include lithic and ceramic scatters, rock art, rock shelters, cavates, a 1- to 3-room structure, Pueblo roomblocks, and plaza Pueblos. Fourteen sites within the vicinity of Area G have been determined to be eligible for listing on the National Register of Historic Places, while 8 are ineligible. A number of prehistoric sites were located within Area G prior to its development; however, these were examined by archaeologists prior to development of the MDA. All 10 prehistoric sites located within TA-54 in the vicinity of Area L have been determined to be eligible for listing in the National Register of Historic Places. Of the 10 sites located in the vicinity of Area L, 1 has been excavated. Eight archaeological sites are located in Zone 4, which is where low-level radioactive waste disposal operations are being expanded.

Construction, DD&D, and Operations Impacts—Under this option all actions in TA-54, including new construction and removal of the domes, would take place within developed areas. Thus, there would be no direct impact on cultural resources. However, a number of cultural resource sites are located nearby; and, the potential exists for indirect impacts to these resources. In order to ensure these resources would not be affected, cultural resource site boundaries would be marked and fenced, as appropriate, prior to groundbreaking activities. Fencing would prevent accidental intrusion and disturbance to the sites.

As noted in Table H–22, archaeological resource sites are located within the vicinity of all generic TRU Waste Facility sites, except those in TA-35 and TA-63. National Register of Historic Places-eligible sites and sites of undetermined status include 1- to 3-room structures, rock and wood enclosures, pueblo roadblocks, lithic and historic scatters, caveats, and rock shelters. Although archaeological resources are located in the vicinity of a number of generic sites, only those in TA-50, TA-54 West, and TA-66 have the potential to be directly affected by construction of the TRU Waste Facility. Direct and indirect impacts to archaeological resources would require notifying appropriate LANL personnel and implementation of the requirements of the *Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico* (LANL 2006c). Mitigation measures, including avoidance, would be taken to ensure that construction activity, traffic, and ground disturbances would not result in damage to the resources. These measures would be incorporated into a formal Memorandum of Agreement between DOE and the New Mexico Historic Preservation Division to resolve adverse effects. The Advisory Council on Historic Preservation would be notified of the Memorandum of Agreement and would have an opportunity to comment. Construction of the TRU Waste Facility would not impact any National Register of Historic Places-eligible buildings or structures.

Adverse impacts on traditional cultural properties from activities associated with the waste management facilities would be unlikely since most activities would take place within previously disturbed portions of TA-54. However, removal of the domes at TA-54, some of which are white-colored and therefore highly visible, would have a positive impact on views from Pueblo of San Ildefonso lands which border the TA to the north. As noted for Visual Resources, the TRU Waste Facility would be visible from San Ildefonso Pueblo lands if built within TA-51, TA-52, or TA-54 West. Thus, impacts to traditional cultural properties are possible if the new facility were built within these TAs. Impact potential is reduced within TA-54 West since construction would take place within a developed area.

Socioeconomics and Infrastructure

Both from a utility infrastructure and secondary impacts perspective, the greatest impact would occur from selection of an undeveloped site that is not proximal to existing utility corridors. However, the eastern Pajarito Road corridor from TA-48 to TA-54 West, in which the new TRU Waste Facility is proposed to be constructed, is generally well served by electric power, water, and natural gas distribution lines (LANL 2000a, 2004b). For the purposes of analyzing the potential infrastructure impacts associated with waste management facilities transition options, it was assumed that planned electrical upgrades for TA-50 would occur regardless of this proposed project.

Construction and DD&D Impacts—Utility resource requirements to support construction of the proposed new waste management facilities are expected to have a minor incremental impact on site utility infrastructure. Approximately 422,000 gallons (1.6 million liters) of liquid fuels (diesel and gasoline) would be consumed for site work, mainly for use by heavy equipment and for new facility construction. Liquid fuels would be procured from offsite sources and, therefore, would not be limited resources. In addition, it is anticipated that approximately 2.3 million gallons (9 million liters) of water would be needed for construction, primarily for dust suppression and soil compaction. The existing LANL water supply infrastructure would be capable of handling this demand. Electrical and water usage in Area L would slightly decrease due to a decrease in waste management operations.

Operations Impacts—Upon completion, operation of the new waste management facilities for the timeframes required would be expected to have a negligible incremental impact on LANL utility infrastructure. The operation of new low-level radioactive waste processing facilities in Zone 4, TA-54 would offset decreased infrastructure usage gained by the DD&D of the current facilities. The remote-handled transuranic waste retrieval facility and the TRU Waste Facility do not have energy-intensive operations, regardless of where they are located.

Waste Management

The Solid Radioactive and Chemical Waste Facilities at TA-54 manage a variety of wastes including industrial and toxic wastes, hazardous wastes, low-level radioactive waste, transuranic waste, and mixtures of these wastes. Most of the wastes managed at this Key Facility are generated elsewhere, with waste quantities and associated impacts attributed to the generating facilities. However, the Chemical and Radioactive Waste Management Facilities generate secondary wastes from the treatment, storage, and disposal of chemical and radioactive wastes. Examples of secondary wastes include: repackaging wastes from the visual inspection of transuranic waste, high-efficiency particulate air filters from waste operations, personnel protective clothing and equipment, and process wastes from size reduction and compaction (LANL 2004b). Although operations at this Key Facility include the retrieval of stored legacy transuranic waste, this waste is not included in the waste generation quantities for the Solid Radioactive and Chemical Waste Facilities. Historical chemical and radioactive waste generation information is provided in **Table H–23**.

Table H–23 Waste Generation Ranges and Annual Average Generation Rates for the Solid Radioactive and Chemical Waste Facilities

Waste Type	*Rates for the Period 1999 to 2005*	
Low-level Radioactive Waste (cubic yards)	Range	17 to 368
	Average	114
Mixed Low-level Radioactive Waste (cubic yards)	Range	0 to 0
	Average	0
Transuranic Waste (cubic yards)	Range	0 to 115
	Average	36
Mixed Transuranic Waste (cubic yards)	Range	0 to 77
	Average	18
Chemical Waste (pounds)	Range	70 to 6,240
	Average	2,203

Notes: The Solid Radioactive and Chemical Waste Facilities data were compiled jointly for waste management facilities at both TA-54 and TA-50. Only activities within TA-54 would be affected by closure of MDA L and MDA G; therefore, the values shown are a conservative estimate of waste management impacts to the affected environment. To convert pounds to kilograms, multiply by 0.45359; cubic yards to cubic meters, multiply by 0.76456.
Sources: LANL 2003d, 2004c, 2005d, 2006f.

Construction and DD&D Impacts—Construction of new facilities under Option 1 would generate some waste, primarily construction debris and associated solid waste. Construction debris is not hazardous, and is managed at solid waste landfills. Approximately 250 cubic yards (227 cubic meters) of construction debris would be expected from construction activities under Option 1.

A significant quantity of low-level radioactive waste and a small quantity of mixed low-level radioactive waste would be generated by DD&D of the aboveground facilities in Area L and MDA L, and Area G and MDA G, as detailed in **Table H–24**.

Table H–24 Estimated Waste Volumes from Decontamination, Decommissioning and Demolition Activities (cubic yards)

Low Specific Activity Waste	*Packaged Low-level Radioactive Waste*	*Mixed Low-level Radioactive Waste*	*Solid* [a]	*Hazardous*	*Asbestos*
22,700	7,600	8	54,200	35	530

[a] Includes construction, demolition, and sanitary waste.

Notes: It is assumed 25 percent of the low-level radioactive waste volume requires packaging. To convert cubic yards to cubic meters, multiply by 0.76456.

Operations Impacts—Operations under Option 1 would be expected to produce additional quantities of low-level radioactive waste and transuranic waste, including some mixed low-level radioactive waste and mixed transuranic waste. As contact-handled transuranic waste is retrieved from trenches, pits, and shafts, and remote-handled transuranic waste is retrieved from shafts, secondary wastes would be generated through retrieval efforts, characterization, size reduction, and repackaging efforts. Because the retrieval facilities would be newly designed with waste minimization principles applied, some efficiency over past retrieval operations would be expected. Low-level radioactive waste would be disposed of onsite or shipped offsite, with the selected disposal path determined based on Zone 4 capacity and disposal priorities. Transuranic wastes would be transported to WIPP for disposal. Solid, hazardous and asbestos wastes would be dispositioned according to current practices. The quantities of secondary wastes to be generated would be expected to be small in comparison to the retrieved waste and to LANL-wide quantities from operations. No significant impacts to the waste management infrastructure would be expected from the additional quantities of secondary wastes generated from the wastes generated under Option 1.

Transportation

Motor vehicles are the primary means of transportation at LANL. Regional transportation route(s) to LANL include: Albuquerque and Santa Fe – Interstate-25 to U.S. 84/285 to NM 502; from Española – NM 30 to NM 502; and from Jemez Springs and western communities – NM 4. Hazardous and radioactive material shipments leave or enter LANL from East Jemez Road to NM 4 to NM 502. Only two major roads, NM 502 and NM 4, access Los Alamos County. Los Alamos County traffic volume on these two segments of highway is primarily associated with LANL activities. Pajarito Road generally bisects the LANL site between NM 4 and Diamond Drive in an east-west presentation. NNSA recently closed Pajarito Road to public use; it is now only used by site personnel for accessing the site from Diamond Drive and White Rock and moving between technical areas.

Table H–25 presents results of traffic surveys performed on Pajarito Road just east of TA-63, which is between TA-50 and TA-54. This location would therefore be representative of the stretch of the road impacted by waste shipment activities for Solid Radioactive and Chemical Waste Management Facilities.

Table H–25 2004 Traffic Counts Along Pajarito Road Immediately East of Technical Area 63

Location	*Average Vehicles per Weekday*	*Average Vehicles per Weekend Day*	*AM Eastbound Peak Vehicles per Hour*	*PM Eastbound Peak Vehicles per Hour*
Pajarito Road immediately east of TA-63	5,758	674	859	825

TA = technical area.
Source: KSL 2004.

As part of current operations, LANL security periodically conducts road closures to allow shipments of transuranic waste to occur between TA-54 and TA-50 (where the Waste Characterization, Reduction, and Repackaging Facility is located), between TA-54 Area G and TA-54 West (where the Radioassay and Nondestructive Testing Facility is located), and to allow shipment of transuranic waste from production and research and development facilities to TA-54. These road closures are necessary to allow the safe shipment of transuranic waste that has yet to be packaged in U.S. Department of Transportation-approved containers (such as TRUPACT II containers) and to minimize radiation exposure to non-involved workers (that is, those workers traveling on the road but not supporting the waste management shipments). Since Pajarito Road is closed to public access, these road closures primarily impact only onsite workers and operations.

Construction and DD&D Impacts—The construction of the TRU Waste Facility and remote-handled transuranic waste retrieval facility would slightly increase traffic on Pajarito Road due to shipment of materials and construction equipment to these proposed facilities. This would occur only over a period of a few years (2007 to 2011) until construction is complete. There would not be a noticeable increase in construction workforce traffic because it is assumed that the construction workforce currently onsite on other projects would be sufficient to complete these new waste management facilities. There would not be a significant increase in the operational workforce traffic, as the operators for these two facilities would primarily be drawn from the existing workforce and these facilities would not have large staffing requirements. The construction of the replacement low-level radioactive waste processing facilities in Zone 4 would create temporary, but small increases in construction traffic volume on Pajarito Road. The transportation of DD&D wastes related to some of the facilities in Area L and all of the facilities in Area G would primarily be local and stay within TA-54 for radioactive waste shipments, with additional shipments of rubble and other industrial wastes transported to offsite disposal facilities.

The effects from incident-free transportation of these radioactive wastes for the worker population and the general public are presented as collective dose in person-rem resulting in excess LCFs in **Table H–26**. Excess LCFs are the number of cancer fatalities that may be attributable to the proposed project that may occur in the exposed population over the lifetimes of the individuals. If the number of LCFs is less than one, the subject population is not expected to incur any LCFs resulting from the actions being analyzed. The risk for development of excess LCFs is highest for workers under the offsite disposition option. This is because the dose is proportional to the duration of transport which in turn is proportional to travel distance. As shown in Table H–26, disposal offsite would lead to a higher dose and risk than disposal onsite.

Table H–26 Incident-Free Transportation Impacts – Waste Management Facility Transition Decontamination, Decommissioning and Demolition Activities

Disposal Option	*Low-level Radioactive Waste Disposal Location* [a]	*Crew*		*Public*	
		Collective Dose (person-rem)	*Risk (LCFs)*	*Collective Dose (person-rem)*	*Risk (LCFs)*
Onsite disposal	LANL TA-54	0.02	1×10^{-5}	0.005	3×10^{-6}
Offsite disposal	Nevada Test Site	8.11	5×10^{-3}	2.35	1×10^{-3}
	Commercial Facility	7.86	5×10^{-3}	2.29	1×10^{-3}

LCF = latent cancer fatality, TA = technical area.

[a] Transuranic wastes are disposed of at WIPP.

Note: The number of shipments is based on DD&D of all above-ground facilities in TA-54, Areas G and L and includes only radioactive waste shipments. For Option 1, a few facilities in Area L would remain, but would not result in any appreciable change to the table values.

Table H–27 presents the impacts from traffic and radiological accidents. This table provides population risks in terms of fatalities due to traffic accidents, both from the collision and from excess LCFs due to exposure to radioactive releases. The analyses assumed that all generated wastes would be transported to offsite disposal facilities. The results indicate that no traffic fatalities and no excess LCFs are expected to occur from transportation accidents during DD&D activities in TA-54.

Table H–27 Transportation Accident Impacts – Waste Management Facility Transition Decontamination, Decommissioning and Demolition Activities

Radioactive Waste Disposal Location [a, c]	*Number of Shipments* [b]	*Distance Traveled for All Shipments (million miles)*	*Accident Risks*	
			Radiological (excess LCFs)	*Traffic (fatalities)*
LANL TA-54	4,871	1.3	NA [d]	0.02
Nevada Test Site	4,871	5.9	2×10^{-7}	0.06
Commercial Facility	4,871	5.4	2×10^{-7}	0.06

LCF = latent cancer fatality, TA = technical area, NA = not applicable.

[a] All nonradiological wastes would be transported offsite.

[b] 37 percent of shipments are for radioactive wastes, with the remaining 63 percent for industrial, sanitary, asbestos, and hazardous wastes.

[c] Transuranic wastes are disposed of at WIPP.

[d] No traffic accident leading to releases of radioactivity for onsite transportation is hypothesized.

Note: The number of shipments is based on DD&D of all above-ground facilities in TA-54 and includes radioactive and non-radioactive waste shipments. For Option 1, a few nonradiological facilities in Area L would remain, but would not result in any appreciable change to the table values.

Note: To convert miles to kilometers, multiply by 1.6093.

The above incident-free and accident impacts were derived using the assumptions provided in Appendix K.

Operations Impacts—In Option 1, additional transuranic waste processing capabilities (that is, installation of modular units and additional equipment, and addition of a TRUPACT II loading area) would be installed in Area G to accelerate the offsite shipment of this waste to WIPP. These additions would replace the capabilities currently provided by the Waste Characterization, Reduction, and Repackaging Facility in TA-50 and the Radioassay and Nondestructive Testing Facility in TA-54 West. In this case, the transportation of transuranic waste to and from TA-50 and TA-54 West would be eliminated, as would the need for closing Pajarito Road to transport transuranic waste to and from the Waste Characterization, Reduction, and Repackaging Facility and Radioassay and Nondestructive Testing Facility, which would otherwise occur under the No Action Option. Road closures would continue to allow for the shipment of newly-generated transuranic waste from LANL production areas to TA-54 while Area G and MDA G remains open. In Option 1, LANL staff would ship all transuranic waste stored above-ground and below-ground to WIPP. Appendix K addresses the transportation impacts for removal of these wastes.

The TRU Waste Facility would be located in Pajarito Road corridor somewhere between TA-54 West and TA-50. If this occurs, transportation impacts would be smaller than those for No Action for transporting transuranic waste from facilities generating the waste to waste processing facilities because the TRU Waste Facility would be located closer, or adjacent, to the facilities generating the transuranic waste. This would also mean that road closures to onsite traffic would be reduced or eliminated, and would not occur on Pajarito Road.

Transportation impacts due to use of the new low-level radioactive waste characterization and verification building and compactor building in Zone 4, and continued use of Area L for mixed low-level radioactive waste and hazardous and chemical waste storage would be similar to the impacts related to No Action.

Transportation impacts related to hazardous and chemical waste and mixed low-level radioactive waste storage would be similar to the impacts associated with the No Action Option, because the current transportation pattern would not significantly change.

Facility Accidents

Three accident scenarios not otherwise considered in this SWEIS could occur in association with proposed waste management facilities transition options. For Option 1, an accident scenario would be associated with the retrieval of the higher activity remote-handled transuranic waste from Shafts 200-232 in Area G, which contain 953 cubic feet (27 cubic meters) of this waste in 1-gallon (3.8 liter) cans (LANL 2005c). A remote-handled transuranic waste retrieval facility is proposed to be constructed to allow retrieval of this waste. A bounding accident would be an explosion while retrieving the inventory from a shaft, causing a loss of confinement by the waste facility. Although there is no indication of explosives or chemicals in the shafts which could cause such an explosion, their absence is not completely certain. This scenario is analogous to the accident scenario addressed in Appendix I involving an assumed explosion during waste removal from MDA G.

The radionuclide inventory of each of the shafts was compared and Shafts 205 and 206 were determined to be those which could potentially result in the greatest consequences in the event of an accident. The frequency of occurrence of the accident was estimated to be 1 in 1,000 years. Shaft 206 would result in the largest impacts from inhalation of radionuclide releases based on its transuranic radionuclide inventory, but the external dose to the noninvolved worker (located 110 yards [100 meters] from the source) and to the MEI (located at the site boundary) from the mixed fission product inventory in Shaft 205 together with internal and external dose from releases from this shaft was also investigated to assure that these consequences were not greater. The accident analysis for this facility therefore separately determined the potential impacts for retrieving waste from Shaft 205 and 206.

Also for Option 1, the TRU Waste Facility, which would be located along the Pajarito Road corridor, was analyzed for an accident scenario in which a seismic event occurs and the radiological contents are released. Such an accident would be equivalent to that analyzed for the Decontamination and Volume Reduction System in its Safety Analysis Report, based on the assumption that the operations at the TRU Waste Facility would be similar to current operations at the Decontamination and Volume Reduction System. The area in which the TRU Waste Facility could be located bounds potential sites in the following technical areas: TA-35, TA-46, TA-48, TA-50 (including the south side of Pajarito Road), TA-51, TA-52, TA-54 West, TA-63, and TA-66. To bound these sites, locations were selected for analysis that provide the largest impact to the MEI and the 50-mile (80-kilometer) population. The 50-mile (80-kilometer) population dose is based on two locations, one closest to White Rock and one closest to the Los Alamos townsite. The dose to the MEI was calculated using dose versus distance data in Appendix D. Impacts to the noninvolved worker, located 110 yards (100 meters) from the accident, would be identical for all potential sites.

Table H–28 shows the source information used to calculate impacts to the workers and public from these three accident scenarios. **Tables H–29, H–30, and H–31** present the associated impacts. The analysis of accidents is performed assuming that the exposed people take no protective action that would reduce their exposure.

Based on Table H–31, impacts from an accident involving an explosion at the remote-handled transuranic waste retrieval facility was verified to be higher for Shaft 206 than Shaft 205, although they are on the same order of magnitude. For Option 2a, the impacts from the accidental release of remote-handled transuranic waste from the TRU Waste Facility are less than those that would result from the release of contact-handled transuranic waste from the TRU Waste Facility. The population dose from an accidental release at the TRU Waste Facility is less than that at TA-54 from current operations, mainly as a result of locating two domes at the alternative location versus the eleven domes at TA-54; the decrease is tempered by conservatively assuming a TRU Waste Facility site in TA-48, which is closer to the town of Los Alamos. The MEI dose decreases by a factor of about 3 as a result of the greater distance to the receptor plus the decrease in dome inventory. The MEI dose decreases by an order of magnitude, chiefly as result of the greater distance to this receptor plus the decrease in dome inventory. The non-involved worker dose is roughly the same at the two sites, reflecting the different meteorological data stations used (TA-6 meteorological tower for the alternative site, TA-54 meteorological tower at TA-54) and the smaller dome inventory.

Table H–28 Alternative Site Source Terms

Accident Phase	*Nuclide*	*Material at Risk (curies or grams)*	*Material at Risk*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fraction*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Scenario Name: Explosion at MDA-G RH-TRU Shaft 205													
Explosion	Cesium-137	curies	113	1	0.001	1	-	1	0.113	1	0	0	N
	Europium-155		0.0719	1	0.001	1	-	1	0.0000719	1	0	0	N
	Promethium-147		0.00595	1	0.001	1	-	1	5.95×10^{-6}	1	0	0	N
	Plutonium-239		7.25	1	0.001	1	-	1	0.00725	1	0	0	N
	Ruthenium-106		3.55×10^{-9}	1	0.001	1	-	1	3.55×10^{-12}	1	0	0	N
	Antimony-125		0.00635	1	0.001	1	-	1	6.35×10^{-6}	1	0	0	N
	Strontium-90		101	1	0.001	1	-	1	0.101	1	0	0	N
	Tellurium-125m		0.00154	1	0.001	1	-	1	1.54×10^{-6}	1	0	0	N
	Uranium-235		0.00085	1	0.001	1	-	1	8.50×10^{-7}	1	0	0	N
	Yttrium-90		100	1	0.001	1	-	1	0.1	1	0	0	N
Suspension	Cesium-137	curies	113	1	-	1	4.00×10^{-6}	1	0.0108	1,440	0	0	N
	Europium-155		0.0718	1	-	1	4.00×10^{-6}	1	6.90×10^{-6}	1,440	0	0	N
	Promethium-147		0.00594	1	-	1	4.00×10^{-6}	1	5.71×10^{-7}	1,440	0	0	N
	Plutonium-239		7.24	1	-	1	4.00×10^{-6}	1	0.000695	1,440	0	0	N
	Ruthenium-106		3.55×10^{-9}	1	-	1	4.00×10^{-6}	1	3.40×10^{-13}	1,440	0	0	N
	Antimony-125		0.00634	1	-	1	4.00×10^{-6}	1	6.09×10^{-7}	1,440	0	0	N
	Strontium-90		101	1	-	1	4.00×10^{-6}	1	0.00969	1,440	0	0	N
	Tellurium-125m		0.00154	1	-	1	4.00×10^{-6}	1	1.48×10^{-7}	1,440	0	0	N
	Uranium-235		0.000849	1	-	1	4.00×10^{-6}	1	8.15×10^{-8}	1,440	0	0	N
	Yttrium-90		99.9	1	-	1	4.00×10^{-6}	1	0.00959	1,440	0	0	N
Scenario Name: Explosion at MDA-G RH-TRU Shaft 206													
Explosion	Cesium-137	curies	49.5	1	0.001	1	-	1	0.0495	1	0	0	N
	Europium-155		0.0353	1	0.001	1	-	1	0.0000353	1	0	0	N
	Promethium-147		0.00331	1	0.001	1	-	1	3.31×10^{-6}	1	0	0	N
	Plutonium-239		17.5	1	0.001	1	-	1	0.0175	1	0	0	N
	Ruthenium-106		3.01×10^{-9}	1	0.001	1	-	1	3.01×10^{-12}	1	0	0	N
	Antimony-125		0.00349	1	0.001	1	-	1	3.49×10^{-6}	1	0	0	N

Accident Phase	*Nuclide*	*Material at Risk (curies or grams)*	*Material at Risk*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fraction*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
	Strontium-90		44.4	1	0.001	1	-	1	0.0444	1	0	0	N
	Tellurium-125m		0.000844	1	0.001	1	-	1	8.44×10^{-7}	1	0	0	N
	Uranium-235		0.00178	1	0.001	1	-	1	1.78×10^{-6}	1	0	0	N
	Yttrium-90		43.9	1	0.001	1	-	1	0.0439	1	0	0	N
Suspension	Cesium-137	curies	49.5	1	-	1	4.00×10^{-6}	1	0.00475	1,440	0	0	N
	Europium-155		0.0353	1	-	1	4.00×10^{-6}	1	3.39×10^{-6}	1,440	0	0	N
	Promethium-147		0.00331	1	-	1	4.00×10^{-6}	1	3.17×10^{-7}	1,440	0	0	N
	Plutonium-239		17.5	1	-	1	4.00×10^{-6}	1	0.00168	1,440	0	0	N
	Ruthenium-106		3.01×10^{-9}	1	-	1	4.00×10^{-6}	1	2.89×10^{-13}	1,440	0	0	N
	Antimony-125		0.00349	1	-	1	4.00×10^{-6}	1	3.35×10^{-7}	1,440	0	0	N
	Strontium-90		44.4	1	-	1	4.00×10^{-6}	1	0.00426	1,440	0	0	N
	Tellurium-125m		0.000843	1	-	1	4.00×10^{-6}	1	8.09×10^{-8}	1,440	0	0	N
	Uranium-235		0.00178	1	-	1	4.00×10^{-6}	1	1.71×10^{-7}	1,440	0	0	N
	Yttrium-90		43.9	1	-	1	4.00×10^{-6}	1	0.00421	1,440	0	0	N
Scenario Name: Seismic Event Releasing Entire RH-TRU Inventory from Two Storage Buildings at TRU Waste Facility Location													
Initial Impact	Americium-241	curies	1.82	0.167	0.001	0.3	-	1	0.0000910	10	0	0	N
	Cobalt-60		0.661	0.167	0.001	0.3	-	1	0.0000331	10	0	0	N
	Cesium-137		508	0.167	0.001	0.3	-	1	0.0254	10	0	0	N
	Europium-155		0.392	0.167	0.001	0.3	-	1	0.0000196	10	0	0	N
	Promethium-147		0.0416	0.167	0.001	0.3	-	1	2.08×10^{-6}	10	0	0	N
	Plutonium-238		1.29	0.167	0.001	0.3	-	1	0.0000645	10	0	0	N
	Plutonium-239		77.6	0.167	0.001	0.3	-	1	0.00388	10	0	0	N
	Plutonium-240		2.42	0.167	0.001	0.3	-	1	0.000121	10	0	0	N
	Plutonium-241		29.4	0.167	0.001	0.3	-	1	0.00147	10	0	0	N
	Plutonium-242		0.00146	0.167	0.001	0.3	-	1	7.30×10^{-8}	10	0	0	N
	Ruthenium-106		7.57×10^{-8}	0.167	0.001	0.3	-	1	3.79×10^{-12}	10	0	0	N
	Antimony-125		0.043	0.167	0.001	0.3	-	1	2.15×10^{-6}	10	0	0	N
	Strontium-90		455	0.167	0.001	0.3	-	1	0.0228	10	0	0	N
	Tellurium-125m		0.0104	0.167	0.001	0.3	-	1	5.20×10^{-7}	10	0	0	N

Accident Phase	Nuclide	Material at Risk (curies or grams)	Material at Risk	Damage Ratio	Airborne Release Fraction	Respirable Fraction	Airborne Release Rate (per hour)	Leak Path Factor	Source Term (units of MAR)	Release Duration (minutes)	Plume Heat (mega-watts)	Release Height (meters)	Wake?
	Uranium-234		0.000761	0.167	0.001	0.3	-	1	3.81×10^{-8}	10	0	0	N
	Uranium-235		0.00859	0.167	0.001	0.3	-	1	4.30×10^{-7}	10	0	0	N
	Uranium-236		2.76×10^{-6}	0.167	0.001	0.3	-	1	1.38×10^{-10}	10	0	0	N
	Uranium-238		0.0000401	0.167	0.001	0.3	-	1	2.01×10^{-9}	10	0	0	N
	Yttrium-90		450	0.167	0.001	0.3	-	1	0.0225	10	0	0	N
Suspension	Americium-241	curies	1.82	1	-	1	4.00×10^{-6}	1	0.000175	1,440	0	0	N
	Cobalt-60		0.661	1	-	1	4.00×10^{-6}	1	0.0000635	1,440	0	0	N
	Cesium-137		508	1	-	1	4.00×10^{-6}	1	0.0488	1,440	0	0	N
	Europium-155		0.392	1	-	1	4.00×10^{-6}	1	0.0000376	1,440	0	0	N
	Promethium-147		0.0416	1	-	1	4.00×10^{-6}	1	3.99×10^{-6}	1,440	0	0	N
	Plutonium-238		1.29	1	-	1	4.00×10^{-6}	1	0.000124	1,440	0	0	N
	Plutonium-239		77.6	1	-	1	4.00×10^{-6}	1	0.00745	1,440	0	0	N
	Plutonium-240		2.42	1	-	1	4.00×10^{-6}	1	0.000232	1,440	0	0	N
	Plutonium-241		29.4	1	-	1	4.00×10^{-6}	1	0.00282	1,440	0	0	N
	Plutonium-242		0.00146	1	-	1	4.00×10^{-6}	1	1.40×10^{-7}	1,440	0	0	N
	Ruthenium-106		7.57×10^{-8}	1	-	1	4.00×10^{-6}	1	7.27×10^{-12}	1,440	0	0	N
	Antimony-125		0.0430	1	-	1	4.00×10^{-6}	1	4.13×10^{-6}	1,440	0	0	N
	Strontium-90		455	1	-	1	4.00×10^{-6}	1	0.0437	1,440	0	0	N
	Tellurium-125m		0.0104	1	-	1	4.00×10^{-6}	1	9.98×10^{-7}	1,440	0	0	N
	Uranium-234		0.000761	1	-	1	4.00×10^{-6}	1	7.31×10^{-8}	1,440	0	0	N
	Uranium-235		0.00859	1	-	1	4.00×10^{-6}	1	8.25×10^{-7}	1,440	0	0	N
	Uranium-236		2.76×10^{-6}	1	-	1	4.00×10^{-6}	1	2.65×10^{-10}	1,440	0	0	N
	Uranium-238		0.0000401	1	-	1	4.00×10^{-6}	1	3.85×10^{-9}	1,440	0	0	N
	Yttrium-90		450	1	-	1	4.00×10^{-6}	1	0.0432	1,440	0	0	N

Accident Phase	*Nuclide*	*Material at Risk (curies or grams)*	*Material at Risk*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fraction*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Scenario Name: Seismic Event Releasing CH-TRU from Two Storage Buildings at the TRU Waste Facility Location													
Initial Impact Combustibles													
Drums	Plutonium Equivalent	curies	11,854	0.333	0.001	0.3	-	1	1.19	10	0	0	N
Overpacks			5,202	0.167	0.001	0.3	-	1	0.260	10	0	0	N
Initial Impact Non-combustibles													
Drums	Plutonium Equivalent	curies	35,660	0.333	0.000849	0.3	-	1	3.03	10	0	0	N
Overpacks			15,650	0.167	0.000762	0.3	-	1	0.596	10	0	0	N
Suspension													
Combustibles	Plutonium Equivalent	curies	4,814	1	-	1	4.00×10^{-6}	1	0.462	1,440	0	0	N
Non-combustibles			12,071	1	-	1	4.00×10^{-6}	1	1.16	1,440	0	0	N
Total													
Initial Impact	Plutonium Equivalent	curies	-	-	-	-	-	-	5.07	10	0	0	N
Suspension			-	-	-	-	-	-	1.62	1,440	0	0	N
Scenario Name: Seismic Event Releasing TRU from the TRU Waste Facility Assuming Equivalent to DVRS Operations													
PC-3 Seismic	Plutonium Equivalent	curies	1,100	1	0.001	1	-	1	1.1	1,440	0	0	N

MAR = material at risk, MDA = material disposal area, RH-TRU = remote-handled transuranic, N = no, CH-TRU = contact-handled transuranic, DVRS = Decontamination and Volume Reduction System.

Table H–29 Alternative Site Radiological Accident Consequences

Accident Scenario	*MEI*		*Population to 50 Miles*	
	Dose (rem)	*LCF* [a]	*Dose (person-rem)*	*LCF* [b, c]
Explosion at MDA G RH-TRU Shaft 205	0.33	0.00020	14	0.0081
Explosion at MDA G RH-TRU Shaft 206	0.75	0.00045	15	0.0087
Seismic Event Releasing Entire RH-TRU Inventory from Two Storage Buildings at TRU Waste Facility Location [d]	0.19	0.00011	14	0.0085
Seismic Event Releasing Transuranic Waste from the TRU Waste Facility Assuming Equivalent to DVRS Operations	10	0.0062	1,080	0.65
Seismic Event Releasing CH-TRU from Two Storage Buildings at the TRU Waste Facility Location [d]	142	0.17	6,640	4.0

MEI = maximally exposed individual, LCF = latent cancer fatality, MDA = material disposal area, RH-TRU = remote-handled transuranic waste, DVRS = Decontamination and Volume Reduction System, CH-TRU = contact-handled transuranic waste.

[a] Increased risk of an LCF to an individual, assuming the accident occurs.

[b] Increased number of LCFs for the population, assuming the accident occurs.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 300,000 (generic site), 343,000 (MDA-G).

[d] Option 2 only.

Table H–30 Alternative Site Radiological Accident Onsite Worker Consequences

Accident Scenario	*Non-involved Worker (at 100 meters)*	
	Dose (rem)	*LCF* [a]
Explosion at MDA G RH-TRU Shaft 205	2.4	0.00143
Explosion at MDA G RH-TRU Shaft 206	5.5	0.00329
Seismic Event Releasing Entire RH-TRU Inventory from Two Storage Buildings at TRU Waste Facility Location [b]	2.4	0.00142
Seismic Event Releasing Transuranic Waste from the TRU Waste Facility Assuming Equivalent to DVRS Operations	132	0.158
Seismic Event Releasing CH-TRU from Two Storage Buildings at the TRU Waste Facility Location [b]	1820	2.18

LCF = latent cancer fatality, MDA = material disposal area, RH-TRU = remote-handled transuranic waste, DVRS = Decontamination and Volume Reduction System, CH-TRU = contact-handled transuranic waste.

[a] Increased risk of an LCF to an individual, assuming the accident occurs.

[b] Option 2 only.

Table H–31 Alternative Site Radiological Accident Offsite Population and Worker Risks

Accident Scenario	*Onsite Worker (LCFs)*	*Offsite Population (LCFs)*	
	Non-involved Worker (at 100 meters) [a]	*MEI* [a]	*Population to 50 Miles* [b, c]
Explosion at MDA G RH-TRU Shaft 205	1.4×10^{-6}	2.0×10^{-7}	8.1×10^{-6}
Explosion at MDA G RH-TRU Shaft 206	3.3×10^{-6}	4.5×10^{-7}	8.7×10^{-6}
Seismic Event Releasing Entire RH-TRU Inventory from Two Storage Buildings at TRU Waste Facility Location [d, e]	7.1×10^{-7}	5.6×10^{-8}	4.3×10^{-6}
Seismic Event Releasing Transuranic Waste from the TRU Waste Facility Assuming Equivalent to DVRS Operations [e]	0.000079	3.1×10^{-6}	0.00032
Seismic Event Releasing CH-TRU from Two Storage Buildings at the TRU Waste Facility Location [d, e]	0.0011	0.000085	0.0020

MEI = maximally exposed individual, MDA = material disposal area, RH-TRU = remote-handled transuranic waste, DVRS = Decontamination and Volume Reduction System, CH-TRU = contact-handled transuranic waste.

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs for the population per year.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 302,000 (TRU Waste Facility), 343,000 (MDA-G).

[d] Option 2 only.

[e] An updated probabilistic seismic hazard analysis has been completed for LANL (LANL 2007), which results in higher peak horizontal ground acceleration values for the same annual probability of exceedance. In the seismic accident analyses for the TRU Waste Facility, the radioactive source term was conservatively based on the assumption that all structures, systems, and components failed, therefore, the updated probabilistic seismic hazard analysis is not expected to change the accident consequences or risks.

These accident scenarios bound those that would be associated with other operation options. Leaving remote-handled transuranic waste in place in the shafts (Option 2b) could have a scenario similar to the retrieval explosion scenario analyzed, but would not be associated with a storage scenario described above.

H.3.3.3 Option 2: Interim Actions Necessary for Meeting Consent Order and Other Alternatives

As described in Section H.3.2.3, Option 2 varies from Option 1 in the event that legacy and newly generated stored wastes cannot be removed from storage, processed, and shipped to disposal facilities on an accelerated schedule that would allow completion of closure activities in Area L and MDA L, and Area G and MDA G, as required by the Consent Order. Under Option 2a, NNSA would move the remaining transuranic waste from Area G to two new storage buildings in another location to be stored until the waste could be processed and shipped. Under Option 2b, NNSA would leave the high activity remote-handled transuranic waste in place, while removing the other easier-to-retrieve transuranic waste for storage in two new storage buildings. Under Option 2c, mixed low-level radioactive waste and hazardous waste would also be stored at the TRU Waste Facility and the use of Area L would cease for these operations.

Land Resources

Land Use

As is the case for Option 1, actions taking place under this option within TA-54 would be within disturbed areas. Options 2a and 2b would require the construction of two storage buildings for legacy transuranic waste currently stored in Area G but which needs to be relocated. The two additional storage buildings could be co-located with the TRU Waste Facility or be separate from it. In Option 2c, mixed low-level radioactive waste and hazardous and chemical waste storage would also be provided at the TRU Waste Facility. Providing additional transuranic waste storage space would not result in a meaningful change to impacts described in Option 1 since land use designations would not change. Additional facilities that would be closed in Area L (that would not otherwise be closed in Option 1) are located in previously disturbed areas; therefore impacts to land use would be minimal.

Visual Environment

In addition to the processes and facilities constructed as part of Option 1, the two transuranic waste storage buildings proposed in Options 2a and 2b that would store legacy transuranic waste would cause varying visual impacts, depending upon the specific location chosen. Construction of the new storage buildings within a developed area north of Pajarito Road would result in minimal impacts to visual resources. However, if built south of Pajarito Road, the buildings would alter the current open view. NNSA would mitigate the visual impacts from these storage buildings during their design by taking into consideration visual impacts previously created by the use of white-colored fabric domes in Area G and following the design principles provided in the LANL architectural guide (LANL 2002a).

For Option 2b, since the high activity transuranic waste would be left in the shafts, no change to visual impacts would occur in TA-54 since the remote-handled transuranic waste retrieval facility would not be constructed.

Proposed hazardous and chemical waste management activities to be added to the proposed TRU Waste Facility in Option 2c would have the same visual impacts as those for Option 1, except that all above-ground facilities in Area L would be removed, potentially creating a positive local visual impact.

Geology and Soils

Construction, Operations, and DD&D Impacts—Impacts on geology and soils and impacts due to the consumption of geologic resources under Option 2 would generally be similar to but greater than those described under Option 1. In Option 2a, two additional transuranic waste storage buildings would be constructed in previously disturbed areas, requiring an additional 89,000 cubic yards (68,000 cubic meters) of earthwork over Option 1. In Option 2b, the additional transuranic waste storage buildings would be constructed, but the remote-handled transuranic waste retrieval and processing facility would not be constructed, resulting in an additional 82,000 cubic yards (63,000 cubic meters) of earthwork. In Option 2c, the addition to the TRU Waste Facility of additional storage space for mixed low-level radioactive waste and hazardous and chemical waste would require minimal earthmoving impacts.

Geologic resource consumption would be negligible to small under this option and would not be expected to deplete local sources or stockpiles of required materials. Approximately 5,500 cubic yards (4,205 cubic meters) of additional concrete including associated aggregate (sand and gravel) and Portland cement would be needed during construction, as compared to Option 1. Component aggregate resources are readily available from onsite borrow areas and otherwise abundant in Los Alamos County, with the required concrete expected to be procured via an off-site supplier.

As detailed under Option 1, all proposed new facilities under Option 2 would be designed, constructed, and operated in compliance with the applicable DOE Orders, requirements, and governing standards that have been established to protect public and worker health and the environment. In addition, construction would use best management practices to minimize process impacts to soils and the surrounding environment.

Following the completion of Option 2, operations would not result in additional impacts on geologic and soil resources at LANL. As discussed above, new facilities would be evaluated, designed, and constructed in accordance with DOE Order 420.1B (DOE 2005b) and other governing DOE and LANL construction standards and sited to minimize the risk from geologic hazards, including earthquakes.

Water Resources

Construction Impacts—In Option 2a, construction of two storage buildings to store transuranic waste would require a construction stormwater pollution prevention plan. The construction stormwater controls would augment the existing industrial stormwater pollution prevention plan controls. In Option 2b, construction of any additional covers or other closure actions required to secure the remote-handled transuranic waste that remains in the shafts would require a construction stormwater pollution prevention plan. The construction stormwater controls would augment the existing industrial stormwater pollution prevention plan controls at TA-54. There would be no impacts on surface water for pursuing alternate permitting options for hazardous waste storage in Option 2c.

Operations Impacts—The proposed two transuranic waste storage facilities in Option 2a would have engineered features to minimize the potential for any liquid release from the transuranic waste storage activities. If remote-handled transuranic waste remains in the storage shafts in Area G and MDA G as proposed in Option 2b, then maintenance and regular inspection of any closure cover to ensure site stabilization would protect surface water from potential contamination. Post-closure care provisions would be included in the site's closure or remedial action plan. All staging areas used to store waste at sites other than TA-54 would need to be added to the Multi-Sector General Permit and would require an individual industrial stormwater pollution prevention plan for a hazardous waste storage facility or would need to be added to the TA-54 industrial stormwater pollution prevention plan as an auxiliary site. These sites would need to create spill and leak procedures and maintenance procedures, and begin stormwater monitoring for specific contaminants. Option 2c, which would relocate hazardous and mixed low-level radioactive waste storage operations from Area L to the proposed TRU Waste Facility, would also require this facility to be added to the Multi-Sector General Permit and have an individual stormwater pollution prevention plan.

For groundwater, the observations and considerations described for Option 1 are also relevant to Option 2. Contaminant transport rates in the vadose zone overall are unlikely to change during the SWEIS timeframe, and groundwater resources would not be affected over this period. Appropriately designed and constructed covers should eliminate any increased infiltration resulting from construction, DD&D, and operations activities.

Air Quality and Noise

Construction and DD&D Impacts—Similar to Option 1, construction of new waste processing facilities under Option 2 (that is, the legacy transuranic waste storage buildings) would result in temporary increases in air quality impacts from construction equipment, trucks, and employee vehicles. Impacts would be similar to those described in Option 1, as would the impacts related to DD&D activities.

Operations Impacts—During operations, impacts due to toxic air pollutants would be expected to be small and below the screening level emission values and it is expected that the air quality impacts on the public would be minor. Noise impacts for Option 2 are expected to be similar to impacts for Option 1.

Ecological Resources

Construction, Operations, and DD&D Impacts—Impacts to ecological resources under Option 2 would be similar to those described for Option 1 because similar actions would be taken within the same TAs. Providing additional storage space for legacy transuranic waste using two new buildings would not result in a meaningful change to these impacts, although the land requirement would be approximately 2.25 acres (0.9 hectare). The new storage areas would not adversely affect ecological resources because they would be located adjacent to existing structures and processes.

Human Health

Construction, Operations, and DD&D Impacts—In Option 2, all facilities in Area L and Area G would undergo DD&D. The occupational safety information presented for Option 1 would be applicable to Option 2.

For construction, the structures and processes proposed in Option 1 would still be constructed (except for the remote-handled transuranic waste retrieval facility in Option 2b). In addition, two storage buildings of approximately 30,000 square feet (2,787 square meters) each would be constructed to store transuranic waste from Area G. Approximately 3 recordable injuries could occur, based on available statistics.

Potential impacts from hazardous and toxic chemicals would continue to be prevented through the use of administrative controls and equipment while there would continue to be no impacts related to biological agents.

The dose to the maximum exposed individual and the population would be similar to that for Option 1. For Option 2a, the radiological impacts from the proposed remote-handled transuranic waste retrieval facility and the TRU Waste Facility would be the same as the impacts stated in Option 1. Radiological emissions related to the two proposed storage buildings would be considered "insignificant relative to other sources at LANL," which is a similar determination to that of the Waste Characterization, Reduction, and Repackaging Facility where characterization and packaging activities occur.

For Option 2b, the remote-handled transuranic waste retrieval facility would not be constructed and operated, therefore there would be no radiological dose to workers or the public related to retrieving the higher activity remote-handled transuranic waste from Shafts 200-232. Overall, the area source term would be similar to Option 1, because some retrieval activities, and all DD&D activities, would still occur.

For Option 2c, direct radiation levels in Area L would remain within background levels since mixed low-level radioactive waste storage operations would be removed from Area L.

Worker exposures to direct radiation would be controlled ALARA using engineering design and administrative controls. The LANL performance goal is to maintain a worker's whole body dose to less than 2 rem per year (LANL 2002b).

Cultural Resources

Construction, Operations, and DD&D Impacts—Impacts to cultural resources under Option 2 would be similar to those described for Option 1 since similar actions would be taken within the same TAs. Providing additional storage space for legacy transuranic waste would not result in a meaningful change to these impacts. Although the land requirement would increase to 2.25 acres

(0.9 hectares), construction activities would not directly impact cultural resources. The upgraded storage areas would not adversely affect cultural resources since they would be located adjacent to existing structures and processes.

Socioeconomics and Infrastructure

Construction and DD&D Impacts—Utility resource requirements to support construction of the proposed new waste management facilities under Option 2 would be about two times greater than those described under Option 1. Approximately 893,000 gallons (3.4 million liters) of liquid fuels (diesel and gasoline) would be consumed for site work mainly for use by heavy equipment and for new facility construction. Liquid fuels would be procured from offsite sources and, therefore, would not be limited resources. In addition, it is anticipated that approximately 4.9 million gallons (18.5 million liters) of water would be needed for construction mainly for dust suppression and soil compaction. The existing LANL water supply infrastructure would still be easily capable of handling this demand.

Operations Impacts—Upon completion, operation of the new waste management facilities for the timeframes required would be expected to have a negligible incremental impact on LANL utility infrastructure.

Waste Management

Construction, and DD&D Impacts—Under Option 2, a similar level of impacts associated with construction and DD&D would occur as under Option 1. New buildings would be constructed to retrieve and process waste and older buildings would be demolished to allow remediation activities to take place. Some additional construction (generating an additional 260 cubic yards [200 cubic meters] of construction waste) of waste storage units may be necessary, depending upon the sub-option considered. The types and quantities of waste generated by construction and DD&D would be within the capacity of the LANL waste management infrastructure and mainly disposed of offsite.

Operations Impacts—Under Option 2, the same level of impacts associated with operational wastes would occur as under the Option 1. Some wastes may be stored longer, but operational impacts associated with the longer storage periods would be small. Operations, including remote-handled transuranic waste management activities, may be consolidated within the new TRU Waste Facility, to be located outside Area G. The types and quantities of wastes generated would be the same as those generated under Option 1.

Transportation

Construction and DD&D Impacts—In this option, two transuranic waste storage buildings would be constructed in a location other than Area G to store legacy transuranic waste currently in underground facilities in Area G. Similar construction impacts to Option 1 would occur.

Operations Impacts—Operation of two new transuranic waste storage buildings would require more shipments of transuranic waste on Pajarito Road than what would occur under Option 1 or the No Action Option. If the two transuranic waste storage buildings are not co-located with the proposed TRU Waste Facility, then additional shipments would need to occur to move the transuranic waste from the storage buildings to the TRU Waste Facility for processing and eventual shipment to a disposal facility. The number of shipments from Area G to the two storage buildings would be large and accompanying road closures would occur. Radiological doses to the workers would be monitored and administratively controlled as currently required.

Transportation impacts related to hazardous and chemical waste and mixed low-level radioactive waste storage would be similar to the impacts associated with the No Action Option, as the transportation pattern as currently observed would not significantly change.

Accidents

For Option 2a, it is assumed that complete removal of transuranic waste from TA-54 Area G and shipment to WIPP would not be accomplished on a schedule that would allow closure of Area G and MDA G to occur per the terms of the Consent Order. If this were to occur, two waste storage buildings, equivalent to waste storage domes currently in Area G, could be constructed and co-located with the TRU Waste Facility.

Two analyses were performed that bound the processing and storage of transuranic waste in Option 2. The first considered a seismic event for which the material at risk would be the entire remote-handled transuranic waste in Shafts 200-232. The conservative assumption was made that containers holding the waste would be no stronger than the overpacks used in the present waste storage domes at TA-54, Area G. The TRU Waste Facility would be designed to withstand an earthquake corresponding to a frequency of occurrence of 5×10^{-4} per year (or 1 chance in 2,000 years). This frequency is conservatively taken as the probability of the seismic event resulting in waste release. This scenario is analogous to the Site-wide Seismic 02 event resulting in a release from the waste storage domes at Area G that is analyzed in Appendix D. The second analysis for Option 2 considered the risk if contact-handled transuranic waste relocated from Area G was stored in the two storage buildings and released because of a seismic event. The material at risk in the two storage buildings was conservatively assumed to be double that of the Area G storage dome with the largest waste inventory.

Table H–28 shows the source information used to calculate impacts to the workers and public from these two accident scenarios. Tables H–29, H–30, and H–31 present the associated impacts. The accident results presented for Option 1 are also applicable to Option 2.

H.4 References

ACE (U.S. Army Corps of Engineers), 2005, *Wetlands Delineation Report, Los Alamos National Laboratory, Los Alamos, New Mexico*, Albuquerque District, Albuquerque, New Mexico, October.

Bachmeier, C., 2005, "TRU Waste Processing Facility," INP Meeting Presentation, Los Alamos National Laboratory, Los Alamos, New Mexico, May 18.

DOE (U.S. Department of Energy), 1995, *Environmental Assessment of the Relocation of Neutron Tube Target Loading Operations*, DOE/EA-1131, Los Alamos Laboratory, Los Alamos, New Mexico.

DOE (U.S. Department of Energy), 1999a, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 1999b, *Decontamination and Volume Reduction System for Transuranic Waste at Los Alamos National Laboratory, Los Alamos, New Mexico Environmental Assessment*, DOE/EA-1269, Los Alamos Area Office, Los Alamos, New Mexico, June 23.

DOE (U.S. Department of Energy), 1999c, *DOE Standard, Radiological Control*, DOE-STD-1098-99, Washington, DC, July.

DOE (U.S. Department of Energy), 1999d, *Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico*, DOE/EIS-0293, Los Alamos Area Office, Los Alamos, New Mexico, October.

DOE (U.S. Department of Energy), 2000, *Special Environmental Analysis for the Department of Energy, National Nuclear Security Administration, Actions Taken in Response to the Cerro Grande Fire at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE-SEA-03, Los Alamos Area Office, Los Alamos, New Mexico, September.

DOE (U.S. Department of Energy), 2002a, *Environmental Assessment for the Proposed Issuance of an Easement to Public Service Company of New Mexico for the Construction and Operation of a 12-inch Natural Gas Pipeline within Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1409, National Nuclear Security Administration, Office of Los Alamos Site Operations, Los Alamos, New Mexico, July 24.

DOE (U.S. Department of Energy), 2002b, *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory*, DOE/EIS-0319, National Nuclear Security Administration, Washington, DC, August.

DOE (U.S. Department of Energy), 2002c, *Proposed Future Disposition of Certain Cerro Grande Fire Flood and Sediment Retention Structures at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1408, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, August 8.

DOE (U.S. Department of Energy), 2002d, *Supplement Analysis, Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Modification of Management Methods for Transuranic Waste Characterization at Los Alamos National Laboratory*, DOE/EIS-0238-SA2, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, August 13.

DOE (U.S. Department of Energy), 2005a, *Final Environmental Assessment for the Proposed Consolidation of Neutron Generator Tritium Target Loading Production*, DOE/EA-1532, Sandia Site Office, Albuquerque, New Mexico, June.

DOE (U.S. Department of Energy), 2005b, *DOE Order 420.1B, Facility Safety*, Office of Environment, Safety and Health, Washington, DC, December 22.

DOE (U.S. Department of Energy), 2006, "Radiation Exposure Monitoring System," REMS Database, Office of Environment, Safety and Health, Available at http://www.eh.doe.gov/rems/rems/ri.htm, Accessed on December 6.

EPA (U.S. Environmental Protection Agency), 2000, *Final Reissuance of National Pollutant Discharge Elimination System (NPDES) Stormwater Multi-Sector General Permit for Industrial Activities, Federal Register*/Vol. 65, No. 210/Monday, October 30.

KSL (Kellog Brown and Root Government Services; Shaw Environmental and Infrastructure International; and Los Alamos Technical Associates, Inc.), 2004, LANL Roads/NM-4/502, 24 Hour Vehicular Traffic Counts, Directional AM and PM Peak Hour Traffic, September 12, 2004 – September 18, 2004 and September 2003 (Map), Los Alamos, New Mexico, November 17.

Kwicklis, E., M. Witkowski, K. Birdsell, B. Newman, and D. Walther, 2005, "Development of an Infiltration Map for the Los Alamos Area, New Mexico," *Vadose Zone Journal*, 4:672-693, August 16.

LANL (Los Alamos National Laboratory), 1995, *Final Project Report, TA-21, Buildings 3 and 4 South*, LA-13207, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 1998, *High-Precision Geologic Mapping to Evaluate the Potential for Seismic Surface Rupture at TA-55, Los Alamos National Laboratory*, LA-13456-MS, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 1999, *Historic Building Assessment for the Department of Energy Conveyance and Transfer Project*, LA-UR-00-1003, Environment, Safety, and Health Division, Los Alamos, New Mexico, December 23.

LANL (Los Alamos National Laboratory), 2000a, *Comprehensive Site Plan 2000*, LA-UR-99-6704, Los Alamos, New Mexico, January 31.

LANL (Los Alamos National Laboratory), 2000b, *Threatened and Endangered Species Habitat Management Plan, Site Plans*, LA-UR-00-4747, Los Alamos, New Mexico, April.

LANL (Los Alamos National Laboratory) 2000c, *U.S. Department of Energy Report, 1999 LANL Radionuclide Air Emissions*, LA-13732-ENV, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2001a, *Comprehensive Site Plan 2001*, LA-UR-01-1838, Los Alamos, New Mexico, April 13.

LANL (Los Alamos National Laboratory) 2001b, *U.S. Department of Energy Report, 2000 LANL Radionuclide Air Emissions*, LA-13839-MS, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2002a, *Site + Architectural Design Principles*, LA-UR-01-5383, Site Planning and Development Group, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2002b, *Occupational Radiation Protection Requirements*, LIR402-700-01.1, Attachment D, Chapter 4, Los Alamos, New Mexico, February 14.

LANL (Los Alamos National Laboratory), 2002c, *U.S. Department of Energy Report, 2001 LANL Radionuclide Air Emissions*, LA-13957-PS, Office of Los Alamos Site Operations, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2003a, *Quality Assurance Project Plan for the Asbestos Report Task*, MAQ-ASBESTOS, R2, Risk Reduction and Environmental Stewardship Division, Meteorology and Air Quality Group, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2003b, *U.S. Department of Energy Report, 2002 LANL Radionuclide Air Emissions*, LA-14058-PR, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory) 2003c, *Facility-Wide Air Quality Impact Analysis*, LA-UR-03-3983, Meteorology and Air Quality Group, Environmental Stewardship Division Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2003d, *SWEIS Yearbook—2002, Comparison of 1998 to 2002 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-03-5862, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004a, *U.S. Department of Energy Report, 2003 LANL Radionuclide Air Emissions*, LA-14155-PR, Los Alamos Site Office, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2004b, *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement (DOE/EIS-0238)*, LA-UR-04-5631, Ecology Group, Los Alamos, New Mexico, August 17.

LANL (Los Alamos National Laboratory), 2004c, *SWEIS Yearbook—2003, Comparison of 2003 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-04-6024, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004d, *Environmental Surveillance at Los Alamos during 2003*, LA-14162-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005a, *Field Summary Report for Technical Area-21 Site Surveys*, Draft, Los Alamos, New Mexico, April.

LANL (Los Alamos National Laboratory), 2005b, *U.S. Department of Energy Report, 2004 LANL Radionuclide Air Emissions*, LA-14233, Los Alamos Site Office, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2005c, *Status Report for Integrated Closure Activities at Technical Area 54*, LA-UR-05-6767, Los Alamos, New Mexico, July 7.

LANL (Los Alamos National Laboratory), 2005d, *SWEIS Yearbook—2004, Comparison of 2004 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-05-6627, Ecology Group, Environmental Stewardship Division, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2005e, *Environmental Surveillance at Los Alamos during 2004*, LA-14239-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005f, *Our Mission*, http://www.lanl.gov/natlsecurity/index.html, Accessed on September 9.

LANL (Los Alamos National Laboratory), 2005g, *Direct Environmental Penetrating Radiation at LANL*, Environmental Stewardship Division, Los Alamos, New Mexico, Available at http://www.airquality.lanl.gov, Accessed on September 30.

LANL (Los Alamos National Laboratory), 2005h, *An Evaluation of LANL's Future TRU Waste Management Needs After Project 2010*, LA-UR-04-7125, Los Alamos National Laboratory, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006a, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document,* Data Call Materials, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006b, *Biological Assessment of the Continued Operation of Los Alamos National Laboratory on Federally Listed Threatened and Endangered Species*, LA-UR-06-6679, Ecology and Air Quality Group (ENV-EAQ), Los Alamos Site Office, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006c, *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico*, LA-UR-04-8964, Ecology Group, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2006d, *U.S. Department of Energy Report, 2005 LANL Radionuclide Air Emissions*, LA-14298, Los Alamos Site Office, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006e, *Environmental Surveillance at Los Alamos during 2005*, LA-14304-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006f, *SWEIS Yearbook—2005, Comparison of 2005 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-06-6020, Risk Reduction Office, Environmental Protection Division, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2007, *Update of the Probabilistic Seismic Hazard Analysis and Development of Seismic Ground Motions at the Los Alamos National Laboratory*, LA-UR-07-3965, Los Alamos, New Mexico, May.

Marsh, Laura K., 2001, *A Floodplains and Wetlands Assessment for the Potential Effects of the Wildfire Hazard Reduction Project*, LA-UR-01-3643, National Nuclear Security Administration, Los Alamos National Laboratory, Los Alamos, New Mexico, July 13.

MARSSIM, 2000, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, NUREG-1575, Rev. 1, EPA-402-R-97-016, Rev. 1, DOE/EH-624, Rev. 1, August

NFS (Nuclear Fuel Services Radiation Protection Systems), 2005, "Perma-Con® Turnkey Containment Systems," http://www.nfsrps.com/docs/pcon.pdf, Accessed on September 14.

NMED (New Mexico Environment Department), 2005a, *Compliance Order on Consent, Proceeding Under the New Mexico Hazardous Waste Act Section 74-4-10 and the New Mexico Solid Waste Act Section 74-9-36(D)*, Los Alamos, New Mexico, March 1.

NMED (New Mexico Environment Department), 2005b, Letter to G. P. Nanos, Director, Los Alamos National Laboratory and J. Ordaz, Assistant Manager, Los Alamos Site Office, from J. P. Bearzi, Chief, Hazardous Waste Bureau, Subject: Proposed Closure Strategy for Technical Area 54, Area L Landfill, Los Alamos National Laboratory, EPA ID# NM0890010515, May 10.

NNSA (National Nuclear Security Administration), 2003, *Program Plan for Waste Management, Fiscal Years 2003 To 2013*, Rev. 0, Los Alamos, New Mexico, June.

Stephens & Associates (Daniel B. Stephens & Associates, Inc.), 2005, *Borrow Source Survey for Evapotranspiration Covers at Los Alamos National Laboratory (Draft)*, Albuquerque, New Mexico, January 18.