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Draft Site-wide Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory and Supplemental Stockpile Stewardship and Management Programmatic Environmental Impact Statement

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Abstract: The National Nuclear Security Administration (NNSA), a separately organized agency within DOE, has the responsibility to maintain and enhance the safety, reliability, and performance of the U.S. nuclear weapons stockpile to meet national security requirements. NNSA manages DOE's nuclear weapons programs and facilities, including those at Lawrence Livermore National Laboratory (LLNL). The continued operation of LLNL is critical to NNSA's Stockpile Stewardship Program and to preventing the spread and use of nuclear weapons worldwide. LLNL maintains core competencies in activities associated with research and development, design, and surveillance of nuclear weapons, as well as the assessment and certification of their safety and reliability.

This *Site-wide Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory and Supplemental Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (LLNL SW/SPEIS) prepared pursuant to NEPA, analyzes the potential environmental impacts of continued operation, including near term proposed projects of LLNL. Alternatives analyzed in this LLNL SW/SPEIS include the No Action Alternative, the Proposed Action, and the Reduced Operation Alternative. This document is also a Supplement to the *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* for use of proposed materials at the National Ignition Facility (NIF). This combination ensures timely analysis of these activities concurrent with the environmental analyses being conducted for the site-wide activities and will be referred to as the LLNL SW/SPEIS.

This document assesses the environmental impacts of LLNL operations on land uses and applicable plans, socioeconomic characteristics and environmental justice, community services, prehistoric and historic cultural resources, aesthetics and scenic resources, geology and soils, biological resources, water, noise, traffic and transportation, utilities and energy, materials and waste management, human health and safety, site contamination, and accidents.

Public Comments: In preparing this Draft LLNL SW/SPEIS, NNSA considered comments received during the public scoping period, from June 17, 2002, through September 16, 2002. Two public scoping meetings were held on July 10 and 11, 2002, in Livermore and Tracy, California. Comments made at these meetings, as well as comments received by fax, e-mail and U.S. mail during the scoping period, were considered in the preparation of this LLNL SW/SPEIS. A summary of the comments is included in this draft.

The comment period for this document will run from February 27, 2004, to May 27, 2004. Public hearings on the Draft LLNL SW/SPEIS will also be held during this 90-day comment period. The dates, times, and locations of these hearings will be announced in the *Federal Register* and in local newspapers. All comments received during the comment period will be considered by NNSA in the Final LLNL SW/SPEIS.

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ABBREVIATIONS AND ACRONYMS

AAQS	Ambient Air Quality Standards
ABAG	Association of Bay Area Governments
ACDEH	Alameda County Department of Environmental Health
ACE	Altamont Commuter Express
ACGIH	American Conference of Governmental Industrial Hygienists
ACHCS	Alameda County Health Care Services
ACHP	Advisory Council on Historic Preservation
ACL	Ambient concentration limit
ACM	Asbestos containing materials
AD	Associate Director
ADT	Average daily traffic
AEA	*Atomic Energy Act*
AET	Applied Energy Technologies
AIHA	American Industrial Hygiene Association
ALARA	As low as reasonably achievable
AMP	Advanced Materials Program
ANSI	American National Standards Institute
APDS	Autonomous Pathogen Detection System
APE	Area of potential effect
AQCR	Air Quality Control Region
ARES	Amateur Radio Emergency Services
ARF	Airborne release fraction
ARM	Assembly, resupply, and maintenance
ARO	Assurance Review Office
ARPA	*Archaeological Resources Protection Act*
ASCI	Advanced Simulation and Computing Initiative
ASD	Atmospheric Sciences Division
ATA	Advanced Test Accelerator
ATSDR	Agency for Toxic Substances and Disease Registry
AVLIS	Advanced Vapor Laser Isotope Separation

AWQC	Ambient water quality criteria
BAAQMD	Bay Area Air Quality Management District
BACT	Best Available Control Technology
BART	Bay Area Rapid Transit
BASIS	Biological Aerosol Sentry and Information System
BBRP	Biology and Biotechnology Research Program
BCP	Business commercial park
BDRP	Biological Defense Research Program
BEIR	Biological effects of ionization
BMP	Best management practice
BSL	BioSafety Level
CAA	*Clean Air Act*
CAAQS	California Ambient Air Quality Standards
CAIRS	Computerized Accident/Incident Reporting System
California EPA	California Environmental Protection Agency
CALSTAR	California Shock Trauma Air Rescue
CAMS	Center for Accelerator Mass Spectrometry
CAR	Computing Applications and Research
CARB	California Air Resources Board
CBD	Chronic beryllium disease
CBNP	Chemical and Biological National Security
CCAA	*California Clean Air Act*
CCB	Change Control Board
CCF	Central Characterization Facility
CCP	Central Characterization Project
CCR	*California Code of Regulations*
CD	Critical decision
CDC	Centers for Disease Control
CDFG	California Department of Fish and Game
CEDD	California Employment Development Department
CEDE	Committed effective dose equivalent
CEPRC	Chemical Emergency Planning and Response Commission

CEQ	Council on Environmental Quality
CEQA	*California Environmental Quality Act* of 1970
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFF	Contained Firing Facility
CFR	*Code of Federal Regulations*
CHEW	Chemical Exchange Warehouse
CHP	California Highway Patrol
CMGRAMS or CMG	Controlled materials group
CMS	Chemistry and Materials Science
CNDDB	California Natural Diversity Data Base
CNEL	Community noise equivalent level
CNP	Computer numerical control
CNPS	California Native Plant Society
CRADA	Cooperative research and development agreements
CRD	Catalytic reductive dehalogenation
CSO	Council on Strategic Operations
CSU	Container storage unit
CT	California toxic
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	*Clean Water Act*
CWG	Community Work Group
CWSC	California Water Service Company
CY	Calendar year
D&D	Decontamination and decommissioning
DARHT	Dual Axis Radiographic Hydrodynamic Test
dB	Decibel
dB(A)	A-weighted decibel
DC	Direct current
DDSO	Deputy Director for Strategic Operations
DEAR	Department of Energy Acquisition Regulation
DHS	Department of Health Services
DLM	Designated level methodology

DNA	Deoxyribonucleic acid
DNFSB	Defense Nuclear Facility Safety Board
DNT	Defense and Nuclear Technologies
DoD	United States Department of Defense
DOE	United States Department of Energy
DOF	California Department of Finance
DOR	Direct oxygen reduction
DOT	United States Department of Transportation
DP	Office of Defense Programs
DR	Damage ratio
DRB	Drainage Retention Basin
DTSC	Department of Toxic Substances Control
DWTF	Decontamination and Waste Treatment Facility
EA	Environmental assessment
EBIT	Electron beam ion trap
ECAP	East (Alameda) County Area Plan
ECC	Emergency communications center
EDD	California Employment Development Department
EDE	Effective dose equivalent
EDO	Environmental Duty Officer
EDS	Engineering Demonstration System
EED	Energy and Environment Directorate
EIR	Environmental impact report
EIS	Environmental impact statement
EMPC	Energetic Material Processing Center
EMRL	Environmental Monitoring Radiation Laboratory
EMS	Environmental Management System
EO	Executive Order
EOC	Emergency Operations Center
EPA	United States Environmental Protection Agency
EPCRA	*Emergency Planning and Community Right-to-Know Act* of 1986
EPD	Environmental Protection Department

EPL	Effluent pollutant limit
ERD	Environmental Restoration Division
ERPG	Emergency response planning guideline
ES&H	Environment, Safety, and Health
ES&H WG	ES&H Working Group
EST	Environmental support team
EUV	Extreme ultraviolet
EUVL	Extreme ultraviolet lithography
EWSF	Explosives Waste Storage Facility
EWTF	Explosives Waste Treatment Facility
FAA	Federal Aviation Administration
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FESSP	Fission Energy and Systems Safety Program
FFA	Federal Facility Agreement
FFCA	*Federal Facilities Compliance Act*
FHC	Fuel hydrocarbon
FIRP	Facility Infrastructure Recapitalization Project
FONSI	Finding of no significant impact
FPOC	Facility point of contact
FR	*Federal Register*
FR/O	Federal Reserve/Open Space
Freon 11	Trichlorofluoromethane
Freon 113	Trichlorotrifluoroethane
FSP	Facility safety plan
FTE	Full time equivalent
FY	Fiscal year
GC	Gas chromatograph
GDMS	Glow discharge mass spectrometry
GET	Geosciences and Environmental Technology
GGS	Geophysics and Global Security
GIS	Geographic information system

GPS	Global positioning system
GRR	Guidance request response
GSA	General Services Area
GWP	Groundwater Project
GWPMP	Groundwater Project Management Program
GWTF	Groundwater treatment facility
GWTS	Groundwater treatment system
HAC	Hazard assessment and control
HAP	Hazardous air pollutants
HAZMAT	Hazardous material
HCAL	Hazards Control Department's Analytical Laboratory
HCCI	Homogeneous charge compression ignition
HCD	Hazards Control Department
HE	High explosives
HEA	Health and Ecological Assessment
HEAF	High Explosives Application Facility
HEDC	High Explosives Development Center
HEDP	High-energy-density physics
HEPA	High-efficiency particulate air (filter)
HEU	Highly enriched uranium
HHI	Health Hazard Index
HIV	Human immunodeficiency virus
HMX	cyclotetramethylene tetranitramine
HOV	High occupancy vehicle
HQ	Hazard quotient
HR	Human Resources
HRA	Health risk assessment
HSD	Health Services Department
HSWA	*Hazardous and Solid Waste Amendments*
HVAC	Heating, ventilation, and air conditioning
HW	Hazardous waste
HWCA	*Hazardous Waste Control Act*

HWM	Hazardous Waste Management Division
ICC	Integrated computing and communications
ICF	Inertial confinement fusion
ICP	Inductively coupled plasma
ICRP	International Commission on Radiological Protection
IDLH	Immediately dangerous to life or health
INEEL	Idaho National Engineering and Environmental Laboratory
INL	Idaho National Laboratory
IQR	Interquartile range
IS/EA	Initial study/environmental assessment
ISCT	Industrial Source Complex Short Team
ISM	Integrated safety management
ISMS	Integrated Safety Management System
ISO	Independent system operator
ISRF	International Security Research Facility
IT	Information technology
ITP	Integrated Technology Project
IWS	Integration work sheet
IWS/SP	Integrated work sheet/safety plan
JCATS	Joint Conflict and Tactical Simulation
L/RWD	Lost/restricted work day
LANL	Los Alamos National Laboratory
LBNL	Lawrence Berkeley National Laboratory
LCF	Latent cancer fatalities
LCW	Low pressure cooling water
LDRD	Laboratory Directed Research and Development
LEDO	Laboratory Emergency Duty Officer
LEPC	Local Emergency Planning Committee
LINAC	Linear accelerator
LLNL	Lawrence Livermore National Laboratory
LLW	Low-level waste
LOEC	Lowest observed effect concentration

LOS	Limit of sensitivity
LPF	Leak path factor
LPT	Lymphocyte proliferation test
LS&T	Laser Science and Technology
LSA	Low specific activity
LSO	Laser Safety Officer
LSO	Livermore Safety Officer
LTAB	Laser and Target Area Building
LWC	Low work day cases
LWD	Lost work days
LWPA	Liquid-waste processing area
LWRP	Livermore Water Reclamation Plant
MAPEP	Mixed Analyte Performance Evaluation Program
MAR	Material at Risk
MCL	Maximum contaminant level
MDC	Minimum detectable concentration
MDD	Materials Distribution Division
MEI	Maximally exposed individual
MLLW	Mixed low-level waste
MM	Modified Mercalli
MMS	Materials Management Section
MOU	Memorandum of understanding
MPL	Maximum permitted level
MRP	Monitoring and Reporting Program
MS	Mass spectrometer
MSDS	Material safety data sheet
MSE	Molten-salt extraction
MSR	Materials and Storage Retrieval
MTBE	Methyl tertiary-butyl ether
MTC	Metropolitan Transit Commission
MWMP	Medical Waste Management Plant
NAAQS	National Ambient Air Quality Standards

NAI	Non-proliferation, arms control, and international security
NARAC	National Atmospheric Release Advisory Center
NC	Numerical control
NCDC	National Climatic Data Center
NCR	Nonconformance report
NCRP	National Council on Radiation Protection and Measurements
NEPA	*National Environmental Policy Act*
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NEUMA	Neutron multiplying assembly
NHPA	*National Historic Preservation Act*
NIF	National Ignition Facility
NIOSH	National Institute of Occupational Safety and Health
NMTP	Nuclear Materials Technology Program
NNSA	National Nuclear Security Administration
NOAA	National Oceanic and Atmospheric Administration
NOD	Notice of deficiency
NOEC	No observed effect concentration
NOI	Notice of intent
NOV	Notice of violation
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPOC	Non-precursor organic compounds
NRC	Nuclear Regulatory Commission
NRDC	Natural Resources Defense Council
NRHP	National Register of Historic Places
NTS	Nevada Test Site
NWP	Nationwide permit
OAASIS	Occupational Accident Injury/Illness Analysis Support and Information System
OAB	Optics Assembly Building
OBT	Organically bound tritium
OCRWM	Office of Civilian Radioactive Waste Management
ODS	Ozone-depleting substance

OES	Office of Emergency Services
ORAD	Operations and Regulatory Affairs Division
OSC	Operation Support Center
OSHA	Occupational Safety and Health Administration
OSP	Open space and parks
OU	Operable unit
PA	Programmatic agreement
PAAA	*Price-Anderson Amendments Act*
PAG	Protective Action Guide
PAM	Preamplifier module
PAT	Physics and Advanced Technologies
PC	Personal computer
PCB	Polychlorinated biphenyl
PCE	Perchloroethylene (or perchloroethene tetrachloroethene)
PCU	Power conditioning unit
PDD	Presidential Decision Directive
PEIS	Programmatic Environmental Impact Statement
PEL	Permit exposure limit
PG&E	Pacific Gas and Electric
PHA	Public health assessment
pHMS	pH Monitoring Station
PL	Public Law
PM	Performance measurement
PM_{10}	Particulate matter less than 10 microns in diameter
PMCL	Primary maximum contaminant level
POC	Precursor organic compounds
POTW	Publicly owned treatment works
PPE	Personal protective equipment
PPOA	Pollution prevention opportunity assessment
PPVS	Plant Performance Verification Series
PQL	Practical quantitation limit
PSA	Project-specific analysis

PSHA	Probabilistic seismic hazard assessment
PTU	Portable treatment unit
PVC	Polyvinyl chloride
QA	Quality assurance
QC	Quality control
R&D	Research and Development
RAIP	Remedial Action Implementation Plan
RCRA	*Resource Conservation and Recovery Act* of 1976
RD	Remedial design
RDWP	Remedial Design Work Plan
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
rem	Radiation equivalent-man
RF	Radio frequency
RF	Respirable fraction
RG	Risk group
RGD	Radiation-generating device
RHWM	Radioactive and Hazardous Waste Management
RI/FS	Remedial investigation/feasibility study
RL	Reporting limit
RMA	Radioactive Materials Area
RMMA	Radioactive Materials Management Area
ROD	Record of Decision
ROI	Region of influence
ROW	Right of way
RRP	Risk reduction program
RTW	Return to Work Program
RWPA	Reactive waste processing area
RWQCB	Regional Water Quality Control Board
SAA	Streambed alteration agreement
SAAQS	State Ambient Air Quality Standards
SAER	Site Annual Environmental Report
SAM	Scanning auger microprobe

SAR	Safety analysis report
SARA	*Superfund Amendment and Reauthorization Act* of 1986
SAT	Space Action Team
SBSSMP	Science Based Stockpile Stewardship and Management Program
SCIF	Sensitive Compartmented Information Facility
SDF	Sewer Diversion Facility
SDWA	*Safe Drinking Water Act*
SEIS	Supplemental Environmental Impact Statement
SEP	Safety and Environmental Protection
SERC	State Emergency Response Commission
SFBR	San Francisco Bay Region
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SHARP	Super High Altitude Research Project
SHPO	State Historic Preservation Officer
SIC	Standard industrial code
SIS	Special isotope separator
SJEHD	San Joaquin Environmental Health Department
SJVUAPCD	San Joaquin Valley Unified Air Pollution Control District
SMC	Senior Management Council
SMCL	Secondary maximum contaminant level
SMS	Sewer Monitoring Station
SNL/CA	Sandia National Laboratories/California
SNM	Special nuclear material
SOP	Standard operating procedures
SOV	Summary of violations
SPCC	Spill Prevention Control and Countermeasure
SRS	Savannah River Site
SRU	Size reduction unit
SSM PEIS	Stockpile Stewardship and Management PEIS
SSP	Stockpile Stewardship Program
SST	Safe secure transport
SST/SGT	Safe secure trailers/safeguards transport

STP	Site Treatment Plant
STU	Solar treatment unit
SVE	Soil vapor extraction
SWEIS	Site-wide Environmental Impact Statement
SWMU	Solid-waste management unit
SWPA	Solid waste processing area
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TBACT	Toxic best available control technology
TBD	To be determined
TBOS	Tetrabutyl orthosilicate
TCA	trichloroethane
TCE	Trichloroethene (or trichloroethylene)
TCLP	Toxicity characteristic leaching procedure
TCP	Traditional cultural properties
TDS	Total dissolved solids
TEEL	Temporary emergency exposure limit
TF	Treatment facility
TIG	Tungsten inert gas
TKEBS	Tetrakis (2-ethylbutyl) silane
TLD	Thermoluminescent dosimeter
TLV	Threshold limit value
TNT	Trinitrotoluene
TOC	Tactical operations center
TOX	Total organic halides
TRAGIS	Transportation Routing Analysis Geographic Information System
TRC	Total reportable cases
TRI	Toxic release inventory
TRU	Transuranic waste
TRUPACT-II	Transuranic Package Transporter-II
TSCA	*Toxic Substances Control Act*
TSDF	Treatment, Storage, and Disposal Facility

TSF	Terascale Simulation Facility
TSMP	Transportation Systems Management Program
TSS	Total suspended solids
TTO	Total toxic organics
TWA	Time-weighted average
TWMS	Total Waste Management System
UBC	Uniform Building Code
UC	University of California
USACE	United States Army Corps of Engineers
USC	*United States Code*
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UST	Underground storage tank
UV-visible-NIR	Ultraviolet-visible-near-infrared
VOC	Volatile organic compound
VTF	Vapor treatment facility
WAA	Waste accumulation area
WAPA	Western Area Power Administration
WDR	Waste discharge requirements
WFO	Work for others
WIPP	Waste Isolation Pilot Plant
WMD	Weapons of mass destruction
WSS	Work Smart Standards
XPS	X-ray photoelectron spectrometer
Zone 7	Alameda County Flood Control and Conservation District, Zone 7

UNIT OF MEASURE AND ABBREVIATIONS

acre	ac
billion gallons per year	BGY
centimeters	cm
cubic feet	ft^3
cubic feet per second	ft^3/s
cubic meters	m^3
cubic yards	yd^3
Curie	Ci
decibel	dB
degrees Celsius	^oC
degrees Fahrenheit	^oF
feet	ft
gallon	gal
gallons per day	gpd
gram	g
grams per second	g/sec
gravity	*g*
hectare	ha
Hertz	Hz
hour	hr
kelvin	K
kilogram	kg
kilojoule	kJ
kilometer	km
kilometer per hour	km/hr
kilovolt	kV
kilovoltampere	kVA
kilowatt	kW
kilowatt hour	kWh
liter	L

megajoule	MJ
megavolt-ampere	MVA
megawatt	MW
megawatt hour	MWh
megawatt-electric	MWe
megawatt-thermal	MWt
meter	m
meters per second	m/sec
microcurie	µCi
microcuries per gram	µCi/g
microgram	µg
micrograms per cubic meter	$\mu g/m^3$
micrograms per kilogram	µg/kg
micrograms per liter	µg/L
micron or micrometer	µm
microohms per centimeter	µohms/cm
micropascal	mPa
mile	mi
miles per hour	mph
millicurie	mCi
millicurie per gram	mCi/g
millicurie per millimeter	mCi/ml
milligram	mg
milligram per liter	mg/L
milliliter	ml
millimeters of mercury	mmHg
million	M
million electron volts	MeV
million gallons per day	MGD
million gallons per year	MGY
millirem	mrem
millirem per year	mrem/yr

nanocurie	nCi
nanocuries per gram	nCi/g
part per billion	ppb
part per billion by volume	ppbv
part per million	ppm
particulate matter of aerodynamic diameter less than 10 micrometers	PM_{10}
particulate matter of aerodynamic diameter less than 25 micrometers	PM_{25}
pascal	Pa
picocurie	pCi
picocuries per gram	pCi/g
picocuries per liter	pCi/L
pound	lb
pounds mass	lbm
pounds per square inch	psi
pounds per year	lb/yr
quart	qt
Roentgen equivalent, man	rem[a]
second	sec
square feet	ft^2
square kilometers	km^2
square meters	m^2

CONVERSION CHART

TO CONVERT FROM U.S. CUSTOMARY INTO METRIC			TO CONVERT FROM METRIC INTO U.S. CUSTOMARY		
If you know	**Multiply by**	**To get**	**If you know**	**Multiply by**	**To get**
		Length			
inches	2.540	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.03281	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.6214	miles
		Area			
square inches	6.452	square centimeters	square centimeters	0.1550	square inches
square feet	0.09290	square meters	square meters	10.76	square feet
square yards	0.8361	square meters	square meters	1.196	square yards
acres	0.4047	hectares	hectares	2.471	acres
square miles	2.590	square kilometers	square kilometers	0.3861	square miles
		Volume			
fluid ounces	29.57	milliliters	milliliters	0.03381	fluid ounces
gallons	3.785	liters	liters	0.2642	gallons
cubic feet	0.02832	cubic meters	cubic meters	35.31	cubic feet
cubic yards	0.7646	cubic meters	cubic meters	1.308	cubic yards
		Weight			
ounces	28.35	grams	grams	0.03527	ounces
pounds	0.4536	kilograms	kilograms	2.205	pounds
short tons	0.9072	metric tons	metric tons	1.102	short tons
		Temperature			
Fahrenheit (^{o}F)	subtract 32, then multiply by 5/9	Celsius (^{o}C)	Celsius (^{o}C)	multiply by 9/5, then add 32	Fahrenheit (^{o}F)
kelvin (^{o}k)	subtract 273.15	Celsius (^{o}C)	kelvin (^{o}k)	Multiply by 9/5, then add 306.15	Fahrenheit (^{o}F)

Note: 1 sievert = 100 rems

CHAPTER 1: INTRODUCTION AND PURPOSE AND NEED FOR ACTION

1.1 INTRODUCTION

This *Site-wide Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory and Supplemental Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (LLNL SW/SPEIS) describes the purpose and need for agency action for the continued operation of LLNL and analyzes the environmental impacts of these operations. The primary purpose of continuing operation of LLNL is to provide support for the National Nuclear Security Administration's (NNSA's) nuclear weapons stockpile stewardship missions. LLNL, located about 40 miles east of San Francisco, California, is also needed to support other U.S. Department of Energy (DOE) programs and Federal agencies such as the U.S. Department of Defense, Nuclear Regulatory Commission, U.S. Environmental Protection Agency (EPA), and the newly established U.S. Department of Homeland Security. This LLNL SW/SPEIS analyzes the environmental impacts of reasonable alternatives for ongoing and foreseeable future operations, facilities, and activities at LLNL. The reasonable alternatives include the No Action Alternative, Proposed Action, and the Reduced Operation Alternative.

The major decision to be made by DOE/NNSA is to select one of the alternatives for the continued operation of the LLNL. As part of the Proposed Action, DOE/NNSA is considering: using additional materials including plutonium on the National Ignition Facility (NIF); increasing the administrative limit for plutonium in the Superblock, which includes the Plutonium Facility, the Tritium Facility, and the Hardened Engineering Test Building; conducting the Integrated Technology Project, using laser isotope separation to provide material for Stockpile Stewardship experiments, in the Plutonium Facility; increasing the material-at-risk limit for the Plutonium Facility; and increasing the Tritium Facility material-at-risk. A discussion of these issues is presented in Section 1.5, Major Decisions.

Chapter 1 provides information on the purpose and need for agency action and a history of LLNL's past *National Environmental Policy Act* (NEPA) (42 *United States Code* [U.S.C.] §4321 et seq.) activities, identifies the major decisions to be made, and provides information on the scoping comments received during the scoping period. Chapter 2 provides an overview of LLNL history, missions, operations, programs, and facilities. Chapter 3 discusses the No Action Alternative, Proposed Action, and Reduced Operation Alternative. Chapter 4 describes the existing environment. Chapter 5 identifies the environmental consequences of activities under the No Action Alternative, Proposed Action, and Reduced Operation Alternative. There are several appendices that provide further details on the information provided in Chapters 1 through 5. The remaining chapters and appendices provide additional information on the associated environmental impacts.

1.2 BACKGROUND

Pursuant to the *Atomic Energy Act* of 1954, as amended, DOE is responsible for nuclear weapons research and design as well as other energy research and development (R&D) operations. The *National Defense Authorization Act* (Public Law 103-160, §3138) directed the Secretary of

Energy to "establish a stewardship program to ensure the preservation of the core intellectual and technical competencies of the U.S. in nuclear weapons."

In 1995, the President confirmed the continuing need for three nuclear weapons laboratories, LLNL, Los Alamos National Laboratory, and Sandia National Laboratories, in a "Statement by the President" (White House 1995a) indicating "To meet the challenge of ensuring confidence in the safety and reliability of our stockpile, I have concluded that the continued vitality of all three DOE nuclear weapons laboratories will be essential." This statement emphasized the importance of the continued operation of LLNL to ensure the safety and reliability of the nuclear weapons stockpile.

The *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (SSM PEIS) (DOE/EIS-0236) (DOE 1996a) was completed in September 1996, and a Record of Decision (ROD) was published in the Federal Register on December 26, 1996 (61 FR 68014). The ROD announced the decision to begin the development of the Stockpile Stewardship Program and stated "The President and Congress have directed DOE to maintain the core intellectual and technical competencies for the U.S. in nuclear weapons and to maintain the safety and reliability of the enduring nuclear weapons stockpile." Without underground nuclear testing, DOE must rely on experimental and computational capabilities, especially in weapons physics, to assess and predict the consequences of problems that may occur in an aging stockpile. The ROD further states that without capabilities offered by LLNL, such as the NIF, "DOE would lack the ability to evaluate significant weapon performance issues, which could adversely affect confidence in the Nation's nuclear deterrent."

Under Title 32 of the *National Defense Authorization Act* for fiscal year (FY) 2000 (Public Law 106-65), Congress created NNSA as a separately organized agency within DOE to focus on the management of the Nation's defense nuclear programs. One of the statutory missions of NNSA is to maintain and enhance the safety, reliability, and performance of the U.S. nuclear weapons stockpile to meet national security requirements. On March 1, 2001, NNSA officially commenced its management of DOE's nuclear weapons programs and facilities, which include LLNL.

1.3 PURPOSE AND NEED FOR AGENCY ACTION

The continued operation of LLNL is critical to NNSA's Stockpile Stewardship Program and to preventing the spread and use of nuclear weapons worldwide. LLNL maintains core competencies in activities associated with research, development, design, and surveillance of nuclear weapons, as well as the assessment and certification of their safety and reliability. In response to the end of the Cold War and changes in the world's political regimes, the emphasis on the U.S. nuclear weapons program has shifted from developing and producing new weapons designs to dismantling obsolete weapons and maintaining a smaller weapons stockpile.

1.3.1 Nuclear Posture Review

In 2001, Congress directed DoD to conduct a comprehensive nuclear posture review to lay out the direction for the U.S. nuclear forces over the next 5 to 10 years. The centerpiece of the nuclear posture review is the new triad, with flexible response capabilities. The new triad is composed of the three elements: (1) offensive strike systems, nuclear and nonnuclear; (2) active and passive defenses; and (3) a revitalized defense infrastructure that will provide capabilities in a timely fashion to meet emerging threats.

Of particular interest to DOE and NNSA is the third element of the new triad, which reflects a broad recognition of the importance of a robust and responsive nuclear weapons infrastructure in sustaining deterrence. In this respect, the nuclear posture review notes that the flexibility to sustain the U.S. nuclear weapons stockpile depends on a robust program for stockpile stewardship and peer-review-based stockpile certification.

DOE developed several goals in its draft NNSA Strategic Plan (NNSA 2002b) to achieve its missions in support of the nuclear posture review. The nuclear weapons stewardship goal is to ensure that our nuclear weapons continue to serve their essential deterrence role by maintaining and enhancing the safety, security, and reliability of the U.S. nuclear weapons stockpile. Achieving these goals requires the continued operation of LLNL.

NNSA has developed strategic objectives to support the DOE strategic goals. The strategic objectives that support the nuclear posture review and relate to the purpose for continued operations of LLNL are listed below:

- Conduct a program of warhead evaluation, maintenance, refurbishment, and production planned in partnership with the DoD
- Develop the scientific, design, engineering, testing, and manufacturing capabilities needed for long-term stewardship of the stockpile
- Attract and retain the best laboratory workforce
- Provide state-of-the-art facilities and infrastructure supported by advanced scientific and technical tools to meet the operations and mission requirements
- Protect classified information and assets

NNSA currently certifies the stockpile through the Stockpile Stewardship Program, designed to implement DOE goals and NNSA objectives. LLNL programs and operations are integral components of DOE and NNSA strategies. In order to ensure the safety, reliability, and performance of the nuclear weapons stockpile, DOE has determined that it should: construct the NIF and the Terascale Simulation Facility; operate existing facilities such as Building 332 Plutonium Facility, Building 331 Tritium Facility, and Building 801 Contained Firing Facility; and retain skilled scientists and engineers.

1.3.2 Annual Assessment Review

LLNL participates in the formal review processes and assessments of weapons safety, security, and reliability. The seventh cycle to certify the stockpile, since the cessation of underground nuclear testing, was completed for the President in 2002. The annual assessment review is based on the technical evaluations made by the three weapons laboratories, provided through DOE to the U.S. Strategic Command and the Nuclear Weapons Council. To prepare for this process, LLNL scientists and engineers collect, review, and integrate all available information regarding each stockpile weapons system, including physics, engineering, chemistry, and materials science data.

The annual assessment review and the formal certification of refurbished warheads require weapons experts to "depend" on an extensive range of aboveground experiments, vastly improved simulation capabilities, and the historical nuclear test database. LLNL and Los Alamos National Laboratory are also developing and beginning to apply a rigorous set of quantitative standards as the basis for formal certification actions and setting programmatic priorities.

LLNL conducts a wide range of stockpile surveillance activities to assess the condition of LLNL-designed weapons in the stockpile and to better understand the effects of aging on weapons. These surveillance activities include evaluating the pits in the primaries of nuclear weapons. LLNL is the design laboratory for four weapons systems in the stockpile: the W87 and W62 intercontinental ballistic missile warheads, the B83 bomb, and the W84 cruise missile.

Pit—The central core of a nuclear weapon containing plutonium-239 or highly enriched uranium that undergoes fission when compressed by high explosives.
Primary—The pit and high explosives component of a nuclear weapon.

1.3.3 Other Lawrence Livermore National Laboratory Program Activities

Countering the proliferation and use of weapons of mass destruction is another national security program that uses LLNL's R&D expertise. On December 10, 2002, LLNL introduced a new organization to support the U.S. Department of Homeland Security (LLNL 2002a). A detailed description of other programs and operations is presented in Appendix A of this LLNL SW/SPEIS.

LLNL is organized into a number of other programs to support DOE- and NNSA-assigned missions. These programs include nuclear materials stewardship, energy security and long-term energy needs, environmental assessment and management, advancing bioscience, and breakthroughs in fundamental sciences and applied technology. Additionally, LLNL supports other government organizations and science and industry through the transfer of technology.

1.4 RELATED *NATIONAL ENVIRONMENTAL POLICY ACT* DOCUMENTS

NEPA establishes environmental policy, sets goals, and provides a means for implementing the policy. NEPA contains provisions to ensure that Federal agencies adhere to the letter and spirit of the Act. The key provision requires preparation of an environmental impact statement (EIS) on "major Federal actions significantly affecting the quality of the human environment" (40 *Code of Federal Regulations* [CFR] §1502.3). NEPA ensures that environmental information is available to public officials and citizens before decisions are made and actions are taken (40 CFR §1500.1[b]). This LLNL SW/SPEIS analyzes a range of alternatives that would allow LLNL to provide support for NNSA and other DOE missions.

DOE has a policy to prepare site-wide environmental impact statements (SWEIS) for certain large, multiple-facility sites such as LLNL (10 CFR §§1021.330). In 1982, DOE prepared a SWEIS for LLNL and Sandia National Laboratories, Livermore, now called Sandia National

Laboratories, California (SNL/CA) (DOE 1982a). That document provided environmental information for DOE's decision to "operate the Livermore Sites at the present level of effort which is consistent with national security and defense policy" (47 FR 44836). The ROD, based on the 1982 SWEIS, concluded that work at the two laboratories was essential to the national need for R&D in the nuclear weapons program and other basic energy research. DOE committed to operate the facilities in a manner to reduce further environmental, health, and safety impacts to the extent practical.

Ten years later, in August 1992, DOE released the *Final Environmental Impact Statement and Environmental Impact Report for Continued Operations of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore* (1992 LLNL EIS/EIR) (LLNL 1992a). A ROD was issued in January 1993. The 1992 LLNL EIS/EIR continues to serve as the most comprehensive NEPA document for LLNL operations.

The impacts associated with construction and operation of the NIF were evaluated in the Stockpile Stewardship and Management (SSM) SSM PEIS (DOE/EIS-0236) (DOE 1996a). A project-specific analysis of the NIF was included in the SSM PEIS as an appendix. The SSM PEIS ROD (61 FR 68014), published in the *Federal Register* on December 26, 1996, documented the decision to construct and operate the NIF at LLNL.

In 1998, DOE issued the *Supplement Analysis for Use of Hazardous Materials in NIF Experiments* (DOE/EIS-SA0236-SA2) (DOE 1998c), which addressed the use of plutonium and other hazardous materials. The supplement analysis provided the basis for approval of the use of depleted uranium on the NIF and indicated that there was no new information to warrant the preparation of a supplemental SSM PEIS.

In March 1999, DOE released a supplement analysis that considered whether the 1992 LLNL EIS/EIR should be supplemented, a new EIS should be prepared, or no further NEPA documentation should be required. The supplement analysis concluded that the 1992 LLNL EIS/EIR remained adequate and that no supplemental or new EIS was required at that time (DOE 1999a).

As indicated above, SNL/CA was included in the 1992 LLNL EIS/EIR. Ten years later, NNSA decided that the continued operation of LLNL and SNL/CA required different levels of environmental analysis based on the proposed plans for each site. Therefore, on February 4, 2002 (67 FR 5089), NNSA's Office of Kirtland Site Operations issued a Notice of Intent announcing the preparation of a Site-wide Environmental Assessment for SNL/CA. An environmental assessment for the continued operation of SNL/CA was completed by NNSA in 2003. As a result, this LLNL SW/SPEIS does not include the operations or activities at SNL/CA, other than in a discussion of cumulative impacts.

With the passage of more than 10 years since the publication of the 1992 LLNL EIS/EIR and because of proposed plans for modification to existing projects or new programs, NNSA determined that it was appropriate to update the information contained in the 1992 document. On April 22, 2002, NNSA began planning for the preparation of a LLNL SW/SPEIS for continued operations of LLNL (Hooper 2002). On June 17, 2002, NNSA published a Notice of Intent

(NOI) in the *Federal Register*, announcing its intent to prepare a new SW/SPEIS to evaluate the environmental effects of the operation of LLNL (67 FR 41224).

This LLNL SW/SPEIS provides NNSA with an assessment of the potential environmental impacts in terms of ongoing and reasonably foreseeable facilities, operations, and activities at LLNL. The impacts addressed in this LLNL SW/SPEIS bound LLNL activities and support functions within the envelope of the No Action Alternative, Proposed Action, and Reduced Operation Alternative (see Chapter 3). For actions beyond the scope of this document, further NEPA reviews will be prepared. In appropriate cases however, future environmental documents would be tiered from this LLNL SW/SPEIS.

1.5 MAJOR DECISIONS

A decision will be announced in a ROD issued by NNSA concerning the continued operations of LLNL based on the assessment of the alternatives described in Chapter 3. The ROD will also announce several major issues that are part of the Proposed Action and consider factors other than environmental issues. These major decisions are addressed in the following paragraphs.

1.5.1 Use of Proposed Materials on the National Ignition Facility

In 1996, the programmatic impacts of conducting DOE/NNSA's Stockpile Stewardship and Management Program at all NNSA sites were evaluated in the SSM PEIS. The SSM PEIS ROD documented the decision to construct and operate the NIF at LLNL. In 1997, the Natural Resources Defense Council (NRDC) and 39 other organizations brought suit against DOE in NRDC v. Peña, Civ. No. 97-936(SS) (D.D.C.), challenging the adequacy of the SSM PEIS, partially on the basis that DOE should have analyzed conducting experiments on the NIF using plutonium, other fissile materials, fissionable materials, and lithium hydride. DOE maintained that the use of these materials were not reasonably foreseeable at that time. In August 1998, the judge in the lawsuit issued a Memorandum Opinion and Order that dismissed the plaintiffs' case. The Memorandum Opinion and Order provided in Paragraph 6 that:

> No later than January 1, 2004, DOE shall (1) determine whether any or all experiments using plutonium, other fissile materials, fissionable materials other than depleted uranium (as discussed in the Supplement Analysis for the Use of Hazardous Materials at the NIF experiments, A.R. doc. VIIA-12), lithium hydride, or a Neutron Multiplying Assembly (NEUMA), such as that described in the document entitled Nuclear Weapons Effects Test Facilitization of the National Ignition Facility (A.R. doc VII.A-4) shall be conducted at the NIF; or (2) prepare a Supplemental SSM PEIS, in accordance with DOE NEPA regulation 10 C.F.R.1021.314, analyzing the reasonably foreseeable environmental impact of such experiments. If DOE undertakes the action described in subpart (2) of this paragraph, DOE shall complete and issue the Supplemental SSM PEIS and the Record of Decision based thereon within eighteen (18) months after issuing a notice of intent to prepare the Supplemental SSM PEIS.

In November 2002, the NNSA Deputy Administrator for Defense Programs approved proposing experiments on the NIF using plutonium, other fissile materials, fissionable materials, and lithium hydride. NNSA has chosen to use the LLNL SW/SPEIS as the mechanism for complying with the court's instruction to prepare a supplemental SSM PEIS. The inclusion of this supplemental SSM PEIS in the LLNL SW/SPEIS ensures timely analysis of these proposed experiments within the environmental impacts being evaluated for the continued operation of LLNL. In any ROD to be issued, NNSA will address decisions on the use of any or all of these proposed materials in NIF experiments within the context of continuing LLNL operations. During the LLNL SW/SPEIS scoping period, comments were received from members of the public and non-government organizations stating their concerns and objections to NIF operations.

The evaluation of the reasonably foreseeable environmental impacts of performing experiments with these proposed materials is contained in Appendix M, and the results of the analysis are reflected in the comparison of impacts presented in Appendix M, Section M.5. These results show that the primary impacts from use of the proposed materials would be increased low level waste and increased worker exposure to radiation. The projected increase in waste would be approximately 50 percent of the total volume estimated under the No Action Alternative. The increase in worker exposure was conservatively estimated and is within the range normally accepted for radiological work and is below both DOE regulatory limits and those enforced through the LLNL Environmental Safety and Health Manual.

1.5.2 Increased Administrative Limits for Plutonium in the Superblock

In the 1992 LLNL EIS/EIR, a primary goal of LLNL was to reduce the plutonium inventory to 200 kilograms through offsite disposition of significant portions of the inventory. This goal was partially achieved by relocating approximately half of the excess material offsite; however, DOE facilities were unable to accept all materials identified to be shipped. In 1999, DOE prepared a supplement analysis that reexamined future program requirements at LLNL and identified the need to modify certain radioactive material limits established in the 1992 LLNL EIS/EIR. The 1999 supplement analysis confirmed the need for an administrative limit of 700 kilograms of plutonium to provide for continued LLNL support of the Stockpile Stewardship Program.

Superblock

Superblock is comprised of the Building 332 Plutonium Facility, Building 331 Tritium Facility, and Building 334 Hardened Engineering Test Building.

NNSA continues to rely on LLNL to meet its Stockpile Stewardship Program mission objectives. These objectives include campaigns relating to pit manufacturing and certification, advanced radiography, dynamic materials testing, materials shelf life experiments, and enhanced surveillance research. These NNSA-assigned campaigns and programs require continued and increasing use of plutonium. NNSA continues to work on a solution for disposal of plutonium, but no pathway for LLNL to dispose of excess plutonium currently exists, requiring an increase in the plutonium administrative limits. Therefore, NNSA would increase the administrative limit for fuel-grade equivalent plutonium to 1,500 kilograms

Administrative Limits

Administrative limits are defined as the maximum amount of the referenced material allowed at a facility. The actual inventory for some materials at LLNL for which there is an administrative limit may be classified.

from the existing 700 kilograms. The limit for enriched uranium would remain unchanged at 500 kilograms. During the LLNL SW/SPEIS scoping period comments were received from members of the public and nongovernment organizations stating their concerns that NNSA had not reduced the amount of excess plutonium stored at the Superblock, and that the environment and population surrounding LLNL was at considerable risk to accidents or terrorist acts involving the plutonium inventory.

The Superblock plutonium inventory is stored in robust vaults and no accident scenario involving the material in the vaults is considered reasonably foreseeable. Terrorist acts and Superblock security are considered in the LLNL SW/SPEIS. The information on these accidents is provided in classified or official use only documents. The accidents discussed in the LLNL SW/SPEIS bound the environmental impacts associated with the proposed higher plutonium inventory limit.

1.5.3 Conduct Integrated Technology Project in the Plutonium Facility

In the NOI and at the public scoping meetings for the LLNL SW/SPEIS, NNSA identified a proposed project that might be restricted to a classified appendix that would not be publicly available. During the LLNL SW/SPEIS scoping period, comments were received from members of the public and nongovernment organizations stating their concerns and objections that the LLNL SW/SPEIS would include a classified appendix not available for public review. After completing a classification review, it was decided that a classified appendix was not required. Although certain information remains classified, a detailed description of the project's purpose and need, material processing, and the environmental impacts of the project are included in the LLNL SW/SPEIS in Appendix N, Integrated Technology Project (ITP).

Science-Based Stockpile Stewardship and Management Program (SBSSMP) experiments are needed to increase the understanding of the complex physics and behavior of materials in nuclear weapons and ultimately to certify the efficacy of the Nation's aging stockpile. Accurate, theoretical, scientific, and experimental data are required to validate the computer models of the weapon performance. SBSSMP experiments involve the use of both surrogate and actual materials that would be used in the weapon system.

The Advanced Materials Program involves the development and demonstration of the Atomic Vapor Laser Isotope Separation (AVLIS) technology. The ITP is a follow on activity to the Advanced Materials Program to produce material to augment the current inventory of special nuclear materials (e.g. plutonium and enriched uranium) for use in SBSSMP experiments. The ITP would not proceed until the Advanced Materials Program demonstrations are complete. The expected ITP start would be FY2008. The ITP is one of the bases for the increase in the plutonium material-at-risk limit from the current 20 kilograms in any room of the Plutonium Facility to 60 kilograms of fuel-grade-equivalent plutonium in each of two rooms. This material-at-risk increase would enable LLNL to pursue multiple Stockpile Stewardship Program missions simultaneously. Details of the Advanced Materials Program and ITP are presented in Appendix N.

1.5.4 Increased Material-at-Risk Limit for the Plutonium Facility

> **Material-at-Risk**
>
> A material-at-risk limit is defined as the maximum amount of the referenced material that is involved in the process and thus at risk in the event of a postulated accident. Material locked in secure storage is not considered material at risk.

The Proposed Action would increase the plutonium material-at-risk limit from 20 to 60 kilograms of fuel-grade equivalent plutonium in each of two rooms of the Plutonium Facility. This increase is needed to meet future Stockpile Stewardship Programs such as ITP and the casting of plutonium parts. These activities support campaigns for advanced radiography, pit manufacturing, and certification programs. If the material-at-risk is increased, the bounding Plutonium Facility accident consequences to the population surrounding LLNL would increase from an aircraft crash resulting in 5.82×10^{-2} latent cancer fatalities (LCFs) per year under the No Action Alternative to an unfiltered fire involving 60 kilograms fuel-grade equivalent plutonium resulting in 1.68×10^{-1} LCFs per year under the Proposed Action.

1.5.5 Increase of Tritium Facility Material Limits

The Proposed Action would increase the Building 331 Tritium Facility tritium administrative limit from 30 to 35 grams and the material-at-risk at a single workstation from 3.5 to 30 grams. These increases are needed to support future planned Stockpile Stewardship Program activities such as the high-energy density physics target fill and the Test Readiness Program. The activities support the campaign for inertial confinement fusion and high yield and the readiness to resume testing, if directed. Analysis in the LLNL SW/SPEIS shows the increased material-at-risk would result in higher consequences from an aircraft crash into the Tritium Facility. This accident has an annual frequency of 1.53×10^{-6} and would be bounded by other radiological accidents under all alternatives.

1.6 PUBLIC SCOPING PROCESS

Public involvement is an integral part of NEPA and on June 17, 2002, NNSA published a NOI (67 FR 41224) announcing its intent to prepare this LLNL SW/SPEIS. Consistent with NEPA (42 USC §4321, et seq.) and Council on Environmental Quality regulations (40 CFR Parts 1500–1508), NNSA conducted an early and open process to identify and determine the scope of issues to be addressed in the LLNL SW/SPEIS. The NOI invited interested parties to attend public scoping meetings on July 10 and 11, 2002, in Livermore and Tracy, California, respectively. They were encouraged to submit written comments through August 13, 2002. Subsequently, in response to a request from the public, NNSA extended the deadline for submission of written comments to September 16, 2002.

During the LLNL SW/SPEIS scoping process, NNSA received 250 scoping comment documents from members of the public; interested groups; and Federal, state, and local officials. These included transcripts from the public scoping meetings held in Livermore and Tracy. Table 1.6–1 provides a summary of the scoping comment categories and the number of comments in each category. Although a total of 380 unique comments were identified, these comments may have fallen into more than one category; therefore, the sum of comments in Table 1.6–1 is slightly more than the total of 380 mentioned previously.

The following paragraphs summarize the comments received, grouped by major areas of concern. Each paragraph directs the reader to a section of the LLNL SW/SPEIS that addresses these areas of concern.

TABLE 1.6–1.—*Category Distribution of Scoping Comments*

Category	No. of Comments
Policy	74
Scope and Alternatives	69
Public Involvement	22
Health and Safety/Accidents	77
Air Quality	20
Water Quality	17
Environmental Compliance and Waste Management	71
Project-Specific Comments	79
General Comments	146

Source: Original.

1.6.1 Policy

Comments were received that the LLNL SW/SPEIS should provide information on weapons activities at LLNL; evaluate the effects of reduced budgets on DOE policy for environmental cleanup; evaluate compliance with proposed and existing nuclear weapons treaties such as the Nuclear Non-Proliferation Treaty; and address *California Environmental Quality Act* requirements.

Chapter 1, Section 1.3.1, provides information on the purpose and need for weapons activities at LLNL, and Chapter 2 provides detailed information on the LLNL programs that support the NNSA missions. Chapter 5 presents the impacts of discontinuing current environmental restoration operations; budget information and treaty compliance will be considered in preparing a ROD. This document covers NEPA requirements and does not address the *California Environmental Quality Act* requirements; however, Appendix B discusses *California Environmental Quality Act* information for waste management activities.

1.6.2 Scope and Alternatives

Scoping comments requested the LLNL SW/SPEIS analyze a shutdown of LLNL, conversion of LLNL to an academic laboratory, or conversion of LLNL to an environmental research laboratory. These comments centered on concerns with the LLNL operation of the Plutonium Facility, the NIF, and the ITP. These comments also noted that the LLNL SW/SPEIS should include the activities at SNL/CA in the LLNL SW/SPEIS and address LLNL activities at other sites, i.e., nuclear weapons activities at the Nevada Test Site.

These alternatives were considered as unreasonable; however, the Reduced Operation Alternative represents a significant reduction of Stockpile Stewardship activities at LLNL. SNL/CA is not included in the scope of this LLNL SW/SPEIS. An environmental assessment for the continued operation of SNL/CA was completed by NNSA in 2003 (DOE/EA-1442). However, SNL/CA impacts are discussed as part of the appropriate cumulative impacts addressed in Chapter 5.

Some comments received stated that the LLNL SW/SPEIS should analyze the hazards associated with biological materials that might be used in the BioSafety Level-3 (BSL-3) Facility, included under the No Action Alternative. A final environmental assessment provided NEPA analysis for the construction and operation of this facility, including the impacts of normal and accident conditions (DOE/EA-1442). A DOE Finding of No Significant Impact dated December 2002 approved construction and operation of the BSL-3 Facility at LLNL (NNSA 2002e). Therefore, this LLNL SW/SPEIS does not provide additional information beyond what is provided for the BSL-3 Facility in the environmental assessment.

Chapter 3 provides a discussion of the alternatives considered as a part of this LLNL SW/SPEIS. Chapter 3, Section 3.5, discusses alternatives considered but eliminated from detailed analyses. Section 1.3 of this chapter discusses the role of LLNL in nuclear weapons research, development, design, and surveillance. Chapter 3, Section 3.2, discusses planned LLNL activities that are included in the No Action Alternative as a consequence of previous NNSA decisions based on previous NEPA analyses. LLNL activities at other sites are addressed in the NEPA documents for those sites.

1.6.3 Public Involvement

Comments also indicated that the LLNL SW/SPEIS should afford state, tribal, and local government entities the opportunity to participate in the DOE NEPA process as cooperating agencies and extend the comment period an additional 30 days to allow the public more time to comment on the scope and alternatives. These comments also requested that the nongovernment organizations and members of the general public be provided the opportunity to have independent technical experts participate in the process of reviewing the analysis during the preparation of the LLNL SW/SPEIS.

NNSA extended the deadline for submission of written comments from August 13 to September 16, 2002 (67 FR 52462). The extension notice specifically indicated the opportunity for government agencies interested in participating in the DOE NEPA process as designated cooperating agencies. No cooperating agencies were identified. There are no plans to provide additional review opportunities for nongovernment organizations or members of the public beyond those required by the NEPA process. The LLNL SW/SPEIS provides information in an unclassified form on the environmental impacts of LLNL operations.

1.6.4 Health and Safety/Accidents

Comments requested that the LLNL SW/SPEIS include the potential impacts of accidents with hazardous and radioactive material, analyze the impacts of accidents at Site 300, evaluate the impacts of a Greenville Fault earthquake, evaluate the effects of a terrorist attack on LLNL, include a discussion of the history of accidental releases to the environment, evaluate the impact of air pollutants on the environment and the public, and evaluate the increased levels of melanoma and birth defects in Livermore, California.

An investigation of the incidence of cancer among LLNL employees did not identify any link between employment at LLNL and increased risk of cancer (Moore et al. 1997). Another study found that the cancer rates among children and young adults in the city of Livermore do not differ appreciably from elsewhere in Alameda County (California Department of Health Services 1995). Another study found that birth defect rates in Livermore are similar to the overall rates for the state of California (California Department of Health Services 1996). Therefore, an analysis of the rates for melanoma or birth defects in the city of Livermore was not included in this LLNL SW/SPEIS.

Chapter 5, Section 5.5, and Appendix D provide detailed information on accident evaluations for LLNL operations at the Livermore Site and Site 300, including the effects of an earthquake on LLNL facilities. Terrorist or malevolent attacks on LLNL are analyzed in classified or official use only documents. Environmental airborne release impacts are discussed in Chapter 5, Sections 5.2.8 (No Action Alternative), 5.3.8 (Proposed Action), and 5.4.8 (Reduced Operation Alternative); and seismic evaluations are provided in Sections 5.2.6, 5.3.6, and 5.4.6. Additionally, Appendix C, Section C.4, contains additional information on air quality and Appendix H contains additional information on seismicity. Chapter 4, Section 4.17 describes the history, current status, and ongoing planned remediation activities of contaminated soil and groundwater at LLNL.

1.6.5 Air Quality

Comments were received that the LLNL SW/SPEIS should evaluate controlled burning at Site 300, evaluate LLNL compliance with state and Federal air quality standards, list the air pollutants that are emitted from LLNL operations, address the mitigation measures that will be taken to reduce the impact on air quality in the Bay Area, provide current information on the release of radionuclides to the atmosphere, and address any proposed increases in emissions.

Environmental airborne release impacts are discussed in Chapter 5, Sections 5.2.8 (No Action Alternative), 5.3.8 (Proposed Action), and 5.4.8 (Reduced Operation Alternative). Appendix C, Section C.4, has additional information on air quality.

1.6.6 Water Quality

Comments were received that the LLNL SW/SPEIS should provide current and projected water consumption, evaluate LLNL compliance with state and Federal water quality standards, address the groundwater contamination at LLNL and compliance with state and Federal regulations, and discuss the current and projected wastewater treatment activities and compliance with state and Federal regulations.

Environmental water quality impacts are discussed in Chapter 5, Sections 5.2.9 (No Action Alternative), 5.3.9 (Proposed Action), and 5.4.9 (Reduced Operation Alternative). Site contamination is discussed in Sections 5.2.15, 5.3.15, and 5.4.15. Waste treatment is discussed in Sections 5.2.13, 5.3.13, 5.4.13, and Appendix B.

1.6.7 Environmental Compliance and Waste Management

Comments were received that the LLNL SW/SPEIS should address *Resource Conservation and Recovery Act* and *Toxic Substances Control Act* corrective action activities at LLNL, evaluate radionuclide contamination in LLNL soils, address offsite contamination, list all LLNL permits and the responsible organizations, evaluate compliance with state and Federal environmental regulations, address compliance with the Council on Environmental Quality pollution prevention requirements, address the transportation of waste to the Nevada Test Site, and address the waste minimization activities at LLNL.

Information on compliance with *Resource Conservation and Recovery Act* and *Toxic Substances Control Act* and compliance with Federal and state regulations is provided in Chapter 4, Section 4.17, and Chapter 7, and the impacts analysis for site contamination is discussed in Chapter 5, Sections 5.2.15, 5.3.15, and 5.4.15. Waste management environmental impacts are addressed in Chapter 5, Sections 5.2.13, 5.3.13, 5.4.13, and Appendix B. Environmental impacts of transportation are discussed in Chapter 5, Sections 5.2.11, 5.3.11, and 5.4.11. Transportation accidents are addressed in Chapter 5, Section 5.5. Pollution prevention and waste minimization strategies are discussed in Appendix O.

1.6.8 Project-Specific Comments

National Ignition Facility

During the LLNL SW/SPEIS scoping period, comments were received from members of the public and nongovernment organizations stating their concerns and objections to NIF operations. Comments noted that the LLNL SW/SPEIS should analyze the use of any hazardous and radioactive materials at the NIF and analyze the nonproliferation and treaty compliance impacts of the NIF operations.

Appendix M provides a detailed discussion of the environmental impacts of conducting experiments on the NIF using proposed hazardous and radioactive materials. Nonproliferation and treaty compliance will be addressed as part of the ROD for the LLNL SW/SPEIS.

BioSafety Level 3 Facility

Comments were received that the LLNL SW/SPEIS should analyze the hazards associated with biological materials that might be used in the proposed BSL-3 Facility, analyze the potential for terrorist attacks on the BSL-3 Facility, include the BSL-3 analysis as part of the LLNL SW/SPEIS and not as a separate NEPA document, cover all normal operations and accident conditions at the BSL-3 Facility, and provide data on maximum inventories and transportation of infectious agents.

A final environmental assessment (NNSA 2002a) provides NEPA analysis for the construction and operation of this facility, including the impacts of normal and accident conditions. A DOE Finding of No Significant Impact, dated December 2002 (NNSA 2002e), approved construction and operation of the BSL-3 Facility at LLNL. This LLNL SW/SPEIS does not provide additional information beyond what is provided for the BSL-3 Facility in the environmental assessment. Terrorist or malevolent attacks on LLNL are analyzed in classified or official use only documents referenced in Appendix D.

Classified Project

In the NOI and at the public scoping meetings for the LLNL SW/SPEIS, NNSA presented a project that might be restricted to a classified appendix that would not be publicly available. During the LLNL SW/SPEIS scoping period, comments were received from members of the public and nongovernment organizations stating their concerns and objections that the LLNL SW/SPEIS would include a classified appendix not available for public review. Comments were received that the LLNL SW/SPEIS should justify the need for the classified project, provide as much information as possible in the unclassified discussions, analyze the environmental impacts of the classified project and its effect on the operations at the Plutonium Facility, and analyze all impacts associated with the project. After completing a classification review, it was decided that a classified appendix was not required. Although certain information remains classified, a detailed description of the project's purpose and need, material processing, and the environmental impacts of the project are included in the LLNL SW/SPEIS in Appendix N.

The name for the classified project discussed at the scoping meetings is the Integrated Technology Project. Appendix N provides a detailed unclassified discussion of the environmental impacts of this project, including the purpose and need. Appendix N also describes how the ITP would be implemented in the Plutonium Facility.

East Avenue Security Upgrade

Comments were received that this project should not be part of the No Action Alternative and that it should be part of the Proposed Action.

The East Avenue Security Upgrade project administratively controls a portion of East Avenue between South Vasco and Greenville roads. A final environmental assessment was issued in September 2002 (DOE 2002h) and a Finding of No Significant Impact approved this security upgrade. This project remains a part of the No Action Alternative and is discussed in Chapter 3; the environmental impacts are addressed in Chapter 5.

1.6.9 General Comments

Comments were received in several other areas such as affected environment, biology, document readability, environmental justice, geology and seismicity, land use, LLNL management, mitigation, socioeconomics, visual resources, emergency response, transportation, and cumulative impacts. Information concerning these comments can be found in Chapter 4, Chapter 5, Appendix F, Appendix G, Appendix H, Appendix I, and Appendix J.

1.7 *FINAL SITE-WIDE ENVIRONMENTAL IMPACT STATEMENT FOR CONTINUED OPERATION OF LAWRENCE LIVERMORE NATIONAL LABORATORY AND SUPPLEMENTAL STOCKPILE STEWARDSHIP AND MANAGEMENT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT* AND RECORD OF DECISION

EPA's Notice of Availability (NOA) for the Draft LLNL SW/SPEIS, published in the *Federal Register*, initiates a 90-day comment period. After the comment period, NNSA will consider the comments and, as appropriate, make changes to the Draft LLNL SW/SPEIS. NNSA will then issue a Final LLNL SW/SPEIS. NNSA will consider the Final LLNL SW/SPEIS, along with other information, in making a decision on the continuing operations of LLNL. No sooner than 30 days after EPA publishes its NOA for the Final LLNL SW/SPEIS, NNSA may issue a ROD, which will announce its decision and explain all factors, including environmental impacts, that NNSA considered in reaching its decision. The ROD would make decisions among the three alternatives.

CHAPTER 2: OPERATIONS OVERVIEW OF LAWRENCE LIVERMORE NATIONAL LABORATORY

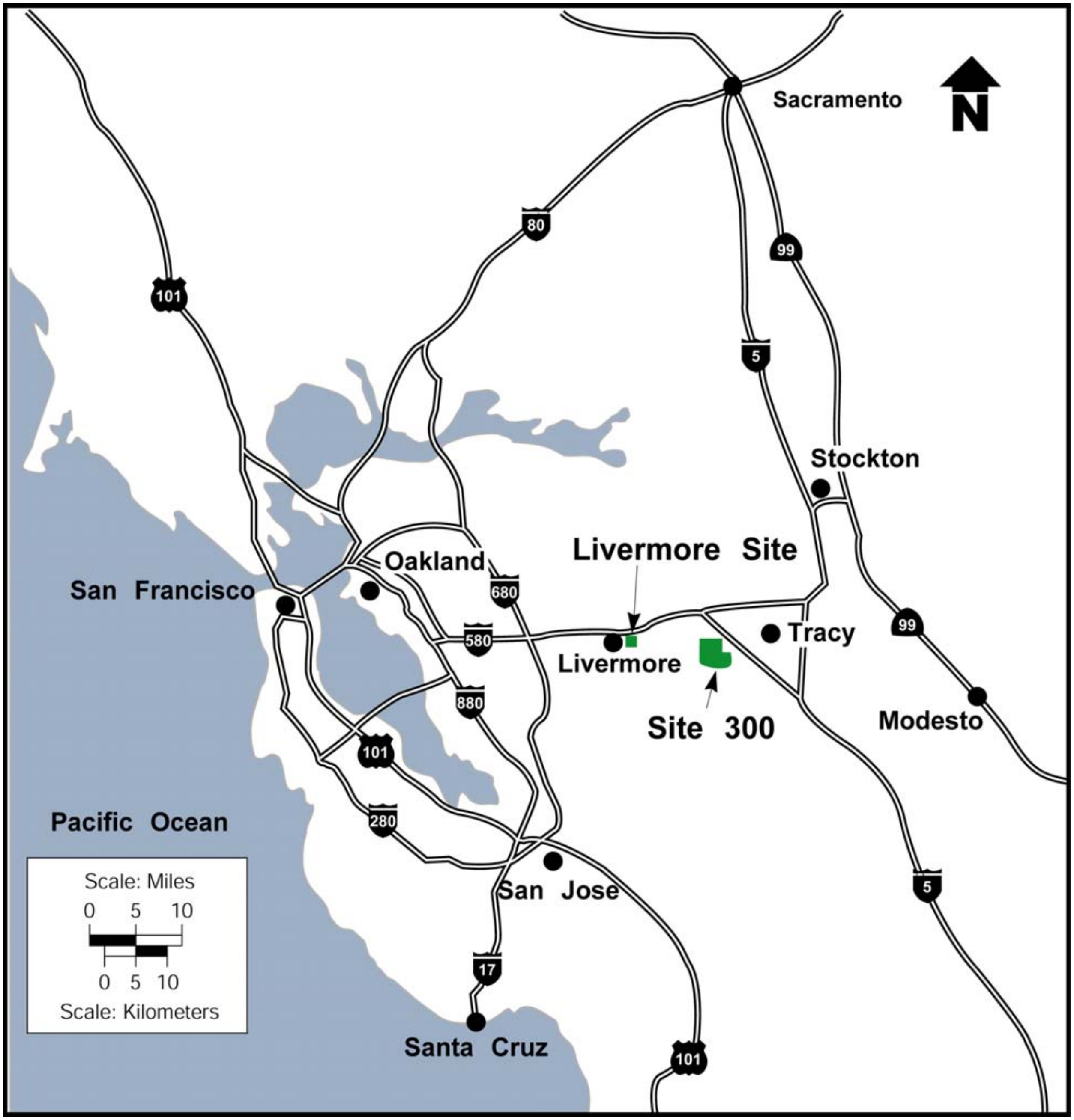
This chapter provides an overview of Lawrence Livermore National Laboratory (LLNL) operations, programs, and facilities. It begins with a brief history of LLNL and its operations, followed by a discussion of programs supported by LLNL. A description of LLNL's organization and facilities is included at the end of this chapter. Descriptions of specific facilities and their operations are summarized in this chapter. Further details of the LLNL programs may be found in Appendix A.

2.1 AN OVERVIEW OF LAWRENCE LIVERMORE NATIONAL LABORATORY

LLNL was founded in September 1952 as a second nuclear weapons design laboratory to promote innovation in the design of our Nation's nuclear stockpile through science and engineering. The University of California has managed the operations of LLNL since its inception for the U.S. Department of Energy (DOE). During the past five decades, LLNL has also developed advanced technologies in energy, biomedicine, and environmental science.

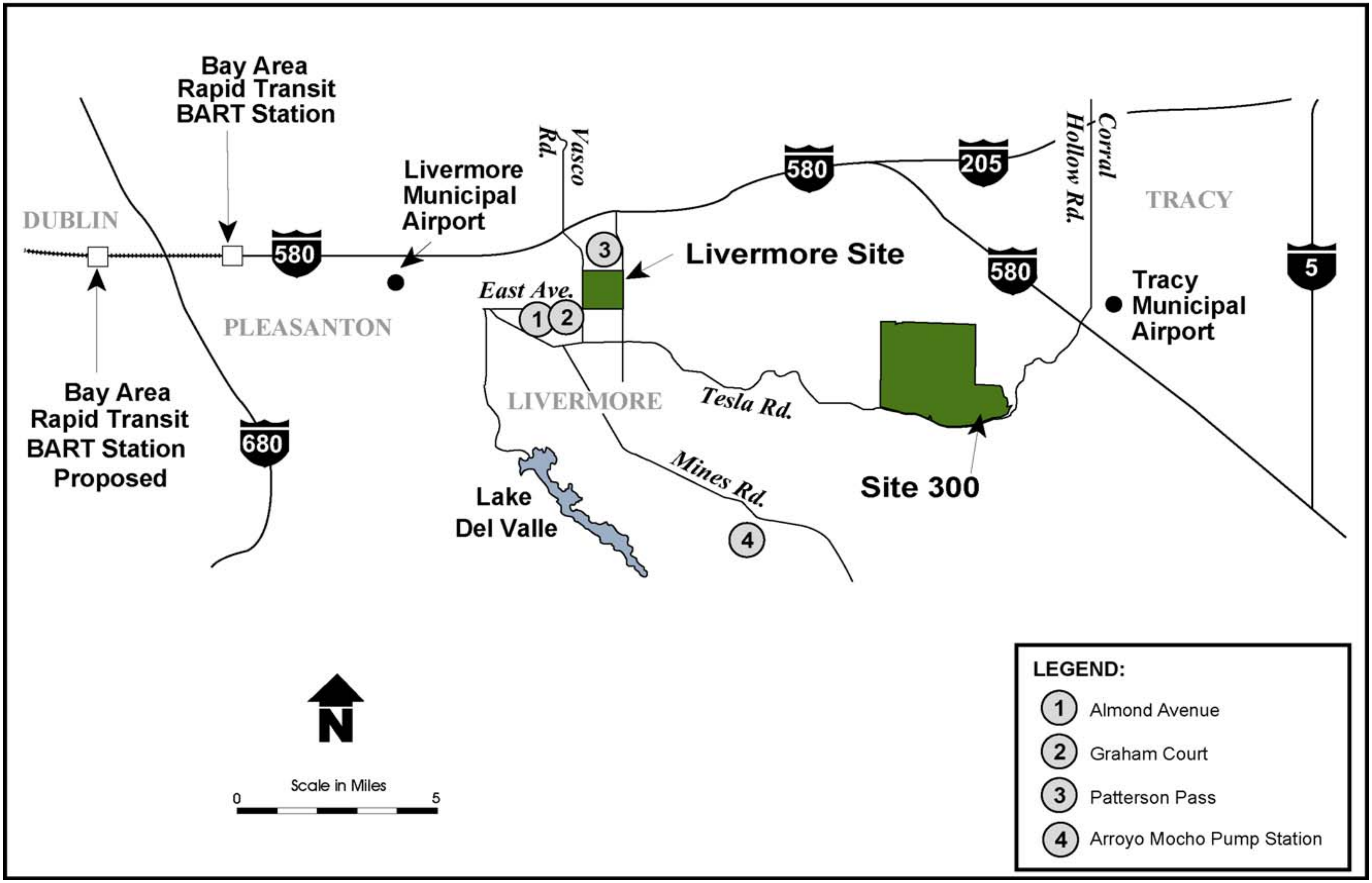
LLNL consists of two sites, the Livermore Site located in Livermore, California (Livermore Site), in Alameda County, and the Experimental Test Site (Site 300), located near Tracy, California, in San Joaquin and Alameda counties. Figures 2.1–1 and 2.1–2 show the locations of the Livermore Site, Site 300, and offsite facilities in the surrounding area. Most LLNL operations are located at the Livermore Site. LLNL also conducts limited activities at several leased properties near the Livermore Site. These include a childcare center and classrooms at the Almond Avenue site and storage facilities at Graham Court and Patterson Pass Road. Additionally, LLNL occupies land leased by the National Nuclear Security Administration (NNSA) for the Arroyo Mocho Pump Station, located 7 miles south of the Livermore Site.

The Livermore Site occupies 821 acres, 1.3 square miles, about 40 miles east of San Francisco at the southeast end of the Livermore Valley in southeastern Alameda County. The Livermore Site is located approximately 3 miles east of Livermore's central business district. Site 300 is located about 15 miles southeast of Livermore in the hills of the Diablo Range. The site covers approximately 7,000 acres, marked with rolling hills and steep ravines. As of September 2002, approximately 10,360 people worked at the Livermore Site. This total includes LLNL employees, other Federal employees, and contractor personnel. As of September 2002, approximately 240 people worked at Site 300. The base year for data in most cases was 2002; however, data from previous years were used if 2002 data were unavailable or if they provided a more conservative analysis.



Source: LLNL 2001v.

FIGURE 2.1–1.—*Livermore Site and Site 300*



Source: DOE 2003b.

FIGURE 2.1–2.—*Locations of Livermore Site, Site 300, and Offsite Facilities Relative to Surrounding Communities*

2.2 UNITED STATES DEPARTMENT OF ENERGY AND NATIONAL NUCLEAR SECURITY ADMINISTRATION PROGRAMS SUPPORTED BY THE LAWRENCE LIVERMORE NATIONAL LABORATORY

LLNL performs work in support of DOE (including NNSA); other government agencies such as the U.S. Department of Defense (DoD), U.S. Nuclear Regulatory Commission, U.S. Environmental Protection Agency, and the U.S. Department of Homeland Security; and private industry through Work-for-Others projects and interagency agreements. The majority of LLNL activities support five major DOE and NNSA programs: Defense Programs, Nuclear Nonproliferation, Environmental Management, Science, and Energy Efficiency. These programs are described below. LLNL's organization, presented in Section 2.3, is largely structured to support these programs. A more detailed description of major programs and facilities is presented in Appendix A of this *Site-wide Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory and Supplemental Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (LLNL SW/SPEIS).

2.2.1 Defense Programs

Defense Programs achieves national security objectives for nuclear weapons established by the President and assists in reducing global nuclear danger by planning for and maintaining a safe, secure, and reliable stockpile of nuclear weapons and associated materials, capabilities, and technologies in a safe, environmentally sound, and cost-effective manner. The core functions of Defense Programs are as follows:

- Manage the Stockpile Stewardship Program, which encompasses operations associated with maintaining, refurbishing, surveilling, and dismantling the nuclear weapons stockpile; activities associated with researching, designing, developing, simulating, modeling, and nonnuclear testing nuclear weapons; and planning, assessing, and certifying safety and reliability.

- Manage the research, development, and computer simulation facilities that maintain the safety and reliability of the nuclear weapons stockpile in the absence of underground testing, and ensure the capability for maintaining the readiness to test and develop new warheads, if required.

- Manage cooperation with other NNSA and DOE elements; external scientific, research, and development agencies; industry; and academia.

- Ensure, through close coordination with the DoD, that the materials, capabilities, and technologies are available to support the production of certified components necessary to extend the lifetime of the nuclear weapons stockpile.

2.2.2 Nuclear Nonproliferation

Nuclear Nonproliferation enhances U.S. national security through a four-pronged strategy:

- Enhancing the capability to detect weapons of mass destruction, including nuclear, chemicals and biological systems
- Preventing and reversing the proliferation of weapons of mass destruction
- Protecting or eliminating weapons and weapons-useable material or infrastructure, and redirecting excess foreign weapons expertise to civilian enterprises
- Reducing the risk of accidents in nuclear fuel cycle facilities worldwide

2.2.3 Environmental Management

Environmental management provides program policy development and guidance for assessing and restoring inactive waste sites and facilities and for waste management operations; develops and implements an aggressive applied waste research and development (R&D) program to provide innovative environmental technologies to yield permanent disposal solutions at reduced costs; and oversees the environmental restoration of contaminated facilities from various programs, once the facilities are determined to be surplus to their original mission.

2.2.4 Science

DOE's Office of Science manages programs in high-energy physics, nuclear physics, and fusion energy sciences. It also manages fundamental research programs in basic energy sciences, biological and environmental sciences, and computational science.

2.2.5 Energy Efficiency

Energy efficiency programs strengthen the Nation's energy security, environmental quality, and economic vitality through partnerships that enhance energy efficiency and productivity and bring clean, reliable, and affordable energy technologies to the marketplace.

2.3 LAWRENCE LIVERMORE NATIONAL LABORATORY PROGRAM ORGANIZATIONS

2.3.1 Director's Office

The Director's Office leads LLNL in applying its resources in computing, engineering, science, and technology to NNSA programs to maintain the U.S. nuclear weapons stockpile and reduce the international threats posed by weapons of mass destruction. The Director's Office comprises the Office of the Deputy Director for Operations, the Office of the Deputy Director for Science and Technology, and the Laboratory Executive Officer.

2.3.1.1 *Deputy Director for Operations*

Working with the institutional support organizations, the Deputy Director for Operations is responsible for all operational functions of LLNL and policies and programs to support LLNL's mission and workforce and for promoting excellence in business practices, safety assurances, and facility management in compliance with regulatory and contractual requirements.

2.3.1.2 *Deputy Director for Science and Technology*

The Deputy Director for Science and Technology is responsible for overseeing the quality of science and technology in scientific and technical program disciplines. This includes management of the Laboratory Directed Research and Development Program; the University Relations Program Office; the DoD Programs Office; and the Office of Planning, Policy, and Special Studies.

2.3.2 Defense and Nuclear Technologies

Defense and Nuclear Technologies ensures the safety, reliability, and security of the U.S. nuclear stockpile without nuclear testing; develops advanced manufacturing and materials technologies to maintain the enduring stockpile; and assures the DOE complex of the safe dismantlement of retired weapons. Multidisciplinary teams apply expertise towards the development of technologies that reduce the Nation’s vulnerability to terrorist nuclear threats, enhance the conventional defense, and support other national needs (LLNL 2002a). Defense and Nuclear Technologies comprises the AX-Division, B-Division, the Nuclear Materials Technology Program, and the Weaponization Program.

2.3.2.1 *AX-Division*

The AX-Division ensures national and global security by maintaining scientific and technical competence and leadership, in the absence of nuclear testing, in all aspects of thermonuclear weapons physics, design, and operation. This involves applying theoretical, computational, and experimental physics to a wide range of problems relevant to national defense and security. Efforts focus on astrophysics, atomic and nuclear physics, computational physics, fluid dynamics and turbulence, high-energy density physics, radiation transfer, and particle transport.

2.3.2.2 *B-Division*

The B-Division integrates experimental and theoretical expertise in high explosive properties and materials science through the use of hydrodynamic testing. Extensive use will be made of the NIF when it becomes operational.

2.3.2.3 *Nuclear Materials Technology Program*

The Nuclear Materials Technology Program provides the overall management and strategic coordination for all LLNL special nuclear material and tritium program elements as well as Superblock facility operations (NMTP 1999).

2.3.2.4 *Weaponization Program*

The Weaponization Program provides support for certification and life prediction, the Stockpile Life Extension Program, and information systems. This is accomplished by providing high quality data and assessment in addition to implementing improved tools and predictive technologies to identify stockpile issues. The objective of the Weaponization Program is to support continued confidence in the safety, performance, and reliability of LLNL’s weapon systems in the U.S. nuclear stockpile.

2.3.3 National Ignition Facility Programs

The NIF Programs support NNSA's Stockpile Stewardship Program mission of ensuring that the Nation's nuclear weapons remain safe, secure, and reliable. The NIF experiments will access high-energy density and fusion regimes with direct applications to stockpile stewardship, energy research, science, and astrophysics (LLNL 2001w). The NIF Programs are comprised of the NIF Project, the Laser Science and Technology Program, and the Inertial Confinement Fusion (ICF) Program.

2.3.3.1 *National Ignition Facility Project*

The NIF is a key component of NNSA's Stockpile Stewardship Program. On the NIF, up to 192 laser beams will compress small fusion targets to conditions where they will ignite and burn, allowing the study of physical processes at temperatures approaching 100 million degrees Celsius and 100 billion times atmospheric pressure. These conditions exist in the interior of stars and in nuclear weapons explosions. The experiments will help scientists sustain confidence in the nuclear weapon stockpile without nuclear tests as a unique element of NNSA's Stockpile Stewardship Program and will produce additional benefits in basic science and fusion energy.

2.3.3.2 *Laser Science and Technology Program*

The Laser Science and Technology Program provides advanced solid state laser and optics technologies to LLNL, government, and industry to support national needs. The primary activities of the Laser Science and Technology Program in recent years have been to complete laser technology development and laser component testing for the NIF project, develop advanced solid state laser systems and optical components for DoD and DOE, and address the needs of other government agencies and U.S. industry.

2.3.3.3 *Inertial Confinement Fusion Program*

The ICF Program advances research and technology development in areas of fusion target theory and design, target fabrication, target experiments, and laser and optical science and technology. The mission of the ICF Program is to execute high-energy density physics experiments for the Stockpile Stewardship Program in order to demonstrate controlled thermonuclear fusion in the laboratory. Technical capabilities provided by the ICF Program also contribute to other DOE missions, including nuclear weapons effects testing and developing inertial fusion power.

2.3.4 Nonproliferation, Arms Control, and International Security

Nonproliferation, Arms Control, and International Security provides technology, analysis, and expertise to aid the U.S. Government in preventing the spread of weapons of mass destruction and in defending the U.S. against the use of such weapons. The major programs include Proliferation Prevention and Arms Control, Proliferation Detection and Defense Systems, Counter-terrorism and Incident Response, International Assessments, and Center for Global Security Research.

2.3.4.1 *Proliferation Prevention and Arms Control Program*

This program focuses primarily on integrating treaty-monitoring technology R&D with policy analysis to support U.S.' arms control efforts. Major program areas are supporting arms control, monitoring worldwide nuclear explosions, protecting and controlling nuclear materials, disposing of fissile material, and collaborating with former Soviet Union weapons scientists.

2.3.4.2 *Proliferation Detection and Defense Systems Program*

The Proliferation Detection and Defense Systems Program concentrates on proliferation detection and reversal by integrating LLNL capabilities in weapons design to identify signatures of proliferation-related activities and to develop remote and onsite monitoring technologies to detect those signatures. Major program areas are counterproliferation analysis, proliferation detection systems, tactical systems, and missile and nuclear technology.

2.3.4.3 *Counter-terrorism and Incident Response Program*

This program focuses on the response phase, including responding to incidents involving weapons of mass destruction. LLNL develops technologies and capabilities to deal with weapons of mass destruction emergencies or terrorist incidents. This program also serves as the focus for local, national, and international emergency response to weapons of mass destruction incidents. Major program areas are nuclear threat assessment, nuclear incident response, chemical and biological detection technologies, and forensic science.

The Forensic Science Center focuses on chemical, nuclear, and explosives counter-terrorism. The center provides chemical and analytical science and support to the Nonproliferation, Arms Control, and International Security, as well as to other LLNL and national sponsors.

The multidisciplinary staff provides expertise in organic and inorganic analytical chemistry, nuclear science, biochemistry, and genetics, useful for supporting law enforcement and verifying compliance with international treaties and agreements.

2.3.4.4 *International Assessments Program*

The International Assessments Program addresses the need to avoid surprise regarding the weapons programs of foreign countries. LLNL conducts analyses and research related to the development and deployment of weapons of mass destruction by countries, states, and groups hostile to the U.S. These assessments provide important input to policy makers and diplomats as they develop strategies for U.S. responses to events affecting national and international security. Major program areas are nuclear weapons states, export control, emerging threats, counterintelligence, and proliferation concerns around the world.

2.3.4.5 *Center for Global Security Research*

The Center for Global Security Research brings scientists and technologists together with analysts and others from the policy community to study ways in which technology can enhance national and international security. This program supports independent, multidisciplinary research that considers the integration of technology in defense, arms control, nonproliferation, and peacekeeping. Major program areas are reduction in the threats associated with weapons of mass destruction, security implications of emerging technologies, anticipation and management of threats to international security, and future roles of deterrence and military force.

2.3.5 Homeland Security Organization

LLNL announced the formation of the Homeland Security Organization on December 10, 2002 (LLNL 2002u). The Homeland Security Organization will be the center for LLNL interactions with the Federal Government's Department of Homeland Security. Initially, this organization will be responsible for those LLNL activities explicitly transferred from NNSA to this new organization. Homeland security at LLNL is divided into six programs: Chemical and Biological Countermeasures, Nuclear and Radiological Countermeasures, Systems Analysis and Studies, Information Analysis and Infrastructure Protection, Border and Transportation Security, and Emergency Preparedness and Response.

2.3.5.1 *Chemical and Biological Countermeasures Program*

This program focuses on addressing the national needs for technologies to quickly detect, identify, and mitigate the use of chemical and biological threat agents against the U.S. civilian population. The principal program is the Chemical and Biological National Security Program, within which are several notable projects, including the Biological Aerosol Sentry and Information System Project, Autonomous Pathogen Detection System, Advanced Biodetection Technology, Biological Signatures, the Forensic Science Center, in situ Chemical Sensors, and Remote Chemical Sensing.

2.3.5.2 *Nuclear and Radiological Countermeasures Program*

The Nuclear and Radiological Countermeasures Program develops technical capabilities aimed at countering the threat of terrorist use of a nuclear or radiological device in or near a U.S. population center, or from detecting and tracking nuclear material to forensic attribution in the event of a nuclear incident. Projects include nuclear emergency response, cargo container security, radiation detection, and detection and tracking systems.

2.3.5.3 *Systems Analysis and Studies Program*

This program focuses on identifying and understanding gaps in U.S. preparedness and response capabilities and the associated opportunities for technology. Systems studies are conducted to evaluate the effectiveness of alternative approaches to mitigating the damage and disruption resulting from a full range of catastrophic terrorist threats. Elements of this program include homeland security analysis, vulnerability assessment of the U.S. energy infrastructure, and outreach to operation entities.

2.3.5.4 *Information Analysis and Infrastructure Protection Program*

This program is aimed at developing tools and capabilities for gathering, manipulating, and mining vast quantities of data and information for the purpose of detecting early warnings of terrorist intentions. This program consists of the Computer Incident Advisory Center, operated as

DOE's cyber alert and warning center; the Information Operations and Assurance Center; International Assessments; and Nuclear Threat Assessment.

2.3.5.5 *Border and Transportation Security Program*

Activities in this area address opportunities for technology to enhance U.S. border and transportation security, from nuclear detection systems for maritime and air cargo and automated facial screening of airline passengers, to integrated data management systems for immigration and border control. Projects supporting this program include concrete-penetrating radar, baggage-screening technologies, and truck-stopping devices.

2.3.5.6 *Emergency Preparedness and Response Program*

This program focuses on the development of technical capabilities for minimizing the damage and recovering from any terrorist attacks. This program works with local, regional, state, and Federal first responders to ensure that the tools developed meet real-world needs. This program includes the National Atmospheric Release Advisory Center, a leader in real-time assessment of the atmospheric dispersion of radionuclides and chemical and biological agents; Joint Conflict and Tactical Simulation; and the Homeland Operational Planning System, developed in partnership with the California National Guard, for homeland security and analysis.

2.3.6 Energy and Environment

Energy and Environment performs research in water and environment, energy technology, carbon management and climate change, the national nuclear waste repository, and aspects of homeland and national security. Energy and Environment also provides discipline support in atmospheric, earth, environmental, and energy science to other LLNL programs. The six programs in Energy and Environment are described below.

2.3.6.1 *Carbon Management and Climate Change Program*

The Carbon Management and Climate Change Program includes research in the areas of climate science, the carbon cycle, carbon management, and the interrelationships between the fate and effects of carbon in the biosphere, atmosphere, ocean systems, and climate change. Research areas include the DOE Program for Climate Model Diagnosis and Intercomparison; DOE's Atmospheric Radiation Measurement Program; programs in atmospheric chemistry; climate research, especially involving the coupling of models to carbon and the increase in model resolution; and carbon management, including research into ocean carbon sequestration, geologic sequestration, and carbon monitoring.

2.3.6.2 *Energy Technology and Security Program*

The Energy Technology and Security Program conducts R&D in fossil, renewable, and nuclear energy technologies to increase the efficiency of existing energy technologies while minimizing environmental impact and developing environmentally responsible technologies.

One project is DOE's Highly Enriched Uranium (HEU) Transparency Implementation Program, which monitors the down-blending of HEU from Russian nuclear weapons to low enriched uranium that is sold to the U.S. Examples of other projects include developing solid oxide fuel cells, reducing aerodynamic drag of heavy vehicles, researching Homogeneous Charge Compression Ignition engines, and researching the cryogenic storage of hydrogen.

2.3.6.3 *National Security Support Program*

This program supports LLNL's mission through research, development, and engineering as it relates to homeland security, weapons programs, stockpile stewardship, nonproliferation, international assessment, and defense-oriented program areas. This program identifies, coordinates, and applies science and technology in the areas of earth, atmospheric, and environmental monitoring; risk assessment; data fusion; energy propagation in complex materials; earth system modeling and simulation; and energy technologies.

2.3.6.4 *Risk and Response Management Program*

This program includes research and technology development in systems safety, systems security, natural and anthropogenic hazards, and atmospheric release assessment and modeling. This program includes Atmospheric Release Assessment Programs for predicting and assessing the dispersal of hazardous material released into the atmosphere, which also encompasses the National Atmospheric Release Advisory Center; Security and Protection Programs to enhance human vigilance, decisionmaking, and control through automation; and Risk and Safety Management, which includes performing risk and hazard assessments, evaluating packaging and transportation safety, and providing regulatory support to government agencies.

2.3.6.5 *Water and Environment Program*

This program covers R&D in water security, environmental fate and transport, environmental technologies, and environmental consequence analysis. This program includes work performed by the Center for Accelerator Mass Spectrometry; the Marshall Islands Dose Assessment and Radioecology Program, at atolls in the Pacific Ocean contaminated with nuclear fallout from earlier weapons testing; water security projects to protect the Nation's water supplies and distribution systems; projects for protection from global environmental threats; and projects addressing issues of the fate, transport, and consequences of these threats in the environment.

2.3.6.6 *Yucca Mountain Program and Repository Science Program*

This program includes materials testing and performance modeling of the storage canister and system of engineered barriers to surround radioactive waste and supports project milestones toward the repository's license application. This program also includes work on international repository initiatives.

2.3.7 Biology and Biotechnology Research Program

The Biology and Biotechnology Research Program conducts basic and applied research in the health and life sciences supporting of national needs to understand causes and mechanisms of ill health, develop biodefense capabilities for national homeland security, improve disease prevention, and lower health care costs. This program focuses on the following five scientific areas (LLNL 2002an):

- **Biodefense—**Provides the underpinning science and tools needed to combat bioterrorism and infectious disease

- **Computational and Systems Biology—**Develops a predictive, systems level understanding of biological processes by applying advanced simulation capabilities to complex experimental data

- **Genome Biology—**Increases understanding of genetic structure, function, regulation, and evolution through genome scale approaches to developing, interpreting, and displaying genetic data

- **Health Effects Genetics—**Increases understanding of the cellular and tissue effects of radiation chemical exposures through novel genomic- and biochemical-based approaches and links this understanding to risk assessments, diagnosis, and treatment

- **Molecular Biophysics—**Develops and applies tools for measuring biochemical and cellular components and processes, emphasizing data that support predictive understanding through complex simulation and modeling

2.3.8 Physics and Advanced Technologies

Physics and Advanced Technologies' (PAT's) focus areas include high-energy density physics, astrophysics, condensed matter physics, and nuclear particle and accelerator physics. Program focus areas also include fusion energy, medical technology, imaging and advanced detectors (LLNL 2002bh). The major facilities supporting experimental research include the Ultra-Short Pulse Laser Facility, a two-stage light-gas gun facility, 100-million-electron volt electron-positron linear accelerator, the Electron Beam Ion Trap Facility, and the Experimental Test Accelerator II Facility. To carry out its mission, the PAT comprises Physical Data Research, Laboratory Directed Research and Development Program, and License- and Royalty-Funded Research and Development.

2.3.8.1 *Physical Data Research Program*

The Physical Data Research Program provides validated physical data and models for the Stockpile Stewardship Program in the areas of nuclear physics, atomic physics, condensed matter/materials science, plasma physics, and the interaction of radiation with matter.

2.3.8.2 *Laboratory Directed Research and Development Program*

The Laboratory Directed Research and Development Program provides a suitable method for LLNL directors to fund projects that are creative and innovative, but that might not otherwise receive funding via the usual process. Program activities are governed by DOE O 413.2a and other NNSA Headquarters and NNSA Livermore Site guidance. Recently, responsibility for this program has been transferred to the Laboratory Science and Technology Office.

2.3.8.3 *License- and Royalty-Funded Research and Development Program*

The License- and Royalty-Funded Research and Development Program provides private funding for R&D through cooperative R&D agreements and licensing technologies developed by LLNL. Cooperative research and development agreement is an agreement between the University of California, as operator of LLNL, and one or more participants including at least one non-Federal party under which LLNL provides personnel, services facilities, equipment, or other resources towards the conduct of specified R&D.

2.3.9 Chemistry and Materials Science

Chemistry and Materials Science provides scientific and technical expertise supporting LLNL's programs, performs work for others under reimbursable contracts, and conducts original research. R&D activities include chemical analysis and characterization, advanced materials, metallurgical science and technology, surfaces and interfaces, energetic materials and chemical synthesis, and energy-related projects. Chemistry and Materials Science contains three divisions: Chemical Biology and Nuclear Science Division, Chemistry and Chemical Engineering Division, and Materials Science and Technology Division.

2.3.9.1 *Chemical Biology and Nuclear Science Division*

The Chemical Biology and Nuclear Science Division performs applied research in radiochemistry, radiation detection and spectroscopy, mass spectrometry, biochemistry, and analytical chemistry to support LLNL programs. This division also conducts fundamental research in several areas including computational biology, deoxyribonucleic acid (DNA) detection and single cell proteomics, heavy element research, noncovalent interactions among biomolecules, transport of actinide colloidal complexes in groundwater, cycling of iodine in the environment, isotopically enhanced molecular targeting, and nanophotonics.

2.3.9.2 *Chemistry and Chemical Engineering Division*

The Chemistry and Chemical Engineering Division conducts fundamental and applied research in chemistry under extreme conditions and on energetic materials and provides chemical engineering in support of national security programs. This division also provides chemistry and chemical engineering support to LLNL programs, including optics development for the NIF, high explosives and energetic materials development for the Stockpile Stewardship Program, and foreign threat assessments and capabilities for development of weapons of mass destruction.

2.3.9.3 *Materials Science and Technology Division*

The Materials Science and Technology Division conducts fundamental and applied research with a focus on materials properties and performance under extreme conditions. The division also provides metallurgy, ceramics, electrochemical processing, materials science, material characterization, surface science, solid state chemistry, and materials theory and modeling support to LLNL programs.

2.3.10 Engineering

Engineering contains two distinct disciplines: Electronics Engineering and Mechanical Engineering. Engineering also operates five technology centers.

2.3.10.1 *Electronics Engineering*

Electronics Engineering is responsible for the design and development of the core technologies needed for the development of microtechnologies, laser systems and electro-optics, pulsed-power electronics, diagnostic instrumentation, and advanced computational modeling and simulation. Electronics Engineering also provides instrumentation services, electronics fabrication, design drafting and documentation, computer systems support, and communications systems.

2.3.10.2 *Mechanical Engineering*

Mechanical Engineering provides a wide range of design, analysis, fabrication, and testing services to support LLNL programs. This group tests and evaluates engineering materials, designs and develops new experimental hardware and machine tools, fabricates parts, and inspects and assembles mechanical components.

2.3.10.3 *Engineering Technology Centers*

Engineering's five technology centers explore future innovations in computational engineering, microtechnology, precision engineering, nondestructive characterization, and complex distributed systems. The centers are responsible for the viability and growth of the core technologies each represents, including designing and building complex instruments and machines ready for production, designing and helping construct most of LLNL's unique test facilities, and conducting research in advanced, broad application technologies for application across all LLNL programs (LLNL 2003g).

2.3.11 Computation

Computation provides integrated computing and information environments, scientific visualization facilities, high-performance storage systems, multi-resolution data analysis, scalable numerical algorithms, computer applications, and information management systems in support of LLNL missions and programs. Directorate missions include providing a balanced, seamless, high-performance computing environment that scales from desktop to petaflop; design, development, and delivery of integrated information systems and multidisciplinary applications; and development and implementation of software technologies to optimize software development and maintenance (LLNL 2003h). Computation is a key partner in the execution of the Advanced Simulation and Computing Initiative (ASCI). To carry out its mission, Computation is organized into three groups.

2.3.11.1 *Integrated Computing and Communications*

The Integrated Computing and Communications group provides computing and networking environments to support stockpile stewardship computational efforts and a variety of other programs at LLNL. This group also undertakes essential computational, communication, and computer security research required to sustain this computing environment. Divisions in this group include High Performance Systems, Science and Development, Computer Systems Support, and Networks and Services.

2.3.11.2 *Computing Applications and Research Department*

The Computing Applications and Research Department partners with other LLNL programs to develop software technologies and application codes in support of NNSA's mission in the defense, energy, and life sciences. This organization also conducts collaborative R&D in computer science, mathematics, and scientific computing focused on the long-term needs of LLNL and NNSA programs.

2.3.11.3 *Chief Information Officer*

The Chief Information Officer for the Computation Directorate provides oversight for information technology at LLNL. Of chief concern are maximizing common information technology solutions for economy of scale and uniformity of purpose, providing information technology solutions, and interacting with DOE, NNSA, and the U.S. Office of Management and Budget on regulatory issues in security, information architecture, and government initiatives.

2.4 LAWRENCE LIVERMORE NATIONAL LABORATORY INSTITUTIONAL SUPPORT ORGANIZATIONS

2.4.1 Administration and Human Resources

Administration and Human Resources is responsible for executing the policies affecting LLNL personnel and administrative support functions. The mission is to promote initiatives that develop and retain a high-quality workforce and create an environment that enhances LLNL's performance. The Directorate includes: Human Resources; Office of Strategic Initiatives and Diversity; Financial/Facility Manager; Information Technology and Projects Office; Staffing and Employment Development; Compensation, Benefits and Worklife Programs; Office of Laboratory Counsel; Public Affairs; Audit and Oversight; Office of Contract Management; and Industrial Partnerships and Commercialization.

2.4.2 Laboratory Services

Laboratory Services manages a major segment of LLNL infrastructure and provides services in the areas of administrative information systems, plant engineering, procurement and material, innovative business and information services, utilities, and telecommunications systems.

2.4.3 Safeguards and Security Organization

The Safeguards and Security Organization is responsible for protective force operations; information and personnel security, including clearances, badging, and information and security awareness; physical security systems, alarm design, installation, and maintenance; and program planning for policy, risk management, audits and inspections, order compliance, and contract performance.

2.4.4 Safety and Environmental Protection

The Safety and Environmental Protection supports LLNL programs and employees by providing resources and services to meet its objectives of environmental protection, occupational health, employee safety, emergency response, and quality assurance. Safety and Environmental Protection is divided into three departments to manage operational activities: the Environmental Protection Department, Hazards Control Department, and Health Services Department.

2.4.4.1 *Environmental Protection Department*

The Environmental Protection Department is responsible for environmental restoration, environmental monitoring, environmental regulatory compliance, and hazardous waste management.

2.4.4.2 *Hazards Control Department*

The Hazards Control Department is responsible for minimizing the risks associated with research and support activities at LLNL. This includes biological, chemical, and physical agents and radioactive and industrial hazards associated with both normal operating conditions and emergencies.

2.4.4.3 *Health Services Department*

The Health Services Department provides LLNL personnel with onsite medical treatment for urgent drop-in services, personal counseling, health risk evaluations, medical surveillance, and library services, to help each employee achieve personal health.

2.5 LAWRENCE LIVERMORE NATIONAL LABORATORY FACILITIES AND INFRASTRUCTURE

2.5.1 Existing Lawrence Livermore National Laboratory Facilities

Table 2.5.1–1 provides physical attributes of the facilities, such as gross square footage and usage, for distinguishing primary buildings. Figure 2.5.1–1 shows the major buildings and facilities at the Livermore Site. Table 2.5.1–2 provides an overview of selected facilities at Site 300.

Since 1992, a number of the LLNL facilities described in the 1992 LLNL EIS/EIR (LLNL 1992a) have changed in status. They have either been demolished, renumbered, excessed, returned to vendor, or subjected to some other status change. Figure 2.5.1–2 identifies facility changes since the 1992 LLNL EIS/EIR for the Livermore Site and Site 300, respectively (see Appendix A for a more detailed description of LLNL facilities).

2.5.2 Infrastructure

In addition to the facilities described above, LLNL operations at the Livermore Site and Site 300 are supported by a facility infrastructure that includes drainage, parking, pathways, telephones, lighting, landscaping, roads, and utilities.

TABLE 2.5.1–1.—*Overview of Major Buildings and Facilities at the Livermore Site*

Number	Facility Name	Gross ft^2	Office	Laboratory/ Research	Service/ Support	Storage	Other	Hazards		
								Chemical	**Radiological**	**Other** [a]
121	Physics and Advanced Technologies	91,145	Yes	Yes	Yes			Yes		Yes
131	Engineering	287,192	Yes	Yes	Yes	Yes		Yes	Yes	
132N	DPRF	204,559	Yes	Yes	Yes	Yes		Yes	Yes	Yes
132S	NAI/Physics	168,715	Yes	Yes	Yes	Yes		Yes	Yes	
134	Storage (part of B132S Complex)	1,284				Yes				
135	Storage (part of B132S Complex)	1,338			Yes	Yes				
141	Electronics Shop	50,927	Yes	Yes	Yes	Yes		Yes		Yes
151	Isotope Sciences Facility (Part of B151 Complex)	87,963	Yes	Yes	Yes	Yes		Yes	Yes	Yes
152	Generator House (Part of B151 Complex)	751			Yes	Yes		Yes	Yes	
153	Microfabrication Laboratory	24,967	Yes	Yes	Yes	Yes		Yes	Yes	
154	BioSecurity and Nanosciences Laboratory (part of B151 Complex)	9,504	Yes	Yes	Yes			Yes	Yes	Yes
155	Isotope Sciences Facility (Part of B151 Complex)	22,000	Yes							
161	Physics and Advanced Technologies	6,119		Yes	Yes			Yes		Yes
162	Research/Crystal Growth	19,840	Yes	Yes				Yes	Yes	Yes
165	Optics/ Development Lab	8,347	Yes	Yes				Yes	Yes	Yes
166	Development Lab	10,864		Yes	Yes	Yes		Yes	Yes	Yes
171	Development Lab	8,632		Yes		Yes		Yes	Yes	Yes
173	Welding Shop	413			Yes					Yes
174	Laser Target Research	19,360	Yes	Yes				Yes	Yes	Yes
174A	Laser Target Research	20,365		Yes				Yes	Yes	Yes
176	Shipping/Receiving	3,958	Yes		Yes	Yes		Yes		Yes

TABLE 2.5.1–1.—*Overview of Major Buildings and Facilities at the Livermore Site (continued)*

Number	Facility Name	Gross ft^2	Office	Laboratory/ Research	Service/ Support	Storage	Other	Hazards		
								Chemical	Radiological	Other [a]
179	Development Lab.	2,720		Yes				Yes		Yes
190	CAMS Facility	10,086		Yes				Yes	Yes	Yes
191	High Explosives Application Facility	120,116	Yes	Yes	Yes	Yes		Yes	Yes	Yes
194	100-MeV Accelerator LINAC Facility	42,031	Yes	Yes	Yes			Yes	Yes	Yes
197	Development Lab.	10,500		Yes	Yes			Yes		Yes
198	Physics	966		Yes		Yes		Yes		Yes
231	Development and Assembly: Engineering	131,454	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
231V	Materials Management Vault	5,426			Yes			Yes	Yes	
232	Fenced Area for Materials Management	1,200		Yes				Yes	Yes	
233	Materials Management	4,900	Yes		Yes	Yes		Yes	Yes	
235	WMRDF	88,475	Yes	Yes	Yes	Yes		Yes	Yes	Yes
239	Radiography Facility	12,517	Yes	Yes	Yes			Yes	Yes	
241	Material Science	53,935	Yes	Yes	Yes	Yes		Yes	Yes	Yes
243	Energy and Environment Research Facility	17,884	Yes	Yes	Yes	Yes		Yes	Yes	
251	Heavy Element Facility	31,809	Yes	Yes	Yes	Yes		Yes	Yes	
253	HC Department	32,276	Yes	Yes	Yes			Yes	Yes	Yes
254	Bioassay Lab	2,465		Yes				Yes	Yes	
255	Calibration Facility	21,813	Yes	Yes	Yes			Yes	Yes	Yes
261	Office	41,221	Yes	Yes	Yes	Yes		Yes		
262	Development Lab	11,976		Yes		Yes		Yes	Yes	
271	Protective Force Office	17,278	Yes			Yes				Yes

TABLE 2.5.1–1.—*Overview of Major Buildings and Facilities at the Livermore Site (continued)*

Number	Facility Name	Gross ft^2	Office	Laboratory/ Research	Service/ Support	Storage	Other	Hazards		
								Chemical	Radiological	Other [a]
272	Electro-Opt. Devel. Lab.	9,978	Yes	Yes		Yes		Yes		Yes
280 Dome	RHWM Waste TSDF	5,343		Yes		Yes		Yes	Yes	
281	HEA Labs	18,549	Yes	Yes	Yes			Yes	Yes	Yes
298	Fusion Target Fabrication	47,780	Yes	Yes	Yes			Yes	Yes	Yes
313	Dispatch Center	4,444	Yes							Yes
321	Materials Fabrication Shop	149,489	Yes		Yes			Yes	Yes	Yes
322	Plating Shop	5,822	Yes	Yes	Yes			Yes	Yes	
322A	Plating Shop Annex	340			Yes	Yes		Yes		
323	Fire Station	18,555	Yes		Yes	Yes				Yes
327	Radiography	19,052	Yes	Yes	Yes			Yes	Yes	Yes
328	Hazards Control Fire Test	372		Yes						Yes
329	Laser Weld Shop	5,214	Yes	Yes	Yes			Yes	Yes	Yes
331	Tritium Facility	28,493	Yes	Yes	Yes	Yes		Yes	Yes	
332	Plutonium Facility	104,687	Yes	Yes	Yes	Yes		Yes	Yes	
334	HETB	8,600	Yes	Yes					Yes	
341	Physics and Advanced Technology	44,322	Yes	Yes	Yes	Yes		Yes	Yes	Yes
343	Pressure Test. (West Wing Mothballed)	25,590	Yes	Yes	Yes			Yes	Yes	Yes
361	Biological Research	67,672	Yes	Yes		Yes			Yes	
362	Biological Research	3,749	Yes	Yes		Yes			Yes	
363	Biological Research	1,584		Yes					Yes	
364	Biological Research	10,951		Yes					Yes	
365	Biological Research	8,871	Yes	Yes				Yes	Yes	Yes
366	Biological Research	2,620	Yes	Yes					Yes	
368	Biological Research	1,500		Yes						Yes

TABLE 2.5.1–1.—*Overview of Major Buildings and Facilities at the Livermore Site (continued)*

Number	Facility Name	Gross ft^2	Office	Laboratory/ Research	Service/ Support	Storage	Other	Hazards		
								Chemical	Radiological	Other [a]
376	Machine Shop	1,560	Yes		Yes					Yes
377	Biological Research	4,333	Yes	Yes		Yes			Yes	
378	Environmental Radioactivity Analysis Lab	3,840	Yes	Yes		Yes		Yes	Yes	Yes
379	Gamma Spectrometry Facility	1,500		Yes				Yes	Yes	Yes
381	Laser Facility	101,598	Yes	Yes		Yes			Yes	Yes
391	ICF Laser Facility	186,594	Yes	Yes	Yes				Yes	
392	Optics Laboratory	8,401		Yes				Yes		Yes
431	Accelerator Research Center	150,366	Yes	Yes	Yes	Yes		Yes	Yes	Yes
432	Mechanical Shop-NIF	34,747	Yes	Yes	Yes	Yes		Yes	Yes	Yes
435	Corrosion Research and NIF Support	54,768	Yes	Yes	Yes	Yes	Yes	Yes		Yes
446	YMP Experimental Facility	1,730		Yes		Yes		Yes	Yes	Yes
453	Terascale Simulation Facility	253,000	Yes	Yes			Yes	Yes		Yes
511	Crafts Shop	76,552	Yes		Yes			Yes		Yes
513	RHWM Liquid Waste TSDF	5,638		Yes	Yes	Yes		Yes	Yes	
514	RHWM Liquid Waste TSDF	4,957	Yes	Yes	Yes	Yes		Yes	Yes	
518	Gas Cylinder Dock	3,270			Yes	Yes		Yes		Yes
518A	Chem Track Facility	195				Yes		Yes		Yes
519	Shop Facility / Fuel Storage	10,206	Yes		Yes	Yes		Yes		Yes
520	Pesticide Storage	400				Yes		Yes		
531	Custodians and Gardeners Shop	12,589	Yes		Yes			Yes		
581	NIF LTAB	677,757	Yes	Yes				Yes	Yes	Yes
612	RHWM Waste TSDF	11,308		Yes	Yes	Yes		Yes	Yes	
614	RHWM Waste TSDF	1,188			Yes	Yes		Yes	Yes	

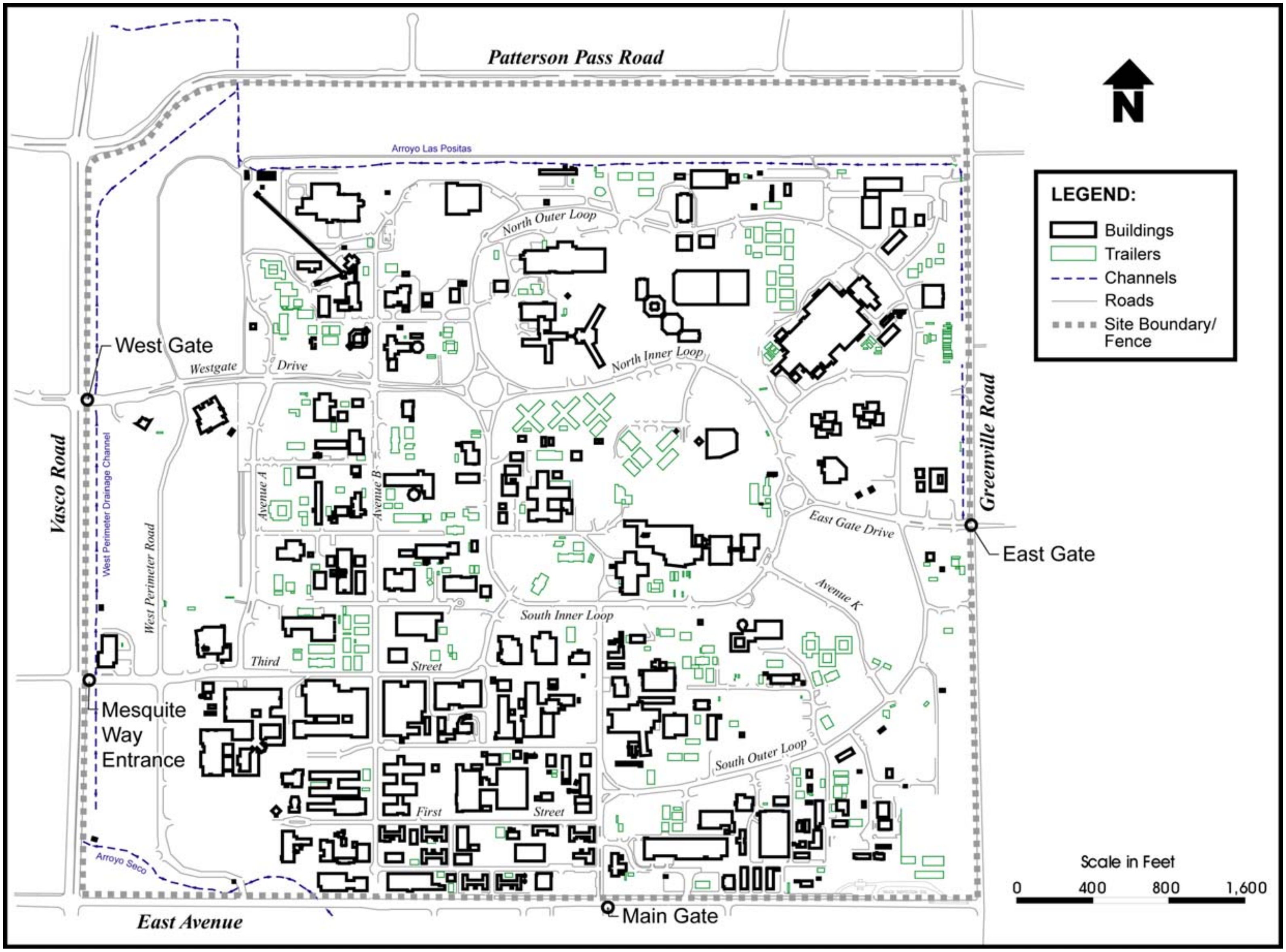
TABLE 2.5.1–1.—*Overview of Major Buildings and Facilities at the Livermore Site (continued)*

Number	Facility Name	Gross ft^2	Office	Laboratory/ Research	Service/ Support	Storage	Other	Hazards		
								Chemical	Radiological	Other [a]
621	CNG Fuel Station	824			Yes					Yes
625	RHWM Waste TSDF	4,800		Yes		Yes		Yes	Yes	
663	Health Services	24,784	Yes					Yes		Yes
681	Optics Assembly Building	46,885		Yes				Yes		Yes
693	HWM Waste Storage	9,600		Yes		Yes		Yes	Yes	
695	DWTF	33,000	Yes	Yes		Yes		Yes	Yes	
696	DWTF	10,184		Yes	Yes	Yes		Yes	Yes	
696R	RWSA	9,960				Yes			Yes	
697	EPD/RHWM Waste Storage/ Warehouse	3,780	Yes	Yes	Yes			Yes	Yes	
T1527	Bioagent Sensing and Testing Lab	3,841	Yes	Yes	Yes			Yes		Yes
T1879	Electronic Fabrication and Testing (part of 197 Complex)	11,118	Yes	Yes				Yes		Yes
T3203	Materials Fabrication (part of 321 Complex)	632			Yes			Yes	Yes	Yes
T6675	Edward Teller Education Center	3,200		Yes		Yes	Yes	Yes		Yes
NA	Container Security Testing Facility (Planned)	54,000		Yes		Yes		Yes	Yes	Yes

Source: Original.

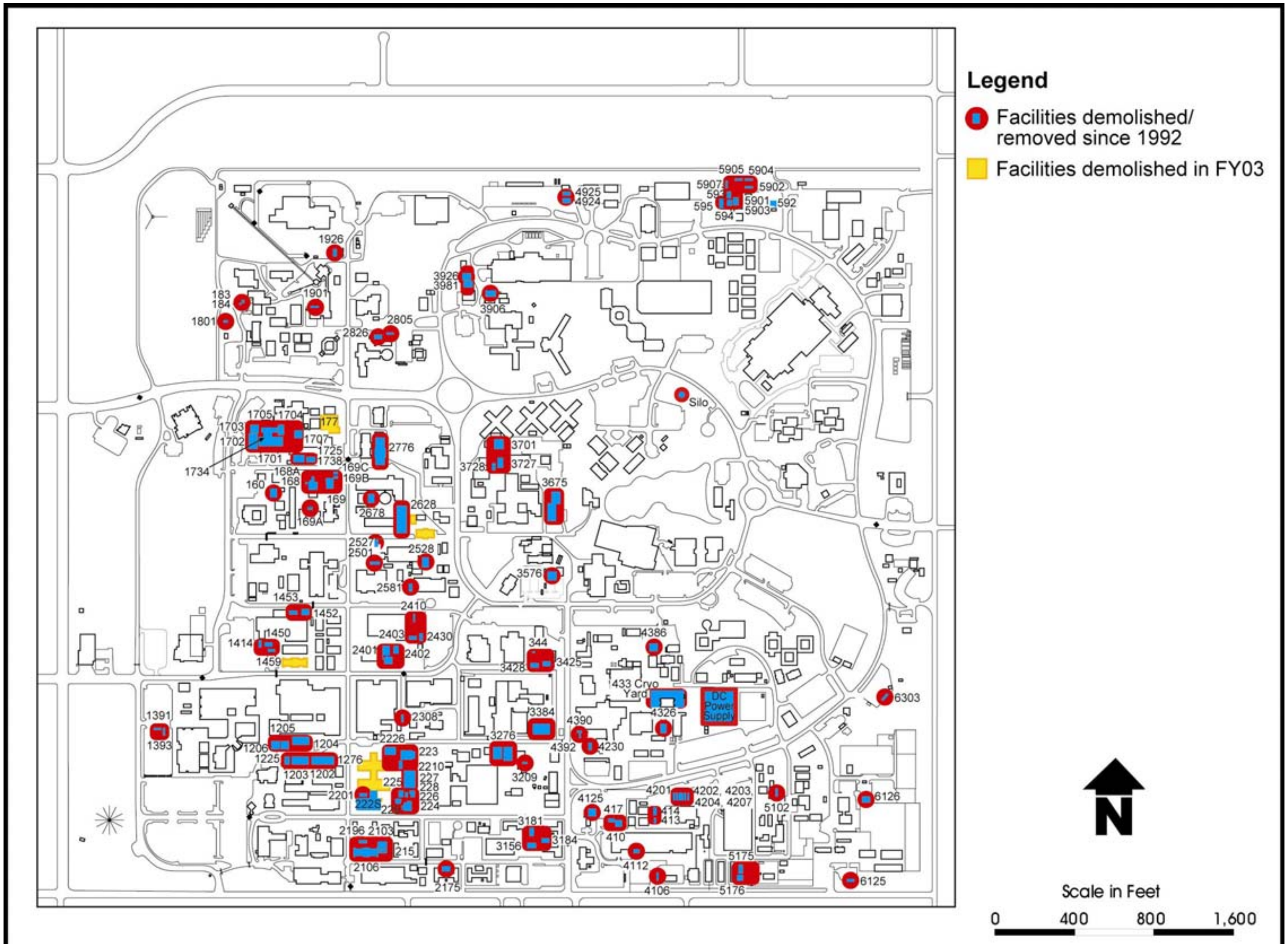
[a] Other hazards include explosives, non-ionizing radiation (accelerators, x-ray machines, lasers, etc.), biological, the storage and handling of compressed gas cylinders, and electrical hazards.

CAMS = Center of Accelerator Mass Spectrometry; CNG = compressed natural gas; DPRF = Defense Program Research Facility; DWTF = Decontamination and Waste Treatment Facility; EPD = Environmental Protection Department; ft_2 = square feet; HC = hazards control; HEA = Health and Environmental Assessment; HETB = Hardened Engineering Test Building; HWM = Hazardous Waste Management; ICF = inertial confinement fusion; LTAB = Laser and Target Area Building; LINAC = linear accelerator; MeV = million electron volts; NA = not available; NAI = Non-Proliferation, Arms Control, and International Security; NIF = National Ignition Facility; RHWM = radioactive and hazardous waste management; RWSA = Radioactive Waste Storage Area; TSDF = Treatment, Storage, and Disposal Facility; WMRDF = Weapons Materials Research and Development Facility; YMP = Yucca Mountain Project



Source: LLNL 2003o.

FIGURE 2.5.1–1.—*Livermore Site Map*



Source: DOE 2003b.

FIGURE 2.5.1–2.—*Facility Changes from the 1992 Final Environmental Impact Statement and Environmental Impact Report for Continued Operation of the Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore at the Livermore Site*

TABLE 2.5.1–2.—*Overview of Major Buildings and Facilities at Site 300*

Facility Number	Facility Name	Gross ft^2	Office	Laboratory/ Research	Service/ Support	Storage	Other	Hazard		
								Chemical	Radiological	Other[a]
801	Contained Firing Facility	51,000	Yes	Yes	Yes			Yes	Yes	Yes
804	Low Level Waste Staging Area	3,733				Yes			Yes	
805	HE Assembly/Machining	6,802	Yes		Yes			Yes		Yes
806	HE Machining	8,314	Yes		Yes	Yes		Yes		Yes
807	HE Machining	1,575			Yes			Yes		Yes
809	HE Pressing Facility	3,005	Yes		Yes	Yes		Yes	Yes	Yes
810	HE Assembly	5,079	Yes		Yes	Yes		Yes	Yes	Yes
812	Explosives Test Laboratory	5,532		Yes	Yes	Yes		Yes	Yes	Yes
816	Explosives Waste Storage Facility	1,200				Yes		Yes		
817	HE Pressing	2,739			Yes	Yes		Yes		Yes
819	Decontamination Facility	811			Yes	Yes		Yes		
821	Chemistry Storage	454				Yes		Yes		
822	Controlled Materials Storage Vault	296				Yes		Yes	Yes	
823	LINAC Radiography	2,748	Yes		Yes			Yes	Yes	Yes
825	Chem Process (Explosives Research)	1,224		Yes				Yes	Yes	Yes
826	Chem Process (Explosives Research)	1,742	Yes	Yes				Yes	Yes	Yes
827	Chemistry Process Facility	7,744	Yes	Yes	Yes	Yes		Yes	Yes	Yes
829	Energetic Materials Processing Center	40,000	Yes	Yes	Yes	Yes		Yes	Yes	Yes
832	Materials Management Shipping/Receiving Facility	10,970	Yes		Yes	Yes		Yes	Yes	Yes
834	Thermal Test Facility	8,267		Yes		Yes		Yes	Yes	
836	Dynamic Test Facility	13,288	Yes	Yes	Yes			Yes	Yes	
845	Explosives Waste Treatment Facility	666				Yes		Yes		Yes
850	Hydrodynamic Test Facility	5,840	Yes	Yes	Yes			Yes	Yes	Yes
851	Hydrodynamic Test Facility	13,681	Yes	Yes	Yes			Yes	Yes	Yes
854A, H, V	Site 300 Response Training Facility	6,142		Yes		Yes		Yes	Yes	Yes

TABLE 2.5.1–2.—*Overview of Major Buildings and Facilities at Site 300 (continued)*

Facility Number	Facility Name	Gross ft^2	Office	Laboratory/ Research	Service/ Support	Storage	Other	Hazard		
								Chemical	Radiological	Other[a]
857	Materials Management Storage Facility	440						Yes		
882	PFD Communication Center	4,912	Yes		Yes					
883	EPD/HWM Container Storage	1,733				Yes		Yes		
889	Health Services/Badging Facility	2,709	Yes		Yes					Yes
890	Fire Station	6,752	Yes		Yes					
NA	HE Rinsewater Surface Impoundment Ponds	42,000					Yes			Yes

Source: Original.

[a] Other hazards include explosives, non-ionizing radiation (accelerators, x-ray machines, lasers, etc.), biological, the storage and handling of compressed gas cylinders, and electrical hazards.

CAMS = Center of Accelerator Mass Spectrometry; CNG = compressed natural gas; DPRF = Defense Program Research Facility; DWTF = Decontamination and Waste Treatment Facility; EPD = Environmental Protection Department; ft_2 = square feet; HC = hazards control; HEA = Health and Environmental Assessment; HETB = Hardened Engineering Test Building; HWM = Hazardous Waste Management; ICF = inertial confinement fusion; LTAB = Laser and Target Area Building; LINAC = linear accelerator; MeV = million electron volts; NA = not available; NAI = Non-Proliferation, Arms Control, and International Security; NIF = National Ignition Facility; RHWM = radioactive and hazardous waste management; RWSA = Radioactive Waste Storage Area; TSDF = Treatment, Storage, and Disposal Facility; WMRDF = Weapons Materials Research and Development Facility; YMP = Yucca Mountain Project

CHAPTER 3: DESCRIPTION OF ALTERNATIVES

This chapter describes the No Action Alternative, Proposed Action, and Reduced Operation Alternative. The National Nuclear Security Administration (NNSA) has analyzed them in detail in this *Site-wide Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory and Supplemental Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (LLNL SW/SPEIS). This chapter describes the types and levels of activities for each action and presents a summary of environmental impacts.

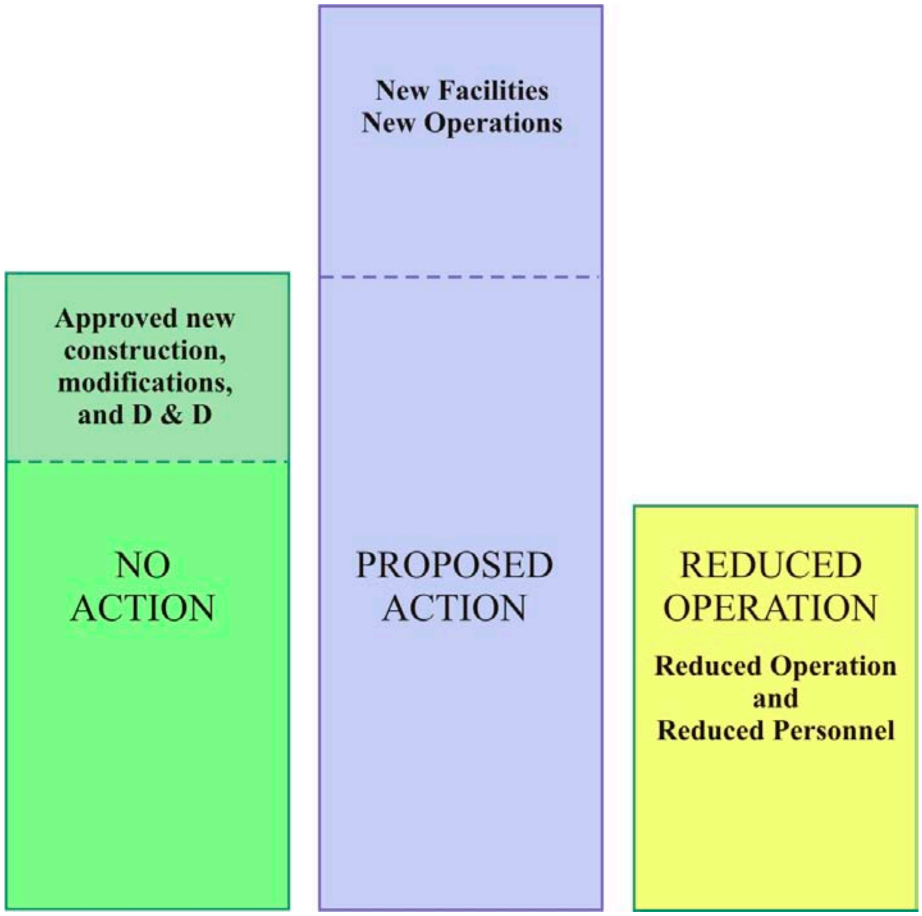
3.1 DEVELOPMENT OF ALTERNATIVES

Council on Environmental Quality (CEQ) regulations (40 *Code of Federal Regulations* [CFR] Parts 1500–1508) require Federal agencies to use the review process established by the *National Environmental Policy Act* (NEPA) of 1969, as amended (42 *United States Code* [U.S.C.] §4321 et seq.), and the U.S. Department of Energy (DOE) regulations implementing NEPA (10 CFR Part 1021) to evaluate not only the Proposed Action, but also to identify and evaluate reasonable alternatives to the Proposed Action, as well as the No Action Alternative. CEQ regulations implementing NEPA require that all reasonable alternatives be evaluated in an Environmental Impact Statement (EIS) (40 CFR §1502.14 [a]). The term "reasonable" has been interpreted by CEQ to include alternatives that are practical or feasible from a common sense, technical, and economic standpoint.

Figure 3.1–1 illustrates a qualitative comparison of the level of operation under the No Action Alternative, Proposed Action, and Reduced Operation Alternative.

NNSA's work assignments to LLNL are based on using existing personnel and facility capabilities, as described in Chapters 1 and 2 of this LLNL SW/SPEIS. To provide comprehensive baseline data from which operational levels could be projected, NNSA gathered the best available data for the current level of operation. The base year for data in most cases was 2002; however, data from previous years were used if 2002 data were unavailable or if they provided a more conservative analysis. The plans used to define the No Action Alternative, Proposed Action, and Reduced Operation Alternative include the Presidential Decision Directives and Executive Orders, Congressional legislation, Nuclear Posture Review, DOE and NNSA program plans for LLNL, the LLNL Ten-Year Comprehensive Site Plan, Work-for-Others proposals, and interagency agreements such as those between DOE/NNSA and the U.S. Department of Defense (DoD).

A range of operations have been evaluated, from the minimum level that maintains core capabilities (Reduced Operation Alternative) to the highest reasonable activity levels that could be supported by current facilities and the potential expansion and construction of new facilities for specifically identified future actions (Proposed Action). All operations assume LLNL would continue to operate as an NNSA national laboratory. However, the Reduced Operation Alternative includes an overall reduction of LLNL activities to a level that would prevent LLNL from accomplishing the currently assigned NNSA Stockpile Stewardship Program mission, as described in the following paragraphs. The No Action Alternative, Proposed Action, and Reduced Operation Alternative represent the range of operating levels that could be considered in the reasonably foreseeable future.



Source: Original.

FIGURE 3.1–1.—*Qualitative Comparison of Operations Among the No Action Alternative, Proposed Action, and Reduced Operation Alternative*

Stockpile Stewardship Program

The Stockpile Stewardship Program is divided into six campaign categories that are multiyear, multifunctional efforts involving, to varying degrees, every NNSA site in the nuclear weapons complex.

- **Science Campaigns (Primary Certification, Dynamic Materials Properties, Advanced Radiography, and Secondary Certification and Nuclear Systems Margins)—**These four campaigns develop certification methodologies and the associated capabilities and scientific understanding required to ensure the safety and reliability of aged and remanufactured weapons in the absence of nuclear testing. This technology base must be in place to carry out weapons refurbishments and other stockpile support work.

- **Engineering Campaigns (Enhanced Surety, Weapons System Engineering Certification, Nuclear Survivability, Enhanced Surveillance, and Advanced Design and Production Technologies)—**These five campaigns and engineering construction activities provide the required tools, methods, and technologies for the continued certification and long-term sustainment, via refurbishment, of the nuclear weapons stockpile. Many of the deliverables are timed to coincide with the individual Life Extension Program schedule, negotiated with DoD for these refurbishments, and in a number of instances provide capabilities lost with the cessation of underground nuclear testing.

- **Inertial Confinement Fusion Ignition and High Yield Campaign—**This campaign advances the Nation's capabilities to achieve inertial confinement fusion (ICF) ignition in laboratory experiments and addresses high-energy density physics issues required for the Stockpile Stewardship Program.

- **Advanced Simulation and Computing Campaign—**This campaign provides the simulation and modeling tools that enable the design community to assess and certify the safety, performance, and reliability of the U.S. nuclear weapons stockpile. The campaign evolved from the merging of the Advanced Simulation and Computing Initiative and the ongoing Stockpile Computing Program.

- **Pit Manufacturing and Certification Campaign—**This campaign's mission is to regenerate the nuclear weapons complex capability to produce nuclear primaries. In the near term, the campaign will focus mainly on W88 pit manufacturing and certification, while planning for a modern pit facility that is capable of reestablishing and maintaining sufficient levels of production to support requirements for the safety, reliability, and performance of all forecast U.S. requirements for nuclear weapons.

- **Readiness Campaigns** (**Stockpile Readiness, High Explosives Manufacturing and Weapon Assembly/Disassembly Readiness, Nonnuclear Readiness, and Tritium Readiness**)**—**These four campaigns are technology based efforts designed to reestablish, maintain, and enhance manufacturing and other capabilities needed for the future production of weapons components, mostly needed for the near-term Life Extension Program.

Balance of Operations

Some activities at LLNL, defined as balance-of-operations activities, are not expected to change significantly, regardless of which alternative NNSA selects for continued operations. Balance-of-operations analyses were included for each resource area, along with more detailed analyses of specific facilities, to provide the impacts from all operations. Examples of balance-of-operations activities are maintenance, fire hazard management, safety and health enhancements, asbestos management, custodial services, reconfiguration of research facilities and offices, infrastructure projects, and landscaping.

3.2 No Action Alternative

The No Action Alternative has been analyzed to comply with CEQ's NEPA implementing regulations (40 CFR Parts 1500–1508), providing a baseline against which the impacts of the Proposed Action and Reduced Operation Alternative can be compared. Under the No Action Alternative, LLNL would continue to support major DOE and NNSA programs such as defense programs, environmental management, nuclear nonproliferation, and energy research. The No Action Alternative includes approved interim actions, facility construction, facility expansion or modification, and facility decontamination and decommissioning for which NEPA analysis and documentation already exist. Therefore, the No Action Alternative includes a level of operation for LLNL greater than exists today. The major facilities and operations included in the No Action Alternative, including those that are currently under construction or planned in the near future, are described below.

3.2.1 National Ignition Facility

Conventional facilities construction of the NIF is complete. Completion of systems leading to full operations in fiscal year (FY) 2008 is in progress. In operation, the NIF would perform fusion ignition, high energy density, and radiation effects experiments in support of stewardship of the Nation's nuclear weapons stockpile and fusion energy and applied sciences objectives. The NIF is designed and constructed for a 30-year operating life. The *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (SSM PEIS) (DOE/EIS-0236) provides NEPA coverage for the construction and operation of this facility. The ROD for the SSM PEIS (61 FR 68014) announced DOE's decision to proceed with NIF construction and operations. The SSM PEIS was amended by the *Supplement Analysis for Use of Hazardous Materials in NIF Experiments* (DOE/EIS-SA236-SA2) and the *National Ignition Facility Final Supplemental Environmental Impact Statement to the Stockpile Stewardship and Management Environmental Impact Statement* (DOE/EIS-0236-S1F).

3.2.2 BioSafety Level 3 Facility

A BioSafety Level 3 (BSL-3) Facility would provide for environmentally safe and physically secure manipulation and storage of infectious micro-organisms, many of which are potential bioweapon agents.[1] NNSA's BSL-3 work at LLNL would require efficient, high-quality sample processing for scientific and security reasons. The BSL-3 Facility would be a 1,500-square-foot laboratory and office complex designed to accommodate work on detection and counter-terrorism technologies. The facility is scheduled to be constructed and become operational in FY2004. The projected life of this facility is 30 years. An environmental assessment provides NEPA coverage for the construction and operation of this facility (NNSA 2002a). A Finding of No Significant Impact, dated December 16, 2002 (NNSA 2002e), was issued for the BSL-3 Facility at LLNL.

3.2.3 Terascale Simulation Facility

The Terascale Simulation Facility is a new facility currently under construction in the center of the Livermore Site scheduled to be operational in FY2005. The 253,000-square-foot facility would accommodate parallel processing computer systems of increasing computational power within the same footprint and building space. The facility would be capable of housing the 100-Teraflops-class (trillion operations per second) computers and networks and the data and visualization capabilities necessary to perform the simulations essential to ensuring the safety and reliability of the U.S. nuclear stockpile. The projected lifetime of the building is beyond 30 years. A final environmental assessment providing NEPA coverage for this facility was issued in

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[1] BSL – 3 facilities are suitable for work with infectious agents which may cause serious or potentially lethal disease as a result of exposure by the inhalation route.

1999 (DOE 1999b), along with a Finding of No Significant Impact that was issued on October 29, 1999.

3.2.4 Superblock Stockpile Stewardship Program Operations

The LLNL Superblock has several Stockpile Stewardship Programs and operations under the No Action Alternative. These include the Shelf Life Program, Enhanced Surveillance Program, Emergency Response Program, W88 Stockpile-to-Target Sequence Testing Program, and disassembly and feed preparation demonstrations. The SSM PEIS provides NEPA coverage for these operations (DOE 1996a). The ROD for the SSM PEIS approved these operations in the LLNL Superblock (61 FR 68014). Full implementation of these projects would become constrained in the future by the existing administrative limit of 700 kilograms of fuel-grade equivalent plutonium unless a disposition pathway becomes available. NNSA is working on a long-term comprehensive solution for disposal of excess plutonium. Superblock operations would have to be modified or curtailed if a disposition pathway is not established for plutonium.

3.2.5 Container Security Testing Facility

The Container Security Testing Facility is a planned NNSA facility wherein an intermodal cargo container can be introduced, with a variety of contents, and evaluated while stationary, moving laterally, being lifted, or being stacked. Various actual or simulated threat materials that could be illicitly introduced to the U.S. for the purposes of terrorism, would be loaded in the container, along with other contents. These configurations would then be used to challenge the best available detection methods. The construction would start in FY2005. Facility lifetime is 30 years. DOE determined that this facility was categorically excluded from further NEPA review (DOE 2003a).

3.2.6 East Avenue Security Upgrade

The East Avenue security upgrade project administratively controls a portion of East Avenue between South Vasco and Greenville roads. This project would be completed in FY2004. This project provides NNSA with the ability to control access to the roadway by the general public on either a temporary or permanent basis to improve security at LLNL and Sandia National Laboratories/California. This is consistent with DOE’s overall security enhancement plan at both institutions. An environmental assessment was prepared and a Finding of No Significant Impact was issued in September 2002 (DOE 2002h) for this security upgrade.

3.2.7 Central Cafeteria Replacement

The replacement for the central cafeteria would be located near the existing Drainage Retention Basin. The 16,300-square-foot facility would accommodate food preparation and dining and can also be used as meeting rooms. Construction has started and the facility is to be operational in FY2004. The life of the facility is beyond 30 years. DOE determined that this facility was categorically excluded from further NEPA review (DOE 2002a).

3.2.8 International Security Research Facility

The International Security Research Facility is a new 64,000-square-foot, two-story building currently under construction on the west side of the Livermore Site, adjacent to and north of the Building 132 Defense Programs Research Facility. The facility would provide enhancements in information management, optical-fiber networking, storage and retrieval, and real-time communications with NNSA and the intelligence community (DOE 2001a). The International Security Research Facility would contain capabilities for handling classified information. Construction is ongoing and operation is scheduled to begin in FY2004. The projected life of the facility is beyond 30 years. DOE determined that this facility was categorically excluded from further NEPA review (DOE 2000a).

3.2.9 Waste Isolation Pilot Plant Mobile Vendor

In an effort to expedite the removal of transuranic waste from the Livermore Site, a Waste Isolation Pilot Plant (WIPP)-qualified "mobile" contractor would package and ship more than 1,000 drums of transuranic and mixed transuranic waste to WIPP. This work would be initiated in FY2004. DOE determined that this facility was categorically excluded from further NEPA review (DOE 2003k).

3.2.10 Modifications, Upgrades, and Decontamination and Decommissioning

In addition to the new construction described above, a number of facilities at LLNL would undergo modification, upgrades, or D&D. For the main Livermore Site, these would include Plutonium Facility ductwork replacement, Tritium Facility modernization, Engineering Technology Complex upgrade, modifications to the biological safety and security laboratories, roof replacement on a number of facilities, and seismic and safety upgrades on a number of facilities. Nearly 255,000 square feet of floorspace would undergo D&D. D&D facilities are listed in Appendix A, Table A.2.3–2 and A.3.3–2. In addition to these projects, three major road-related projects are planned to improve site security and movement of traffic at the Livermore Site. They are to extend Fifth Street to improve traffic circulation, Westgate Drive widening and improvements, and security upgrades.

Decontamination and Decommissioning

D&D may include deactivation, decontamination, decommissioning or demolition. Deactivation is the process of placing a facility in a stable and known condition including the removal of readily removable hazardous and radioactive materials to ensure adequate protection of the worker, public health and safety, and the environment. Decommissioning takes place after deactivation and includes surveillance and maintenance, decontamination, and/or dismantlement. Decontamination is the removal or reduction of residual radioactive and hazardous material. Demolition is the destruction and removal of facilities or systems from the construction site.

At Site 300, modifications would include wetlands enhancements, completion of the hookup to the Hetch Hetchy water supply, and modification to an existing building for emergency response training.

3.3 PROPOSED ACTION

The Proposed Action would result in an increase in LLNL operations to support reasonably foreseeable mission requirements. This includes the expansion or modification of current facilities and construction of new facilities, as well as those projects, activities, and facilities described in the No Action Alternative.

3.3.1 Use of Proposed Materials on the National Ignition Facility

In 1996, the programmatic impacts of conducting DOE/NNSA’s Stockpile Stewardship and Management Program at all NNSA sites were evaluated in the SSM PEIS. The SSM PEIS ROD documented the decision to construct and operate the NIF at LLNL. In 1997, the Natural Resources Defense Council (NRDC) and 39 other organizations brought suit against DOE in NRDC v. Peña, Civ. No. 97-936(SS) (D.D.C.), challenging the adequacy of the SSM PEIS, partially on the basis that DOE should have analyzed conducting experiments on the NIF using plutonium, other fissile materials, fissionable materials, and lithium hydride. DOE maintained that the use of these materials were not reasonably foreseeable at that time. In August 1998, the judge in the lawsuit issued a Memorandum Opinion and Order that dismissed the plaintiffs’ case. The Memorandum Opinion and Order provided in Paragraph 6 that:

> No later than January 1, 2004, DOE shall (1) determine whether any or all experiments using plutonium, other fissile materials, fissionable materials other than depleted uranium (as discussed in the Supplement Analysis for the Use of Hazardous Materials at the NIF experiments, A.R. doc. VIIA-12), lithium hydride, or a Neutron Multiplying Assembly (NEUMA), such as that described in the document entitled Nuclear Weapons Effects Test Facilitization of the National Ignition Facility (A.R. doc VII.A-4) shall be conducted at the NIF; or (2) prepare a Supplemental SSM PEIS, in accordance with DOE NEPA regulation 10 C.F.R.1021.314, analyzing the reasonably foreseeable environmental impact of such experiments. If DOE undertakes the action described in subpart (2) of this paragraph, DOE shall complete and issue the Supplemental SSM PEIS and the Record of Decision based thereon within eighteen (18) months after issuing a notice of intent to prepare the Supplemental SSM PEIS.

In November 2002, the NNSA Deputy Administrator for Defense Programs approved proposing experiments on the NIF using plutonium, other fissile materials, fissionable materials, and lithium hydride. NNSA has chosen to use the LLNL SW/SPEIS as the mechanism for complying with the court’s instruction to prepare a supplemental SSM PEIS. The inclusion of this supplemental SSM PEIS in the LLNL SW/SPEIS ensures timely analysis of these proposed experiments within the environmental impacts being evaluated for the continued operation of LLNL. In any ROD to be issued, NNSA will address decisions on the use of any or all of these materials in NIF experiments within the context of continuing LLNL operations.

3.3.2 Increased Administrative Limits for Plutonium in the Superblock

In the 1992 *Final Environmental Impact Statement and Environmental Impact Report for Continued Operations of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore* (LLNL EIS/EIR), a primary goal of LLNL was to reduce the plutonium inventory to 200 kilograms through offsite disposition of significant portions of the inventory. This goal was partially achieved by relocating approximately half of the excess material offsite; however, DOE facilities were unable to accept all materials identified to be shipped. In 1999, DOE prepared a supplement analysis that reexamined future program requirements at LLNL and identified the need to modify certain radioactive material limits established in the 1992 LLNL EIS/EIR. The 1999 supplement analysis confirmed the need for an administrative limit of 700 kilograms of plutonium to provide for continued LLNL support of the Stockpile Stewardship Program.

Administrative Limits

Administrative limits are defined as the maximum amount of the referenced material allowed at a facility. The actual inventory for some materials at LLNL for which there is an administrative limit may be classified.

NNSA continues to rely on LLNL to meet its Stockpile Stewardship Program mission objectives. These objectives include campaigns relating to pit manufacturing and certification, advanced radiography, dynamic materials testing, materials shelf life experiments, and enhanced surveillance research. These NNSA-assigned campaigns and programs require continued and increasing use of plutonium. NNSA continues to work on a solution for disposal of plutonium, but no pathway for LLNL to dispose of excess plutonium currently exists, requiring an increase in the plutonium administrative limits. Therefore, NNSA would increase the administrative limit for fuel-grade equivalent plutonium to 1,500 kilograms from the existing 700 kilograms. The limit for enriched uranium would remain unchanged at 500 kilograms.

3.3.3 Integrated Technology Project in the Plutonium Facility

Science-Based Stockpile Stewardship and Management Program (SBSSMP) experiments are needed to increase the understanding of the complex physics and behavior of materials in nuclear weapons and ultimately to certify the efficacy of the Nation's aging stockpile. Accurate, theoretical, scientific, and experimental data are required to validate the computer models of the weapon performance. SBSSMP experiments involve the use of both surrogate and actual materials that would be used in the weapon system.

The Advanced Materials Program involves the development and demonstration of the Atomic Vapor Laser Isotope Separation (AVLIS) technology. The ITP is a follow-on activity to the Advanced Materials Program to produce material to augment the current inventory of special nuclear materials (e.g., plutonium and enriched uranium) for use in SBSSMP experiments. The ITP would not proceed until the Advanced Materials Program demonstrations are complete. The expected start would be FY2008. The ITP is one of the bases for the increase in the plutonium material-at-risk limit from the current 20 kilograms in any room of the Plutonium Facility to 60 kilograms of fuel-grade equivalent plutonium in each of two rooms. This material-at-risk increase would enable LLNL to pursue multiple Stockpile Stewardship Program missions simultaneously. Details of the Advanced Materials Program and ITP are presented in Appendix N.

3.3.4 Increased Material-at-Risk Limit for the Plutonium Facility

The Proposed Action would increase the plutonium material-at-risk limit from 20 to 60 kilograms of fuel-grade equivalent plutonium in each of two rooms of the Plutonium Facility. This increase is needed to meet future Stockpile Stewardship Programs such as the ITP and the casting of plutonium parts. These activities support campaigns for advanced radiography, pit manufacturing, and certification programs. If the material-at-risk is increased, the bounding Plutonium Facility accident consequences to the population surrounding LLNL would increase from an aircraft crash resulting in 5.82×10^{-2} latent cancer fatalities (LCFs) per year under the No Action Alternative to an unfiltered fire involving 60 kilograms fuel-grade equivalent plutonium resulting in 1.68×10^{-1} LCFs per year under the Proposed Action.

Material-at-Risk

A material-at-risk limit is defined as the maximum amount of the referenced material that is involved in the process and thus at risk in the event of a postulated accident. Material locked in secure storage is not considered material at risk.

3.3.5 Increase of Tritium Facility Material Limits

The Proposed Action would increase the Building 331 Tritium Facility tritium administrative limit from 30 to 35 grams and the material-at-risk at a single workstation from 3.5 to 30 grams. These increases are needed to support future planned Stockpile Stewardship Program activities such as the high-energy density physics target fill and the Test Readiness Program. The activities support the campaign for ICF and high yield and the readiness to resume testing, if directed. Analysis in the LLNL SW/SPEIS shows that the increased material-at-risk would result in higher consequences from an aircraft crash into the Tritium Facility.

3.3.6 National Ignition Facility Neutron Spectrometer

A neutron spectrometer would be constructed and operated as part of the NIF core facility diagnostics capability. The neutron spectrometer would provide a sensitive and accurate measure of the neutrons generated in experiments. The construction would not start before FY2008 and when completed, the neutron spectrometer would become part of the NIF operational facility. The neutron spectrometer would be installed in a specially constructed concrete shaft from the target chamber to a point 52 feet below the surface. The neutron spectrometer would reside at the end of the shaft and contain solid plastic scintillation sheets layered between sheets of lead, with a total mass of approximately 20 tons.

3.3.7 High Explosives Development Center Project

The High Explosives Development Center Project would construct new buildings and renovate the current complex located in the south-central section of Site 300. The construction and renovation would be completed and the center would become operational in FY2013. The lifetime of new construction would be beyond 30 years. This project would consolidate operations currently conducted in four existing buildings. Operations and equipment would include mechanical pressing; vertical temperature-controlled mixers for mixing explosives, binders, plasticizers, and other compounds; a 50-cubic-inch deaerator loader for processing the extrudable explosives; vacuum ovens for drying materials; mills for reducing particle sizes; a loader for processing extrudable explosives; blenders and kettles for preparing explosives; an environmental chamber and associated control and interlock modules; electrical resistance measurement devices; a gas-sampling oven; and a computer system (LLNL 2002ap).

3.3.8 Energetic Materials Processing Center Replacement

Existing energetic materials processing facilities and equipment at Site 300 are becoming obsolete and inadequate to meet the requirements of LLNL programs. This project would move the operations currently conducted in the Building 805 High Explosives Assembly/Machining, Building 806 High Explosives Machine Shop, Building 807 High Explosives Machining, Buildings 810A-C High Explosives Assembly Facility, Building 813 Change House, and Building 823A-B LINAC Radiography Facility into a new, modern facility. The Building 810A-C complex would be retained for some assembly operations currently conducted and waste package operations currently conducted in Building 805. The proposed Energetic Materials Processing Center would be located at the Site 300 process area, in the vicinity of the Magazine 21-24 loop. The project would include the construction of a new 40,000-square-foot processing facility and four magazines: two capable of storing 1,000 pounds of high explosives and two capable of storing 500 pounds of explosives. The center would house explosives machining, pressing assembly, inspection, and radiography. Additionally, the facility would provide an inert machine shop, offices, inert storage, showers/changing room facilities, equipment rooms, and miscellaneous support spaces. The construction would be completed and operation begun in FY2008. The life of the new Energetic Materials Processing Center would be beyond 30 years.

3.3.9 Materials Science Modernization Project

The Materials Science Modernization Project is an upgrade of existing facilities in the southwest quadrant of the Livermore Site. A modern materials research complex would provide LLNL with infrastructure in the areas of materials fabrication, characterization, and testing, relevant to LLNL’s national security mission. The facility would be engineered to conduct precision experiments and precision fabrication of designer materials to a level not currently available. The facility construction would be completed and operation begun in FY2013. The lifetime of the facility would be beyond 30 years.

3.3.10 Chemical and Biological Nonproliferation Program Expansion

NNSA proposes to perform research and development activities to develop a variety of biodetector technologies in the Building 132S NAI/Physics Facility, and the Building 153 Microfabrication Laboratory at the Livermore Site. Two classes of detectors would require deoxyribonucleic acid (DNA) sequences or antibodies to identify and characterize biological pathogens. Planned activities would include fluid manipulation experiments using LLNL equipment for optical or flow cytometer analysis. This activity would be performed no sooner than FY2005.

Other experiments would evaluate the performance of an electrophoresis detection system for applications involving trace detection of biological warfare agents and precursors. Lasers and an ultra-violet-visible-near-infrared spectrometer would also be used in the laboratories.

3.3.11 Petawatt Laser Prototype

The proposed petawatt laser prototype would be installed and operation would begin no earlier than FY2005. The petawatt laser is a short-pulse, high-power laser that can be generated by modifying existing solid state glass laser technology developed at LLNL and other laboratories. The first petawatt laser prototype was demonstrated in the Building 391 Inertial Confinement Fusion Laser Facility and then dismantled when the NOVA laser facility was shut down. To continue this area of research, a second petawatt prototype is proposed for installation and operation in the Building 381 Laser Facility.

3.3.12 Consolidated Security Facility

The proposed Consolidated Security Facility would result in the physical consolidation of security services to improve functionality, efficiency, and effectiveness. The scope of work would include the construction of a multipurpose security structure of approximately 50,000 square feet. The facility would contain offices, vaults, conference and meeting rooms, interview rooms, shops, and specialized technical support areas. The facility would be operational in FY2012 and would operate for 30 years. The new facility would be collocated with the existing Security Department Administration Facility.

3.3.13 Waste Management

Under the Proposed Action, waste management activities would change to accommodate increased waste generation and to improve overall operational methods. These proposed changes would include modifying the permit status of existing facilities to allow different types of waste to be stored or treated; e.g., obtaining hazardous waste facility permits for areas now used for nonhazardous or radioactive waste management, and to improve operational flexibility and efficiencies; e.g., relocate permitted waste treatment units from old facilities to newer facilities. A detailed explanation of permit changes under the Proposed Action is included in Appendix B, Section B.3.

3.3.14 Building 625 Waste Storage

The amount of transuranic waste stored in the Building 625 Radiological and Hazardous Waste Storage Facility would be increased to consolidate waste from LLNL facilities planned for D&D and to accept drums from facilities prior to shipment to the Waste Isolation Pilot Plant (WIPP). The maximum curie limit under the Proposed Action would be equivalent to an array of drums where one drum contains 60 plutonium-equivalent curies and the other surrounding drums contain 12 plutonium-equivalent curies. Possible configurations of drums would be limited to those where the consequences of the bounding accident for Building 625 analyzed in Appendix D would not be exceeded.

3.3.15 Direct Shipment of Transuranic Wastes from the Superblock

NNSA is proposing to develop the capability to load transuranic waste into pipe overpacks in the Superblock, beginning in FY2005. These pipe overpacks would allow for significantly higher actinide loading into each drum for disposal at WIPP. The proposed pipe overpack would allow up to 80 plutonium-equivalent curies per drum and up to 200 fissile-gram equivalents. The pipe overpack provides a way for LLNL to dispose of waste, such as plutonium with high americium levels. The pipe overpack can be loaded and stored into Transuranic Package Transporter-II (TRUPACT-II) shipping containers, and shipped from Superblock to WIPP without increasing the nuclear material inventory or hazard levels in other LLNL facilities. The TRUPACT-II shipping containers would be loaded to the limits of the WIPP waste acceptance criteria.

3.3.16 Berkeley Waste Drums

DOE/NNSA is proposing that LLNL accept up to 14 drums of low-activity transuranic and mixed transuranic waste from the Lawrence Berkeley National Laboratory. All liquids would be solidified and corrosive mixed transuranic waste would be neutralized before shipment to LLNL. DOE would use mobile vendors to certify the waste for shipment to the WIPP. This activity would be performed no sooner than FY2005. This one-time shipment is proposed in order to remove legacy waste from the Lawrence Berkeley National Laboratory without creating a WIPP-certified packaging operation. The packaged waste would then be shipped directly to WIPP in a single TRUPACT-II container.

3.3.17 Building Utilities Upgrades

Within the next 10 years, many of LLNL's key facilities will be past their expected life, severely outdated, and code deficient. The proposed building utilities upgrade project would provide state-of-the-art technological upgrades and reduce maintenance backlog items to selected mission-critical laboratory and office buildings at the Livermore Site. Examples of technological upgrades include expanding building network capability for computing environments; rewiring facilities for high-speed networking; replacing secondary electrical distribution system components such as transformers, panelboards, wiring, lighting systems, and power conditioning equipment for sensitive computing and instrumentation equipment; and increasing capacities of mechanical systems to handle increased cooling requirements for computing and laboratory environments.

3.3.18 Building Seismic Upgrades

Executive Order 12941, *Seismic Safety of Existing Federally Owned or Leased Buildings* (59 FR 65245), requires that all federally owned and leased buildings that do not meet current seismic design and construction standards should be identified and mitigated if necessary. There were 108 buildings identified at LLNL as having potential seismic deficiencies relative to current codes. The deficiencies of these buildings have been prioritized based on a scoring approach that incorporates building vulnerability, failure consequence, and mission essential factors. This project includes designing and installing seismic upgrades needed to bring these 108 buildings into compliance with applicable seismic design and construction standards.

3.3.19 Decontamination and Decommissioning

LLNL would D&D excess facilities totaling approximately 820,000 square feet of floorspace, including approximately 255,000 square feet under the No Action Alternative. D&D facilities are listed in Appendix A, Tables A.2.3–2 and A.3.3–2. The D&D process includes performance of surveillance, maintenance, and minor facility deactivation to ensure facilities remain in stable condition pending their final disposition. Facility deactivation may include disposition of stored or surplus materials that may be potentially contaminated. These materials and equipment are designated as legacy items, meaning there is no identified sponsor or program. Most legacy materials are materials that were placed in storage or set aside for a future need that never materialized.

3.3.20 Increased Administrative Limit for Highly Enriched Uranium for Building 239

Building 239, Radiography Facility, contains equipment for performing nondestructive evaluations. Facility operations involving radiography are carried out in the basement of the building. The Proposed Action would increase the Building 239 HEU administrative limit from 25 to 50 kilograms to support Stockpile Stewardship Program activities. The use of 50 kilograms of HEU is analyzed in Appendix D and is bounded by the consequences of an accident involving the use of plutonium in Building 239.

3.4 REDUCED OPERATION ALTERNATIVE

The Reduced Operation Alternative includes reductions in LLNL operations supporting the NNSA Stockpile Stewardship Program. A commensurate reduction in scientific and institutional support is part of the analysis. The Reduced Operation Alternative maintains full operational readiness for NNSA facilities and operations listed below, but does not represent the level of operation required to fulfill the Stockpile Stewardship Program mission assigned to LLNL for the foreseeable future. However, LLNL operations would not be reduced beyond those required to maintain safety and security activities, such as maintaining nuclear materials, explosives, or other hazardous materials in storage or use.

The Reduced Operation Alternative is broadly defined as approximately a 30 percent scaledown from the Stockpile Stewardship Program operations under the No Action Alternative. This includes reduction in support activities in addition to direct program cuts. This alternative considers and analyzes reasonable proposals provided by the public for the reduction or cessation of specific operations to reduce adverse environmental impacts.

As stated in the Notice of Intent (NOI) for this LLNL SW/SPEIS (67 FR 41224), NNSA will not consider the complete closure and D&D of the Livermore Site or Site 300, as this is inconsistent with the LLNL mission as defined by NNSA. Though the Reduced Operation Alternative includes reductions in specific project areas, it maintains existing LLNL capabilities and infrastructure. This alternative would affect planned operations and activities, new facilities, and D&D of structures described in Section 3.1 under the No Action Alternative. The changes to planned operations and activities under the Reduced Operation Alternative are listed in the following sections.

3.4.1 Integrated Technology Project

The Advanced Materials Program demonstration activities would be discontinued. No laser separation of isotopes of surrogate material or plutonium would take place. The Plutonium Facility Engineering Demonstration System equipment would remain in its current status of cold standby. These changes would reduce specific environmental impacts such as transuranic waste generation and worker dose.

3.4.2 National Ignition Facility Operations Reduction

Annual yield from NIF ignition experiments would decrease by approximately 30 percent under the Reduced Operation Alternative, from 1,200 megajoules per year to 800 megajoules per year. The individual experiment yields would remain at up to 20 megajoules (45 megajoules maximum credible yield), but the total number of experiments with high yield would be reduced and the annual tritium throughput would be reduced by approximately 250 curies.

3.4.3 Reduce Number of Engineering Demonstration Units

LLNL fabricates engineering demonstration units to demonstrate the acceptability of different nuclear weapons pit technologies for several weapons systems in the U.S. stockpile. Engineering demonstration units are used to recapture the technology needed to manufacture pits of various types and to develop and demonstrate pit fabrication processes. Under the Reduced Operation Alternative, NNSA proposes to only fabricate engineering demonstration units for half of the pits under the No Action Alternative in the U.S. stockpile. These changes would reduce specific environmental impacts such as transuranic waste generation and worker dose.

3.4.4 Reduce Pit Surveillance Efforts

LLNL performs surveillance activities for pits in the active and inactive U.S. stockpiles. Pit surveillance activities include determination of important pit characteristics through destructive examination of the pits to assess suitability for safety and performance. Under the Reduced Operation Alternative, NNSA proposes to perform pit surveillance activities on LLNL-designed pits only, a reduction of 50 percent from the No Action Alternative. These changes would reduce specific environmental impacts such as transuranic waste generation and worker dose.

3.4.5 Reduce the Number of Subcritical Assemblies

LLNL fabricates subcritical assemblies for the U.S. weapons testing program. Under the Reduced Operation Alternative, NNSA would fabricate subcritical assemblies for the LLNL testing program only. This nearly 50-percent reduction in operations from the No Action Alternative would reduce specific environmental impacts such as transuranic waste generation and worker dose.

3.4.6 Terascale Simulation Facility Operations Reduction

Under the Reduced Operation Alternative, NNSA proposes to operate the Terascale Simulation Facility computer at 60 percent capacity versus 100 percent capacity under the No Action Alternative. These changes would reduce energy requirements for the facility from 25 megawatts to 15.3 megawatts, but would not meet the full Stockpile Stewardship Program mission. However, by maintaining the facility in full operational readiness in terms of hardware, software, and operations staff, the Terascale Simulation Facility could be ramped back to full capacity in a very short time. Therefore, the Reduced Operation Alternative would include no reduction in staff.

3.4.7 Reduce Number of Hydroshots at Site 300

NNSA proposes fewer detonation experiments containing tritium at Site 300 firing tables or the Building 801 Contained Firing Facility, resulting in a reduction in the maximum annual tritium emissions to 150 curies versus 200 curies under the No Action Alternative. Other types of experiments, such as environmental testing of explosives assemblies would continue unchanged from the No Action Alternative in the number of experiments and amounts of tritium. The programmatic impacts of this alternative would include less confidence in the evaluation of nuclear weapons systems.

3.5 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

DOE carefully considered public input and comments received during the scoping process in determining the range of alternatives in this LLNL SW/SPEIS. The following alternatives were evaluated as a result of scoping comments, but were eliminated from detailed analysis:

- **Shutdown of LLNL—**LLNL would be shut down, all facilities subject to D&D, restoration, and removal of hazardous and nuclear materials. The Federal Government would develop alternatives for disposition of the land.

- **Conversion of LLNL to an Academic Laboratory—**LLNL would cease its work involving nuclear materials, remove nuclear materials from the premises, and remove all waste. LLNL would use existing facilities and staff for academic research.

- **Conversion of LLNL to an Environmental Research Laboratory—**LLNL would cease its work involving nuclear materials, remove nuclear materials from the premises, and remove all waste. LLNL would use existing facilities and staff for environmental research in the areas of energy efficiency, energy security, renewable energy, environmental remediation, and clean coal.

None of these alternatives would meet the statement from the President (White House 1995a); Public Law 103-160, the *National Defense Authorization Act* of 1994; Presidential Decision Directives; U.S. compliance with treaties; as well as Congressional guidance and national security policy, all of which require the continued viability of all three NNSA weapons laboratories (Los Alamos National Laboratory, Sandia National Laboratories, and LLNL). LLNL's continued operations fulfill national security requirements for stockpile stewardship, and it is not economically feasible to reassign certain LLNL activities to other NNSA laboratories. LLNL's activities in the area of weapons research are assigned by NNSA and it is up to LLNL to meet the requirements of the Stockpile Stewardship Program mission. Public Law 106-65, the *National Defense Authorization Act* of 2000, assigned to NNSA and subsequently to the national laboratories, a charter:

> …to conduct basic and applied research that enhances United States national security and reduces the global danger from the proliferation of weapons of mass destruction and special nuclear materials through needs-driven research and development. The emphasis is on developing the requisite technologies to detect and deter nuclear proliferation, to meet United States nuclear explosion monitoring goals, and to develop and demonstrate chemical and biological

detection and related technologies to enable the United States to better prepare for and respond to domestic chemical and biological attacks.

3.6 Comparison of Impacts of Alternatives

A comparison of the environmental consequences for the continued operation of LLNL is provided in Table 3.6–1 at the end of this chapter. At this time, NNSA has not identified a preferred alternative among the No Action Alternative, the Proposed Action, or the Reduced Operation Alternative. The table compares the potential impacts to environmental resources associated with the continued operation of LLNL under Baseline (2002) conditions, the No Action Alternative, the Proposed Action, and the Reduced Operation Alternative. The data in Table 3.6–1 includes data for both the construction and operational phases of the Proposed Action at LLNL.

The major impacts occur in three areas: materials and waste management, human health and safety, and radiological accidents. These impacts are significant in both an absolute level and relative levels among the alternatives.

There are no major differences in the environmental impacts among the alternatives in land uses and applicable plans, prehistoric and historic cultural resources, geology and soils, nonradiological air quality, water, and noise.

For other resource areas evaluated, the analyses indicate that there maybe some environmental impact differences, or based on scoping comments are of greater interest to the public. Resource areas falling into these categories include socioeconomic characteristics and environmental justice, community services, aesthetics and scenic resources, biological resources, radiological air quality, traffic and transportation, utilities and energy, and site contamination. These are discussed below in addition to materials and waste management, human health and safety, and radiological accidents.

3.6.1 Socioeconomic Characteristics and Environmental Justice

The socioeconomic impact for continued operations at LLNL would vary under the No Action Alternative, Proposed Action, and Reduced Operation Alternative and would primarily affect Alameda and San Joaquin counties. For the No Action Alternative, LLNL employment would increase by 300 workers to 10,650 at the Livermore Site and 250 at Site 300. For the Proposed Action, 11,150 workers would be required at the Livermore Site and 250 workers would be required at Site 300. For the Reduced Operation Alternative, worker population would be 9,770 at the Livermore Site and 230 at Site 300. The number of housing units affected would be proportional to the changes in worker population in both counties.

3.6.2 Community Services

Within the umbrella of community services, the only notable impact would be to the generation and disposal of nonhazardous solid waste. For the No Action Alternative, it is estimated that 4,600 metric tons per year of nonhazardous solid waste would be generated at the Livermore Site. Under the Proposed Action, the Livermore Site would generate 4,900 metric tons per year of nonhazardous solid waste. Under the Reduced Operation Alternative, nonhazardous solid waste generation at the Livermore Site would be reduced to 4,200 metric tons per year. Site 300 nonhazardous waste generation would be 208 metric tons per year under both the No Action Alternative and Proposed Action. Under the Reduced Operation Alternative, Site 300 nonhazardous solid waste generation would be reduced to 191 metric tons per year.

3.6.3 Aesthetics and Scenic Resources

Changes to aesthetics would be similar under the No Action Alternative, Proposed Action, and Reduced Operation Alternative at the Livermore Site and at Site 300. The offsite views of the Livermore Site would change due to the completion of the East Avenue security upgrade project, the International Security Research Facility, and the NIF. At Site 300, the proposed changes would have little or no impact on aesthetics and scenic resources. Changes would be consistent with the existing character of LLNL.

3.6.4 Biological Resources

As a result of consultation with the U.S. Fish and Wildlife Service (USFWS), it was identified that LLNL operations could potentially affect six federally listed endangered, threatened, proposed threatened, or candidate species due to potential disturbance of habitat. The six species include the California red-legged frog, California tiger salamander, San Joaquin kit fox, large-flowered fiddleneck, valley elderberry longhorn beetle, and Alameda whipsnake. All of these species are at Site 300 with only one species, the California red-legged frog, at the Livermore Site. Land disturbance in undeveloped zones at the Livermore Site would total 462,000 square feet under the No Action Alternative, Proposed Action, and Reduced Operation Alternative. Potential impacts to habitat would be the same under the No Action Alternative, Proposed Action, and Reduced Operation Alternative at the Livermore Site, with no impacts to the California red-legged frog. Jurisdictional wetlands along Arroyo Las Positas could be affected if the Environmental Restoration Program terminated the discharge of treated water. For Site 300, the impacts are the same under the No Action Alternative, Proposed Action, and Reduced Operation Alternative, with potential impacts to threatened, proposed threatened, or candidate species. There would be limited land disturbance in undeveloped areas except for 40,000 square feet required by the Energetic Materials Processing Center under the Proposed Action. NNSA will complete necessary Biological Assessments and obtain Biological Opinions from USFWS on any identified impacts on critical habitiat(s).

3.6.5 Radiological Air Quality

There are differences among the No Action Alternative, Proposed Action, and Reduced Operation Alternative regarding the potential radiological air quality impacts, all of which would be low. The maximally exposed individual (MEI) would be located due east of the NIF, once the NIF becomes operational. The MEI dose for the Livermore Site under the No Action Alternative would be 0.1 millirem per year. This compares to an MEI dose of 0.13 millirem per year under the Proposed Action and 0.09 millirem per year under the Reduced Operation Alternative. The population dose for the Livermore Site would be 1.8 person-rem per year under the No Action Alternative, Proposed Action, and the Reduced Operation Alternative. At Site 300, the MEI would be west-southwest of Firing Table 851, the only outdoor firing facility that would use tritium. The MEI dose at Site 300 would be 0.055 millirem per year under the No Action Alternative and the Proposed Action, and 0.054 under the Reduced Operation Alternative. The population dose for Site 300 would be 9.8 person-rem per year under the No Action Alternative, Proposed Action, and Reduced Operation Alternative.

3.6.6 Traffic and Transportation

Traffic at the Livermore Site would be directly affected by the change in worker population under the No Action Alternative, Proposed Action, and Reduced Operation Alternative. Under the No Action Alternative, traffic would increase slightly as a result of the increase in worker population by 290 workers (22,600 total vehicle trips per day). Traffic volume would increase further under the Proposed Action due to the addition of 500 workers (23,700 total vehicle trips per day). Traffic volume would decrease under the Reduced Operation Alternative due to the loss of 880 workers at the Livermore Site (21,000 total vehicle trips per day). At Site 300, the impact to traffic due to changes in the number of workers would be negligible under the No Action Alternative, Proposed Action, and Reduced Operation Alternative.

Transportation of radioactive materials offsite would increase under the No Action Alternative and Proposed Action, primarily as a result of programmatic agreements. Under the No Action Alternative, modeling of the offsite shipments yields a collective dose of 5.9 person-rem per year. Under the Proposed Action, the modeling of offsite shipments yields a collective dose of 6.2 person-rem per year. This would decrease for the Reduced Operation Alternative to 4.9 person-rem per year. The potential cancer risk as a result of shipments of radioactive materials from the Livermore Site would be low under the No Action Alternative, Proposed Action, and Reduced Operation Alternative. The calculated potential LCF under the No Action Alternative and the Proposed Action would be 4×10^{-3}. Under the Reduced Operation Alternative, the LCF would fall to 3×10^{-3}. Under the Proposed Action, the amount of explosive materials transported to Site 300 would increase slightly. Under the Reduced Operation Alternative, transportation of these materials would decrease.

3.6.7 Utilities and Energy

Under the No Action Alternative, the projected peak electrical demand at LLNL would be 82 megawatts and the annual total use would be 446 million kilowatt-hours. Peak demand is a measure of the maximum electrical load being used by LLNL at a single moment in time, usually on the hottest day of the year. In 2004, the State of California projects the statewide peak demand will be 53,464 megawatts and projects a growth in peak demand of about 2.4 percent per year. LLNL's projected peak demand in 2004 would be 0.1 percent of the total State demand. There would be virtually no change in the peak demand under the Proposed Action and the Reduced Operation Alternative. Annual electric use among the No Action Alternative, Proposed Action, and Reduced Operation Alternative would be 446, 442, and 371 million kilowatt-hours, respectively. The State currently projects an adequate supply/demand balance through 2008, but has not made supply projections beyond that year. LLNL's essentially flat projection of electrical demand and usage from 2004 to 2014 reflects an ongoing commitment to energy conservation. The decrease in electricity usage from the No Action Alternative to the Proposed Action is due to a cumulative reduction of LLNL floorspace under the Proposed Action. For the same reason the Livermore Site would experience a decrease in water consumption and sewage discharges under the Proposed Action.

3.6.8 Materials and Waste Management

Waste generation for both routine wastes and nonroutine wastes would be higher under the Proposed Action than under the No Action Alternative or Reduced Operation Alternative, primarily due to differences in the operation of the ITP and the NIF. Routine waste is generated from the normal operation of the facility. Nonroutine waste is generated from construction, D&D, and environmental restoration. Notable differences in the amount of waste generated include routine low-level waste at 200 cubic meters per year under the No Action Alternative, 340 cubic meters per year under the Proposed Action, and 180 cubic meters per year under the Reduced Operation Alternative. Differences for routine transuranic waste are 50 cubic meters per year under the No Action Alternative, 60 cubic meters per year under the Proposed Action, and 45 cubic meters per year under the Reduced Operation Alternative.

Differences in waste generation cover all major waste categories across the No Action Alternative, Proposed Action, and Reduced Operation Alternative, with generation the highest under the Proposed Action and lowest under the Reduced Operation Alternative. These quantities are summarized in Table 3.6–1. Levels of waste generation are within the capacities for treatment, transportation, or storage either onsite or at waste repositories such as WIPP.

3.6.9 Human Health and Safety

The occupational (involved) worker ionizing radiation dose was 28 person-rem per year in 2002. Under the No Action Alternative, the dose would increase to 90 person-rem per year. The increase includes a worker dose of 15 person-rem per year for NIF operations and a projected increase from approximately 26 person-rem per year to 72 person-rem per year due to a higher level of operation associated with approved projects for which NEPA analysis has been completed. These projects include stockpile stewardship and the packing in the Building 332 Plutonium Facility of excess plutonium in canisters certified for a 50-year shelf life. The Proposed Action would increase occupational worker dose to ionizing radiation to approximately 125 person-rem per year, including 32 person-rem per year from the ITP and approximately 5 person-rem per year from the use of the proposed materials in the NIF. Under the Reduced Operation Alternative, worker dose to ionizing radiation would be approximately 38 person-rem per year. LCFs calculated from these exposures would be 5.4×10^{-2}, 7.5×10^{-2}, and 2.3×10^{-2} per year of exposure under the No Action Alternative, Proposed Action, and Reduced Operation Alternative, respectively.

The ionizing radiation dose to the general public was 0.5 person-rem per year from the Livermore site and 2.5 person-rem per year from Site 300 in 2002. The population dose to the general public under all three alternatives would increase to 1.8 person-rem per year from the Livermore Site and 9.8 person-rem per year from Site 300. The corresponding LCFs for all three alternatives would be 1.1×10^{-3} from the Livermore site and 5.9×10^{-3} from Site 300. The dose from both sites is within the envelope of doses seen within the past 5 years.

3.6.10 Site Contamination

Areas of soil and groundwater contamination exist at the Livermore Site and Site 300. These are primarily the result of past waste management practices, some of which took place during the 1940s when the Livermore Site was a naval air station. Although there is no immediate or long-term threat to human health from this contamination, there is localized degradation of groundwater. Remediation systems are currently operating to reduce the concentrations and extent of contamination. Appropriate cleanup measures implemented with the concurrence of regulators would continue regardless of the action selected.

Increased site activities under the No Action Alternative or Proposed Action could increase the likelihood of soil contamination due to increased levels of activity and corresponding increases in the potential for accidental releases. However, minimal deposition of contaminants is expected because of spill prevention and control procedures. Under the Reduced Operation Alternative, a lower likelihood of soil contamination would be expected.

3.6.11 Accidents

The LLNL SW/SPEIS discusses accidents for all major facilities. Appendix D has detailed information regarding potential accidents at LLNL facilities. Assessment of the impacts of aircraft crashes into LLNL facilities was not presented in the 1992 LLNL EIS/EIR. It is included in this LLNL SW/SPEIS because of advances in DOE/NNSA's methods for performing safety analyses for nuclear and radiological facilities. Potential LCFs in the offsite population for median meteorological conditions were used to identify bounding radiological accidents for nuclear material handling and waste management operations.

The bounding radiological accident for nuclear material handling under the Proposed Action is an unfiltered fire involving radioactive material in the Building 332 Plutonium Facility resulting in 0.168 LCF within the offsite population. The calculated annual frequency for this accident is 3.9×10^{-7}, which is less frequent than once in a million years. Under the No Action Alternative and the Reduced Operation Alternative, the bounding accident for nuclear material handling in the Building 332 Plutonium Facility is a single piston engine aircraft accident resulting in 0.058 LCF within the offsite population.

The bounding radiological accident for waste management operations is a single engine piston aircraft accident at the Building 625 Radiological and Hazardous Waste Storage Facility that would result in 1.21 LCFs within the offsite population under the Proposed Action. The number of LCFs calculated for the same accident under the No Action Alternative and the Reduced Operation Alternative is 0.397 LCF. The calculated annual frequency of an aircraft crashing into the building structure with subsequent gasoline pool fire is 6.1×10^{-7}, which is less frequent than once in a million years. The aircraft accident scenario evaluated at the Building 625 Radiological and Hazardous Waste Storage Facility is very conservative in that it assumes the facility is loaded to its physical limit with containers of transuranic waste loaded to their maximum curie limit. The maximum curie limit under the Proposed Action is equivalent to an array of drums where one drum contains 60 plutonium-equivalent curies and the other surrounding drums contain 12 plutonium-equivalent curies. It is planned that by the end of 2005, all legacy transuranic waste drums in Building 625 Radiological and Hazardous Waste Storage Facility would be shipped to WIPP. It is projected that waste shipments to WIPP would be completed before Building 625 Radiological and Hazardous Waste Storage Facility and other LLNL transuranic waste storage facilities are fully loaded. Therefore, the consequences discussed above are associated with what would be considered a maximum peak inventory in the Building

625 Radiological and Hazardous Waste Storage Facility that would be allowed under the facility's operational procedures but may never occur.

Bounding accident scenarios for chemical, explosive, and biological accidents are the same among the No Action Alternative, the Proposed Action, and the Reduced Operation Alternative, and are unlikely to result in fatalities to the general public.

TABLE 3.6–1.—*Comparison of Environmental Impacts and Parameters Among Baseline, No Action Alternative, Proposed Action, and Reduced Operation Alternative*

Site / Environmental Component	Baseline (2002)	No Action Alternative	Proposed Action	Reduced Operation Alternative
		Land Uses and Applicable Plans		
Livermore Site	Land uses at Livermore Site are compatible with surrounding areas and with the land use plans of local jurisdictions.	Planned and approved projects have gone through the land use compatibility process. No new land use changes or development would occur. No change to existing land uses or the approved amount of onsite development would occur. There would be no change to the total acreage of the site.	New facility construction and upgrades represent minor infill in areas of compatible land use. No major alterations in the types of land use would occur. There would be no change to the total acreage of the site.	Same as No Action Alternative
Site 300	Land uses at Site 300 are compatible with surrounding areas and with the land use plans of local jurisdictions.	Planned and approved projects have gone through the land use compatibility process. Minor new development would occur. Existing facilities are dispersed, and they would not represent infill of land uses. The existing character of the site would remain unaltered.	Although there would be some development of additional land, projects and facilities would be dispersed and would not represent infill of land uses. The existing character of the site would remain unaltered.	Same as No Action Alternative
		Socioeconomic Characteristics and Environmental Justice		
Livermore Site and Site 300				
Employment				
Livermore Site	10,360 LLNL and other site workers	10,650 LLNL and other site workers	11,150 LLNL and other site workers	9,770 LLNL and other site workers
Site 300	240 LLNL employees	250 LLNL employees	Same as No Action Alternative	230 LLNL employees
Payroll	$668 M	$690 M	$729 M	$635 M

TABLE 3.6–1.—*Comparison of Environmental Impacts and Parameters Among Baseline, No Action Alternative, Proposed Action, and Reduced Operation Alternative (continued)*

Site / Environmental Component	Baseline (2002)	No Action Alternative	Proposed Action	Reduced Operation Alternative
Socioeconomic Characteristics and Environmental Justice (continued)				
Worker Population and Housing				
Alameda County				
Employment	10,360 total LLNL employment in county	10,650 total LLNL employment in county	11,150 total LLNL employment in county	9,770 total LLNL employment in county
Housing units	5,883 housing units occupied by LLNL workers living in county	6,050 housing units occupied by LLNL workers living in county	6,327 housing units occupied by LLNL workers living in county	5,550 housing units occupied by LLNL workers living in county
San Joaquin County				
Employment	240 total LLNL employment in county	250 total LLNL employment in county	250 total LLNL employment in county	230 total LLNL employment in county
Housing units	1,961 housing units occupied by LLNL workers living in county	2,017 housing units occupied by LLNL workers living in county	2,109 housing units occupied by LLNL workers living in county	1,850 housing units occupied by LLNL workers living in county
Environmental Justice	No predominantly minority or low-income populations within 5 miles of Livermore Site or Site 300	No disproportionately high and adverse impacts	Same as No Action Alternative	Same as No Action Alternative
Community Services				
Livermore Site				
Fire protection and emergency services	Mutual assistance agreements in effect with neighboring jurisdictions	No additional burden on local fire protection and emergency services	Same as No Action Alternative	Same as No Action Alternative
Police and security services	Mutual assistance agreements in effect with neighboring jurisdictions	No additional burden on local police and security services	Same as No Action Alternative	Same as No Action Alternative
Nonhazardous solid waste disposal	4,500 metric tons/yr	4,600 metric tons/yr	4,900 metric tons/yr	4,200 metric tons/yr

TABLE 3.6–1.—*Comparison of Environmental Impacts and Parameters Among Baseline, No Action Alternative, Proposed Action, and Reduced Operation Alternative (continued)*

Site / Environmental Component	Baseline (2002)	No Action Alternative	Proposed Action	Reduced Operation Alternative
Community Services (continued)				
Site 300				
Fire protection and emergency services	Mutual assistance agreements in effect with neighboring jurisdictions	No additional burden on local fire protection and emergency services	Same as No Action Alternative	Same as No Action Alternative
Police and security services	Mutual assistance agreements in effect with neighboring jurisdictions	No additional burden on local police and security services	Same as No Action Alternative	Same as No Action Alternative
Nonhazardous solid waste disposal	200 metric tons/yr	208 metric tons/yr	Same as No Action Alternative	191 metric tons/yr
Livermore Site and Site 300				
Workers' students enrolled in Livermore Valley Joint Unified School District	2,090 students	2,150 students	2,250 students	1,970 students
Prehistoric and Historic Cultural Resources				
Livermore Site				
Prehistoric	No resources identified	No impacts	Same as No Action Alternative	Same as No Action Alternative
Historic	Some buildings may be eligible for NRHP. Not all buildings have been assessed.	Potential impacts from D&D and renovation. Programmatic agreement to avoid or mitigate any potential impacts.	Same as No Action Alternative	Same as No Action Alternative
Site 300				
Prehistoric	Potentially significant resources identified	Impacts unlikely. Areas protected under Programmatic agreement.	Same as No Action Alternative	Same as No Action Alternative

TABLE 3.6–1.—*Comparison of Environmental Impacts and Parameters Among Baseline, No Action Alternative, Proposed Action, and Reduced Operation Alternative (continued)*

Site / Environmental Component	Baseline (2002)	No Action Alternative	Proposed Action	Reduced Operation Alternative
Prehistoric and Historic Cultural Resources (continued)				
Historic	Some buildings may be eligible for NRHP. Not all buildings have been assessed.	Potential impacts from D&D and renovation. Programmatic agreement to avoid or mitigate any potential impacts.	Same as No Action Alternative	Same as No Action Alternative
Aesthetics and Scenic Resources				
Livermore Site	Offsite views consist primarily of security fencing, buffer areas, and trees with facilities and industrial storage yards in the background. LLNL facilities dominate view on East Avenue. Light industry across north boundary, scenic roadway to the east, SNL/CA facilities to the south, and residential areas to the west.	Three facilities to be built would be visible from residential areas and scenic roadways. Short-term impacts from construction. Long-term changes in view in character with remainder of site.	Same as No Action Alternative	Same as No Action Alternative
Site 300	Offsite views of site structures limited to GSA building complex. Interior facilities generally hidden from public view. Tesla Road is designated a scenic route by Alameda County.	Changes in interior hidden from public view. Changes in GSA in character of existing public view.	New buildings in built areas. No change to visual character.	Same as No Action Alternative
Geology and Soils (geologic hazards are considered in Accidents)				
Livermore Site				
Mineral deposits and fossils	No mineral deposits onsite. Fossils have been found at 20-to-30 foot depths.	No mineral deposits onsite. Fossils have been found at 20- to 30-foot depths.	Same as No Action Alternative	Same as No Action Alternative
Soils	Site is 80% developed. Undeveloped areas along west and north sides and east of central pond. Soils not used for agriculture.	462,000 ft^2 would be disturbed by construction activities in undeveloped zones	Same as No Action Alternative	Same as No Action Alternative

TABLE 3.6–1.—*Comparison of Environmental Impacts and Parameters Among Baseline, No Action Alternative, Proposed Action, and Reduced Operation Alternative (continued)*

Site / Environmental Component	Baseline (2002)	No Action Alternative	Proposed Action	Reduced Operation Alternative
Geology and Soils (continued)				
Site 300				
Mineral deposits and fossils	Region has potential presence of mineral deposits, fossils, and soil resources.	No known geologic resource would be adversely impacted.	Same as No Action Alternative	Same as No Action Alternative
Soils	Soils are potentially useful for limited agriculture and grazing and wildlife.	No projects would disturb soils in undeveloped areas.	Construction of EMPC would disturb 40,000 ft^2 of undeveloped area.	Same as No Action Alternative
Biological Resources				
Livermore Site				
Habitat disturbance	Site is 80% developed and landscaped, consisting mainly of disturbed habitat. Wildlife diversity is low. California red-legged frog (federally listed threatened species) present onsite.	462,000 ft^2 would be disturbed by construction activities in undeveloped zones resulting in minor direct and indirect loss of animals and habitat. No impacts to California red-legged frog habitat.	Same as No Action Alternative	Same as No Action Alternative
Wetlands	1.96 acres, primarily along Arroyo Las Positas, could qualify as jurisdictional wetlands.	Wetlands along Arroyo Las Positas could be impacted upon termination of treated water discharge from environmental restoration program.	Same as No Action Alternative	Same as No Action Alternative

TABLE 3.6–1.—*Comparison of Environmental Impacts and Parameters Among Baseline, No Action Alternative, Proposed Action, and Reduced Operation Alternative (continued)*

Site / Environmental Component	Baseline (2002)	No Action Alternative	Proposed Action	Reduced Operation Alternative
Biological Resources (continued)				
Site 300				
Habitat disturbance	6,800 acres of mostly undisturbed land. Site supports a diversity of wildlife species. Six federally listed endangered, threatened, proposed threatened, or candidate species present onsite: large-flowered fiddleneck, Valley elderberry longhorn beetle, California tiger salamander, California red-legged frog, Alameda whipsnake, and possibly the San Joaquin kit fox.	No previously undeveloped areas would be impacted by construction. Habitat for the California red-legged frog would be adversely affected by proposed termination of releases to breeding ground at artificial wetland at Building 865. Fire prevention program has potential to affect critical habitat for Alameda whipsnake. Stormwater runoff improvement activities could adversely affect California tiger salamander habitat.	Construction of EMPC would disturb 40,000 ft^2 of undeveloped area.	Same as No Action Alternative
Wetlands	8.6 acres of wetlands, 4.4 acres of which that could qualify as jurisdictional wetlands.	Water releases to artificial wetlands near Buildings 801, 827, 851, and 865 would be terminated.	Same as No Action Alternative	Same as No Action Alternative

TABLE 3.6–1.—*Comparison of Environmental Impacts and Parameters Among Baseline, No Action Alternative, Proposed Action, and Reduced Operation Alternative (continued)*

Site / Environmental Component	Baseline (2002)	No Action Alternative	Proposed Action	Reduced Operation Alternative
Air Quality				
Livermore Site and Site 300 Nonradiological	Bay Area and San Joaquin air basins are in nonattainment for PM_{10} and ozone and so these pollutants and organic precursors to ozone are strictly regulated. LLNL is in compliance with all BAAQMD regulations and has been found to have good controls on oxides of nitrogen and precursor organic compounds.	Carbon monoxide concentration would remain within 20% to 30% of ambient standards. Total projected air pollutant emissions would be a small fraction of project significance levels and threshold levels for conformity. No adverse impact to air resources.	Carbon monoxide emissions dominated by current regional traffic levels and background sources. Emissions associated with proposed projects do not differ appreciably from the No Action Alternative. Total projected air pollutant emissions would be a small fraction of project significance levels and threshold levels for conformity. No adverse impact to air resources.	Emissions associated with the proposed projects do not differ appreciably from the No Action Alternative. There would be a reduction in vehicular activity and electrical and fuel demand. Therefore, there would be a small reduction in air pollutant loading and a net positive impact on air quality.
Livermore Site Radiological	The MEI is located at the UNCLE Credit Union outside the eastern perimeter of site. The MEI dose is 0.023 mrem/yr. The population dose is 0.50 person-rem/yr.	The MEI location would be due east of the NIF stack because of NIF emissions. The MEI dose would be 0.1 mrem/yr. The population dose would be 1.8 person-rem/yr.	The MEI location would be the same as the No Action Alternative. The MEI dose would be 0.13 mrem/yr. The population dose would be 1.8 person-rem/yr.	The MEI location would be the same as the No Action Alternative. The MEI dose would be 0.09 mrem/yr. The population dose would be 1.8 person-rem/yr.
Site 300 Radiological	The MEI is located on the south central boundary bordering the Carnegie State Vehicular Recreation Area. The MEI dose is 0.021 mrem/yr. The population dose is 2.5 person-rem/yr.	The MEI would be west-southwest of Firing Table 851. The MEI dose would be 0.055 mrem/yr. The population dose would be 9.8 person-rem/yr.	Same as No Action Alternative	The MEI location would be the same as No Action. The MEI dose would be 0.054 mrem/yr. The population dose would be 9.8 person-rem/yr.

TABLE 3.6–1.—*Comparison of Environmental Impacts and Parameters Among Baseline, No Action Alternative, Proposed Action, and Reduced Operation Alternative (continued)*

Site / Environmental Component	Baseline (2002)	No Action Alternative	Proposed Action	Reduced Operation Alternative
		Water		
Livermore Site				
Surface water	Discharges within NPDES requirements. Ongoing spill prevention, stormwater runoff, and erosion control management.	Surface water discharges within NPDES requirements. Ongoing spill prevention, stormwater runoff, and erosion control management.	Same as No Action Alternative	Same as No Action Alternative
Floodplains	100-year and 500-year floodplains near Arroyo Las Positas and Arroyo Seco	No new facilities in either 100-year or 500-year floodplain.	Same as No Action Alternative	Same as No Action Alternative
Groundwater	Groundwater contamination above drinking water standards. Remediation ongoing.	Contaminants above drinking water standards. Would continue to be remediated.	Same as No Action Alternative	Same as No Action Alternative
Site 300				
Groundwater supply	Water supplied by onsite wells.	Planned to link to Hetch Hetchy system.	Same as No Action Alternative	Same as No Action Alternative
Surface water	Ongoing spill prevention, stormwater runoff, and erosion control management. Discharges within NPDES requirements.	Ongoing spill prevention, stormwater runoff, and erosion control management.	Same as No Action Alternative	Same as No Action Alternative
Floodplains	100-year floodplain extends onsite.	No activities within floodplain.	Same as No Action Alternative	Same as No Action Alternative
Groundwater	Groundwater contamination above drinking water standards. Remediation ongoing.	Contaminants above drinking water standards. Continues to be remediated. Discharges within NPDES requirements.	Same as No Action Alternative	Same as No Action Alternative

TABLE 3.6–1.—*Comparison of Environmental Impacts and Parameters Among Baseline, No Action Alternative, Proposed Action, and Reduced Operation Alternative (continued)*

Site / Environmental Component	Baseline (2002)	No Action Alternative	Proposed Action	Reduced Operation Alternative
		Noise		
Livermore Site and Site 300				
Construction	Ongoing short-term noise due to construction.	Ongoing short-term noise due to construction. Noise from near – fence line projects as high as 82 dB(A).	Same as No Action Alternative	Same as No Action Alternative
Operations	Normal operations long-term noise not noticeable beyond fence line. Administrative limit for impulse noise of 126 dB. Highest recorded was 99.3 dB.	Normal operations long-term noise not noticeable beyond fence line.	Same as No Action Alternative	Same as No Action Alternative
Traffic	Peak one hour daytime L_{eq} (dBA) along roadways surrounding site is 60 to 75 L_{eq} (dBA).	Transportation vehicle noise levels 81 to 87 dB(A).	Same as No Action Alternative	Same as No Action Alternative
		Traffic and Transportation		
Livermore Site				
Traffic in vicinity of site	Heavy traffic in vicinity of site. Site-related commuter traffic of 22,000 total vehicle trips/day.	Slight increase in employment under No Action would have negligible impact to commuter traffic (22,600 total vehicle trips/day). Fewer construction projects would result in smaller temporary increases in commuter traffic and deliveries.	Employment would increase amount of commuter traffic (23,700 total vehicle trips/day). Construction projects would result in temporary increases in commuter traffic and deliveries.	Slight decrease in employment would have small beneficial impact to commuter traffic (21,000 total vehicle trips/day). Few construction projects would result in small temporary impacts to commuter traffic and deliveries.
Material (annual shipments radioactive, chemical, and explosives)	470	540	600	550

TABLE 3.6–1.—*Comparison of Environmental Impacts and Parameters Among Baseline, No Action Alternative, Proposed Action, and Reduced Operation Alternative (continued)*

Site / Environmental Component	Baseline (2002)	No Action Alternative	Proposed Action	Reduced Operation Alternative
Traffic and Transportation (continued)				
Waste (includes hazardous and radioactive, annual shipments)	88	240	310	200
Sanitary waste (maximum annual shipments)	518	534	570	492
TRU legacy waste shipments (total)	0	24	Same as No Action Alternative	Same as No Action Alternative
LLW legacy waste shipment (total)	1	64	Same as No Action Alternative	Same as No Action Alternative
MLLW legacy waste shipment (total)	1	80	Same as No Action Alternative	Same as No Action Alternative
LBNL TRU shipment (one time)	0	0	1	Same as No Action Alternative
Mixed TSCA waste shipments	1	13	Same as No Action Alternative	Same as No Action Alternative
Dose to public	Collective dose would be 1.5 person-rem/yr with the risk of 9×10^{-4} LCFs.	Collective dose would be 5.9 person-rem/yr with a risk of 4×10^{-3} LCFs.	Collective dose would be 6.2 person-rem/yr with a risk of 4×10^{-3} LCFs.	Collective dose would be 1.9 person-rem/yr with a risk of 1×10^{-3} LCFs.
Site 300				
Traffic in vicinity of site	Site is in a rural location with low traffic volumes.	No substantial changes in traffic or transportation.	No change in workforce commuting. Construction projects would result in temporary increases in commuter traffic and deliveries. Transportation of explosive materials would increase slightly.	Slight decrease in workforce commuting. No construction projects. Transportation of explosive materials would decrease.

TABLE 3.6–1.—*Comparison of Environmental Impacts and Parameters Among Baseline, No Action Alternative, Proposed Action, and Reduced Operation Alternative (continued)*

Site / Environmental Component	Baseline (2002)	No Action Alternative	Proposed Action	Reduced Operation Alternative
Utilities and Energy				
Livermore Site				
Water				
Capacity	2.88 M gal/day	2.88 M gal/day	Same as No Action Alternative	Same as No Action Alternative
Use	212 M gal/yr	276 M gal/yr	273 M gal/yr	230 M gal/yr
Sewer discharge	216,400 gal/day	224,000 gal/day	222,000 gal/day	Same as No Action Alternative
Electricity use				
Peak demand	57 MW	82 MW	82 MW	82 MW
Annual	321 M kWh	446 M kWh	442 M kWh	371 M kWh
Fuel (natural gas) use	12,900 therms/day	23,600 therms/day	23,000 therms/day	22,600 therms/day
Site 300				
Water				
Capacity	930,000 gal/day	648,000 gal/day	Same as No Action Alternative	Same as No Action Alternative
Use	67,900 gal/day[a]	67,900 gal/day	Same as No Action Alternative	Same as No Action Alternative
Sewer discharge	2,100 gal/day[a]	2,100 gal/day	Same as No Action Alternative	Same as No Action Alternative
Electricity use	16.3 M kWh/yr[a]	16.3 M kWh/yr	Same as No Action Alternative	Same as No Action Alternative
Fuel (fuel oil) use	16,600 gal/yr[a]	16,600 gal/yr	Same as No Action Alternative	Same as No Action Alternative
Materials and Waste Management				
Livermore Site and Site 300				
Waste storage facility modifications	NA	Within existing footprint	Same as No Action Alternative	Same as No Action Alternative
Class 1 permit modifications (total requests)	NA	75	100	50
Class 2 permit modifications (total requests)	NA	10	20	0

TABLE 3.6–1.—*Comparison of Environmental Impacts and Parameters Among Baseline, No Action Alternative, Proposed Action, and Reduced Operation Alternative (continued)*

Site / Environmental Component	Baseline (2002)		No Action Alternative		Proposed Action		Reduced Operation Alternative	
Materials and Waste Management (continued)								
Class 3 permit modifications (total number)	NA		0		2		Same as No Action Alternative	
RCRA closures	NA		4 closures		Same as No Action Alternative		Same as No Action Alternative	
Waste Generation by Type	**Routine**[b,g]	**Nonroutine**[b,g]	**Routine**[g]	**Nonroutine**[g]	**Routine**[g]	**Nonroutine**[g]	**Routine**[g]	**Nonroutine**[g]
LLW	170 m^3/yr	480 m^3/yr	200 m^3/yr	630 m^3/yr	340 m^3/yr	710 m^3/yr	180 m^3/yr	550 m^3/yr
MLLW	67 m^3/yr	44 m^3/yr	61 m^3/yr	72 m^3/yr	88 m^3/yr	81 m^3/yr	42 m^3/yr	63 m^3/yr
TRU	35 m^3/yr	4.2 m^3/yr	50 m^3/yr	55 m^3/yr	60 m^3/yr	10 m^3/yr	45 m^3/yr	5 m^3/yr
Mixed TRU	2.6 m^3/yr	0 m^3/yr	1.7 m^3/yr	0 m^3/yr	2.8 m^3/yr	0 m^3/yr	0.7 m^3/yr	0 m^3/yr
Total hazardous	440 metric tons/yr	880 metric tons/yr	390 metric tons/yr	1,500 metric tons/yr	510 metric tons/yr	1,700 metric tons/yr	300 metric tons/yr	1,300 metric tons/yr
Sanitary solid	4,700 metric tons/yr	Included in routine	4,800 metric tons/yr	Included in routine	5,100 metric tons/yr	Included in routine	4,400 metric tons/yr	Included in routine
Wastewater	300,000 gal/day	Included in routine	310,000 gal/day	Included in routine	330,000 gal/day	Included in routine	290,000 gal/day	Included in routine
Human Health and Safety								
Receptor	**Annual Dose**	**Annual LCFs**	**Annual Dose**	**Annual LCFs**	**Annual Dose**	**Annual LCFs**	**Annual Dose**	**Annual LCFs**
Livermore Site								
MEI	0.023 mrem	1.4×10^{-8}	0.30 mrem	1.8×10^{-7}	0.33 mrem	2.0×10^{-7}	0.22 mrem	1.3×10^{-7}
Population[d]	0.5 person-rem	3.0×10^{-4}	1.8 person-rem	1.1×10^{-3}	Same as No Action Alternative		Same as No Action Alternative	
Involved-worker population[df]	28 person-rem	1.7×10^{-2}	90 person-rem	5.4×10^{-2}	125 person-rem	7.5×10^{-2}	38 person-rem	2.3×10^{-2}
Noninvolved worker population[d]	Included in involved worker population		0.14 person-rem	8.9×10^{-5}	0.16 person-rem	9.6×10^{-5}	0.14 person-rem	8.2×10^{-5}
Site 300								
MEI	0.021 mrem	1.3×10^{-8}	0.055 mrem	3.3×10^{-8}	Same as No Action Alternative		0.054 mrem	3.3×10^{-8}
Population	2.5 person-rem	1.5×10^{-3}	9.8 person-rem	5.9×10^{-3}	Same as No Action Alternative		Same as No Action Alternative	
Involved-worker population	See footnote F.		90 person-rem	5.4×10^{-2}	125 person-rem	7.5×10^{-2}	38 person-rem	2.3×10^{-2}
Noninvolved worker population	Included in involved worker population		0.005 person-rem	2.8×10^{-6}	Same as No Action Alternative		Same as No Action Alternative	

TABLE 3.6–1.—*Comparison of Environmental Impacts and Parameters Among Baseline, No Action Alternative, Proposed Action, and Reduced Operation Alternative (continued)*

Site / Environmental Component	Baseline (2002)		No Action Alternative		Proposed Action		Reduced Operation Alternative	
Site Contamination								
Livermore Site and Site 300	Continued possibility of soil contamination from ongoing activities. Minimal deposition of contaminants expected due to precautions and quick response procedures. Continued removal of known contaminants.		Increased likelihood of soil contamination due to increase in activities and increased potential for accidents and releases. Minimal deposition of contaminants is expected due to precautions and quick response procedures. Continued removal of known contaminants.		Same as No Action Alternative		Decreased likelihood of soil contamination due to decrease in activities and decreased potential for accidents and releases. Minimal deposition of contaminants is expected due to precautions and quick response procedures. Continued removal of known contaminants.	
Accidents								
Bounding Radiological Accidents	**Dose**	**LCFs**	**Dose**	**LCFs**	**Dose**	**LCFs**	**Dose**	**LCFs**
Materials Handling Accident, Offsite Population (Building 332 Plutonium Facility)	Same as No Action Alternative		97 person rem	5.82×10^{-2} [h]	280 person rem	1.68×10^{-1} [h]	Same as No Action Alternative	
Waste Management Accident, Offsite Population (Building 625 Radiological and Hazardous Waste Storage Facility)	Same as No Action Alternative		662 person rem	0.397	2,020 person-rem	1.21	Same as No Action Alternative	

TABLE 3.6–1.—*Comparison of Environmental Impacts and Parameters Among Baseline, No Action Alternative, Proposed Action, and Reduced Operation Alternative (continued)*

Site / Environmental Component	Baseline (2002)	No Action Alternative	Proposed Action	Reduced Operation Alternative
Accidents (continued)				
Bounding Chemical Accident (Building 332 Plutonium Facility – Chlorine release)	Same as No Action Alternative	ERPG-2 level would extend 600 meters beyond site boundary.	Same as No Action Alternative	Same as No Action Alternative
Bounding Explosive Accident (Building 801, Contained Firing Facility or Open Air Firing Table)	Same as No Action Alternative	Up to 20 worker fatalities.	Same as No Action Alternative	Same as No Action Alternative
Bounding Biological Accident (Building 368, BioSafety Level 3 Facility)	Same as No Action Alternative	Population—no credible hazard Noninvolved worker—no credible hazard Involved worker—1 potential illness	Same as No Action Alternative	Same as No Action Alternative

[a] average from 1998 through 2002
[b] based on average quantities since 1992 and one standard deviation
[c] based on 1999 measurements
[d] includes both Livermore Site and Site 300
[e] based on median meteorology
[f] Total LLNL involved worker population (Livermore Site and Site 300)
[g] Routine waste is generated from the normal operation of the facility. Nonroutine waste is generated from construction, decontamination and decommissioning, and environmental restoration.
[h] Increased number of latent cancer fatalities.

BAAQMD = Bay Area Air Quality Management District; D&D = decontamination and decommissioning; dB = decibel; dBA = A-weighted decibel; EMPC = Energetic Material Processing Center; ft^2 = square feet; gal/day = gallons per day; gal/yr = gallons per year; GSA = General Services Area; kWh/yr = kilowatt hours per year; LBNL = Lawrence Berkeley National Laboratory; LCF = latent cancer fatality; Leq = equivalent continuous sound level; LLNL = Lawrence Livermore National Laboratory; LLW = low-level waste; MLLW = mixed low-level waste; M = million; m^3/yr = cubic meters per year; MEI = maximally exposed individual; MW = megawatts; mrem/yr = millirems per year; NA = not applicable; NIF = National Ignition Facility; NPDES = National Pollution Discharge Elimination System; NRHP = National Register of Historic Places; PM_{10} = particulate matter smaller than 10 microns in diameter; RCRA = *Resource Conservation and Recovery Act*; SNL/CA = Sandia National Laboratories/California; TRU = transuranic; therm = a unit of heat equal to 100,000 British thermal units; TSCA = *Toxic Substances Control Act*.

CHAPTER 4: DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 INTRODUCTION

This chapter of the *Site-wide Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory and Supplemental Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (LLNL SW/SPEIS) describes the environmental setting and existing conditions associated with the current operations of LLNL. The information presented in this chapter forms a baseline for evaluating the environmental impacts associated with implementing the No Action Alternative, Proposed Action, and Reduced Operation Alternative.

4.2 LAND USES AND APPLICABLE PLANS

This section summarizes existing onsite and surrounding land uses at the Livermore Site, offsite leased properties, and Site 300, as well as adopted land use plans applicable to surrounding areas. It also describes local land use plans and city and county programs. City or county organizations have no planning jurisdiction at the site because LLNL is a Federal facility owned by the U.S. Department of Energy (DOE). Nevertheless, LLNL does consider local planning policies, to the extent practicable, in its land use decisions as a good neighbor policy.

4.2.1 Existing Land Uses

4.2.1.1 Livermore Site

Onsite Land Uses

Onsite land uses at the 821-acre Livermore Site include offices, laboratory buildings, support facilities such as cafeterias, storage areas, maintenance yards, and a fire station; roadways, parking areas, buffer zones, and landscaping. The site also includes internal utility and communication networks. See Chapter 2 and Appendix A of this LLNL SW/SPEIS for detailed descriptions of onsite land uses, facilities, and major programs. A 500-foot-wide security buffer zone lies along the northern and western borders of the Livermore Site.

Surrounding Land Uses

All designations used in this section are from the relevant municipal or county general plan and zoning maps. Figure 4.2.1.1–1 illustrates land uses near the Livermore Site.

The Livermore Site is bordered on the east by Greenville Road. The property east of Greenville Road is agricultural with a few scattered rural residences and is used primarily for grazing. A Western Area Power Administration (WAPA) electrical substation is on the southeast corner of Greenville Road and Patterson Pass Road. The South Bay Aqueduct, a branch of the California Aqueduct, traverses the land east of the Livermore Site in a north-south direction. The Patterson Reservoir and filtration plant for the South Bay Aqueduct are northeast of the Livermore Site along Patterson Pass Road.

Patterson Pass Road runs along the northern boundary of the Livermore Site. A light industrial park lies across Patterson Pass Road to the north. Several new industrial park complexes have been completed in recent years. A Union Pacific Railroad line runs in an east-west direction along the northern boundary of the industrial park. Land uses farther north include vacant land, industrial, and Interstate 580 (I-580). Land northeast of the site is agricultural and used primarily for grazing. Wind turbines are installed on the hills of the Altamont Pass, northeast of the site.

Vasco Road borders the Livermore Site to the west. A low-density, single-family residential subdivision begins at the southwest corner of Patterson Pass Road and Vasco Road and extends south and west. A new housing development of attached single-family residences is currently being completed directly west of the site (north of East Avenue). Medium-density residential areas, mainly apartment complexes, exist on the west side of this new development approximately 2,000 feet west of Vasco Road.

East Avenue borders the Livermore Site to the south. Sandia National Laboratories, California (SNL/CA), which has land uses very similar to those at LLNL, is south of East Avenue. The primary land uses to the east and west of SNL/CA are rural residential and agricultural (mainly grazing). The Stivers Academy, a Kindergarten through 8^{th} grade school, is located west of SNL/CA on the east side of Vasco Road, between East Avenue and Tesla Road. Public access to the section of East Avenue common to the Livermore Site is administratively controlled. There is a small light-industrial park on the southwest corner of East Avenue and Vasco Road. Single-family housing is being built south of this industrial park.

LLNL also conducts limited activities at various leased properties near the Livermore Site. These include a combination office, childcare, and classroom facility at the Almond Avenue Site in the city of Livermore; a storage warehouse with a service shop for the assembly of laser components at Graham Court in the city of Livermore; a storage warehouse facility on Patterson Pass Road in the city of Livermore; and the Arroyo Mocho pump station located 7 miles south of the Livermore Site. These nearby offsite-leased properties are shown in Chapter 2, Figure 2.1–2.

4.2.1.2 *Site 300*

Onsite Land Uses

Site 300 comprises approximately 7,000 acres of largely undeveloped land. Site 300 is primarily a nonnuclear explosives and other nonnuclear weapons component test facility. The site has three remote explosive testing facilities supported by a chemistry processing area, a weapons test area, maintenance facilities, and a General Services Area (GSA) at the site entrance. One hundred sixty acres at Site 300 have been set aside as the "*Amsinckia grandiflora* Reserve" to protect this species' natural habitat.

Surrounding Land Uses

Figure 4.2.1.2–1 shows the existing land uses surrounding Site 300, the majority of which are agricultural, primarily for grazing cattle and sheep. Two other smaller, privately operated research and testing facilities are located near Site 300. The property east of and adjacent to Site 300 is now owned by Fireworks America and is currently being used to store pyrotechnics. A portion of the property is leased to Reynolds Initiator Systems, Inc., and is used to manufacture initiators, which are agents that cause a chemical reaction to commence.

A facility operated by SRI International, that conducts explosives tests, is approximately 0.6 miles south of Site 300.

Corral Hollow Road borders Site 300 on the south. The Carnegie State Vehicular Recreation Area is south of the western portion of Site 300, across Corral Hollow Road. It covers approximately 5,000 acres and is operated by the California Department of Parks and Recreation, Off-Highway Motor Vehicle Recreation Division, for the exclusive use of off-highway vehicles. The nearest urban area is the city of Tracy, approximately 2 miles northeast of Site 300. Rural residences are located along Corral Hollow Road, west of Site 300 and the Carnegie State Vehicular Recreation Area. Power-generating wind turbines occupy the land northwest of the site.

4.2.2 Land Use Plans and Programs

For land use planning purposes, a city or county general plan usually contains land use designations. A land use designation is assigned to an area of land to indicate its planned and intended use to guide future development. Land use designations serve as a general guide for development and as a guide for determining whether new uses will be compatible with existing land uses or land use designations. Zoning designations are assigned to an area of land for the purpose of regulating its permitted use, massing, and density.

4.2.2.1 *Livermore Site*

The city of Livermore and Alameda County do not have planning jurisdiction over the Livermore Site because it is a Federal facility owned by DOE. However, for purposes of providing a complete description to the public and decision makers of the existing and potentially affected environment, local land use planning in the vicinity of the Livermore Site is presented in this section.

The Livermore Site is in Alameda County. The western 1,100 feet of the Livermore Site are within the city of Livermore. Although the remainder of the Livermore Site is outside the Livermore city limits, the site remains within the city of Livermore's sphere of influence. The Livermore Site and surrounding areas have land use designations under both the Alameda County and city of Livermore general plans.

Alameda County Planning Programs

Alameda County General Plan: East County Area Plan

The East County Area Plan replaces the Livermore-Amador Valley Planning Unit General Plan. The East County Area Plan was adopted by the Alameda County Board of Supervisors on May 5, 1994, and was amended most recently in May 2000 (Alameda County 1994).

Figure 4.2.2.1–1 shows the Alameda County and city of Livermore land use designations for the Livermore Site and surrounding areas. Figure 4.2.2.1–1 also shows the urban growth boundary used by the county and the city. This boundary shows the Livermore Site outside the urban growth area. Areas north and west of the Livermore Site are designated as lands within the Livermore city limits and are within the urban growth boundary. The area to the south, including SNL/CA, is also within the urban growth boundary. Policy 144 of the East County Plan states "The County shall ensure that all new uses approved near the Lawrence Livermore National Laboratories in East Livermore are compatible with Laboratory operations."

The county describes the land use designations in and near the Livermore Site as follows:

Industrial Areas—This category provides for manufacturing and processing uses as well as administrative and laboratory uses.

- **Large Parcel Agricultural—**This category allows for both intensive and extensive agricultural activities and for other open-space uses, such as range and watershed management, consistent with site conditions and plan objectives and policies. The category includes privately held lands, as well as publicly owned lands not otherwise designated in the General Plan for major park or major public uses.

- **Residential Areas—**Density and housing unit assumptions for the Livermore planning area are based on analysis of existing development, current zoning, and city and county plan development proposals. The East County Area Plan indicates four urban residential density ranges: low, medium, medium-high, and high. The East County Area Plan also provides for a Rural Density Residential designation.

The portion of the Livermore Site within Alameda County is designated industrial. SNL/CA, south of East Avenue, is also designated industrial. The areas adjacent to SNL/CA on the east, west, and south are designated limited agriculture. The areas directly east of the Livermore Site, across Greenville Road, are designated large parcel agricultural.

The East County Area Plan identifies open space areas in the Open Space Diagram. Features from the Open Space Diagram are included in Figure 4.2.2.1–2. The land adjacent to the Livermore Site on the east is designated in the Open Space Diagram as large parcel agricultural. There are no other open space areas adjacent to the Livermore Site, but there are other designated open space areas in east Alameda County in the general vicinity of the Livermore Site. Two areas are designated as parklands: one is approximately 4 miles south and the other is approximately 3 miles north of the Livermore Site. An area designated as a Wind Resource Area is approximately 3 miles northeast and east of the Livermore Site. The South Bay Aqueduct, which is designated as Water Management, runs northeast to southwest approximately 100 yards west of the Livermore Site.

South Livermore Valley Area Plan

The East County Area Plan incorporates the South Livermore Valley Area Plan in its entirety (Alameda County 1994). Policies 339 through 341 for the South Livermore Valley Area Plan state the following:

- The county shall encourage the expansion of cultivated agriculture, particularly viticulture.

- The county shall prohibit additional development in the unincorporated portions of the South Livermore Valley unless it will directly further the purpose of expanding and enhancing cultivated agriculture.

- The county shall encourage the establishment and permanent protection of existing and new cultivated agricultural lands.

Potentially relevant policies from the open space section include:

Policy 73. The county shall require buffers between those areas designated for agricultural use and new nonagricultural uses within agricultural areas or abutting parcels. The size, configuration, and design of buffers shall be determined based on the characteristics of the project site and the intensity of the adjacent agricultural uses and if applicable, the anticipated timing of future urbanization of adjacent agricultural land where such agricultural land is included in a phased growth plan. The buffer shall be located on the parcel for which a permit is sought and shall provide for the protection of the maximum amount of arable, pasture, and grazing land feasible.

Alameda County Zoning

The Livermore Site lies within Alameda County and most of it is zoned "MP" for industrial-park use. The Alameda County Zoning Code specifies "laboratory, including research, commercial, testing, developmental, experimental or other types" as a permitted use within the MP Zone. The remaining portions of the Livermore Site lie within the city of Livermore and are not subject to county zoning.

City of Livermore Planning Programs

Livermore Community General Plan, 1976–2000

The Livermore Community General Plan, 1976–2000, was adopted by the Livermore City Council on March 8, 1976, and updated in August 1998 (City of Livermore 1975). The planning area for the city of Livermore encompasses approximately 88,960 acres and is bordered on the north by the Alameda County line, on the east by the ridgeline of the Altamont Hills, on the south by a line 8 miles south of the Livermore City Hall, and on the west by the Murray-Pleasanton Township. The largest single use within the city of Livermore planning area is open space (83 percent), mostly grassland.

Of the urban developed area, 50 percent is devoted to residential uses, 22 percent to streets, over 18 percent to public uses, and the remainder to commercial/industrial uses (City of Livermore 1975). Among the relevant land use policies in the Livermore Community General Plan are the following:

- The city shall make industrial development subject to design principles and performance standards that support environmental resources management policies.

- The city shall encourage the retention in open space of as much land as possible for agriculture, viticulture, rangeland, and grassland.

- Open space shall be used to protect and enhance local community character and identity and to guide the physical shape and direction of urban growth to preserve the rural characteristics of the area.

- Open space shall be used as a buffer between incompatible land uses within urban or essentially undeveloped areas.

- The city shall apply regulations that reserve large tracts for exclusive industrial use to encourage development of an industrial community and prevent encroachment by incompatible uses.

The city of Livermore has also adopted specific policies of Alameda County's South Livermore Valley Area Plan under its own South Livermore Valley Policies, including:

- Using economic incentives to facilitate the expansion of cultivated agriculture.

- Creating permanent urban/rural boundaries to protect the long-term viability of agriculture/viticulture.

These policies are directed at development within the Livermore city limits and include specific area designations and policies to encourage preserving agricultural lands and limiting commercial and residential development that may reduce agricultural lands.

Figure 4.2.2.1–1 illustrates the land use designations for the Livermore Site and surrounding areas as determined by the Livermore Community General Plan land use map (City of Livermore 2002a). Most of the Livermore Site is designated low intensity industrial, with the northern 500-foot perimeter area designated high intensity industrial. The Livermore Community General Plan designates the areas north of the Livermore Site as high intensity industrial. Areas west of the Livermore Site are designated as urban low-medium residential to urban high residential. Small areas within the residential areas are designated as open space parks, which include parks, trail ways, recreation corridors, and protected areas. Areas south and east of the Livermore Site and SNL/CA are designated low intensity industrial and the area farther east of Greenville Road is designated as limited agricultural with a 20-acre minimum lot requirement.

North Livermore Area General Plan Amendment

The Livermore City Council adopted the North Livermore Area General Plan Amendment in March 1988 (City of Livermore 1975). The North Livermore area comprises the portion of North Livermore bordered on the west by the western city limits of the Springtown Community, on the north and east by the base of the Livermore foothills, and on the south by I-580. The North Livermore Area General Plan Amendment revised the pattern of residential land uses and densities, and provided for supporting neighborhood commercial facilities, community facilities, and open space uses. The amendment provides for a 35-percent increase in residential land use, a 54-percent increase in commercial use, a 32-percent decrease in public facility use, and a 51-percent decrease in open space and agriculture use over a 20 to 25 year planning horizon (City of Livermore 1975). This amendment allowed for approximately 3,000 more dwelling units and approximately 170 more commercial acres to be built in the Springtown Community. Most development permitted by this amendment has been completed (Lee 2002).

City of Livermore Zoning

The northern perimeter area is zoned I-3 for heavy industrial use, and the western perimeter area is zoned I-2 for light industrial use (City of Livermore 2002a). The city of Livermore zoning ordinance provides for manufacturing facilities, warehousing, and distribution facilities; research and development facilities; professional and administrative offices, restaurants, wholesale certified recycler and recycle processor facilities; and off-street parking as principal permitted uses within the I-2 zones. In addition to those uses in the I-2 zone, the I-3 zone permits contractor storage yards, truck terminals, or other open storage uses and recycle processor uses (City of Livermore 1975).

The surrounding areas north of the Livermore Site are designated I-3. Areas west of the Livermore Site are designated as PD for planned development, PDR for planned-development residential, RS-3 for residential use with a maximum density of three dwelling units per acre, RG-10 for suburban-multiple-residential use (approximately 10 dwelling units per acre), RS-5 for residential use with a maximum density of five dwelling units per acre, and RL-6 for low-density residential with a minimum lot size of 6,000 square feet.

Livermore Municipal Airport Master Plan

The Livermore Municipal Airport is located just south of I-580/Airway Boulevard. The Livermore Municipal Airport Master Plan, prepared for the city of Livermore in 1975, provides guidelines for the future development of airport facilities (City of Livermore 1975). The master plan includes a land use map for the airport vicinity, illustrating projected land uses for 1995. Land uses shown on this map are consistent with existing land uses surrounding the airport, with the exception that the area adjacent to the southern boundary of the airport is designated for future “general or light industry.” Section 4.13 provides information on current airport operations.

On March 25, 1991, the Livermore City Council established an airport protection area (Resolution No. 90-11) (LLNL 1992a). The amendment prohibits new residential land use designations or the intensification of existing land use designations within the airport protection area. The protection area was established to ensure continued safety in the airport region and to avoid potential noise incompatibilities between the airport and encroaching residential uses.

The city of Livermore has completed a draft revision of the Livermore Municipal Airport Master Plan and is reviewing the completed Initial Study and Environmental Assessment (IS/EA) and is reviewing the IS/EA. Upon approval of the IS/EA, the city will consider adoption of the Airport Master Plan (City of Livermore 2002b).

4.2.2.2 *Site 300*

Most of Site 300 is in San Joaquin County, with a small portion in Alameda County. The city of Tracy is located approximately 2 miles northeast of the site. Planning programs of these three government entities are addressed below to provide a basis for evaluating Site 300’s compatibility with future surrounding land uses. San Joaquin and Alameda counties and the city of Tracy do not have planning jurisdiction over Site 300 because it is a Federal facility, owned by DOE.

San Joaquin County Planning Programs

San Joaquin County General Plan

The San Joaquin County Board of Supervisors adopted the San Joaquin County General Plan on June 29, 1992 (San Joaquin County 1992). The land use/circulation element of the General Plan contains goals, objectives, and principles for land use development and circulation and transportation within San Joaquin County.

Figure 4.2.1.2–1 shows the land use designations for Site 300 and the surrounding areas. The San Joaquin County General Plan land use designations are described in Table 4.2.2.2–1.

The portion of Site 300 in San Joaquin County is designated public and quasi-public. Areas north and east of Site 300 are designated general agricultural. Areas south of Site 300 along Corral Hollow Road are designated as recreation and conservation areas. Areas to the north and west are designated as general agriculture.

The following are resources/agricultural policies of the San Joaquin County General Plan that could be relevant to a public facility in or near an agricultural area:

- Agricultural areas shall be used principally for crop production, ranching, and grazing. All agricultural support activities and nonfarm uses shall be compatible with agricultural operations.

- Agriculture shall be protected from nuisance complaints from nonagricultural land uses by appropriate regulatory and land use planning mechanisms.

- Nonagricultural land uses at the edge of agricultural areas shall incorporate adequate buffers (e.g., fences and setbacks) to prevent conflicts with adjoining agricultural operations.

Open space areas include the San Joaquin portion of the Carnegie State Vehicular Recreation Area. As illustrated in Figure 4.2.2.1–2, a corridor along Corral Hollow Road is designated as a conservation area and the areas surrounding Site 300 to the north, south, and east are designated as extensive agricultural areas.

TABLE 4.2.2.2–1.—*San Joaquin County Land Use Designations*

General Agriculture	Areas generally committed to agriculture with viable commercial agricultural enterprises that require large land areas to efficiently produce their crops.
Limited Agriculture	Areas with small-scale agricultural operations on 5 to 10 acres.
Agriculture-Urban Reserve	Areas currently undeveloped and perhaps in agricultural production but expected to be converted to urban uses at some point, most likely beyond the planning period of this plan.
Rural Residential	Large lot (1 to 5 acres) residential development where full urban services are not available or expected.
Very Low Density Residential	Large lot (0.5 to 1 acre) residential development within urban communities, with community sewerage, water, and drainage.
Low Density Residential	Single-family dwelling units at two to six dwelling units per gross acre.
Medium Density Residential	Mobile home parks, and attached units such as duplexes, triplexes, and fourplexes at 6 to 10 dwelling units per gross acre.
Medium-High Density Residential	Attached units such as townhouses and garden apartments at 10 to 15 dwelling units per gross acre.
High Density Residential	Apartment buildings and other multifamily dwelling units at 15 to 40 dwelling units per gross acre.
Neighborhood Commercial	Small, localized retail and/or service businesses that offer goods and merchandise to the immediate neighborhood.
Community Commercial	Areas offering a full range of commercial retail and service establishments, allowing comparison shopping and serving urban communities or regional markets.
General Commercial	Areas offering a wide variety of individual, specialized retail and service uses that are typically not oriented to comparison shopping, may require single-purpose trips, and cater to urban communities or regional markets.
Office Commercial	Administrative or professional offices.
Freeway Service	Commercial uses oriented almost exclusively to serving the needs of the freeway traveler.

Source: San Joaquin County 1992.

San Joaquin County Zoning

The portion of Site 300 in San Joaquin County is zoned AG-160 for general agriculture with a 160-acre minimum parcel size. The agricultural zone was established to preserve agricultural lands for the continuation of commercial agricultural enterprises. In addition, hazardous industrial operations using explosives are permitted within the agricultural zone, subject to use permits (San Joaquin County 1992).

Alameda County Planning Programs

Alameda County General Plan, East County Area Plan

The East County Area Plan designates the area surrounding Site 300 in Alameda County as "major public" (Alameda County 1994). The East County Area Plan Policy 138 states "the County shall allow development and expansion of major public facilities (e.g., hospitals, research facilities, landfill sites, jails, etc.) in appropriate locations inside and outside the Urban Growth Boundary consistent with the policies and Land Use Diagram of the East County Area Plan."

Alameda County Zoning

The portion of Site 300 in Alameda County is zoned A for agricultural use. The Alameda County ordinance code specifies "remote testing facilities" as a conditional use within the A district, subject to approval by the zoning administrator for Alameda County (Title 17, Chapter 6, Section 40, Conditional Uses).

City of Tracy Planning Programs

City of Tracy General Plan

Site 300 is approximately 2 miles southwest of the city of Tracy. The Site 300 area is designated on the city of Tracy Community Areas Map as Federal Reserve/Open Space (City of Tracy 1993). Site 300 borders the city of Tracy's sphere of influence, which is designated as the Tracy Hills area. The Tracy Hills planning area includes both Tracy sphere of influence lands in San Joaquin County and an area southwest of I-580 recently annexed by the city of Tracy. The area adjacent to Site 300 in Tracy's sphere of influence has been designated open space habitat. The Tracy Hills area within the city limits of Tracy has been zoned as low and medium density residential. A residential development project has been proposed for the Tracy Hills area (Lombardo 2002) and is expected to break ground in 2006.

Tracy Municipal Airport Master Plan

The Tracy Municipal Airport is located within the southwestern portion of the city of Tracy. The airport is surrounded by aggregate mineral extraction operations to the north, south, and east. The Delta-Mendota Canal borders the airport on the west and southwest. Section 4.13 provides information on current airport and LLNL-related operations. The San Joaquin County General Plan identifies the Tracy Metropolitan Airport area of influence as extending from the airport to the edge of the current city limits just south of I-280 (San Joaquin County 1992).

The Tracy Municipal Airport Master Plan was prepared in 1998 for the city of Tracy (City of Tracy 1998). The master plan provides data from 1998 on airport facilities, operations, and capacity, and forecasts future airport demands.

4.3 SOCIOECONOMIC CHARACTERISTICS AND ENVIRONMENTAL JUSTICE

This section describes the existing socioeconomic characteristics of LLNL and the surrounding areas, focusing primarily on Alameda, San Joaquin, Contra Costa, and Stanislaus counties. Approximately 93 percent of LLNL employees reside within these four counties. These four counties make up the region of influence (ROI) for this resource (Figure 4.3–1).

4.3.1 Employment

Employment characteristics of the communities in the region surrounding the Livermore Site and Site 300 are presented in this section by the four counties and major cities within the ROI. Specific employment information about LLNL is integrated into this discussion and summarized at the beginning of Section 4.3.2.

Alameda County

The California Employment Development Department (EDD) reported a total employed labor force of 721,000 persons in Alameda County (Table 4.3.1–1) for the year 2001. This represented a 13.3-percent increase of employed persons over the 1991 annual average of 636,300. The average annual unemployment rate for 2001 was 4.5 percent (33,900 persons), which was lower than the statewide average of 5.3 percent for the same year (EDD 2002a).

During the 1990s, Alameda County's employment mix continued its shift away from heavy industries, which were either in decline or stagnant, and toward office- and service-related industries, particularly high technology. Employment opportunities created by this shift helped to invigorate the county's economy and stimulate population growth. By the end of the 1990s, this shift in population growth had peaked. Employment projections through 2006 estimate wholesale trade, services, and manufacturing as the three employment sectors that will experience the greatest percent job growth (EDD 2002b).

San Joaquin County

The EDD reported a 2001 total employed labor force of 241,600 persons in San Joaquin County (Table 4.3.1–1). This represented an 18.5-percent increase over the 1991 annual average of 203,900. The average 2001 unemployment rate was 8.7 percent (23,100 persons), substantially higher than the state average for that year (5.3 percent) (EDD 2002a). Agricultural areas, such as in San Joaquin County, tend to have greater seasonal variations in employment and higher unemployment rates than non-agriculturally based communities. Robust job growth is expected through 2006, with services, retail trade, and government expected to experience the greatest percent increase (EDD 2002b).

TABLE 4.3.1–1.—*Employment and Income Profile in the Four-County Region of Influence*

	Alameda	San Joaquin	Contra Costa	Stanislaus	ROI
		Employment			
Total Labor Force					
Number of available workers (2001 average)	754,900	264,700	509,800	210,300	1,739,700
Employed	721,000	241,600	493,100	188,800	1,644,500
Unemployed	33,900	23,100	16,700	21,500	95,200
Percent unemployed	4.5%	8.7%	3.3%	10.2%	5.5%
LLNL Labor Force (September 2002)					
Number of workers	4,919	1,636	1,132	533	8,220 [a]
Percent of 2001 workforce	0.7%	0.6%	0.2%	0.3%	0.5%
		Income			
Personal Income for Total Labor Force (2000 Average)					
Total personal income ($1,000)	$55,972,377	$13,208,972	$39,194,448	$10,302,276	$108,375,797
Per capita income ($)	$38,624	$23,242	$41,110	$22,889	$36,479

Sources: BEA 2002, EDD 2002a, LLNL 2003ak.
[a] Represents 93 percent of the 8,850 total labor force directly employed by LLNL living in the ROI.
LLNL = Lawrence Livermore National Laboratory; ROI = region of influence.

Contra Costa County

The EDD reported a 2001 total employed labor force of 493,100 persons in Contra Costa County (Table 4.3.1–1). This represented a 19.9-percent increase over the 1991 annual average of 411,400. The average annual unemployment rate for 2001 was 3.3 percent (16,700 persons), which was significantly lower than the statewide average of 5.3 percent for the same year (EDD 2002a).

Contra Costa County's varied economic base is dominated by the services industry, which accounts for 32 percent of total employment. The job growth forecast to 2006 indicates services jobs will grow at the greatest pace, followed by government and retail trade (EDD 2002b).

Stanislaus County

The EDD reported a total employed labor force of 188,800 persons in Stanislaus County for 2001 (Table 4.3.1–1). This represented a 20.6-percent increase over the 1991 annual average of 156,500. The average annual unemployment rate for 2001 was 10.2 percent (21,500 persons), which was significantly higher than the statewide average of 5.3 percent for the same year (EDD 2002a). Agricultural areas, such as in Stanislaus County, tend to have greater seasonal variations in employment and higher unemployment rates than non-agriculturally based communities.

While agriculture has traditionally been the basis of Stanislaus County's economy, other economic sectors are expanding dramatically. Growth is expected through 2006 in all major industries, with services, manufacturing, and retail trade experiencing the greatest percentage increases (EDD 2002b).

Lawrence Livermore National Laboratory

As of September 2002, approximately 8,850 persons were employed by LLNL (8,610 at the Livermore Site and 240 at Site 300) (LLNL 2003ak). This total does not include contractor personnel involved in various technical and administrative support or facility construction operations, which may include up to 1,750 additional persons.

4.3.2 Population

Of the approximately 8,850 employees working at LLNL at the end of September 2002, 8,220 lived within Alameda, San Joaquin, Contra Costa, and Stanislaus counties (Table 4.3.2–1). The majority of LLNL personnel reside in Alameda County, with the largest concentration (approximately 3,270 employees) residing in the city of Livermore. Recent shifts in population have led workers east, making the city of Tracy the second largest concentration of LLNL employees (approximately 720). Pleasanton is home to approximately 550 LLNL employees, while about 420 reside in Manteca (LLNL 2003ak).

TABLE 4.3.2–1.—*Geographic Distribution of Lawrence Livermore National Laboratory Employee Residences by County and Major Cities, 2002*

County	Livermore Site	Site 300	Total
Alameda	4,871	48	4,919
San Joaquin	1,528	108	1,636
Contra Costa	1,108	24	1,132
Stanislaus	485	48	533
Other counties	622	11	633
Total	**8,614**	**239**	**8,853**
City, County			
Livermore, Alameda	3,239	35	3,274
Tracy, San Joaquin	674	48	722
Pleasanton, Alameda	541	6	547
Manteca, San Joaquin	390	32	422
Castro Valley, Alameda	353	3	356
Modesto, Stanislaus	251	28	279
Brentwood, Contra Costa	231	8	239
San Ramon, Contra Costa	235	1	236
Stockton, San Joaquin	218	14	232
Dublin, Alameda	188	2	190
Oakland, Alameda	188	0	188

Source: LLNL 2003ak.

The populations of each county in the ROI are described below and summarized in Table 4.3.2–2.

TABLE 4.3.2–2.—*Historic and Projected Population Within the Four-County Region of Influence*

County	Year				
	1990 (actual) [a]	**2000 (actual)** [a]	**2005** [b]	**2010** [b]	**2015** [b]
Alameda	1,279,182	1,443,741	1,580,200	1,671,200	1,735,800
San Joaquin	480,628	563,598	645,600	727,800	803,400
Contra Costa	803,732	948,816	1,021,400	1,071,400	1,108,100
Stanislaus	370,522	446,997	522,700	587,600	646,800
Total	2,934,064	3,403,152	3,769,900	4,058,000	4,294,100
Average annual % growth	—	1.5	2.1	1.5	1.1

Sources: [a] Census 2002a, [b] California Department of Finance (DOF) 2001.

Alameda County

In 2000, the population of Alameda County was 1,443,741 (Census 2002a), 166,972 of which lived within the communities of Livermore, Pleasanton, and Dublin, near the Livermore Site (Census 2002b). A supplementary survey profile estimates the 2001 Alameda County population at 1,430,686 (Census 2003). During the 10-year period from 1990 through 2000, the population increased 12.9 percent. From 2000 through 2015, Alameda County is expected to grow by approximately 292,000 residents, an increase of 20.2 percent (DOF 2001). Increases to population growth during this period may be constrained by a lack of land suitable or available for development.

San Joaquin County

In 2000, the population of San Joaquin County was 563,598 (Census 2002a). A supplementary survey profile estimates the 2001 San Joaquin County population at 576,553 (Census 2003). During the 10-year period from 1990 through 2000, the population increased 17.3 percent. From 2000 through 2015, San Joaquin County is expected to grow by approximately 240,000 residents, an increase of 42.5 percent (DOF 2001). This anticipated increase is directly related to the increased employment opportunities in the eastern portion of Alameda County, as well as diversification of the San Joaquin County economy. Residential development and population increases in the southern part of San Joaquin County are anticipated to continue because commute times from San Joaquin County to Alameda County are similar to other Bay Area commute times. In addition, housing is less expensive and land more readily available in San Joaquin County than in Alameda County.

Contra Costa County

In 2000, the population of Contra Costa County was 948,816 (Census 2002a). During the 10-year period from 1990 through 2000, the population increased 18.1 percent. From 2000 through 2015, Contra Costa County is expected to grow by approximately 160,000 residents, an increase of 16.8 percent (DOF 2001). Growth during this period may be constrained by a lack of land suitable or available for development.

Stanislaus County

In 2000, the population of Stanislaus County was 446,997 (Census 2002a). During the 10-year period from 1990 through 2000, the population increased 20.6 percent, the highest growth rate of the four counties in the ROI. From 2000 through 2015, Stanislaus County is expected to grow by approximately 200,000 residents, an increase of 44.7 percent, similar to the expected growth rate of San Joaquin County (DOF 2001). This anticipated increase is directly related to the increased employment opportunities in the eastern portion of Alameda County, as well as diversification of the Stanislaus County economy. Residential development and population increases in the northwestern part of Stanislaus County are anticipated to continue because of its proximity to Bay Area businesses, less expensive housing than Bay Area counties, and readily available land.

4.3.3 Housing

Alameda County

The Alameda County housing stock (all units) totaled 546,735 units as of January 2002 (Table 4.3.3–1). The vacancy rate in Alameda County was 3.0 percent, indicating a low percentage of available housing. The total number of housing units increased 4.9 percent between 1997 and 2002 (DOF 2002). The overall county rate of housing growth is fairly moderate; however, this figure is not indicative of the higher subregional rate of housing growth in the eastern portion of the county (Tri-Valley area). The high rate of housing growth in the cities of Livermore, Dublin, and Pleasanton, in comparison to Alameda County, is the result of job growth in the Tri-Valley area and the availability of land.

TABLE 4.3.3–1.—*Housing Units and Vacancy Rates Within the Four-County Region of Influence and Selected Cities, 1997 – 2002*

County	1997			2002			% Housing Unit Growth (1997 – 2002)
	Housing Units	Occupied	% Vacant	Housing Units	Occupied	% Vacant	
Alameda	521,101	495,598	4.9	546,735	530,115	3.0	4.9
San Joaquin	182,444	173,439	4.9	197,279	189,512	3.9	8.1
Contra Costa	342,980	325,659	5.1	361,748	351,134	2.9	5.5
Stanislaus	147,088	139,688	5.0	156,515	150,649	3.7	6.4
City							
Livermore	24,524	23,558	3.9	27,357	26,856	1.8	11.6
Tracy	15,953	14,687	7.9	20,571	20,040	2.6	28.9
Pleasanton	22,085	21,090	4.5	24,517	23,845	2.7	11.0
Manteca	15,616	15,011	3.9	18,649	18,023	3.4	19.4
Modesto	65,693	62,542	4.8	69,848	67,540	3.3	6.3
Brentwood	4,874	4,590	5.8	9,784	9,419	3.7	100.7
San Ramon	16,087	15,272	5.1	17,917	17,296	3.5	11.4
Stockton	79,420	75,333	5.1	84,266	80,722	4.2	6.1
Dublin	7,949	7,731	2.7	11,107	10,496	5.5	39.7
Oakland	154,640	144,285	6.7	158,607	151,843	4.3	2.6

Source: DOF 2002.

Based on the distribution of LLNL employee residences shown in Table 4.3.2–1, and assuming one worker per household, LLNL workers (including LLNL employees, other Federal employees, and contractors) occupy approximately 5,883 housing units in Alameda County.

San Joaquin County

The San Joaquin County housing stock (all units) totaled 197,279 units as of January 2002 (Table 4.3.3–1). The vacancy rate in the county was 3.9 percent, indicating a moderate percentage of available housing. The total number of housing units in the county increased 8.1 percent between 1997 and 2002 (DOF 2002). The overall county rate of housing growth is fairly rapid as Bay Area workers seek lower housing prices. Tracy, in particular, has experienced a rapid housing growth of 28.9 percent from 1997 through 2002.

Based on the distribution of LLNL employee residences shown in Table 4.3.2–1, and assuming one worker per household, LLNL workers (including LLNL employees, other Federal employees, and contractors) occupy approximately 5,883 housing units in San Joaquin County.

Contra Costa County

The Contra Costa County housing stock (all units) totaled 361,748 units as of January 2002 (Table 4.3.3–1). The vacancy rate in the county was 2.9 percent, indicating a low percentage of available housing. The total number of housing units in the county increased 5.5 percent between 1997 and 2002 (DOF 2002). The overall county rate of housing growth is fairly moderate; however, this figure is not indicative of the higher subregional rate of housing growth in the eastern portion of the county. For example, Brentwood grew a total of 101 percent from 1997 through 2002.

Stanislaus County

The Stanislaus County housing stock (all units) totaled 156,515 units as of January 2002 (Table 4.3.3–1). The vacancy rate in the county was 3.7 percent, indicating a moderate percentage of available housing. The total number of housing units in the county increased 6.4 percent between 1997 and 2002 (DOF 2002). As with San Joaquin County, the overall county rate of housing growth in Stanislaus County is fairly rapid as Bay Area workers seek lower housing prices and the county economy continues to diversify and create additional jobs.

4.3.4 Economic Factors

Alameda and Contra Costa counties had a total of 69,993 business establishments in 2001, with a combined annual payroll of $38.7 billion (including LLNL) (Table 4.3.4–1). This figure is lower than the total personal income listed for Alameda and Contra Costa counties in Table 4.3.1–1, in that personal income includes income from many sources, such as wages, pensions, alimony, and interest. The services industry was the largest employment sector, with a $15 billion total payroll (EDD 2002c).

San Joaquin County had 12,920 business establishments in 2001. Payroll for these companies totaled $5 billion (Table 4.3.4–1). The services industry was the largest employment sector, with a $1.5 billion total payroll (EDD 2002c).

Stanislaus County had 11,276 business establishments in 2001. Payroll for these companies totaled $4.1 billion (Table 4.3.4–1). The services industry was the largest source of revenue, with a $1.4 billion total payroll (EDD 2002c).

TABLE 4.3.4–1.—*Annualized Payroll for Four-County Region of Influence by Industry Sector, 2001 ($1,000)*

	Alameda/Contra Costa [a]	San Joaquin	Stanislaus
Agriculture	$102,860	$346,260	$272,492
Mining	$350,836	$10,740	$776
Utilities	$222,976	$65,700	$11,764
Construction	$3,493,652	$511,460	$384,844
Manufacturing	$6,194,008	$830,308	$893,384
Wholesale trade	$2,898,288	$281,700	$212,284
Retail trade	$3,356,488	$588,760	$505,948
Transportation and warehousing	$1,484,200	$409,728	$120,728
Information	$2,536,288	$138,344	$70,676
Finance and insurance	$2,260,504	$235,992	$151,368
Real estate rental and leasing	$655,652	$66,392	$40,804
Services	$15,115,788	$1,489,472	$1,410,480
Total	**$38,671,540**	**$4,974,856**	**$4,075,548**

Source: EDD 2002c.
[a] Combined Oakland Metropolitan Statistical Area.

As of the last quarter of fiscal year (FY) 2002, LLNL had a monthly payroll of approximately $59 million. LLNL payroll originates entirely from the Livermore Site in Alameda County, even though some personnel are located at Site 300 in San Joaquin County. The total annual LLNL payroll for FY2002 was approximately $668 million, not including temporary labor and contractor personnel (LLNL 2002b). This amount represents 1.7 percent of the total combined payroll generated by all business establishments in Alameda and Contra Costa counties.

LLNL also contributes considerably to this region's economy through its direct purchases of goods and services. LLNL purchased a total of $568 million in goods and services in FY2001. Of that total, more than half ($348 million) was purchased in California. Of the amount purchased in California, $142 million in goods and services were purchased in the Bay Area (LLNL 2002c).

LLNL jobs and expenditures generate indirect jobs in the region. The Regional Input-Output Modeling System (RIMS) II economic model produces two multipliers that are useful for the evaluation of economic effects (BEA 2003). The first multiplier is used to calculate worker earnings, and the second calculates employment. These multipliers provide information needed to estimate LLNL's economic impact. Earnings and employment multipliers make possible the identification of not only the direct impacts of an activity on regional income and jobs, but also the indirect effects. Based on the FY2002 LLNL payroll of $668 million, the regional earnings multiplier of 1.64 yields an overall economic effect of $1,096 million within the ROI. Based on the total LLNL direct employment and the regional employment multiplier of 1.97, an estimated total of 17,400 jobs in the ROI are attributable to LLNL. In effect, one out of every 95 jobs (or 17,400 out of 1,644,500) in the ROI is directly or indirectly attributable to LLNL.

4.3.5 Environmental Justice

Environmental Justice has been defined as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (EPA 2002a). Concern that minority and/or low-income populations might be bearing a disproportionate share of adverse health and environmental impacts led President Clinton to issue an Executive Order (EO) in 1994 to address these issues (59 *Federal Register* [FR] 7629). That order, EO 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," directs Federal agencies to make Environmental Justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations. When conducting NEPA evaluations, the NNSA incorporates Environmental Justice considerations into both its technical analyses and its public involvement program in accordance with the U.S. Environmental Protection Agency (EPA) and the Council on Environmental Quality (CEQ) regulations (CEQ 1997).

NNSA selected an area within 50 miles of the Livermore Site and Site 300 for analysis, an area that encompasses all or portions of 19 counties (Table 4.3.5–1). This radius was selected to be consistent with possible effects evaluated as part of the air impacts and accident consequence analyses.

4.3.5.1 *Identifying Minority and Low-Income Populations*

Demographic information from the U.S. Census Bureau was used to identify minority and low-income populations within 50 miles of LLNL (Census 2001). Information on locations and numbers of minority populations was obtained from the 2000 census; information on low-income populations was developed from 1999 incomes reported in the 2000 census. Census data are reported on the level of block groups, a geographical area that varies with size depending largely on population density (low-population density block groups generally cover larger geographical areas). Areas of minority or low-income populations are identified based on comparing the percentage of individuals who are minority or low-income within a block group with the average percentages for the State of California.

For this LLNL SW/SPEIS, minority populations are considered to be all *people of color*, which includes all ethnic and racial groups except non-Hispanic whites. For California, the minority population is 53.3 percent. Figure 4.3.5–1 shows the locations of block groups within 50-miles of each LLNL site where the minority population is greater than 53.3 percent.

For this LLNL SW/SPEIS, low-income populations are those individuals living below the poverty threshold, as defined by the 2000 census. This threshold varies from an annual household income of $8,259 to $38,138, depending on the number and age of household members. For California, the percent of the population living in poverty is 14.2 percent. Figure 4.3.5–2 shows the location of block groups within 50 miles of each LLNL site where the low-income population is greater than 14.2 percent.

TABLE 4.3.5–1.—*Summary of Minority and Low-Income Populations within 50 Miles of the Livermore Site and Site 300*

	Livermore Site			Site 300		
County	**Population**	**Minorities[a]**	**Low-Income[b]**	**Population**	**Minorities[a]**	**Low-Income[b]**
Alameda	1,443,741	852,646	159,219	1,443,741	852,646	159,219
Amador	—	—	—	1,466	238	227
Calaveras	—	—	—	12,476	2,055	1,146
Contra Costa	950,017	399,598	72,307	947,683	397,301	71,563
Marin	149,192	35,453	10,186	—	—	—
Merced	16,099	6,205	2,645	47,720	26,952	9,162
Napa	17,383	6,990	1,245	—	—	—
Sacramento	39,803	15,427	3,785	42,136	16,048	3,903
San Benito	—	—	—	3,399	1,427	314
San Francisco	776,733	437,824	87,908	406,806	256,994	58,629
San Joaquin	563,598	296,596	98,978	563,598	296,596	98,978
San Mateo	707,161	354,806	41,229	537,818	242,838	31,706
Santa Clara	1,682,585	938,303	126,408	1,682,585	938,303	126,408
Santa Cruz	96,502	18,064	6,961	77,026	16,496	5,606
Solano	372,123	192,003	30,360	192,225	104,315	15,960
Sonoma	3,479	1,172	299	—	—	—
Stanislaus	436,483	187,264	69,856	446,997	190,996	71,197
Tuolumne	—	—	—	352	66	55
Yolo	1,375	676	185	676	389	83
Totals	7,256,274	3,743,027	711,571	6,406,704	3,343,660	654,156
Percent of Population		51.6%	9.8%		52.2%	10.2%

Source: Census 2001.
[a] For this LLNL SW/SPEIS, minority populations are considered to be all *people of color*, which includes all ethnic and racial groups except non-Hispanic whites.
[b] For this LLNL SW/SPEIS, low-income populations are considered to be those individuals living below the poverty threshold, as defined by the 2000 census.

4.3.5.2 *Livermore Site*

Minority Populations

A total population of 7,256,274 resides within a 50-mile radius of the Livermore Site. Of these, 3,743,027, or 51.6 percent, are minorities. This percentage is less than the State of California as a whole. As shown in Figure 4.3.5–1, there are no block groups within a 5-mile radius that are categorized as minority. A very small area of Alameda County, approximately 10 miles west of the Livermore Site, is categorized as minority. Within 20 miles, higher concentrations of minorities are found within portions of western Alameda County and San Joaquin County in the Central Valley.

Low-Income Populations

Of the total population of 7,256,274 within 50 miles of the Livermore Site, 711,571, or 9.8 percent, are low income. This percentage is less than the State of California as a whole. As shown in Figure 4.3.5–2, there are no block groups within a 10-mile radius of the Livermore Site that have percentages of low-income populations greater than the state average. Within 20 miles, some higher concentrations of low-income populations are located in the eastern portion of Contra Costa County, San Joaquin County, the southwestern portion of Alameda County, and the northern portion of Santa Clara County.

4.3.5.3 *Site 300*

Minority Populations

A total population of 6,406,704 resides within a 50-mile radius of Site 300. Of these, 3,343,660, or 52.2 percent, are minorities. This percentage is less than the State of California as a whole. As shown in Figure 4.3.5–1, there are no block groups within a 5-mile radius that are categorized as minority. Several areas of San Joaquin County, approximately 9 miles north and northeast of Site 300, are categorized as minority. Within 20 miles, higher concentrations of minorities are found within western portions of San Joaquin and Stanislaus counties in the Central Valley.

Low-Income Populations

Of the total population of 6,406,704 within 50 miles of Site 300, 654,156, or 10.2 percent, are low income. This percentage is less than the State of California as a whole. As shown in Figure 4.3.5–2, there are no block groups within a 5-mile radius of Site 300 that have percentages of low-income populations greater than the state average. Within 10 miles, two areas of western San Joaquin County, to the north and northeast of Site 300, are categorized as low income. Within 20 miles, some higher concentrations of low-income populations are located in the western portions of San Joaquin and Stanislaus counties and the northern portion of Santa Clara County.

4.4 COMMUNITY SERVICES

This section describes the existing demands on fire protection and emergency services, police protection and security services, school services, and nonhazardous solid waste disposal from the operation of LLNL. Appendix I contains a more detailed discussion of emergency preparedness planning and response and mutual assistance agreements.

4.4.1 Fire Protection and Emergency Services

The existing fire protection and emergency services at LLNL are provided by the LLNL Emergency Management Division and by offsite fire protection agencies through mutual aid agreements.

4.4.1.1 Livermore Site

Onsite Facilities

The Emergency Management Division at the Livermore Site occupies two facilities: a fire station at Building 323 (Fire Station No. 1) and an emergency dispatch center at Building 313. All Livermore Site health and safety alarms are received by the emergency dispatch center through the site-wide alarm system. In addition to monitoring the Livermore Site alarms and dispatching personnel, the emergency dispatch center serves as the mutual aid dispatch center for both the Twin Valley Mutual Aid Plan and the Alameda County Mutual Aid Plan. Requests for mutual aid are processed and appropriate mutual aid equipment is dispatched based on a standard response schedule. The LLNL fire chief is the mutual aid coordinator for the Twin Valley Mutual Aid Plan and the Alameda County Mutual Aid Plan.

There are about 62 fire protection and emergency services personnel at LLNL in the following categories: fire protection engineering and fire prevention, training, emergency dispatch, and emergency operations. Personnel are rotated between the Livermore Site fire station and the Site 300 fire station (Fire Station No. 2). The minimum staff level for the Livermore Site (Fire Station No. 1) is eight nonmanagement personnel and one chief officer on call 24 hours per day.

Onsite Fire Apparatus Description and Replacement Schedule

LLNL Fire Station No. 1 is equipped with four large-capacity pumpers (1,000 to 1,500 gallons per minute), including one ladder truck and one four-wheel drive; one smaller capacity (325 gallons per minute) four-wheel drive pumper; a special services unit with hazardous material containment equipment; two ambulances; and three command vehicles.

A fire apparatus replacement schedule, which covers a rolling 5-year period, is updated on a yearly basis. Each apparatus has a planned lifespan and replacement date. Amendments are made annually to reflect changes or additions in the replacement schedule. Adequate funding for replacement apparatus is available.

Onsite Emergency Procedures

LLNL has compiled its general emergency response policies and procedures for the Livermore Site into the Emergency Plan (LLNL 2003a). The plan provides an overview of emergency response procedures for LLNL management and for major departments and programs. Appendix I contains a more detailed discussion of the Emergency Plan.

Onsite Emergency Response Characteristics

The average Livermore Site Fire Department response time onsite is 3.5 minutes. One vehicle and four personnel will initially respond to a call onsite. Additional equipment and personnel will respond as needed. Table 4.4.1.1–1 provides a summary of the numbers and types of onsite emergency calls to which the LLNL fire safety division responded from 1999 through 2002 (LLNL 2003b).

TABLE 4.4.1.1–1.—*Summary of Emergency Response Calls for 1999 through 2002*

Type of Incident	Number of Incidents							
	1999		2000		2001		2002	
	Livermore Site	Site 300[a]	Livermore Site	Site 300[a]	Livermore Site	Site 300[a]	Livermore Site	Site 300[a]
Ambulance	141		120		142		196	
Fire	466		319		341		394	
Hazardous materials	74		66		69		61	
Mutual/automatic aid[b]	683		668		1,079[c]		885[c]	
Total	**1,364**	**59**	**1,173**	**68**	**1,631**	**59**	**1,536**	**65**

Source: LLNL 2003b.
[a] Site 300 emergency response calls are not categorized by incident type.
[b] Includes responses under agreements with offsite agencies.
[c] Increase from previous years primarily due to expansion of service area and calls on and after September 11, 2001.

At the Livermore Site, the ambulances transport patients to a medical facility that offers care commensurate with the severity of the injury (based on evaluation using emergency medical service protocols). These facilities include the onsite Health Services Department, Valley Care Medical Center (Pleasanton), or Eden Medical Center (Castro Valley).

Offsite Agency Involvement

The LLNL Emergency Management Division participates in several automatic and mutual aid agreements with various offsite agencies. Automatic aid is dispatched offsite without request on a first alarm. Mutual aid assistance is specifically requested after local agency resources have been depleted. LLNL participates in automatic and mutual aid agreements with the Livermore-Pleasanton Fire Department and the Alameda County Fire Patrol, respectively. LLNL participates in a mutual aid network that extends throughout the state of California.

The LLNL Fire Department responds to approximately 300 of the Livermore-Pleasanton Fire Department’s total annual calls. Conversely, the Livermore-Pleasanton Fire Department responds to three of the Livermore Site’s total annual calls. LLNL responds to an average of 300 Alameda County Fire Patrol calls per year; the Alameda County Fire Patrol typically is not called on to respond to LLNL calls. The California Department of Forestry, which provides mutual aid to Site 300, does not respond to mutual aid requests at the Livermore Site because it does not maintain structural fire equipment. The Livermore Site fire station assists with approximately three wildland fires per year within the California Department of Forestry's jurisdiction. This constitutes less than 1 percent of the California Department of Forestry's total annual calls (LLNL 2003b).

Offsite Facilities

The mutual and automatic aid agreements between the LLNL Fire Department and the local fire departments are based on the concept that the closest emergency aid responds to the call. For example, the LLNL Fire Department would respond, along with the Livermore-Pleasanton Fire Department, to a call at the Graham Court warehouse, the Research Drive offices, or the Almond Avenue school site.

4.4.1.2 Site 300

Onsite Facilities

LLNL Fire Station No. 2 is located in Building 890 at Site 300. This facility is part of the overall Emergency Management Division of LLNL and is operated under the direction of the LLNL fire chief. At a minimum, four personnel are on duty 24 hours a day at Fire Station No. 2. One chief officer, who is responsible for Site 300, is on call at the Livermore Site during normal business hours and from an offsite residence outside of normal business hours.

Onsite Fire Apparatus Description

LLNL Fire Station No. 2 is equipped with two large (1,000 and 1,250 gallons per minute) pumpers, the smaller of which is four-wheel drive; one smaller four-wheel drive pumper (325 gallons per minute); and one ambulance.

Onsite Emergency Procedures

LLNL has compiled its general emergency response policies and procedures for Site 300 into the Site 300 Emergency Plan (LLNL 2003c). Appendix I contains a more detailed discussion of the Site 300 Emergency Plan.

The dispatcher at Building 313, who dispatches fire personnel and equipment from Fire Station No. 2, monitors alarms at Site 300. The Livermore Site Emergency Dispatch Center dispatches additional resources from the LLNL Fire Station No. 1 if necessary.

Onsite Emergency Response Characteristics

The average Site 300 fire station response time onsite is 4.5 minutes. One vehicle and four personnel respond from the Site 300 fire station. In addition, a vehicle from the Livermore Site responds as a "cover" in case an additional fire breaks out. The minimum response time to the Site 300 main gate from the Livermore Site is 15 minutes. Table 4.4.1.1–1 provides the number of onsite emergency calls to which the Site 300 Fire Department from 1999 through 2002.

At Site 300, the ambulance transports patients to a medical facility that offers care commensurate with the severity of the injury (based on evaluation using emergency medical service protocols). These facilities include the Sutter Hospital in the city of Tracy or the nearest trauma center.

Offsite Agency Involvement

The LLNL Emergency Management Division maintains mutual aid agreements with several agencies that could serve Site 300, including the city of Tracy and the California Department of Forestry.

The city of Tracy Fire Department and the Site 300 fire station typically do not request aid from each other. The Site 300 fire station has not historically responded to calls within the Tracy Rural County Fire Protection District's jurisdiction. Conversely, the Tracy Rural County Fire Protection District typically receives one call annually from Site 300. The California Department of Forestry and the Site 300 fire station respond to an average of less than three of each other’s calls per year (LLNL 2003b).

4.4.2 Police Protection and Security Services

This section presents an overview of onsite security services at LLNL. The existing police protection and security services provided by offsite agencies participating in emergency response agreements with LLNL are also discussed.

Onsite Activities

The Office of Investigative Services and Protective Force Division of the Safeguards and Security Department provide police protection and security services at LLNL. It is the function of the Protective Force Division to provide protection for LLNL personnel and assets. This protection is provided through several channels, including access control, fixed access and surveillance points, random vehicle and foot patrols, response elements, and special response team elements.

Emergency Response Characteristics

The Protective Force Division provides emergency response service to the Livermore Site and Site 300 and has contingency plans to cover credible emergencies, including work stoppages, bomb threats, natural disasters, site-wide evacuations, callout procedures, satellite command center activation procedures, executive protection, alarm response procedures, and civil disorders.

Offsite Agency Involvement

LLNL participates in emergency response agreements with the Livermore Police Department, the Alameda County Sheriff’s Department, the San Joaquin County Sheriff’s Department, the California Highway Patrol (CHP), and the Federal Bureau of Investigation (FBI). Offsite agencies generally provide first alarm response to LLNL offsite leased properties (LLNL 2002bz).

The Livermore Police Department is rarely requested to respond to calls at the Livermore Site through its emergency response agreement. The Alameda County Sheriff's Department responds to an average of six calls at the Livermore Site per year, which is less than 1 percent of the agency's total annual calls. Site 300 is within Patrol District 8 of the San Joaquin County Sheriff's Department. LLNL did not request assistance from the Sheriff's Department during 2001. The CHP responds to calls from the Protective Force Division during large-scale demonstrations that have the potential to block Vasco Road and Greenville Road. The CHP responds to calls for crowd control from the Protective Force Division on an average of once per year. There is occasional interaction with the FBI for criminal and security investigations (LLNL 2002bz).

4.4.3 School Services

In the 2001 – 2002 school year, student enrollment totaled 606,967 (Table 4.4.3–1) in the four-county ROI described in Section 4.3. The local school district is the Livermore Valley Joint Unified School District and includes schools from kindergarten through high school. This district serves approximately 14,000 students from a 240-square-mile area that includes the city of Livermore. Neither LLNL nor the Livermore Valley Joint Unified School District tracks the number of children of LLNL employees that attend district schools. Based on the number of LLNL employees and other LLNL workers residing within Livermore (see Section 4.3.1 and Table 4.3.2–1), and the percentage of the Livermore population attending Livermore Valley Joint Unified School District schools, it is calculated that approximately 2,090 children of LLNL workers attend schools within the district.

TABLE 4.4.3–1.—*School Enrollment in the Four-County Region of Influence*

	Alameda	San Joaquin	Contra Costa	Stanislaus	ROI
Total school enrollment	217,591	127,354	161,742	100,280	606,967

Source: California Department of Education 2003.

4.4.4 Nonhazardous and Nonradioactive Solid Waste Disposal

This section discusses only nonhazardous and nonradioactive solid waste disposal. Disposal of hazardous and radioactive waste generated at LLNL is discussed in Section 4.15.2.

Livermore Site

Description of Landfill Facilities

Nonhazardous solid waste generated at the Livermore Site is transported to the Altamont Landfill for disposal (LLNL 2003bd). The landfill is estimated to have sufficient capacity to receive waste until the year 2038 (Hurst 2003). The current total daily permitted throughput at the Altamont Landfill is 11,150 tons per day (SWIS 2002).

Plans for Expansion of Onsite Facilities

There are no plans to expand the Livermore Site nonhazardous solid waste storage facilities or to modify nonhazardous waste disposal methods.

Onsite Solid Waste Characteristics

During 2002, of the 15,300 tons of nonhazardous waste generated at the Livermore Site, approximately 5,650 tons were collected and transported to the Altamont Landfill from the Livermore Site (LLNL 2003bd). Construction waste made up approximately two-thirds of this total, and the remaining one-third consisted of paper, plastics, glass, other organics, and other wastes. Livermore Site waste is collected in 222 onsite containers with average volume capacities of 4 cubic yards each (LLNL 2003bd). LLNL disposes of waste daily at the Altamont Landfill. Waste is collected and disposed of daily from 178 of the containers, twice weekly from 31 of the containers, weekly from 10 of the containers, and monthly from 3 of the containers.

Waste Reduction and Recycling Programs

In 2002, LLNL diverted more than 60 percent of its 15,300 tons of nonhazardous waste for recycling and reuse. A portion of the nonhazardous waste generated annually is sold, including cardboard containers and metals. Additionally, soil is reused at the Livermore Site and for daily cover at the Altamont landfill (LLNL 2002cc). Approximately 560 tons of landscape clippings were composted in 2002 (LLNL 2003bd).

Site 300

During 2002, approximately 200 tons of nonhazardous solid waste was transported from Site 300. The waste generated at Site 300 is collected from 3 to 5 times per month and transported to the Tracy Material Recovery and Solid Waste Transfer Station, a facility where waste is sorted for recycling. A 16-cubic-yard trash truck (compactor), which can carry 3 to 4 tons per load, collects waste an average of two times per month. A 10-cubic-yard dump truck collects waste an average of one time per month (LLNL 2003bd).

Site 300 has waste reduction and recycling programs in effect, including cardboard, paper, and metal salvage activities. Waste is also sorted at the disposal site for recycling (LLNL 2003bd).

4.5 PREHISTORIC AND HISTORIC CULTURAL RESOURCES

This section provides a summary evaluation of the prehistoric and historic cultural resources on the Livermore Site and Site 300. Paleontological resources, or fossils, are discussed in Section 4.8. Cultural resources include prehistoric, Native American, and historic resources.

Prehistoric resources are physical properties resulting from human activities that predate written records and are generally identified as isolated finds or sites. Prehistoric resources can include village sites, temporary camps, lithic scatters, roasting pits/hearths, milling features, petroglyphs, rock features, and burials.

Native American resources are sites, areas, and materials important to Native Americans for religious, spiritual, or traditional reasons. These resources are also known as Traditional Cultural Properties. These resources may include villages, burials, petroglyphs, rock features, spring locations, or natural geologic formations. Fundamental to many Native American religions is the belief in the sacred character of physical places, such as mountain peaks, springs, or burials. Traditional rituals may also prescribe the use of particular native plants, animals, or minerals. Therefore, activities that may affect sacred areas, their accessibility, or the availability of materials used in traditional practices are a primary concern. Interested Native American parties identified by the California Native American Heritage Commission were contacted with the result that no Traditional Cultural Properties are known to exist at LLNL.

Historic resources consist of physical properties, structures, or built items resulting from human activities that postdate written records. Historic resources can include archaeological remains, standing buildings and architectural structures, and historic landscapes. Historic archaeological site types include town sites, homesteads, agricultural or ranching features, mining-related features, refuse concentrations, and features or artifacts associated with early military use of the land. Historic architectural resources can include houses, cabins, barns, and lighthouses; local structures, such as churches, post offices, and meeting halls; and early military structures, such as hangars, administration buildings, barracks, officer's quarters, warehouses, and guardhouses. Structures or engineering features associated with scientific or technological developments, or buildings or objects that relate to programs associated with political eras such as the Cold War, may also represent historic resources.

4.5.1 Federal Regulations Related to Cultural Resources

The *National Historic Preservation Act* (NHPA) of 1966 (16 U.S.C. §470 et seq.), and subsequent amendments, is the basis for a process that Federal agencies such as the NNSA use to consider the effects of projects on significant cultural resources. The procedure an agency follows to achieve compliance with this legislation is commonly called the Section 106 process. Although the NHPA was created primarily in response to numerous federally funded urban renewal projects that demolished old neighborhoods and historic homes, it applies to any action an agency may take that will affect historic or cultural resources as they are defined in the law. The most recent guidelines were put into effect January 11, 2001, and essentially define a Section 106 process that places primary responsibility on the involved Federal agency. Other laws governing cultural resources include the *Archaeological and Historic Preservation Act* of 1974 (16 U.S.C. §469), the *Archaeological Resources Protection Act* (ARPA) of 1979 (16 U.S.C. §470 aa-mm), and their implementing regulations. The primary purpose of the NHPA is to require Federal agencies to consider the effects of their actions on properties listed, or eligible for listing, in the National Register of Historic Places (NRHP). Federal eligibility criteria for NRHP listing are included in Appendix G.

Federal agencies are also required to consult with recognized Native American tribes regarding the potential effects of the project on Native American resources or Traditional Cultural Properties. NNSA has conferred with the California Native American Heritage Commission (Appendix G) to define a list of appropriate Native American representatives to contact, and has consulted with eleven representatives of Ohlone/Costanoah groups. No Traditional Cultural Properties have been identified on the Livermore Site or Site 300.

4.5.2 Prehistoric Resources

Livermore Site

Field surveys and records searches conducted prior to and for the 1992 LLNL Environmental Impact Statement/Environmental Impact Report (EIS/EIR) did not reveal the presence of prehistoric resources on the Livermore Site (LLNL 1992a). Previous work included archival reviews conducted at the California Archaeological Inventory at Sonoma State University; the California Archaeological Inventory at California State, Stanislaus; a records search at Basin Research Associates in San Leandro, California; and review of the archaeological files at LLNL (LLNL 1992a). In addition, field surveys conducted by Holman & Associates in the undeveloped western and northern perimeter areas, including a 500-foot-wide buffer, and an undeveloped area survey conducted in 1991 did not reveal the presence of prehistoric resources (LLNL 1992a).

Because most of the Livermore Site is developed, the likelihood of finding unrecorded and undisturbed prehistoric sites is low; however, there is still the possibility that undisturbed prehistoric sites lay buried under the modern landscaping.

Site 300

Site 300 has been surveyed for both prehistoric and historic cultural resources, and a number of potentially significant prehistoric sites have been identified (LLNL 1992a). Further investigation and delineation of the known resources has resulted in the establishment of four archaeological sensitivity areas that contain these prehistoric cultural resources (LLNL 2002bj). The resources include rock shelters and other areas used for making stone tools. No formal subsurface testing program has occurred and formal NRHP eligibility determinations are incomplete. Development or ground disturbing activities have not been permitted in or within 300 feet of the delineated areas unless the activity was approved or monitored by LLNL archaeologists (LLNL 2002bj). It is likely the subsurface prehistoric cultural resources exist at Site 300. This is because prehistoric resources are known to exist at the site, and much of the site is undeveloped.

4.5.3 Historic Resources

Livermore Site

The Livermore Site has a number of buildings associated with historic events or significant LLNL achievements. These include buildings from the World War II-era Livermore Naval Air Station as well as buildings built after 1952. Some of the buildings and facilities, or groups of facilities, at the Livermore Site, may be eligible for listing in the NRHP. To facilitate evaluation of the properties, an historic context is being developed and analysis of specific individual properties is in progress (LLNL 2002bj).

To date, DOE and the State Historic Preservation Officer (SHPO) have evaluated and concurred that 52 buildings are not eligible for listing on the NRHP. The negative or not eligible determinations include the following buildings: 177, 222, 251, 317, 328A, 412, 431, 490, 592, 593, 1253, 1477, 1478, 1482, 1601, 1602, 1631, 1734, 1877, 2512, 2527, 2529, 2530, 2629, 2685, 2687, 2626, 2801, 2802, 2808, 3629, 3703, 3751, 3777, 3903, 3904, 3905, 3907, 3982, 4107, 4180, 4302, 4377, 4378, 4383, 4384, 4387, 4388, 4440, 4442, 8011, and 8806 (LLNL 2002bj, LLNL 2003ca).

Site 300

Field surveys and archival research conducted prior to and for the 1992 LLNL EIS/EIR revealed the presence of potentially eligible historic archaeological resources at Site 300. Most notable is CA-SJO-173H, the Carnegie townsite, associated with the Carnegie Brick and Pottery Company founded in 1895. The site has components and material remains that are within the Site 300 boundaries and it has been determined that places associated with Carnegie are considered eligible for the NRHP.

Following the 1992 LLNL EIS/EIR, additional investigation and delineation of known resources by LLNL has resulted in the establishment of 17 archaeological sensitivity areas that contain historic cultural resources (LLNL 2002bj). Development or ground-disturbing activities have not been permitted in or within 300 feet of the delineated areas unless approved or monitored by LLNL archaeologists (LLNL 2002bj).

4.6 AESTHETICS AND SCENIC RESOURCES

The scenic quality or character of an area consists of the landscape features and social environment from which they are viewed. The landscape features that define an area of high visual quality may be natural, such as mountain views, or man-made, such as city skyline. To assess the quality of visual resources in the project area, this section describes the overall visual character and distinct visual features on or in the view shed of the Livermore Site and Site 300.

4.6.1 Scenic Resources Policies

The Landscape Architecture Master Plan for LLNL provides guidance for development at LLNL (LLNL 2002d). Because there are no strict standards at LLNL for matching exterior building color or style, the landscape architecture planning process is the only means of creating cohesiveness in image. The Landscape Architecture Master Plan is intended to ensure that all site improvements are architecturally compatible with their immediate surroundings and that other aesthetic qualities, such as temperature, wind, and glare are moderated.

The Livermore Site is within Alameda County. In addition, the western 1,100 feet of the Livermore Site is within the city of Livermore. Most of Site 300 is within San Joaquin County, with a small portion in Alameda County. The surrounding cities and counties have no planning jurisdiction for the site because LLNL is a Federal facility owned by DOE. Nevertheless, as a good neighbor policy, LLNL does consider local planning policies, to the extent practicable, in its land decisions. An overview of the relevant scenic resource policies of the surrounding jurisdictions is provided below.

Alameda County

East County Area Plan

The East County Area Plan of the Alameda County General Plan presents Alameda County's intent regarding future development and resource conservation in the East County area (Alameda County 1994). The East County Area Plan provides specific visual resource goals and policies as well as specific implementation programs to achieve the goals and policies. The East County Area Plan also provides specific guidance as to preservation of sensitive view sheds and scenic corridors. Policies relevant to the Livermore Site or Site 300 are summarized in Table 4.6.1–1.

TABLE 4.6.1–1.—*Visual Resource Policies of the East County Area Plan Relevant to the Livermore Site or Site 300*

Trees	
Policy 110	Alameda County shall require that developments are sited to avoid or, if avoidance is infeasible, to minimize disturbance to large stands of mature, healthy trees and individual trees of notable size and age.
Policy 111	Alameda County shall not allow any structure to exceed the height of the tree canopy in woodland areas.
Landscaping	
Policy 114	Alameda County shall require the use of landscaping…to enhance the scenic quality of the area and screen undesirable views.
Policy 115	In all cases appropriate…landscaping and screening shall be required to minimize the visual impact of development…To the maximum extent practicable, all exterior lighting must be located, designed, and shielded so as to confine direct rays to the parcel where lighting is located.
Utilities	
Policy 120	Alameda County shall require that utility lines be placed underground whenever feasible. When located aboveground, utility lines and supporting structures shall be sited to minimize their visual impact.

Source: Alameda County 1994.

Scenic Route Element of the Alameda County General Plan

The Alameda County Board of Supervisors adopted the scenic route element of the Alameda County General Plan in May 1966. The East County Area Plan recommends an update to the scenic route element but this task has not been completed. The scenic route element serves as a guide for establishment of programs and legislation for the development of a system of scenic routes. A primary goal of the element is the preservation and enhancement of scenic qualities and natural scenic areas adjacent to and visible from scenic routes. The element contains objectives, definitions, policies, standards, and implementation measures (Alameda County 1966).

Scenic routes are defined as consisting of three elements: the right-of-way (ROW), the adjacent scenic corridor, and areas extending beyond the scenic corridor. Scenic corridors are described in two ways: (1) areas that extend beyond a scenic route ROW and are of sufficient scenic quality to be acquired by state or local jurisdictions, and (2) areas to which development controls should be applied to preserve and enhance nearby views or maintain unobstructed distant views along a scenic route and provide a pleasant route of travel (Alameda County 1966).

The following roadway segments in the vicinity of the Livermore Site are designated as scenic routes in the scenic route element of the Alameda County General Plan:

- I-580
- Vasco Road
- Patterson Pass Road (from Vasco Road to the San Joaquin County border)
- Tesla Road (from Vasco Road to the San Joaquin County border)
- Greenville Road (from I-580 to Tesla Road)

- Altamont Pass Road (from I-580 to Route 239)
- Cross Road (from Patterson Pass Road to Tesla Road)
- Flynn Road (from Patterson Pass Road to I-580)
- Mines Road

Figure 4.2.2.1–2, in Section 4.2.2.1, illustrates the scenic routes designated in the Alameda County scenic route element.

The visual resource preservation policies contained in the Alameda County scenic route element are similar to those described above for the East County Area Plan but are specific to designated scenic routes. These policies are summarized below.

- **Provide for normal uses of land and protect against unsightly features.** In both urban and rural areas, normally permitted uses of land should be allowed in scenic corridors, except that panoramic views and vistas should be preserved and enhanced by supplementing normal zoning regulations with special height, area and side-yard regulations and by providing architectural and site design review.
- **Use landscaping to increase scenic qualities of scenic route corridors.** Landscaping should be designed and maintained in scenic route corridors to provide added visual interest, to frame scenic views, and to screen unsightly views.
- **Use underground utility distribution lines when feasible and make overhead lines inconspicuous.** New, relocated, or existing utility distribution lines should be placed underground whenever feasible. When it is not feasible to place lines underground, they should be inconspicuous from the scenic route. Poles of an improved design should be used wherever possible. Combined or adjacent ROWs and common poles should be used wherever feasible.
- **Control tree removal.** As a means of preserving the scenic quality of the county, no mature trees should be removed without permission from the local jurisdiction.

City of Livermore

Livermore Community General Plan

The Livermore Community General Plan is the comprehensive, long-term general plan for the physical development of the city and any land outside city boundaries relevant to its long-range planning (City of Livermore 1975). The plan specifies a number of natural and man-made visual amenities that should be preserved including some near the Livermore Site and Site 300 (Table 4.6.1–2).

TABLE 4.6.1–2.—*Amenities Designated for Preservation in the Livermore Community General Plan*

Natural Amenities	Man-made Amenities
Ridgelines	Vineyards (i.e., Wente Winery and Concannon Winery)
Grasslands	Other agriculture
Corral Hollow	Buildings of historic or architectural interest (i.e., Tesla historical town site and coal mines)
	Scenic highways, roads, and corridors

Source: City of Livermore 1975.

Scenic Route Element of the Livermore General Plan

The scenic route element of the Livermore Community General Plan is designed to guide the preservation and enhancement of scenic values along streets and highways in the Livermore Valley. It also aims to preserve and enhance scenic values that are of outstanding quality or that provide access to important scenic, recreational, cultural, or historic points. Furthermore, the scenic route element provides a comprehensive plan and expands the scenic route plans of Alameda County and the California Department of Transportation within the Livermore planning area. The following roadway segments in the vicinity of the Livermore Site are designated as scenic routes in the city of Livermore's scenic route element (Figure 4.2.2.1–2) (City of Livermore 1975):

- I-580
- Greenville Road
- Tesla Road
- Altamont Pass Road
- Patterson Pass Road (east of Greenville Road)
- Flynn Road

The policies in the scenic route element of the city of Livermore Community General Plan are similar to those contained in the East County Area Plan (Alameda County 1994) and scenic route element of the Alameda County General Plan (Alameda County 1966). These policies address the use of landscaping to increase the scenic qualities of scenic corridors and encourage the use of underground utilities and the preservation of mature trees (City of Livermore 1975).

Scenic Highways Element of the San Joaquin County General Plan

The San Joaquin County Board of Supervisors adopted the scenic highways element of the San Joaquin County General Plan on October 19, 1978. The purpose of the element is to establish scenic routes in the county and guide the preservation and enhancement of scenic qualities and natural scenic areas adjacent to and visible from scenic routes (San Joaquin County 1978).

San Joaquin County recognized the value of scenic resources surrounding a 16-mile portion of I-580 and I-5 between Stanislaus and Alameda counties. In 1974, the county adopted a scenic corridor zone, designed to give aesthetic protection to county-designated scenic highways. Later in 1974, this 16-mile segment of I-580 and I-5 received official designation as a state scenic highway. No other highways or roadways within San Joaquin County have been identified as scenic. Figure 4.2.2.1–2 shows the location of a segment of the I-580 state scenic highway corridor within San Joaquin County.

4.6.2 Visual Character of the Project Area

Regional Character

Hills and mountains that define the regional view shed and provide open space around the development on the valley floor ring the Livermore Valley of eastern Alameda County, where the Livermore Site is located. The terrain in the vicinity of the sites ranges from relatively flat land to gently rolling hills. The hills east and south of the Livermore Site gradually become steeper as they trend eastward to form the Altamont Hills of the Diablo Range. Wind turbines north and south of the Altamont Pass punctuate the eastern horizon and have become part of the eastern valley landscape identity.

Site 300 is located in the Altamont Hills of the Diablo Range. This area is largely grasslands and low shrubs in areas ranging in topography from gently rolling hills to steeply sloping ridges and drainages. View sheds in the area around Site 300 are severely constrained by topography.

Livermore Site

The Livermore Site has a campus-like or business park-like setting with buildings, internal roadways, pathways, and open space. Portions of the site along the western and northern boundaries remain largely undeveloped and serve as security buffer zones. A row of eucalyptus and poplar trees surrounds much of the developed portion of the Livermore Site and screens most ground-level views of the facility. Onsite buildings range in height from 10 feet to approximately 110 feet. A 9-foot chainlink and barbed wire security fence surrounds the Livermore Site. The most prominent buildings in the public view shed are the administrative buildings off of East Avenue in the southwest corner of the site, the Sunshine building in the western portion of the site, and NIF in the northeast corner. These buildings are visible from locations along adjacent roads.

The area surrounding the Livermore Site is a mixture of rural and pastoral uses and urban development. SNL/CA is located immediately south of the Livermore Site. Rural residences and grazing land are the primary visual features to the east. Detached residences occupy the area west of the Livermore Site, giving the area a suburban character. A small area of commercial use occupies lands immediately southwest of LLNL. A mixture of vineyards and residential uses surrounds the commercial area, although residential development is currently underway and the visual character of the area is shifting from pastoral to suburban. The area north of the Livermore Site to I-580 is industrial, primarily one- and two-story industrial buildings, business parks, and the Union Pacific railroad line that traverses the area. This area is visually similar with the research, business, and industrial character of the Livermore Site.

Site 300

The main gate and the GSA of Site 300, including a number of buildings, roads, and infrastructure, are foreground and middle-ground features in view from Corral Hollow Road, which forms the southern boundary of Site 300. Vegetative screening and topography partially obscure many of the features associated with the GSA. The majority of Site 300 is obscured from view by topography.

The surrounding area is primarily undeveloped open space or rural, with some exceptions. Fireworks America is adjacent to and northeast of Site 300. Although the sign at the entrance to the facility is visible from Corral Hollow Road, structures associated with this facility are obscured by topography. The SRI International Testing Facility is approximately 0.6 mile south of Site 300 and is not visible from Corral Hollow Road.

Carnegie State Vehicular Recreation Area, located south of the western portion of Site 300, is used by off-road vehicles. The park includes dirt trails on the surrounding hillsides and a ranger station, picnic areas, and several contoured riding areas in the valley floor adjacent to Corral Hollow Road. These features are all visible from Corral Hollow Road. The high degree of modification is substantially out of character with the surrounding open space and rural features of the area.

4.6.3 Sensitive Views in the Surrounding Area

Locations of visual sensitivity are defined in general terms as areas where high concentrations of people may be present or areas that are readily accessible to large numbers of people. They are further defined in terms of several site-specific factors including

- Areas of high scenic quality (i.e., designated scenic corridors or locations)
- Recreation areas characterized by high numbers of users with sensitivity to visual quality (i.e., parks, preserves, and private recreation areas)
- Important historic or archaeological locations

No visually sensitive locations are defined on the Livermore Site or Site 300. The visual sensitivities of areas surrounding the Livermore Site and Site 300 are described below.

Livermore Site

Sensitive views around the Livermore Site include residential areas and scenic routes or visual amenities designated by the city of Livermore or Alameda County, as described in Section 4.6.1, Scenic Resources Policies.

The Livermore Site is not visible from several designated scenic resource areas (e.g., Wente and Concannon wineries, Tesla historical town site, Altamont Pass Road, Cross Road, and Mines Road) and is only minimally visible from several other designated scenic resource areas as a result of distance or intermittent topography. The Livermore Site is relatively distant from I-580 (approximately 1.5 miles) and views are obstructed by vegetation and development. Only the tallest onsite building on the Livermore Site is intermittently visible from this highway. The Livermore Site is not visible from most of Flynn Road but does occupy the middle-ground views from the western end of Flynn Road. As a result of distance, the facilities are visually indistinct and are consistent with surrounding development. The view of the Livermore Site from Tesla Road is almost completely obstructed by intervening topography.

The Livermore Site is prominently visible from residences near and motorists traveling along Vasco Road. Vegetation that surrounds the Livermore Site obstructs or partially screens most views of the facilities from this area (Figure 4.6.3–1). The buffer zone provides visual separation between the Livermore Site and surrounding viewers.

The Livermore Site is also visible from residences and vineyards to the southwest, and to motorists traveling north on Vasco Road (Figure 4.6.3–2). The security buffer area and vegetation provide partial screening of the Livermore Site from this view. In addition, residential and vineyard development in this area is currently taking place and will further screen views of the facilities.

The Livermore Site is prominent in views from most of Greenville Road. Although Greenville Road follows the eastern boundary of the Livermore Site, views from this portion of the road are heavily screened by vegetation. Views from Greenville Road south of the Livermore Site are more panoramic due to the elevated viewing perspective, but are partially screened by the rolling topography (Figure 4.6.3–3). The Livermore Site is visually distinct in the foreground and middle-ground, but is visually consistent with the overall pattern of development in the view shed.

The Livermore Site is also prominent in views from the western portions of Patterson Pass Road from Vasco Road to Flynn Road. Views from Patterson Pass Road adjacent to the Livermore Site, similar to those described for Vasco Road, are largely screened by vegetation and are separated from viewers by a security buffer area (Figure 4.6.3–2). Views toward the west from the lower reaches of Patterson Pass Road are similarly obstructed by vegetation. Views of the facilities from the higher reaches of Patterson Pass Road are obstructed by topography.

Site 300

Sensitive views around Site 300 include the Carnegie State Vehicular Recreation Area and scenic routes designated by Alameda County or San Joaquin County, as described in Section 4.6.1.

Source: Original.

FIGURE 4.6.3–1.—*View of the Livermore Site Looking Southeast from Patterson Pass Road and Vasco Road*

Source: Original.

FIGURE 4.6.3–2.—*View of the Livermore Site Looking Northeast from Vasco Road*

Source: Original.

FIGURE 4.6.3–3.—*View of the Livermore Site Looking North from Greenville Road*

Site 300 is not within the view shed of any of the designated scenic corridors except for a very short section of Tesla Road at the eastern end of Alameda County. Tesla Road becomes Corral Hollow Road at the San Joaquin County boundary. Corral Hollow Road follows the southern boundary of Site 300 and affords views of the site, but is not designated as a scenic corridor. Corral Hollow Road, which is adjacent to and south of Site 300, is the nearest public roadway with a view of the site. The view of Site 300 from Corral Hollow Road is of parking areas and several single-story structures in the GSA (Figure 4.6.3-4). The remainder of the view of Site 300 from Corral Hollow Road consists of rolling hillsides and a few scattered small structures on the hilltops. Other than the GSA, the facilities of Site 300 are not apparent in landscape views from publicly accessible viewpoints; however, a 3-foot-high wire fence surrounding Site 300 is visible from Corral Hollow Road, along the site's southern boundary.

Site 300 can be seen from the Carnegie State Vehicular Recreation Area, which lies directly south. Building 899, a single-story structure, and its surrounding light posts are visible from the recreation area. From the picnic area near the park entrance, the view of Site 300 consists primarily of undeveloped hillsides.

Source: Original.

FIGURE 4.6.3–4.—*View of Site 300 Looking North from Corral Hollow Road*

4.7 METEOROLOGY

Situated between the Pacific Coast and warmer inland valleys, the Livermore area experiences climatic conditions that are dominated by the differential heating between these land and water surfaces and local undulating terrain. In summer, cold water welling up along the coast and hot inland temperatures cause a strong onshore pressure gradient. Together with the semi-permanent high-pressure area centered over the northeastern Pacific Ocean, summers are characterized by plentiful clear skies, negligible precipitation, and strong, afternoon winds. By winter, the inflow of maritime air is not as prevalent because the differential heating between the coast and inland valleys is less pronounced. High pressure along the coast weakens and shifts southward, allowing winter storms to frequent the area.

Further detail on temperature, precipitation, winds, and storm events is provided below. Much of the information is gleaned from long-term records compiled by the National Weather Service from its recording station in the city of Livermore and two locations (Tracy Carbona and Tracy Pumping Plant) within the nearby city of Tracy. These long-term profiles are supplemented with data collected onsite. Meteorological data (including wind speed, wind direction, rainfall, humidity, solar radiation, and air temperature) are continuously gathered onsite at the Livermore Site and at Site 300. Onsite monitoring programs are discussed in detail in the LLNL Site Annual Environmental Report (SAER), which is published annually, and some data have been extracted from recent reports.

4.7.1 Temperature

Average daily maximum and minimum temperature plots for National Weather Service stations at Livermore and Tracy are provided in Figure 4.7.1–1. Although the area is some distance from the coast, summer temperatures are moderated to a degree by an inflow of cooler marine air to replace the rising warm air in the San Joaquin Valley. In the Livermore Valley, the daily temperature ranges from a low of 55 degrees Fahrenheit (°F) in the early morning to almost 90°F by late afternoon. Afternoon temperatures in the summer at Site 300 are typically about 10°F warmer than the Livermore Site.

Temperatures begin to drop noticeably in October. Average daily highs and lows are approximately 6 degrees lower than in the summer months, and continue to drop by another 10 degrees in November, and almost 7 degrees more in December. Average daily low and high temperatures range from 37°F to 57°F during the winter months at Livermore. Temperatures at Tracy are a couple of degrees cooler, typically ranging from 35°F to 55°F. As spring approaches, temperatures begin to increase by about 4°F per month, beginning as early as February, until reaching peak temperatures in July.

4.7.2 Precipitation

Annual rainfall is typically 10 to 15 inches within the Livermore Valley, and about 8 to 13 inches closer to Site 300. However, fluctuations from year to year may produce rainfall totals ranging from 8 to 32 inches. About 80 percent of the annual rainfall occurs during November through March, and, although temperatures can drop below freezing, measurable snowfall is extremely rare, as is hail. Summer months are quite dry; it is not uncommon to go for months without more than a few tenths of an inch of precipitation. Summer thunderstorms are infrequent, occurring fewer than 10 days per year, and are not intense.

Average monthly rainfall totals collected and compiled by the National Climatic Data Center for both Livermore and Tracy are shown in Figure 4.7.1–1. Measurements from onsite monitoring programs show very similar totals. Annual and maximum hourly precipitation rates measured onsite at the Livermore Site and Site 300 from 1997 through 2002 are provided in Table 4.7.2–1.

TABLE 4.7.2–1.—*Annual and Maximum Hourly Precipitation Rates, 1997-2002*

	Total Annual Rainfall (inches)						6-Year Average
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	
Livermore Site	9.8	20.6	9.6	11.6	13.4	10.7	12.6
Site 300	7.6	18.7	7.8	10.0	9.7	8.7	10.4
	Maximum Hourly Rainfall (inches)						**6-Year Maximum**
	1997	**1998**	**1999**	**2000**	**2001**	**2002**	
Livermore Site	0.33	0.34	0.31	0.27	0.33	0.47	0.47
Site 300	0.28	0.66	0.34	0.32	0.38	0.41	0.66

Sources: LLNL 2002bx, 2002ci, and 2003am.

4.7.3 Winds

Winds are often characterized in terms of a joint frequency distribution, which provides the frequency of occurrence in percent of wind speeds (using wind speed classes) and wind directions (direction from which the wind is blowing). These data are often depicted graphically as a wind rose. Seasonal and annual wind roses for the Livermore Site and Site 300 are provided in Figures 4.7.3–1 and 4.7.3–2, respectively.

Data collected at the Livermore Site show a predominant southwest to westerly wind flow (direction from). This prevailing pattern occurs about 50 percent of the time. On average, highest wind speeds occur in conjunction with the westerly sea breezes during spring and summer. In winter and fall, winds are typically lighter, but very strong winds can accompany winter storm events. Peak winds associated with storms are generally from the south in advance of storms and from the north after storm passage. Wind direction is more varied in winter, although there is a tendency for winds from the southwest, and a relatively strong northeast component associated with frequent high pressure over the Great Basin and cold air spilling out of the San Joaquin Valley. Further east, the undulating terrain near Site 300 exerts a more pronounced influence on local wind patterns. Winds are more consistently from the west-southwest, and wind speeds are generally higher than those measured at the Livermore Site. Local slope flows (up during day and down during night) occur during periods of fair skies and light, large-scale winds.

4.7.4 Storm Events

The Livermore Site and Site 300 environs rarely experience severe weather. A database search of severe storm events, as compiled by the National Climatic Data Center (NCDC) for the period January 1950 through February 2003, is provided in Table 4.7.4–1.

TABLE 4.7.4–1.—*Regional Storm Events*

Storm Event Listing for Areas near LLNL Facilities[a]		
Location	**Date**	**Comments**
Tracy	February 2, 1993	Dense fog on Highway 33 led to a fatal traffic accident.
Livermore	April 25, 1994	Small tornado (Category F0 – speeds of 40 – 72 mph) skipped across a residential housing development, causing minor damage.
3 miles east of Tracy	May 17, 1994	Funnel cloud reported.
South of Livermore	May 17, 1994	Funnel cloud reported.
Pleasanton	November 17, 1996	Flash flood - After nearly 3 inches of rain in the fairly arid hills of Alameda County, a series of levees were breached.
Tracy	January 10, 1997	Flash flood - levee breached
Livermore	February 3, 1998	Flash flood - levee breached
8 miles southeast of Tracy	March 28, 1998	Small and brief tornado (Category F0 – speeds of 40 – 72 mph) ripped up 60 feet of fence on one home lot.
2 miles northwest of Tracy	May 5, 1998	Two funnel clouds reported from one thunderstorm.
Livermore	November 6 – 9, 2002	A very strong weather system affected Alameda, San Francisco, and Sonoma counties for a 3-day period. High winds, to 115 mph maximum, were reported (unspecified location). Rainfall totaling 2 – 5 inches fell across the North Bay counties; 2.90 inches (storm total) were reported for Livermore Airport.

Additional Storm Events with Unspecified or County-wide Locations			
County	**No. of Events**	**Event Type**	**Comments**
Alameda	1	Excessive heat	
San Joaquin	5	Excessive heat	
San Joaquin	5	Fog	
San Joaquin	6	Flood	
San Joaquin	3	Heavy rain	
Alameda	2	Heavy rain, high winds	The November 6 – 9, 2002, weather event affecting Alameda, San Francisco, and Sonoma counties is described above.
San Joaquin	26	High winds	44 – 78 mph
San Joaquin	5	Thunderstorm wind	58 mph, 71 mph
Alameda	13	High winds	69 – 112 mph
Alameda	2	Tornado	Category F0 – speeds of 40 – 72 mph
San Joaquin	6	Tornado	Category F0 – speeds of 40 – 72 mph
San Joaquin	2	Tornado	Category F1 – speeds of 73 – 112 mph
San Joaquin	2	Tornado	Category not specified

TABLE 4.7.4–1.—*Regional Storm Events (continued)*

Additional Storm Events with Unspecified or County-wide Locations			
County	**No. of Events**	**Event Type**	**Comments**
Alameda	1	Heavy snow	
Alameda	5	Winter storm, high winds	
San Joaquin	1	Winter storm	
San Joaquin	4	Extreme cold	

Source: NCDC 2002b.
[a] The NCDC Storm Event database, http://www.ncdc.noaa.gov/oa/climate/linktoed.html, contains data from the following sources: all weather events from 1993, as entered into storm data, plus additional data from the Storm Prediction Center, including tornadoes 1950 – 1992, thunderstorm winds 1955 – 1992, and hail 1955 – 1992. The events listed above include all reported events in the local areas, from January 1, 1950 through February 28, 2003, as available on the website accessed July 6, 2003.
LLNL = Lawrence Livermore National Laboratory; mph = miles per hour; NCDC = National Climatic Data Center.

4.7.5 Dispersion Meteorology and Atmospheric Pollution Potential

A combination of topographic and climatologic factors affects the atmosphere's ability to mix and disperse air pollutants. This ability is limited under certain conditions. The Bay Area Air Quality Management District (BAAQMD) has evaluated past high air pollutant episodes and determined the mix of conditions most conducive to pollutant buildup in the air basin. By looking for these conditions, BAAQMD is able to predict periodic episodes, and preemptive actions are taken to limit pollutant loading during such periods. The primary atmospheric processes that tend to concentrate pollutants are discussed below. Air pollutants and potential health impacts are further discussed in Section 4.10.

Inversions and Pollutant Trapping

Inversions often form on clear, calm winter nights through radiation cooling of air in contact with the earth's cold surface. When cool air near the earth's surface is trapped by warmer air above, vertical mixing is limited and air contaminants are not effectively dispersed. In such cases, as more pollutants are emitted but not dispersed, the total loading (pollutant level per volume of air) is increased. Low wind speeds also limit dilution, and the Livermore Valley is characterized by a high frequency of light winds due to the sheltering effect of surrounding terrain. Light winds occur most frequently during nighttime and early morning hours of fall and winter, which further enhances the radiation inversion.

There are frequent winter dry periods lasting over a week. These are particularly conducive to concentrating pollutants emitted close to the ground, such as carbon monoxide from auto exhaust. In contrast, during winter rainy periods, inversions are weak or nonexistent, winds are often moderate, ventilation and vertical mixing are usually high, and consequently air pollution potential is very low.

Inversions can also form under high pressure, through compression warming of sinking air. These subsidence inversions occur most frequently during summer under the dominance of the Pacific Coast high-pressure cell. When the inversion is strong, the air beneath the inversion is decoupled from the larger scale system. Dilution is then limited, and locally high pollutant buildup can occur if stagnation is prolonged.

Although prevalent during certain seasons, both inversion mechanisms may operate at any time of the year. At times, surface inversions formed by radiation cooling may reinforce the subsidence inversion aloft, particularly in fall and winter. The thick, strong inversion resulting in this case is especially effective in trapping pollutants (BAAQMD 1999).

Sheltering Terrain and Dispersion

In addition to supporting the formation of inversions, the sheltering terrain around the Livermore Valley reduces the amount of vertical exchange between air in the basin and the larger scale synoptic flow. The surrounding hills also restrict horizontal wind flow and dilution. This is more problematic when the thermal gradient between inland desert and coastal areas is less pronounced, allowing the air in sheltered valleys to become relatively stagnant. Air pollutants in the air mass can accumulate as they pass back and forth across valley areas under the typical up-valley daytime and down-valley nighttime flow regimes.

Solar Radiation and Photochemical Pollutant Buildup

Ozone is formed in the atmosphere through a number of complex photochemical reactions that take place over several hours. Because of the required formation time, more distant, upwind pollutant sources, rather than local sources, are responsible for ozone in the Livermore Valley. The primary reactants are hydrocarbons and oxides of nitrogen, key components of automobile exhaust. These are emitted during morning commute hours and transported inland as the sea breeze begins to develop. Ideal conditions for ozone formation occur in summer and early fall, with high temperatures and intense ultraviolet light. Ozone begins to break down during late afternoon, as the intensity of the sunlight decreases (BAAQMD 1999).

4.8 GEOLOGY

This section provides an overview of the affected physical environment, including discussions of the local and regional geologic setting, stratigraphy (rock and sediment types), soils, economic geology, structural geology, and geological hazards (including seismicity). A discussion of existing contamination in the soils at the sites is included in Section 4.17.

4.8.1 General Geology

The general understanding of geology for LLNL has not changed to any great degree from that presented in the 1992 LLNL EIS/EIR (LLNL 1992a).

Topography and Geomorphology

The Livermore Site and Site 300 are located in the California Coast Ranges geologic province (Dibblee 1980a, 1980b), which is characterized by low rugged mountains and relatively narrow intervening valleys. Figures 4.2.1.1–1 and 4.2.1.2–1 show the locations of the Livermore Site and Site 300 relative to the surrounding area, respectively.

Livermore Site

The Livermore Site is located in the southeastern portion of the Livermore Valley. The valley forms an irregularly shaped lowland area about 16 miles long east-to-west and 7 to 10 miles wide north-to-south. The floor of the valley slopes to the west at about 20 feet per mile.

The Livermore Site slopes gently to the north-northwest at an inclination of less than 1 degree (USDA 1966). The Livermore Site property ranges in elevation from 676 feet in the southeast corner to 571 feet in the northwest corner. Hills border the Livermore Site to the east and south.

Site 300

Site 300 is located in the Altamont Hills near the western boundary of San Joaquin County. The site occupies approximately 7,000 acres of steep ridges and canyons with a decrease in elevation toward the southeast. Slopes vary greatly in the canyons and can exceed 45 degrees in places. The slopes are much gentler in the GSA, located in the southeastern portion of the site and can be as low as 2 or 3 degrees (USDA 1990). The maximum elevations onsite are found in the northwest portions of Site 300 and range from 1,476 feet to 1,722 feet above mean sea level. The lowest elevation onsite, where Corral Hollow Creek follows the Site 300 southern boundary, is approximately 500 feet above mean sea level.

Structural Geology

A generalized map of the regional structural geology of the San Francisco Bay Area is presented in Figure 4.8.1–1. The Livermore Site is located near the boundary between the North American and Pacific tectonic plates, and the structural geology of the area is characterized by the San Andreas Fault system, which trends northwest southeast.

The Diablo Range, which includes the Altamont Hills, is part of the northwest-trending Coast Ranges, and parallels three major faults in the area (Nilsen 1977, Atwater 1970): the San Andreas Fault system, the Sur-Nacimiento Fault, and the Coast Range thrust fault system. The Sur-Nacimiento Fault and the Coast Range thrust are not exposed in the area shown in Figure 4.8.1–1. These faults can generally be considered to define three different lithologic blocks (Page 1966). The westernmost block, or Salinian Block, lies west of the San Andreas Fault

(Figure 4.8.1–1) and consists primarily of mixed metamorphic and intrusive igneous granitic rocks. East of the Salinian Block, between the San Andreas and the Coast Range thrust fault zones, lies the Franciscan Assemblage composed of marine sedimentary and volcanic rocks. Rocks positioned above the Coast Range thrust fault zone consist of late Mesozoic to late Tertiary marine sediments which overlie structurally complex rocks of continental and oceanic origins. This block lies primarily along the eastern margin of the Coast Range Province. Structural relationships along the Coast Range thrust are complex due to later reactivation of the structure by high-angle normal and strike-slip faulting.

The Hayward Fault, which is part of the San Andreas Fault system, forms the western boundary of the East Bay Hills and is located about 17 miles west of the Livermore Site. An additional element of the San Andreas Fault system, the Calaveras Fault zone, trends northwest southeast through the San Ramon Valley which borders the Livermore Valley to the west. A major structural feature north of the Livermore Valley is the Mount Diablo Complex, a deformed package of rock in the vicinity of Mount Diablo and the surrounding hills (Page 1966). This complex is bordered on the northeastern edge by the Green Valley-Clayton Fault system. The Suisun Bay is to the north and the Livermore Valley is to the southeast flank of the Diablo Complex. As depicted in Figure 4.8.1–2, the two regional structural features located closest to the Livermore Site are the Greenville and Las Positas fault zones.

A geologic map showing folds and faults mapped in the vicinity of the Livermore Site is presented in Figure 4.8.1–3. More detailed discussions of faulting in the Livermore area are presented in Section 4.8.3 and Appendix H.

Stratigraphy

Geologic maps outlining the distribution of geologic materials outcropping in the vicinity of the Livermore Site and Site 300 are shown in Figure 4.8.1–3 and Figure 4.8.1–4, respectively. The distribution of rock types mapped at Site 300 is shown in Figure 4.8.1–4. The Diablo Range consists primarily of metamorphic and igneous rocks known as the Mesozoic Franciscan Assemblage (Dibblee 1980a, 1980b). These formations extend to, and in places are overlain by, oceanic crustal and marine sedimentary rocks from late Mesozoic and late Tertiary ages (CDMG 1964).

Figure 4.8.1–5 presents a schematic stratigraphic column of geologic units outcropping at the Livermore Site and Site 300.

The Franciscan Assemblage generally contains graywacke, metagraywacke, shale, argillite, blueschist, and greenstone, with minor limestones, cherts, and assorted igneous rocks. Deformed igneous rocks, such as gneiss, are present throughout the Franciscan Assemblage in laterally discontinuous exposures.

Overlying the Franciscan Assemblage are sedimentary rocks known as the Great Valley Sequence, which consists of layers that are somewhat deformed (Ingersoll 1981). The Great Valley Sequence is thought to have formed during the late Mesozoic within a basin resting between the Sierra Nevada, which was then the location of a volcanic island-arc, and a trench to the west (Page 1981, Atwater 1970). Outcrops of the Great Valley Sequence are seen in the Altamont Hills east of Livermore and especially along the eastern edge of the Coast Ranges. The Franciscan Assemblage is thought to have been formed as an accretionary wedge of trench sediments that were thrust beneath the western edge of the Great Valley Sequence deposits (Hamilton 1969, Ernst 1970, Hsu 1971). The contact between the Great Valley Sequence and the Franciscan Assemblage is defined by the Coast Range thrust which outcrops along the eastern margin of the Coast Ranges.

Livermore Site

The rocks underlying the Livermore Site are late Tertiary and Quaternary age sediments comprising the Livermore Formation (Figure 4.8.1–5) (Carpenter et al. 1984, Huey 1948) which has a maximum thickness of approximately 4,000 feet. This formation has been divided into Upper and Lower Members (Huey 1948, Thorpe et al. 1990). Massive gravel beds mixed with sand, silt, and clay characterize the Upper Member. The Lower Member is dominated by greenish- to bluish-grey silt and clay, with lenses of gravel and sand (Huey 1948, Thorpe et al. 1990). For additional information on the local stratigraphic units and hydrogeology at the Livermore Site (see Section 4.11.3.2).

Site 300

Sedimentary rocks at Site 300 are generally older than the alluvial sediments that underlie the Livermore Site in the eastern Livermore Valley. This hilly terrain contains sedimentary units that dip 5 degrees or more to the east and southeast. Some older formations, including the Upper Cretaceous Panoche Formation, are exposed in limited areas of the northwest and northeast corners of the site. A majority of the exposed strata onsite are of Tertiary age, including the Miocene Cierbo and Neroly Formations. The Miocene Neroly Formation is exposed over the greatest areal extent of all sedimentary units onsite. Nonmarine sedimentary rocks of Pliocene age occupy a similar position in the local stratigraphy (see Figure 4.8.1–5) and possibly formed simultaneously with the lower portion Livermore Formation rocks in the Livermore Valley. Additionally, younger Quaternary alluvial landslide deposits are present onsite in limited areas. Additional information on the local Site 300 stratigraphy and hydrogeology is presented in Section 4.11.3.2.

Soils

Soil properties and extent are important factors in evaluating potential transport of contaminants. A discussion of the distribution of soil and sediment contamination at the Livermore Site is presented in Section 4.17. Hazardous materials, if sorbed to surficial soil, could leave the Livermore Site and Site 300 as components of airborne dust particles or be transported by surface water flow. Soil properties, especially infiltration capacity, govern the transport of hazardous material to the saturated zone. For example, the infiltration rates in the LLNL retention basin, located in the center of the Livermore Site, varied from 0.01 foot per day near the center, where a silt layer had been deposited on the basin floor, to 1.9 feet per day in the banks of the basin (Toney 1990). Based on percolation and whole-trench tests, reported surface infiltration rates in the recharge basin south of the Livermore Site range from 0.24 to 10 feet per day, depending on lithology (LLNL 1998b). The U.S. Department of Agriculture estimated the permeability for undisturbed soils covering the central and eastern areas of the Livermore Site at approximately 0.4 to 1.6 feet per day. Most Livermore Site soil, excepting parts of the western and northern areas, has been paved over, compacted, or reworked for landscaping, thus lowering its natural permeability.

Livermore Site

A generalized soil map of the Livermore area is shown in Figure 4.8.1–6. The soils in the Livermore Valley beneath the Livermore Site are formed primarily upon sediments deposited by local streams. Most of the deposits in the eastern part of the valley are relatively young, and thus, the soils are only moderately developed. These soils, generally loam, have minimal horizon or development of layers and can be locally several meters thick. The soils are used for crop production when provided with sufficient water and nutrients or minerals (Brady 1974, USDA 1966). Four soils cover most of the Livermore Site vicinity. In order of decreasing extent, they are Rincon loam, Zamora silty clay loam, San Ysidro loam, and Yollo gravelly loam. These soils are primarily Alfisols, or moderately developed soils, and grade into Mollisols, which are grassland soils (Brady 1974).

Site 300

A generalized map of Site 300 soils is provided in Figure 4.8.1–7. Site 300 soils have developed on marine shales and sandstones, uplifted river terraces, and fluvial deposits. They are classified as loamy Entisols. Entisols are young soils that have little or no horizon development. Clay-rich soils, known as Vertisols, are also present and have been mapped as the Alo-Vaquero Complex. Vertisols are mineral soils characterized by high clay content that display shrink/swell capability. The remaining soil types identified at Site 300 occur only in limited areas. These units are mixtures of the soils described and are not readily separable, including grassland Mollisols, or are poorly developed Inceptisols (USDA 1966, 1990). The Wisfiat-Arburnia-San Timoteo Complex soils cover most of Site 300, differing slightly depending upon slope. The Alo-Vaquero Complex and Vaquero-Carnoa Complex soils cover most of the rest the site. All Site 300 soil types are potentially useful for limited agriculture but are constrained by location and steepness of the slopes. The loamy soils easily erode, and vegetation can be churned into the soil by moderate livestock or other traffic during wet periods. Vertisols exhibit low permeability and are subject to moderate erosion. Wildlife habitat and limited grazing by livestock are the best uses of these soils.

4.8.2 Geologic Resources

The geologic resources found on or near the Livermore Site and Site 300 include aggregate deposits, mineral deposits, fossil occurrences, and petroleum. These resources are described below.

Aggregate Deposits

The present and potential stone and aggregate resources of the eastern Livermore Valley and western San Joaquin County were assessed in 1987 and 1988 (CDMG 1987, 1988). Mineral Resource Zones have been established that identify sand, gravel, and stone source areas. Most of the Livermore Valley floor south of I-580 has been classified as an area of significant mineral resources. The areas north of I-580 and within and immediately surrounding the Livermore Site are classified as having no significant mineral deposits or areas where information is inadequate to indicate the presence of significant mineral resources (City of Livermore and LSA 2002). Several deposits within the eastern Livermore Valley have been identified as recoverable and marketable resources. Land that is currently developed for urban areas, industry, or research, including the Livermore Site, was not included in these inventories. The estimated gravel resource for the eastern Livermore Valley, western San Joaquin County, and vicinity is 570 million tons with 242 million tons of reserves. Several gravel quarries have operated in the Livermore-Pleasanton Valley, west of the city of Livermore. Large reserves and resources of gravel are described for the area of western San Joaquin County, south of Tracy (CDMG 1988); this area contains at least one large-scale gravel quarry. No sand or gravel resources have been assessed within the drainage basin of Corral Hollow Creek; i.e., Corral Hollow and Site 300 (CDMG 1988).

Mineral Resources

Clay, coal, and silica are the three types of mineral resources that have been mined or have the potential to be mined in the vicinity of the Livermore Site and Site 300 (CDMG 1950). Clays found in this region have been used for brick, sewer pipe, and roofing tile. Substantial clay deposits are associated with outcrops of the Eocene Tesla Formation near the old settlement of Tesla in Corral Hollow, and some clay has been excavated from the perimeter of the Livermore Valley (CDMG 1950). The clay beds near Tesla were mined from 1897 to 1912. Extensive clay deposits still remain, but the need for and cost of subsurface mining prevents the economic exploitation of these deposits (CDMG 1957).

Lignite coal was discovered near the settlement of Tesla before 1857. This coal was often found layered with clay in the Tesla Formation and was mined between 1897 and 1902. More than 70,000 tons per year of lignite coal were produced during that time (CDMG 1950). Silica was mined in an unspecified location in the hills north and west of Corral Hollow from high silica Tesla Formation sandstone. The extent of this resource is presently unknown. Silica was mined only intermittently for use in manufacturing machine parts and for furnace linings (CDMG 1950).

Several occurrences of other potentially economically valuable mineral deposits are within a 10-mile radius of the Livermore Site. These include deposits of manganese, chromium, clay, gemstones, pyrite, dimension stone, sand and gravel, and natural gas. Past production statistics and the current development status of these mineral resources are unknown. No commercially exploitable mineral deposits are known to exist within the boundaries of the Livermore Site and Site 300.

Fossil Occurrences

Fossils in the eastern Livermore Valley and the hills to the east are principally found in unconsolidated and poorly consolidated Cenozoic deposits. The primary fossil-bearing units are the Miocene Neroly and Cierbo Formations (Figure 4.8.1–5), and some younger units of the Pleistocene age (Hansen 1991). Four late Pleistocene vertebrate fossils were discovered in the peripheral parts of the excavation for the NIF: two of the locations yielded fragmentary remains of Equus or horse, the third location included remains of proboscidean or elephant order, probably Mammuthus or mammoth, and the fourth location yielded remains of Columbian Mammoth or *Mammuthus columbi*. The geologic unit in which all four localities occur is a geographically restricted fluvial valley fill deposit (Hansen 2000). The fossil localities were found 20 to 30 feet below the present surface.

Livermore Site

The only vertebrate fossil deposits in the vicinity of the Livermore Site, other than those from the NIF excavation mentioned above, are in the Quaternary deposits of the surrounding low hills of the east Livermore Valley. These fossils are few in number and quite scattered. They have been tentatively identified as Pleistocene age, specifically Rancho La Brean and Blancan, and consist of bone fragments of the mammoth and giant sloth (Hansen 1991). Invertebrate shells and leaf and stem fossils have also been found. These appear to be randomly dispersed, mainly within the Neroly Formation. No invertebrate or botanical fossil deposits of significance are believed to be present in the eastern Livermore Valley (Hansen 1991).

Site 300

Several vertebrate fossil deposits have been found on Site 300 and in the vicinity of Corral Hollow. Most finds have been a result of road improvement or erosion along stream banks. Nearly all bone fragments found are considered to be Miocene age, specifically Clarendonian, and are scattered within the Neroly Formation. An assortment of mammalian groups is represented: camelids, mastodon, assorted early horses, shrews, beavers, and squirrels. Fossil finds are generally widely scattered, and none consist of more than one or a few fragments of bone. The eroded terraces of exposed Neroly Formation rocks on the south side of Corral Hollow Creek adjacent to Site 300 are the only locations where numerous fragments have been recovered (Hansen 1991).

Gravels from the Franciscan Assemblage are known to contain Icthyosaurus fossils, but no fossil locales have been mapped (CDMG 1964). An occasional vertebrate bone fragment has been found within Site 300. In May 1991, numerous fossil bones and bone fragments were found on the fire trail and road improvement areas along the ridge south of Building 827. The locale is protected from disturbances caused by LLNL operations. The fossils are within the Neroly Formation and were tentatively identified as mastodon, horse, and an extinct predator. Invertebrate shells, primarily oysters, have been recovered from the Cierbo Formation. Stem and leaf fossils are found in many places within the finer-grained sediments of the Lower Neroly Formation. The fossils are generally scattered, and no significant invertebrate or botanical fossil locales have been identified on Site 300 or in the surrounding area (Hansen 1991).

Petroleum Production

The Livermore oil field, just east of the Livermore Site, was discovered in 1967 and is the only oil field in the Livermore-San Ramon Valley area to date (California Division of Oil and Gas 1982). The Livermore oil field was originally operated by the Hershey Corporation and consisted of 10 producing wells. These wells are located east of the northeastern corner of the Livermore Site. Production is primarily from Miocene Cierbo Formation sandstones from depths of 900 to 2,000 feet. The XL Operating Company of Fort Worth, Texas, now operates the Livermore oil field. Four of the original 10 wells are still producing an average of 40 barrels of oil per day, 1 well has been plugged and abandoned, 4 wells have been shut in, and 1 well is used for water injection (Blake 2003). Reserves are thought to be only about 200,000 barrels and production is declining (California Division of Oil and Gas 2002). No oil or gas exploration is being conducted in the hills to the east of the Livermore Site (Reid 1991).

4.8.3 Geologic Hazards

Seismicity of the Livermore Site

The LLNL Site Seismic Safety Program recently performed a new assessment of the geologic hazards at the Livermore Site (LLNL 2002dk). Although new data and updated methodologies were used, the most recent study reports essentially the same results as previous studies for the prediction of the peak ground acceleration as previous studies. This evaluation of seismic hazards for the Livermore Site was performed by a team of LLNL staff and outside consultants from academia and private consulting firms (LLNL 2002dk). Appendix H presents the results of these seismic hazard analyses and the evaluation of structures.

The Livermore Site is located near the northwest-southeast trending boundary separating the North American and Pacific tectonic plates, or San Andreas Fault system (Figure 4.8.1–1). Local plate interaction generally results in the accumulation of strain along fault structures, which may be released during an earthquake event. The high level of seismicity active locally has resulted in the area's classification of Seismic Risk Zone 4, the highest risk zone in the California Building Code (City of Livermore and LSA 2002).

Faults

Faults that show evidence of Holocene and earlier activity in Quaternary time comprise the source of potential seismic hazard to the Livermore Site. Regionally significant structures are associated with the San Andreas Fault system, including the Hayward and Calaveras faults east of the San Francisco Bay Area (Figure 4.8.1–1). The closest structure to the Livermore Site associated with the San Andreas Fault system, the Calaveras Fault, is situated approximately 15 miles west of the site. The San Andreas, Hayward, and Calaveras faults have produced the majority of significant historical earthquakes in the Bay Area, and accommodate the majority of slip along the Pacific North American plate boundary. These structures will likely continue generating moderate to large earthquakes more frequently than other faults in the region (LLNL 2002dk). Local structures include the Greenville, Mount Diablo, Las Positas, and Corral Hollow faults (Figure 4.8.1–2). Although the Greenville Fault outcrops are within 1 mile of the Livermore Site, it contains the lowest slip rate of any structures associated with the San Andreas Fault system. The Mount Diablo Thrust Fault, postulated to underlie the Livermore and Sycamore Valleys on the basis of seismic reflection data, is related to the development of fold structures in the area. The Las Positas Fault passes within 1 mile southeast of the Livermore Site and is considered capable of generating relatively infrequent moderate earthquakes. Additionally, the Corral Hollow Fault zone passes approximately 2 miles east of the site. In a recent study (LLNL 2002dk) assessing local seismic hazards, the existence and characteristics of the Verona, Williams, Livermore, and Springtown faults were considered.

Earthquakes

Major earthquakes have occurred in the region in the past and can be expected to occur again in the future. The greatest probability for large earthquakes is associated with the San Andreas Fault zone. However, the large earthquakes that have occurred in the San Francisco Bay Area such as the 1906 Great San Francisco Earthquake, with an estimated magnitude of 8.3 on the Richter Scale, produced limited structural damage in the Livermore Valley.

The local faults in the Livermore Valley region are still the main seismic hazard to the Livermore Site (Scheimer 1985). The potential for local, damaging earthquakes was highlighted by the January 1980 Livermore earthquake sequence on the Greenville Fault, which produced two earthquakes of magnitudes 5.5 and 5.6 on the Richter Scale (Bolt et al. 1981). The first earthquake caused discontinuous surface displacements along 3.9 miles of the fault and produced a maximum peak ground acceleration of 0.26 *g* at nearby Lake Del Valle. The unit *g* is equal to the acceleration due to the Earth's gravity or 9.8 m/s/s (32 ft/s/s). The earthquake caused structural and nonstructural damage to the Livermore Site.

The most recent study (LLNL 2002dk) found that the Greenville Fault system contributes the most to the estimate of seismic hazard at the Livermore Site. The contributions from the Calaveras and Corral Hollow faults closely follow the Greenville Fault. The Mount Diablo thrust and Springtown and Livermore faults together contribute as much seismic hazard as the Greenville Fault. At lower frequencies, the more distant Hayward and San Andreas faults are substantial contributors to the total hazard. Additional information regarding seismic activity in the vicinity of the Livermore Site is presented in Appendix H.

Seismic Hazards

Ground Motion. Strong earthquake ground motion is responsible for producing almost all of the damaging effects of earthquakes, except for surface-fault rupture. The intensity of ground motion or shaking that could occur at LLNL as a result of an earthquake is related to the size of the earthquake, its distance from LLNL, and the response of the geologic materials beneath LLNL. Ground shaking generally causes the most widespread effects, not only because it propagates considerable distances from the earthquake source, but also because it may trigger secondary effects from ground failure and water inundation. Potential sources for future ground motion at the Livermore Site include the major regional faults, as well as the local faults.

A recent U.S. Geological Survey (USGS) study of the likelihood of major earthquakes in the San Francisco Bay Area has determined that there is a 62 percent probability of one or more earthquakes with a magnitude of 6.7 on the Richter Scale or greater occurring within the next 30 years (USGS 2003). The study concluded that the probability of these earthquakes occurring along the Calaveras and Greenville faults, and the Mt. Diablo Thrust Fault within the next 30 years was 11 percent, 3 percent, and 3 percent, respectively. The study calculated that there was a 50-percent chance of the Livermore area exceeding a ground shaking of Modified Mercalli (MM) intensity VII to VIII. The Association of Bay Area Governments (ABAG) has mapped the distribution of ground-shaking intensity (Association of Bay Area Governments 2001). A large earthquake on the Greenville Fault is projected to produce the maximum ground-shaking intensities in the Livermore area with intensity ranging from strong (MM VII) to very violent (MM X). The MM IX level is associated with damage to buried pipelines and partial collapse of poorly built structures (City of Livermore and LSA 2002).

Seismic hazard analyses have been performed for the Livermore Site to quantify the hazard. The analyses identify the probability of exceeding a given peak ground acceleration. Maximum horizontal peak ground accelerations at the Livermore Site for return periods of 500, 1,000, and 5,000 years are 0.38 *g*, 0.65 *g*, and 0.73 *g*, respectively. The technical basis for these peak ground acceleration values is provided in Appendix H.

Surface Faulting. Surface faulting is the displacement of ground along both sides of a "trace," the surface expression of an earthquake fault. The potential for surface faulting within the Livermore Site is very low, although potential for surface faulting does exist south of the Livermore Site at SNL/CA.

Liquefaction. Liquefaction is a type of soil failure in which a mass of saturated soil is transformed from a solid to a fluid state in response to earthquake shaking. The liquefaction potential of a soil deposit is controlled by several factors, including the depth to groundwater, the type and density of the soil, and the intensity and duration of ground shaking. Depths to groundwater range from about 30 to 130 feet beneath the Livermore Site (Carpenter et al. 1984). Based on the fairly deep groundwater levels, the uniformly distributed, poorly sorted sediments beneath the site, and a relatively high degree of sediment compaction, the potential for damage from liquefaction at the Livermore Site is quite low. The ABAG map of liquefaction susceptibility in the Bay Area shows a low susceptibility for the majority of the Livermore Site with a moderate susceptibility in the southwestern 20 percent of the site (Association of Bay Area Governments 2001).

Seismically Induced Landslides. The Livermore Site consists of a relatively flat land surface that slopes gently to the northwest. Ground surface elevations within the Livermore Site range from a low of 571 feet at the northwest corner of the site to 676 feet at the southeast corner. Little potential for slope instability exists at the Livermore Site because of the very low relief.

Seismicity of Site 300

The evaluation of seismic hazards for Site 300 was based on a review of the literature, an aerial photographic analysis of the faults and landslides prior to field reconnaissance mapping, and a review of features identified in detailed studies of faulting and geology at the site (Carpenter et al. 1991, Dugan et al. 1991).

Site 300 is located near the eastern edge of the Coast Range Province, which is characterized by northwest trending, strike-slip faults of the San Andreas Fault system. The boundary between the Coast Ranges and the San Joaquin Valley lies immediately east of Site 300 and is characterized by east-northeast compression, resulting in reverse and thrust faulting and folding (Wong et al. 1988, Wentworth and Zoback 1989).

The principal faults in the vicinity of Site 300 are the Corral Hollow-Carnegie, Black Butte, and Midway (Figure 4.8.1–2). These faults are further described in Appendix H. The active Carnegie Fault of the Corral Hollow-Carnegie Fault zone crosses the southern portion of the site (Carpenter et al. 1991). The Elk Ravine Fault, a complex structure composed of pre-Holocene strike-slip faults, reverse faults, normal faults, and local folds, crosses Site 300 from the northwest corner to the southeast corner (Dibblee 1980a). No significant recorded earthquakes have occurred on any of the local faults.

Seismic Hazards

Ground Motion. The region surrounding Site 300 has experienced strong ground shaking during historic earthquakes. In 1906, the Great San Francisco Earthquake on the San Andreas Fault produced structural damage a few miles west of Site 300 (Nason 1982). Potential sources for future ground motion at Site 300 include major regional faults such as the San Andreas, Hayward, and Calaveras, as well as smaller faults including the Greenville, Las Positas, Corral Hollow-Carnegie, Black Butte, and Midway.

A seismic hazard analysis of Site 300 produced hazard curves that display peak horizontal ground acceleration versus return period for two locations within Site 300: the Building 854 Complex near the western boundary of the site and the Building 834-836 Complex near the eastern boundary. Peak ground accelerations corresponding to return periods of 500, 1,000, and 5,000 years were calculated at 0.32 *g*, 0.38 *g*, and 0.56 *g*, respectively, for the Building 854 Complex; and 0.28 *g*, 0.34 *g*, and 0.51 *g*, respectively, for the Building 834-836 Complex (TERA Corp. 1983).

Using another approach which is described in more detail in Appendix H, the largest ground motions produced at the Building 854 Complex would be from a magnitude 6.5 earthquake on the Corral Hollow-Carnegie Fault zone at a distance of 0.9 miles. Average peak horizontal ground accelerations from various mean and standard deviation relations range from 0.53 to 0.82 *g*. The ground motions at the Building 834-836 Complex would be greatest when considering a magnitude 6.6 earthquake on the Black Butte Fault at a distance of 1.5 miles. Average values of peak horizontal ground acceleration range from 0.59 to 0.91 *g*. Values for maximum ground acceleration at both Site 300 locations for return periods of 500, 1,000, and 5,000 years would be similar to those for the Livermore Site, 0.38 *g*, 0.65 *g* and 0.73 *g*, respectively.

Larger earthquakes on more distant faults such as the San Andreas do not significantly affect the hazard estimation.

Surface Faulting. Potential for surface faulting exists at Site 300. The areas adjacent to the active Carnegie Fault could experience ground deformation should a major earthquake occur on the fault. A 10- to 13-foot-wide zone of faulting is present in Holocene and late Pleistocene deposits near the Carnegie Fault, attesting to the potential for surface rupture. In addition to the principal Holocene strike-slip Carnegie Fault strand, two subsidiary faults subsequently named the Elk Ravine Fault) could produce minor amounts of surface rupture (Dugan et al. 1991). The only structures located adjacent to the Holocene strand of the Carnegie Fault, and, therefore, subject to the hazard of surface faulting, are Buildings 899A and 899B at the pistol range.

Liquefaction. Site 300 is underlain almost entirely by Tertiary bedrock, which is not liquefiable. The Quaternary alluvium at the site is limited to generally unsaturated Pleistocene gravel-bearing terrace deposits above Corral Hollow and minor amounts of younger alluvium in canyon bottoms (LLNL 1983). Based on the presence of bedrock beneath Site 300 and the age, composition, and unsaturated condition of the terrace deposits, the potential for liquefaction at Site 300 is low.

Seismically Induced Landslides. Numerous ancient landslides are located at Site 300 with the largest landslide covering approximately 0.5 square mile (see Figure 4.8.1–4). Potential exists for seismically induced landslides at Site 300. The potential for slope instability is greater on northeast-facing slopes that have exposed strata of the Cierbo Formation. Buildings 825, M825, 826, M51, 847, 851A, 851B, 854, 855, and 856 are located on old landslides. The potential for ground deformation at these buildings is considered to be moderate to high.

Nonseismically Induced Landslides

Livermore Site

At the Livermore Site, there is generally little potential for nonseismically induced landslides because the site is situated on gently sloping to nearly flat topography.

Site 300

At Site 300, the topography ranges from gently sloping to nearly vertical in places, and numerous landslide features have been mapped (Figure 4.8.1–4). The potential for nonseismically initiated landslides is great along the canyon walls, especially where soils consist of deep loams and clay loams. During periods of extended wet weather, the saturated soils can become structurally weakened and expand, with resulting slope failure. The potential for localized slope instability greatly increases if slopes are made steeper by road cutting or building excavation. The presence of landslide deposits and colluvium or other historic evidence of slope failure increases the probability of a failure in the future.

4.9 BIOLOGICAL RESOURCES

The biological resources considered in this section consist of the following components: vegetation, wildlife, protected and sensitive species, and wetlands. The information in this section is a summary of a more detailed analysis of the ecological characteristics and the status of threatened and endangered species in Appendix E and of wetlands in Appendix F. The scientific names of species mentioned in this section appear in Appendix E.

4.9.1 Vegetation

Livermore Site

The Livermore Site covers 821 acres of which approximately 640 acres are developed. The vegetation at this site was initially altered in the 1800s when livestock grazing began on a large scale in the Central Valley and surrounding areas of California. The intensity of grazing that took place on lands at this site is not known; however, it is highly likely that grazing and other agricultural activities adversely altered the perennial grasslands and riparian plant communities. Grazing is one of the principal reasons for the significant loss and degradation of wetland riparian plant communities in the Central Valley and surrounding areas (LLNL 1992a).

The plant communities at the Livermore Site were further degraded and destroyed when the U.S. Navy acquired the land in 1942 and covered the site with runways, roads, and buildings. In addition, Arroyo Las Positas, which flowed through the site, was channeled and now traverses part of the eastern boundary and flows through the northern part of the site (LLNL 1992a).

Vegetation surveys at the Livermore Site have been conducted as part of previous projects (LLNL 1992a, Jones and Stokes 1997). In June 2002, an additional survey was conducted. This recent survey confirmed that site conditions and species composition have changed relatively little during the past 10 years. The developed areas at the Livermore Site are planted with ornamental vegetation and lawns. There are also small areas of disturbed ground with early successional plant species. The undeveloped land in the security zone is an introduced grassland plant community dominated by nonnative grasses such as wild oat, brome grasses, foxtail barley, curly dock, and wild radish (Jones and Stokes 2002a).

The Arroyo Seco bisects SNL/CA and traverses the southwest corner of the Livermore Site. Arroyo Seco is a steep-sided channel at the Livermore Site. The tree canopy consists of both native and nonnative species including willows, oaks, California buckeye, glossy privet, and black locust. Vegetation along the arroyo's channel includes perennial peppergrass, sweet fennel, and common cocklebur (Jones and Stokes 2002a).

Plant species along Arroyo Las Positas were surveyed in 2002 and observed to be essentially as those found during a 1997 survey. Common species in the annual grassland along the upper channel bank of the arroyo include wild oats, brome grasses, alkali mallow, and yellow star-thistle (Jones and Stokes 1997, 2002a). See Section 4.9.4 for wetland plants observed along the Arroyo Las Positas.

Site 300

Site 300 covers approximately 7,000 acres of land in eastern Alameda County and western San Joaquin County. The northern portion is characterized by rolling hills while the southern part consists of steep, deep canyons. The site was acquired in 1953, and since then no grazing or farming has taken place. A relatively small part (approximately 5 percent) has been developed for LLNL activities; the remainder is undisturbed, except for controlled burning. Controlled burning takes place every year on approximately 2,000 acres of land during late May to early June depending on weather conditions (LLNL 2003q). Approximately 620 acres of formerly designated California red-legged frog critical habitat and 385 acres of formerly designated Alameda whipsnake critical habitat fall within the prescribed burn zones as shown in Figure 4.9.1–1 (Jones and Stokes 2001, USFWS 2002b). As a result of court orders in November 2002 and May 2003, designation of critical habitat for these two species has been rescinded including habitat at Site 300 (USDCDC 2002, CC Times 2003). However, it is possible that during the next few years that critical habitat for these species may be redesignated again at Site 300 when the USFWS publishes a new critical habitat proposal (USFWS 2003).

Several site-wide vegetation surveys have been conducted at Site 300. These surveys have identified a total of 406 plant species at this site (Jones and Stokes 2002a).

The 1986 botanical survey identified four upland major plant community types that are located within Site 300: (1) introduced grassland, (2) native grassland, (3) coastal sage scrub, and (4) oak woodlands (BioSystems 1986a). A recent survey (Jones and Stokes 2002a) expanded that number to eight major upland plant-type categories, based primarily on the classification in the List of California Terrestrial Natural Communities recognized by the California Natural Diversity Data Base, and also accounted for disturbed and urban habitat. The revised list of major communities was further divided into the following vegetation types: annual grassland, native grassland, coastal scrub, coastal sage scrub oak, poison oak scrub, cottonwood riparian forest/woodland, Great Valley willow scrub, Mexican elderberry, blue oak woodland, valley oak forest/woodland, juniper-oak woodland/scrub, juniper-oak cismontane woodland, disturbed land, and urban habitat (Jones and Stokes 2002a).

Annual grassland covers more than 5,000 acres, and is dominated by annual grasses introduced from Mediterranean Europe during the Spanish Colonial Era (e.g., slender oat and ripgut brome); native grassland covers more than 700 acres, and is dominated primarily by one-sided bluegrass and purple needlegrass. The coastal sage scrub plant community type is dominated by California matchweed, California sagebrush, *Eriogonum fasiculatum*, and black sage. Oak woodland, dominated by blue oak, occurs in scattered areas on steep slopes in the southern half of the site and covers approximately 150 acres. The understory is dominated by grassland species such as brome grass and slender oat. Small areas of wetlands occur at the site and are discussed in Section 4.9.4 (LLNL 1992a).

Ongoing practices at Site 300 that affect site vegetation include the exclusion of grazing and other agricultural uses; annual maintenance of fire roads and breaks; an annual controlled burn; weed control along roads, power poles, and security fences; planned minor construction in or adjacent to existing facilities; and road-widening projects. The maintenance of fire roads and breaks, and weed control measures, for example, have resulted in sparse vegetative cover dominated by early successional plant species including introduced grass species. The area of land disturbed for fire roads, weed control, buildings, and other facilities, however, occupies less than 5 percent of Site 300 total area. This area is designated as disturbed or urban habitat in the recent plant survey. Acreage including facilities and adjacent landscaping are considered urban habitat, while that for fire roads, perimeter fences, and power poles are considered disturbed habitat (LLNL 1992a).

No prime or unique farmland protected by the *Farmland Protection Policy Act* exists at Site 300. No grazing or other agricultural activities occur at Site 300. As a result, a greater diversity of plant community types occurs on the installation than in nearby offsite lands that are grazed. In addition, steep onsite slopes show less instability and erosion than nearby grazed lands because of a more stable plant cover, including soil-building native plant species (LLNL 1992a).

Approximately 2,000 acres are burned annually at Site 300 to control vegetation that could become an uncontrolled fire hazard (Figure 4.9.1–1) (LLNL 2003q). These burns have been conducted for the last 41 years (Jones and Stokes 2001). The development of stands of native grassland is strongly correlated with the burn area. The exclusion of grazing and other agricultural practices in 1953 may also have contributed to the presence of the more than 700 acres of native perennial grasslands onsite (LLNL 1992a).

Tritium Levels in Vegetation and Commodities

LLNL has been monitoring tritium in vegetation since 1966 and has performed vegetation sampling in the vicinity of the Livermore Site and Site 300 since 1971. The monitoring program is designed to measure changes in the environmental levels of radioactivity, to evaluate the environmental effect of LLNL operations, and to calculate potential human doses from tritium in the food chain. In 1977, wine was added to the monitoring program (LLNL 2002cc). The results of this monitoring program and LLNL impacts on vegetation in the Livermore Valley are provided in Section 5.2.7.

4.9.2 Fish and Wildlife

Livermore Site

Four species of fish, 6 species of amphibians and reptiles, 52 species of birds, and 10 species of mammals were reported observed at the Livermore Site during the biological survey conducted for the 1992 LLNL EIS/EIR or in subsequent documentation (LLNL 1992a, USFWS 1998, LLNL 2003bz) (see Appendix E for lists of species).

Wildlife includes species that live in the undeveloped grassland in addition to a number of species that live in the developed areas of the site or along the arroyo. Representative species observed in the undeveloped grassland areas include the fence lizard, black-tailed hare, California ground squirrel, red fox, and western meadowlark. The California red-legged frog has been observed in the Arroyo Las Positas and the Drainage Retention Basin (DRB) and is discussed in greater detail in Section 4.9.3 (LLNL 2003ab). The bullfrog, a known predator of the California red-legged frog, has been observed since 1997. Nesting birds include the American crow, American robin, house finch, mockingbird, and house sparrow. These species nest in the planted trees onsite. Canada geese and muskrats have been observed at the DRB. A raven's nest was observed among some pipes at the Livermore Site. Some bird species observed include the mourning dove, Nuttall's woodpecker, Cooper's hawk, and turkey vulture (LLNL 1992a). Catfish, mosquito fish, goldfish, and sculpin have been observed in the DRB (LLNL 2003bz, USFWS 1998). Recent studies have provided new information about raptor activity at the Livermore Site. In 1996, the red-shouldered hawk, not previously known to occur on LLNL property, nested at the Livermore Site (LLNL 1997e). Between 1994 and 2003, the white-tailed kite, a state-protected bird of prey, was observed foraging, nesting, and fledging young at the Livermore Site. The kites were marked with aluminum leg bands in 1999 to initiate long-term studies of the species in a semi-urban edge habitat. In 2000, a pair of white-tailed kites attempted to nest, but the nesting was unsuccessful, possibly due to climatic conditions or low incidence of prey. This reduced nesting trend was observed in other parts of California in 2000 (LLNL 2000a, LLNL 2001v). Breeding success improved in 2003 with nine young fledged from two nests.

Site 300

Site 300, with large areas of wildland vegetation, interspersion of various plant community types, and availability of water at springs, provides habitat for a diversity of wildlife.

Twenty amphibian and reptile species have been observed at Site 300 (Table E.1.2.2–1 in Appendix E). Aquatic habitat is available at some of the drainages containing aquatic vegetation supported by underground springs and seeps. In addition, aquatic species may opportunistically use existing wastewater treatment facilities like the domestic sewage oxidation ponds and the class II surface impoundments (near Building 817). Two species of salamanders were observed: the California slender salamander and the California tiger salamander. The latter species was observed during 1986 biological surveys (BioSystems 1986b), but not during 1991 surveys, although both species are currently known to occur onsite. Frog and toad species known to occur onsite are the western toad, western spadefoot toad, Pacific treefrog, and California red-legged frog. Section 4.9.3 contains additional information on the California red-legged frog and California tiger salamander (LLNL 1992a). No exotic bullfrogs have been observed onsite to date.

Conditions are far more favorable for reptiles than for amphibians at Site 300. Grassland provides ideal habitat for racers and gopher snakes. Rocky sites provide suitable habitat for such species as the western fence lizard, western skink, common kingsnake, and the western rattlesnake. Seeps and springs provide excellent habitat for the northern alligator lizard. Side-blotched lizards and California horned lizards frequent areas with vegetation that is more open and sandy soils (LLNL 1992a).

Earlier avian surveys reported 70 bird species present at Site 300 on either a resident or transient basis (BioSystems 1986b, LLNL 1992a). In 2002, an extensive survey was conducted using variable circular plot point counts and constant effort mist netting. During the 2002 survey, 90 bird species were observed, representing 73 genera and 32 families. With the integration of observations from previous years by LLNL biologists, a new Site 300 list of bird species was prepared including the documented presence of 103 species, 84 genera, and 39 families. Of the 103 species, 24 are current Federal or California species of special concern (see Section 4.9.3, Table 4.9.3–1). The Swainson's hawk is state listed as threatened and considered an occasional forager within Site 300 based on its observation on the southeastern perimeter of the site and the adjacent California Department of Fish and Game (CDFG) Ecological Reserve in 1994 (LLNL 2003by). In addition, the state endangered willow flycatcher was observed in 2003.

Although grasslands normally support a limited resident bird population, the Site 300 interspersion of several different plant community types and an abundance of seeds and insects provide good habitat for a variety of birds. The western meadowlark, horned lark, and savannah sparrow are the most common small birds seen throughout the open grassland areas. Vegetation at springs and seeps provides nesting habitat for red-winged and tricolored blackbirds. These permanent water sources attract a greater number of birds than normally found in the adjacent grasslands. For example, mourning dove, cliff and barn swallow, and California quail all require daily water. Oak woodland and a few cottonwoods provide nesting habitat for the western kingbird, northern oriole, loggerhead shrike, and American goldfinch. Coastal sage scrub supports scrub jay, Anna's hummingbird, rufous-crowned sparrow, and white-crowned sparrow. Ecotones (boundary areas between two habitats) of sage scrub and grassland provide ideal habitat for mourning dove, California quail, lazuli bunting, and lark sparrow. Rocky outcrops and cliffs provide breeding sites for white-throated swift, cliff swallow, Say's phoebe, and rock wren (LLNL 1992a). A relatively large population of loggerhead shrikes was present at Site 300 in 2002. Eighteen pairs of loggerhead shrike were identified during the 2002 surveys with 9 of the 18 pairs actively nesting. Six of the nests were in junipers and three were in oaks (Bloom 2002).

Site 300 also supports a population of nesting raptors. A breeding raptor survey conducted at Site 300 in April and July 2002 identified four species of diurnal raptors and four species of owls. The raptors included the turkey vulture, red-tailed hawk, golden eagle, and American kestrel (the most frequently observed raptor on Site 300). Owls observed included the barn owl, western screech owl, great horned owl, and western burrowing owl. The survey detected the presence of four active red-tailed hawk, four great horned owl, and three burrowing owl nests. One inactive barn owl nest was found on the exterior of the Advanced Test Accelerator (ATA) Building. In addition, numerous recently fledged American kestrels and one young western screech owl were observed. Blue oaks and conglomerate cliffs were the most frequently used nest structures. The numbers of breeding pairs and diversity of these birds of prey was relatively low compared to other large land units in California. A pair of turkey vultures was observed, although no nest was found (Bloom 2002). Although no golden eagle or white-tailed kite nests were found, both species have occasionally nested onsite in the past. The golden eagle nested at Site 300 in 1996, and the white-tailed kite nested in a valley oak at Site 300 in 1997 and 1998 (LLNL 1997, Bloom 2002). In addition to these species, the northern harrier and prairie falcon were identified in 1986 and 1991 surveys (BioSystems 1986b, LLNL 1992a). A complete list of raptor species observed at Site 300 is included in an avian monitoring program report (LLNL 2003by).

Thirty mammal species have previously been observed on site (see Appendix E). Mammals were recorded during threatened and endangered species surveys that included conducting ground surveys over the entire site, night spotlighting, establishing of scent stations in 1986 and 1991, and trapping small mammals in 1986 (LLNL 1992a). An inventory was recently conducted on small mammals at Site 300 and 10 small mammal species were identified (Jones and Stokes 2002b).

Productive and diverse grasslands on Site 300 support an abundance of rodents and lagomorphs (rabbits and hares). Conditions are ideal for California ground squirrels in the northern portion of Site 300 where the terrain is less rugged and annual prescribed burns occur. Other common rodents include the house mouse, deer mouse, brush mouse, western harvest mouse, California vole, Heermann’s kangaroo rat, San Joaquin pocket mouse, California pocket mouse, and valley pocket gopher (Jones and Stokes 2002b). Lagomorphs such as black-tailed hares and desert cottontails are also widespread and abundant, with the latter tending to occupy areas with more cover (LLNL 1992a).

Many mammalian predators are supported by this rich prey base. Grassland predators include long-tailed weasels, striped skunks, coyotes, American badgers, and bobcats. Red foxes, which have been reported from nearby areas to the east and north of the site, have greatly expanded their range in the Central Valley in recent years. They show a preference for more disturbed areas, often denning in roadside culverts (LLNL 1992a). A mammal survey (carnivores) was conducted from mid-September through mid-October 2002. Species observed included badger, bobcat, and coyote (CSUS 2003). See Section 4.9.3 and Table 4.9.3–1 for discussion of the San Joaquin kit fox.

Sage scrub, wooded, and riparian habitats attract other mammalian predators not normally found in grasslands, including gray fox, raccoon, and mountain lion. Although these habitats are preferred, they are relatively limited on Site 300; consequently, grassland areas are used as well. Only limited areas of riparian vegetation are associated with the seeps and springs that occur along the canyon bottoms. Black-tailed deer prefer these habitats but are frequently seen in the open grasslands (LLNL 1992a).

4.9.3 Protected and Sensitive Species

The *Endangered Species Act* provides Federal protection for threatened and endangered species. Section 3 of the *Endangered Species Act* defines endangered species as any animal or plant species in danger of extinction throughout all or a significant portion of its range. This Act further defines threatened species as any species likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. The *California Endangered Species Act* (California Fish and Game Code Sections 2050 through 2098) includes provisions intended to protect threatened and endangered species that may be affected by development projects subject to the *California Environmental Quality Act*.

Species that are Federal candidates for listing as threatened or endangered do not receive legal protection under the *Endangered Species Act*. However, under NEPA, both candidate and proposed species require analysis to the same level of detail as listed species. Candidate species (formerly designated as Category 1 species) include those plants and animals for which the U.S.

Fish and Wildlife Service (USFWS) has on file sufficient information on biological vulnerability and threat to support issuance of a proposed rule for listing as threatened or endangered. The USFWS encourages the consideration of impacts to these species in project planning since their status can be changed to threatened or endangered in the foreseeable future. Critical habitat may be established by the USFWS for threatened or endangered species consisting of geographic area determined essential for the conservation of a species.

The USFWS species of concern category includes former Category 2 species (i.e., species that possibly were appropriate for listing). Species of concern is a term that describes a broad realm of plants and animals whose conservation status may be of concern to the USFWS, but do not have official status.

Detailed surveys of federally listed species were conducted at the Livermore Site and Site 300. The results are summarized in this section. The details regarding these studies appear in the Biological Assessment in Appendix E, Section E.2.

Informal consultation was initiated on October 21, 2002, when the USFWS was requested to provide a list of potential sensitive species that may occur at the sites. Such a list was provided on October 29, 2002 (The USFWS letter is provided in Appendix E). The CDFG has also been requested to provide a list of potential sensitive species that may occur at the sites. This consultation process assisted in the identification of plant and animal sensitive species that are known to occur at the sites (Table 4.9.3–1).

All of the bird species listed in Table 4.9.3–1 also receive protection under the *Migratory Bird Treaty Act* (16 U.S.C. §703) and Executive Order 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds). This law governs the taking, killing, possessing, transporting, and importing of migratory birds, their eggs, parts, and nests. Of these, 20 are special status but none are threatened or endangered. Further discussion is provided later in this section and in Appendix E.

The methods used to evaluate the status of the species listed in Table 4.9.3–1 are presented in Appendix E, Section E.1.2.1. The methods were consistent with Federal and/or state guidelines where such guidelines exist. Where such guidelines do not exist, survey methods consistent with accepted biological techniques were used. Surveys for the species in question were conducted by botanists and zoologists with training and experience in conducting surveys.

Livermore Site

No sensitive plants, invertebrates, reptiles, or mammals were observed during the 1992 or recent biological surveys at the Livermore Site (LLNL 1992a, 1998a; Jones and Stokes 2002a). The California red-legged frog (a federally listed threatened species) occurs at the Livermore Site. This species is the largest native frog in California, growing to more than 5 inches in length, also known as the original Calaveras jumping frog made famous by Mark Twain's writings (LLNL 1998f). It was listed as a threatened species in June 1996 (61 FR 25813). The California red-legged frog is found in the Arroyo Las Positas and in the DRB at the Livermore Site. A single adult California red-legged frog was also found in the West Perimeter Drainage Ditch during the 2002 nocturnal surveys (LLNL 1998a, LLNL 2003ab).

Critical habitat was determined for the California red-legged frog species in March 2001 (66 FR 14626). Critical habitat for this species was designated in the North Buffer Zone and eastern edge of the Livermore Site (Figure 4.9.3–1) (LLNL 2002cc). As a result of a court order in November 2002, critical habitat for this species at the Livermore Site has been rescinded (USDCDC 2002). However, it is possible that during the next few years that critical habitat for this species may be reinstated again at the Livermore Site when the USFWS publishes a new critical habitat proposal (USFWS 2003).

The DRB was drained in 2000 and 2001 in an effort to eliminate bullfrog larvae, because this species is a known predator of the California red-legged frog. Bullfrogs were first detected at the Livermore Site in 1997 (DOE 2002j). The USFWS was consulted and approved this management technique (USFWS 2002e).

Although the California tiger salamander (a federally listed proposed threatened species and a state species of special concern) is not presently found at the Livermore Site; it has been observed on nearby lands (68 FR 28649, LLNL 1992a, LLNL 2002cc).

The loggerhead shrike (a Federal species of concern and a state species of special concern) has recently been reported in the vicinity of the Arroyo Las Positas (LLNL 2003bz). Over 60 species of migratory birds listed in Table 4.9.3–1 have been observed in surveys at the Livermore Site and their status is monitored by LLNL wildlife biologists (LLNL 2003bz). More information is provided in Appendix E.

Site 300

Plants

The only federally-protected plant species known to occur at Site 300 is the large-flowered fiddleneck (a federally listed and state listed endangered species). A 160-acre portion of Site 300 has been designated as critical habitat for this plant (Jones and Stokes 2002c).

The large-flowered fiddleneck was considered one of the most endangered plant species in California and perhaps the Nation. This species is known to exist naturally in only three locations; two are at Site 300 (see Figure 4.9.3–2), and one is on a nearby ranch. The largest onsite population (Drop Tower population), located in designated critical habitat, was discovered in the 1960s. It fluctuates between as many as 355 individual plants and historic lows during the past 3 years with 14 plants observed in 2001, 40 plants observed in 2000, and 6 plants observed in 1999. The number of fiddleneck plants observed in the original experimental population area (59 plants) is similar to that observed during the past 2 years (45 plants in 2000 and 42 plants in 1999). A dramatic increase in seed predation by small rodents in 1998 and 1999 may be responsible for the reduction in Site 300's original experimental large-flowered fiddleneck population (LLNL 2002dj).

In addition to the Drop Tower population, a native large-flowered fiddleneck population (Draney Canyon population) was discovered onsite near the bottom of a deep canyon in 1988 approximately 2 miles west of the Drop Tower population. This smaller population of fiddleneck was wiped out in 1997 when the bank containing the population washed away. No plants have been observed at this site since 1998 (LLNL 2002cc, Jones and Stokes 2002a).

In May 1985, 160 acres surrounding the Drop Tower at Site 300 was designated as critical habitat for the large-flowered fiddleneck (LLNL 2002dj). In April 2000, the area where the Drop Tower population is located was designated the *Amsinckia grandiflora (*i.e., large-flowered fiddleneck) Reserve through a declaration by the DOE Secretary via a memorandum of agreement signed between DOE and the USFWS concerning activities within the reserve (DOE 2000b). LLNL has also established an experimental population area within the reserve. LLNL is working with USFWS on continued monitoring of native and experimental large-flowered fiddleneck populations, and further development of habitat restoration and maintenance techniques. An annual report on all management activities is prepared by LLNL and provided to USFWS (LLNL 2001v, Jones and Stokes 2002a).

In addition to the large-flowered fiddleneck, seven rare plants listed by the California Native Plant Society (CNPS) also occur at Site 300:

- The big tarplant, listed on the CNPS Rare Plant 1B List, is widespread and common at Site 300.
- The diamond-petaled poppy, a plant thought to be extinct until rediscovered in 1993 and thus on the CNPS 1B List, is present at two locations at Site 300.
- The round-leaved filaree, listed on the CNPS Rare Plant 2 List, was identified at one location at Site 300.
- The gypsum-loving larkspur, listed on the CNPS Rare Plant 4 List occurs at six locations with most being on upper slopes in perennial grassland at Site 300.
- The California androsace (or California rock jasmine), also listed on the CNPS Rare Plant 4 List, is widespread and common at Site 300.
- Stinkbells, another CNPS Rare Plant 4 List species, is found at several locations at Site 300.
- The hogwallow starfish, a CNPS Rare Plant 4 List species, is found at one location west of Building 851 at Site 300.

Additional information on these sensitive plant species and other nonsensitive plants is included in a recent site-wide plant survey at Site 300 and in Appendix E (Jones and Stokes 2002a).

Invertebrates

The valley elderberry longhorn beetle (a federally listed threatened species) is the only sensitive insect that has been observed at Site 300. This species occurs almost exclusively on elderberry bushes, so elderberries that grow within the range of this species are considered potential habitat.

In 2002, four surveys were conducted during April and May at Site 300 for the valley elderberry longhorn beetle and its host, the blue elderberry plant. Elderberry plants were surveyed at six locations at Site 300 and two locations on adjacent land southeast of Site 300 in a CDFG preserve. During these surveys, 10 exit holes, considered to be from valley elderberry longhorn beetles, were found in elderberry plants. Additionally, six adult beetles were observed in a canyon just north of Elk Ravine, with two of the adults clearly exhibiting identifying characteristics of the valley elderberry longhorn beetle (Arnold 2002).

The California linderiella fairy shrimp, a Federal species of concern, occurs in seasonal wetlands in Site 300. During a 2001-2002 wet season survey, this branchiopod species was rediscovered in a vernal pool (FS-04) in the northwest part of the installation. Another branchiopod, the California clam shrimp (which is not on Federal or California special status species lists) was also found in this vernal pool (Condor Country Consulting 2002). Appendix E contains a discussion on these species and vernal pools.

Amphibians

The California red-legged frog, a federally listed threatened species and a state species of special concern, occurs at Site 300. This amphibian was listed as a federally threatened species in June 1996 (61 FR 25813). Critical habitat was determined for the species in March 2001 (66 FR 14626). As a result of a court order in November 2002, critical habitat for this species at Site 300 has been rescinded (USDCDC 2002). However, it is possible that during the next few years that critical habitat for this species may be reinstated again at Site 300 when the USFWS publishes a new critical habitat proposal (USFWS 2003). Formerly designated critical habitat for the California red-legged frog at Site 300 is shown in Figure 4.9.3–3.

Breeding locations, identified in 2001 for the California red-legged frog are also shown in Figure 4.9.3–3, with one of the largest locations in an artificially created wetland near Building 865 in Upper Elk Ravine (Jones and Stokes 2001). During surveys in 2002, California red-legged frog breeding was noted in the Ambrosino Pool, Lower Juniper Slide Pool, and Elk Ravine at the ATA (LLNL 2003ab). Nonbreeding California red-legged frogs have been observed at Mid Elk Ravine, the Upper Droptower Canyon Wetland, Danger Pond, Harrier Pool, the Old Spring Wetland, Song Pond, Overflow Pond, Oasis Canyon, Lower Drop Tower Canyon Wetland, and Round Valley Wetland (Figure 4.9.3–3) (Jones and Stokes 2001, DOE 1997a).

The California tiger salamander (a federally listed proposed threatened species and a state species of special concern) is present at Site 300 (68 FR 28649). This amphibian has been reported at a number of locations including Ambrosino Pool, Harrier Pool, Song Pond, and Danger Pond as shown in Figure 4.9.3–4 (Jones and Stokes 2001, LLNL 2002cc). The California tiger salamander has also been reported at the explosive process water surface impoundments, which are not shown in Figure 4.9.3-4.

The Western spadefoot toad is a Federal species of concern and state species of special concern. During wet years, this amphibian has been observed at the Overflow Pond located in the GSA of Site 300 (LLNL 2003ab).

Reptiles

The Alameda whipsnake (a federally listed and state listed threatened species) was observed onsite in 1986 (BioSystems 1986b). The Alameda whipsnake was collected in April 1998 during a live-trapping survey on Site 300. Fourteen Alameda whipsnakes were captured with the individuals identified as intergrades between the Alameda whipsnake and the closely related chaparral whipsnake (Jones and Stokes 2001). The Alameda whipsnake is typically found in northern coastal scrub, coastal sage scrub and chaparral plant communities, but it may also occur in adjacent grasslands (62 FR 64306). Potential Alameda whipsnake habitat at Site 300 (mostly the coastal sage scrub plant community type) is shown in Figure 4.9.3–5 (LLNL 1992a, Jones and Stokes 2001).

Critical habitat was established for this species in October 2000 (65 FR 58933). As a result of a court order in May 2003, critical habitat for this species at Site 300 has been rescinded (CC Times 2003). However, during the next few years that critical habitat for this species may or may not be included at Site 300 when the USFWS publishes a new critical habitat proposal. Formerly designated critical habitat for the Alameda whipsnake is shown in Figure 4.9.3–5.

A research proposal has recently been coordinated with the USFWS to evaluate the effects of prescribed burning on the Alameda whipsnake at Site 300 and several other locations (Swaim 2002c). The research proposal received a favorable biological opinion by the USFWS (USFWS 2002a).

The California horned lizard (Federal species of concern and state species of special concern) was observed during the 1991 field surveys. This species was observed in the more open grasslands with sandy or gravelly areas at the northern portion of the site (LLNL 1992a). This lizard was identified at 8 locations in 2002, and at 23 locations in 2003.

The San Joaquin coachwhip (Federal species of concern and state species of special concern) is a fairly large slender snake, reaching up to 5 feet in length. It has been observed at Site 300 (Swaim 2002b).

Birds

The golden eagle (state species of special concern), and the burrowing owl and tricolored blackbird (both Federal species of concern and state species of special concern) have been observed at Site 300. The golden eagle is also afforded protection under the *Bald and Golden Eagle Protection Act* (16 U.S.C. §668). Immature and adult golden eagles were frequently observed soaring and feeding, mostly in the rolling terrain in the northern segment of the site (LLNL 1992a). In 1996, the first documented breeding pair of golden eagles nested on a live power pole at Site 300. Eggs were laid and incubated in the nest, but it was abandoned (LLNL 2000a). All of the bird species listed in Table 4.9.3–1 also receive protection under the *Migratory Bird Treaty Act* (16 U.S.C. §703). This law governs the taking, killing, possessing, transporting, and importing migratory birds, their eggs, parts, and nests. Executive Order 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds), issued on January 10, 2001, provides additional guidance on the responsibilities of Federal Agencies to protect migratory birds on property under their jurisdiction.

In 1986, the burrowing owl was a relatively common nesting species at Site 300, especially in the more gently rolling terrain in the north. Surveys in 1991 confirmed that this species is still nesting at Site 300, but at reduced levels (LLNL 1992a). Between 1991 and 2000, as many as 18 pairs of burrowing owls were observed nesting at Site 300 in a single year. In 2001, eight active burrowing owl dens were discovered and monitored throughout the breeding and wintering season (LLNL 2002cc).

A small population of tricolored blackbirds has been observed nesting in part of the Elk Ravine wetland. The presence of tricolored blackbirds is considered unusual because this species typically does not inhabit foothill areas such as those at Site 300 (LLNL 2000a). The number of tricolored blackbirds can vary greatly between survey years. For example, tricolored blackbirds were observed onsite in 1986 but not in 1991 (LLNL 1992a). However, 835 nests were found in Elk Ravine over 3-day surveys in August and September 2002. Nest location analysis determined that 91.7 percent of nests were located in stinging nettle, 6.8 percent in cattail, 1 percent in Russian thistle, and 0.5 percent in horehound (LLNL 2002di).

Mammals

Detailed surveys for the San Joaquin kit fox, a federally listed endangered and state listed threatened species, were conducted at Site 300 in 1980, 1986, and 1991. The kit fox was not recorded in the 1991 protocol-level surveys or detected subsequently. A comprehensive mitigation plan was developed for this species in 1992. The kit fox is not considered a resident species at Site 300, although this area provides potential habitat (LLNL 1992a, Jones and Stokes 2001).

The San Joaquin pocket mouse, a Federal species of concern, was observed during the 1986 (BioSystems 1986b), 1991, and 2002 (Jones and Stokes 2002b) surveys and is considered a resident species at Site 300. Potential habitat for this species at Site 300 is extensive since this species inhabits grassland with fine soils and scattered shrubs. This species is listed as a Federal species of concern.

The American badger generally occurs in the more rolling terrain at the northern segment of Site 300. During 2001, three occupied American badger dens were discovered and two unoccupied dens were identified in proposed project areas, although numerous dens are known to occur site-wide (LLNL 2002cc). This species was removed from the list of California species of special concern by the California Department of Fish and Game in 1993 (CDFG 2003).

Three special status bat species have been observed at Site 300 during a recent bat survey. These include the pallid bat (a state species of special concern), the long-legged myotis (a Federal species of concern), and the Yuma myotis (a Federal species of concern) (LLNL 2003bh).

4.9.4 Wetlands

Wetlands were mapped at LLNL using the methodology provided in the *United States Army Corps of Engineers Wetland Delineation Manual* (USACE 1987). A detailed analysis of wetlands appears in Appendix F. The locations of the wetlands at the Livermore Site and Site 300 are provided in Appendix F. The following subsections provide a summary of the results of the analysis.

Livermore Site

Wetlands, although very limited in the developed areas of the Livermore Site, do occur along Arroyo Las Positas at the northern perimeter of the site. These wetlands occur in three distinct areas and are associated with culverts that channel runoff from the surrounding area into this arroyo. In 1992, three areas totaling 0.36 acres were determined to qualify as jurisdictional wetlands. The wetlands were dominated by salt grass and a third by cattails (LLNL 1992a, Jones and Stokes 1997).

Since 1992, wetlands along Arroyo Las Positas have increased due to the release of water associated with environmental restoration activities at the Livermore Site. In 1997, an additional wetland delineation study was performed along Arroyo Las Positas (Jones and Stokes 1997). That study determined that the size of jurisdictional wetlands had expanded to 1.96 acres, and involved three different wetland plant communities as follows:

- Ruderal wetland (1.22 acres) dominated by tall flatsedge, bristly ox-tongue, bearded sprangletop, Bermuda grass, and barnyard grass.
- Freshwater marsh (0.65 acres) dominated by cattails and bullrushes.
- Riparian scrub (0.09 acres) dominated by willows and a small stand of cottonwoods.

Sedimentation and vegetation growth in the Arroyo Las Positas reduced the flood capacity less than the design capacity required by DOE O 5480.28 (Jones and Stokes 2001). As a result, LLNL initiated the Las Positas Maintenance Project to restore the channel to its original 100-year flood design capacity. The two-stage program was conducted in accordance with the 1997 and 1998 amended USFWS Biological Opinion for this project requiring Livermore Site populations of the California red-legged frog to be monitored to minimize impact from the Las Positas Maintenance Project. Subsequently, excess vegetation is removed annually (if needed) in 100- to 300-foot checkerboard sections. Measures previously coordinated with the USFWS ensure that California red-legged frogs are protected from harm in project locations during the maintenance process. The arroyo in this part of the Livermore Site was formerly designated as critical habitat by USFWS as shown in Figure 4.9.3–1 (LLNL 1998a, USFWS 1997, LLNL 2001v).

Approximately 1,800 feet of Arroyo Seco is on the Livermore Site. In July 2001, a wetland delineation survey was performed. Within the arroyo, six vegetated areas were determined to be potential jurisdictional wetlands, totaling 0.04 acres (LLNL 2001ap).

Site 300

A study for the 1992 LLNL EIS/EIR delineated 6.76 acres of wetlands at Site 300 (LLNL 1992a). In August 2001, another wetland delineation study was conducted identifying 46 wetlands and determining that the total size of wetlands had increased to 8.61 acres. A total of 4.39 acres were found to meet criteria for jurisdictional wetlands. These wetlands are small and include freshwater seeps, cooling tower discharges from some of the buildings, vernal pools, and seasonal ponds (Jones and Stokes 2002c). Appendix F includes additional discussion on the wetlands present at Site 300.

Many of the wetlands occur at springs in the bottom of deep canyons in the southern half of the site. These springs occur where water-bearing sandstone units outcrop in the canyon or valley bottoms. The wetlands that have developed at these springs are confined by the steep-sided canyon wall. They typically range in width from 5 to 30 feet wide with most being 10 to 20 feet wide. Most are relatively short, 100 to 600 feet; the longest, in Oasis Canyon, is approximately 2,800 feet long. The plant species observed in these wetlands grow in relatively homogenous stands. Cattail is dominant in areas of flowing or totally saturated soil, forming dense stands, typically at the spring and downstream. Species such as rush, seep-spring monkey flower, and, in some places, white watercress are common in areas of flowing water. In some limited areas, rush is dominant in standing water or saturated soil. In drier areas, the alkali ryegrass forms dense stands and then intergrades into the upland plant communities. Large, isolated cottonwoods and willows are often present in the deep canyon spring-fed wetlands (LLNL 1992a).

Several of the larger wetlands were artificially created by past operations at four building complexes onsite. The dominant plant species at these wetlands are cattail, alkali ryegrass, and rush, as in the natural wetlands. These wetlands tend to occur in drainage ditches along roads or on steep banks near the buildings.

Site 300 responsibilities under the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) include extracting and treating contaminated groundwater at the eastern GSA, and then discharging this treated water into Corral Hollow Creek. Treated groundwater from this operation has been released into Corral Hollow Creek since in June 1991. Corral Hollow Creek, in the GSA, is bordered by wooded riparian vegetation with cottonwood being the dominant canopy tree species. Mulefat and willow occur in the understory. One spring dominated by rush occurs approximately 700 feet downstream from the eastern GSA. The wooded riparian vegetation is well developed in some areas and sparse in others (LLNL 1992a).

4.10 AIR QUALITY

Air quality laws and regulations have been established to protect the public from harmful effects of air pollution. These rules take several forms. In some cases, the goal is to designate acceptable levels of pollution in ambient air, as in the establishment of ambient air quality standards (AAQSs). Other regulations establish limits on air pollutant emission sources or activities to reduce their impact. Still others establish jurisdictional authority to regulate air pollutant emission sources and enforce laws and regulations.

The following sections provide a general summary of air protection programs and ambient pollutant levels in the environs of LLNL:

- Section 4.10.1 highlights the regulatory authorities that oversee air protection programs.
- Section 4.10.2 provides summary information on the potential harmful effects of air pollutants, the primary sources, and recommended control measures.
- Section 4.10.3 provides more specific details on the requirements placed on facilities in order to control and remedy air pollutant problems.
- Section 4.10.4 details LLNL's air pollutant sources and emissions, the programs developed to manage these sources, and the program effectiveness.
- Section 4.10.5 discusses radiological air quality, providing information on LLNL's effluent monitoring and ambient air sampling programs, radionuclide emission estimates, as well as dose calculations for maximally exposed receptors and the populace.

4.10.1 Regulatory Authorities

EPA is charged with protecting the Nation's air resources. The authority is derived from the *Clean Air Act* and subsequent amendments, which provide the framework to protect the Nation's air resources. In addition to federally mandated air programs, the state of California has enacted legislation with the *California Clean Air Act* and the California Health and Safety Code to further protect the air resources. Some of these programs are similar to, but more stringent than, Federal counterparts, while others are unique to California.

Within California, the authority to administer both Federal and state air programs has been delegated to the California Air Resources Board (CARB), a department of the California EPA. The CARB, in turn, has further delegated the authority to regulate stationary air emissions sources (i.e., nonvehicular sources) to local air districts. Local program requirements must be at least as strict as any underlying state or Federal requirements.

Locally, the Bay Area Air Quality Management District (BAAQMD) and San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) hold jurisdiction. The Bay Area air basin includes Alameda County (home of the Livermore Site and a small portion of Site 300) and all or portions of eight other bay area counties. The San Joaquin Valley air basin extends to inland areas including San Joaquin County (home of Site 300) and all or portions of eight other counties. Each air district is required to assess the local air pollutant situation and to develop and implement programs to protect the air resource.

LLNL activities, therefore, are subject to air quality regulations and standards established under the *Clean Air Act,* by the State of California, and under the rules and regulations of the local air districts, as well as internal policies and requirements of NNSA and the University of California.

Summaries of program requirements and the LLNL air protection program are provided below. Table 4.10.1–1 provides a summary of air pollutant sources, potential health effects, and strategies for air pollutant prevention and control.

4.10.2 Public Health Criteria and Air Protection Programs

To support the protection of air resources, local air pollution control agencies routinely collect information related to air emission sources and measure ambient air pollutant levels. Air emission source information is collected in the form of an emissions inventory. Together, these data are used to assess and develop air pollutant programs targeted to local and regional pollutant problems and emission sources, and design long-range strategies for continued protection of the air resources while allowing for future growth.

Where air pollutant levels are problematic, more stringent requirements are placed on emission sources, and additional oversight is given to those sources responsible for a greater portion of the pollutant loading. In the development of emissions inventories, air districts work with affected facilities to gather necessary information. The task of preparing an emissions inventory involves a detailed evaluation of facility processes, hours of operation, equipment ratings, material throughput, operational efficiency, and control mechanisms. This information is used to quantify emission rates. Facilities must report all emission information for each air contaminant for which emission rates exceed a reporting threshold. The inventory process in California is quite extensive, and involves the collection of data on more than 300 compounds. Using this information, the air districts throughout the state are required to prioritize facilities for additional review. The inventory also provides a feedback loop to assist in the determination of the adequacy of placement and extent of air monitoring programs.

This section provides data developed in the air monitoring and inventory programs, specifically the criteria and toxic air pollutant programs. Locally, air pollutants are measured at air district monitoring stations in Livermore and Tracy, although monitoring in Tracy is not as extensive as that in Livermore. Both monitoring and emissions inventory data are compiled by the air districts and CARB and published in annual reports. This section draws heavily on data and assessments from these annual reports to provide an objective measure of the status of air quality.

4.10.2.1 *Criteria Air Pollutant Programs*

With the enactment of air protection programs, Congress established the National Ambient Air Quality Standards (NAAQS) for certain pervasive pollutants, termed criteria air pollutants, that were recognized as particular environmental concerns. These criteria air pollutants include sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, particulate matter, and lead. Standards for particulate matter were later refined to specify smaller size particles that are more easily inhaled and retained in the lungs. NAAQS are designed to protect public health and welfare. In addition, the State of California has promulgated State Ambient Air Quality Standards (SAAQS). California standards are equal to or more restrictive than Federal standards, and include additional air contaminants; specifically, hydrogen sulfide, sulfates, vinyl chloride, and visibility-reducing particles.

Air quality standards are expressed as an allowable volume of pollutant per million volumes of air (parts per million), or as micrograms of pollutant per cubic meter of air. Each NAAQS or SAAQS is related to an averaging time. Short-term averaging times of 1 to 24 hours are designed to protect against acute (short-term) exposures to relatively high pollutant levels. Longer-term averaging times of 1 month to 1 year are designed to protect against the ongoing or day-to-day exposure to relatively lesser pollutant levels.

Ambient air pollutant measurements are used in determining an area's status with respect to NAAQS or SAAQS (i.e., as an attainment or nonattainment area). Ozone and nitrogen dioxide are measured locally in Livermore and Tracy. Particulate matter and carbon monoxide are also measured in Livermore, as well as some toxic air contaminants (discussed in Section 4.10.2.2).

While attaining and maintaining compliance with NAAQS or SAAQS is a primary goal of all air pollution control agencies, both the Bay Area and San Joaquin Valley have been designated as nonattainment areas with respect to both the Federal ozone standard and the more stringent state standard. The Bay Area air district is classified as nonattainment with respect to California standards for particulates, attainment for the Federal PM_{10} annual standard, and unclassified for both $PM_{2.5}$ and 24-hour PM_{10} standards. The San Joaquin Valley air district is classified as nonattainment for state particulate matter standards and as a serious nonattainment area for Federal PM_{10} standards. The designation for the Federal $PM_{2.5}$ standard has not yet been determined (SJVUAPCD 2002). Although particulates are not measured in Tracy, it is recognized as a regional problem. The Bay Area has been a nonattainment area for carbon monoxide; however, in 1998, the Bay Area was redesignated as an attainment area for carbon monoxide, and further problems are not anticipated (BAAQMD 2003, 1999).

Regionally, the most complex air quality problem has been ozone. Ozone is not regulated directly because it is formed in the atmosphere by photochemical reactions (i.e., in the presence of sunlight). Nitrogen oxides and many organic compounds are precursors to the formation of ozone. For this reason, air districts are particularly interested in reducing precursor organic compounds and nitrogen oxides. As discussed in Section 4.7.5, the local topography, meteorology, and proximity to large metropolitan areas upwind, contribute to the buildup of air pollutants in the Livermore Valley. This area, in fact, experiences a disproportionate number of exceedances of NAAQS. Because it takes some time for the photochemical reactions to occur, emissions of precursors, primarily from motor vehicles and the morning commute, are transported away from their sources and affect ozone concentrations in downwind areas. Although the Bay Area's highest ozone levels can fluctuate from year to year depending on weather conditions, ambient ozone standards are exceeded most often in the Santa Clara, Livermore, and Diablo valleys. These same locations typically register the highest particulate matter levels as well, although in this case, the high levels are due to the dry conditions and limited mixing within the sheltered terrain (BAAQMD 1999). The basin-wide annual criteria pollutant emissions inventory projected for years 2005 and 2010 is shown in Figure 4.10.2–1. The contribution attributable to motor vehicles is highlighted to show the dominance of this source category. Figure 4.10.2–2 provides a 7-year profile of the number of exceedances.

With the goal of expeditiously attaining conformance with NAAQS, the *California Clean Air Act* requires air districts to reduce emissions of nonattainment pollutants or precursors by 5 percent per year, and requirements are adopted within each air district's clean air plan. The stringency of requirements within each local clean air plan and subsequent implementing air regulations is based on the severity of the problem and projected timeframe when the area is expected to achieve attainment. As part of this process, both the BAAQMD and SJVUAPCD have adopted “no net increase” provisions within their clean air plans. The “no net increase” programs require that, as a precondition to the issuance of an air permit for a significant new or modified emission source, any increases in emissions of nonattainment pollutants or precursors be offset by mandatory reductions in emissions of other sources onsite or potentially at other facilities. In the BAAQMD, the offset requirement is triggered for mid-size facilities (emissions of 15 tons per year or more of nonattainment pollutants), and a greater burden is placed on large facilities (emissions of 50 tons per year or more). These large facilities must offset any proposed emission increases by a slightly greater decrease, at a ratio of 1.15 to 1.0. The added 15-percent in part satisfies the 5-percent annual emission reduction requirement of nonattainment areas (LLNL 2002e). The Livermore Site falls into the mid-size facility category and must abide by the requirements of the BAAQMD for emission offsets. Site 300, the majority of which lies within San Joaquin County, is under the jurisdiction of the SJVUAPCD.[1] In SJVUAPCD, offset requirements are triggered at 10 tons per year. Although this level is much lower than that established by the BAAQMD, emissions at Site 300 are substantially less than the offset trigger level (LLNL 2002e). Additional information on emission levels and the offset management program are provided in Section 4.10.4.

4.10.2.2 *Toxic Air Pollutant Programs*

Programs regulating toxic air contaminants differ from those regulating criteria air pollutants. Rather than establishing standards, regulating air toxics is based on managing risk. Risk can be thought of as a probability of harm. That probability can be determined for any air toxicant based on its toxicity, airborne concentration, and exposure rate. The California Office of Environmental Health Hazard Assessment classifies and determines compound toxicity. Air toxics are generally classified as carcinogenic (based on evaluations related to the substance’s expected potency as a cancer-causing agent) or noncarcinogenic.

Noncarcinogenic health impacts may involve either transient or long-term impacts to either one or a number of individual organs (e.g., skin or eye irritations, kidney damage, etc.) or systems (respiratory, nervous, cardiovascular, reproductive, etc.). Noncarcinogens are further classified as acute or chronic, based on the ability to cause harm due to either short-term exposures to high levels or long-term, repeated exposure to lower levels. Many substances are classified as both acutely and chronically toxic and also have been categorized as carcinogens. Impacts of toxic air contaminants are typically evaluated cumulatively (i.e., as the sum of the impact of each air toxicant with similar effects). For example, the impact to the respiratory system is calculated as the sum of the impacts of each air toxicant identified as a respiratory irritant.

The California Office of Environmental Health Hazard Assessment has also developed standardized methods used to evaluate human health risk. The methods are designed to be conservative so as to not underestimate the risk. For carcinogens, the risk is expressed as either

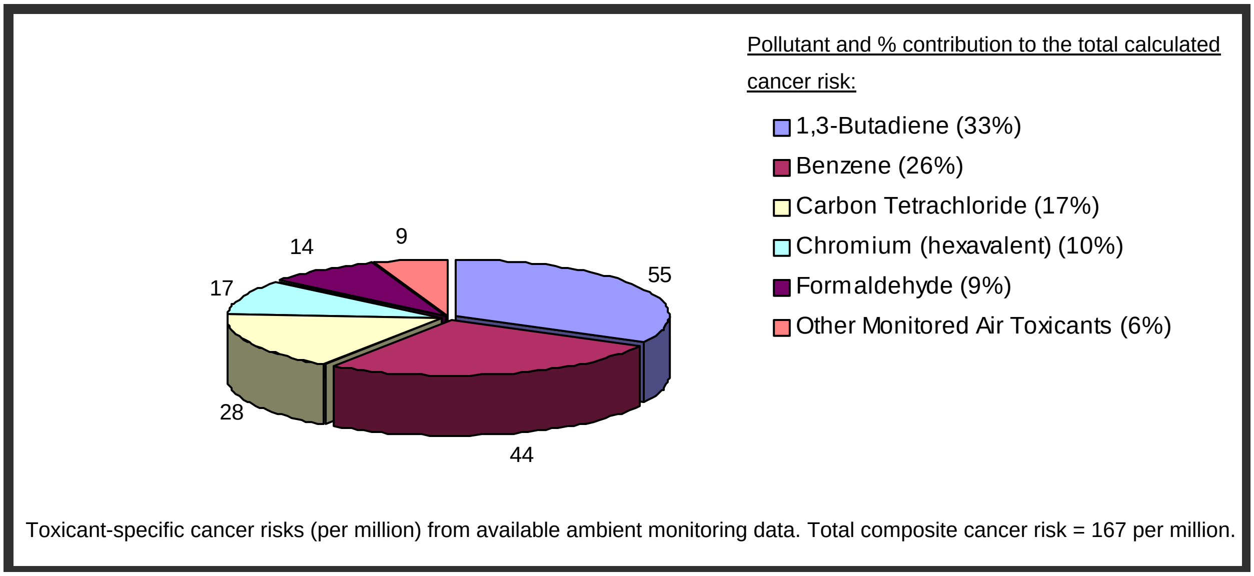
[1] As stated in Section 4.10.1, a small portion of Site 300 falls within Alameda County, which is under the jurisdiction of the BAAQMD.

an individual excess lifetime cancer risk or a population risk. Excess is used here to refer to a risk above background (generally assumed to be 1 in 3). Cancer risk is typically calculated assuming a full-time (70-year) exposure period. In many cases, the risk is stated as a risk per million.

A cancer risk of one in one million (1×10^{-6}) is generally considered negligible. For non-cancer, the risk is presented as a health hazard index (HHI). It is simply the ratio, summed over all contaminants, of the amount of contaminant to the level of that contaminant below which health impacts are not expected to occur. An HHI less than 1 is generally acceptable; no impact is expected. The air districts, together with guidance from state agencies and considering all public input, determine generally acceptable risk levels.

Air districts monitor toxic air contaminant levels and use the data to estimate background risk. The BAAQMD monitors a number of air contaminants throughout the Bay Area and has compiled a composite cancer risk for exposure to air toxics. Figure 4.10.2–3 shows the individual excess cancer risk calculated from average measured ambient concentrations of air toxics in the Bay Area. Of the pollutants for which monitoring data[2] are available, 1,3-butadiene and benzene (which are emitted primarily from motor vehicles) account for over one-half of the average calculated cancer risk. The BAAQMD reports that ambient benzene levels declined dramatically in 1996 with the advent of reformulated gasoline, with significant reductions in ambient 1,3-butadiene levels also occurring. Due largely to these observed reductions in ambient benzene and 1,3-butadiene levels, the calculated average cancer risk has been significantly reduced in recent years. Based on 2000 ambient monitoring data, the calculated cancer risk is 167 in one million, which is about 45 percent less than that observed 5 years earlier (BAAQMD 2001). The calculated risk in and around the city of Livermore is likely to be similar, or slightly less than this composite value (on the basis of ambient levels of gaseous carcinogens monitored in Livermore in 2000, and default Bay Area composite values for substances not monitored locally). Although data are not available for Site 300 environs or the city of Tracy, ambient levels of gaseous carcinogens are likely to be lower in these less densely populated areas.

[2] Ambient monitoring data are available for a limited number of toxic air contaminants. Diesel particulate matter, recently listed by the State of California as carcinogenic, is not included in the referenced evaluation.



Source: BAAQMD 2001.

FIGURE 4.10.2–3.—*Cancer Risk Due to Average Ambient Concentrations of Toxic Air Contaminants Measured in the Bay Area in 2000*

In addition to monitoring ambient levels, air districts develop air toxic emissions inventories. The inventory is part of California's comprehensive Air Toxics "Hot Spots" program, whereby industrial facilities and air districts are required to inventory emissions of some 300 toxic air contaminants and evaluate potential risks posed by their emissions. Where the risk is considered significant, the air districts must notify the exposed public and expeditiously reduce the risk. Facilities must report all emission information for each air contaminant for which emission rates exceed a reporting threshold. Each pollutant-specific reporting threshold reflects the emission level that is estimated to result in a *de minimis* (negligible) level of health risk based on a series of conservative risk assessment assumptions (e.g., lifetime exposure and close proximity to the emission source). For carcinogens, the threshold reporting levels have been set at the emission level that corresponds to a cancer risk of one in one million (1×10^{-6}). Noncarcinogen reporting levels represent the amount estimated to result in an HHI of 1. Using this information, air districts throughout the state are required to prioritize facilities for additional review. High-priority facilities are required to submit detailed health risk assessments. Both the Livermore Site and Site 300 are ranked by the air districts as low-risk facilities (LLNL 2003l).

4.10.2.3 *National Emission Standards for Hazardous Air Pollutants*

The Federal EPA has also established programs to reduce emissions of approximately 200 hazardous air pollutants (HAPs). The National Emission Standards for Hazardous Air Pollutants (NESHAP) include requirements categorized by pollutant type, emissions level, and/or industrial category. For the most part, these standards apply to major sources of HAPs, emitting 10 tons per year or more of any single HAP, or 25 tons per year or more in the aggregate.[3] In addition to the state air toxic program, local air districts administer many of the federally mandated programs,

[3] Radiological NESHAP are detailed in Section 4.10.5.

although in most cases the local or state program has been deemed equivalent or more restrictive, and therefore supercedes Federal requirements.

4.10.3 Source Evaluation and Control

In addition to air program development and assessment, local air districts must

- Evaluate air emission sources.
- Issue air permits with operating terms and conditions.
- Inspect sources routinely to determine compliance.
- Take necessary enforcement actions.

This section summarizes some of the more specific aspects of the programs. Emphasis is placed on elements pertinent to LLNL activities.

4.10.3.1 *Permit Program and New Source Review*

All activities with the potential to emit and/or control air pollutants must operate under the requirements of the air permit, unless the activity has been specifically determined to be exempt. In fact, for most operations, a preconstruction review and permit to construct must first be issued.[4] In order to receive a permit to operate, a facility must submit all pertinent data to the air district to demonstrate equipment will be operated, or the facility will be managed, in a manner that complies with all air pollutant control regulations (local, state, and Federal). The air district must evaluate the source and make a determination that reinforces compliance, and the district will specify equipment standards and/or operating conditions within the permit. Major aspects of the review include the following:

Evaluation of Best Available Control Technology (BACT) and No-Net-Increase Program for Nonattainment Pollutants

Many sources are required to incorporate a very stringent level of control. This requirement stems, in part, from the no-net-increase program for nonattainment pollutants. In addition, sources may be required to offset new emissions by incorporating reductions in other sources. The analysis will also evaluate a facility's status with respect to threshold levels that may trigger additional requirements, such as requirements to provide a higher level of offsets. Additional air protection program requirements are triggered for larger emitting facilities. These programs include the Federal Title V Operating Permit Program and major source requirements under NESHAP.

Assessment of Potential Health Impacts of Toxic Air Contaminants and Adherence to District Risk Management Criteria

Many sources are required to incorporate a very stringent level of control on air toxic sources, commonly referred to as Toxic Best Available Control Technology (TBACT).

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[4] The air districts have evaluated certain types of activities and have determined that either due to the scale of the operation (many activities have threshold levels for raw material throughput or equipment rating [horsepower or British thermal units]) or to the nature of the activity (e.g., some research activities are exempt), these activities are exempt. Exempt sources are listed in air district rules, but in some cases, in particular for unique operations, a facility may ask the district to review a source and make a case-by-case determination.

Conformity

Proposed activities that may generate an increase in air pollutants are reviewed for consistency with local, state and Federal air regulations. The local air district will issue operating permits for equipment only after demonstration that the equipment complies with all applicable district regulations, and the owner or operator provides assurance that the equipment will be operated in compliance with imposed conditions.

In addition to their authority for stationary source emission control programs, local regulatory agencies are afforded an additional level of control over Federal projects through the requirements for conformity as codified under the Federal *Clean Air Act.* The conformity evaluation considers project emissions as a whole, including motor vehicle emissions. The underlying basis for the conformity demonstration is to preclude actions that would generate growth in air pollutants to a degree that is inconsistent with the local clean air plan, and thereby frustrate regional efforts to attain and maintain the NAAQS. Within the Bay Area, projects that generate emissions of precursor organic compounds, oxides of nitrogen, or carbon monoxide in excess of 100 tons per year are required to fully offset or mitigate the emissions caused by the action. This includes both direct emissions and indirect emissions over which the Federal Agency has some control (BAAQMD 1999).

4.10.3.2 *Continuing Source Assessment and Compliance*

Air districts use various measures to monitor facility compliance with district rules and operating requirements. The emissions inventory is a key component. Facilities are required to submit emissions information to the air districts on a routine basis; typically this is done annually as part of the permit renewal application. The district evaluates this information and makes a determination prior to permit renewal. The district also routinely inspects air emission sources, and if applicable, reviews operating logs and conducts emissions tests. If a source is operating out of compliance, applicable enforcement actions, which may include fines, imposition of additional oversight, revocation of a source’s operating permit, and other measures will be imposed.

4.10.4 Lawrence Livermore National Laboratory Air Protection Program

4.10.4.1 *Source Evaluation and Regulatory Assessment*

All LLNL activities with the potential to produce air pollutant emissions are evaluated to determine the need for air permits and assessed for continued compliance. LLNL also monitors existing and pending environmental legislation to assess potential impacts to ongoing and proposed operations. LLNL staff also work with air district representatives to evaluate and understand LLNL emission sources (e.g., LLNL Environmental Protection Department [EPD] staff worked with the SJVUAPCD to develop criteria for an explosives testing exemption rule). Sources that have been determined to be exempt from permit requirements are monitored to substantiate that each source operates in agreement with exemption specifications (e.g., throughput remains within the limits of a specified exempt quantity).

4.10.4.2 *Permitted Equipment*

As stated, air permits are obtained from the BAAQMD for the Livermore Site and from the SJVUAPCD for Site 300. In 2002, the BAAQMD issued 199 permits for operation of various types of equipment at the Livermore Site, and SJVUAPCD issued air permits for 44 air emission sources for Site 300. A general listing of air permits is provided in Table 4.10.4.2–1.[5]

4.10.4.3 *Air Pollutant Emissions Inventory*

Criteria Air Pollutants

As part of the annual permit renewal process, facilities supply information to the district on material throughput and/or usage for permitted sources at their sites. This information is entered into the district's database where it is used to estimate air emissions. The emissions inventory serves as a means to determine facility category (small, medium, or large) and thereby dictate requirements, such as those under the no-net-increase programs. The inventory and LLNL's status with respect to facility categorization is of great importance. To encourage good air protection practices, the district allows mid-size facilities, which meet stringent control requirements, to borrow offset credits from the district bank. The Livermore Site meets the emission limits for a mid-size facility in terms of the BAAQMD's no net increase programs, and the district has determined that this facility has emission controls on its precursor organic compound and nitrogen oxide emission sources, which satisfy the stringent control eligibility requirement to receive credits from the district. The conditions associated with obtaining credits from the district include continued compliance with stringent control requirements, and maintaining emissions below the 50-tons-per-year threshold.[6] Requirements to maintain emission levels below applicable thresholds are also dictated within the Livermore Site Synthetic Minor Operating Permit which was finalized by the BAAQMD in November 2002 and forwarded to EPA for review. The Synthetic Minor Operating Permit includes requirements that limit nitrogen oxide emissions from combustion sources to less than 50 tons per year, and precursor organic compound emissions from solvent evaporating sources to less than 50 tons per year. The 50-ton-per-year emission limits within the Synthetic Minor Operating Permit establishes the Livermore Site as a minor source, which is not subject to the federally based Title V Operating Permit program. Permit conditions also require LLNL to prepare an annual emissions report for each year (LLNL 2003l).

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[5] The number of permitted units may vary substantially from year to year. Changes in air district regulations, which categorize the types of equipment and activities that are exempt from the requirement to obtain an air district operating permit, may trigger the need to obtain permits for sources that were previously exempt. In other cases, improvements in technology or air district passage of a prohibitory rule may obviate the need for air permits for a particular source category.

[6] If emissions should rise above the 50-ton-per-year threshold, the facility must immediately repay all borrowed credits. Repayment of borrowed credits must be in the form of credits obtained from another facility; it cannot be in cash. Future market values of offset credits are unknown, but current values are on the order of $10,000 per ton per year.

TABLE 4.10.4.2–1.—*Summary of Lawrence Livermore National Laboratory Permits Active in 2002*

	Permitted Units	
Category	**Livermore Site**	**Site 300**
Coating, printing, and adhesives	Paint spray booths Adhesives operations Optic coating operations Printing press operations Silk-screening operations Silk-screen washers	Paint spray booth
Combustion	Boilers Generators Diesel air-compressor engines	Boilers Generators
Explosives testing	Fire test cells and firing tanks	Contained Firing Facility
Gasoline dispensing	Gasoline dispensing operation	Gasoline dispensing operation
Machining	Metal machining and finishing operations	-
Ovens	Ovens	Drying ovens
Remediation and waste management	Groundwater air strippers/dryers Oil and water separator Sewer diversion system Drum crusher Paper-pulverizer system	Groundwater air strippers Soil vapor extraction units Explosive waste treatment units Woodworking cyclone (exhaust system control device)
Solvent cleaning	Cold cleaners Ultrasonic cleaners Degreasers Manual wipe-cleaning operations	-
Miscellaneous	Storage tanks with volatile organic compound content in excess of 1% Plating tanks Semiconductor operations Image tube fabrication Material-handling equipment	Fire hazard management prescribed burning permit (see Section 4.10.4.7)
Total Permitted Units	**199**	**44**

Source: LLNL 2003l.

Site-wide criteria pollutant emission rates for LLNL are provided in Table 4.10.4.3–1. The Livermore Site currently emits approximately 109 kilograms per day of criteria air pollutants from both permitted and exempt sources. The largest sources of criteria pollutants from the Livermore Site are surface coating operations, internal combustion engines, solvent operations, and natural gas-fired boilers. The largest sources at Site 300 are internal combustion engines, boilers, a gasoline-dispensing operation, open burning of brush for fire hazard management, paint spray booths, drying ovens, and soil vapor extraction operations (LLNL 2003l). Even though the SJVUAPCD no-net-increase threshold is much lower than the BAAQMD threshold, Site 300 is currently well below both the precursor organic compound and nitrogen oxide emission thresholds that trigger requirements for no net increase and should remain so in the foreseeable future (LLNL 2002e).

TABLE 4.10.4.3–1.—*Emission Rates for Criteria Air Pollutants and Precursors*

Pollutant [b]	Estimated releases (kilograms per day) [a]									
	Livermore Site					Site 300				
	1998	1999	2000	2001	2002	1998	1999	2000	2001	2002
Precursor organic compounds	25	24	20	19	16	0.90	1.2	0.4	0.1	0.23
Nitrogen oxides	56	81	54	52	67	2.1	3.2	2.3	0.9	1.1
Carbon monoxide [c]	11	24	14	14	17	0.48	0.71	0.5	1.1	1.0
Particulates (PM_{10})	5.7	8.6	5.5	5.5	6.1	0.53	0.33	0.2	0.3	0.09
Oxides of sulfur	0.72	0.98	0.6	0.6	2.8	0.15	0.28	0.2	0.1	0.07

Source: LLNL 2003l, LLNL 2002cc, LLNL 2001v, LLNL 2000g, LLNL 1999c.

[a] One kilogram equals 2.2 pounds.

[b] Individual air pollutants, or pollutant categories listed above, are those which are most widely regulated in air protection programs aimed at controlling sources and ambient levels of criteria air pollutants, both Federal and State of California. Organic compounds are regulated (and listed above) as precursors to the formation of the criteria air pollutant ozone. Other criteria air pollutants (state and Federal) are listed in Table 4.10.1-1.

[c] In 1999, the emission factor used to calculate carbon monoxide was 0.035 pound per 1,000 cubic feet for large boilers and 0.021 pound per cubic foot for small boilers. In previous years, the emission factor used was 0.017 pound per cubic foot for both large and small boilers. This resulted in a significant change in carbon monoxide emissions reported for 1999.

Toxic Air Contaminants

LLNL also compiles an inventory of toxic air contaminants under the California Air Toxics “Hot Spots” program (see Section 4.10.2.2). Of the more than 300 hot spot chemicals, only a few are emitted from LLNL processes at levels that exceed the *de minimis* reporting threshold. On the basis of the air toxics inventories, BAAQMD and SJVUAPCD have ranked LLNL as a low-risk facility for nonradiological air emissions (LLNL 2003l).

Hazardous Air Pollutants

A separate Federal listing of approximately 200 compounds is evaluated to confirm applicability under NESHAP. Thresholds defining a major source under NESHAP are 10 tons per year for a single hazardous air pollutant or 25 tons per year for a combination of hazardous air pollutants. Emission rates at both LLNL sites are less than one-half of these thresholds (LLNL 2002e). The Livermore Site Synthetic Minor Operating Permit (discussed above) includes a limitation on total HAP emissions (less than 23 tons per year) and annual reporting requirements, which establishes LLNL’s minor source status. Although, LLNL is not a major facility in terms of HAP emission rates, specific NESHAP programs apply for beryllium (discussed in Section 4.10.4.8) and radionuclides (Section 4.10.5).

4.10.4.4 *Annual Compliance Inspections and Enforcement Actions*

Each year, BAAQMD and SJVUAPCD officials inspect operations at the Livermore Site and Site 300, respectively. Annual compliance inspections entail a review of permitted and exempt equipment, including documentation to demonstrate adherence to prohibitions; operating, record keeping, and notifications requirements; and emissions limitations. New equipment is also inspected prior to issuance of a new permit to operate, to ensure that equipment specifications comply with conditions specified in the authority to construct permit. In the last several years, there have been no enforcement actions or deficiencies noted; however, LLNL received a Notice of Violation from the BAAQMD on April 9, 2003, for an alleged record keeping violation during the period September 2002 through February 2003. The Notice of Violation was resolved by LLNL’s payment of a monetary penalty to BAAQMD (LLNL 2003l, LLNL 2002cc, LLNL 2001v, LLNL 2000g, and LLNL 1999c).

4.10.4.5 *Lawrence Livermore National Laboratory Air Emissions Offsets Management Plan*

The LLNL Air Emissions Offsets Management Plan establishes responsibilities for LLNL's management of air emissions and emission credits necessary to meet offset requirements of the regional air districts (LLNL 2002e). The plan specifically states that:

> BAAQMD emissions will be maintained below the 50 tons per year pollutant-specific threshold, and SJVUAPCD emissions will be maintained below the 10 tons per year pollutant-specific threshold. Emission sources may be prioritized in the future, so that some emission sources are curtailed to allow replacement by new sources in order to maintain overall emissions below the thresholds.

The system is guided by the principal of maintaining emissions as low as reasonably achievable (ALARA) and managing emissions on the basis of cost effectiveness to obtain maximum benefit to LLNL, meet or exceed the intent of the *California Clean Air Act*, provide for timely permitting of new projects, and avoid the necessity for additional permitting associated with major source programs.

4.10.4.6 *Integrated Air Pollution Prevention Programs*

Pollution prevention is a cross-disciplinary program implemented at LLNL. Examples of LLNL pollution prevention and waste minimization activities with resultant benefit to the air resources include transportation demand management, reduced precursor organic solvent use and recycling programs, programs to substitute steel weight (rather than lead weight) at the Site 300 firing table, energy conservation, and programs to reduce the use of stratospheric ozone-depleting substances sitewide (LLNL 1997a). These are part of the Environmental Management System (EMS) and Integrated Safety Management System (ISMS) programs at LLNL, which are discussed in detail in Appendix O.

4.10.4.7 *Controlled Burning Operations at Site 300*

Site 300 has conducted controlled burns (i.e., prescribed burns) throughout its 40+ year history for wildfire control. The annual prescribed burn can cover up to 2,100 acres, which is divided into control plots ranging from less than 1 acre to 600 acres. Daily prescribed burn acreage can range between approximately 10 acres to 1,200 acres. Annual prescribed burning typically takes place from mid-May through July when the grass (i.e., fuel) is dry enough to sustain a burn and not too dry to present uncontrollable fire risk. Prior to the prescribed burn each year, LLNL submits a prescribed burn/smoke management plan to both the SJVUAPCD and BAAQMD and meets each air district's planning and reporting requirements.

Planning and coordination with both air districts is critical. Each district imposes stringent review and approval requirements before allowing prescribed burn activities to take place to meet their smoke management objectives. In addition, each air district prioritizes burn activities requested within their air basin and provides daily burn allocations to the requesting facility based on air quality, weather conditions, declared burn days, and other scheduled burn activities. In addition to meeting air district requirements, LLNL conducts prescribed burns to meet DOE wild land management requirements and follows best management practices to minimize the creation of smoke and ensure safe burn conditions.

Annual prescribed burn areas are shown in Figure 4.10.4.7–1. Prescribed burning conducted at Site 300 is considered a long-term asset to air quality as it reduces the potential for destructive wildfires. In addition, fires remove potential airborne residues that accumulate, such as pollen and other respirable matter. The principal objectives of the LLNL Site 300 Explosive Test Facility Prescribed Burn/Smoke Management Plan (LLNL 2003q) are to:

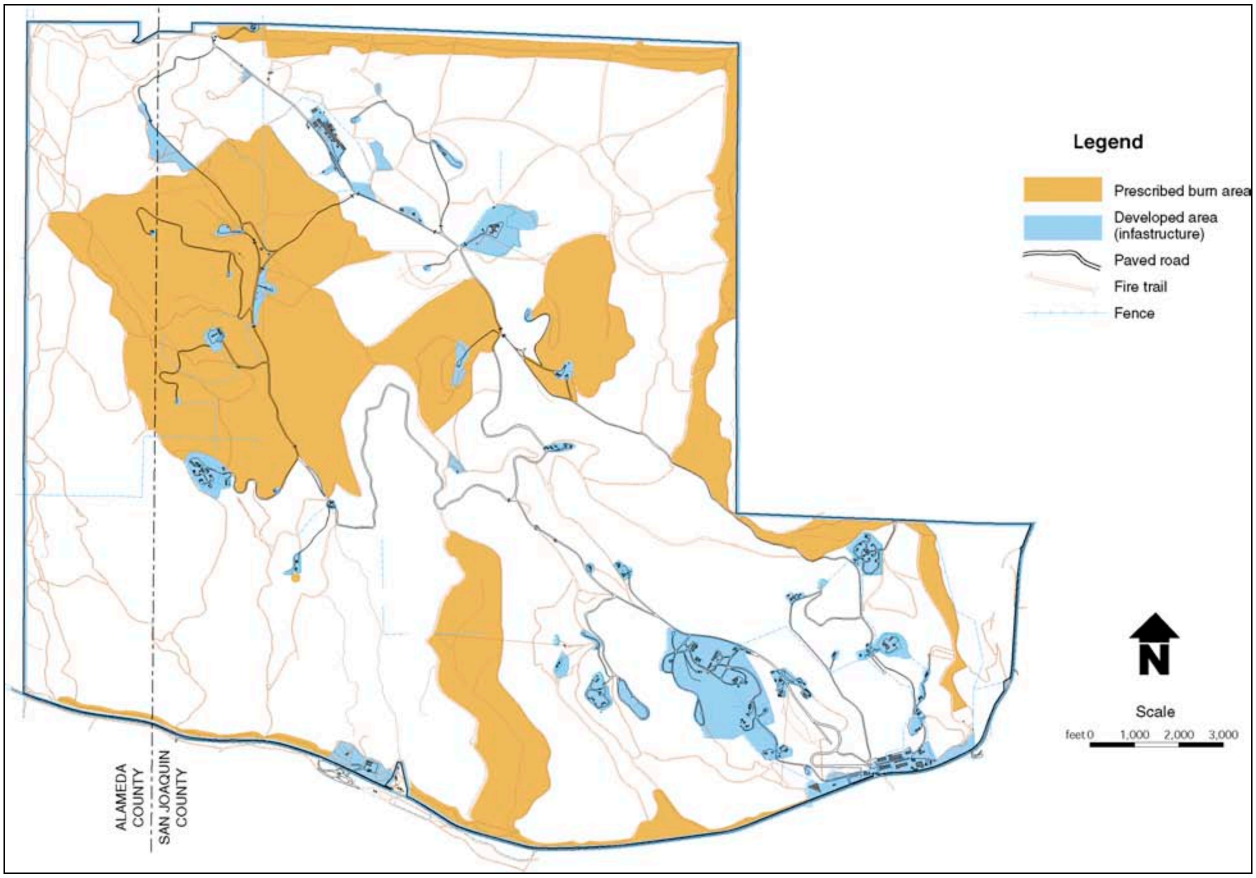
- Minimize the occurrence of unnaturally intense fires by reducing the amount of vegetation that can fuel larger, more catastrophic fires.
- Preserve the capability to safely test explosives while protecting the environment.
- Minimize the occurrences of fires that could leave the Site 300 boundaries and impact neighbors and limit the extent of prescribed fires, which could reduce the air quality for neighbors.
- Use minimum impact prescribed burns and fire suppression techniques, and rehabilitate areas to protect natural and cultural resources from adverse impacts attributable to wildfire suppression activities.

Fire has been one of the primary forces that created and maintains the biodiversity and specialized wildlife habitats throughout Central California. Alternatives to prescribed burning have been researched. Livestock grazing was found to be nonbeneficial due to its threat to native grasses, wetlands, and endangered species and is also limited in value due to the restriction of areas available for grazing. Disking was found to have limited benefit but has been used on an infrequent basis on a small portion of the site perimeter in lieu of controlled burning to avoid the spread of fire to adjacent private lands. Mowing is not suited for most areas because of the terrain. Herbicides are used around facilities where controlled burning could pose a threat to the facility, but herbicides are not used in the large tracts of land where controlled burning is employed because they limit plant ecosystem diversity, unlike controlled burning which fosters the growth of native plants. The planting of fire-resistant, nonnative species would pose a further threat to native grasses, which prove a more favorable habitat for other native flora and fauna (LLNL 2001c).

4.10.4.8 *Beryllium Monitoring and Exposure Evaluation*

Beryllium metal, alloys, and compounds are used at LLNL. Although LLNL is not a major facility in terms of HAP emission rates, specific NESHAP requirements (40 CFR Part 61, Subpart C) apply for beryllium. Beryllium is identified with respiratory and immune system toxicity, and is regulated under both state and Federal programs. The State of California has identified a reference exposure level (air concentration) associated with long-term (chronic) exposures to the public. Chronic exposure to concentrations in excess of this level (0.007 micrograms per cubic meter)[7] require the implementation of air toxic risk reduction measures.

[7] The chronic reference exposure level for beryllium (previously 0.01 $\mu g/m^3$) was reevaluated and revised by the State of California Office of Environmental Health Hazard Assessment, December 2001(OEHHA 2003).



Source: LLNL 2001c.

FIGURE 4.10.4.7–1.—*Site 300 Annual Prescribed Burn Areas*

LLNL measures beryllium at fenceline locations, both at the Livermore Site and Site 300, and within the city of Tracy.[8] All air samplers are positioned to provide reasonable probability that any significant concentration of beryllium effluents from LLNL operations will be detected. The median beryllium concentration for Livermore Site perimeter locations for 2002 was 1.4×10^{-5} micrograms per cubic meter, and the highest value was 2.8×10^{-5} micrograms per cubic meter. At Site 300, the median was 6.8×10^{-6} micrograms per cubic meter, and the maximum was 2.0×10^{-5} micrograms per cubic meter. The median concentration in Tracy over the same period was about 30 percent higher than that at Site 300, and the maximum value was almost 60 percent higher than the level recorded at Site 300. This is believed to be the result of the location of the sampler which is situated in a congested part of town, and therefore accumulates more industrial particulate pollutants. When compared to the reference concentration level, all values are less than one-half of one percent of this standard, and do not indicate the presence of a threat to the environment or public health. The concentrations of beryllium at both sites can be attributed

[8] To satisfy beryllium reporting requirements and determine the effects of the Laboratory's beryllium operations, LLNL conducted a technical assessment of the beryllium monitoring locations at Site 300 in 1997. Although there is no requirement to sample for beryllium at Site 300, LLNL has decided, as a best management practice, to continue beryllium monitoring at three locations onsite and at one location in the city of Tracy.

primarily to resuspension of surface soil containing naturally occurring beryllium. Local soils contain approximately 1 parts per million of beryllium (LLNL 2003l, LLNL 2003cb).

4.10.5 Radiological Air Quality

Some LLNL facilities discharge low quantities of radionuclides to the air. These releases can be evaluated according to the individual and population dose they create. The degree of hazard to the public is directly related to the type and quantity of the radioactive materials released. Dose estimates are modeled from emissions determined at each facility or, in the case of diffuse sources such as soil resuspension, from air sample measurements. Separate doses are calculated for the Livermore Site and Site 300 because of their spatial separation and are compared to regulatory dose limits for the protection of public health. Historically, doses have never exceeded regulatory limits. Recent annual doses to the hypothetical site-wide maximally exposed individual (see Table 4.10.5–2) have been less than 2 percent of a chest x-ray (West and Coronado 2003).

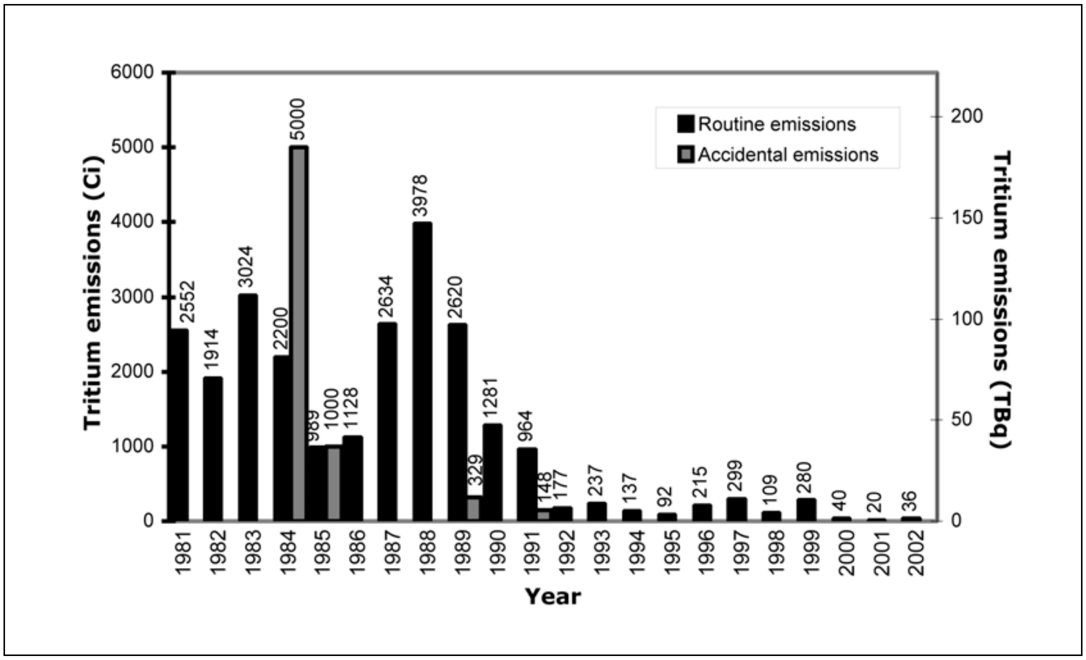
New, modified, and ongoing LLNL projects having potential radiological impact on the public and the environment are identified and assessed in NEPA reviews and Integration Work Sheets (IWSs). Such projects are documented each year in LLNL's NESHAP Annual Report and SAER. Facilities with designated Radioactive Materials Management Areas (RMMAs) report usage of radioactive materials that have potential for emission to air. Facility documents such as Safety Analysis Reports (SARs), Facility Safety Plans (FSPs), and Operational Safety Plans (OSPs) describe administrative controls designed to keep radiation exposures to workers, the public, and the environment as low as reasonably achievable.

4.10.5.1 *Radioactive Airborne Emissions*

LLNL monitors the stack effluent from its principal facilities and measures concentrations of radionuclides in ambient air both on and offsite, to determine if radionuclides are being released and in what concentrations. LLNL performs research using a variety of radioactive materials, including tritium, uranium, plutonium and other transuranic radionuclides, biomedical tracers, and mixed fission products. The contribution to the offsite dose is predominated by tritium from the Livermore Site and depleted uranium from Site 300 (see Section 4.10.5.2). Although even less important than these, other radionuclides such as carbon-14, strontium-90 and other beta emitters, and transuranics such as plutonium-239, americium-241 and other alpha emitters can also be released. A complete list of radionuclides which can potentially be emitted can be found in the NESHAP Annual Report (LLNL 2002bb).

In 2002, 74 systems sampled radioactivity from air exhausts at 7 Livermore Site facilities (MARS, Extractor Test Facility, Chemistry and Materials Science, Heavy Elements, Tritium, Plutonium, and Laser Isotope Separation) (LLNL 2003l). The only Site 300 effluent sampling, at Building 801, was installed in 2002 to measure releases from the Contained Firing Facility (LLNL 2003l).

In 2002, 36 curies of tritium were released, 90 percent of it as tritiated water, from the Tritium Facility. Emissions from this facility continued to remain considerably lower than those during the 1980s due to a reduction in programmatic work. Figure 4.10.5–1 illustrates these historical releases. None of the facilities monitored for gross alpha and beta had emissions in 2002 (LLNL 2003l).



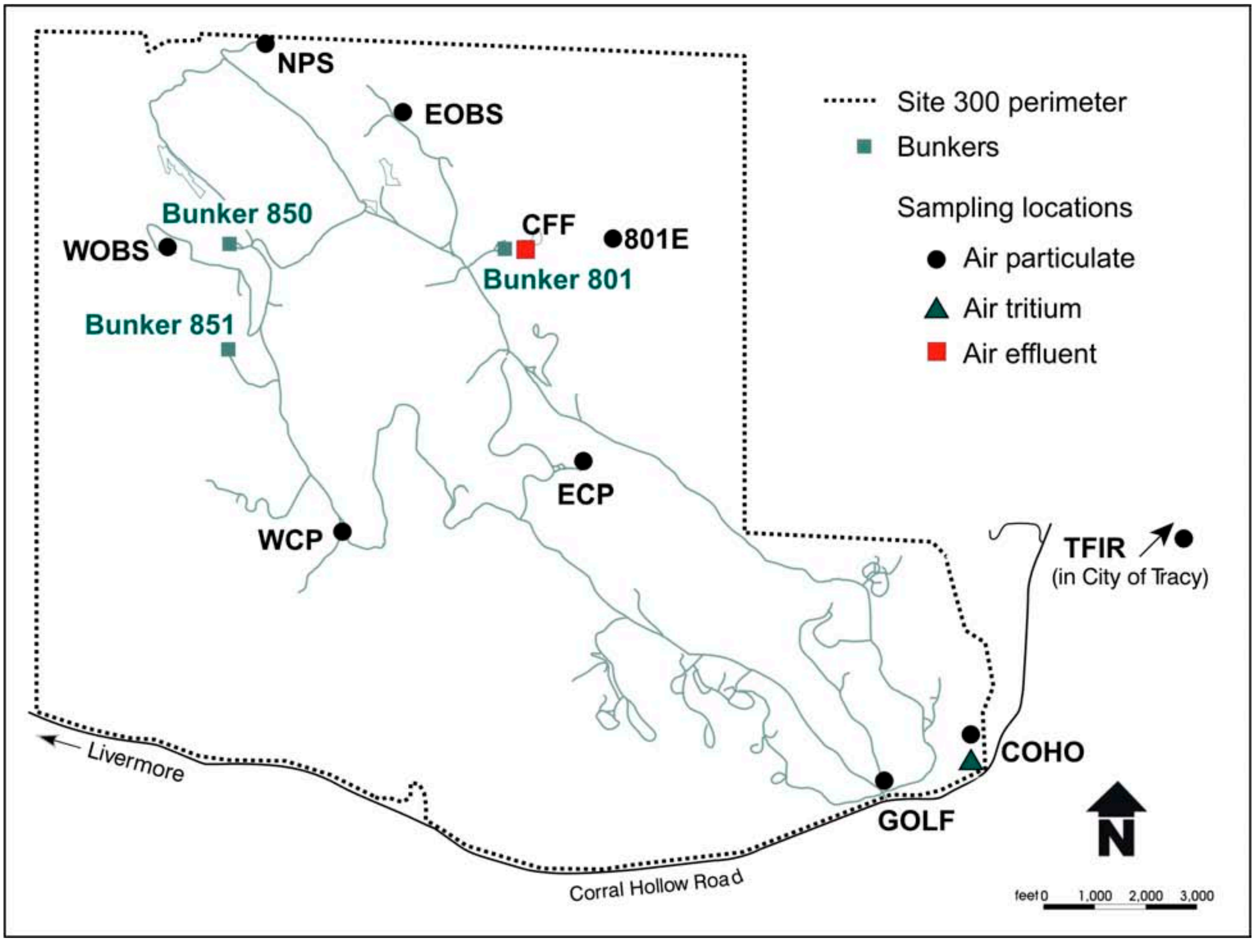
Source: LLNL 2003z.
Ci = curies; TBq = terabecquerel.

FIGURE 4.10.5–1.—*Tritium Emissions From the Tritium Facility, 1981-2002*

Ambient air is monitored by a network of air particulate and tritium samplers located on the Livermore Site (7 particulate samplers and 12 tritiated water vapor samplers), in the Livermore Valley (9 and 6, respectively), at Site 300 (8 and 1, respectively), and in Tracy (1 particulate sampler) (LLNL 2002cc). The samplers are positioned so that there is a reasonable probability that any potential release from LLNL operations would be detected (LLNL 2002bb). Figures 4.10.5–2 and 4.10.5–3 (LLNL 2001v) illustrates the effluent and ambient air sampling locations for the Livermore Site and Site 300, respectively.

Annual median concentrations of tritium (as tritiated water), plutonium-239 and 240, and uranium-238 reported at any Livermore Site location for the 5-year period beginning in 1998 range up to 4.5×10^{-10}, 1.1×10^{-18}, and 2.4×10^{-17} curies/cubic meter. Site 300 locations show even lesser concentrations of tritium and plutonium (LLNL 1999c, LLNL 2000g, LLNL 2001v, LLNL 2002cc, LLNL 2003l). The annual median concentration of uranium-238 reported at any Site 300 location for the same period is 3.0×10^{-17} curies/cubic meter.

Due to a recent refinement in the methodology to quantify tritium air samples (LLNL 2002bb), it is likely that tritium measurements made by site boundary and offsite tritium samplers prior to 2001 were a factor of up to 2 too low. This methodology change does not apply to effluent measurements, such as shown in Figure 4.10.5–1. Since calculations of dose to individuals and the public prior to 2001 are most significantly based on effluent releases (only the component of dose due to diffuse releases would be impacted by this concentration correction), conclusions based on the doses reported for years prior to 2001 are still valid.



Source: LLNL 2001v.

FIGURE 4.10.5–3.—*Site 300 Radiation Effluent and Air Sampling Locations*

4.10.5.2 *Radiation Dose to Members of the Public*

The maximally exposed individual (MEI) is a hypothetical member of the public at a fixed location who, over an entire year, receives the maximum effective dose equivalent (summed over all pathways) from a given source of radionuclide releases to air. The site-wide MEI is located where the composite dose from all site sources is greatest.

Dose is a measure of the quantity of radiation absorbed. Health effects from exposure to radiation can be estimated from this quantity (see Section 4.16.2). The radiation doses received by individual members of the public are bounded by the Livermore and Site 300 site-wide MEI. The LLNL sites, Livermore and Site 300, are far enough apart that the site-wide MEI from each site does not affect the other. Hence, a separate site-wide MEI is defined for each of the two LLNL sites.

The site-wide MEI dose is obtained by using the information gathered from effluent monitoring of point sources, knowledge of facility inventories for non-monitored locations, and ambient monitoring of diffuse sources, and then using this information in computer codes that model atmospheric dispersion, environmental transport, and human exposure. The site-wide MEI dose is also used to demonstrate compliance with 40 CFR Part 61, Subpart H (40 CFR Part 61).

The population dose to a distance of 50 miles from each site, characterizes the total dose received by the surrounding resident population. A population dose is presented for each site. In addition, a total population dose from all LLNL operations is presented as the sum of the two individual site collective doses.

The site-wide MEI can change from one year to the next, chiefly as a result of varying quantities and locations of releases. The Livermore Site site-wide MEI has been located at the UNCLE Credit Union, about 10 meters outside the controlled eastern perimeter of the site, for the past dozen years or more (LLNL 2002bb).

The Site 300 site-wide MEI has been located on the south-central boundary of the site bordering the Carnegie State Vehicular Recreation Area, approximately 3.2 kilometers south-southeast of the firing table at Building 851 (LLNL 2002bb), since the year 2000. Prior to 2000, the Site 300 site-wide MEI was located in an area operated by Primex Physics International (presently by Fireworks America), 300 meters outside the east-central boundary of Site 300 (2.4 kilometers east-southeast of the present Building 801 Contained Firing Facility) (LLNL 2000h).

Table 4.10.5–1 gives annual radiological releases over the most recent 5-year period from the important dose (site-wide MEI) contributing site locations. It is generally found that a few sources (less than a dozen out of nearly 200 emissions sources at the Livermore Site) contribute over 90 percent of the individual and collective doses.

The contribution of tritium releases from Building 331 to the Livermore site-wide MEI dose is evident from Table 4.10.5–1. In 2000, 2001, and 2002 the releases from this building were markedly decreased from prior years. This decrease resulted in the Building 612 storage yard release becoming a relatively greater contributor (in terms of percent of total) to the site-wide MEI dose because of its ground-level release (as opposed to the elevated stack release from Building 331) and its proximity to the site boundary.

Doses are calculated from the releases using the CAP88-PC computer code. The code's database includes dosimetric and health affects data. It also accommodates site-specific input data characterizing meteorological conditions and population distributions for both individual and collective (population) doses (CAP88-PC 2000). Table 4.10.5–2 shows the individual (site-wide MEI) and collective doses for the recent 5-year period. The total population dose from all LLNL operations is the sum of the two site population doses shown in the table. The total population dose over the 5 years has ranged from 3.0 to 12.7 person-rem.

The EPA's radiation dose standard that applies to air emissions limits the dose (effective dose equivalent) to members of the public caused by operations to 10 mrem/yr (40 CFR 61). The individual doses from LLNL are two to three orders of magnitude below this standard. The latter is verified by site ambient air measurements. An individual breathing air for 24 hours a day, 365 days per year containing the annual Livermore Site median concentrations of tritium, plutonium-239 and 240 and uranium-238 described in Section 4.10.5.1 would be exposed to a dose of 0.2, 0.001, and 0.06 mrem/yr, respectively. These values occur at different locations around the Livermore Site. Such doses are 2, 0.01, and 0.6 percent of the NESHAP limit. Site 300 doses from measured uranium concentrations would be even less. The corresponding Site 300 dose for uranium-238 would be 0.08 mrem/yr, 0.8 percent of the NESHAP limit. The population doses can be compared with background radiation doses; population doses due to LLNL releases are approximately 200,000 times less than that received by the population from background radiation. Section 4.16.2 (Human Health and Worker Safety – Radiological Effects) describes the health effects associated with these doses.

TABLE 4.10.5–2.—*Dose to the Site-Wide Maximally Exposed Individual (Site-Wide MEI) and to the Population from LLNL Releases, 1998-2002*

Year	Livermore Site		Site 300		Total Population Dose[a]
	Site-wide MEI Dose (mrem)	Population Dose (person-rem)	Site-wide MEI Dose (mrem)	Population Dose (person-rem)	
1998	0.055	0.68	0.024	11	11.68
1999	0.12	1.7	0.035	11	12.7
2000	0.038	0.47	0.019	2.5	2.97
2001	0.017	0.16	0.054	9.4	10.1
2002	0.023	0.50	0.021	2.5	3.0

Source: LLNL 1999a, LLNL 2000h, LLNL 2001n, LLNL 2002bb, LLNL 2003z.
[a] Total population dose includes Livermore Site and Site 300 population doses.

4.11 WATER

This section provides an overview of surface water and groundwater at the Livermore Site and Site 300. Additionally, this section describes water use and floodplains at these sites. Wastewater is discussed in Section 4.14.4. A discussion of existing contamination in the groundwater at and adjacent to the sites is included in Section 4.17.

4.11.1 Surface Water

Livermore Site

Surface drainage and natural surface infiltration at the Livermore Site are generally good, but drainage decreases locally with increasing clay content in surface soils. Surface flow may occur intermittently from October to April, during the valley's wet season. Only intermittent streams flow into the eastern Livermore Valley from the surrounding uplands and low hills, where they merge on the valley floor. The four major intermittent streams that drain into the eastern Livermore Valley are Arroyo Mocho, Arroyo Seco, Arroyo Las Positas, and Altamont Creek (Figure 4.11.1–1). Arroyo Seco and Arroyo Las Positas pass through the Livermore Site, while Altamont Creek and Arroyo Mocho flow offsite to the north and southwest, respectively. Recharge to sediments underlying the Livermore Valley is primarily from the arroyos that originate in the eastern foothills and flow across the valley. When surface flow occurs in these channels, water infiltrates into the underlying alluvium and eventually percolates to the aquifers within the Livermore Valley (LLNL 1992a).

The headwaters of the Arroyo Seco drainage are in the hills southeast of the Livermore Site. Arroyo Seco has a drainage length of approximately 12 miles and a watershed area of approximately 8,960 acres upstream of SNL/CA. The Arroyo Seco flows through SNL/CA before crossing over the southwest corner of the Livermore Site and continuing southwesterly. Flow only occurs in the arroyo during rainfall because discharge to the stream is from storm runoff only. The channel is well defined in the section that passes directly through the Livermore Site and is dry for at least 6 months of the year. In fact, during dry years, it may flow only 10 to 15 days per year in the vicinity of the Livermore Site vicinity (LLNL 2002cc).

Arroyo Las Positas is an intermittent stream that drains from the hills directly east of the Livermore Site with a watershed area of approximately 3,300 acres. This channel enters the Livermore Site from the east, is diverted along a storm ditch around the northern edge of the site, and exits the site at the northwest corner. Discharge from the onsite Drainage Retention Basin (DRB), discussed below, keeps the arroyo flowing perennially. Additionally, water from springs and runoff in the nearby hills feed into Arroyo Las Positas (LLNL 2002cc). Flow has increased in the arroyo over the past several years, due to treated groundwater discharges. A desilting project is currently underway to restore 100-year flood capacity to the arroyo (Water KPT 2002).

Before 1992, it was determined that stormwater was infiltrating and dispersing contaminated groundwater in the area of what is currently the DRB. Therefore, the DRB was constructed with a liner in 1992 to prevent this infiltration of stormwater. The DRB collects about one-fourth of the surface water runoff from the site and a portion of the Arroyo Las Positas drainage. When full, the DRB discharges north to a culvert that leads to Arroyo Las Positas. During wet weather, the majority of the discharge from the DRB is stormwater, but a substantial amount of the flow is discharged from groundwater treatment facilities (LLNL 2002cc).

Nearly all of the surface water runoff at the Livermore Site is discharged into Arroyo Las Positas; only surface runoff along the southern boundary and storm drains in the southwest corner of the Livermore Site drain into Arroyo Seco. Regional drainage flows through the southwestern part of the Livermore Valley into the San Francisco Bay through Alameda Creek.

Other natural and man-made water bodies present in the eastern Livermore Valley are shown in Figure 4.11.1–1. There are more than 27 ponds located in and around the eastern Livermore Valley. The majority of the small ponds are used for private water storage for livestock watering; some have other uses, such as ornamental. The Patterson Reservoir is located 0.8 mile northeast of the Livermore Site. This reservoir covers 3.23 acres and contains about 100 acre-feet. The South Bay Aqueduct is an open canal that circles the Livermore Valley and delivers drinking water to the south San Francisco Bay Area, as well as to the Livermore Site.

LLNL performs semi-annual monitoring of reservoirs and ponds, the Livermore Site swimming pool, the DRB, rainfall, tap water, stormwater runoff, and receiving waters, in accordance with DOE O 450.1 *Environmental Protection Program*, and DOE O 5400.5, *Radiation Protection of the Public and the Environment*. Samples are analyzed for gross alpha, gross beta, and tritium concentrations. EPA-established maximum contaminant levels (MCLs) for drinking water are used as a benchmark at which a sample exceeding this level would be a potential cause for concern. Surface water and drinking water sampling locations are shown in Figure 4.11.1–2.

The median activity for tritium in surface and drinking waters was estimated from calculated values to be below the laboratory's minimum detectable activities.[1] Sampling location PALM demonstrated the highest tritium activity offsite, however, the value was still less than 1 percent of the MCL. Median activities for gross alpha and gross beta radiation were both less than 5 percent of their respective MCLs. Since 1988, water in the Livermore Site swimming pool demonstrated the highest tritium activities because it is closest to tritium sources within the site. However, the tritium activity measured in the pool in 2002 was less than minimum detectable activity (LLNL 2003l).

Site 300

Surface water at Site 300 consists of seasonal runoff, springs, and natural and man-made ponds (Figure 4.11.1–3). There are no perennial streams at or near Site 300 (LLNL 2003l). The canyons that dissect the hills and ridges at Site 300 drain into intermittent streams. The majority of the intermittent streams within the site drain south to Corral Hollow Creek, also intermittent, which runs along the southern boundary of Site 300 toward the east into the San Joaquin Valley. Elk Ravine, a major drainage channel for most of Site 300, extends from the northwest portion of the site to the east-central area and drains the center of the site into Corral Hollow Creek. Some of the canyons in the northeast section of Site 300 drain to the north and east toward the city of Tracy in the San Joaquin Valley (LLNL 1992a). Downstream of the GSA, Corral Hollow Creek has flow from a groundwater treatment facility.

[1] At a level this low, the counting error associated with the measurements is nearly equal to or greater than the calculated value.

Naturally occurring springs are shown by the presence of flowing water or wet soils where the water table is close to the surface and the presence of distinct hydrophytic vegetation (cattails, willow). There are at least 22 springs at Site 300. Most of the springs have very low flow rates and are recognized only by small marshy areas, pools of water, or vegetation (LLNL 2003l).

Eight surface water bodies are present at Site 300. Several areas of surface water discharge are present onsite near cooling towers. These runoff areas have the same characteristics as natural springs because they contain running water and support hydrophytic vegetation. A sewage oxidation pond and a sewage percolation pond are located in the southeast corner of the site in the GSA, and two lined class II explosives process water surface impoundments are located a mile to the west. Three wetlands were created from past cooling tower discharges at Buildings 827, 851, and 865. These wetlands are currently irrigated with potable water (LLNL 2003l).

4.11.2 Stormwater

Livermore Site

LLNL monitors two storm events per rainy season at the Livermore Site for radioactive and nonradioactive constituents in accordance with waste discharge requirements (WDR 95-174), NPDES Permit No. CA0030023, issued in 1995 by the San Francisco Bay Regional Water Quality Control Board (RWQCB) (RWQCB 1982). This permit requires the collection of two samples each wet season at effluent locations identified as ASW and WPDC, and at influent locations identified as ALPE, ALPO, ASS2, ASSE, and GRNE on Figure 4.11.2–1. Samples from locations CDB and CDB2 characterize runoff from the southeastern portion of the Livermore Site, and samples from CDBX characterizes water leaving the DRB. Storm sampling and analyses are performed for gross alpha, gross beta, plutonium, and tritium. The samples are also analyzed for nonradioactive parameters including several pesticides and metals, hardness, pH, total suspended solids (TSS), chemical oxygen demand, and oil and grease (LLNL 2003l). LLNL also meets the stormwater compliance monitoring requirements of the statewide General NPDES Permit for Stormwater Discharges Associated with Construction Activity (Order 99-08-DWQ, NPDES Permit No. CAS 000002) (SWRCB 1999) for projects that disturb one or more acres of land (LLNL 2002cc).

LLNL has developed a set of site-specific water quality guidelines to gain a better understanding of the stormwater quality at LLNL. These guidelines were developed using historic site-specific monitoring data. Federal, state, and local criteria were also considered in developing LLNL's site-specific guidelines.

The Federal criteria used to establish LLNL's site-specific guidelines are EPA ambient water quality criteria (AWQC) and benchmark values that EPA established to determine if stormwater discharged from any facility warrants further monitoring. As such, these benchmark levels represent target concentrations for a facility to achieve through implementation of pollution-prevention measures (65 FR 210). EPA drinking water MCLs were also used to develop LLNL's guidelines. State and local criteria used are those listed in the San Francisco Bay Water Quality Control Plan for the Livermore Site, and the Sacramento/San Joaquin River Basins Water Quality Control Plan for Site 300, and the Water Quality Control Plan for the California Regional Water Quality Control Board. If a measured concentration is higher than the comparison guideline, but the value is the same or higher at the influent locations, the source is assumed to be unrelated to LLNL operations; therefore, further analysis is not warranted (LLNL 2002f).

Radionuclides in Stormwater

In response to elevated tritium levels in stormwater runoff, additional tritium investigations began in 1998 to identify potential sources of tritium. In 2001, tritium was detected at 838 picocuries per liter in the main Arroyo Las Positas channel. High levels were found at location 3726, downgradient of Building 343 (see Figure 4.11.2–1). The source of elevated tritium was related to a transportainer containing materials exposed to tritium. Sampling of surface runoff directly downgradient from the transportainer near Building 343 found tritium concentrations as high as 1.1 million picocuries per liter in April 2000. Samples collected later that same day contained tritium levels less than 800 picocuries per liter, which is 4 percent of the tritium drinking water standard. Continued monitoring of both surface runoff near Building 343 and sampling in the storm channels has demonstrated a rapid decrease in measured tritium activities since the transportainer was removed in August 2000. Subsequent monitoring of this network demonstrated that tritium activities in the north-south storm drain near Building 343 had returned to near-background levels by December 2000 (LLNL 2002cc).

Tritium activities at effluent locations were less than 1 percent of the MCL. No gross alpha, gross beta, or tritium activities were above the LLNL site-specific thresholds in 2002 (Table 4.11.2–1). Radioactivity in the stormwater samples collected during 2002 had medians around background levels (LLNL 2003l).

TABLE 4.11.2–1.—*Drinking Water Maximum Contaminant Levels and Livermore Site-Specific Threshold Comparison Guidelines for Radioactive Stormwater Constituents*

Parameter	EPA Drinking Water MCL (pCi/L)	LLNL Comparison Guideline [a] (pCi/L)
Tritium	20,000	973
Gross alpha	15	9.19
Gross beta	50	13

Sources: LLNL 2002f, EPA 2003a.
[a] Site-specific value calculated from historical data and studies.
EPA = Environmental Protection Agency; MCL = maximum contaminant levels; pCi/L = picocuries per liter.

Rainwater is collected and analyzed for tritium activities in support of DOE O 450.1 and DOE O 5400.5. Rainfall in the Livermore area has exhibited elevated tritium levels in the past, primarily from atmospheric emissions of tritiated water from stacks at LLNL's Tritium Facility (Building 331) and from the former Tritium Research Laboratory at SNL/CA. Operations at LLNL were significantly reduced after 1991, when the administrative limit for the LLNL Tritium Research Laboratory was lowered from 300 grams to 5 grams; in 1999, it was raised to 30 grams. Operations at the SNL/CA, Livermore Tritium Research Laboratory, ceased in October 1994. The reduced measurements of tritium in rain reflect the reduction of emissions from the facilities; however, the median tritium activity measured in rainfall at the Livermore Site increased from 53.2 picocuries per liter in 2001 to 83.8 picocuries per liter in 2002 (LLNL 2003l). This is most likely attributed to a slight increase of total measured atmospheric emissions of tritiated water from the Tritium Facility at the Livermore Site from 18.3 picocuries per liter in 2001 to 32.4 picocuries per liter in 2002. All offsite routine rainfall samples measured during 2002 showed tritium activities less than 0.3 percent of the tritium MCL of 20,000 picocuries per liter for stormwater (LLNL 2003l).

LLNL began analyzing stormwater runoff for plutonium in 1998. Samples were analyzed from Arroyo Seco and Arroyo Las Positas effluent locations identified as ASW and WPDC in Figure 4.11.2-1. Plutonium concentrations were below the minimum detection limit of 0.1 picocuries per liter in both liquid and sediment samples for 2002 runoff.

Nonradioactive Contaminants in Stormwater

Sample results for nonradioactive contaminants were evaluated against the site-specific threshold comparison criteria shown in Table 4.11.2–2. All contaminants listed in the table are those that exceed the comparison criteria. The constituents of greatest concern are those exceeding comparison criteria at effluent points and whose concentrations are lower in influent than in effluent (LLNL 2002cc).

Single point chronic algae toxicity testing with freshwater algae (*Selenastrum capricornutum*) was performed in early 2001 as a followup to investigate toxicity problems. Stormwater runoff samples continued to demonstrate an inhibitory effect on growth and survival of green algae through 2002. This Livermore Site annual stormwater monitoring report suggested that the source of this toxicity was upstream of Arroyo Las Positas, most likely from an herbicide called diuron (LLNL 2003l). A Western Area Power Administration electrical transfer station was identified as the likely source of diuron, having just received a calculated application of 40 kilograms of herbicide per 2.5 acres. In 2002, the maximum diuron concentration was measured at 0.29 milligrams per liter, down from 5.3 milligrams per liter in 2001 (LLNL 2002f).

Elevated nitrate levels were found in stormwater flowing onsite. Potential upstream sources include a small vineyard and cattle ranches (LLNL 2003l).

The total hardness of stormwater flowing on the Livermore Site is often relatively low (20 to 100 milligrams per liter) in the Arroyo Seco and occasionally low in Arroyo Las Positas. Metals toxicity is dependent on total hardness of the water; the harder the water, the lower the toxicity. Total hardness and metals values were not at toxic levels in either arroyo. The discharge from groundwater treatment systems at the Livermore Site actually serves to increase total hardness and thus reduces the potential for metal toxicity in stormwater runoff. Relationships between total hardness and metals toxicity will continue to be evaluated at the Livermore Site (LLNL 2002f).

Drainage Retention Basin

The DRB receives treated groundwater from Treatment Facilities D and E and from related portable treatment units. Stormwater runoff dominates wet weather flows through the DRB, but discharges from the treatment facilities now constitute a substantial portion of the total flow in the basin (LLNL 2002cc).

LLNL established the DRB monitoring program to comply with regulatory requirements. In addition to establishing a sampling and analysis plan, management action levels for specific constituents were established to aid in characterizing water quality before its release. These action levels were established based on recommendations made in the *Drainage Retention Basin Management Plan* and are quantitative water quality management objectives (LLNL 2002cc). When these action levels are exceeded, further evaluation is initiated to aid in determining possible causes and immediate remedies. Detailed descriptions of subsequent actions can be found in the site annual environmental reports that are published every year.

TABLE 4.11.2–2.—*Stormwater Quality Parameters Above the Site-Specific Threshold Comparison Guidelines for the Livermore Site in 2002*

Parameter	Location	Influent or Effluent	Result (mg/L)	LLNL Threshold Guideline[a] (mg/L)
Beryllium	ALPO	Influent	0.0018	0.0016
	GRNE	Influent	0.0022	0.0016
	ASS2	Influent	0.0020	0.0016
	ASW	Effluent	0.0019	0.0016
Chemical oxygen demand	ALPO	Influent	259	200
	ASS2	Influent	240	200
Copper	ALPE	Influent	0.015-0.070	0.013
	GRNE	Influent	0.030	0.013
	WPDC	Effluent	0.018	0.013
	ASS2	Influent	0.034-0.060	0.013
	ASW	Effluent	0.028-0.051	0.013
	ALPO	Influent	0.021-0.055	0.013
Diuron	ALPO	Influent	0.29	0.014
	WPDC	Effluent	0.044	0.014
Lead	ALPE	Influent	0.030	0.015
	ALPO	Influent	0.019	0.015
	GRNE	Influent	0.017	0.015
	ASS2	Influent	0.024-0.033	0.015
	ASW	Effluent	0.017-0.028	0.015
Nitrate	GRNE	Influent	11	10
	ASS2	Influent	14	10
	ASW	Effluent	13	10
	GRNE	Influent	19	10
Ortho-phosphate	ALPE	Influent	4.24-5.56	2.5
	ASS2	Influent	5.61	2.5
	ASW	Influent	5.12	2.5
Total suspended solids	ALPE	Influent	1,300	750
	ALPO	Influent	800	750
	ASS2	Influent	800-1,100	750
	ASW	Effluent	980	750
Zinc	ASS2	Influent	0.39	0.35

Source: LLNL 2003l.
[a] not a regulatory limit. Values were established by LLNL to assess stormwater quality.
Note: Influent is stormwater entering the site and effluent is stormwater exiting the site.
mg/L = milligrams per liter.

Stormwater samples are taken from four DRB locations: two influent locations, CDB and CDB2, and two effluent locations, CDBX and WPDC (Figure 4.11.2–1). The DRB is sampled during the first release of the rainy season, from at least one additional storm, and from each dry-season discharge event. Samples are measured for dissolved oxygen saturation, temperature, transparency, nitrate, total dissolved solids, total phosphorus, ammonia nitrogen, chemical oxygen demand, pH, and specific conductance. DRB samples not meeting management action levels are listed in Table 4.11.2–3. Dissolved oxygen levels in 2002 were at or above management action levels of at least 80 percent oxygen saturation for 4 to 12 months. Chemical oxygen demand, total dissolved solids, nitrate, and specific conductance exceeded the management action levels in the 2002 samples. Phosphorus was near management action levels. Sources of nitrate and phosphorus include external sources, stormwater runoff, treated groundwater discharges, and internal sources of nutrient cycling related to algae and plant growth (LLNL 2003l).

TABLE 4.11.2–3.—*Summary of Drainage Retention Basin Samples Exceeding Management Action Levels-2002*

Parameter	Range	Median	Management action level
Dissolved oxygen saturation (%)	31 – 76	59.5	<80%
Temperature (^{o}C)	11.1 – 29	15.4	<15 or >26
Transparency (m)	0.84	N/A	<0.91
Nitrate (as N) (mg/L)	0.9 – 2.3	1.6	>0.2
pH (pH units)	9.04 – 9.21	9.1	not <6.0 nor >9.0
Specific Conductance (μS/cm)	939 – 1,270	1,100	>900
Total Dissolved Solids (TDS) (mg/L)	557 – 820	671	>360
Total phosphorus (as P) (mg/L)	<0.05 – 0.22	0.08	>0.02
Chemical Oxygen Demand (mg/L)	<25 – 81	41.4	>20

Source: LLNL 2003l.
C = Celsius; m = meters; mg/L = milligrams per liter; μS/cm = microsiemens/centimeter.

Site 300

Stormwater at Site 300 and in the vicinity is monitored twice during the wet season in accordance with the statewide General NPDES Permit for Stormwater Discharges Associated with Industrial Activity (WDR 97-03-DWQ, NPDES Permit No. CAS000001, State Water Resources Control Board). The Site 300 stormwater and rainwater sampling network consists of seven stormwater locations and three rainfall locations (Figure 4.11.2–2).

These locations were chosen to best characterize stormwater runoff that would be affected by specific Site 300 activities. Typically, a single storm does not produce runoff at all Site 300 locations because the site receives relatively little rainfall and is largely undeveloped (LLNL 2003l).

LLNL has developed site-specific water quality guidelines for Site 300. These guidelines are shown on Tables 4.11.2-4 and 4.11.2-5.

TABLE 4.11.2–4.—*Site 300 Site-Specific Threshold Comparison Guidelines for Radioactive Drinking Water Stormwater Constituents*

Parameter	MCL (pCi/L)	Comparison Guideline[a] (pCi/L)
Tritium	20,000	85.7
Gross alpha	15	24.3
Gross beta	50	46.8

Source: LLNL 2002f, EPA 2003a.
[a] Site-specific value calculated from historical data and studies.
EPA = Environmental Protection Agency; MCL = maximum contaminant level; pCi/L = picocuries per liter.

TABLE 4.11.2–5.—*Stormwater Quality Parameters Above the Threshold Comparison Guidelines for Site 300 in 2002*

Parameter	Location	Influent or Effluent	Result (mg/L)	LLNL Comparison Guideline[a] (mg/L)
TSS	CARW	Influent	1,800-10,000	1,700
	NLIN	Effluent	4,800	1,700
	GEOCRK	Downstream	14,200	1,700
Chemical oxygen demand	CARW	Influent	393	200
	NLIN	Effluent	289	200
	GEOCRK	Downstream	615	200
Lead	CARW	Influent	0.174	0.015
	NLIN	Effluent	0.065	0.015
	GEOCRK	Downstream	0.237	0.015
Mercury	CARW	Influent	0.0003	0.0002

Source: LLNL 2003l.
[a] not a regulatory limit. Values were established by LLNL to assess stormwater quality.
Note: Influent is stormwater entering the site and effluent is stormwater exiting the site.
mg/L = milligrams per liter; TSS = total suspended solids.

Radionuclides in Stormwater

Tritium levels in all samples were below the minimum detectable activity in Site 300 stormwater during 2002. The maximum values of all gross alpha and gross beta results were 6.76 picocuries per liter and 29.7 picocuries per liter, respectively, approximately 45 percent and 59 percent of the drinking water MCLs (Table 4.11.2–4) (LLNL 2003l). Although these values are higher than those at the Livermore Site, they are not unusual. This area has relatively high natural background gross alpha and gross beta levels in stream flow that are closely associated with suspended sediment from naturally occurring uranium (LLNL 2002cc).

Nonradioactive Contaminants in Stormwater

Specific conductance and TSS were above LLNL comparison guidelines and EPA benchmarks. Most values exceeding benchmark levels at Site 300 are related to high suspended sediment (Table 4.11.2–5). See Figure 4.11.2–2 for stormwater sampling locations. In 2002, TSS was measured at discharge location NLIN at 4,800 milligrams per liter, but this is consistent with the range of historic data at this location. High TSS values were also measured at downstream location GEOCRK and influent location CARW at 14,200 and 1,800 milligrams per liter, respectively. Low TSS concentrations at N883, in addition to lack of flow at sampling locations

NPT6 and NLIN, indicate that LLNL activities were not the direct cause of elevated concentrations at sampling location GEOCRK. Both the GEOCRK and CARW locations are influenced by the larger Corral Hollow watershed, which is dominated by a state off-road motorcycle park and ranching activities (LLNL 2003l). Specific conductance is generally high at the site, most likely due to natural chemical weathering and low annual rainfall (LLNL 2002cc).

Elevated levels of lead and mercury (see Table 4.11.2–5) have been demonstrated in the past to be related to suspended sediment (LLNL 2003l).

Past CERCLA remedial investigations have found dioxin releases related to activities in the vicinity of Building 850. Dioxin cogeners (types of dioxins) have varying degrees of toxicity. The EPA only provides an MCL for the most toxic cogener, to which all other cogeners' maximum contaminant standards are compared. The most toxic cogener, 2,3,7,8-TCDD, was detected at sampling location NLIN at a concentration of 4×10^{-9} milligrams per liter. This concentration was less than the MCL of 3×10^{-8} milligrams per liter. All dioxin cogeners displayed values less than the MCL (LLNL 2003l).

4.11.3 Groundwater

4.11.3.1 *Regional Hydrogeology*

Livermore Site

The majority of Livermore Valley sediments is water bearing and transmits groundwater in varying degrees. In contrast, the uplands generally do not yield groundwater in sufficient quantities to constitute a groundwater resource. The Livermore Valley has been divided into a series of 12 groundwater subbasins based on the locations of faults, topography, and other hydrogeological barriers that affect groundwater occurrence, movement, and quality (Figure 4.11.3.1–1) (LLNL 1992a).

The Livermore Site lies primarily within the Spring and Mocho I subbasins. The water-bearing sediments in the Livermore Valley include late-Pleistocene to Holocene-age alluvial sediments, generally less than 200 feet thick, which overlie Plio-Pleistocene alluvial and lacustrine Livermore Formation sediments, up to 4,000 feet thick. The Livermore Formation consists of beds of gravel, sand, silt, and clay of varying permeabilities. Sandy gravelly layers alternate with fine-grained, relatively impermeable layers, and groundwater can be both confined and semiconfined (LLNL 1992a).

Stream runoff from precipitation, controlled releases from the South Bay Aqueduct, direct rainfall, irrigation, and treated groundwater infiltration recharge the Livermore Valley groundwater basin. In addition, stream channels, ditches, and gravel pits west of the city of Livermore are important sources for shallow, alluvial aquifer recharge. Groundwater is naturally discharged from the basin at Arroyo de la Laguna, located over 11 miles southwest of the Livermore Site. Some minor discharges also occur at springs, including those along Arroyo Las Positas near its confluence with Altamont Creek (LLNL 1992a). Natural recharge occurs primarily along the fringes of the Livermore Valley groundwater basin and through the arroyos during periods of winter flow. Artificial recharge, if needed to maintain groundwater levels, is accomplished by releasing water from Lake Del Valle or from the South Bay Aqueduct into arroyo channels in the east (LLNL 2002cc).

Groundwater generally moves east to west within the Livermore Valley, westward through the Amador Subbasin, eventually terminating in a large groundwater depression near two gravel mining areas located west of the city of Livermore. A former gravel mining company had extracted deep groundwater, causing the large groundwater depression. Current gravel mining is not as deep as in the past, decreasing the need for deep groundwater pumping. Subsequently, the groundwater depression has decreased. At the eastern edge of the Livermore Site, groundwater gradients are relatively steep, but under most of the site and farther to the west, the contours flatten to a gradient of approximately 0.003 foot per foot (LLNL 2002cc).

Pumping of groundwater for agricultural uses has historically accounted for the major withdrawal of groundwater from the Livermore Valley groundwater basin. As the valley has become increasingly urbanized, a shift in groundwater users has caused the amount of pumping for municipal use and gravel quarrying to exceed agricultural withdrawals. Agricultural use, namely vineyards and a few ranches, account for approximately 1,000 acre-feet per year of water in the Livermore Site vicinity. Although agricultural withdrawals are still a major source of drawdown, agriculture is increasingly using more surface water from the state water project than groundwater.

Site 300

Site 300 lies on the eastern flank of the Diablo Range. Most surface runoff and most groundwater flow toward the San Joaquin Valley. Runoff that concentrates in the Elk Ravine and Corral Hollow Creek recharges local bedrock aquifers. The regional groundwater table beneath Site 300 largely occurs within sandstone and conglomerate beds of the Neroly Formation, and groundwater moves through both pores and fractures. A deep confined aquifer (400 to 500 feet deep) is present beneath the southern part of Site 300 within the lower Neroly Formation sandstones. This confined aquifer provides the Site 300 water supply. Pumping tests performed in Site 300 water supply wells affirm the integrity of the aquitard separating the shallow and deeper aquifers within the lower Neroly Formation. In addition to the regional aquifers, local perched aquifers containing small amounts of water occur in some deposits within the Neroly Formation and the marine Tertiary sequence (LLNL 1992a). Because the water quality is generally poor and yields are low, these perched water-bearing zones do not meet the State of California criteria for aquifers that are potential water supplies (LLNL 2002cc).

4.11.3.2 *Local Hydrogeology*

The following section describes the local hydrogeology for the Livermore Site and Site 300.

Water-bearing Units

Livermore Site

Figure 4.11.3.2–1 shows the major water-bearing hydrostratigraphic units beneath the Livermore Site. These water-bearing units include deposits formed during the late Pleistocene to Holocene-age and are composed of shallow, heterogeneous, unconsolidated alluvium and deep fluvial and lacustrine sediments. The permeable sediments, shown as lenses on Figure 4.11.3.2–1, transmit water within each unit, and are separated by clay layers, and may comprise confining layers. A regional confining layer at the top of Unit 6 slopes westward and varies in depth from about 60 feet beneath the eastern edge of the Livermore Site to about 400 feet near the western site boundary (LLNL 2002cc).

Site 300

Two regional aquifers or major water-bearing zones have been identified at Site 300: an upper water table aquifer in the sandstones and conglomerates of the Neroly Formation and a deeper confined aquifer located in Neroly sandstones just above the Neroly/Cierbo Formation contact. Both aquifers have permeable zones layered with lower permeability claystones, siltstones, or tuffs. Many of the sandstones are fine-grained and silty and contain fractures. Groundwater flow is both intergranular and in fractures (LLNL 2003l). In addition to the two regional aquifers, several perched aquifers have been identified, some of which give rise to springs. Extensive perched aquifers are present beneath the Pit 7 area and the Building 834 complex. In addition, shallow Quaternary alluvium and undifferentiated Tertiary nonmarine sediments are locally water bearing, such as under the GSA (see Figure 4.11.3.2–2). These local aquifers are generally unconfined or water table aquifers (LLNL 1992a).

Occurrence and Flow of Groundwater

Livermore Site

Water table depth at the Livermore Site varies from 30 to 130 feet (LLNL 2003l). Figure 4.11.3.2–2 shows approximate water table elevations in 2002. Although water table elevations vary slightly with seasonal and year-to-year differences in natural and artificial recharge and pumping, the patterns shown in Figure 4.11.3.2–3 are generally maintained.

Groundwater at the Livermore Site and vicinity generally flows to the southwest in the northeastern part of the site and to the west in the western portion of the site. This differs from the generally westward regional flow observed in the 1980s. The shift in flow direction is a consequence of groundwater recovery and remediation in the southwest portion of the site and agricultural pumping (LLNL 2002cc). Groundwater from the northern half of the Livermore Site eventually discharges to Arroyo Las Positas near First Street, about 1.5 miles northwest of the site. Groundwater from the southern half of the Livermore Site may flow westward through the mapped gap between the Mocho I and Mocho II subbasins (see Figure 4.11.3.1–1), about 1.5 miles west of the Livermore Site, where it may continue to flow westward toward the municipal well field near central Livermore. The majority of sediments are hydraulically continuous between the Mocho I and Mocho II subbasins. Although the magnitude and direction of groundwater flow in the Mocho I-Mocho II gap are uncertain, it is conservatively assumed that at least some groundwater from the Livermore Site exits the Mocho I subbasin in this area (LLNL 1992a).

The groundwater gradient is steepest near the northeast corner of the Livermore Site and at the southeast corner near the Las Positas Fault (about 0.15 foot per foot) and decreases to between 0.001 and 0.005 foot per foot west of the site. Hydraulic heads in wells at the Livermore Site decrease with increasing depth, indicating downward vertical gradients. The vertical component of the hydraulic gradient reportedly increases in and near the regional confining layer. Vertical gradients are typically lower in the shallow saturated alluvium west of the site, where the confining layer in the Lower Member of the Livermore Formation is deeper, and increase near the eastern margin of the site, where the confining layer is close to the ground surface (LLNL 1992a). Vertical gradients generally range from as high as 0.23 foot per foot (downward) near the eastern margins to less than 0.003 foot per foot (downward) at the western edge of the Livermore Site (LLNL 2003l).

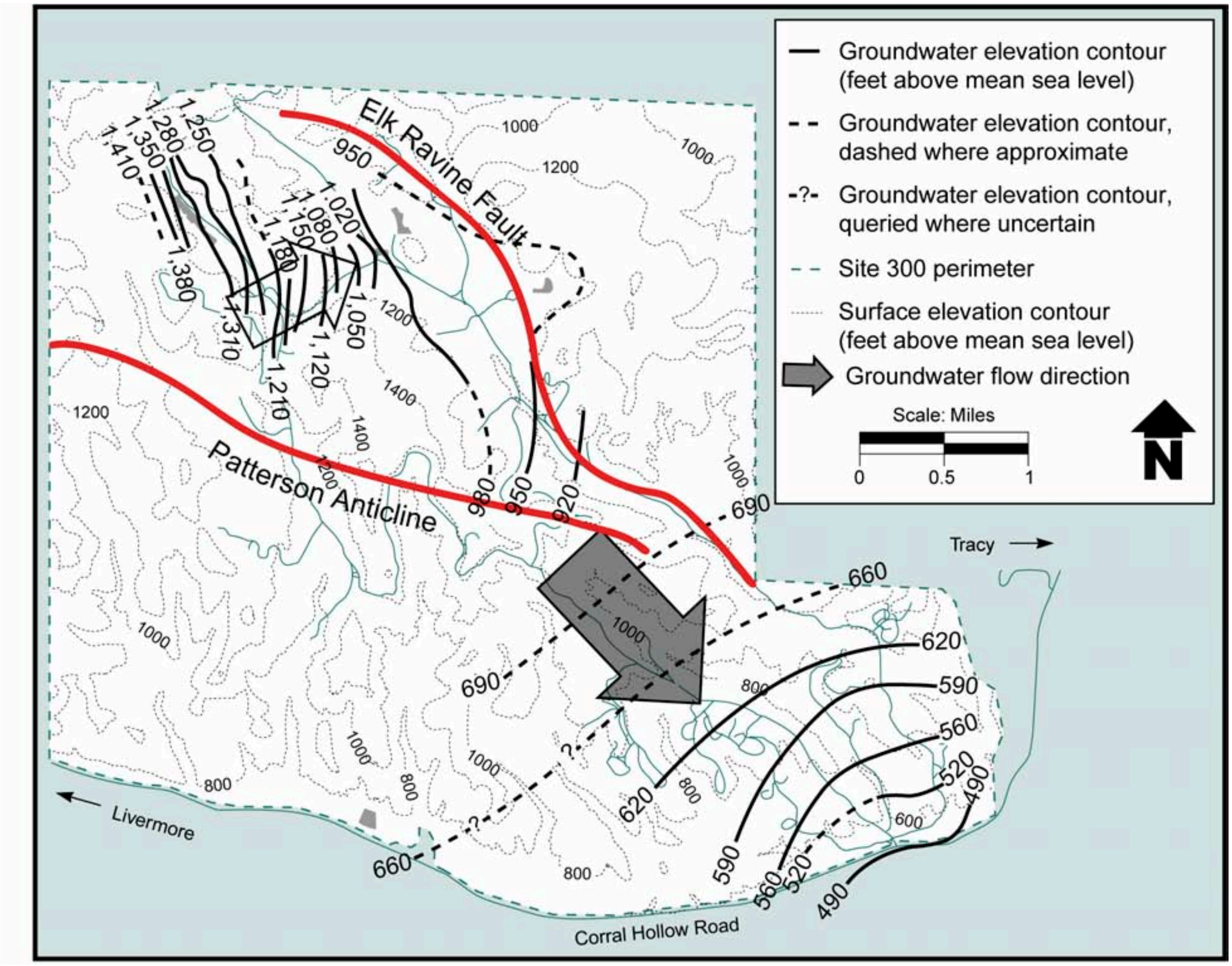
Based on the results of extensive long-term hydraulic testing, the hydraulic conductivity of sediments beneath the site is highly variable, ranging from 3.3 to 52 feet per day (LLNL 2003l). Aquifers in the southwest quadrant of the Livermore Site and the adjacent offsite area have the highest average hydraulic conductivity. There is a greater abundance of coarse-grained deposits in the area, possibly the location of ancient channels of Arroyo Seco. In contrast, the southeast quadrant of the area, including the Livermore Site, has the lowest average hydraulic conductivity and the greatest abundance of fine-grained sediments. Based on pumping tests, the connection between hydrostratigraphic units also appears to be more vertical in the southwest corner and offsite from the Livermore Site (LLNL 2003l).

The estimated groundwater velocities beneath the Livermore Site for the Upper Member of the Livermore Formation, the main water-bearing unit, average 66 feet per year (LLNL 2003l). The wide range in flow rates reflects the broad range of groundwater gradients and lithologies and associated hydraulic conductivities.

Site 300

Site 300 is a large and hydrogeologically complex site where groundwater occurs in both bedrock and alluvial aquifers. Due to steep topography and structural complexity, the geologic units are discontinuous across the site. Consequently, locally unique hydrogeologic conditions govern the occurrence and flow of groundwater and the fate and transport of contaminants. The hydraulic relationships between the northwest and southeast sections of the site have not been well established due to sparse borehole control in the center of the site. Separate groundwater contours for the different hydrogeologic units at Site 300 are shown in Figure 4.11.3.2–4. North of the Patterson Anticline, groundwater occurs under unconfined to confined conditions, primarily within the Neroly and Cierbo bedrock aquifers. General groundwater flow in this area is to the east, and is controlled primarily by the inclination of the rock layers. Perched water-bearing zones also occur within the Quaternary alluvial sands and gravels and in fractured siltstones and claystones. These perched zones are highly discontinuous and variable.

Throughout most of the southeastern portion of Site 300, the lower Neroly bedrock aquifer is a continuous, regional water-bearing zone. Groundwater in this aquifer occurs under confined to flowing artesian conditions. As indicated by the contours in Figure 4.11.3.2–4, groundwater generally flows to the south-southeast in the southern and southeastern parts of the site. Estimated groundwater velocities in the shallow Quaternary alluvial gravels at the GSA range from 1 foot to 10 feet per day (or about 365 to 3,650 feet per year). The estimated groundwater flow rates for bedrock aquifers at Site 300 range from about <0.01 to 1 foot per day (3.6 to 365 feet per year). The wide range of estimated velocities reflects the diverse Site 300 hydrology.



Source: LLNL 2003l.

FIGURE 4.11.3.2–4.—*Approximate Groundwater Surface Elevations and Flow Direction in the Principal Site 300 Water-Bearing Zones*

4.11.3.3 *Background Groundwater Quality*

Livermore Site

Groundwater near the Livermore Site is generally suitable for use as a domestic, municipal, agricultural, and industrial supply; however, use of some shallower groundwater may be limited by its marginal quality. Groundwater less than 300 feet deep is usually unsuitable for domestic use without treatment (LLNL 1992a).

Groundwater in the vicinity of the Livermore Site is mostly a calcium-bicarbonate type, with sodium-chloride waters to the northeast. The maximum concentrations observed for most metals exceed EPA drinking water MCLs; however, the maximum concentrations are usually confined to limited areas. Elevated levels of sodium, hardness, total dissolved solids, specific conductance, and nitrate also exceed EPA water quality standards. High concentrations of boron, chloride, and sulfate limit the use of this groundwater for irrigation. Samples from the Mocho I and Mocho II subbasins (Figure 4.11.3.1–1) have shown that some groundwater is classified as Class II and Class III for irrigation, largely due to high boron concentrations. The high bicarbonate and calcium concentrations may limit the use of this groundwater for livestock. High concentrations of chromium, lead, and manganese may limit the discharge of this groundwater to surface water drainages (LLNL 1992a).

Site 300

Groundwater quality at Site 300 has a relatively high concentration of total dissolved solids, though variability in natural water quality has been observed. Sodium bicarbonate water is most common in water supply wells. The amount of total dissolved solids ranges from 400 parts per million to 4,000 parts per million in local groundwater. Naturally occurring elements such as barium and uranium in rocks and sediments have contributed to elevated levels (LLNL 2002cc).

4.11.3.4 *Groundwater Contamination*

Livermore Site

Groundwater surveillance monitoring at LLNL complies with DOE O 450.1 and remediation monitoring under CERCLA. The following compounds, mostly volatile organic compounds (VOCs), exist in groundwater at various locations in concentrations above drinking water quality standards: trichloroethylene, perchloroethylene, 1,1-dichloroethylene, chloroform, 1,2-dichloroethylene, 1,1-dichoroethane, 1,2-dichloroethane (1,2-DCA), trichlorotrifluoroethane (Freon 113), trichlorofluoromethane (Freon 11), and carbon tetrachloride (LLNL 2003l). See Section 4.17, Site Contamination and Remediation, for additional water quality information.

To determine the fate and transport of contaminants in each hydrostratigraphic unit, personnel in the Environmental Restoration Division at LLNL use three-dimensional groundwater computer models. Groundwater flow and transport models allow for optimization of well extraction rates, evaluation of potential capture zones of proposed extraction wells, and evaluation of plume migration and hydraulic interference patterns under increased pumping conditions.

In 2002, the Livermore Site Groundwater Project treated more than 248 million gallons of groundwater and removed approximately 146 kilograms of VOCs (LLNL 2003l). LLNL removes contaminants from groundwater at the Livermore Site through a system of 27 treatment facilities located throughout the 6 hydrostratigraphic units containing contaminants of concern (LLNL 2002cc). Since remediation began in 1989, approximately 1,960 million gallons of groundwater have been treated (LLNL 2003l). Contaminated groundwater is pumped from individual wells and sent to a treatment facility. If the treated groundwater meets the discharge limits, it is either discharged to surface drainage channels, including Arroyo Las Positas, or routed to the central DRB. Treated water remains in the DRB until it is released to Arroyo Las Positas by way of a stormwater drainage channel.

Livermore Site treatment facilities use a variety of techniques to remove VOCs from groundwater including granular activated carbon, air strippers, and catalytic reductive dehalogenation (CRD). Air-stripping units replaced ultraviolet/hydrogen peroxide systems that had been in use since 1990. Cumulative VOC mass removed from groundwater and soil vapor extraction through 2002 was 1,380 kilograms (LLNL 2003l). The decrease in size and concentration observed in the Livermore Site VOC plumes is consistent with VOC mass removed since remediation began in 1989. Groundwater is also treated at some facilities for chromium (VI), using an ion-exchange unit during the wet season, December though March (LLNL 2002cc).

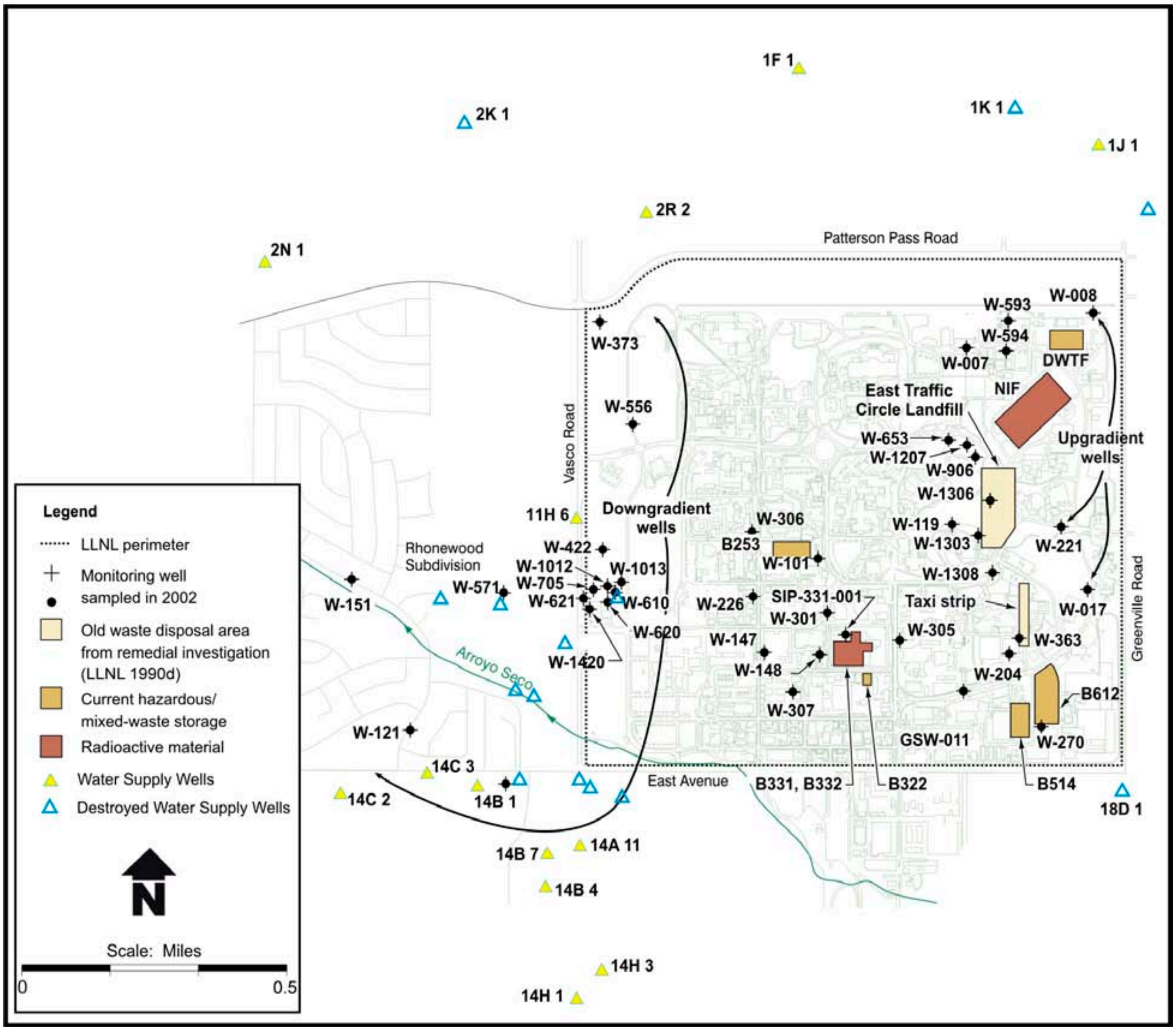
As discussed in the Livermore Site Five-Year Review, from 1996 to 2001, the size and concentrations of VOC plumes had decreased significantly in areas where groundwater extraction and treatment had been implemented (LLNL 1997p). Where groundwater extraction was not occurring, contaminant plumes had migrated, increased in size, or remained unchanged. Along the western margin of the Livermore Site, comprehensive hydraulic containment of all contaminant plumes migrating offsite had been achieved. In the southeastern quadrant, however, total VOC concentrations increased from 521 parts per billion in 2001 to 1,684 parts per billion in 2002. Cleanup in this VOC hot spot is scheduled to begin in 2005. All treatment facilities complied with all permits through 2002 (LLNL 2003l).

Tritiated water is potentially the most mobile groundwater contaminant emanating from the Livermore Site. In August 2002, concentrations of tritium were found at 2,900 ± 300 picocuries per liter (about 15 percent of the MCL) in groundwater from well W-148, downgradient from the Tritium Research Laboratory (Building 331). See Figure 4.11.3.4–1 for Livermore Site groundwater monitoring well locations. Groundwater tritium levels had reduced to approximately 2,600 ± 300 picocuries per liter by December 2002 in all the wells sampled downgradient of Building 331. During 2002, tritium groundwater activities in all wells remained below the MCL and continued to decrease by natural decay (LLNL 2003l).

Dissolved chromium has been detected in groundwater samples at the Livermore Site. Groundwater at well W-307, near Building 322, showed a maximum concentration of dissolved chromium of 15 parts per billion, the highest concentration of hexavalent chromium measured in any background well since 1996. Dissolved chromium also has been detected downgradient from the Building 253 catch basin, in wells W-226 and W-306, where concentrations were 10 parts per billion and 40 parts per billion, respectively. No concentrations of either dissolved chromium or hexavalent chromium exceeded the 50 parts per billion total chromium MCL for drinking water (LLNL 2003l).

In 2001, a leaking pipe was discovered connected to a Building 151 mixed-waste retention tank system. It is unknown how long the pipe leaked because it was buried underground. Liquid wastes in this tank system have included various VOCs, trace metals, americium-241, tritium, and various gamma-emitting radioisotopes. Excavations were made around the pipe and soils were analyzed, but no soil contamination was discovered. One upgradient and two downgradient groundwater sampling locations were established to monitor contaminants. VOCs detected in groundwater are being remediated under CERCLA. Concentrations of trace metals, americium, tritium, and gamma-emitting radioisotopes in samples show no indication of being elevated downgradient from Building 151 (LLNL 2002cc).

LLNL currently has in place a storage tank compliance program that is responsible for upgrading and monitoring storage tanks to be certain that they are in compliance with all Federal and state regulations. Information on the storage tank surveillance monitoring program is updated annually and is discussed in detail in the Site Annual Environmental Report.



Source: Hong 2002.

FIGURE 4.11.3.4–1.—*Livermore Site Groundwater Monitoring and Supply Well Locations*

Site 300

The primary contaminants at Site 300 include the solvent trichloroethylene and other VOCs, high explosive compounds, perchlorate, tritium, uranium-238, nitrate, polychlorinated biphenyls (PCBs), silicone-based oil, and metals. In some cases, these compounds have migrated into groundwater as shown on Figure 4.11.3.4–2. Excessive rainfall during the El Niño season (1997 to 1998) contributed to the release of contaminants of concern, mainly tritium in the form of tritiated water, in the Pit 3 and 5 Areas. Because of reduced rainfall since 1998, groundwater elevations have fallen at much of Site 300, thus reducing the potential for releases to occur.

Several groundwater contaminant plumes exist at Site 300 (see Figure 4.11.3.4–2). All contaminant release sites have been assigned to a CERCLA environmental restoration operable unit (OU), based on the nature and extent of contamination and topographic and hydrologic consideration. In the GSA OU, past leaks of solvents from storage areas and buried debris have resulted in three VOC groundwater plumes (LLNL 2002cc). The maximum total VOC concentration in the eastern GSA plume in 2002 was 7.5 parts per billion. VOC plumes in the central GSA had a maximum groundwater concentration of 958 parts per billion. After 8 years of remediation, in 1999, the eastern offsite plume has been restricted to Site 300 property.

VOC and nitrate groundwater plumes are present in the Building 834 OU. The highest VOC concentration of 220,000 parts per billion (predominantly trichloroethylene) occurred in a perched water-bearing zone. This layer has very low hydraulic conductivity, but does yield some groundwater and is hydraulically isolated from the underlying aquifer by more than 295 feet of unsaturated zone. High levels of nitrate; e.g., a maximum 2002 concentration of 280 parts per billion, also occurred in groundwater in the Building 834 OU.

The High Explosives Process Area OU 2002 maximum concentrations of TCE, hexahydro-1,3,5-trinitro-1,3,5-traizine (RDX), nitrate, and perchlorate were 80 parts per billion, 93 parts per billion, 130 parts per billion, and 30 parts per billion, respectively. At Building 854 OU, trichloroethylene, nitrate, and perchlorate plumes had maximum groundwater concentrations of 270 parts per billion, 57 parts per million, and 10 parts per billion, respectively. Building 832 Canyon OU contains groundwater plumes of trichloroethylene, perchlorate, and nitrate at maximum concentrations of 12,000 parts per billion, 11 parts per billion, and 190 parts per million, respectively (LLNL 2003l).

In the past, explosives operations at the Building 850/Pits 3 and 5 OU resulted in releases of tritium and uranium into the groundwater (LLNL 2002cc). In 2002, the maximum tritium activity was approximately 706,000 picocuries per liter in the perched water-bearing zone and 23,700 picocuries per liter in the regional aquifer at the Elk Ravine Fault. Although tritium continues to leach into groundwater, plume activity is decreasing at approximately the radioactive decay rate of tritium (12.3 years). Computer modeling suggests that by the time tritium and depleted uranium in groundwater could reach the Site 300 boundary, both radionuclides would exist at near-background activities. Two smaller depleted uranium plumes had maximum concentrations in 2002 of approximately 118 picocuries per liter and 10.2 picocuries per liter. Both plumes are confined to the perched water-bearing zone. Nitrate and perchlorate maximum concentrations in 2002 were 86 parts per million and 44 parts per billion, respectively.

The Pit 6 OU contains trichloroethylene, perchlorate, and tritium groundwater contaminant plumes with maximum concentrations in 2002 of 5.2 parts per billion, 15 parts per billion, and 1,970 picocuries per liter, respectively (LLNL 2003l). Both tritium and perchlorate plumes are confined to shallow depths in the perched water-bearing zone. No plumes extend beyond the Site 300 boundary. The tritium plume, however, appears to be affected by heavy pumping from offsite Carnegie State Vehicular Recreation Area water supply wells. This plume migration and the associated potential risks are being closely monitored under the CERCLA program. LLNL's CERCLA program is summarized annually in the Site Annual Environmental Report (LLNL 2002cc).

In 2002, 11 treatment facilities treated 24.6 million gallons of groundwater and removed 9.5 kilograms of VOCs. Since remediation efforts began in 1990, more than 226 million gallons of groundwater and 3.93 million cubic meters of vapor have been treated, yielding 231 kilograms of removed VOCs (LLNL 2003l).

For surveillance and compliance monitoring at Site 300, LLNL uses DOE CERCLA wells onsite and private wells and springs offsite. Groundwater samples are measured for organic compounds and general radioactivity at least once a year. Figure 4.11.3.4–3 shows the locations of monitoring wells used for groundwater surveillance. Twelve groundwater-monitoring locations are offsite. Onsite wells monitor a former open-air explosives burn pit, closed landfills, two connected surface water impoundments, and two connected sewer ponds. Two onsite supply wells (well 18 and well 20) are used for surveillance monitoring. Historically, well 18 has shown trace amounts of trichloroethylene. The maximum concentration for 2002 was 0.3 parts per billion, which is equal to 6 percent of the MCL for trichloroethylene. CERCLA studies have not yet determined the source of trichloroethylene in well 18. Well 20 showed no evidence of contamination in 2002 (LLNL 2003l). Trichloroethylene concentrations have decreased below drinking water standards in all offsite wells.

Tritium activity was above background in many of the shallow groundwater surveillance samples obtained during 2002 from Elk Ravine. Tritium, in the form of tritiated water, was released previously near Building 850 and continues to leach into groundwater from vadose zone sources at Building 850. The largest tritiated water plume, which extends eastward more than a mile from a source beneath Building 850, is confined to shallow depths in the Neroly lower blue sandstone unit and overlying alluvium. This confinement is illustrated by comparing the tritium activity of 46,000 picocuries per liter at well NC7-61, which samples the shallowest water-bearing zone, and the tritium activity of 49 picocuries per liter at well NC7-69, which samples the deeper water-bearing zone in this area. Despite past releases, CERCLA modeling studies indicate that tritium concentrations and plume extent are generally diminishing over time.

Natural decay (tritium has a half life of 12.3 years) and slow groundwater velocities (16 – 50 feet per year) will allow released tritiated water to decrease several orders of magnitude below its MCL before it can reach the site boundary and migrate offsite (LLNL 2003l).

The city of Tracy, located northeast of Site 300, uses groundwater from alluvial aquifers in the San Joaquin Valley, which are isolated from contamination at Site 300 by thick claystone layers and a horizontal distance of more than 5 miles. Modeling suggests that contaminants from Site 300 will not affect groundwater used in the Tracy area (LLNL 2000b).

4.11.4 Water Use

Livermore Site

The Livermore Site's primary water source is the San Francisco Hetch Hetchy Aqueduct system. This system obtains its water from a reservoir in the Hetch Hetchy Valley of Yosemite National Park. The secondary or emergency water source is the Alameda County Flood and Water Conservation District, Zone 7. This water is a mixture of groundwater and water from the South Bay Aqueduct of the state water project (LLNL 1992a).

In 2002, 1.2 million gallons per day were derived from the Hetch Hetchy Aqueduct and Zone 7 for use at the Livermore Site. Water is primarily used for industrial cooling processes, sanitary systems, and irrigation at the Livermore Site. Minor amounts of water are used for drinking, manufacturing, washing, system filters, boilers, and a swimming pool (LLNL 1992a).

Livermore Site Vicinity

Water for commercial, residential, and agricultural use near the Livermore Site is derived from private wells, Zone 7, city of Livermore wells, and California Water Service Company (CWSC) wells. CWSC has 13 wells in the Livermore area that produce 1,200 million gallons per year, which is augmented by the purchase of 2,200 million gallons per year from Zone 7 Water Service. CWSC water supply serves approximately 54,000 people in the Livermore area.

Figure 4.11.3.4–1 illustrates water supply well locations in the Livermore vicinity. Ten active domestic supply wells are located within one-half mile of the Livermore Site boundary. Well 11H6 is the closest domestic supply well, located just east of Vasco Road.

Two wells within a half-mile of the Livermore Site are used for irrigation used for agriculture (including lawns and gardens) and industrial supply. Of those, well 14B1 is the closest to the Livermore Site, about 200 feet south of East Avenue. The main agricultural groundwater user in the vicinity was the Wente Brothers Winery located southwest of LLNL. Groundwater for the winery is pumped from Well 14C3 during periods of peak water demand. Ten supply wells have been destroyed since the 1990 inventory near the VOC plume in the southwest corner of the Livermore Site.

Site 300

Site 300 draws drinking water from two onsite groundwater production wells in the southeastern part of Site 300. Therefore, water is subject to the *Safe Drinking Water Act* of 1974 regulations (LLNL 2002cc). The system operates under Water Supply Permit No. 03-10-94-001. The system includes a primary drinking water supply well (well 20) and a backup well (well 18), several holding tanks, and a distribution network. Both are deep, high-production wells that can produce up to 23,700 gallons per hour of potable water (LLNL 2003l). Water production from these wells has declined from a peak of 32.7 million gallons in 1992 to 25 million gallons in 2002. LLNL disinfects well water with chlorine and monitors the quality of this water at the well and throughout the distribution system. In addition, the Hazards Control Department reviews the data to ensure that drinking water standards are met. Site 300 Plant Engineering submits the required reports to the California State Department of Health Services (LLNL 2002cc).

In the near future, it is expected that Site 300 will obtain its drinking water from the Hetch Hetchy Aqueduct system. LLNL will maintain the onsite drinking water wells as a backup supply and will be responsible for the Site 300 Drinking Water Permit requirements.

Figure 4.11.3.4–3 shows the groundwater surveillance sampling locations for Site 300. Well VIE2 is located at a private residence 3.7 miles west of the site and represents a typical potable water supply well in the Altamont Hills. One stock watering well (MUL1) and two stock watering springs (MUL2 and VIE1) are adjacent to Site 300 on the north. Eight wells, CARNRW1, CARNRW2, CDF1, CON1, CON2, GALLO1, STONEHAM1, and W35A-04, are adjacent to the site on the south. Seven of these wells are privately owned and were constructed to supply water for drinking, stock watering, and fire suppression. Well W35A-04 was installed for site monitoring purposes only (LLNL 2003l).

4.11.5 Floodplains

Livermore Site

A floodplain is defined as the valley floor adjacent to a streambed or arroyo channel that may be inundated during high water. Arroyo Las Positas and Arroyo Seco are the only potential sources of flooding onsite. Localized flooding is most likely to occur during the rainy season from October to April. Open ditches and storm drains are designed for a 10-year storm event. Most of the Livermore Site ultimately drains to the north into Arroyo Las Positas, and a small percentage of land in the southwest corner drains southward to Arroyo Seco.

The original course of Arroyo Las Positas was through what is now the Livermore Site. In the 1940s, the U.S. Navy diverted the arroyo to its current location. It now approaches the Livermore Site from the east, runs north along the eastern boundary of the Livermore Site for approximately 1,000 feet, then turns west and flows adjacent to the northern boundary of the Livermore Site until it exits the site in the far northwest corner.

Flood insurance studies were performed by the Federal Emergency Management Agency (FEMA) to determine flood hazards in Alameda County and to identify the approximate limits of the 100-year floodplain. These floodplains were incorporated into Flood Insurance Rate Maps (FEMA 1981, FEMA 1997a, FEMA 1997b). Maps depicting the 100-year and 500-year floodplains for the Livermore Site are presented in Appendix F, Figure F.2.1–1.

Arroyo Las Positas is an intermittent stream that drains approximately 3,300 acres in the northeastern and eastern hills above the Livermore Site. Flow has increased in the arroyo over the past several years, due mostly to discharge from the DRB. The additional flow has improved water quality and habitat value (Water KPT 2002). This arroyo has a maximum predicted 100-year base flood peak flow adjacent to the Livermore Site of 822 cubic feet per second (LLNL 1992a). The 100-year floodplain broadens as it approaches the Livermore Site from the east, from 100 feet wide to approximately 800 feet wide, covering Greenville Road along the northeastern boundary of the Livermore Site. The spreading is due to the shallow channel that cannot contain the 100-year flood. As the arroyo flows westward along the northern boundary of the Livermore Site and approaches the northwest corner of the site, the 100-year flood flow exceeds the channel banks to a width of approximately 120 feet. Storm flow within the northern perimeter channel combines with the western area drainage at the northwest corner of the site. The flow is conveyed to the north, beyond the site, within a drainage easement (the north buffer zone) managed and maintained by LLNL. The 500-year floodplain extends approximately 2,000 feet to the north and is generally bounded by the Western Pacific Railroad right of way (Appendix F, Figure F.2.1–1).

After the FEMA studies were complete, the Arroyo Las Positas Maintenance Project was implemented to protect the Livermore Site from the 100-year flood by ensuring that the arroyo would be capable of handling the 10-year storm event and using the north buffer zone as a floodplain for storm events exceeding the capacity of the arroyo. The maintenance project is permitted under several agencies, including the USFWS, the RWQCB, and USACE nationwide permit. A 2-foot-high berm was constructed along portions of the southern bank of the arroyo to ensure that the 100-year flood event would not inundate the Livermore Site. Maintenance activities undertaken to ensure that the channel can handle the 10-year storm event include a 5-year phased project to desilt the 7,000-linear-foot stretch of arroyo on LLNL property, trimming cattail heights, and conducting bank stabilization/erosion control activities (LLNL 2003l).

Arroyo Seco is an intermittent stream that drains approximately 8,960 acres in the foothills to the southeast of the Livermore Site. The channel is narrow and deeply incised where it is present for about 900 linear feet in the far southwest corner of the Livermore Site. It has a 100-year base flood peak flow of 1,200 cubic feet per second that is contained within the channel at the Livermore Site (LLNL 1992a).

Site 300

Site 300 is primarily on undeveloped land characterized by steep hills and deep ravines. A floodplain analysis was conducted for the 1992 LLNL EIS/EIR for this site to determine the depth and width of inundation due to the 100-year storm event. This analysis is summarized in Appendix F.

Based on the results, there are no 100-year floodplains on Site 300 as the 100-year base flood event is contained within all channels. However, due to the steep slopes and high runoff potential, velocities within these channels could be high during a peak flood event.

4.12 NOISE

This section describes ambient noise levels in the environs of LLNL with emphasis on community noise levels in areas where the community may be exposed. Regulations and guidelines related to community noise issues are discussed in Section 4.12.1. Regional noise sources, including those associated with LLNL, are described in Section 4.12.2. Finally, Section 4.12.3 presents the results of local field surveys.

4.12.1 Regulatory Framework

Noise-related criteria and guidelines have been promulgated at the Federal, state, and local level. Various Federal agencies have been delegated responsibility to set noise control standards. Uniform noise control standards have been set by these agencies for equipment such as aircraft and airports, interstate motor carriers and railroads, medium and heavy-duty trucks, motorcycles and mopeds, and portable air compressors. With the exception of federally assisted housing projects, however, community exposures are regulated at either the state or local level, and emphasis is placed on these programs.

4.12.1.1 *State of California*

The State of California has issued land use compatibility criteria for noise elements of local general plans. These guidelines outline the compatibility of various land uses based upon existing community noise levels. They are often adopted by city and county agencies for land use planning purposes and include specific exterior noise exposure standards for commercial, industrial, office, professional, and public recreation land uses. The State of California has also issued community noise equivalent level (CNEL) standards for new multiple-dwelling construction to provide adequate interior protection from exterior noise sources. These standards require a level of protection be incorporated to limit interior noise levels attributable to exterior sources to a level not to exceed 45 A-weighted decibels (dB[A])[1] in any habitable room with windows closed. These standards apply to hotels, motels, and dwellings other than detached single-family structures with windows closed, and are included here to provide a standard for comparison, although not specifically applicable.

4.12.1.2 *Local Noise Ordinances*

City of Livermore and Alameda County

The city of Livermore, within the noise element of the general plan, provides acceptable noise levels for certain land uses, based on state guidelines (Table 4.12.1.2–1), and identifies local noise problems and noise-sensitive areas within the city. It further establishes goals to be achieved in noise abatement and identifies a basic framework for implementing a noise-control program. Several elements of the city general plan are currently being updated. In the update, the city identifies noise levels compatible with various land uses to guide future mitigation of noise

[1] Sound is often expressed using the decibel (dB) scale. The decibel scale is a nonlinear scale of measurement that simplifies presentation data that have a wide range of variation, but its values cannot be added together without conversion; i.e., 1 dB + 1 dB does not equal 2 dB. The A-weighted decibel (dB[A]) scale is an instrument response that mimics the human ear at moderate sound pressure levels. The CNEL represents a time-weighted, 24-hour average noise level based on the A-weighted decibel scale. “Time-weighted” refers to the fact that noise that occurs during certain sensitive times is weighted more heavily in calculations. This scale includes a 5-decibel upward adjustment for sounds occurring in the evening (defined as 7 p.m. to 10 p.m.) and a 10-decibel upward adjustment for sounds occurring in the late evening and early morning (defined as 10 p.m. to 7 a.m.).

issues. The city also addresses noise considerations in its municipal code noise ordinance. This ordinance is intended to reduce and restrict certain noise-generating activities within its jurisdiction and provides methods for addressing noise problems, but it does not contain explicit noise level limits.

The Alameda County general plan noise element is similar to that of the city of Livermore. Noise criteria are also included in the East (Alameda) County Area Plan (ECAP). The goals contained in these two plans are generally more stringent than those set in the city's noise ordinance. In addition, the ECAP addresses potential impacts of proposed activities, characterized by a net increase in dB(A). The County's noise element also sets limits on the allowable amount of noise (maximum decibels) that can be heard from one property to another to protect certain noise-sensitive land uses (City of Livermore and LSA 2002).

TABLE 4.12.1.2–1.—*City of Livermore Land-Use Compatibility for Community Noise Environments, Day-Night Average Levels* [a]

Land Use	Normally Acceptable Levels (dB[A])	
	City	County
Residential – low density	< 60	50 – 60
Residential – multi-family, and transient lodging	< 65	50 – 65
School, library, church, playground, park	< 70	50 – 70
Golf course, water recreation	< 75	50 – 75
Office building	< 70	-
Industrial, manufacturing, agricultural	< 75	-

Source: City of Livermore and LSA 2002.
[a] The *Day-Night Average Level* is a time-weighted average noise level wherein the individual "pockets" of noise that occur during late evening through early morning (10 p.m. to 7 a.m.) are multiplied by 10 (i.e., given a 10-decibel upward adjustment) to account for the fact that certain noises would be more objectionable and the community is more sensitive to noises that occur during these times.
dB(A) = A-weighted decibels.

City of Tracy and San Joaquin County

The city of Tracy's noise control ordinance was established to reduce and restrict certain noise-generating activities and provide methods for addressing noise problems. Unlike Livermore, however, it provides explicit noise level limits for various zoning types (Table 4.12.1.2–2) and requirements for exemptions to the ordinance. San Joaquin County has adopted a noise ordinance and guidelines for noise levels associated with various land uses within its unincorporated territory. The ordinance sets noise limits for various land uses, summarized as follows:

- No sound may exceed 65 decibels day-night average level at property lines that abut parks, schools, hospitals, rest homes, homes for the care of the aged and infirmed, or areas developed or zoned as residential.
- The sound within commercial-manufacturing zones must not exceed 75 decibels day-night average level at property lines of the property being developed.

TABLE 4.12.1.2–2.—*City of Tracy Sound Level Limits for Base District Zones*

Base District Zone	Sound Level (dB[A])
Residential districts	55
Commercial districts	65
Industrial districts (light and heavy)	75
Agricultural	75
Aggregate mineral overlay zone	75

Source: City of Tracy 2002.
dB(A) = A-weighted decibels.

For comparative purposes, typical indoor and outdoor noise levels generated by various activities are listed in Table 4.12.1.2–3.

TABLE 4.12.1.2–3.—*Typical Sound Levels*

Noise Source	Sound Level (dB[A])
Near jet engine	140
Accelerating motorcycle at a few feet away	110
Pile driver; noisy urban street/heavy city traffic	100
Ambulance siren; food blender	95
Pneumatic drill; vacuum cleaner	80
Near freeway auto traffic	70
Suburban street	55
Light traffic; soft radio music in apartment	50
Average residence without stereo playing	40
Soft whisper	30

Source: City of Livermore and LSA 2002.
dB(A) = A-weighted decibels.

4.12.2 Environmental Setting and Existing Noise Sources

This section provides a description of local noise sources and sources attributable to LLNL and presents the results of local noise monitoring surveys.

4.12.2.1 *Local Noise Sources*

Noise sources local to Livermore include the following (City of Livermore and LSA 2002):

- **Construction Activity—**Construction generally comprises discrete steps, including demolishing, excavating, grading, and building, resulting in intermittent noise levels generally higher than background. Each of these steps involves different equipment and, consequently, its own noise characteristics. Typical noise levels can reach 90 decibels or more at 50 feet during the noisiest construction phases. Mitigation is typically required to reduce the impact of construction activity noise on the surrounding community. The city of Livermore requires that all construction vehicles or equipment be equipped with properly operating and maintained mufflers. For certain equipment, hours of operation are restricted to between 7 a.m. and 8 p.m.
- **Equipment—**The variety of machinery or equipment that generates noise during operation includes heating, ventilating, and air-conditioning equipment, cooling towers, motors, pumps, fans, generators, air compressors, jackhammers, and loudspeakers.
- **Vehicular Traffic—**Traffic noise varies depending on factors such as traffic volume, vehicle mix (percentage of cars and trucks), and average traffic speed. Major regional roadway noise

sources include I-580, Highway 84, Livermore Avenue, First Street, and other arterial and collector roadways throughout the city.

- **Rail Operations—**The Union Pacific and Southern Pacific rail lines, located just north of the Livermore Site, produce noise from whistles, engines, and wheels and ground-borne vibration.
- **Aircraft Operations—**The Livermore Airport, located south of I-580 just within the western boundary of the city of Livermore, provides a variety of services to small and large noncommercial aircraft. It is a source of intermittent noise associated with takeoffs, landings, taxiing, and support vehicles. Aircraft overflights, however, currently contribute little to the ambient noise levels in Livermore.

Local noise sources in the Site 300 environs include off-road vehicles using the Carnegie State Vehicular Recreation Area south of Site 300, vehicular traffic along Corral Hollow Road, and occasional aircraft flybys. The city of Tracy Municipal Airport is somewhat distant and a relatively minor source of noise.

4.12.2.2 *Noise Sources Associated with Lawrence Livermore National Laboratory Activities*

Noise sources at LLNL are, for the most part, common to other local industrial/commercial settings, although on a somewhat larger scale. Construction and demolition activities are similar, however, because of the size of the site, perimeter buffer zone, and intervening roads. The contribution of these activities to noise levels offsite is small. The contribution of mobile noise sources associated with heavy-duty trucks and employee vehicles is greater, due to the relatively large number of shipments of materials and waste to and from the site and the large employment base; i.e., compared with other area businesses. Occasionally, noise may also be heard from the pistol and rifle firing range located at Site 300. These activities are not in conflict with land use compatibility guidelines.

LLNL is unique in the category of impulse (short-blast) noise associated with explosives research testing. High explosive tests are conducted regularly (daily and/or weekly) at both the Livermore Site, in the High Explosives Application Facility (HEAF), Building 191; and at Site 300, within the Contained Firing Facility and on open firing tables.

Because this type of source is unique, it is not considered within local agency land use compatibility guidelines. LLNL has evaluated this type of noise and, in an effort to limit nuisance to nearby residents and preclude damage to property, imposes a maximum allowable sound pressure level of 126 decibels, not to be exceeded in nearby populated areas. This value is considerably lower than some known damage thresholds and is considered to be well within the safe limit for both humans and structures in residential areas (LLNL 1991a). LLNL uses "blast forecasting" for open air detonations at Site 300. Blast forecasting considers explosive type and detonation characteristics together with various sound-wave propagation factors such as atmospheric attenuation, local topography, ground surface roughness, and monitored meteorological conditions to predict the magnitude and location of impulse noise levels. Blast forecasting is used to determine the maximum explosive weight that can be detonated without an irritant effect on the nearest populated areas; i.e., maintains sound levels within the self-imposed 126-decibel limit. Prior to tests on the open firing tables, LLNL also launches a weather balloon to obtain more detailed input data for the predictive noise-modeling program.

At the Livermore Site, explosive tests are conducted within the HEAF Building and, although these may at times be audible offsite, the insulating properties limit noise levels in nearby populated areas to a small fraction of the self-imposed 126-decibel limit.

4.12.3 Noise Monitoring Surveys

A field survey was conducted in January 2003 to characterize typical daily maximum noise levels in the vicinity of the Livermore Site (Sculley 2003). Measurements were taken for 1-hour periods using standard sound-level meters during the heart of the morning and evening commute. The monitors were placed at eight locations surrounding and just outside the Livermore Site perimeter, in regions of maximum activity (intersections and site entrance and exit locations) shown in Figure 4.12.3–1. Results of the survey, listed in Table 4.12.3–1, indicated that, as expected, vehicular traffic was the dominant noise source at most monitored locations. Rail operations and light aircraft overflights were minor contributors. The only recognizable noise sources from site activities within LLNL were some heavy equipment backup warning beepers, which were detectable during low traffic intervals at the monitoring sites on Patterson Pass Road. All levels were within the acceptable range established by the city of Livermore and Alameda County.

In addition to the 1-hour monitoring activity, additional measurements were taken to characterize the variations in noise over a 24-hour period. These measurements were taken along Vasco Road, approximately 1,000 feet south of Patterson Pass Road. The results indicated noise levels typical of suburban and near-freeway streets, with highest levels occurring during periods corresponding to peak traffic hours (Figure 4.12.3–2).

In 1991, a less extensive field survey, consisting of 5 perimeter locations and 10- to 15-minute collection periods, was conducted in the vicinity of Site 300 to document weekday ambient noise levels. The study showed ambient noise levels along Corral Hollow Road/Tesla Road ranging from 56 to 66 dB(A) equivalent continuous sound level (L_{eq})[2], which is typical of traffic noises associated with suburban street to near-freeway traffic (Table 4.12.3–2). At the time of the survey, no noticeable noise was being generated at the Site 300 firing range or the Carnegie State Vehicular Recreation Area. Higher ambient noise levels would be expected at the monitoring sites along Corral Hollow Road/Tesla Road during weekend periods when the Carnegie State Vehicular Recreation Area has the greatest off-highway vehicle activity.

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[2] The *Equivalent-Continuous Sound Level* (L_{eq}) is an energy-averaged noise level for the indicated time.

TABLE 4.12.3–1.—*Results of Ambient Noise Measurements Around Livermore Site*[a]

Locations [b]	Date	Start and End Times [c]		1-Hour L_{eq}[d] (dB[A])
1 Patterson Pass Rd: 16 ft from near traffic lane	Jan. 9, 2003	7:00 -	8:00 a.m.	70.5
		4:30 -	5:30 p.m.	68.5
2 Patterson Pass Rd: 19 ft from near traffic lane	Jan. 9, 2003	7:00 -	8:00 a.m.	68.1
		4:30 -	5:30 p.m.	63.7
3 Greenville Rd: 6.8 ft from near traffic lane	Jan. 7, 2003	7:15 -	8:15 a.m.	73.0
		4:30 -	5:30 p.m.	74.0
4 Vasco Rd: 17 ft from near traffic lane	Jan. 8, 2003	7:00 -	8:00 a.m.	70.2
		4:30 -	5:30 p.m.	68.6
	Jan. 9, 2003 [e]	7:00 -	8:00 a.m.	70.2
5 Vasco Rd: 32 ft from near traffic lane	Jan. 10, 2003	7:15 -	8:15 a.m.	73.2
		4:30 -	5:30 p.m.	66.5
6 Vasco Rd: 43 ft from near traffic lane	Jan. 10, 2003	7:15 -	8:15 a.m.	73.4
		4:30 -	5:30 p.m.	69.3
7 Greenville Rd: 21 ft from near traffic lane	Jan. 7, 2003	7:00 -	8:00 a.m.	72.2
		4:30 -	5:30 p.m.	73.5
8 Greenville Rd: 11 ft from near traffic lane	Jan. 8, 2003	7:00 -	8:00 a.m.	72.3
		4:30 -	5:30 p.m.	72.6

Source: Sculley 2003.

[a] Monitoring was conducted using Larson-Davis Model 820 Type I sound level meters mounted on tripods, about 4 to 5 feet aboveground level. Instruments have a 110-decibel dynamic range with a noise floor of about 20 dB(A). Meters were programmed for slow response (8 samples per second, 1 second averaging), A-weighted setting. Weather protection for the body of the meter was provided as necessary using plastic bags or vinyl pouches.

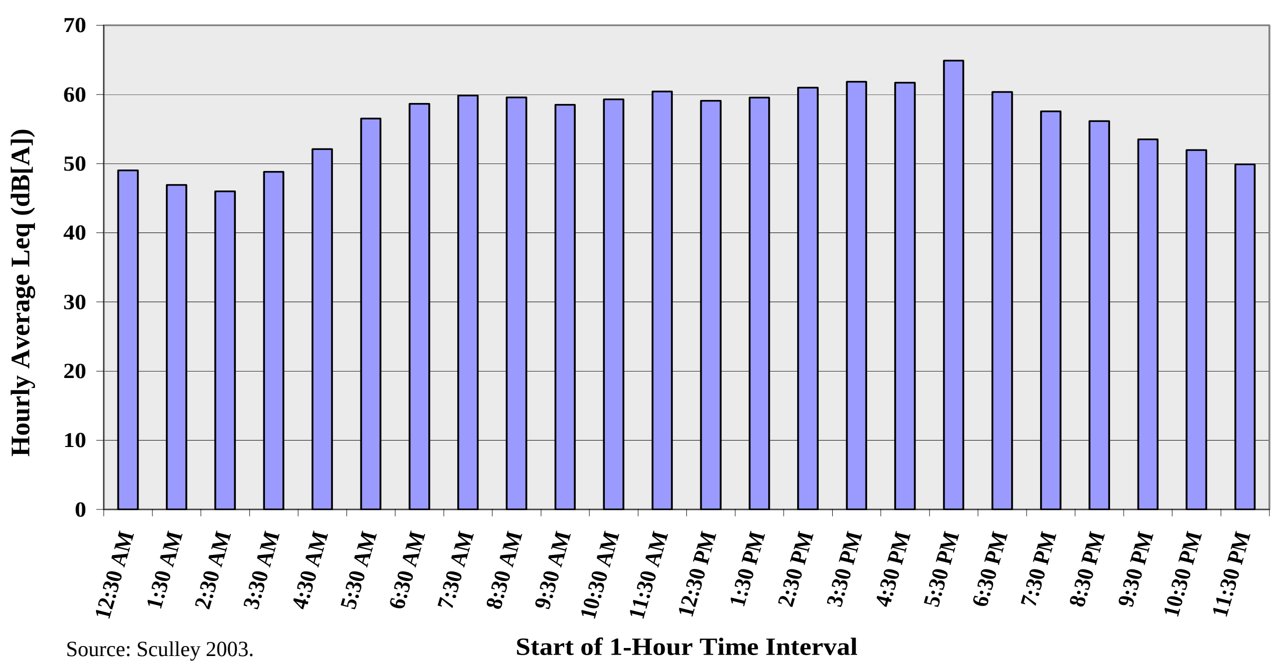
[b] Locations are shown on Figure 4.12.3–1.

[c] Meters were started and stopped manually, with 1-minute time histories and 15-minute interval histories collected; interval histories were synchronized to clock hours.

[d] The *Equivalent-Continuous Sound Level* (L_{eq}) is an energy-averaged noise level for the indicated time.

[e] Morning noise monitoring at Station # 4 was repeated on January 9, 2003.

dB(A) = A-weighted decibels



Source: Sculley 2003.

FIGURE 4.12.3–2.—*Hourly Average Noise Levels Along South Vasco Road*

TABLE 4.12.3–2.—*Lawrence Livermore National Laboratory Site 300 Offsite Ambient Noise Measurement Results*

Approximate Location	Time	L_{eq} [a] (dB[A])	Description
Along eastern Site 300 boundary	11:15 - 11:30 AM	59	No dominant noise sources
Next to Corral Hollow Road			Ambient noise dominated by
0.75 mile west of I-580	9:05 - 9:20 AM	60	Earth-moving equipment (operating at Corral Hollow landfill, 0.5 mile from monitor)
2 miles east of I-580	9:35 - 9:50 AM	56	Overflying hawk
Across from Carnegie State Vehicular Recreational Area	12:50 - 1:05 PM	66	Wind and a few vehicles on roadway
Next to Tesla Road			Ambient noise dominated by
0.5 mile west of Alameda/San Joaquin County Line	1:15 - 1:30 PM	64	Wind and a few vehicles on roadway

[a] The *Equivalent-Continuous Sound Level* (L_{eq}) is an energy-averaged noise level for the indicated time.
dB(A) = A-weighted decibels.

4.13 TRAFFIC AND TRANSPORTATION

4.13.1 Regional and Local Circulation System

Livermore Site

Regional access to the Livermore Site by motor vehicle is from I-580, which runs east and west approximately 1 mile north of the Livermore Site. As depicted in Figure 4.13.1–1, the Vasco Road/I-580 interchange provides access to the western site boundary, and the Greenville Road/I-580 interchange provides access to the eastern site boundary.

Approximately 35 percent of the Livermore Site employees live within 12 miles of the Laboratory (LLNL 2001d). The remaining employees come to work from greater distances, mostly from the counties of Alameda, San Joaquin, Contra Costa, and Stanislaus. Many of these commuters travel in personal vehicles and arrive either on local roads or on I-580. Alternate modes of commuter transportation, such as carpools, vanpools, bicycles, or public transit, are described in Section 4.13.6. Trucks carrying radioactive or hazardous material shipments almost exclusively arrive from or depart to the east on I-580 and I-5, except for local deliveries from the Bay Area.

Site 300

Regional access to Site 300 is from I-580 to Corral Hollow Road. Alternately, travel between the Livermore Site and Site 300 is by way of Tesla Road as shown in Figure 4.13.1–1. Tesla Road changes to Corral Hollow Road at the Alameda-San Joaquin county line. There is one primary access gate to Site 300 from Corral Hollow Road plus another gate for the pistol range.

4.13.2 Local Traffic Conditions and Issues

Livermore Site

Traffic Conditions

The major street system in the vicinity of LLNL includes I-580, South Vasco Road, Greenville Road, East Avenue, and Patterson Pass Road. Most of these are primarily located in the city of Livermore, but with portions of all streets lying in unincorporated portions of Alameda County. Figure 4.13.1–1 shows a vicinity map and existing daily traffic volumes.

I-580 is a major east-west freeway in the vicinity of the Livermore Site. This roadway is a connector freeway between I-5, which extends the entire length of California, and I-80, the major freeway in the San Francisco/Oakland area. I-580 is an eight-lane roadway from east of the Altamont Pass near Livermore to the I-80 complex. I-580 also continues over the Richmond-San Rafael Bridge to connect with Highway 101 in Marin County. In the Livermore vicinity, I-580 carries approximately 120,000 vehicles per day with about 10.4 percent trucks. I-580 experiences significant congestion during extended peak commute hours in the morning; the westbound lanes experience congestion in the Vasco Road/Greenville Road area (and beyond). In the evening, the eastbound lanes are congested from west of I-680 on the west to the Altamont Pass and eastward. Because of the congestion on I-580, the three parallel roads that connect the Tri-Valley area with the San Joaquin Valley—Patterson Pass Road, Tesla Road, and Altamont Pass Road—are increasingly used by commuters.

South Vasco Road is an important north-south roadway with four to six lanes and a median between East Avenue and I-580, with a continuation north of I-580. This roadway serves as a major route for traffic to LLNL, with an estimated 36 percent of all traffic accessing the site by way of South Vasco Road (LLNL 2002be). South Vasco Road connects to I-580 with an interchange that will require upgrading in the future. Daily traffic volumes average 30,000 vehicles per day between I-580 and Las Positas Road, 26,200 vehicles per day between Las Positas Road and Patterson Pass Road, and 16,600 vehicles per day between Patterson Pass Road and East Avenue along the western border of the Livermore Site. South Vasco Road has a grade-separated over-crossing of the Union Pacific Railroad, located between Brisa Street and Patterson Pass Road, and an at-grade crossing of a different, lightly used, Union Pacific Railroad track north of Brisa Street. This crossing is protected with crossing gates. South Vasco Road has existing traffic signals at seven of the nine intersections between I-580 and East Avenue (Industrial Way, Las Positas Road, Brisa Street, Patterson Pass Road, Daphne Drive/Westgate Drive, Emily Way/Mesquite Way, and East Avenue). The South Vasco Road intersections with Preston Avenue and Naylor Avenue do not have traffic signals. In addition to serving the Livermore Site and existing residential districts west of the Livermore Site, South Vasco Road provides key access to the large industrial/business parks located north of the area extending from Greenville Road to west of South Vasco Road. South Vasco Road also provides access to the existing Altamont Commuter Express (ACE) (see Section 4.13.6) commute train station located near the southwest quadrant of the intersection of South Vasco Road and Brisa Street. The northern section of South Vasco Road, generally between I-580 and Las Positas Road, experiences the greatest degree of congestion in this corridor due to higher traffic volumes and a greater density of intersections with traffic signals.

Greenville Road is the other north-south roadway serving the Livermore Site. Portions of Greenville Road are two, three, four, and six lanes wide, with the wider sections to the north. Ultimately, Greenville Road is expected to be six lanes wide with a median north of National Drive and four lanes wide with a median between National Drive and East Avenue. (As noted elsewhere, the city of Livermore is currently updating its general plan and its circulation element, which may result in new ultimate descriptions of all major streets in the city). Traffic volumes on Greenville Road vary from 15,600 vehicles per day near Southfront Road to 12,000 vehicles per day near Patterson Pass Road. It is estimated that 21 percent of all Livermore Site traffic uses Greenville Road for access (LLNL 2002be).

Greenville Road has a split interchange with I-580. The westbound ramps on the north side of I-580 form a buttonhook interchange with Northfront Road. The eastbound ramps on the south side of I-580 form a buttonhook interchange with Southfront Road. Both buttonhook intersections are controlled with stop signs. Greenville Road passes beneath I-580 and forms the connection between Northfront Road and Southfront Road, to complete the interchange. The interchange will be upgraded and modified in the future, but there are no projects scheduled at this time.

There are nine public street intersections with Greenville Road between Northfront Road and East Avenue. Four of these intersections have traffic signals (Southfront Road, Las Positas Road, National Drive, and Lupin Way/Eastgate Drive). The intersections without signals are Northfront Road, Hawthorne Avenue, Marathon Drive, Patterson Pass Road, and East Avenue. Greenville Road has an antiquated grade separation of the Union Pacific Railroad located between National Drive and Marathon Drive. The railroad passes over the roadway, which is at grade. The portion of Greenville Road below the railroad overpass is a narrow two-lane section on reversing curves. This grade separation and about 600 feet of roadway will be upgraded to modern standards within the next 2 years in a project sponsored by the city of Livermore.

Greenville Road connects with Tesla Road south of East Avenue. In this area, Greenville Road is a straight, two-lane roadway traveling through rolling terrain. It has an estimated traffic volume of 3,000 vehicles per day.

East Avenue is the major east-west roadway serving the Livermore Site. An estimated 43 percent of all Livermore Site traffic uses East Avenue for access (LLNL 2002be). The western half of the section of East Avenue between South Vasco Road and Greenville Road is four lanes wide, and the eastern half has two lanes. This roadway was closed and gated in 2003 and will not be usable for non-Livermore Site or SNL/CA traffic. (See a description of this proposed change under “Relevant Transportation Issues” in this section.) The daily two-way traffic on this section of East Avenue is about 10,350 vehicles per day east of South Vasco Road and about 3,200 vehicles per day west of Greenville Road. According to a recent traffic study (Korve 1999), only about 2 percent of all traffic on this roadway was not related to the Livermore Site or SNL/CA.

West of South Vasco Road, East Avenue serves as an arterial road linking predominately residential land uses abutting the East Avenue corridor, with downtown uses to the west and Livermore Site/industrial uses to the east. East Avenue is generally a five-lane roadway with the fifth lane serving left turn movements. East Avenue extends approximately 2.5 miles westerly to South Livermore Avenue. There are traffic signals at the East Avenue/South Vasco Road intersections as well as along East Avenue at the intersections of Charlotte Way, North Mines Road, Loyola Way, Madison Avenue, Hillcrest Avenue, Dolores Street, and South Livermore Avenue. The daily traffic volume on East Avenue, west of South Vasco Road, is approximately 12,500 vehicles per day.

Patterson Pass Road is a four-lane divided highway between South Vasco Road and Greenville Road, located just north of the Livermore Site. Industrial buildings occupy the north side of the street; the south side of the street is an undeveloped buffer for the Livermore Site. Patterson Pass Road carries about 6,200 vehicles per day. The Patterson Pass Road intersection with South Vasco Road has a traffic signal and the Greenville Road intersection is controlled by stop signs.

West of South Vasco Road, Patterson Pass Road extends about 1.5 miles to North Mines Road, which has a connection to First Street since a railroad overpass was constructed in 1999. The Patterson Pass Road/North Mines Road system provides access to a major residential portion of Livermore and also provides an additional route for employees to reach the Livermore Site.

East of Greenville Road, Patterson Pass Road extends about 10.5 miles east to an interchange with I-580 on the west side of the city of Tracy. In this section, Patterson Pass Road is a winding two-lane roadway with no paved shoulders. Due to congestion on I-580 through the Altamont Pass, Patterson Pass Road is receiving increased usage during commute periods. The current traffic volumes are estimated at 3,500 vehicles per day. East and north of the I-580 interchange, Patterson Pass Road changes its name to Mountain House Parkway, which extends as a north-south roadway into the newly developing community of Mountain House, located on the north side of I-205.

Relevant Transportation Issues

City of Livermore General Plan Update

The city of Livermore is currently updating its general plan. Two general plan issues that relate to transportation are land use and circulation. Livermore has had its update process underway since April 2002, and the schedule calls for completion of the process by September 2003.

The city of Livermore has made some interim land use decisions that could be a precursor to the direction the final general plan update will take. At a December 2002 meeting, the city council decided to take action that would establish an urban limit line around the borders of the city. The urban limit line on the east side of the community generally would follow the boundary of Greenville Road. This boundary would preclude any residential-, employment-, or transportation-related developments that had been contemplated east of Greenville Road, between Southfront Road and the Livermore Site. With the placement of the growth boundary, this land would not be immediately available for LLNL-related uses and their associated traffic impacts. The same urban limit line has been drawn to preclude any major residential development in north Livermore, north of I-580. A proposal to develop up to 12,500 homes with a related population of about 30,000 would be precluded by the adoption of the urban limit line as proposed.

The circulation element is also being updated. The city of Livermore is developing a major traffic model to forecast the traffic volumes and impacts resulting from various land use proposals that will be considered as part of the process. The circulation element may change the function of any of the major streets described above, although it is not likely that this process will change the role and function of South Vasco Road, Greenville Road, East Avenue, Patterson Pass Road, or Tesla Road. The updated traffic model will be able to determine if ultimate widths of these and other major streets should be adjusted from earlier plans.

Road Improvements Near the Livermore Site

The city of Livermore is contemplating the update of the Vasco Road/I-580 interchange. The interchange would be improved in stages, and the first stage would be to modify and install signals on the eastbound ramps. Signals would also be added to Preston Avenue. The net effect of the first stage would be to improve the capacity and safety of the south side of the interchange by removing the loop off-ramp and replacing it with a ramp with traffic signals located closer to I-580. This would reduce the speed of traffic exiting the freeway and increase the distance between Preston Avenue and the I-580 off-ramp. Later improvements would improve the ramps on the north side of the interchange. The first stage is scheduled for 2005 although, because of budget limitations, the actual construction could be delayed.

The city of Livermore is planning to construct improvements on Greenville Road near the Union Pacific Railroad structure south of National Drive. In this area, the roadway is a narrow two lanes and has reversing curves in the railroad area. The roadway will be straightened and widened to four lanes. The total project length is about 600 feet. The work was scheduled to start in 2003.

Security Upgrade of East Avenue at the Livermore Site

LLNL and SNL/CA have conducted studies to close East Avenue as a public street between South Vasco Road and Greenville Road. Although this closure was identified in the 1992 LLNL EIS/EIR, heightened security at the Nation's government facilities has prompted a re-examination of this closure, which has been evaluated in an environmental assessment (EA) (DOE 2002i, DOE 2002h) and is part of the No Action Alternative in this SWEIS. In 2003, DOE placed this East Avenue segment under administrative control and constructed security checkpoints at both ends of the segment. A truck inspection station would be built west of the Greenville Road intersection. Because only two percent of the existing traffic on East Avenue is not LLNL- and SNL/CA-related, closure of the road to public traffic would have very minimal impacts on the surrounding street system.

During 2002, both the city of Livermore City Council and the Alameda County Board of Supervisors vacated easement rights on East Avenue in the subject area, in effect removing it as a public street. Construction of the security checkpoints or other recommended street and system modifications commenced in May 2003.

Bay Area Rapid Transit District to Livermore Studies

The Bay Area Rapid Transit District (BART) (see Section 4.13.6) and the Alameda County Congestion Management Agency are co-sponsoring a study of a potential BART extension from its current terminus at the Pleasanton/Dublin Station to stations in Livermore. The two previously identified station locations in Livermore are in the I-580 corridor near Isabel Avenue and near Greenville Road. BART owns property at both locations. Although the study recommendations confirmed the alignment and station locations previously identified, additional studies are currently taking place to analyze the potential for use of the Union Pacific Railroad Corridor through downtown Livermore, using diesel-powered train units. The current studies are being considered as interim, more affordable, solutions to the BART extension issue. The Union Pacific Corridor is located only a few hundred feet north of the Livermore Site near Patterson Pass Road, so additional commuter facilities on this line (now serving the ACE) would provide improved commute opportunities to LLNL employees.

Funds are available for preliminary engineering of the selected alternatives, but full funding of the extension is not currently available. The construction cost for the range of alternatives is about $500 million to $1 billion. The BART to Livermore studies are anticipated to continue beyond 2003.

I-580 Improvements

The California Department of Transportation is conducting a study to determine the details of a plan to construct high-occupancy vehicle (HOV) lanes on I-580 between Santa Rita/Tassajara Roads and Greenville Road. The HOV lanes project is estimated to cost between $100 million and $200 million and is not yet fully funded. The I-580 study is also examining ways to stage the project so that available funds can be used to construct feasible pieces of the ultimate project. The HOV lanes are expected to help reduce the prevailing commute-period congestion on I-580 between Pleasanton and the Altamont Pass.

Site 300

Traffic Conditions

Tesla Road is an east-west arterial highway located one mile south of the Livermore Site. The name of the road changes to Corral Hollow Road at the boundary between Alameda County and San Joaquin County near the western end of Site 300. The access for Site 300 is located on Corral Hollow Road, 13.1 miles east of Greenville Road. Between Site 300 and Greenville Road, the daily traffic on Tesla Road averages approximately 4,500 vehicles per day. In this area, Tesla Road is a winding two-lane roadway with no paved shoulders; the terrain is rolling. Posted speed limits range from 45 to 55 miles per hour in the vicinity of Site 300. East of the Site 300 access, Corral Hollow Road continues as a two-lane winding roadway, 4.1 miles to an interchange with I-580 south of the city of Tracy. Tesla Road is receiving increased usage during commute periods because of congestion on I-580 through the Altamont Pass.

Relevant Transportation Issues

Altamont Corridor Improvements

The cities of Tracy and Livermore and Alameda County have formed a joint powers authority to expend transportation impact fees collected from the developers of the Tracy Hills project in the city of Tracy. Although the Tracy Hills development has not yet commenced, its developers will be required to contribute $1,500 per residential unit to help solve regional transportation issues in

San Joaquin and Alameda counties. A study is underway to determine the most effective way to spend these funds.

City of Tracy/San Joaquin County Plans

The California Department of Transportation is planning to improve I-205 between Eleventh Street in Tracy and I-5 near Lathrop. This project will widen the freeway from four lanes to six lanes and is scheduled to begin construction in 2004.

4.13.3 Traffic and Transportation Accident History

NNSA reviewed the California Statewide Integrated Traffic Records System accident reports for 1999, 2000, and 2001. The information was for all streets near the Livermore Site and Site 300 and included South Vasco Road, Greenville Road, Patterson Pass Road, East Avenue, and Tesla Road. The accidents are summarized in Table 4.13.3–1.

The accident rates on the main roads serving the Livermore Site are also compared with the average accident rates for similar roads in the State of California. Average accident rates in California on urban four-lane divided roadways are 2.18 accidents per million vehicle miles (MVM). For two- and three-lane urban roadways, the average rate is 1.93 accidents per MVM. For two-lane rural roadways, the average rate is 1.21 accidents per MVM.

Two of the 10 sections analyzed have accident rates above the statewide average. Both sections are on South Vasco Road between I-580 and Patterson Pass Road. The accident rates on the two sections within these limits are 2.48 and 2.43, about 114 and 111 percent, respectively, of the statewide rates. On these two sections, the roadway volumes are high, ranging from 26,200 vehicles per day to 30,000 vehicles per day. In the first section, the city of Livermore is planning to install traffic signals at Preston Road and improve the I-580 interchange, which should reduce the accident rate. In the next section to the south, traffic signals and street improvements have been made recently that should improve the rate.

The remaining eight roadway sections all have accident rates considerably below the statewide average, ranging from 6 percent to 40 percent of the statewide rates on the two- and three-lane sections, and from 18 percent to 28 percent in the four-lane divided sections.

Overall, the accident history near the Livermore Site is good, with 8 of the 10 sections analyzed having accident rates considerably below statewide averages, while 2 of the 10 sections had rates up to 14 percent higher than the statewide averages. The rates that are above the averages are either expected to be improved or are not considered to be significant.

4.13.4 Onsite Circulation and Parking

Livermore Site

Vehicle access to the Livermore Site is provided through five security gates and one shipping and receiving gate (Figure 4.13.4–1). The principal gate is on Westgate Drive from South Vasco Road. The Westgate Badge Office is also on Westgate Drive. Westgate Drive, having the highest volume, occasionally queues traffic into the intersection at South Vasco Road, causing congestion. In 2002, a traffic study was conducted when only four gates were operating. Data from that study indicated that Westgate Drive handled 36 percent of the traffic; 8,000 vehicles per day enter and exit (LLNL 2002be). The study also showed that, with the exception of the shipping and receiving gate from East Avenue, the least used gate is the Southwest Gate. The East Avenue gate had 18 percent of the traffic; 4,000 vehicles per day enter and exit. Total weekday traffic into the five gates in the 2002 study was approximately 22,000 vehicles. In late 2002, the Mesquite Gate from South Vasco Road was opened to provide the fifth access gate.

The Livermore Site and SNL/CA, through a shared initiative, are in the process of placing the section of East Avenue between South Vasco Road and Greenville Road under enhanced security control. The roadway is scheduled to be closed to public traffic and will become a Property Protection Security Area known as the East Avenue Corridor Property Protection Area, with guard kiosks at both ends and additional traffic lane modifications (DOE 2002i). The three original East Avenue gates will continue to provide secure access to the Livermore Site. A truck inspection station for deliveries will be constructed at the northwest corner of Greenville Road and East Avenue and will only be accessible from the Greenville Road intersection. This project is part of the No Action Alternative and is currently under construction.

Once vehicles enter the site, traffic flow is dominated by an inner and outer circular loop road system shown in Figure 4.13.4–1. Two roundabouts (traffic circles) facilitate flow of traffic into and out of the loops. The onsite transportation system is also characterized by roads and streets, meandering bike and pedestrian pathways, and parking lots. Even during peak traffic periods, traffic at the Livermore Site is light. In 1999, LLNL commissioned a study of onsite traffic to obtain recommendations for improvements in traffic flow (Korve 1999). Improvements in pavement markings, signage, lane widths and crosswalk locations and elimination of angle parking were suggested and are continually being implemented.

As of mid-2002, there were approximately 8,200 parking stalls at the Livermore Site to serve approximately 9,600 employees (i.e., LLNL employees, contract employees, DOE personnel, visitors with LLNL offices, and others, not including construction workers and consultants with sporadic presence). These stalls were provided in 73 designated institutional parking lots distributed across the Livermore Site and placed with a goal of limiting walking distance from vehicle to work location to 540 feet. Some of the parking lots have a surplus of stalls, and some have a deficit, but the overall parking stall supply and demand is approximately balanced for the site. Areas with a deficit of parking stalls adapt by employees parking in other areas, parking in non-institutional parking areas (e.g., unmarked areas around buildings controlled by building managers), and parking illegally. For some areas of the Livermore Site, parking presents a limitation on growth. The *Parking Master Plan and Parking Policy* (LLNL 2002bv) discusses parking issues and recommends mitigation measures.

The safety culture and transportation infrastructure at the Livermore Site have kept the traffic accident rate very low. The latest comprehensive study of traffic data covered the years 1992 to 1998 (Korve 1999). These data suggest that the full range of accidents typical of most urban areas occur in the Livermore Site, but that the rates are lower and the so-called preventable accidents are particularly low in number. The Traffic Safety Committee works closely with the Protective Force Division to review incident and violation reports to develop a better understanding of which locations might be considered hot spots.

Site 300

Access to Site 300 is through a single gate from Corral Hollow Road. Personal vehicles are only allowed in the parking area in the GSA just beyond the gate. Only government and contractor's company vehicles are allowed on Site 300 roads. The parking stall availability is adequate to meet demand. Traffic on Site 300 roads is extremely light.

4.13.5 Hazardous and Radiological Shipments

Livermore Site

LLNL ships approximately 4,000 containers per year of hazardous and radiological waste to approximately 50 different treatment, storage, or disposal facilities across the U.S. This results in about 200 separate shipments of hazardous waste, low-level waste, and mixed hazardous waste. Additionally, LLNL sends or receives approximately 300 shipments per year of hazardous or radioactive materials involved in the mission of LLNL.

The current shipment rate is approximately 22 low-level waste shipments per year to the Nevada Test Site near Las Vegas, Nevada, and 4 mixed low-level waste shipments per year to a mixed waste treatment facility in Kingston, Tennessee. In some cases, other destinations may be selected such as the Chem-Nuclear site in Barnwell, South Carolina, the DOE *Toxic Substances Control Act* (TSCA) incinerator in Oak Ridge, Tennessee, and the Envirocare facility near Clive, Utah. Transuranic waste shipments are expected to begin in 2004 with the shipment of approximately 1,000 drums that had accumulated while waiting for disposal capacity and waste characterization and packaging capability. This one-time campaign of approximately 24 shipments to the Waste Isolation Pilot Plant in Carlsbad, New Mexico, is the beginning of a smaller annual rate that will continue into the foreseeable future.

Radioactive materials are also shipped to and from the Livermore Site as part of its mission. These include plutonium metals and oxides, uranium metals and oxides, tritium, and other radioactive materials. Current annual shipments include approximately 11 shipments of special nuclear material (primarily plutonium and uranium), approximately 5 major shipments of tritium, and approximately 60 shipments of small amounts of miscellaneous radioactive material.

Radioactive wastes and materials are routinely transferred between Livermore Site facilities without leaving the boundaries of the site. These operational transfers have the potential to expose workers to direct radiation. Such radiation exposures are accounted for under facility operations as described in Section 4.16.2. In the event of an accident, the operational transfers also have the potential to release radioactivity to the public. LLNL has carefully examined onsite transfers of radioactive materials and has established engineered and administrative controls to minimize the impact and frequency of such accidents. Two documents describe the envelope within which operations must occur to meet safety objectives. The *Onsite Hazardous Material Packaging and Transportation Safety Manual* (LLNL 1996a) prescribes operational requirements for smaller quantity transfers. The *Nuclear Material Transportation Safety Manual* (LLNL 2003e) prescribes the requirements for the larger quantity transfers. Consequences of accidents for operational transfers are reported in Section 5.5.5.

Site 300

Most of the hazardous shipments to and from Site 300 are explosives shipments. Radiological shipments, such as those containing depleted uranium, are infrequent and contain little radioactivity. Approximately 200 explosives shipments arrive per year and 100 are sent per year. The outgoing shipments include explosive waste that cannot be treated at the Explosive Waste Treatment Facility at Site 300. These explosive wastes are currently shipped to a licensed facility in Louisiana but could be shipped to other locations. The shipment of explosive materials can be hazardous. LLNL has analyzed the hazards of explosives transport and prepared procedures for safe operations (LLNL 1996a). All onsite and Site 300 shipment operations are conducted within the bounds of the safety envelop established by that analysis. All offsite shipments are conducted in accordance with U.S. Department of Transportation regulations. There have been no explosions or fires resulting from accidents with explosive shipments.

4.13.6 Alternate Modes of Transportation

Livermore Site

As of June 2002, 87 percent of Livermore Site personnel commuted to work alone in personal vehicles. The remaining commuters traveled by carpool (3 percent), vanpool (3 percent), bicycle (1 percent), and public transit (4 percent) (LLNL 2001d). Because the Bay Area suffers from heavy traffic congestion, LLNL has established programs to help commuters find alternative means to get to work.

LLNL's Transportation Systems Management Program maintains a database that commuters can use to advertise for new riders or to find an appropriate carpool. There are approximately 300 carpools in use. LLNL provides preferential parking for those willing to use carpools. Similarly, there are approximately 30 vanpools. Vans are either leased or privately owned. A LLNL incentive program provides gasoline at reduced prices for vanpools.

Mass transit opportunities include the ACE, BART, Livermore Amador Valley Transit Authority, and commuter buses. ACE is a rail service between Stockton and San Jose, passing through Livermore, Pleasanton, and other points along the route. The LLNL taxi service provides free shuttle service between the ACE Train South Vasco Station and the Livermore Site. BART provides rapid transit rail service from San Francisco, Oakland, and other points in the Bay Area with a station in Pleasanton/Dublin. WHEELS is a service of the Livermore Amador Valley Transit Authority and provides public transportation for the Tri-Valley communities of Dublin, Livermore, and Pleasanton, with stops at the Livermore Site. Commuter buses from points in San

Joaquin and Contra Costa counties provide service directly to the Livermore Site. A shuttle van also runs between the Livermore Site and the University of California campus at Davis.

Site 300

The LLNL Transportation Systems Management Program provides services for setting up carpools and vanpools for employees of Site 300. There is neither public transportation nor LLNL shuttle service to Site 300.

4.13.7 Aircraft Operations

The Livermore Municipal Airport is located just south of I-580 at Airway Boulevard. The Airport occupies 400 acres and has been in operation at its existing location since 1965. The airport has approximately 570 based aircraft and 250,000 annual aircraft operations. LLNL leases aircraft for research and conducts research while on aircraft managed by others. The manned and unmanned aircraft fly in the Livermore Valley and around Site 300, as well as other sites outside of the area.

4.14 UTILITIES AND ENERGY

4.14.1 Water Consumption

Water consumption for the Livermore Site and Site 300 remained relatively constant from 1998 to 2002 (Figure 4.14.1–1). Water consumption at the Livermore Site averaged 214 million gallons over the 5-year period with a standard deviation of 5.5 million gallons. This standard deviation represents a 2.6 percent variation from the average. At Site 300, water consumption averaged 23.8 million gallons over the same 5-year period with a standard deviation of 1.5 million gallons. This standard deviation represents a 6.5 percent variation from the average. The annual average total consumption for both sites was 237.8 million gallons with a standard deviation of 6.8 million gallons. This standard deviation represents a 2.9 percent variation from the average.

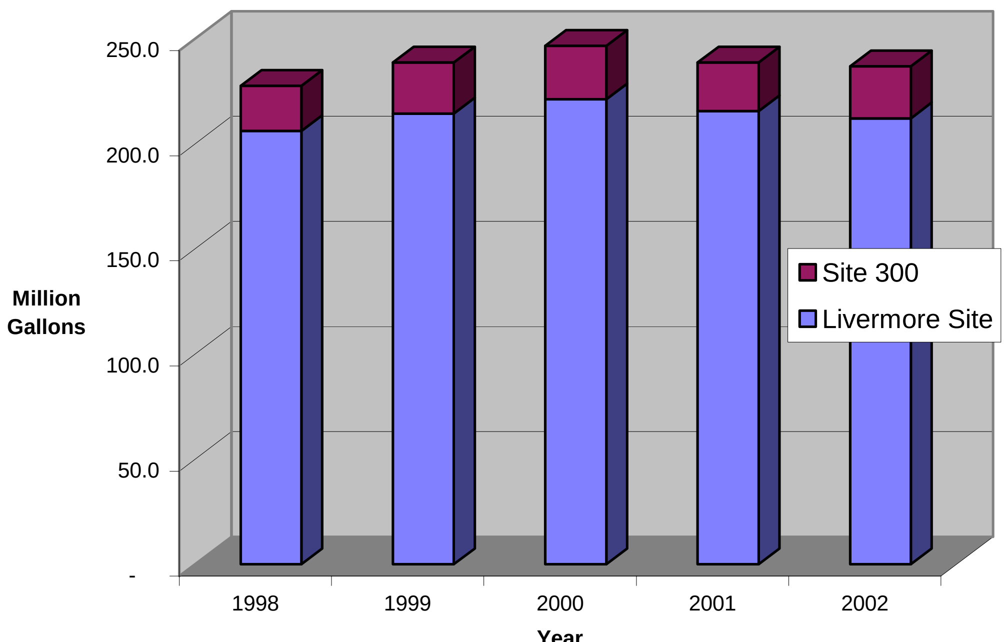


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FIGURE 4.14.1–1.—*Annual Water Consumption for the Livermore Site and Site 300, 1998 through 2002*

Livermore Site

Water for the Livermore Site is provided by three sources (DOE 2003b):

- The primary supply is from the city of San Francisco's Hetch Hetchy water system.
- A backup supply is available from Zone 7 of the Alameda County Flood Control and Water Conservation District.
- Cross-connections exist with the city of Livermore water line for fire protection through a mutual aid agreement (DOE 2003b).

Water consumption rates at the Livermore Site have decreased from an average of 261.8 million gallons per year in 1986, to 212 million gallons per year (581,000 gallons per day) in 2002 (LLNL 2003al, LLNL 2003ce). Currently, peak water usage is approximately 1.2 million gallons per day and is projected to increase to approximately 1.38 million gallons per day as the NIF (110,000 gallons per day) and the Terascale Simulation Facility (60,000 gallons per day) become operational. The capacity of the domestic water system is 2.88 million gallons per day (DOE 2003b).

Site 300

Site 300 is supplied with water from a system of wells. The existing capacity of usable wells is approximately 930,000 gallons per day. A project to connect Site 300 with water pumped from the city of San Francisco's Hetch Hetchy water supply system should be completed by early 2004. The capacity of this new system is estimated to be 648,000 gallons per day, with the capability of expanding to 1.2 million gallons per day (LLNL 2000a).

Site 300 consumed an average of 23.8 million gallons per year (67,900 gallons per day) from 1998 to 2002 (LLNL 2003aq, DOE 2003b). Water consumption rates at Site 300 have remained relatively constant during the past 5 years, but reflect a 22-percent decrease from the 31.8 million gallons per year reported in the 1992 SWEIS (LLNL 1992a).

4.14.2 Electricity Consumption

Electricity consumption for the Livermore Site and Site 300 has remained relatively flat from 1998 to 2000 (Figure 4.14.2–1). Electricity use at the Livermore Site decreased in 1999 and 2000, and increased in 2001 and 2002. Electricity consumption at Site 300 remained relatively constant during the same period.

Electricity consumption at the Livermore Site averaged 321 million kilowatt-hours per year over the 5-year period (1998 to 2002) with a standard deviation of 13.9 million kilowatt-hours. This standard deviation represents a 4.3 percent variation from the average. At Site 300, electricity consumption averaged 16.3 million kilowatt-hours per year over the same 5-year period with a standard deviation of 0.4 million kilowatt-hours. This standard deviation represents a 2.2-percent variation from the average. The total consumption for both sites was 337.3 million kilowatt-hours per year with a standard deviation of 13.8 million kilowatt-hours. This standard deviation represents a 4.1-percent variation from the average.

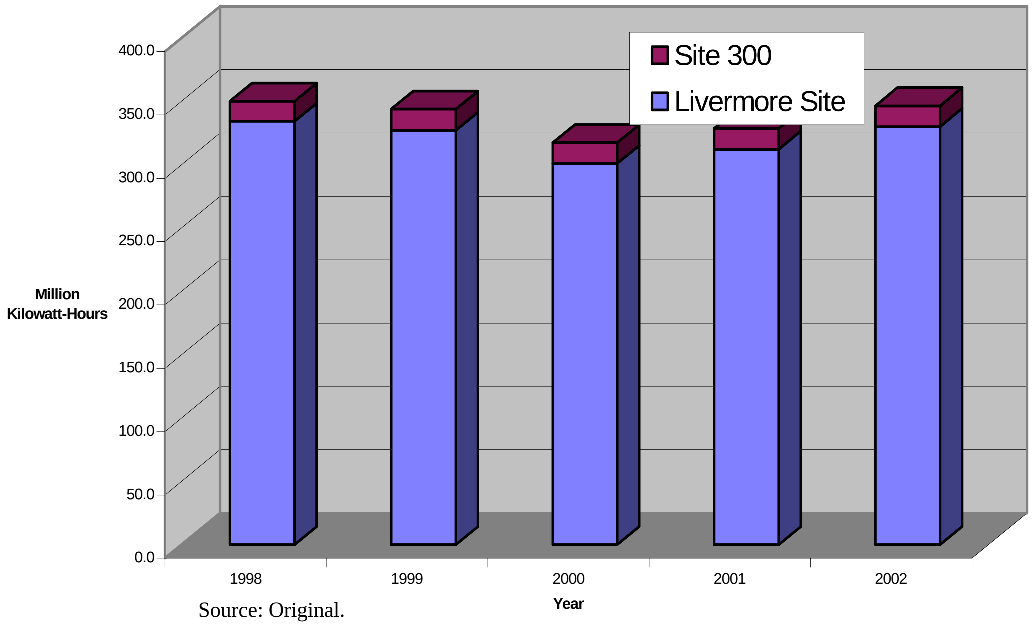

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FIGURE 4.14.2–1.—*Annual Electricity Consumption for the Livermore Site and Site 300, 1998 through 2002*

Livermore Site

Pacific Gas and Electric (PG&E) and the Western Area Power Administration supply electrical power to the Livermore Site. The electrical energy used at the Livermore Site is devoted almost entirely to the operation of office buildings and research laboratory facilities. Under DOE guideline definitions of "building" and "metered process," Livermore Site space is classified as approximately 50 percent "building" and 50 percent "metered process" load.

Electrical power usage at the Livermore Site declined from about 360 million kilowatt-hours per year in 1990 to about 330 million kilowatt-hours per year in 2002 (LLNL 2003ce). The peak electrical load at the Livermore Site was 57 megawatts in 2002 and is projected to increase to 82 megawatts as the NIF (approximately 12 megawatts), Terascale Simulation Facility (approximately 11 megawatts), and other site projects become operational (DOE 2003b).

Site 300

PG&E supplies electrical power to Site 300. From 1998 to 2002, Site 300 consumed an average of 16.3 million kilowatt-hours per year. Electricity consumption rates at Site 300 have remained stable over the past 5 years, but reflect a 24.9 percent decrease from the 1992 average of 21.75 million kilowatt-hours per year.

The electrical load at Site 300 averages 2.7 megawatts and is projected to increase to 2.8 megawatts as site improvements are completed (LLNL 2000a). The peak electrical load in 2002 was 3.4 megawatts (DOE 2003b).

4.14.3 Fuel Consumption

Livermore Site

Natural Gas

PG&E supplies natural gas to the Livermore Site by way of the meter station at the south end of Southgate drive. Natural gas is used mostly for comfort heating in the building category. In the metered process category, natural gas is used mostly for programmatic experiments and comfort heating. Continuing efforts to decrease energy use include modification to HVAC controls, the design of more efficient buildings, boiler tune-ups, and other site energy conservation efforts.

In 2002, annual natural gas consumption at the Livermore Site totaled 4.7 million therms (12,900 therms per day). Peak consumption in 2002 was 18,700 therms per day and is expected to increase to approximately 23,300 therms per day as the NIF and Terascale Simulation Facility become operational. Natural gas consumption rates at the Livermore Site have remained relatively constant during the past 5 years, but reflect a 27.3 percent increase from the 3.69 million therms per year reported in the 1992 LLNL EIS/EIR (LLNL 1992a). The current capacity of the natural gas system is 24,500 therms per day (DOE 2003b). One therm is equivalent to 100,000 British thermal units.

Diesel Fuel

Diesel fuel is used in vehicles and heavy equipment and for backup electric power generation in the building category. Diesel fuel use averages 72,200 gallons per year (LLNL 2003cf, LLNL 2003cg), a 16.7-percent decrease from the 1992 average of 86,600 gallons per year (LLNL 1992a).

Unleaded Gasoline

At the Livermore Site, unleaded gasoline use averages 451,800 gallons per year (LLNL 2003cf), a 9 percent decrease from the 1992 average of 496,200 gallons per year (LLNL 1992a).

Site 300

At Site 300, fuel oil is used mostly for backup electric power generation in the building category. In the metered process category, fuel oil is used for comfort heating and in some experiments.

Fuel oil consumption at Site 300 averages 16,600 gallons per year (LLNL 2003aq), a 79-percent decrease from the 1992 average of 78,100 gallons per year (LLNL 1992a). This substantial decrease in fuel oil consumption is primarily due to completion of HVAC retrofit and modernization projects.

4.14.4 Sewer Discharges

Livermore Site

The Livermore Water Reclamation Plant (LWRP) handles sewage from the Livermore Site. Sewage flows through two main laterals on the east and west sides of the site, combines in a flow-measuring flume near Building 196 (located at the northwest corner of the Livermore Site), then leaves the site and enters the city of Livermore's sewer system. The western lateral includes wastewater from SNL/CA. From 1998 to 2002, Livermore Site and SNL/CA daily flows averaged a total of 238,500 gallons per day (LLNL 2003l), with a peak of 626,330 gallons per day (DOE 2003b). The Livermore Site portion of the 5-year daily average is approximately 220,400 gallons per day (LLNL 2003al, DOE 2003b). LLNL maintains a sewer diversion facility to protect city of Livermore treatment facilities against accidental contamination. Up to 205,000 gallons of potentially contaminated sewage can be held pending analysis to determine the appropriate handling method (LLNL 2003b).

Sewer discharges at the Livermore Site have remained stable over the past 5 years with small variations in flow (Figure 4.14.4–1). In 2002, sewer discharges attributable to the Livermore Site averaged 216,400 gallons per day (LLNL 2003l). Most discharges to the sanitary sewer system at the Livermore Site are considered batch discharges, since they occur on a sporadic basis. Because these discharges occur randomly and as necessary, there is considerable variation both in the number of discharges per month and in the time of day of the discharges. One exception is the cleaning of cooling towers. Generally, each tower is emptied once a year. This usually occurs during the winter months, when demand on the towers is lower, and on weekends, when more capacity is available in the Livermore Site sewer system.

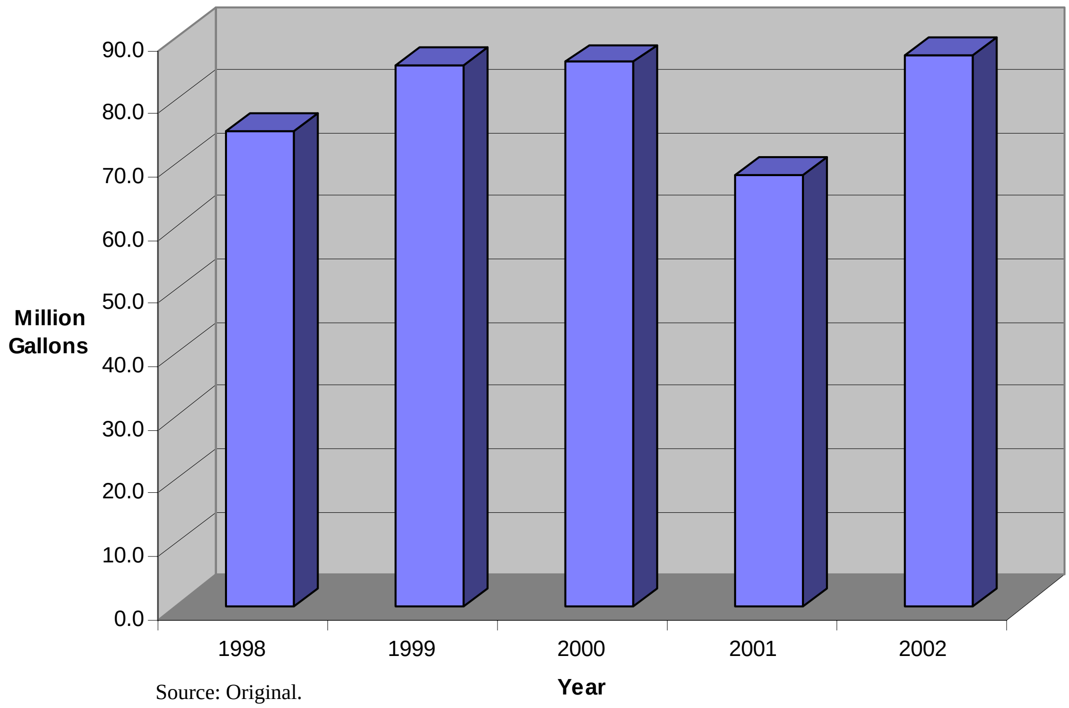

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FIGURE 4.14.4–1.—*Annual Sewer Discharges for the Livermore Site, 1998 through 2002*

There are four principal sources of large-volume batch discharges: air washes, cooling towers, boilers, and wastewater treatment/retention tanks. The amount of releases to the sanitary system varies substantially for each. These four principal sources of large-volume batch discharges are briefly discussed below (LLNL 2000z).

Air Washes

There are 26 building air washes, ranging in capacity from about 4 to 1,500 gallons. Each air wash is cleaned and the water is released to the sanitary sewer once a year at a rate of approximately 15 gallons per minute. Only one air wash is cleaned at a time (LLNL 2000z).

Cooling Towers

There are four active sets of cooling towers at the Livermore Site: three large sets located at U291, U325, and OS683; and one small set at Building 133. The large cooling tower complexes have capacities ranging from 20,000 to 252,000 gallons. The cooling towers are emptied and cleaned on a schedule that ranges from annually to every three years, depending on the tower. Only one tower is cleaned on a given day, and the flow is controlled to release at a rate that will not overflow the sewer-monitoring weir. Unlike other discharges, the cooling towers are generally emptied on weekends and on colder days. The maximum discharge occurs when the largest tower (U235) is cleaned; that discharge includes five cells, totaling approximately 150,000 gallons (LLNL 2000z).

In 1997, a sand filtration system consisting of three filters, each with a separate tank, was installed at the U291 cooling tower. The OS683 cooling tower also has a sand filtration system.

The sand filters are backwashed daily using cooling tower blowdown water. The sand filter backwash is discharged to the sanitary sewer (LLNL 2000z).

Boilers

There are 121 boilers on the Livermore Site: 23 are steam boilers and the remaining 98 are hot water boilers. Only the steam boilers have regular blowdown releases, and eight of the steam boilers have a continuous, rather than batch, blowdown. The remaining 15 steam boilers discharge approximately 5 to 10 gallons, 3 times per week, at a rate of 5 to 6 gallons per minute. Other than the eight continuous discharges, blowdown of the boilers is a manual procedure, and only one boiler is released at a time.

The steam boilers, which hold an average of approximately 1,500 gallons each, are emptied once a year for cleaning. The hot water boilers hold an average of 400 gallons each and are drained every two years (LLNL 2000z).

Wastewater Treatment/Retention Tanks

The Livermore Site has 33 wastewater retention systems, including the liquid waste treatment area and the sewer diversion facility (LLNL 2003l). Each of these systems contains sumps or tanks that can make releases to the sewer if concentrations of the constituents in the system meet discharge limitations; however, the contents of some of the retention systems are never released to the sewer. Most of the retained wastewater is generated at the Livermore Site, but some wastewater is received from Site 300 for treatment or discharge to the sanitary sewer or for disposal as a hazardous waste (LLNL 2000z).

When wastewater is discharged to the sewer system, it combines with other sewage from the Livermore Site and SNL/CA. The combined flow leaves the Livermore Site at Building 196, the Sewage Monitoring Station. The Livermore Site Sewage Monitoring Station is equipped with a continuous monitoring system designed to detect radiation, excessive pH, and metals. To protect the LWRP and to minimize any cleanup that might become necessary, the Livermore Site has an onsite sewage diversion and retention system. This system is capable of containing approximately 205,000 gallons of potentially contaminated sewage until analyses can be completed and appropriate handling methods are determined. This system would contain approximately 6 hours of total discharge from the SNL/CA and Livermore Site facilities. The system ensures that, if the alarm is triggered by the flow, all but the first few minutes of flow is retained at the Livermore Site for evaluation of appropriate treatment for disposal (LLNL 2003l). The city of Livermore has a holding basin into which releases can be diverted for further analysis and disposition. It takes approximately 3 hours for sewage to reach the LWRP from the Livermore Site sewage monitoring station; therefore, the city has adequate time to divert the flow if necessary (LLNL 2000z).

In addition to continuous monitoring of the effluent, sewer samples are collected from both the sewage monitoring station (Building 196) and the LWRP. Samples are analyzed daily for radioactivity and are composited monthly to determine the concentrations of specific isotopes (cesium-137 and plutonium-239) and various metals (LLNL 2000z). Samples are collected quarterly at the point of discharge of specified metal finishing and electrical and electronic component categorical processes to ensure compliance with wastewater discharge permit limits for those processes. LLNL experienced one permit exceedance from an elevated lead concentration in 2002. The concentrations of all other anions, metals, and organic compounds were well below their respective discharge limits (LLNL 2003l).

The LLNL 2002 Annual Environmental Monitoring Report reports that LLNL is in compliance with all regulations and guidelines governing releases of radioactivity to the sanitary sewer (LLNL 2003l). Since 1992, the concentrations of radionuclides in Livermore Site sewage have steadily declined. The 2002 annual average activity levels of radionuclides in wastewater were 2.3×10^{-5} picocuries per milliliter for cesium-137, 3.5×10^{-6} picocuries per milliliter for plutonium-239, and 0.068 picocuries per milliliter for tritium. A total of 0.02 curies of tritium were released in wastewater during 2002 by LLNL and SNL/CA, representing 0.4 percent of the 10 CFR Part 20 limit. The discharges of plutonium-239 and cesium-137 represented even smaller portions of their respective limits (LLNL 2003l).

Site 300

Site 300 sanitary sewage generated outside the GSA is disposed of through septic tanks and leachfields or cesspools at individual building locations. Sanitary sewage generated at the GSA is piped into an asphalt membrane-lined oxidation pond east of the GSA at an average rate of 2,100 gallons per day (LLNL 2000a).

Wastewater discharges from Site 300 are handled in a variety of ways. In the GSA, wastewater is treated and piped into an asphalt membrane-lined oxidation pond at an average rate of 2,100 gallons per day, with overflow to an evaporation-percolation pond. GSA sewage is domestic in nature. Sanitary sewage generated outside the GSA is disposed of through septic tanks and leach fields or cesspools at individual building locations (LLNL 2000a).

In the process and chemistry areas, industrial wastewater goes through a clarifier and weir system and is discharged to two Class II surface impoundments located south of Building 817. Wastewater from the chemistry buildings and photo lab rinsewaters are trucked to the clarifier/weir system for treatment prior to discharge into the surface impoundment. Explosive process waste from the machining area and pressing facility is plumbed directly to the treatment system (LLNL 2000a).

Cooling tower wastewater from various Site 300 operations is currently discharged in accordance with prescribed permit conditions to septic systems, the sewage evaporation and percolation ponds, engineered percolation systems, or in a manner that otherwise percolates into the ground. Wastewater from mechanical equipment, other than cooling towers, is discharged to septic systems, the sewage evaporation and percolation ponds, and engineered percolation systems. Wastewater generated at the contained firing facility is evaporated. Other industrial wastewater generated at Site 300 is stored in retention tanks, drummed, and hauled to the Livermore Site for reprocessing and/or disposal (LLNL 2000a).

4.14.5 Resource Conservation and Waste Minimization

Livermore Site and Site 300

Through implementation of DOE O 430.2A, DOE requires that LLNL attain the following energy usage goals:

- Reduce energy consumption per gross square foot for buildings through life-cycle cost-effective measures by 40 percent by 2005 and 45 percent by 2010, using a 1985 baseline.
- Reduce energy consumption per gross square foot (or other unit as applicable) for laboratory and industrial facilities through life-cycle cost-effective measures by 20 percent by 2005 and 30 percent by 2010, using a 1990 baseline.
- Increase the purchase of electricity from nonhydroelectric renewable energy sources by including provisions for such purchases as a component in all future DOE competitive solicitations for electricity. DOE will purchase 3 percent of its total electricity needs from nonhydroelectric renewable energy sources by 2005 and 7.5 percent of its total from nonhydroelectric renewable energy sources by 2010. Nonhydroelectric renewable energy is energy generated from solar, geothermal, biomass, or wind technologies.
- Increase the purchase of electricity from less greenhouse gas-intensive sources, including, but not limited to, new advanced technology fossil energy systems and other highly efficient generating technologies.
- Retrofit or replace all chillers greater than 150 tons of cooling capacity and manufactured before 1984 that use Class I refrigerant by 2005.
- Reduce greenhouse gas emissions attributed to facility energy use through life-cycle cost-effective measures by 25 percent by 2005 and 30 percent by 2010, using 1990 as a baseline. Greenhouse gas emissions are carbon dioxide emissions calculated from reported energy consumption.

To achieve these goals, the Energy Management Program performs studies and conducts surveys to identify opportunities for retrofit projects to reduce energy use at LLNL. In 2002, LLNL achieved a 23 percent reduction in energy use from 1990 levels.

NNSA has mandated that LLNL will attain the following waste reduction goals:

- Reduce hazardous waste from routine operations by 90 percent by 2005, using 1993 as a baseline.
- Reduce the amount of waste in all radioactive waste streams by 80 percent by 2005, using 1993 as a baseline.
- Reduce sanitary waste from routine operations by 75 percent by 2005 and 80 percent by 2010, using a 1993 baseline.

- Recycle 45 percent of sanitary wastes from all operations by 2005 and 50 percent by 2010.

- Reduce waste resulting from cleanup, stabilization, and decommissioning activities by 10 percent on an annual basis.

In 2002, LLNL generated approximately 5,800 metric tons of routine sanitary waste, a 1 percent reduction since 1993 (LLNL 2003l). However, LLNL diverted 4,000 metric tons, or 69 percent, of its sanitary waste for recycling or reuse. Additional details regarding waste reduction are provided in Appendix O, Pollution Prevention.

Beginning in 1988, LLNL began curtailing water use by implementing several water conservation measures. The following water use limitations and/or restrictions exist at LLNL:

- Reduce landscape watering to 35 percent below 1989 levels.

- Reduce blowdown in cooling towers to minimal operable levels.

- Use reclaimed groundwater in place of potable water in cooling towers to the greatest extent possible.

- Monitor all water use to discourage waste or unnecessary use.

4.15 MATERIALS AND WASTE MANAGEMENT

This section provides an overview of management responsibilities regarding receipt, transfer, and shipment of radioactive, controlled, and hazardous materials and wastes as well as mixed and medical wastes at LLNL. Additional supporting information and analyses, including descriptions of programs and buildings associated with use of these materials, are provided in Appendices A and B. The use of these materials historically has resulted in both their planned and inadvertent releases to the environment. The consequences of using radioactive, controlled, and hazardous materials are discussed in the sections associated with the affected media. For example, releases to the air associated with the use of radioactive materials are discussed in Section 4.10, and releases affecting vegetation are discussed in Section 4.9. The workplace use of these materials and associated occupational exposures are discussed in Section 4.16. Pollution prevention and waste minimization are discussed in Appendix O.

4.15.1 Materials

4.15.1.1 *Regulatory Setting*

LLNL's materials management operations are conducted pursuant to DOE orders and to various applicable Federal, state, and local laws and regulations. Regulatory oversight is vested among various Federal, state, and local agencies. Major laws, regulations, and orders are summarized in Table 4.15.1.1–1.

4.15.1.2 *Radioactive, Controlled, and Hazardous Materials Management*

Radionuclide Inventories

LLNL uses radioactive materials in a wide variety of operations including scientific and weapons R&D, diagnostic research, research on the properties of materials, and isotope separation. A list of Livermore Site selected facility inventories, approximate quantities, and status by radionuclide is provided in Table 4.15.1.2–1. Radioactive material quantity limits for Site 300 are included in Table 4.15.1.2–2. Based on facility design and operation, LLNL establishes administrative limits for fissile, special use, radioactive, and sealed materials. An administrative limit is the total amount of certain materials allowed in a specific building at LLNL. These limits are used in determining potential risks associated with accidents. For a discussion on accidents and materials at risk, see Section 5.5, Bounding Accident Scenarios. Actual inventories may be classified.

Chemical Inventories

Because of the wide variety of research activities performed at LLNL, the amounts and concentrations of chemicals maintained vary at any given time and from facility to facility. Most research operations use small quantities of a wide variety of chemicals; however, in some operations, chemicals are used in large quantities. In general, the following chemical types are used and stored at LLNL:

- Corrosives (acids and bases)
- Toxics (poisonous chemicals)
- Flammables and combustibles (solids, liquids, and gases)
- Reactives (materials that are inherently readily capable of detonation or becoming flammable at normal temperatures and pressures)
- Asphyxiants (physical asphyxiants are materials capable of physically displacing the volume of air in a given space; chemical asphyxiants are materials that inhibit oxygen transfer from blood tissues or within cells when breathed)
- Carcinogens (materials capable of inducing cancer)

The primary management strategy for the control and management of hazardous chemicals at LLNL is to prevent overexposures to hazardous substances in accordance with the requirements of 29 CFR Part 1910, Subpart Z. Procedures for chemical management at LLNL include personnel training, inventory control and monitoring, safety assessments, and handling. Additionally, standard operating procedures, operating procedures, and operating instructions are prepared for specific activities to establish safe procedures, barriers, controls, and safe work practices with regard to hazardous operations, including chemical use and storage.

As part of the chemical management strategy, LLNL maintains a centralized chemical inventory database, the ChemTrack system, for tracking hazardous and chemicals in primary (those containers shipped by the manufacturer). The ChemTrack system requires bar coding of chemical containers as they enter LLNL to allow container tracking and access to online chemical inventory data. The bar-coded chemical containers are tracked to provide location and usage information from arrival at LLNL through disposal of the container by the waste management program. LLNL links the bar-coded chemical containers to a location and a chemical custodian (a person[s] or organization); the material safety data sheets, if available; related chemical property and hazardous data; and regulatory information. The ChemTrack system serves as the chemical inventory resource used for meeting Federal *Emergency Planning and Community Right-to-Know Act* (EPCRA) reporting and California community right-to-know requirements.

In 2001, more than 166,000 chemical containers, ranging from 55-gallon drums to small-quantity vials, were in use or stored at LLNL (LLNL 2002cc). Table 4.15.1.2–3 presents a representative list of FY2001 hazardous chemicals at the Livermore Site. A detailed list of chemicals at the NIF is provided in Appendix M. A detailed list of chemicals at LLNL is provided in Appendix B.

A representative listing of chemical inventories in FY2001 for Site 300 is presented in Table 4.15.1.2–4. Site 300 operations generally require smaller chemical inventories than the Livermore Site due in part to fewer operations and programs. More details on chemical inventories at Site 300 are provided in Appendix B.

TABLE 4.15.1.2–4.—*Types of Hazardous Chemicals (Partial List[a]) in Use at Site 300*

Chemical	Chemical Abstract Number	Average Maximum/Average Quantity[b]
Paints/Solvents		
Paint (variety)	NA	7,200/1,200 lb
Thinner, lacquer	NA	310/95 gal
Methyl alcohol	67-56-1	90/5 gal
Acetone	67-64-1	400/30 gal
Metals		
Lead bricks or ingots	NA	25,000/25,000 lb
Acids/bases/oxidizers		
Oxygen, compressed	7782-44-7	16,000/5,000 ft^3
Sulfuric acid	7664-93-9	845/60 lb
Cyanuric acid	108-80-5	500/50 lb
Industrial Gases		
Argon, compressed	7440-37-1	30,000/30,000 ft^3
Helium	7440-59-7	25,000/25,000 ft^3
Hydrogen, compressed	1333-74-0	700/700 ft^3
Nitrogen, compressed (liquified, gaseous)	7727-37-9	312,000/280,000 ft^3
Carbon dioxide	124-38-9	44,000/5,000 ft^3
Refrigerants		
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	76-13-1	150/10 gal
Freon 22 (Chlorodifluoromethane)	75-45-6	1,400/870 lb
Freon 12 (Dichlorodifluoromethane)	75-71-8	660/220 lb
Freon 13 (Chlorotrifluoromethane)	75-72-9	478/478 ft^3
Freon 14 (Tetrafluoromethane)	75-73-0	2,000/500 ft^3
Explosives		
More than one type and class	NA	100,000/10,000 lb

Source: NNSA 2002c.
[a] For a comprehensive list covering other chemicals like chlorine, please refer to Appendix B.
[b] Represents average maximum and average quantity based on one or more buildings as reported in 2001 and 2002. The inventories represent a snapshot and are intended to give the reader an understanding of the variety and relative quantities of materials.
ft^3 = cubic feet ; gal = gallons; lb = pounds; NA = not available.

Explosive Materials

LLNL uses explosives in various R&D and test applications. Explosive quantities used per activity range from milligrams to several kilograms; however, for special test applications several hundred kilograms may be handled. Overall, the quantities of explosive material maintained onsite are restricted by the approved explosive capacity of various storage areas.

Site 300 is the primary laboratory location for explosives storage. This site is designated as a limited area accessible to approved personnel only. In 2001, 59 locations handled explosives. The explosives storage includes nearly 40 earth-covered explosive storage magazines, approximately 10 magazettes, and 1 packaging/receiving building. Other facilities include those for machining, assembling, pressing, testing, and firing explosives (see Appendix A). At the Livermore Site, the HEAF conducts explosive R&D (see Appendix A).

An explosives safety program is used to manage explosives at LLNL. The LLNL Explosives Safety Committee provides continual review, interpretation, and necessary revision to the explosives safety program. As part of its explosive material management strategy, LLNL uses facility-based explosives inventory systems to track and manage explosive inventories. The inventory systems maintain information on material composition, characteristics, and shipping requirements; life cycle cost information; plan of use; security and hazard classifications; and compatibility codes. When an explosive material is transferred (delivery or receipt), the system requires a safety check to ensure that the intended storage location can accept the type and quantity of material received. The facility-based inventory systems flag any storage capacity overages and incompatible explosive items.

Onsite Receipt and Distribution

LLNL classifies certain materials as controlled materials for environment, safety, and health (ES&H) protection, security, strategic importance, monetary value, or programmatic urgency reasons. Some of these materials are also classified as hazardous. Examples of controlled materials include explosives, radioactive materials, special nuclear materials, classified substances and parts, and precious metals.

All Category 3 hazardous materials and some Category 1 materials (see text box for category descriptions) shipped by commercial vendors or other DOE sites are received by the Receiving Section of the Materials Distribution Division (MDD), Procurement and Materiel Department. An exception is made when MDD and the ES&H Team Leader have reviewed and authorized a specific, direct delivery area. Direct delivery areas must meet established ES&H requirements that include both administrative and physical controls. Figure 4.15.1.2–1 illustrates conceptually how materials move at LLNL. Special arrangements are in place for industrial gases and 55-gallon chemical and solvent drums that are received at the Industrial Gas Yard by the Industrial Gases Section of MDD, Building 518.

Hazardous materials enter Site 300 through the Receiving Group of MDD; explosives and other controlled materials are delivered to and received by the Site 300 Controlled Materials Group of the Materials Management Section.

The Materials Management Section of the Mechanical Engineering Department receives Category 1 materials from vendors, the MDD, and other DOE sites. These include radioactive materials, accountable nuclear material, nuclear explosive-like assemblies, classified parts, and controlled or classified hazardous materials (e.g., some alkali metals and carcinogens). Fissile materials are sent only to the main Livermore Site through Materials Management, whereas explosives are sent only to Site 300 through Materials Management. The Materials Management Section, along with the requester, arranges for storage and transportation of these materials and delivers them to qualified end users.

The Industrial Gases Section of MDD ensures that the material received is properly packaged and secured. Bar codes are placed on each primary chemical container, which is then entered into the ChemTrack system at the time of receipt.

The Radioactive and Hazardous Waste Management (RHWM) Division of the EPD receives reusable hazardous materials (Chemical Exchange Warehouse, Figure 4.15.1.2–1) and hazardous waste, including hazardous waste generated from the use of Category 1 and 3 materials (some limitations apply). At the Chemical Exchange Warehouse, RHWM staff arranges for the reuse or temporary storage and/or transportation of such materials to RHWM treatment and storage facilities in accordance with LLNL guidelines and applicable RHWM operational procedures.

The Site 300 Controlled Materials Group (CMGRAMS) of the Materials Management Section (of the Mechanical Engineering Department) is responsible for packaging, marking, and labeling explosives shipments leaving Site 300 and the Livermore Site in a manner that complies with U.S. Department of Transportation (DOT), DOE, and LLNL standards. To ensure that the standards are observed, all explosives shipments to or from offsite locations are delivered in accordance with Document 21.2, “Onsite Hazardous Materials Packaging and Transportation Safety Manual” (LLNL 1996a) in the ES&H Manual. Controls for shipping and transporting explosives offsite are described in Document 21.4, “Shipping Explosives Offsite” (LLNL 2001h) in the ES&H Manual. All incoming explosive material is labeled and the transport is placarded DOT Division 1.1, 1.2, 1.3, 1.5, or 1.6 (see text box).

Explosive Materials

An explosive is any substance or article, including a device, which is designed to function by explosion or which, by chemical reaction within itself, is able to function in a similar manner even if not designed to function by explosion (unless the article is otherwise classified under a provision of 49 CFR).

Division 1.1 Explosives are explosives that have a mass explosion hazard. A mass explosion is one that affects almost the entire load instantaneously.

Division 1.2 Explosives are explosives that have a projection hazard, but not a mass explosion hazard.

Division 1.3 Explosives are explosives that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.

Division 1.4 Explosives are explosives that present a minor explosion hazard. The explosive effects are largely confined to the package and no projection of fragments of appreciable size or range would be expected. An external fire must not cause virtually instantaneous explosion of almost the entire contents of the package.

Division 1.5 Blasting Agents are very insensitive explosives. This division comprises substances that have a mass explosion hazard but are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions of transport.

Division 1.6 Explosives are extremely insensitive articles that do not have a mass explosion hazard. This division comprises articles that contain only extremely insensitive detonating substances and that demonstrate a negligible probability of accidental initiation or propagation.

Specific authorization and training are required to transport explosives. Transportation at each site requires individual authorization. Only CMGRAMS and Site 300 Procurement & Materiel Department MDD personnel may transport explosives offsite.

4.15.1.3 *Nonhazardous Materials*

The Central Stores, Building 411, is located in the southeast quadrant of the Livermore Site. This 69,505-gross-square-foot building is managed by the Procurement and Materiel Department and handles all onsite receiving and temporary storage and offsite shipment of materials to Site 300. Material deliveries (nonhazardous, hazardous, and radioactive) are received and sorted and then forwarded to the requesting program. Only standard (nonhazardous) supply items are placed in the storage area in Building 411, and program representatives may obtain needed material from Central Stores.

For Site 300, no central storage facility is currently in operation. Materials are shipped from the Livermore Site directly to the user facility at Site 300.

4.15.1.4 *Decontamination of Equipment and Facilities*

At LLNL, decontamination of equipment and facilities must be done in accordance with LLNL safety procedures that are based on DOE orders and other Federal and State of California laws and guidelines. It is also the policy of LLNL that decontamination of equipment must be managed in a safe manner to ensure the protection of employees.

Decontamination of equipment is done at the facility where the equipment is located, provided that no hazardous waste treatment is performed as part of this process. Equipment that cannot be decontaminated is reduced in size, if necessary, and disposed of through waste management procedures. Size reduction for large pieces of equipment (e.g., gloveboxes, pumps, machining tools, and tanks) contaminated with hazardous and/or mixed waste or hazardous chemical constituents can be done in Building 612. These pieces of equipment may be vacuumed, wiped down, or steam cleaned to remove residual contaminants. The equipment is then dismantled using a cutoff saw, or is taken apart with hand tools. Contaminated areas of equipment exposed during dismantling are vacuumed or wiped down. Equipment contaminated with transuranic (TRU) radionuclides, such as plutonium, is not decontaminated; when removed from service, the equipment is managed as TRU waste.

4.15.1.5 *Excess Properties Salvage and Reclamation*

LLNL follows a process for the disposal of excess equipment through a policy of making this property available for other needs at the site, to other Federal and state agencies, or for sale to reduce the cost of LLNL operations. The LLNL custodian is responsible for providing an explanation of the condition of the item on an excess equipment card and making arrangements for delivery of the items to storage, excess, or recycling.

The equipment custodian (with support from several organizations) is responsible for screening, reusing, and disposing of items declared excess to the needs of LLNL.

The excess and recycling operations use approximately 25,500 gross square feet of covered space.

4.15.2 Waste Management

This section describes the regulatory setting, waste generation, waste management practices, and treatment/storage facilities at LLNL and offsite disposal of waste. For a brief discussion on pollution prevention and waste minimization, see Section 4.14.5, with an expanded discussion in Appendix B. The waste generation rates (1993 to 2002) presented in this section represent actual data based on NNSA and LLNL records (see Appendix B). Because multiple organizations generate and manage waste at the two sites, with a high degree of integration, the term LLNL includes the Livermore Site and Site 300, unless otherwise specified. Further, because multiple organizations, including plant engineering; the Chemistry and Material Sciences Directorate; and the Safety and Environmental Protection Directorate, manage waste facilities at LLNL, the term RHWH includes all waste management facilities, unless otherwise specified.

Waste management activities consist of managing, treating, storing, and preparing for offsite disposal of all wastes in accordance with applicable Federal and state regulations, permits obtained under these regulations, and DOE orders. The waste categories routinely generated onsite under normal operations include radioactive waste (low-level waste [LLW], mixed low-level waste [MLLW], and TRU waste); hazardous waste, which includes *Resource Conservation and Recovery Act* (RCRA) hazardous (chemical and explosives) waste; state-regulated waste; TSCA waste (primarily asbestos, PCBs, and biohazardous [medical] waste); nonhazardous solid waste; and process wastewater. Figure 4.15.2–1 shows locations of the Decontamination and Waste Treatment Facility (DWTF) and other RHWM facilities.

Generally, wastes generated at individual buildings are accumulated at the point of generation in satellite accumulation areas. Generators, with support from RHWM staff, must segregate, identify, characterize, separate, package, label, document, and transfer waste to designated waste accumulation areas (LLNL 2002n). These wastes (with the exception of medical waste) are then transferred to waste accumulation areas where hazardous and mixed wastes may be stored for up to 90 days. Wastes are collected from waste accumulation areas or retention tanks by hazardous waste technicians. The wastes are either transferred to onsite waste management facilities for treatment, storage, and/or preparation for offsite disposal or to various offsite permitted treatment, storage, and disposal facilities. Some LLW and all TRU radioactive wastes are currently being stored awaiting shipment to the Nevada Test Site, the Waste Isolation Pilot Plant, or another DOE-approved facility for storage or disposal. LLNL legacy mixed wastes are being managed in accordance with the *Federal Facility Compliance Act* Site Treatment Plan. Medical wastes are typically collected at the generator facility before being treated onsite or shipped offsite for treatment and disposal.

Table 4.15.2–1 lists the waste management facilities at LLNL, including maximum inventory quantities. Table 4.15.2–1 includes information on the facility type and waste types managed. Most facilities manage both radioactive and hazardous wastes. However, certain facilities are restricted to only one waste type (for example the Explosive Waste Treatment Facility). The DWTF, Area 612, and Area 514 are the primary waste management facilities. Appendix B describes these facilities in detail.

Normal (Routine) Operations

The affected environment considered in this LLNL SW/SPEIS is limited to those facilities that generate waste under normal (routine) operations at LLNL. Normal operations encompass all current operations that are required to maintain R&D at LLNL facilities.

New Operations

Several new operations are currently in the planning stages at LLNL. However, they are considered outside of the scope of the current affected environment description for this LLNL SW/SPEIS because they have not yet reached operational status. New operations are defined as programmatically planned projects with defined implementation schedules that will take place in the future. Two facilities, the NIF and BioSafety Level (BSL)-3 Laboratory, are examples of these new operations and have had separate NEPA evaluations.

Special (Nonroutine) Projects

Special (nonroutine) projects are limited-duration projects, such as construction, that are considered separately from facility operations. These projects can make a large contribution to the overall waste generation activities at LLNL. Three areas are considered special projects: construction, decontamination and decommissioning (D&D), and environmental restoration. The wastes generated from these areas are identified as nonroutine. Typically, the projects are well defined to allow waste management activities to directly support the project.

For several years, excess facility management activities have been underway to remove legacy facilities, material, and equipment from the site. This effort has removed over 260,000 square feet of facility space (DOE 2002d). One hundred and sixty-one buildings, accounting for approximately 700,000 gross square feet (an estimated 46,000 tons of construction debris), are potentially scheduled for removal. As much as 99 percent of the construction debris would be diverted wastes and recoverable assets (LLNL 2003bd). Future space reduction at LLNL will focus on buildings that are beyond their useful lives. These buildings will become vacant after new buildings are built. Twenty-three buildings, accounting for 53,500 gross square feet, are categorized as being in poor condition, beyond their useful life (DOE 2002d).

Waste Categories

Low-Level Waste (LLW)—LLW is waste that contains radioactivity and is not classified as high-level waste, TRU waste, or spent nuclear fuel or byproduct tailings containing uranium or thorium from processed ore (as defined in Section 11[e][2] of the *Atomic Energy Act* [42 U.S.C. §2011]). Test specimens of fissionable material, irradiated for research and development only and not for the production of power or plutonium, may be classified as LLW, if the concentration of transuranic is less than 100 nanocuries per gram.

Mixed Low-Level Waste (MLLW)—MMLW is waste that contains both hazardous waste, regulated under RCRA, and low-level waste.

Transuranic Waste (TRU)— TRU waste is waste containing more than 100 nanocuries of alpha-emitting TRU isotopes per gram of waste, with a half-life greater than 20 years, except for high-level radioactive waste. TRU waste is waste that the DOE Secretary has determined, with concurrence of the Administrator of EPA, does not need the degree of isolation required by the disposal regulations or waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61.

Mixed Transuranic Waste (Mixed TRU)—Mixed TRU waste contains both hazardous wastes, regulated under the RCRA, and TRU waste.

RCRA Hazardous Waste—RCRA hazardous waste is any solid waste (definition includes semisolid, liquid, or gaseous material) listed in Subpart D of 40 CFR Part 261 or having the characteristics of ignitability, corrosivity, toxicity, or reactivity, as defined by RCRA.

LLNL Hazardous Waste—LLNL hazardous waste includes RCRA hazardous waste, state-regulated waste, TSCA waste, and biohazardous waste.

TSCA Waste—TSCA waste contains materials exceeding identified limits in TSCA. LLNL manages two TSCA-regulated materials: PCBs and asbestos.

Sanitary Solid Waste—Sanitary solid waste includes nonhazardous office and laboratory trash.

Building debris estimates associated with D&D projects are included in the assessments of the waste generated from existing operations (potentially 53,000 tons of debris). However, separate NEPA review may be required in the future depending on the scale and extent of the work involved.

This LLNL SW/SPEIS considers environmental restoration activities as nonroutine operations due in part to the fluctuation of year-to-year waste quantities. To comply with CERCLA groundwater remedial actions at the Livermore Site, Environmental Restoration Division (ERD) has designed, constructed, and operated 5 fixed groundwater treatment facilities and associated pipeline networks and wells, 20 portable groundwater treatment units, 2 catalytic dehalogenation units, and 3 soil vapor extraction facilities (see Appendix B), to date. In 2001, ERD operated 4 fixed, 19 portable, 2 catalytic reductive dehalogenation, and 2 soil vapor treatment units. ERD also installed an electro-osmosis system to improve its ability to remove contaminants from fine-grained sediments.

At Site 300, ERD has designed, constructed, and operated 3 soil vapor extraction facilities and 11 groundwater extraction and treatment facilities. In addition, ERD has capped and closed four landfills and the High Explosives Rinse Water Lagoons and Burn Pits, excavated and closed numerous wastewater disposal sumps, and removed contaminated waste and soil to prevent further impacts to groundwater at Site 300.

The environmental restoration program also generates soil, personal protective equipment, and sampling tools during soil boring, well installation, equipment maintenance (filters, pumps, tubing), and trenching activities. The quantities of waste generated are highly variable depending on the purpose of the activity. The quantities are characterized within the nonroutine quantities presented in Section 4.15.2.2.

4.15.2.1 *Regulatory Setting*

Management of hazardous, radioactive, mixed, and medical wastes generated at LLNL is pursuant to applicable DOE orders and Federal, state, and local laws and regulations. LLNL waste management programs implement site-wide plans and operating practices to comply with permits and other regulatory requirements. LLNL operates under three RCRA Part B permits (one for the Livermore Site and two for Site 300). Inspections and findings of the Livermore Site and Site 300 by external agencies in 2001 are listed in Table 4.15.2.1–1. A summary of permitting activities is presented in Table 4.15.2.1–2. Major laws, regulations, and orders are summarized in Table 4.15.2.1–3.

TABLE 4.15.2.1–3.—*Summary of Major Laws, Regulations, and Orders Relevant to Waste Management*

Laws, Regulations, and Orders	Description
Solid Waste Disposal Act of 1976 (42 U.S.C. §6902)	This Act regulates the management of solid waste. Solid waste is broadly defined to include any garbage, refuse, sludge, or other discarded material including solid, liquid, semisolid, or contained gaseous materials resulting from requirements and controls for transport, test procedures, and administrative requirements. Schedules include industrial, commercial, mining, or agricultural activities. Source-special nuclear or by-product material, as defined by the *Atomic Energy Act* (AEA), is specifically excluded as solid waste.
Resource Conservation and Recovery Act of 1976 (42 U.S.C. §6901)	This Act amends the *Solid Waste Disposal Act* and establishes requirements and procedures for the management of hazardous wastes. As amended by the *Hazardous and Solid Waste Amendments* of 1984 (HSWA), RCRA defines hazardous wastes that are subject to regulation and sets standards for generation, treatment, storage, and disposal facilities. The HSWA emphasize reducing the volume and toxicity of hazardous waste. They also establish permitting and corrective action requirements for RCRA-regulated facilities. RCRA was also amended by the *Federal Facilities Compliance Act* (FFCA) in 1992. It requires EPA, or a state with delegated authority, to issue an order for compliance. A Federal facilities compliance order was issued by the Cal-EPA, requiring DOE and LLNL to comply with the FFCA. Compliance with the order is achieved through Site Treatment Plans prepared by DOE.
Underground Storage Tanks (42 U.S.C. §6901, Subtitle I)	Underground storage tanks (USTs) are regulated as a separate program under RCRA, which establishes regulatory requirements for USTs containing hazardous or petroleum materials. Cal-EPA has been delegated authority for regulating LLNL.
Federal Facility Compliance Act of 1992 (42 U.S.C. §6961)	This 1992 Act waives sovereign immunity from fines and penalties for RCRA violations at Federal facilities. However, it postponed the waiver for three years for storage prohibition violations with regard to land disposal restrictions for DOE's mixed wastes. It required DOE to prepare plans for developing the required treatment capacity for each site at which it stores or generates mixed waste. The state or U.S. EPA must approve each plan (referred to as a Site Treatment Plan) after consultation with other affected states, consideration of public comments, and issuance of an order by the regulatory agency requiring compliance with the plan. The Act further provides that DOE will not be subject to fines and penalties for storage prohibition violations for mixed waste as long as it complies with an existing agreement, order, or permit. The FFCA requires that Site Treatment Plans contain schedules for developing treatment capacity for mixed waste for which identified technologies exist. DOE must provide schedules for identifying and developing technologies for mixed waste without an identified existing treatment technology. A Federal Facility Compliance Order was signed in 1997 to address treatment prior to disposal of mixed waste, as well as characterization and disposal of mixed TRU waste.
Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as Amended (42 U.S.C. §9601, et seq.)	This Act, commonly referred to as the CERCLA, or Superfund, establishes liability standards and governmental response authorization to address the release of a hazardous substance or contaminant into the environment. EPA is the regulating authority for the Act. CERCLA was amended by the *Superfund Amendments and Restoration Act* (SARA) in 1986. SARA Title III establishes additional requirements for emergency planning and reporting of hazardous substance releases. These requirements are also known as the *Emergency Planning and Community Right-to-Know Act* (EPCRA), which, due to its unique requirements is discussed separately below. SARA also created liability for damages to or loss of natural resources resulting from releases into the environment and required the designation of Federal and state officials to act as public trustees for natural resources. LLNL is subject to, and required to report releases to the environment under the notification requirements in 40 CFR Part 302 (Designation, Reportable Quantities, and Notification) and EPCRA, as applicable. Pursuant to CERCLA, Section 120, DOE signed a Federal Facility Agreement for LLNL in 1989.

TABLE 4.15.2.1–3.—*Summary of Major Laws, Regulations, and Orders Relevant to Waste Management (continued)*

Laws, Regulations, and Orders	Description
Pollution Prevention Act of 1990 (42 U.S.C. §13101)	This Act sets the national policy for waste management and pollution control that focuses first on source reduction, followed sequentially by environmentally safe recycling, treatment, and disposal. In response, DOE committed to voluntary participation in EPA's 33/50 Pollution Prevention Program, as set forth in Section 313 of SARA.
Toxic Substances Control Act of 1977 (15 U.S.C. §2601)	TSCA, unlike other statutes that regulate chemicals and their risk after they have been introduced into the environment, was intended to require testing and risk assessment before a chemical is introduced into commerce. It also establishes record-keeping and reporting requirements for new information regarding adverse health and environmental effects of chemicals. The Act governs the manufacture, use, storage, handling, and disposal of PCBs; sets standards for cleaning up PCB spills; and establishes standards and requirements for asbestos identification and abatement in schools. It is administered by EPA. Because LLNL's R&D activities are not related to the manufacture of new chemicals, PCBs are LLNL's main concern under the Act. Activities at LLNL that involve PCBs include, but are not limited to, management and use of authorized PCB-containing equipment, such as transformers and capacitors; management and disposal of substances containing PCBs (dielectric fluids, contaminated solvents, oils, waste oils, heat transfer fluids, hydraulic fluids, paints, slurries, dredge spoils, and soils); and management and disposal of materials or equipment contaminated with PCBs as a result of spills. At LLNL, PCB-contaminated wastes are transported offsite for treatment and disposal unless they also have a radioactive component. Nonradioactive wastes containing PCBs are disposed of at an offsite facility that has been approved by EPA for such disposal (provided that strict requirements are met with respect to notification, reporting, record-keeping, operating conditions, environmental monitoring, packaging, and types of wastes disposed). Radioactive PCB waste, typically known as mixed TRU waste or mixed waste, is currently stored at one of LLNL's hazardous waste storage facilities until the Waste Isolation Pilot Project, or other approved facility, accepts this waste for final disposal. LLNL conducts asbestos abatement projects in accordance with OSHA requirements (29 CFR Part 1926), applicable requirements of the *Clean Air Act* and the California Solid Waste Management Regulations.
EO 13148, "Greening the Government through Leadership in Environmental Management"	This EO directs all Federal agencies to develop and implement environmental management systems to support environmental compliance; right-to-know and pollution prevention; reducing toxic chemical releases; reducing use of toxic chemicals, hazardous substances, and other pollutants; reducing ozone-depleting substances; and promoting environmentally and economically beneficial landscaping.
Atomic Energy Act	The AEA of 1954 makes the Federal government responsible for regulatory control of the production, possession, and use of three types of radioactive material: source, special nuclear, and byproduct (includes waste). Regulations promulgated by the U.S. Nuclear Regulatory Commission (NRC) under the AEA establish standards for the management of these radioactive materials (including waste).
Hazardous Waste Control Act (California Health and Safety Code § 25100 et seq.)	This act is the state authorization to implement the state hazardous waste programs pursuant to RCRA.
Hazardous Waste Reduction Act (California Health and Safety Code § 25244.12-25)	This act expands the State of California's hazardous waste source reduction activities to accelerate reduction in hazardous waste generation.

TABLE 4.15.2.1–3.—*Summary of Major Laws, Regulations, and Orders Relevant to Waste Management (continued)*

Laws, Regulations, and Orders	Description
Medical Waste Management Act (California Health and Safety Code § 117600-11860)	The *Medical Waste Management Act* establishes a comprehensive program for regulating the management, transport, and treatment of medical wastes that contain substances that may potentially infect humans.
40 CFR Part 260 Series	The implementing regulations established by EPA governing hazardous waste.
Title 22 CCR Division 4.5	The implementing regulations established by Cal-EPA for management of hazardous waste.
DOE O 435.1, "Radioactive Waste Management"	DOE O 435.1 establishes the policies, guidelines, and minimum requirements by which DOE and its contractors manage radioactive waste, mixed waste, and contaminated facilities. This order establishes DOE policy that radioactive and mixed wastes be managed in a manner that ensures protection of the health and safety of the public, DOE, contractor employees, and the environment. In addition, the generation, treatment, storage, transportation, and disposal of radioactive wastes, and the other pollutants or hazardous substances they contain, must be accomplished in a manner that minimizes the generation of such wastes across program office functions and complies with all applicable Federal, state, and local environmental, safety, and health laws and regulations and DOE requirements.
DOE O 450.1, "Environmental Protection Program"	This order directs facilities to implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by DOE operations and by which DOE cost-effectively meets or exceeds compliance with applicable environmental, public health, and resource protection laws, regulations, and DOE requirements.

Source: LLNL 2002cc.

4.15.2.2 *Radioactive Waste*

Radioactive waste generated at LLNL includes LLW, MLLW, TRU waste, and mixed TRU waste. LLNL does not manage or generate high-level waste (a highly radioactive material that results from the reprocessing of spent nuclear fuel). LLW, MLLW, and TRU waste are produced primarily in laboratory experiments and component tests. Mixed wastes are discussed in Section 4.15.2.4. See Appendix B for a detailed description of radioactive waste, storage quantities, and treatment quantities.

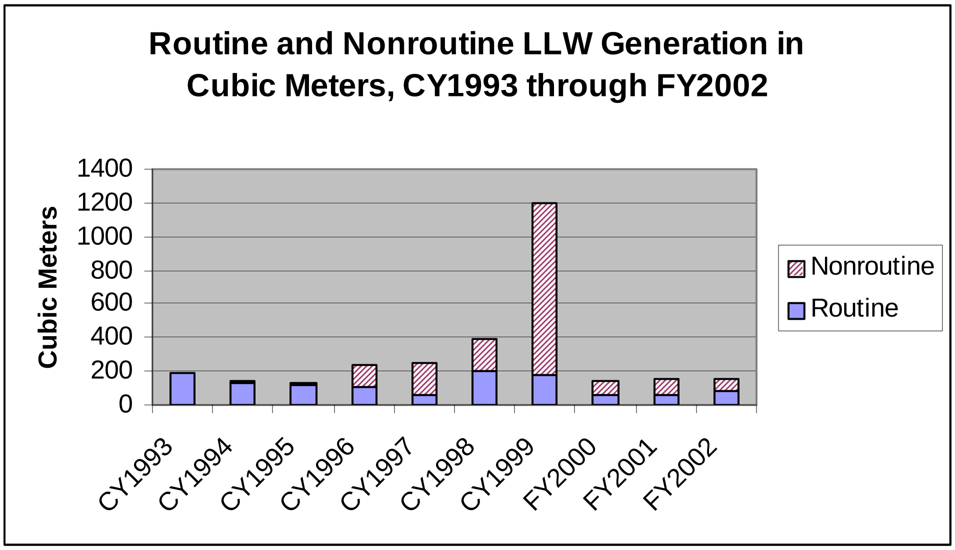
DOE O 435.1 permits onsite storage of LLW and TRU wastes until appropriate disposal becomes available. Currently, there are no regulatory restrictions on the length of time this waste may be stored onsite, provided that disposal or offsite storage options are being pursued and the waste is stored in accordance with all applicable regulations. LLNL maintains the capability to treat solid radioactive wastes onsite. LLNL has treated liquid radioactive wastes at the Area 514 Tank Farm. The DWTF is replacing Area 514 (LLNL 2002ca). LLNL disposes of solid LLW offsite at the Nevada Test Site. Available storage space for LLW and TRU waste is limited by exposure considerations (i.e., radiation exposure to personnel) at a given storage location. However, radioactive wastes, unlike RCRA-regulated wastes, can be stored at various locations onsite provided that the wastes are properly packaged, labeled, and monitored. Radioactive waste management facilities are listed in Table 4.15.2–1.

As part of the effort to minimize the total quantity of radioactive waste that is generated at LLNL, facilities that generate this type of waste are designated as a Radioactive Materials

Management Area (RMMA). An RMMA is an area where a reasonable potential exists for contamination due to the presence of unconfined or unencapsulated radioactive material or an area that is exposed to sources of radioactive particles (such as neutrons and protons) capable of causing activation. Managers of facilities must document the location of all RMMAs. Procedures to minimize the generation of radioactive wastes are then developed.

Historic and Current Radioactive Waste Generation

Radioactive waste has historically been generated from R&D activities that used radioactive materials. Figure 4.15.2.2–1 summarizes historic routine and nonroutine LLW quantities generated onsite from calendar years (CYs) 1993 through fiscal year (FY) 2002. Annual routine TRU waste generation ranged from 0 to 12 cubic meters. Annual nonroutine TRU waste was 0 cubic meters, with the exception of 10 cubic meters in 1995.



Source: DOE 2002s.

FIGURE 4.15.2.2–1.—*Routine and Nonroutine Waste Generation*

4.15.2.3 *Hazardous Waste*

Hazardous waste refers specifically to nonradioactive waste, including RCRA chemical and explosives waste, state-regulated hazardous waste, biohazardous (for this document medical is included) waste, and TSCA waste (primarily asbestos and PCBs). Almost all buildings at LLNL generate hazardous wastes, ranging from common household items such as fluorescent light bulbs, batteries, and lead-based paint to solvents, metals, cyanides, toxic organics, pesticides, asbestos, and PCBs.

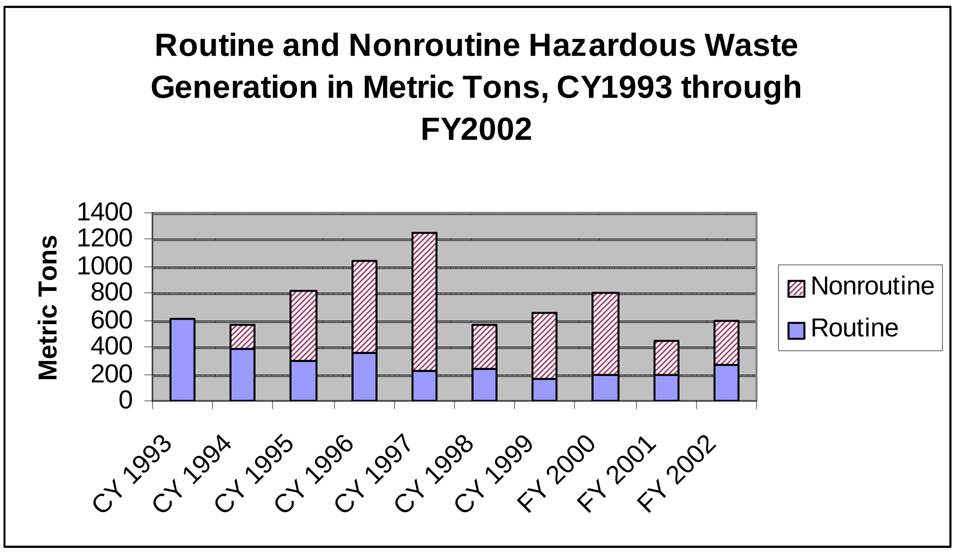
RCRA allows onsite management of hazardous waste at the point of generation or in designated waste accumulation areas or storage in permitted storage facilities. There are regulatory restrictions on the length of time that waste may be stored onsite and it must be stored in accordance with all applicable regulations. LLNL does maintain the capability to treat certain hazardous wastes onsite. LLNL treats explosive wastes at Site 300. Except for empty-container crushing, hazardous wastes are usually not treated before offsite shipment to a licensed treatment, storage, and disposal facility. Hazardous wastes are shipped offsite through licensed commercial transporters to various permitted treatment, storage, and disposal facilities. See Appendix B for a more detailed description of hazardous waste-related topics.

Historic and Current Hazardous Waste Generation

The hazardous waste generated at LLNL is predominantly chemical laboratory trash generated from experiments, tests, other R&D activities, and infrastructure fabrication and maintenance. Figure 4.15.2.3–1 illustrates the quantities of routine and nonroutine hazardous waste generated for all operations from CY1993 through FY2001. From CY1993 to FY2002, annual total (routine plus nonroutine) RCRA hazardous waste generation ranged from 126 to 514 metric tons. During the same period, total annual state-regulated and total annual TSCA waste ranged from 155 to 723 metric tons and 9 to 515 metric tons, respectively.

Explosive Waste

The explosive waste generated at LLNL ranges from explosives and analytical chemicals to wastewater contaminated with explosives. In 2002, 6,000 pounds of explosive waste were managed. Waste explosives are treated at the EWTF (approximately 2,700 pounds in 2002). For further details, see Appendix B.

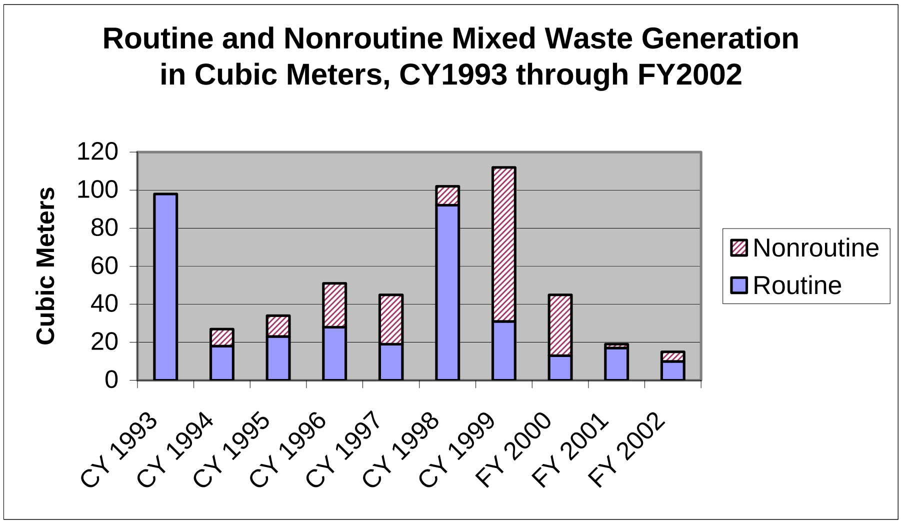


Source: DOE 2002s.

FIGURE 4.15.2.3–1.—*Routine and Nonroutine Hazardous Waste Generation*

4.15.2.4 *Mixed Wastes*

MLLW and mixed TRU waste are produced primarily in laboratory experiments and component tests. Figure 4.15.2.4–1 illustrates the quantities of MLLW generated from CY1993 through FY2002. Mixed TSCA waste is produced primarily during D&D and environmental restoration activities. Most years, LLNL does not generate mixed TRU and mixed TSCA waste; however, one or more metric tons are possible in any given year.



Source: DOE 2002s.

FIGURE 4.15.2.4–1.—*Routine and Nonroutine Mixed Waste Generation*

LLNL does not maintain the capability to treat or dispose of solid mixed wastes onsite. In the past, LLNL treated liquid mixed wastes at the Area 514 Tank Farm (LLNL 2002p). The DWTF is designed to replace Area 514. LLNL treats and disposes MLLW offsite under the Federal Facility Compliance Order issued to DOE and requires DOE to direct the University of California, Davis (current operator), to comply fully (LLNL 2002cc, DOE 1997g). LLNL is continuing to work with DOE to maintain compliance with the *Federal Facilities Compliance Act* Site Treatment Plan (STP) for LLNL that was signed in February 1997 (DOE 1997g). All milestones for 2001 were completed on time. Reports and certification letters were submitted to DOE as required. An agreement was reached with DTSC to extend all FY2002 and FY2003 milestones to allow LLNL to concentrate resources on characterizing and disposing of mixed TRU waste. LLNL continued to pursue the use of commercial treatment and disposal facilities that are permitted to accept mixed waste. These facilities provide LLNL greater flexibility in pursuing the goals and milestones set forth in the Site Treatment Plan.

4.15.2.5 *Biohazardous Wastes*

Division 104, Part 14, Sections 117600-118360 of the California Health and Safety Code is known as the *California Medical Waste Management Act*. This Act is a comprehensive program for regulating the management, transport, and treatment of medical wastes. The California Department of Health Services (known as DHS) administers the *California Medical Waste Management Act* and has given authority to Alameda County Health Care Services Agency to oversee LLNL's medical waste management practices.

The Livermore Site is considered a large-quantity generator of medical waste, which means that 200 or more pounds of medical waste are generated in any month of a 12-month period. Therefore, the Livermore Site is subject to annual inspections conducted by Alameda County, annual waste generator/treatment permit fees, and maintenance of the Medical Waste Management Plan that contains emergency plans for each program at LLNL that generates and treats medical waste.

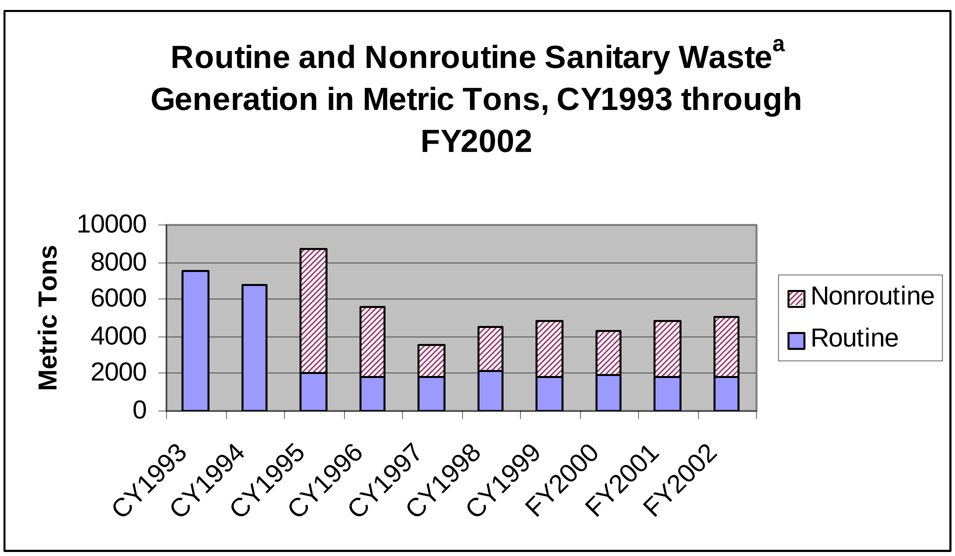
Medical waste plus hazardous waste is designated as hazardous waste and is subject to regulation as specified in the statutes and regulations applicable to hazardous waste. Medical waste plus radioactive waste is designated as radioactive waste and is subject to regulation as specified in the statutes and regulations applicable to radioactive waste.

Site 300 is considered a small-quantity generator of medical waste, which means that less than 200 pounds of medical waste is generated per month. Therefore, Site 300 is not subject to medical waste generator and treatment permit fees and is not subject to annual inspections by San Joaquin County. Site 300 does, however, submit a minimal annual fee for a Limited Quantity Hauling Exemption, which allows registered LLNL haulers to transport medical waste generated at Site 300 to the Livermore Site for waste consolidation prior to offsite shipment.

4.15.2.6 *Other Wastes*

Sanitary Solid Waste

Routine sanitary solid waste consists predominantly of office and laboratory nonhazardous trash. Nonroutine sanitary solid waste consists predominately of nonhazardous building debris generated from major construction and D&D activities. All solid waste from the Livermore Site is currently disposed of at the Altamont Landfill in Livermore, California or diverted for recycling (see Appendix O). The Altamont Landfill has a remaining capacity of approximately 15 million cubic yards (over 10 years) (CIWMB 2002). There are two active landfills in San Joaquin County that have over 10 years of capacity. Figure 4.15.2.6–1 summarizes historic sanitary solid waste quantities generated onsite from CY1993 through FY2002 showing portions of routine and nonroutine generated each year with the exception of CY1993 and CY1994. In FY2001 and FY2002, LLNL generated 1,900 and 1,800 metric tons of routine sanitary waste each year and 3,000 and 3,300 metric tons of nonroutine sanitary waste, respectively (DOE 2002s).



Source: DOE 2002s.
[a] Nonroutine quantities included in routine total for CY1993 and CY1994.

FIGURE 4.15.2.6–1.—*Sanitary Waste Generation in Metric Tons*

Environmental Restoration Wastes

For a discussion of onsite contamination, placement on the National Priorities List (NPL), and the nature and extent of contamination, see Section 4.17. A general discussion of treatment is provided below.

Current activities include 30 treatment facilities; there are 28 groundwater treatment facilities and 2 vapor treatment facilities. Eighty-four groundwater extraction wells operated at an average flow rate of 2,540 liters per minute. Two vapor extraction wells operated at an average flow rate of 0.27 cubic meters per minute. Table 4.15.2.6–1 presents the treatment area and VOCs removed from groundwater and soil at the Livermore Site. Table 4.15.2.6–2 summarizes FY2002 and cumulative totals of volumes and masses of contaminants removed from groundwater and soil vapor at Site 300.

Other environmental restoration wastes (soil, personal protective equipment, sampling tools) are rolled into nonroutine radioactive, hazardous, and sanitary solid waste categories previously discussed.

TABLE 4.15.2.6–1.—*Volatile Organic Compounds Removed From Groundwater and Soil at the Livermore Site*

		2002		Cumulative Total	
Treatment Area	**Startup Date**	**Water Treated (million liters)**	**VOCs Removed (kilograms)**	**Water Treated (million liters)**	**VOCs Removed (kilograms)**
TFA	1989	251.4	5.7	3,658	154
TFB	1990	130.2	6.1	787	54.2
TFC	1993	107.9	7.1	595	53.9
TFD	1994	281.3	68.4	1,505	500
TFE	1996	110.5	17.5	544	139
TFG	1996	12.1	0.7	70.4	3.7
TF406	1996	40.5	1.0	211	7.7
TF518	1998	4.9	0.6	37.1	4.3
TF5475	1998	0.72	0.7	2.3	4.8
		Soil Vapor Treated (thousand cubic meters)	**VOCs Removed (kilograms)**	**Soil Vapor Treated (thousand cubic meters)**	**VOCs Removed (kilograms)**
VTF518	1995	0	0	425	153
VTF5475	1999	143.5	37.7	659	306

Source: LLNL 2003l.
TF = Treatment Facility; VOC = volatile organic compound; VTF = Vapor Treatment Facility.

Industrial Wastewater

Industrial wastewater is waste that contains constituents at concentrations too high to allow discharge to the sanitary sewer but does not meet the criteria to be designated as hazardous waste. The majority of wastewater is treated and discharged to the sanitary sewer. Several thousand gallons of wastewater are routinely held pending analysis. After treatment, the wastewater is discharged to the sanitary sewer if discharge criteria are met. For additional information, see Section 4.11.

At Site 300, Buildings 801, 806, 807, 809, 825, and 826 process nonhazardous wastewater through several steps (e.g., filters) into Class II surface impoundments (LLNL 2002cc, LLNL 2000a, LLNL 1999d).

TABLE 4.15.2.6–2.—*Volatile Organic Compounds Removed From Groundwater and Soil Vapor at Site 300*

Treatment Area	Startup Date	2002		Cumulative Total	
		Water Treated (million liters)	VOCs Removed (kilograms)	Water Treated (million liters)	Volatile Organic Compounds Removed (kilograms)
GSA-Eastern GWTF	1991	78.7	0.17	806.6	6.19
GSA-Central GWTF	1993	4.19	0.59	29.16	10.66
Building 834	1995	0.11	0.81	0.93	31.84
High Explosives Process Area	1999	4.5	0.012	10.5	0.058
Building 832	1999	1.90	0.12	5.68	0.44
Building 854	1999	3.67	0.78	12.25	6.14
Pit 6	1998	Not Applicable	Not Applicable	0.268	0.0014
		Soil Vapor Treated (thousand cubic meters)	**Volatile Organic Compounds Removed (kilograms)**	**Soil Vapor Treated (thousand cubic meters)**	**Volatile Organic Compounds Removed (kilograms)**
GSA-Central	1994	293.58	1.54	1,987.18	66.16
Building 834	1998	406.18	5.19	1,657.56	108.26
Building 832	1999	96.2	0.28	282.5	1.39

Source: LLNL 2003l.
GSA = general services area; GWTF = groundwater treatment facility; VOC = volatile organic compound.

Sanitary (Domestic) Wastewater

Liquid effluents with contaminants below limits specified by the city of Livermore are released to the city of Livermore sewer system. In FY2002, LLNL discharged approximately 240,000 gallons per day (LLNL 2002l). The sewer system capacity is approximately 1,685,000 gallons per day (DOE 2002d). In FY2001, Site 300 (GSA) generated approximately 2,100 gallons per day (LLNL 2002cc, LLNL 2000a, LLNL 1999d). Site 300 remote facilities use septic systems.

4.16 HUMAN HEALTH AND SAFETY

This section describes the responsibilities of existing LLNL programs for assuring that their respective activities are executed in a manner protective of the general public, worker safety and health, and the environment.

Environment, Safety, and Health Functions and Responsibilities

It is the policy of NNSA and LLNL to operate in a manner that protects the health and safety of employees and the public, preserves the quality of the environment, and prevents property damage. ES&H is to be a priority consideration in the planning and execution of all work activities at LLNL. It is also the policy of LLNL to comply with applicable ES&H laws, regulations, and requirements; and with directives promulgated by DOE regarding occupational safety and health, as adopted in the LLNL Work Smart Standards. LLNL encourages public participation on matters of importance to the community related to environmental protection and health and safety. Public participation is encouraged through the initiation of communications and solicitation of public input to the decision-making process on matters of significant public interest and by providing access to information on LLNL ES&H activities (LLNL 1998d).

LLNL has implemented an Integrated Safety Management System (ISMS), in accordance with DOE P 450.4 to "…systematically integrate safety into management and work practices at all levels so that missions are accomplished while protecting the public, the worker, and the environment." The ISMS is a systematic approach to defining the scope of work, identifying, planning, and performing work that provides for early identification of hazards and associated control measures for hazardous mitigation or elimination. The ISMS process also forms the basis for work authorization and provides for both internal and external assessment through a continuous feedback and improvement loop for identifying both shortcomings and successes for incorporation into subsequent activities (LLNL 2003k). ISMS is discussed in detail in Appendix C.

The LLNL Director is responsible for the overall implementation and oversight of ES&H responsibilities and is assisted by the Senior Management Council and the ES&H Working Group. The Senior Management Council, composed of the Director (Chair), the Deputy Directors, and all Associate Directors, advises the LLNL Director on policies and oversees the effectiveness of activities and programs to implement those policies. The Senior Management Council is responsible for:

- Reviewing LLNL policies and recommending changes to the Director
- Ensuring the implementation of those policies and reviewing the effectiveness of their implementation
- Discussing accidents, incidents, audits, and reviews at LLNL and other NNSA contractor facilities to identify lessons learned and ensuring that those lessons are incorporated into LLNL operations
- Establishing and overseeing working groups and committees as appropriate
- Providing a forum to receive input from LLNL employees and ensuring that they are adequately informed

- Reviewing proposed exemptions to standards and regulations
- Reviewing and resolving outstanding institutional issues

The ES&H Working Group supports the Deputy Director for Operations and the Senior Management Council. Its broad membership and close association with the Deputy Director for Operations and Senior Management Council provides a key mechanism for LLNL-wide reviews of proposed ES&H policies and issues and for the development of effective ES&H guidance. The ES&H Working Group consists of assurance managers from each directorate and the heads of the ES&H functional organizations. ES&H Working Group responsibilities include the following:

- Responding to requests for reviews and studies by the Deputy Director for Operations
- Reviewing and developing LLNL implementation plans to meet Federal, state, and DOE requirements
- Addressing ES&H and quality assurance issues raised by the programs and preparing recommended actions for consideration by the Deputy Director for Operations and Senior Management Council
- Reviewing generic or institutional ES&H and quality assurance issues, and bringing those issues to the attention of the Deputy Director for Operations for policy development or change

The EPD assists LLNL managers to ensure that LLNL operations comply with applicable laws and regulations and that environmental impacts from LLNL operations are mitigated to the maximum extent possible. The EPD's key missions are as follows (LLNL 1996b):

- Assist LLNL programs in developing environmentally sound practices in their day-to-day tasks by: (1) conducting environmental evaluations and addressing requirements under NEPA, CEQA, and related Federal and state requirements; (2) identifying and developing methods to monitor, prevent, reduce, and clean up air emissions, wastewater discharges, and hazardous wastes; and (3) obtaining the permits or exemptions for air, water, and hazardous waste activities
- Ensure environmental compliance through environmental monitoring, risk assessment, and analysis for LLNL sites by evaluating the impact of ongoing LLNL operations on the surrounding environment by sample collection, analysis, data reduction, and other simulation modeling methods for water and air
- Develop and conduct cost-effective restoration and remediation
- Design and apply appropriate, cost-effective treatment technologies to manage hazardous and nonhazardous waste streams
- Develop and implement waste minimization and pollution abatement strategies
- Coordinate LLNL-wide D&D activities

The EPD is divided into three operating divisions, each with specific responsibilities (for more details, see Appendix C, Environment, Safety, and Health): RHWM Division, ERD, and Operations and Regulatory Affairs Division. The RHWM Division develops and improves methods to ensure that wastes from LLNL operations have minimal environmental impacts. They operate LLNL's hazardous, radioactive, and mixed waste management systems. The ERD investigates and cleans up soil and groundwater contaminated by past activities of LLNL and its predecessors at the Livermore Site and Site 300. The Operations and Regulatory Affairs Division is the focal point for interactions with Federal, state, and local environmental regulatory agencies. It offers technical guidance and expertise on regulatory requirements and related compliance options, permitting issues, and monitoring techniques and technologies, as well as providing 24-hour emergency response for environmental incidents.

The Hazards Control Department, through its five ES&H teams, works with LLNL programs to minimize the risks presented by research and support activities. The hazards encountered include all biological, physical, and radiological agents from normal operating conditions to emergencies. The Hazards Control Department also provides safety analysis, and emergency preparedness and response training services and operates state-of-the-art analytical laboratories. The Hazards Control Department's primary responsibilities include monitoring operations to provide management with the information needed to maintain an acceptable-risk work environment, provide guidance in formulating LLNL's health and safety policies, directives, and standards; conduct facility design reviews; and specify any protective equipment that might be required by employees to perform their work assignments safely. The Hazards Control Department assists the programs in the implementation of the LLNL ISMS. In the ISMS context, the term safety is synonymous with the LLNL term ES&H. It encompasses protection of employees, the public, and the environment. The overall responsibility for implementing this belongs to line management.

The Health Services Department provides occupational health services for LLNL. This department works collaboratively with the Hazards Control Department and EPD. The Health Services Department Head serves the role of Chief Medical Officer at LLNL and provides input for health-related decisions made by LLNL management. The Health Services Department staff provides clinical services and employee assistance and offers the following occupational health services:

- Treatment for occupational and minor non-occupational injuries and illness
- Emergency care, stabilization, and transfer to local emergency room if necessary
- Return-to-work assistance after illness or injury
- Multidisciplinary work site inspections regarding health hazards and environmental conditions, medical surveillance, and qualification and fitness for duty examinations
- Educational programs designed to address health concerns in the workplace
- Health promotion services
- Physical therapy for occupational injuries or illness
- Decontamination and treatment for chemical or radiological exposures
- Employee assistance services

The Health Services Department also implements prevention programs for occupational illnesses and injuries, such as monitoring worker exposure data with the Hazards Control Department and preventing Valley Fever (coccidioidomycosis) at Site 300. The programs mentioned above are further discussed in Appendix C.

4.16.1 Occupational Safety

4.16.1.1 *Regulatory Setting*

The Work Smart Standards, which includes Federal and state regulatory requirements, is a set of codes, standards, and regulations adopted between LLNL and NNSA (LLNL 1998e). Information on the contractual adoption of Work Smart Standards, as well as standards maintenance, flow down of requirements, and change control process, is included in Appendix C, Section C.2.2, of this LLNL SWEIS.

4.16.1.2 *Lawrence Livermore National Laboratory Occupational Safety*

Each employee at LLNL, from Director to laboratory worker, is required to know and understand the ES&H requirements of his or her assignment, the potential hazards in the work area, and the controls necessary for working safely. He or she must participate in all required ES&H training and health monitoring programs. All work assignments must be performed in full compliance with applicable ES&H requirements as published in LLNL manuals and guidelines and established in safety procedures. All employees are responsible for working in a manner that produces high quality results, preserves environmental quality, and protects the health and safety of workers and members of the public. Program implementation is a line management responsibility, with primary oversight of program implementation resting with the Hazards Control Department and Health Services Department (LLNL 1996b). These organizations are described briefly above and further discussed in Appendix C. An organization chart is also provided in Appendix C, Section C.2.2, of this LLNL SW/SPEIS.

The Assurance Review Office is LLNL’s institutional-level ES&H oversight organization reporting to the Deputy Director for Operations. The Assurance Review Office mission is to assist the Laboratory’s Deputy Director for Operations in discharging his ES&H and related quality assurance responsibilities by providing independent, institutional-level oversight of LLNL’s ES&H systems and nuclear facility safety. The Assurance Review Office also serves as a point of contact and coordinating agent for major DOE and University of California ES&H reviews, assessments, and audits. The Assurance Review Office’s role is to conduct independent reviews of LLNL’s ES&H and related quality assurance systems, including nuclear facility operations and the directorate self-assessment processes.

The Assurance Review Office evaluates the adequacy of existing ES&H systems relative to LLNL's ES&H policies and procedures and applicable ES&H laws, regulations, and directives. The results of the Assurance Review Office’s reviews are communicated to the Deputy Director for Operations, directorates, nuclear facility management, and ES&H support organizations with the intent of facilitating improvements in LLNL's ES&H, nuclear facility safety, self-assessment, and institutional oversight programs. The Assurance Review Office is responsible for independently assessing conformance with LLNL's nuclear safety implementation plans prepared in accordance with the *Price-Anderson Amendments Act* rules. The Assurance Review Office maintains the institutional ES&H deficiency tracking system (DefTrack) to monitor actions taken in response to its evaluations and assessments conducted by outside agencies and the directorates. The Assurance Review Office is precluded from assuming any line or programmatic responsibilities to ensure functional independence and appropriate segregation of responsibility (ARO 2003).

The LLNL ISMS addresses the identification of workplace hazards, control measures, safe work practices, and feedback and continuous improvement functions necessary to perform work safely at LLNL. This program articulates the institutional requirements for all LLNL operations, whether at the Livermore Site, Site 300, or Nevada Test Site, or at any other sites where LLNL personnel and contractors are working. The LLNL ISMS was implemented in 1998 with the updating of existing safety manuals and organization into a formal structure within the ISMS Plan. Additionally, in 1997, LLNL and the DOE Oakland, California office initiated the selection of Work Smart Standards to protect workers, the public, and the environment. These standards are the basis for selecting hazard controls and other processes at LLNL (LLNL 2003k).

Special Illness Prevention Program

Site 300 workers and visitors face the potential of contracting coccidioidomycosis, a respiratory disease commonly known as Valley Fever, caused by the fungus *Coccidioides immitis*. The disease is common in warm, dry alkaline areas including the entire San Joaquin Valley. Coccidioidomycosis is acquired from inhalation of the spores (arthroconidia). Once in the lungs, the arthroconidia transform into spherical cells called “spherules.” An acute respiratory infection occurs 7 to 21 days after exposure and typically resolves rapidly. However, the infection may alternatively result in a chronic pulmonary condition or disseminate to the meninges, bones, joints, and subcutaneous and cutaneous tissues. About 25 percent of the patients with disseminated disease have meningitis (DoctorFungus 2002). The Health Services Department tests each employee or prospective employee for Valley Fever immunity before assignment to Site 300, subject to the availability of the antigen (see Appendix C). The test is currently unavailable and may remain unavailable beyond 2003. Based on the test results and physical factors (e.g., greater susceptibility or being pregnant), employees are counseled regarding increased risk, and the Health Services Department recommends if working at Site 300 is appropriate. An employee can work at Site 300 despite a contrary recommendation if an informed consent form is signed (LLNL 2000i).

Other Exposures and Potential Hazards

Exposures to Hazardous Materials

LLNL is an R&D facility in which a large variety of hazardous materials are used. LLNL operations represent a potential for exposure of some workers to hazardous materials (such as solvents, metals, and carcinogens). Typically operations are controlled so that those workers may be exposed to very low levels of a wide variety of chemicals that are below a threshold of concern throughout the duration of their research. A summary of radioactive materials and chemicals to which workers may be exposed can be found in Appendix B, Waste Management. Radioactive and hazardous wastes are also discussed in Appendix B. LLNL evaluates operations and prevents employee exposures to chemical hazards. Hazards Control tracks measured exposures to hazardous chemicals in an electronic database (LLNL 2002bk).

Workers are provided with information and training on identified hazards to protect them from exposure. LLNL has several programs and procedures in place to provide direction for monitoring, handling, storing, and using these materials. These programs and safety procedures include the Hazard Communication Program, Chemical Hygiene Program, Respiratory Protection Program, and written safety procedures for handling and use of carcinogens and biohazard materials. Work activities are periodically monitored with measurements performed at personal breathing zones and general work areas. ES&H monitoring records indicate that personnel exposure to hazardous materials is maintained well below established regulatory requirements and exposure guidelines. Additional information regarding worker exposure to toxic materials is found in Appendix C (LLNL 2000i).

Biohazards

Biological operations at LLNL include using and safely handling biohazardous materials, agents, or their components (e.g., microbial agents, bloodborne pathogens, recombinant deoxyribonucleic acid [DNA], and human or primate cell cultures), and research proposals and activities concerning animal or human subjects. Biological materials can cause illness and infection. Examples of potential sources of exposure to biological hazards are as follows:

- Human fluids, secretions, or feces
- Class II and III etiologic agents
- Infectious agents from animal infestation or droppings
- Biological toxins
- Human cell and tissue culture systems
- Research involving animals
- Research involving allergens of biological origin (e.g., certain plants and animal products, danders, urine, and some enzymes)
- Laundry soiled with blood or other potentially infectious materials
- Contaminated sharps
- Unfixed human tissues or organs

Personnel exposure to biological hazards is minimized using administrative controls, engineered controls, and personal protective equipment. By analyzing the hazards for each specific operation, LLNL personnel develop and implement the appropriate controls to protect themselves, the community, and the environment from potential exposure (LLNL 2000i).

Carcinogens

Carcinogens are only used in LLNL operations when it is not possible to use a noncarcinogenic material. Any use of carcinogens requires stringent controls to be in place to prevent exposures to workers, the public, and the environment. Examples of operations where carcinogenic materials may be encountered include:

- Brazing with cadmium-containing alloys or grinding of cadmium-coated work pieces
- Work that generates or involves contact with soots and tars
- Use of mineral oil products that may contain polyaromatic hydrocarbons
- Electric arc discharge machining
- Discharging of gas propellants in a vacuum
- Handling refractory ceramic fibers
- Welding stainless steels (due to the formation of hexavalent chromium compounds and nickel oxide)
- Chromium plating and other operations that disperse hexavalent chromium compounds or irritatingly strong concentrations of sulfuric acid into the air
- Generating hardwood dust, including carpentry and cabinet-making activities
- Spraying hexavalent chromium compounds including, but not limited to, primers, paints, and sealants containing barium, calcium, sodium, strontium, or zinc chromate
- Handling inorganic arsenic compounds and arsenic metal, including gallium arsenide, in a manner that can result in exposure to arsenic
- Handling animals in research activities involving carcinogens
- Using or synthesizing of carcinogens in laser chemistry or biochemistry laboratories
- Using asbestos, beryllium, laser dyes, or lead and lead compounds

At LLNL, chemical carcinogens are used by employees only when required by a specific research project. The use of chemical carcinogens is addressed in the Chemical Hygiene Plan and the ES&H Manual requirements (LLNL 2000i). The program addresses control and storage of chemicals, preparation of work plans, worker safety, personnel protective measures, engineering controls, and waste management.

As addressed previously, worker exposures to certain hazardous materials are monitored by industrial hygiene staff and tracked using an occupational exposure database. Likewise, personnel may be monitored for certain chemical agents by way of routine medical examinations performed by the Health Services Department.

The use, synthesis, and storage of carcinogens must be evaluated by an industrial hygienist. Depending on the nature of the chemical use, the quantity of material involved, and the control measures engaged, procedural guidance might be required for the performance of work using carcinogens.

The purchase and receipt of chemical carcinogens is primarily controlled through procurement administrative controls. Authorization for the purchase of carcinogens requires either a current Operation Safety Plan or the approval of the area industrial hygienist. Occupational Safety and Health Administration (OSHA)-regulated carcinogens may only be purchased with approval of the Hazards Control Department.

All employees who work with carcinogens must receive sufficient information and training so that they may work safely and understand the relative significance of the potential hazard they may encounter (LLNL 2000i).

Beryllium Disease Prevention Program

Beryllium metal, alloys, and compounds are widely used at LLNL and other DOE facilities because of the materials' nuclear properties as moderators (i.e., reflectors) of neutrons. Favorable mechanical properties have also resulted in beryllium's widespread use in the aerospace industry. The addition of 2 percent or less beryllium to copper forms an alloy with high strength and hardness, properties that have made the alloy useful in electronics, automotive, defense, and aerospace industries worldwide. Beryllium oxide (also known as beryllia) can be formed into beryllia ceramics, which have an exceptional combination of high thermal conductivity, electrical resistivity, and dielectric properties. Beryllium ceramics are used widely in electronics, laser, automotive, and defense applications (LLNL 2000i).

Although solid beryllium poses no health hazard, inhaling beryllium particulates (such as dust, mists, or welding fumes) can produce acute or chronic lung disease. Skin irritation may result from direct contact with soluble beryllium compounds, and healing is impaired in beryllium-contaminated wounds. Health effects from beryllium are caused by the body’s immune system response to inhaled dust or fumes containing beryllium metal, alloys, or compounds. This immune system response to beryllium is similar to an allergic reaction and may evolve over many years, even decades. Early evidence of this reaction may be detected by a blood test; i.e., the beryllium lymphocyte proliferation test, before there is evidence of damage to the lungs. Positive test results indicate beryllium sensitization. Sensitization is not a disease. There is no impairment from or symptoms of, sensitization itself.

The body’s reaction may continue to progress and cause damage to the lungs. Chronic beryllium disease is said to exist when there is evidence of harmful effects to the lungs; i.e., when healthy lung; tissue becomes damaged and changes from functioning lung tissue to fibrotic tissue. Damage to the lungs may be detected early by biopsy before there are symptoms (such as shortness of breath. Damage such as fibrosis may progress to the point that symptoms are severe enough to disable or cause death.

LLNL's Beryllium Disease Prevention Program addresses a new DOE effort designed to reduce the number of workers exposed to beryllium, minimize the levels of beryllium exposure, and ensure early detection of beryllium-related disease. LLNL's control program consists of:

- Workplace evaluations and establishment of controls
- Training
- Medical surveillance

The Beryllium Disease Prevention Program is part of long-standing beryllium control efforts at LLNL that predate any Federal mandates. These controls, plus a high level of awareness of the hazards of beryllium among scientists, engineers, technicians, and other staff who work in areas where beryllium is used, have resulted in a low beryllium disease rate at LLNL.

Workplace exposure questionnaires and the availability of a new blood test are two major enhancements to LLNL's Beryllium Disease Prevention Program. The blood test, called the lymphocyte proliferation test, detects sensitivity to beryllium. Employees who become sensitized are more likely to develop beryllium lung disease.

For most people, chronic beryllium disease results from significant exposures to beryllium from activities such as machining or working with powder or dust. A small percentage of individuals can develop chronic beryllium disease from a very low level of dust. Chronic beryllium disease, a poorly understood lung disease, may take years or even decades to develop, and the primary symptom is shortness of breath on exertion. The lymphocyte proliferation test can identify individuals who have a greater risk of getting chronic beryllium disease, because their bodies have developed a response to the metal (a positive sensitivity).

As part of the hazard assessment process, everyone involved in beryllium work is evaluated to determine if DOE's criteria for classification as a "beryllium worker" is met. This determination is made by both program management and the ES&H team industrial hygienist. ES&H Manual Document 14.4, "Implementation of Chronic Beryllium Prevention Program Requirements" identifies the requirements and provides guidance for making the determination (LLNL 2000i). Part of the process is the "Beryllium Occupational History Questionnaire." This is filled out by everyone involved in beryllium work. A copy is maintained by the Hazards Control Department and Chemical and Biological Safety Section and a copy is forwarded to the Health Services Department and placed in the employee's medical record. The questionnaire provides important information to both the Health Services Department and the Hazards Control Department about current and past exposure potential.

If an employee has a confirmed positive (meaning two consecutive positive lymphocyte proliferation tests), additional medical testing (e.g., bronchoscopy, etc.) will be recommended to determine if the employee actually has beryllium disease. Positive sensitivity does not necessarily mean that disease is present. Health Services Department clinicians provide health counseling, which include a recommendation to eliminate any work with beryllium. All lymphocyte proliferation test results are managed in a medically confidential manner. Training on beryllium hazards is available from the Hazards Control Department.

LLNL's Health Services Department offers medical screening and surveillance to beryllium-associated workers. These are workers in any one of the following categories:

- Beryllium workers
- A worker whose work history shows he or she may have been exposed to airborne beryllium
- A current worker who shows signs or symptoms of beryllium exposure
- A current worker who is receiving medical removal protection benefits

Although the Beryllium Disease Prevention Program is open only to current LLNL employees, DOE has developed medical screening options for former employees who may have had beryllium exposure. The *Energy Employees Occupational Illness Compensation Program Act* of 2000 as amended concerns workers involved in various ways with the nation's atomic weapons program. Part A of the Act provides Federal monetary and medical benefits to workers having radiation-induced cancer, beryllium illness, or silicosis. Eligible workers include DOE employees, DOE contractor employees, as well as workers at an "atomic weapons employer facility" in the case of radiation-induced cancer and illness.

LLNL analyzes Site 300 soils for beryllium. Soils at the Livermore Site were analyzed for beryllium from 1991 to 1994. However, analysis for beryllium was discontinued at the Livermore Site in 1995, because it was never measured above background values (LLNL 2001v).

Physical Hazards

LLNL employees could also be exposed to physical hazards such as non-ionizing radiation, to include static magnetic and electric fields, extremely low frequency fields, radio frequency fields, and microwaves, noise, electric shock, tripping hazards, and lasers. The ES&H Manual provides procedural guidance for mitigating these types of hazards, and occurrences of such hazards are monitored by the Hazards Control Department.

Occupational Injuries

LLNL records occupational injuries pursuant to DOE orders that use OSHA criteria. Total recordable case rates for injury and illness incidence at LLNL varied from an annual average of 6.9 to 3.0 per 200,000 hours worked from 1996 to 2002. During this time, total lost and restricted day case rates ranged from 2.8 to 0.9 per 200,000 hours worked (LLNL 2002ck, LLNL 2003u). The total recordable case rate for LLNL workers is more than for DOE and its contractors at other facilities, which varied from 3.5 to 2.4 per 200,000 hours worked. During this time, total lost day case rates for DOE varied from 1.7 to 0.9 per 200,000 hours worked. No fatalities occurred at LLNL between 1996 and 2002 (DOE 2002f).

4.16.2 Human Health and Worker Safety (Radiological Effects)

The environment potentially affected by radiological site releases includes air, water, and soil. These transport pathways (the environmental medium through which a contaminant moves) require an associated exposure pathway (e.g., inhaling air, drinking water, or dermal contact with soil) to affect human health. The specific resource sections in this LLNL SW/SPEIS (e.g., Air Quality and Water) describe the existing conditions of the environmental media.

4.16.2.1 *Public Health*

A radiation dose is calculated to determine the health impact from exposure to radiation. The dose is a function of the exposure pathway (external, inhalation, or ingestion) and the type and quantity of radionuclide involved. The transport pathway (air, water, soil) concentrations, uptake parameters, usage rates, exposure duration, and radionuclide-specific dose factors determine the dose. The dose is always presented in this document (unless otherwise noted) as the Committed Effective Dose Equivalent, which weights the impacts on particular organs so that the dose from radionuclides that affect different organs can be compared on a similar (effect on whole body) risk basis. Health impacts (cancer fatalities) are calculated from the risk factor of 0.0006 fatal cancers to the general population expected per person-rem effective dose equivalent (Lawrence 2002).

The levels of exposure from the small quantities of radiation released from LLNL can be put in perspective by considering the doses received in the U.S. from exposure to natural and man-made background radiation. Table 4.16.2.1–1 compares the dose received from background and from a recent year of LLNL operations, 1999. The year 1999 is used because the doses received from LLNL operations were generally the greatest of the 5-year period 1998 through 2002. The air transport pathway results in almost all of the doses to the public from LLNL, either directly or through deposition and subsequent ingestion.

The risk of the hypothetical site-wide MEI contracting a fatal cancer from exposure to 1999 releases is 7.2×10^{-8} and 2.1×10^{-8} from the Livermore Site and Site 300, respectively. These same releases are unlikely (0.008 cancers calculated) to increase the number of LCFs in the population surrounding LLNL above those that occur naturally. The average annual cancer death rate nationally is 171.4 per 100,000 population; for California the rate is 161.7 per 100,000 population (Ries et al. 2002). Thus, approximately 11,000 fatal cancer deaths per year would be expected to naturally occur in the population of approximately 7 million people within 50 miles of LLNL.

TABLE 4.16.2.1–1.—*Comparison of Radiation Dose Received from Background and Lawrence Livermore National Laboratory Operations for 1999*

Location/Source	Individual Dose to Site-wide MEI[a] (millirem)	Population Dose[a] (person-rem)
Livermore Site		
Atmospheric emissions	0.12	1.7
Site 300		
Atmospheric emissions	0.035	11
Other (background)[b]		
Natural background		
Cosmic radiation	30	190,000
Terrestrial radiation	30	190,000
Food consumption	40	250,000
Radon	200	1,250,000
Man-made background		
Medical (diagnostic)	53	330,000
Weapons test fallout	1.1	6,800
Nuclear fuel cycle	0.4	2,500

Sources: LLNL 2000g, LLNL 2002cc.
[a] See Section 4.10, Air Quality, for description of site-wide maximally exposed individual (MEI) and population dose.
[b] Average over the U.S. population; values vary with location.

4.16.2.2 *Worker Health and Safety*

The LLNL Hazards Control Department provides training, planning, and documentation support to site programs to minimize potential risks to workers and the environment. The department implements the ES&H Manual that specifies health and safety management, controls, and procedures in the workplace (LLNL 2000i). The manual requires that all individuals employed at LLNL wear a dosimetry badge; visitors are also required to wear such a badge if they enter a radiation area. A dosimetry badge measures external exposure to radiation.

Internal exposure is typically monitored by bioassays (e.g., urinalysis, whole-body scans, lung counts). Routine bioassays are done on workers who, under typical conditions, are likely to receive a dose from an occupational exposure of 0.1 rem or more in one year. Others who could be assayed include occupationally exposed minors, members of the public, and pregnant workers who are likely to receive internal doses of at least 0.05 rem (or, in the case of pregnant workers, an equivalent dose to the embryo/fetus).

The applicable regulatory standard for radiological workers (those given unescorted access to radiation areas) is 5 rem per year (internal + external) (10 CFR Part 835). Table 4.16.2.2–1 lists the distribution of annual radiation doses (external + internal) received by LLNL workers for the recent 5-year period of 1998 through 2002.

TABLE 4.16.2.2–1.—*Distribution of Worker Doses for 1998 through 2002*

Dose Range (rem)	Number of Workers				
	1998	**1999**	**2000**	**2001**	**2002**
≥ 2	0	0	0	0	0
1.5 – 1.999	0	0	0	0	3
1.000 – 1.499	0	1	1	3	4
0.5 – 0.999	4	6	3	7	10
0.1 – 0.499	8	24	22	26	30
0.01 – 0.099	85	106	112	126	115
< 0.01	7,236	8,868	8,855	8,721	8,979
Total (Population) Worker Dose (person-rem)	**6.9**	**14.9**	**12.7**	**18.4**	**28.0**

Source: LLNL 2003as.

As seen in Table 4.16.2–2, the maximum individual worker dose for this period was less than 2 rem. Even with safety procedures and controls in place, inadvertent exposures can occur. There were no such occurrences from 1998 through 2001. There was one such instance in 2002; a worker's fingers were inadvertently exposed as a result of handling unsealed radioactive material. The worker population dose, when multiplied by the risk factor, implies that it is unlikely (0.02 cancers calculated for 2002 exposures) that an additional fatal cancer would result from occupational exposure at LLNL.

4.17 SITE CONTAMINATION AND REMEDIATION

This section describes the history, current status, and ongoing and planned remediation activities of contaminated soil and groundwater at LLNL. Separate discussions are presented for the Livermore Site and Site 300.

4.17.1 Site Contamination—Livermore Site

4.17.1.1 *Contamination History*

LLNL was founded at the Livermore Site in 1952 at a former U.S. Navy training base. Initial releases of hazardous materials occurred at the Livermore Site in the mid-to-late 1940s when the site was the Livermore Naval Air Station. There is also evidence that localized spills, leaking tanks and impoundments, and landfills contributed VOCs, fuel hydrocarbons, lead, chromium, and tritium to the groundwater and unsaturated sediment in the post-Navy era. The major contaminants are VOCs, primarily TCE. Environmental investigations and clean-up activities at the Livermore Site began in 1981. The Livermore Site was placed on the NPL in 1987 for cleanup under CERCLA. By the end of FY2006, DOE, depending on budget allocations, will have in place remediation facilities for long-term stewardship (in some cases, 50 to 60 years). The CERCLA environmental restoration treatment facilities and areas (see descriptions below) are shown in Figure 4.17.1.1–1. Contaminant release sites are assigned to 12 treatment facility (TF) areas, based on the nature and extent of contamination, infrastructure, and topographic and hydrologic considerations. The 12 areas are TFA, TFB, TFC, TFD, TFE, TFF406, TFG, TF518, TF5475, Building 331 area, Building 419/511 area, and Building 292 area. TF areas include both groundwater and vapor treatment facilities (VTFs). For 2002, the groundwater extraction wells operated at an average flow rate of 1,787 liters per minute; the vapor extraction average flow rate was 0.27 cubic meter per minute.

The objective of the TFs is to prevent the further movement of groundwater offsite, to remediate groundwater to drinking water standards, and to remediate the sources of contamination. Cleanup at each TF area includes groundwater monitoring, data analysis, and modeling. The results of the data analyses are used in decisionmaking for continued remediation optimization.

4.17.1.2 *Contamination Treatment Facilities and Areas*

Treatment Facility Area A

Treatment Facility Area A (TFA) is located in the southwest corner of the Livermore Site. Beginning operation in 1989, it is the oldest operating groundwater treatment system (GWTS) at the Livermore Site.

The TFA groundwater plumes affect approximately 98 acres, of which about 56 acres are located offsite. In 2002, TFA treated 251.4 million liters of groundwater, removing 5.7 kilograms of VOCs (Table 4.17.1.2–1). While the size of the offsite VOC plumes remained largely the same, the concentrations have declined below MCLs in most locations. The contaminants of concern are presented in Table 4.17.1.2–2.

TABLE 4.17.1.2–1.—*Volatile Organic Compounds Removed from Groundwater and Soil at the Livermore Site*

Treatment Area	Startup Date	2002 Water Treated (million liters)	2002 VOCs Removed (kilograms)	Cumulative Total Water Treated (million liters)	Cumulative Total VOCs Removed (kilograms)
TFA	1989	251.4	5.7	3,658	154
TFB	1990	130.2	6.1	787	54.2
TFC	1993	107.9	7.1	595	53.9
TFD	1994	281.3	68.4	1,505	500
TFE	1996	110.5	17.5	544	139
TFG	1996	12.1	0.7	70.4	3.7
TF406	1996	40.5	1.0	211	7.7
TF518	1998	4.9	0.6	37.1	4.3
TF5475	1998	0.72	0.7	2.3	4.8
Total [a]		**939**	**108**	**7,410**	**922**
		Soil Vapor Treated (thousand cubic meters)	**VOCs Removed (kilograms)**	**Soil Vapor Treated (thousand cubic meters)**	**VOCs Removed (kilograms)**
VTF518	1995	0	0	425	153
VTF5475	1999	143.5	37.7	659	306
Total [a]		**144**	**38**	**1,084**	**459**

Source: LLNL 2003l.
[a] Rounded to nearest whole number.
TF = treatment facility; VOC = volatile organic compound; VTF = vapor treatment facility.

TFA was constructed to prevent VOCs from migrating downgradient toward municipal water supply wells to the west and agricultural and domestic wells to the south. Groundwater is treated using the large capacity air-stripping system installed in June 1997, replacing an ultraviolet hydrogen peroxide system. VOCs are stripped from the groundwater, and the effluent air from the stripper is passed through granular activated carbon filters to remove VOCs. The treated effluent air is then vented to the atmosphere. Another TF in the TFA uses granular activated carbon to remove VOCs and is solar powered.

In the TFA area, depth to groundwater is about 75 feet and groundwater flows to the west. Contaminants are generally confined from 75 to 140 feet below ground surface.

Treatment Facility Area B

Treatment Facility Area B (TFB) is located along Vasco Road on the western edge of the Livermore Site. TFB, which began operating in 1990, is the second oldest operating GWTS at the Livermore Site.

The TFB groundwater plumes affect approximately 27 acres, of which all are located onsite. In 2002, TFB treated 130.2 million liters of groundwater from six wells, removing 6.1 kilograms of VOCs (Table 4.17.1.2–1). The contaminants of concern are presented in Table 4.17.1.2–2.

TFB was constructed to prevent VOCs from migrating downgradient toward a residential area to the west. Groundwater is treated using a large capacity air-stripping system installed in October 1998. This unit replaced an ultraviolet/hydrogen peroxide system that had been in use since 1990. Groundwater is also treated for hexavalent chromium using an ion-exchange unit. Treated groundwater from TFB is discharged into the north-flowing drainage ditch parallel to Vasco Road, which empties into Arroyo Las Positas to the north.

TABLE 4.17.1.2–2.—*Contaminants of Concern, Including Sources, by Treatment Area*

Treatment Area	Brief Source[a] Description	Contaminants of Concern
TFA	Local storm drain outlets, spills into the retention tanks, and a transformer rupture	Primarily tetrachloroethylene and to a lesser degree TCE and 1,1-dichloroethylene
TFB	Local dumping of oils and solvents, open sewer lines, plating shop sumps, etc.	Primarily tetrachloroethylene and to a lesser degree TCE, 1,1-dichloroethylene, carbon tetrachloride, and other solvents. Hexavalent chromium is also present.
TFC	Releases from buildings, cooling tower discharges, tank leaks, etc.	Primarily tetrachloroethylene and TCE and to a lesser degree 1,1-dichloroethylene and chloroform. Hexavalent chromium is also present.
TFD	A number of sources including the old runways of the former Livermore Naval Air Station and landfills	TCE, trichlorofluoromethane, and other solvents. Hexavalent chromium is also present.
TFE	Underground storage tanks, oil, and chemical spills, etc.	TCE, tetrachloroethylene, and 1,1-dichloroethylene
TFF 406	Fuel and spills	Fuel hydrocarbons, toluene, benzene, etc. Chlorinated solvents are also present.
TFG	Floor drains, drum racks, potential releases from shops, spills, and leaking equipment	TCE and tetrachloroethylene
TF518	Accidental spills, solvent storage	Primarily tetrachloroethylene, TCE, and 1,1-dichloroethylene
TF5475	Former waste disposal pits and evaporation ponds	Tritium and chlorinated solvents.
Building 331	Tritium Facility operations	Tritium and solvents
Building 419/511	Former Navy aircraft assembly and maintenance operations	Primarily tetrachloroethylene, TCE, and carbon tetrachloride
Building 292	Former energy research facility	Tritium and VOCs

Source: LLNL 2003l.
[a] Source of contamination is based on best available information and may not be completely known.
TF = treatment facility; VOC = volatile organic compound.

Depth to groundwater is about 60 feet and groundwater flows to the west. Contaminants are generally confined from 60 to 120 feet below ground surface.

Treatment Facility Area C

Treatment Facility Area C (TFC) is located in the northwest part of the Livermore Site. TFC, which began operating in 1993, is the third oldest operating GWTS at the Livermore Site.

The TFC groundwater plume affects approximately 110 acres, all of which are located onsite. In 2002, TFC treated 107.9 million liters of groundwater, removing 7.1 kilograms of VOCs (Table 4.17.1.2–1). The contaminants of concern are presented in Table 4.17.1.2–2.

TFC was constructed to prevent VOCs from migrating downgradient toward a residential area to the west. TFC treats VOCs in groundwater using air stripping. The effluent air from the stripper is treated with granular activated carbon prior to discharge to the atmosphere. Groundwater is treated for hexavalent chromium using an ion-exchange unit. Treated groundwater from TFC is discharged into Arroyo Las Positas to the north.

The depth to groundwater is about 45 feet and groundwater flows to the west. Contaminants are generally confined from 45 to 65 feet below ground surface.

Treatment Facility Area D

Treatment Facility Area D (TFD) is located in the northeast quadrant of the Livermore Site. TFD, which began operating in 1994, is the fourth oldest operating GWTS at the Livermore Site.

The TFD groundwater plumes affect approximately 111 acres, all located onsite. In 2002, TFD treated 281.3 million liters of groundwater, removing 68.4 kilograms of VOCs (Table 4.17.1.2–1). The contaminants of concern are presented in Table 4.17.1.2–2.

TFD was constructed to prevent VOCs from migrating downgradient onsite and to clean up source areas near TFD. Fixed and portable TFs, operating in the TFD area, process VOCs in groundwater using air stripping. The effluent air from the air strippers is treated with granular activated carbon prior to discharge to the atmosphere. Treated groundwater from TFD is discharged either into the Drainage Retention Basin (DRB), into an underground pipeline downstream of the DRB weir, into a nearby storm sewer, or into drainage ditches, each flowing north into the DRB. All discharge eventually empties into Arroyo Las Positas.

Depth to groundwater is about 70 feet and groundwater flows to the west. Contaminants are generally confined from 70 to 140 feet below ground surface.

Treatment Facility Area E

Treatment Facility Area E (TFE) is located in the central eastern part of the Livermore Site. TFE, which began operating in 1996, is one of three operating GWTSs that were activated in 1996 at the Livermore Site.

The TFE groundwater plumes affect approximately 42 acres, located onsite. In 2002, TFE treated 110.5 million liters of groundwater, removing 17.5 kilograms of VOCs (Table 4.17.1.2–1). The contaminants of concern are presented in Table 4.17.1.2–2.

TFE was constructed to prevent VOCs from migrating downgradient onsite and to clean up nearby contaminant source areas. VOCs are treated using an air stripper. Before the effluent air is vented to the atmosphere, it is treated using granular activated carbon to remove VOCs. Treated groundwater is discharged into a drainage ditch that flows north into the DRB.

Depth to groundwater is about 75 feet and groundwater flows to the west. Contaminants are generally confined from 75 to 120 feet below ground surface.

Treatment Facility Area F 406

Treatment Facility Area F 406 (TFF406) is located in the central southern area of the Livermore Site. TFF began operation in 1991 as a pilot study, testing vacuum-induced venting followed by stripping to remediate hydrocarbons at the site of an old gasoline station. By 1996, the vadose (unsaturated) zone remediation was complete and only residual concentrations of hydrocarbons remained in the saturated zone. No further action status for hydrocarbons was granted in 1996. TFF406 began operating in 1996 to treat VOCs as one of three GWTSs activated in 1996 at the Livermore Site. Treated groundwater is discharged into storm drains leading to Arroyo Las Positas.

There is no unsaturated zone soil contamination in the TFF406 area requiring remediation. The TFF406 groundwater VOC plume is approximately 9 acres and is located onsite and south of East Avenue (extending offsite by approximately 750 feet), including a portion of the SNL/CA site. In 2001, TFF 406 treated 40.5 million liters of groundwater, removing 1.0 kilogram of VOCs (Table 4.17.1.2–1). The contaminants of concern are presented in Table 4.17.1.2–2.

TFF406 was constructed to prevent VOCs from migrating downgradient toward municipal water supply wells to the west and agricultural wells and domestic wells to the south. TFF406 uses an air stripper to treat VOCs in groundwater. Granular activated carbon removes VOCs from effluent air prior to discharge to the atmosphere. All treated groundwater is discharged to an underground storm drain that flows north to Arroyo Las Positas.

Depth to groundwater is about 100 feet and groundwater flows to the west. Contaminants are generally confined from 150 to 190 feet below ground surface.

Treatment Facility Area G

Treatment Facility Area G (TFG) is located in the central south region of the Livermore Site. TFG, which began operating in 1996, is one of three operating GWTSs activated in 1996 at the Livermore Site.

The TFG groundwater plumes affect approximately 77 acres, all located onsite. In 2002, TFG treated 12.1 million liters of groundwater, removing 0.7 kilogram of VOCs (Table 4.17.1.2–1). The contaminants of concern are presented in Table 4.17.1.2–2.

TFG was constructed to prevent VOCs from migrating downgradient onsite. Depth to groundwater is about 70 feet and groundwater flows to the west. Contaminants are generally confined from 70 to 90 feet below ground surface.

Treatment Facility Area 518

Treatment Facility Area 518 (TF518) is located in the southeast corner of the Livermore Site. TF518, which began operating in 1998, is one of several recent additions to operating GWTSs at the Livermore Site.

The TF518 groundwater plume affects approximately 15 acres, most located onsite. The remainder extends south of East Avenue by several hundred feet, including a portion of the

SNL/CA site. In 2002, TF518 treated 4.9 million liters of groundwater, removing 0.6 kilogram of VOCs (Table 4.17.1.2–1). The contaminants of concern are presented in Table 4.17.1.2–2.

TF518 was constructed to prevent VOCs from migrating downgradient toward SNL/CA to the south. Depth to groundwater is about 110 feet and groundwater flows to the west. Contaminants are generally confined from 110 to 130 feet below ground surface.

Treatment Facility Area 5475

Treatment Facility Area 5475 (TF5475) is located in the southeastern region of the Livermore Site. TF5475, which began operating in 1998, is one of several recent additions to operating GWTSs at the Livermore Site.

The TF5475 groundwater plumes affect approximately 11 acres, all located onsite. In 2002, TF5475 treated 0.38 million liters of groundwater, removing 0.7 kilograms of VOCs (Table 4.17.1.2–1). Also, tritium concentrations remained below the MCL and continued to decrease. The contaminants of concern are presented in Table 4.17.1.2–2.

TF5475 was constructed to prevent VOCs and tritium from migrating downgradient toward SNL/CA to the south and remediate contaminant sources in the area. Depth to groundwater is about 85 feet and groundwater flows to the west. Contaminants are generally confined from 85 to 130 feet below ground surface.

Building 331 Area

Environmental restoration activities in the Building 331 area, located in the south-central region of the Livermore Site, include groundwater monitoring and sampling. Building 331, which began operating in 1959, once provided primary support to the LLNL weapons program. The main effluent releases from this building were gaseous tritium discharges through 100-foot-high stacks. NNSA expects no active soil vapor treatment system will be required as the tritium naturally decays.

The Building 331 area groundwater plume affects approximately 2 acres; the entire plume is located in the vicinity of Building 331, also referred to as the Tritium Facility. The primary contaminant of concern is tritium as presented in Table 4.17.1.2–2.

The Building 331 area is monitored for tritium migration. Depth to groundwater is about 70 feet. Tritium is generally confined to this depth and the vadose (unsaturated) zone.

Building 419/511 Area

Environmental restoration activities in the Building 419/511 area, located in the southeastern quadrant of the Livermore Site, include groundwater monitoring and sampling. The area was part of the former Naval Site, where aircraft assembly and maintenance was completed. Building 419 was used as an assay lab and then as a decontamination and size reduction facility by the RHWM Division, for which a partial RCRA closure was completed. NNSA expects to continue to monitor the area until cleanup standards are reached or the building is demolished or decommissioned.

The Building 419/511 area groundwater plume affects approximately 3 acres, located near Building 419/511. The contaminants of concern are presented in Table 4.17.1.2–2. VOCs removed at Building 419/511 are included in the TF518 results on Table 4.17.1.2–1.

Building 292 Area

Environmental restoration activities in the Building 292 area, located in the northwestern part of the Livermore Site, include tritium monitoring and sampling around the building. Building 292 housed a rotating target neutron source that was used for energy research. DOE expects to continue to monitor the area until cleanup standards are reached.

The Building 292 area groundwater plume affects approximately 3 acres, all located in the vicinity of Building 292. Tritium is the primary contaminant of concern (Table 4.17.1.2–2).

Spills

Small, localized chemical, oil, or hazardous material spills or releases have occurred at the site in the past. The possibility of a spill occurring still exists, given the variety of materials handled at LLNL. Some buildings use a variety of chemicals, including solvents, paints, and industrial gases (Section 4.15.1); however, industry-accepted controls are in place to minimize the potential for soil contamination from any ongoing LLNL operations.

The RHWM Division stores, treats, and handles hazardous and radioactive wastes prior to shipment offsite for disposal. These facilities have the potential for hazardous spills, releases, or fires. The RHWM Division is responsible for maintaining control and countermeasures to prevent and protect the environment in accordance with the site's hazardous waste permit. At the waste management facilities, industry-accepted controls are in place to minimize the potential for soil contamination from any LLNL waste management facility operations.

4.17.1.3 *Remedial Actions*

Status of Remediation Efforts

Since remediation began in 1989, the concentrations within the Livermore Site VOC plumes has been decreasing (Figure 4.17.1.3–1). Most of the observed trends in VOC concentrations are attributed to active groundwater extraction and remediation. Notable results of VOC analyses of groundwater are discussed below.

VOC concentrations on the western margin of the site either declined or remained unchanged during 2002, indicating continued hydraulic control of the western site boundary plumes in the TFA, TFB, and TFC. Concentrations in the TFA and TFB source areas increased slightly, however. The entire offsite Hydrostratigraphic Unit 2 plume from TFA dropped below 50 parts per billion for the first time (hydrostratigraphic units are shown in Figure 4.17.1.1–1).

In TFB, VOC concentrations were lower in Hydrostratigraphic Unit 1B close to Vasco Road, where TCE declined from 23 parts per billion in 2001 to 14 parts per billion in 2002.

In the central to northern parts of TFC, the lateral extent of Hydrostratigraphic Unit 1B total VOC concentrations above 50 parts per billion decreased significantly. Total VOC concentrations decreased along the western margin of TFC.

Concentrations began to decline in 2002 in a Hydrostratigraphic Unit 2 plume located in the western part of TFE in response to pumping. TCE declined from 220 parts per billion in 2001 to 76 parts per billion in one extraction well in 2002.

Hydrostratigraphic Unit 3A total VOC concentrations continued to decline in the T5475 area in 2002 due to a combination of soil vapor extraction and regional dewatering of Hydrostratigraphic Unit 3A. VOCs in Hydrostratigraphic Units 3A, 3B, and 4 declined in the south-central part of TFD in response to pumping. Hydrostratigraphic Unit 4 TCE concentrations also declined in the southwestern part of TFE due to ongoing pumping.

Significant decreases in Hydrostratigraphic Unit 5 VOC concentrations were observed in TFF406 during 2002 in response to groundwater extraction, particularly at SNL/CA south of East Avenue. TCE in one well at the leading edge of a TCE plume, declined from 27 parts per billion in 2001 to less than 0.5 part per billion in 2002. Closer to TFF406, TCE in one well declined from 31 parts per billion to 9 parts per billion over the same period.

Proposed Remedial Actions

LLNL and NNSA believe that the following proposed major milestones would continue to best meet the criteria established in the original 1992 CERCLA Record of Decision (ROD) for this site (DOE 1992a) and the most recent five-year review:

FY2004

- Begin Helipad source area remediation
- Begin TF518 perched-zone remediation
- Begin Southern East Traffic Circle source area remediation

FY2005

- Begin TFD hotspot remediation
- Begin TFE hotspot remediation
- Begin Northern East Traffic Circle source area remediation
- Begin TF406 hotspot remediation

FY2006

- Begin Building 419 source area remediation
- Begin TF406 South remediation

- Begin TFB/C source area remediation
- Begin Buildings 511/514 source area remediation
- Begin TF5475 South remediation

By the end of FY2006, NNSA expects that approximately 38 groundwater remediation systems will be in place. NNSA's ongoing investigations are focused on identifying all remaining sources of groundwater contamination. The goals of groundwater remediation are to remove contaminant mass, reduce contaminant concentrations, and contain the migration of the plumes. NNSA will continue to operate pump treat systems until cleanup levels are achieved. NNSA plans to manage remedial sites as part of the site-wide long-term stewardship effort.

4.17.2 Site Contamination—Site 300

4.17.2.1 *Contamination History*

LLNL Site 300 is a NNSA experimental test facility that conducts research, development, and testing associated with high explosives materials. During past Site 300 operations, contaminants were released to the environment from surface spills and pipe leaks, leaching from unlined landfills and pits, high explosive test detonations, and disposal of waste fluids in lagoons and dry wells. LLNL began environmental investigation and restoration activities in 1981, and the site was placed on the NPL in 1990. The primary contaminants of concern at Site 300 include VOCs, high explosive compounds, perchlorate, tritium, depleted uranium, nitrate, PCBs, dioxins, furans, silicone oils, and metals (Table 4.17.2.1–1).

All contaminant release sites at Site 300 are assigned to one of eight operable units (OUs) (see Figure 4.11.3.4–2), based on the nature and extent of contamination and hydrogeologic considerations. More detailed background information for Site 300 environmental characterization activities may be found in the *Final Site-wide Remedial Investigation Report, Lawrence Livermore National Laboratory Site 300* (LLNL 1994a, LLNL 1994b), and the *Final Site-wide Feasibility Study, Lawrence Livermore National Laboratory Site 300* (LLNL 1999d).

In 2001, NNSA and the regulatory agencies signed an interim site-wide ROD in which interim remedial actions were selected for the cleanup of Site 300. This ROD was designated as interim to ensure remediation activities commence while additional testing and evaluation of cleanup technologies occur and final groundwater cleanup standards are negotiated. The overall NNSA/LLNL remedial strategy for Site 300 is to achieve a rapid, efficient, and cost-effective cleanup within budgetary constraints and in compliance with regulatory requirements. The selected interim remedies are being implemented in phases using a prioritized, risk-based approach.

More detailed information for the interim remedial actions at Site 300 may be found in the *Interim Site-wide Record of Decision, Lawrence Livermore National Laboratory Site 300* (LLNL 2001u), and the *Remedial Design Work Plan for Interim Remedies at Lawrence Livermore National Laboratory Site 300* (LLNL 2001i).

TABLE 4.17.2.1–1.—*Major Groundwater Contaminants of Concern at Site 300*

Operable Unit (OU)	Contaminant(s) of Concern
General Services Area (GSA) (OU1)	VOCs (primarily TCE)
Building 834 Complex (OU2)	VOCs (primarily TCE), organosilicate oil, nitrate
High Explosives Process Area (OU4)	VOCs (primarily TCE), high explosive (primarily RDX), nitrate, perchlorate
Building 850/Pits 3 and 5 (OU5)	Tritium, depleted uranium, VOCs (primarily TCE), nitrate, perchlorate
Building 854 (OU6)	VOCs (primarily TCE), nitrate, perchlorate
Pit 6 (OU3)	VOCs (primarily TCE), tritium, nitrate, perchlorate
Building 832 Canyon (OU7)	VOCs (primarily TCE), nitrate, perchlorate
Site 300 (OU8)	VOCs (primarily TCE and Freon 113), nitrate, perchlorate, depleted uranium, tritium metals, RDX

Source: LLNL 2003l.
RDX = cyclo-1, 3, 5 – trimethylene – 2, 4, 6 - trinitramine; TCE = trichloroethene; VOC = volatile organic compound

4.17.2.2 *Operable Units*

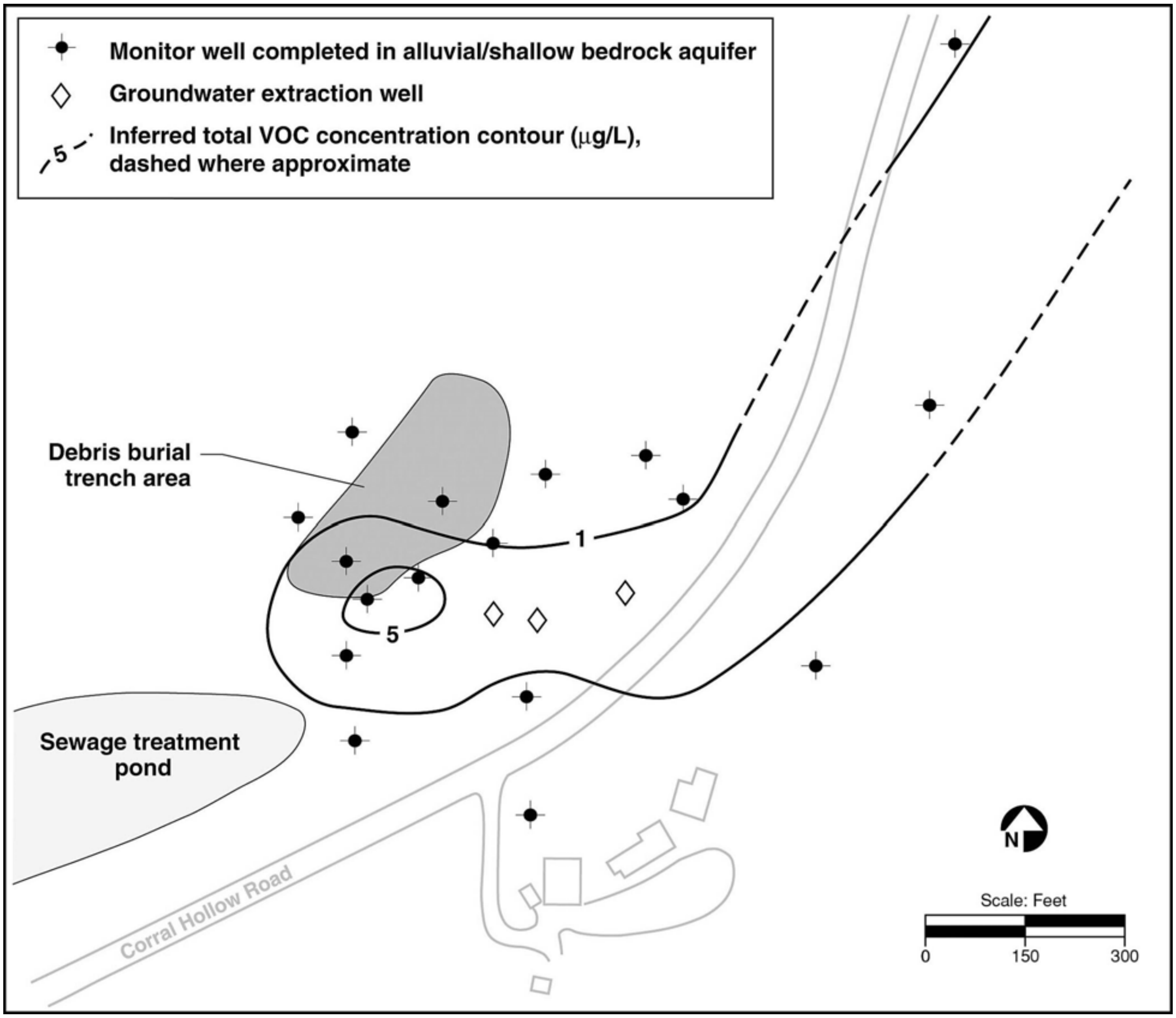
The following sections briefly summarize background information and characterization activities for each of the operable units.

General Services Area Operable Unit

TCE and other solvent-related VOCs were released to the soil and groundwater as a result of past activities in the craft shops and equipment fabrication and repair facilities in the GSA. For the purposes of remediation management, the GSA has been subdivided into the eastern and central GSA subareas, based on differences in contaminant sources and hydrogeology. The eastern and central GSA subareas are discussed individually below.

Eastern General Services Area

In the eastern GSA, the highest VOC concentrations in groundwater occur in the vicinity of a former debris burial trench area where craft shop debris was disposed of in the 1960s and 1970s. A VOC groundwater plume, shown in Figure 4.17.2.2–1, extends approximately 1,400 feet east and northeast of the burial trench area in the direction of alluvial groundwater flow. The depth to groundwater in this area is 10 to 30 feet below ground surface. The maximum total VOC concentration detected in groundwater collected from eastern GSA wells in the fourth quarter of 2002 was 7.5 micrograms per liter (LLNL 2003l).



Source: LLNL 2003l.

FIGURE 4.17.2.2–1.—*Total Volatile Organic Compound Concentrations in Groundwater in the Eastern General Services Area and Vicinity (Fourth Quarter, 2002)*

In 1991, an extraction and treatment system was installed and began to remove VOCs from groundwater. In 1997, an area-specific ROD was signed in which a remedial action for the cleanup of the eastern GSA was selected. The selected remedy includes continued groundwater vapor extraction and treatment. The volume of groundwater treated and mass of VOCs removed by the eastern GSA facility through 2002 are presented in Table 4.17.2.2–1. The eastern GSA treatment facility effluent discharge is regulated under an NPDES permit issued by the Central Valley RWQCB.

Before treatment commenced in 1991, a TCE groundwater plume extended more than a mile offsite. By 2001, the TCE plume, as defined by the 5-micrograms-per-liter TCE isoconcentration contour, was contained onsite with only two onsite wells containing TCE at concentrations slightly above the safe drinking water standard of 5 micrograms per liter. The effectiveness of the remediation effort in the eastern GSA is reevaluated every 5 years in the GSA Five-Year Review report (LLNL 2001ba).

TABLE 4.17.2.2–1.—*Volatile Organic Compounds Removed from Groundwater and Soil Vapor at Site 300 through 2002*

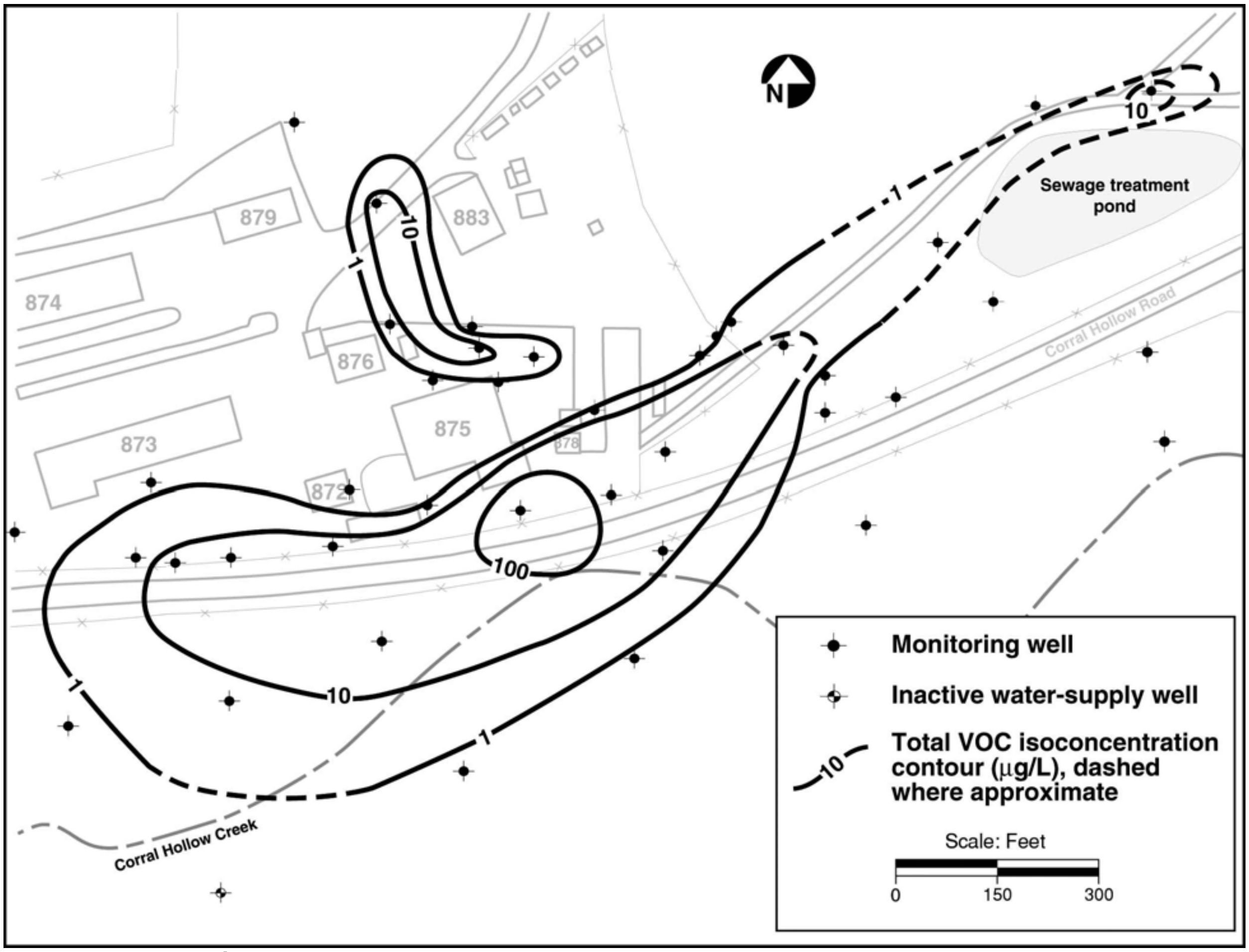
Treatment Area	2002			Cumulative Total	
	Startup Date	Water Treated (million liters)	VOCs Removed (kilograms)	Water Treated (million liters)	VOCs Removed (kilograms)
Eastern GSA	1991	78.7	0.17	806.6	6.19
Central GSA	1993	4.19	0.59	29.16	10.66
Building 834	1995	0.11	0.81	0.93	31.84
High Explosives Process Area	1999	4.5	0.012	10.5	0.058
Building 832	1999	1.90	0.12	5.68	0.44
Building 854	1999	3.67	0.78	12.25	6.14
Pit 6	1998	Not Applicable	Not Applicable	0.268	0.0014
Total		**93.1**	**2.48**	**865.4**	**55.33**
		Soil Vapor Treated (thousand cubic meters)	**VOCs Removed (kilograms)**	**Soil Vapor Treated (thousand cubic meters)**	**VOCs Removed (kilograms)**
Central GSA	1994	293.58	1.54	1,987.18	66.16
Building 834	1998	406.18	5.19	1,657.56	108.26
Building 832	1999	96.2	0.28	282.5	1.39
Total		**795.96**	**7.01**	**3,927.44**	**175.81**

Source: LLNL 2003l.
GSA = General Services Area; VOC = volatile organic compound.

Central General Services Area

In the central GSA, VOCs were released to the ground in wastewater from the craft and repair shops and as leaks/spills from solvent storage tanks or drums. TCE typically comprises 85 to 95 percent of the total VOCs detected in the subsurface. These releases originally affected approximately 33,900 cubic yards of soil onsite. Two VOC plumes in the central GSA, shown in Figure 4.17.2.2–2, are present in groundwater at a depth of 10 to 30 feet below ground surface. The northern plume is approximately 350 feet long and is contained onsite. The plume located south of Building 875 is approximately 1,600 feet long and extends about 250 feet offsite. TCE concentrations in groundwater in the central GSA area have decreased over time from an historical maximum of 240,000 micrograms per liter to 958 micrograms per liter in 2002. VOC concentrations in soil/bedrock have also been significantly reduced.

In 1995, an extraction and treatment system was installed in the central GSA to remediate VOCs in both soil/bedrock and groundwater. In 1997, an area-specific ROD was signed in which the remedial action for the cleanup of the central GSA was selected. The selected remedy includes continued groundwater and soil vapor extraction (SVE) and treatment. The volume of groundwater and soil vapor treated and mass of VOCs removed by the central GSA facility through 2002 are presented in Table 4.17.2.2–1. The central GSA treatment facility effluent discharge is regulated under Substantive Requirements for Wastewater Discharge issued by the Central Valley RWQCB. The effectiveness of the remediation effort in the central GSA is reevaluated every five years in the GSA Five-Year Review report (LLNL 2001ba).



Source: LLNL 2003l.

FIGURE 4.17.2.2–2.—*Total Volatile Organic Compound Concentrations in Groundwater in the Central General Services Area (Fourth Quarter, 2002)*

Building 834, Operable Unit 2

Facilities at the Building 834 Complex have been used since the late 1950s to conduct thermal-cycling experiments on weapon components. Aboveground pipes carried TCE-based heat-exchange fluid from the main buildings to and from surrounding test cells. Occasionally, TCE was mixed with silicone oil to prevent the degradation of pump seals and gaskets.

From 1962 to 1978, intermittent spills and piping leaks resulted in the contamination of the subsurface bedrock and shallow groundwater with TCE and silicone oils. These releases originally affected approximately 33,900 cubic yards of soil. The TCE groundwater contamination extends approximately 1,100 feet downgradient from the source area in several discrete, shallow, perched, water-bearing zones as shown in Figure 4.17.2.2–3. TCE concentrations in groundwater in the Building 834 area have decreased over time from an historical maximum of 800,000 micrograms per liter to 87,000 micrograms per liter in 2002. Nitrate contamination in groundwater results from septic system effluent but may also have natural sources.

In 1995, an extraction and treatment system was installed that simultaneously extracts contaminated soil vapor and groundwater from the subsurface. Studies have shown that natural biodegradation of TCE through anaerobic dehalogenation has been occurring in the source area of Building 834. Treatability studies, focusing on understanding and enhancing the bioremediation process, are underway.

An area-specific interim ROD was signed in 1995 that was superceded by the interim site-wide ROD in 2001. The selected interim remedy for Building 834 includes continued groundwater and SVE and treatment using an expanded well field. The volume of groundwater and soil vapor treated and mass of VOCs removed by the Building 834 facility through 2002 are presented in Table 4.17.2.2–1. The Building 834 treatment facility effluent discharge is regulated under Substantive Requirements for Wastewater Discharge issued by the Central Valley RWQCB. A five-year review was completed in 2002 to reevaluate the effectiveness of the remediation effort in the Building 834 operable unit (LLNL 2001ab).

High Explosives Process Area, Operable Unit 4

The High Explosives Process Area was established in the 1950s to chemically formulate, mechanically press, and machine high explosive compounds into detonation devices that are tested in explosive experiments at Site 300. The High Explosives Process Area Operable Unit includes Building 815, high explosive lagoons, high explosive burn pit release sites, and related downgradient groundwater plumes. Depth to groundwater in the High Explosives Process Area ranges from 30 to 250 feet below ground surface.

Surface spills at the former Building 815 steam plant resulted in TCE contaminant plumes that extend up to 3,000 feet from the source area (Figure 4.17.2.2–4). VOC concentrations in the Building 815 area have decreased over time from an historical maximum of 1,000 micrograms per liter to 80 micrograms per liter in 2002. In 1999, a groundwater extraction and treatment system was installed at the site boundary to prevent offsite migration of the TCE plume. In 2000 and 2002, additional extraction and treatment systems were installed at and downgradient from the Building 815 source area to remove TCE mass and prevent further plume migration.

From the late 1950s to 1985, wastewater containing high explosive compounds, nitrate, and perchlorate was discharged to unlined rinse water lagoons. These lagoons are thought to be the primary source of high explosive compounds, nitrate, and perchlorate in groundwater. The plumes of high explosive compounds and perchlorate extend approximately 700 and 2,000 feet, respectively, downgradient from the lagoon source area. High explosive compound concentrations have decreased with time. There is evidence that the nitrate present in groundwater is naturally attenuated through denitrification processes in the aquifer. The former rinse water lagoons were capped and closed in 1989 to prevent further releases of high explosive compounds and associated constituents (nitrate and perchlorate).

From the late 1950s to 1998, three burn pits were used to burn high explosive particulates and cuttings, explosive chemicals, and explosives-contaminated debris. High explosive compounds have been detected at low levels in soil but do not present a risk to human health or threat to groundwater. Groundwater data indicate that TCE, believed to be from a spill at an adjacent waste storage area, has affected groundwater. The high explosive burn pits were capped and closed under RCRA in 1998.

The selected interim remedy for the High Explosives Process Area Operable Unit includes continued and expanded groundwater extraction and treatment. The volume of groundwater and soil vapor treated and the mass of VOCs removed by the High Explosives Process Area treatment facilities through 2002 are presented in Table 4.17.2.2–1. The High Explosives Process Area treatment facility effluent discharges are regulated under Substantive Requirements for Wastewater Discharge issued by the Central Valley RWQCB.

Building 850/Pits 3 and 5, Operable Unit 5

The Building 850/Pits 3 and 5 Operable Unit includes the Building 850 firing table and sand pile, landfill Pits 3 and 5, and groundwater plumes originating at the Building 850 release site and Landfill Pits 2, 3, 5, and 7.

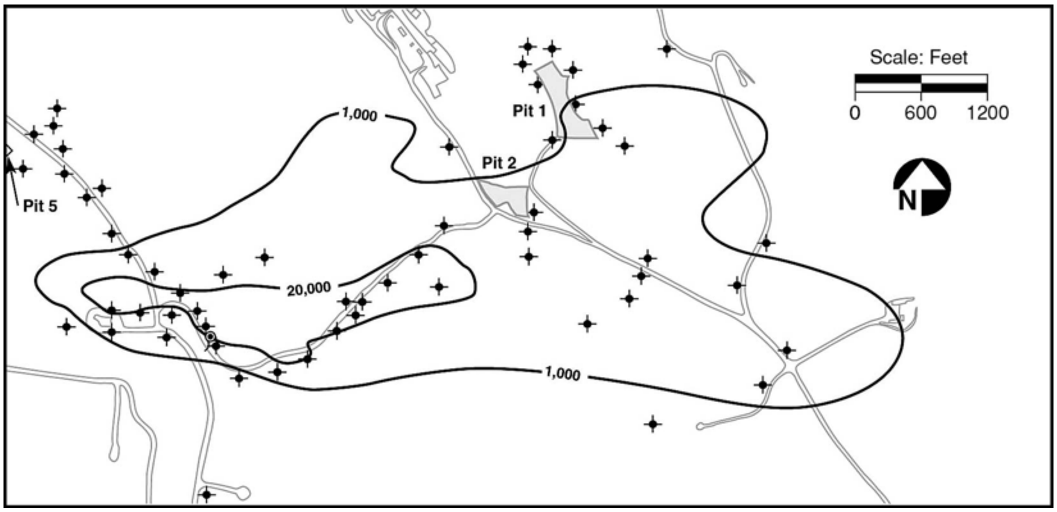
The Building 850 firing table has been used to conduct high explosive experiments since 1958. Tritium was used in some of these experiments, primarily between 1963 and 1978. As a result of the destruction and dispersal of test assembly debris during detonations, surface soil was contaminated with metals, PCBs, dioxins, furans, cyclotetramethylene tetranitramine, and depleted uranium. Leaching from firing table debris has resulted in tritium and depleted uranium in groundwater. Nitrate has also been identified in groundwater.

Gravel was removed from the firing table in 1988 and placed in the Pit 7 landfill. PCB-contaminated shrapnel and debris were removed from the area around the firing table in 1998. The selected remedy for the Building 850 area includes the excavation of the contaminated surface soil and a nearby sand pile as a final remedy and monitored natural attenuation of tritium in groundwater as an interim remedy.

Landfill Pits 3 and 5 were used from 1958 to 1967 to dispose of firing table debris and from 1968 to 1979, to dispose of firing table gravel. VOCs, tritium, depleted uranium, nitrate, and perchlorate were released from these landfills as a result of leaching of these contaminants from the pit waste. Data indicate continued releases of tritium are occurring as groundwater rises into the pits during high rainfall years (i.e., during El Niño). TCE concentrations in groundwater in the vicinity of the Pit 5 release area have decreased to below drinking water standards (5 micrograms per liter).

Depth to groundwater ranges from 15 to 65 feet below ground surface in Operable Unit 5. The tritium emanating from Pits 3 and 5 flows to the south-southeast in shallow alluvial groundwater and commingles with the tritium plume emanating from Building 850 (Figure 4.17.2.2–5). The total length of the commingled tritium plume is about 10,000 feet. Tritium has also been detected in bedrock groundwater that flows northeast of the pits. Concentrations of depleted uranium in groundwater near Pits 3 and 5 remain above drinking water standards while depleted uranium levels in groundwater in the vicinity of Building 850 are well below drinking water standards.

A remedial investigation/feasibility study is in progress for the Pits 3 and 5 areas. Source isolation and containment technologies are being evaluated to prevent further releases of tritium and uranium from the pits to groundwater. An amendment to the interim site-wide ROD is scheduled for 2006 in which a remedy for the Pits 3 and 5 areas will be selected.



Source: LLNL 2003l.

FIGURE 4.17.2.2–5.—*Distribution of Tritium in Groundwater in the First Water-Bearing Zone in Building 850/Pits 3 and 5 Operable Unit (Second Quarter, 2002)*

Building 854, Operable Unit 6

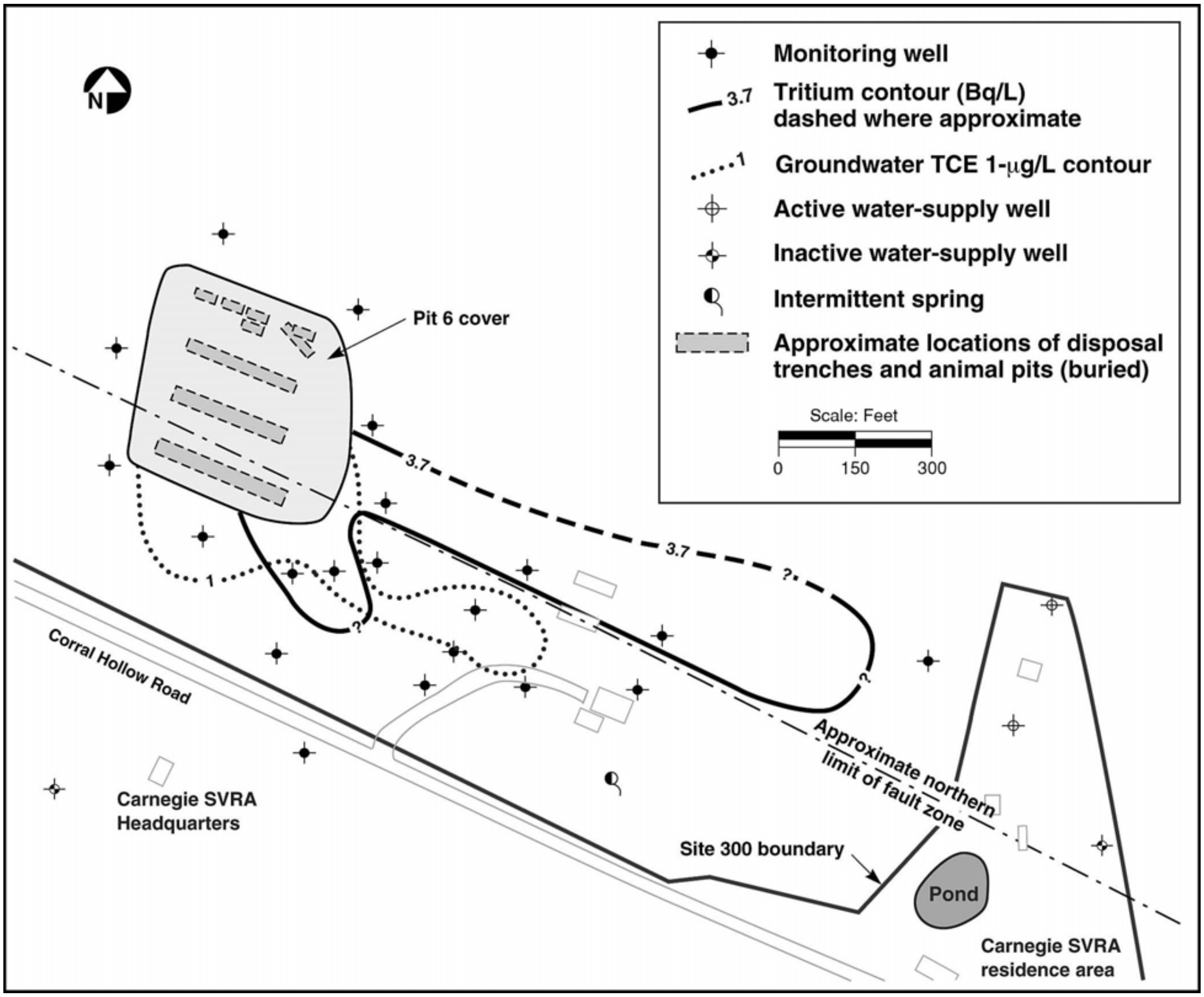
Facilities at the Building 854, 855, 856, and 857 complex were used between 1959 and 1970 to test the stability of weapons and weapon components under various environmental conditions and mechanical and thermal stresses. TCE was released to soil and groundwater through leaks and discharges of TCE-based heat exchange fluids from the brine system at Buildings 854D, E, and F. Discharge at the Building 854H drain outfall also resulted in releases of TCE to the ground surface. As a result, a plume of TCE extends approximately 3,000 feet from the Building 854 complex source area (Figure 4.17.2.2–6). The affected aquifer occurs at depths of 10 to 180 feet below ground surface. TCE concentrations in groundwater in the Building 854 area have decreased over time from an historical maximum of 2,900 micrograms per liter to 270 micrograms per liter in 2002. A septic system, located east of Building 855A, may have released nitrate to groundwater, although natural sources are likely to have contributed to nitrate mass as well. Perchlorate has also been detected in groundwater at concentrations exceeding the state action level.

The TCE brine system was removed in 1989. TCE-contaminated soil was excavated in 1983 in the vicinity of the Building 854H drain outfall and near Building 854F. Extraction and treatment systems were installed at and downgradient from the Building 854 source area in 1999 and 2000, respectively, to remove VOCs, nitrate, and perchlorate from the groundwater. The selected interim remedy for Building 854 includes groundwater and SVE and treatment. The volume of groundwater and soil vapor treated and mass of VOCs removed by the Building 854 treatment facilities through 2002 are presented in Table 4.17.2.2–1. The Building 854 treatment facility effluent discharges are regulated under Substantive Requirements for Wastewater Discharge issued by the Central Valley RWQCB.

Pit 6, Operable Unit 3

From 1964 to 1973, approximately 1,900 cubic yards of waste from the Livermore Site and Lawrence Berkeley National Laboratory were buried in 9 unlined trenches and animal pits at the Pit 6 landfill. As a result of rainwater percolating through the waste, VOCs (primarily TCE), tritium, nitrate, and perchlorate were released to the subsurface. These contaminants are present onsite in a shallow water-bearing zone approximately 80 feet below ground surface. VOC concentrations in groundwater have naturally attenuated by almost two orders of magnitude over the past few years and are near or below drinking water standards in all wells. Tritium activities exceed background in several wells, indicating a possible localized release. Maximum historical tritium activities in groundwater are well below the drinking water standard of 20,000 picocuries per liter. The extent of TCE in groundwater is shown in Figure 4.17.2.2–7. Perchlorate has been detected in several wells at concentrations above the state action level of 4 micrograms per liter.

In 1971, DOE/LLNL excavated portions of the waste contaminated with depleted uranium. In 1997, an engineered landfill cap was installed as a CERCLA removal action to prevent infiltrating precipitation from further leaching contaminants from the waste. Because of the decreasing TCE concentrations in groundwater, and the short half-life of tritium (12.3 years), the selected interim remedy for TCE and tritium at the Pit 6 landfill is monitored natural attenuation. During the period covered by the interim site-wide ROD, NNSA will continue evaluating the source, extent, and natural degradation of perchlorate and nitrate at the Pit 6 landfill. The interim remedy for these substances in groundwater is continued monitoring.



Source: LLNL 2003l.

FIGURE 4.17.2.2–7.—*Distribution of TCE in Groundwater in the Pit 6 Area (Fourth Quarter, 2002)*

Building 832 Canyon, Operable Unit 7

Contaminants, primarily VOCs, were released from Buildings 830 and 832 from the late 1950s to 1985 through piping leaks and surface spills. TCE was used as a heat exchange fluid as part of testing activities at these buildings. TCE concentrations in groundwater in the Building 830 area have decreased over time from an historical maximum of 30,000 micrograms per liter to 12,000 micrograms per liter maximum in 2002. As shown in Figure 4.17.2.2–8, TCE plumes extend approximately 4,600 feet downgradient from Buildings 830 and 832. Depth to groundwater ranges from 15 to 200 feet in this OU.

Nitrate and perchlorate are also present in groundwater at both Buildings 830 and 832. Nitrate contamination in groundwater may be the result of a combination of high explosive related testing and septic system releases, with a possible contribution from naturally occurring nitrate from local geologic units. High explosive compounds released may have degraded and migrated downward as nitrogenous compounds. Although the source of perchlorate is not known at this time, it may be that perchlorate was a component of high explosive test assemblies.

A groundwater and SVE and treatment system was installed at the Building 832 source area in 1999. Extraction and treatment systems were installed downgradient from the Building 830 source area and near the site boundary in 2000 to remove contaminant mass from groundwater and prevent the offsite migration of the plumes. The selected remedy for Buildings 830 and 832 includes continued soil vapor and groundwater extraction and treatment. The volume of groundwater and soil vapor treated and mass of VOCs removed by the Building 832 Canyon treatment facilities through 2002 are presented in Table 4.17.2.2–1. The Building 832 Canyon treatment facility effluent discharges are regulated under Substantive Requirements for Wastewater Discharge issued by the Central Valley RWQCB.

Site 300 Site-wide, Operable Unit 8

The Site 300 site-wide operable unit consists of several small release sites where active remediation is not required. These release sites include the Building 801D dry well and Pit 8 landfill, Building 833, the Building 845 firing table and Pit 9 landfill, and the Building 851 firing table.

Building 801D Dry Well and the Pit 8 Landfill

Waste fluid was discharged to a dry well located adjacent to Building 801D from the late 1950s to 1984, resulting in minor subsurface VOC contamination. VOC concentrations in groundwater are within drinking water standards. The dry well was decommissioned and filled with concrete in 1984. The adjacent Pit 8 landfill received debris from the Building 801 firing table until 1974, when it was covered with compacted soil. No contaminants have been detected in the vicinity of the landfill. The selected interim remedy for Building 801 and the Pit 8 landfill is enhanced vadose zone and groundwater monitoring of VOC concentrations to detect any future releases from the landfill.

Building 833

TCE was used as a heat-exchange fluid in the Building 833 area from 1959 to 1982 and was released through spills and rinse water disposal, resulting in minor VOC contamination of the shallow soil and perched, ephemeral groundwater. VOC concentrations have decreased over time, likely due to natural attenuation. The selected interim remedy for Building 833 is continued groundwater monitoring to ensure that TCE continues to attenuate.

Building 845 Firing Table and Pit 9 Landfill

High explosive experiments were conducted at the Building 845 firing table from 1958 to 1963. Leaching from firing table debris resulted in minor contamination of subsurface soil with depleted uranium and cyclotetramethylene tetranitramine. No groundwater contamination has been detected. Debris and gravel from the Building 845 firing table were routinely placed in the adjacent Pit 9 landfill. No unacceptable risk to human health has been associated with the Pit 9 landfill and there is no evidence of any release from the landfill. The selected interim remedy for the Building 845 firing table and Pit 9 landfill is enhanced vadose zone and groundwater monitoring to detect any future releases from the landfill.

Building 851 Firing Table

The Building 851 firing table has been used for high explosive research since 1982. These experiments resulted in minor VOC, depleted uranium, metals, and the high explosive compound cyclo-1,3,5-trimethylene-2,4,6-trinitramine (RDX) contamination in soils and groundwater. Contaminant concentrations in groundwater are below drinking water standards. No unacceptable risk to human health has been associated with contaminants in this area. In 1988, the firing table gravel was removed and has been replaced periodically since then. The selected interim remedy for Building 851 is continued groundwater monitoring to ensure that contaminant concentrations do not increase to a level presenting risk.

Continuing Characterization

Additional characterization is underway or planned at Building 865 (Advanced Test Accelerator), Building 812, and the former Sandia Test Site.

Building 865 (Advanced Test Accelerator)

The Building 865 area contains the Advanced Test Accelerator, a linear electron accelerator used for charged particle beam research, and control and support buildings. Freon-113 has been detected in groundwater monitor wells located downgradient from a former waste Freon-113 storage tank near the Building 865A machine shop. In 1988, the waste tank was removed and the use of Freon-113 was discontinued. Further characterization will be conducted at Building 865 to determine the nature and extent of contamination.

Building 812 Firing Table

The Building 812 firing table is used for explosives testing. Uranium-238 has been detected at activities up to 22,630 picocuries per liter in soil at a depth of 5 feet beneath the Building 812 firing table. Low activities of uranium-238 have been detected in groundwater collected from two cross-gradient wells near Building 812. Data are inadequate to confirm if contaminant releases have occurred in deeper soil/rock beneath the Building 812 firing table. Further characterization of the Building 812 firing table area is planned.

Sandia Test Site

SNL/CA operated a small, temporary firing table at Site 300 from about 1959 to 1960. The facility consisted of a portable steel building and six other smaller structures, surrounded by sandbags. The buildings and six structures, which are no longer present, may have been either high explosive test chambers or magazines used for storing high explosive materials. Shattered electronic components and structure remnants are still present on the ridge crest to the east and may represent the location of the firing table. Data are inadequate to confirm if contaminant releases have occurred at the Sandia Test Site. Further characterization of this area is planned.

4.17.2.3 *Remedial Actions*

Status of Remediation Efforts

Since 1992, dedicated groundwater and SVE and treatment facilities began operating at the eastern GSA, central GSA, and Building 834 areas. In 2002, eight portable treatment facilities also were operating. Thus, 11 treatment facilities that remove and treat VOCs operated throughout 2002. Twenty-one wells that extract only groundwater, 7 wells that extract only soil vapor, and 24 wells that extract both groundwater and soil vapor operated during 2002, treating 93.1 million liters of groundwater. The 24 wells that extract both vapor and groundwater and the 7 wells that extract only vapor removed 795,960 cubic meters of vapor. In 2002, the Site 300 groundwater and soil vapor treatment facilities removed 9.49 kilograms of VOCs. Since remediation efforts began in 1990, more than 865 million liters of groundwater and 3.93 million cubic meters of vapor have been treated, removing about 231 kilograms of VOCs. Table 4.17.2.2–1 summarizes CY2002 and cumulative totals of volumes and masses of contaminants removed from groundwater and soil vapor at Site 300.

The central GSA, eastern GSA, and two Building 830 treatment facilities discharge to surface drainage courses. Three treatment systems discharge to an infiltration trench. The other four treatment systems discharge to air by misting.

General Services Area

During 2002, the soil vapor extraction and treatment system in the central GSA dry-well source area was continuously operated and maintained to reduce VOC concentrations in soil vapors, remediate dense nonaqueous-phase liquids in the soil, and mitigate the VOC inhalation risk inside Building 875. The groundwater extraction and treatment systems in the central and eastern GSA areas were continuously operated and maintained to reduce VOC concentrations in the groundwater to MCLs, prevent further migration of the contaminant plume, and dewater the shallow water-bearing zone in the Building 875 dry-well area to enhance soil vapor extraction.

At the end of 2002, three wells were being considered for modification as extraction wells for the second phase of planned expansion to the groundwater extraction and treatment facility at central GSA. The addition of these extraction wells would enhance the system’s ability to capture the contaminant plume and increase the mass removal. Treatability tests were being scheduled to determine if passive venting of soil vapor extraction wells in the central GSA area would result in a suitable long-term remedial technology.

Groundwater treated at the eastern GSA groundwater treatment facility was discharged offsite to Corral Hollow Creek, in accordance with the waste discharge requirements order. The central GSA groundwater treatment system is operating under substantive requirements for wastewater discharge issued by the Central Valley RWQCB. Both the central and eastern GSA treatment systems operated in compliance with regulatory requirements during 2002. LLNL submitted quarterly reports for the GSA treatment systems to the California EPA and the Central Valley RWQCB in accordance with the waste discharge requirements order for the eastern GSA and the substantive requirements for waste discharge for the central GSA.

Building 834 Complex

At the end of 2002, groundwater and SVE treatment, using air sparging and granular-activated carbon, respectively, were in progress. Work was initiated during 2002 to expand the well field to wells outside of the core area. Testing the use of aqueous phase granular activated carbon for VOC removal from the groundwater continued during 2002. Plans were being made for the replacement of the current air-sparging system with aqueous-phase granular-activated carbon.

In 2002, the groundwater and SVE treatment systems were operated at full scale for the first half of the year. Equipment problems, followed by programmatic activities, prevented any facility operations for the remainder of the year. The Defense Technologies Evaluations Program began conducting experiments in October 2002. These experiments continued into 2003 and will likely affect future operations. LLNL had been observing a significant drop in both groundwater and soil vapor VOC concentrations in the Building 834 area over the last couple of years. These declining VOC concentrations and temporary suspension of treatment operation provided an opportune time to allow for rebound of contaminants. LLNL plans to conduct detailed monitoring activities following completion of the Defense Technologies Evaluations Program experiments to evaluate potential contaminant rebound in both the vapor and aqueous phase. In situ biodegradation, via reductive dechlorination of TCE, occurs in areas within the Building 834 core area where sufficient amounts of silicon oils exist. However, it was demonstrated that this intrinsic microbial degradation is inhibited during periods of active soil vapor extraction because the soil vapor extraction system draws oxygen-rich vapors into the subsurface and the microbes become dormant. In essence, the SVE system acts like an on/off switch to control biodegradation. As such, allowing the system to remain off-line will promote biodegradation and will achieve some level of mass removal, although this mass is not easily quantified.

During 2001, the combined groundwater and soil vapor VOC mass removal at Building 834 was 31.96 kilograms. During 2002, the combined VOC mass removal at Building 834 was 6.0 kilograms. Table 4.17.2.2–1 shows the volumes of water and soil vapor treated and masses of VOCs removed at Building 834. Quarterly reports for the Building 834 treatment facility were submitted to the EPA, California EPA, and the Central Valley RWQCB in accordance with the substantive requirements for waste discharge. Because treated groundwater is discharged to misters and is not discharged to the ground, there are no treatment system surface discharge permit requirements for Building 834.

TABLE 4.17.2.3–1.—*General Services Area Groundwater Treatment System Surface Discharge Permit Requirements*

Parameter	Treatment Facility	
	Central General Services Area	**Eastern General Services Area**
VOCs	Halogenated and aromatic VOCs	Halogenated VOCs
Maximum daily	5.0 µg/L	5.0 µg/L
Monthly median	0.5 µg/L	0.5 µg/L
Dissolved oxygen	Discharges shall not cause the concentrations of dissolved oxygen in the surface water drainage course to fall below 5.0 mg/L	Discharges shall not cause the concentrations of dissolved oxygen in the surface water drainage course to fall below 5.0 mg/L
pH (pH units)	Between 6.5 and 8.5, no receiving water alteration greater than ±0.5 units	Between 6.5 and 8.5, no receiving water alteration greater than ±0.5 units
Temperature	No alteration of ambient receiving water conditions more than 3°C	No alteration of ambient receiving water conditions more than 3°C
Place of discharge	To groundwater during dry weather and to surface water drainage course in eastern GSA canyon during wet weather	Corral Hollow Creek
Flow rate	272,500 L/day (30-day average daily dry weather maximum discharge limit)	272,500 L/day
Mineralization	Mineralization must be controlled to no more than a reasonable increment	Mineralization must be controlled to no more than a reasonable increment
Methods and detection limits for VOCs	EPA Method 601—detection limit of 0.5 µg/L EPA Method 602—method detection limit of 0.3 µg/L	EPA Method 601—detection limit of 0.5 µg/L

Source: LLNL 2003l.
°C = degrees Celsius; EPA = U.S. Environmental Protection Agency; GSA = General Services Area; L = liter; µg/L = micrograms per liter; VOC = volatile organic compound.

High Explosives Process Area

In 2002, Phase 3 of the High Explosives Process Area remedial strategy was implemented with the installation of two more extraction wells near the center of mass of the TCE plume. With the addition of these wells, five groundwater extraction wells are in the high explosives process area and the total extraction flow rate is about 30 liters per minute.

To date, more than 10 million liters of groundwater have been extracted and treated by the three existing facilities in the high explosives process area. As presented in Table 4.17.2.2–1, 4.5 million liters of groundwater were extracted and treated during 2002. In addition to removal of 0.027 kilogram of VOCs, 0.134 kilogram of RDX, 0.034 kilogram of perchlorate have also been removed from extracted groundwater. Quarterly reports for the high explosives process area treatment facilities were submitted to the EPA, California EPA, and the Central Valley RWQCB in accordance with the substantive requirements for waste discharge.

Building 854 Area

During 2002, LLNL continued to define the extent of TCE in groundwater and the conceptual hydrogeological model. Three new monitoring wells were installed within the central portion of the groundwater TCE plume.

During 2002, 3.67 million liters of groundwater were treated and discharged at the two treatment systems (Table 4.17.2.2–1). A mass of 780 grams of VOCs, primarily TCE, was removed from this groundwater. The Building 854 Operable Unit discharges were in accordance with the draft Central Valley RWQCB substantive requirements for the Building 832 canyon and Building 854 OUs.

Building 832 Canyon

Table 4.17.2.2–1 shows the volume of water treated and the mass of VOCs removed in the treatment systems during 2002. The Building 854 OU discharges were in accordance with the draft Central Valley RWQCB substantive requirements for the Building 832 canyon and Building 854 Operable Units. Progress of the pump-and-treat systems and groundwater monitoring results are published quarterly.

Building 850/Pits 3 and 5 Operable Unit

At the end of 2002, a remedial investigation/feasibility study was in process for the Pits 3 and 5 area. The anticipated remedial technologies to be implemented at the landfill site include source isolation to prevent further release of tritium and uranium to groundwater. These technologies may include an upgradient groundwater interceptor trench and surface and shallow subsurface water diversion. LLNL is testing reactive media, such as cow bone char and fish bones (apatite mineral sources) and other novel sorbents, for possible deployment in a permeable reactive barrier for removal of depleted uranium from groundwater downgradient Pits of 5 and 7.

Although tritium continues to leach into groundwater from vadose zone sources at Building 850, the long-term trend in total groundwater tritium activity in this portion of the tritium plume is one of decreasing activity at approximately the radioactive decay rate of tritium. The extent of the 20,000 picocuries per liter-MCL contour for this portion of the plume is shrinking.

Nitrate and perchlorate in the Building 850/Pits 3 and 5 area occurred at maximum concentrations of 86 milligrams per liter and 44 micrograms per liter, respectively, in 2002. Trace amounts of TCE (less than 6.4 micrograms per liter) are also present in groundwater near Pit 5.

To determine the appropriate remediation strategy for the Pits 3 and 5 landfills, LLNL is completing a water budget for the Pits 3 and 5 valley, continuing to build and calibrate a three-dimensional geological structural model and model of groundwater flow and contaminant transport, and evaluating several remediation strategies to keep water from entering the landfills. These techniques include subsurface groundwater interceptor trenches, shallow terraced drains, horizontal dewatering wells, landfill grouting, other forms of permeability reduction, and in situ geochemical techniques using sorbents, such as bone apatite, to immobilize uranium in groundwater.

LLNL is also conducting field studies to determine how water recharges the perched water-bearing zone and enters the landfills. These studies include monitoring of wells completed at shallow depths, horizontal wells, and terraced drains, all completed in the hillslope west of the landfills where much of the recharge that enters the landfills originates. Additionally, LLNL is conducting laboratory treatability tests of cow bone char and fish bone in removing uranium from Pits 3 and 5 groundwater. Cow bone char mixed with inert sand has been emplaced in a portion of the alluvial aquifer containing uranium at Pit 5 to test the in situ removal of uranium from area groundwater. Wells within and downgradient of this emplacement are being monitored to define the long-term chemical effectiveness and hydraulic characteristics of the emplaced material. If successful, this emplacement may be expanded as a long-term remedy for depleted uranium in groundwater.

Proposed Remedial Actions

In 1992, a CERCLA federal facility agreement formalized the cleanup process for Site 300 remedial actions. LLNL and NNSA believe that the following proposed major milestones would best meet the criteria established in the agreement (EPA 1992a), the Interim Site-wide ROD for LLNL Site 300 (LLNL 2001u), and the most recent five-year reviews:

FY2004

- Prepare the Building 854 Draft Final Interim Remedial Design Report
- Prepare the Building 854 Final Interim Remedial Design Report
- Prepare the Building 850 Draft Interim Remedial Design Report
- Prepare the Draft Remedial Investigation/Feasibility Study for the Pit 7 Complex
- Conduct a public workshop for the Pit 7 Complex Draft Remedial Investigation/Feasibility Study
- Prepare the Building 850 Draft Final Interim Remedial Design Report
- Prepare the Building 850 Final Interim Remedial Design Report
- Prepare the Draft Final Remedial Investigation/Feasibility Study for the Pit 7 Complex
- Prepare the Final Remedial Investigation/Feasibility Study for the Pit 7 Complex
- Prepare the Building 812 Characterization Summary Report
- Install monitor wells for Building 865 (Advanced Test Accelerator)
- Construct the Building 832-PRX groundwater extraction and treatment facility in the Building 832 Canyon Operable Unit

FY2005

- Prepare the Draft Proposed Plan for the Pit 7 Complex
- Prepare the Building 832 Canyon Draft Interim Remedial Design Report
- Prepare the Draft Final Proposed Plan for the Pit 7 Complex
- Prepare the Final Proposed Plan for the Pit 7 Complex
- Conduct a public meeting for the proposed plan for the Pit 7 Complex
- Prepare the Site-wide Draft Remediation Evaluation Summary Report
- Conduct a public workshop for the Site-wide Draft Remediation Evaluation Summary Report
- Prepare the Draft Amendment to the Interim Site-wide ROD for the Pit 7 Complex
- Prepare the Building 832 Canyon Draft Final Interim Remedial Design Report
- Remove contaminated surface soil at Building 850
- Remove the contaminated sand pile at Building 850
- Prepare the Building 832 Canyon Final Interim Remedial Design Report
- Prepare the Building 865 (Advanced Test Accelerator) Characterization Summary Report
- Conduct surface soil sampling for the Sandia Test Site
- Construct the Building 829-SRC groundwater extraction and treatment facility in the High Explosives Process Area Operable Unit
- Construct the Building 817-PRX groundwater extraction and treatment facility in the High Explosives Process Area Operable Unit

FY2006

- Prepare the Site-wide Draft Final Remediation Evaluation Summary Report
- Prepare the Site-wide Final Remedial Evaluation Summary Report
- Prepare the Draft Final Amendment to the Interim Site-wide ROD for the Pit 7 Complex
- Prepare the Site-wide Draft Proposed Plan for the Final ROD
- Prepare the Final Amendment to the Interim Site-wide ROD for the Pit 7 Complex

- Conduct a public workshop for the Site-wide Draft Proposed Plan
- Prepare the GSA Draft Five-Year Review
- Prepare the Site-wide Draft Final Proposed Plan for the Final ROD
- Prepare the Site-wide Final Proposed Plan for the Final ROD
- Prepare the Pit 7 Complex Draft Interim Remedial Design Report
- Conduct a public meeting for the Site-wide Draft Proposed Plan
- Prepare the GSA Draft Final Five-Year Review
- Prepare the Building 834 Draft Five-Year Review
- Prepare the GSA Final Five-Year Review
- Hook up the Building 830-PRX extraction wells to the Building 830-SRC groundwater treatment system in the Building 832 Canyon Operable Unit
- Construct the Building 830-DIS groundwater extraction and treatment facility in the Building 832 Canyon Operable Unit
- Prepare the Sandia Test Site Characterization Summary Report

FY2007

- Prepare the Site-wide Draft ROD
- Prepare the Pit 7 Complex Draft Final Interim Remedial Design Report
- Prepare the Pit 7 Complex Final Interim Remedial Design Report
- Prepare the Building 834 Draft Final Five-Year Review
- Conduct a public workshop for the Site-wide ROD
- Prepare the Building 834 Final Five-Year Review
- Prepare the Site-wide Draft Final ROD
- Prepare the Site-wide Final ROD
- Prepare the Site-wide Draft Revised Remedial Design Work Plan
- Expand the Building 817-PRX groundwater extraction and treatment facility in the former high explosive lagoon area

- Construct the Building 832-DIS groundwater extraction and treatment facility in the Building 832 Canyon Operable Unit

FY2008

- Prepare the Site-wide Draft Final Revised Remedial Design Work Plan
- Prepare the Site-wide Final Revised Remedial Design Work Plan
- Prepare the Site-wide Draft Revised Compliance Monitoring Plan/Contingency Plan for Final Remedies
- Prepare the Site-wide Draft Final Revised Compliance Monitoring Plan/Contingency Plan
- Prepare the Site-wide Final Revised Compliance Monitoring Plan/Contingency Plan
- Install enhanced monitoring systems at the Pit 2, Pit 8, and Pit 9 landfills

Consistent with the agreement, the final selected remedies and cleanup standards will not be determined until the issuance of the Site 300 final ROD, scheduled for 2007. The interim ROD covers additional testing and evaluation of technologies, proposed final cleanup standards, and proposed investigations. NNSA expects GWTSs and other remedial actions to be in place and operational by 2009. NNSA will continue to operate treatment systems until cleanup levels are achieved and to manage remedial sites as part of the site-wide long-term stewardship effort.

4.17.3 Environmental Impacts of Contamination

In the 1992 LLNL EIS/EIR, environmental impacts resulting from a no-remediation scenario were presented. For this LLNL SW/SPEIS, a no-remediation scenario is also presented.

The extent of groundwater and soil contamination at the Livermore Site and Site 300 is discussed earlier in this section. Cleanup and remediation are required by law and LLNL is fully committed to these efforts; however, for purposes of a complete analysis of the existing setting, this section discusses the environmental effects on the existing environment assuming there is no remediation.

Over the last 10 years, LLNL, with Federal and state approval, has been actively remediating known areas of contamination. If no remediation of groundwater or soils were to occur, environmental impacts could result, as summarized below.

4.17.3.1 *Livermore Site*

In 1991, as part of the evaluation of remedial alternatives for groundwater and soil cleanup at the Livermore Site conducted under the Federal Facility Agreement (FFA), a no-remediation alternative was evaluated to provide a baseline from which to evaluate the various remedial alternatives. As remedial alternatives were implemented, as would be expected, remediation efforts have reduced the extent and concentration of contaminants in the environment.

Based on 2002 information, potential environmental impacts that could occur as a result of the no-remediation scenario are summarized as follows:

- Exceedance of regulatory agency-approved levels would place DOE in a situation of noncompliance with state and Federal laws.
- Contaminants in the unsaturated zone could migrate to groundwater in some areas of the Livermore Site.
- Concentrations of contaminants in groundwater would exceed state and Federal regulatory levels over broader areas.
- Degradation of the Livermore area groundwater would occur over a larger area as contamination plumes resume migration. The contaminant plumes would again migrate downgradient toward local water supply wells and city of Livermore municipal wells. This could inhibit future beneficial uses of increasingly greater proportions of the aquifer system. Over time, however, reduction in chemical concentrations would occur through natural attenuation processes, including biodegradation, dispersion, and abiotic degradation.

Twelve active domestic drinking water supply wells and seven industrial and/or agricultural supply wells are located within 1 mile of the Livermore Site VOC groundwater plumes (Hong 2002). These wells are generally either transverse, cross gradient or upgradient, or are in a different groundwater regime; therefore, they do not appear to be in the direct (downgradient) flow path of the plumes. Should lateral dispersal be significant or should a change in groundwater flow direction occur (which are both highly unlikely scenarios based on existing data), these wells could be affected by the advancing plumes. Additionally, although further development of the groundwater resource in the vicinity of the VOC plumes for domestic consumption is unlikely, development of additional water sources for irrigation is highly possible.

Groundwater data gathered in the remedial efforts indicate that impacts from VOCs in groundwater have stabilized and are declining (LLNL 2003l). If remediation were to cease and if contaminated groundwater were to reach municipal wells, economic impacts associated with the loss of water resources to local water consumers could result. Water purveyors supplying water pumped from municipal wells to constituents would need to treat the contaminated water sources or purchase water from other sources, resulting in increased water costs. Given the estimated maximum concentrations of TCE (6 parts per billion) and perchloroethene (5 parts per billion) would occur after 950 years (the MCLs of both these VOCs are 5 parts per billion), the impact would be minimal (Toblin 2003). This is a conservative estimate in that no degradation is assumed.

Assuming that no remediation occurs and contamination reaches municipal wells and that an individual consumes 2 liters of water each day from a municipal well in downtown Livermore for a 70-year (lifetime) period, the maximum additional cancer risk from a lifetime exposure to VOCs (TCE and perchloroethene are assumed to be the VOCs for the purpose of health estimates) could be 2×10^{-6} (Toblin 2003). This risk is much lower than the normal 1 in 4 cancer risk faced by all Americans due to both natural and artificial (i.e., medical) radiation exposures.

Assuming that an individual consumes 2 liters of water each day from a hypothetical drinking water well located 250 feet west of the Livermore Site boundary for a 70-year (lifetime) period, the maximum additional cancer risk from exposure to these same constituents would be 8×10^{-6}, based on present concentrations (~50 parts per billion of VOCs). However, administrative controls discouraging the use of this water for drinking and the continued availability of municipal water would greatly reduce, if not eliminate, this possibility.

Under the no-remediation scenario, tritium could migrate through soils to groundwater and be transported by groundwater. By the time the tritium reached the Livermore Site boundary, however, the tritium would have naturally decayed to lower concentrations.

Chromium in groundwater would again migrate downgradient and offsite. However, the levels of chromium are so low that combined with further dilution and natural attenuation, chromium would not likely represent an offsite health threat.

4.17.3.2 *Site 300*

Environmental investigations and cleanup activities at Site 300 began in 1981. Site 300 became a CERCLA site in 1990, when it was placed on the NPL. At present, eight CERCLA environmental restoration Operable Units are being managed to mitigate contamination at Site 300. These Operable Units are the GSA; Building 834 Complex; High Explosives Process Area; Building 850/Pits 3 and 5; Building 854, Pit 6; Building 832 Canyon, and other areas at Site 300. Details of the extent of contamination and proposed remedial action strategies are presented in Section 4.17.3, Site Contamination—Site 300.

Based on 2002 information, environmental impacts that could occur as a result of the no-remediation scenario are summarized as follows:

- Exceedance of regulatory agency-approved levels would place DOE in a situation of noncompliance with state and Federal laws.
- Contaminants in unsaturated zone soil could migrate to groundwater in many of the Operable Units.
- Concentrations of contaminants in groundwater and soil could again exceed state and Federal regulatory levels.
- Degradation of Site 300 groundwater over a larger area could occur as the plumes resume migration. The VOC and other contaminant plumes would migrate downgradient toward the site boundaries.

Groundwater data gathered in the remedial efforts indicate that impacts have stabilized and are declining (LLNL 2003l). If the no-remediation scenario were to occur, this trend would reverse.

CHAPTER 5: ENVIRONMENTAL CONSEQUENCES

This chapter provides the scientific and analytical base for the comparison of the alternatives. Approaches used for addressing potential impacts are presented in Section 5.1.

The three alternatives analyzed in this *Site-wide Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory and Supplemental Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (LLNL SW/SPEIS) are the No Action Alternative (Section 5.2), Proposed Action (Section 5.3), and Reduced Operation Alternative (Section 5.4). Fifteen environmental resource elements are analyzed for each alternative:

- Land Uses and Applicable Plans
- Socioeconomic Characteristics and Environmental Justice
- Community Services
- Prehistoric and Historical Cultural Resources
- Aesthetics and Scenic Resources
- Geology and Soils
- Biological Resources
- Air Quality
- Water
- Noise
- Traffic and Transportation
- Utilities and Energy
- Materials and Waste Management
- Human Health and Safety
- Site Contamination

Bounding accident scenarios are presented in Section 5.5 and mitigation measurers are discussed in Section 5.6.

The impact analysis for this LLNL SW/SPEIS is based on the best data currently available. This LLNL SW/SPEIS will serve as a baseline document for the preparation of subsequent, tiered *National Environmental Policy Act* (NEPA) documents that may be required prior to implementation of future specific projects.

5.1 METHODOLOGY

The following paragraphs are brief descriptions of the impact assessment approaches used in the LLNL SW/SPEIS for addressing potential impacts of Lawrence Livermore National Laboratory (LLNL) operations under the No Action Alternative, Proposed Action, and Reduced Operation Alternative. Methodologies used for each resource area are discussed below to identify and, if possible, measure potential impacts.

5.1.1 Land Uses and Applicable Plans

To estimate possible impacts of the No Action Alternative, Proposed Action, and Reduced Operation Alternative, the land use analysis relied on information for current and planned facilities presented in Chapter 3 and Appendix A of this LLNL SW/SPEIS. A comparative methodology was used to determine land use impacts from the project alternatives in terms of function and acreage. Facility operations and particularly any facility construction activities were examined and compared to existing land use conditions. Impacts, if any, were identified as they relate to changes in land ownership and land use classifications as well as conflicting uses.

5.1.2 Socioeconomic Characteristics and Environmental Justice

The socioeconomic analysis measured the incremental effects from changes in expenditures, income, and employment associated with the No Action Alternative, Proposed Action, and Reduced Operation Alternative at LLNL, as well as their overall effect on the region of influence (ROI). The ROI, as described in Chapter 4 of the LLNL SW/SPEIS, is a four-county area surrounding LLNL where 93 percent of LLNL employees and their families live, spend their wages and salaries, and use their benefits. Impacts for the Livermore Site were analyzed in combination with those for Site 300 for population and housing because of the overlap in employee residence locations, and because employee statistics for non-LLNL employees are not available by individual site.

Spending by LLNL directly affects the ROI in terms of dollars of expenditures gained or lost for individuals and businesses, dollars of income gained or lost to households, and the number of jobs created or lost. Changes in employment at LLNL directly affect the overall economic and social activities of the communities and people living in the ROI. These changes directly affect the amount of income received by individuals and businesses. Businesses and households in the ROI respend LLNL money, which creates indirect socioeconomic effects from LLNL operations. Every subsequent respending of money by businesses and households in the ROI is another tier of indirect and induced socioeconomic effects originating from LLNL operations.

The analysis compared the magnitude of LLNL employment changes to the year 2014 with future employment, population, and housing levels. Determination of impacts was based on the percentage of these future levels that are attributable to LLNL influence.

Estimates of the geographic distribution of residences of potential new hires associated with the No Action Alternative, Proposed Action, and Reduced Operation Alternative were based on the existing distribution of the workforce residences. This demographic pattern could change over the project period due to various economic and quality of life factors. Indeed, a trend toward more employees living outside of the nearby communities of Livermore and Pleasanton has been observed in the past 11 years. From 1991 to 2002, the percentage of LLNL employees living in Livermore and Pleasanton has decreased from 49.3 percent to 43.2 percent. Only part of the redistribution has been to the Central Valley cities of Tracy, Manteca, Modesto, and Stockton (17.5 percent in 1991 increasing to 18.7 percent in 2002), as employees balance factors such as housing costs, commute times, and quality of schools. For purposes of this analysis, no change in the distribution was assumed because there could be limiting factors to redistribution such as significantly longer commute times from traffic congestion, the calculations of which were beyond the scope of this LLNL SW/SPEIS.

The potential for disproportionately high and adverse human health or environmental impacts from the alternatives on minority and low-income populations was examined in accordance with Executive Order (EO) 12898, *Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations* (59 FR 7629). Both the *Environmental Justice Guidance Under the National Environmental Policy Act* (CEQ 1997) and the *Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses* (EPA 2002a) provide guidance for identifying minority and low-income populations and determining whether the human health and environmental effects on these populations are disproportionately high and adverse. The environmental justice analysis presents selected demographics and identifies the locations of minority and low-income populations living within a 50-mile radius of LLNL.

5.1.3 Community Services

The community services analysis measured effects on four local government support services: fire protection and emergency services, police protection and security services, school services, and nonhazardous solid waste disposal.

The analysis evaluated the burden placed on each of these support services by changes in LLNL demands under the No Action Alternative, Proposed Action, and Reduced Operation Alternative. In the case of impacts to school services resulting from changes in LLNL staffing levels, the analysis directly examined the increases or decreases in the number of children of LLNL employees attending schools. For the other community services, the analysis relied on indirect indicators of service needed, as data does not support the establishment of a relationship between activities under each alternative and demand for these services. In the case of fire protection, the analysis assumed changes in the demand for service would be proportional to gross square footage of usable floorspace across LLNL. In the cases of police protection and nonhazardous solid waste disposal, the analysis assumed changes in demand for service would be proportional to the number of LLNL employees.

5.1.4 Prehistoric and Historic Cultural Resources

Section 106 of the *National Historic Preservation Act* (NHPA) and its implementing regulations (36 CFR Part 800) state that an undertaking has an effect on a historic property when that undertaking may alter those characteristics of the property that qualify it for inclusion in the National Register of Historic Places (NRHP). An undertaking is considered to have an adverse effect on a historic property when it diminishes the integrity of the property's location, design, setting, materials, workmanship, feeling, or association.

Adverse effects include, but are not limited to:

- Physical destruction, damage, or alteration of all or part of the property
- Isolation of the property or alteration of the character of the property's setting when that character contributes to the property's qualifications for the NRHP
- Introduction of visual, audible, or atmospheric elements that are out of character with the property, or changes that alter its setting
- Neglect of a property resulting in its deterioration or destruction
- Transfer, lease, or sale of a property, without adequate provision to protect the property's historic integrity

The analysis addressed potential impacts or effects to NRHP-eligible resources located within the boundaries of the Livermore Site and Site 300. Proposed activities under the three alternatives were reviewed to identify those that would cause ground disturbance, introduce visual or audible changes, or make changes to existing buildings and structures. The proposed activities were then analyzed to determine if they would cause adverse effects to NRHP-eligible resources.

To fulfill its responsibilities under the NHPA, a Programmatic Agreement has been developed among the National Nuclear Security Administration (NNSA), the Advisory Council on Historic Preservation (ACHP), the California State Historic Preservation Officer (SHPO), and LLNL (Appendix G). The Programmatic Agreement is a guideline for NNSA to comply with Section 106 for all present and future actions until management plans are completed and this interim Programmatic Agreement is superseded by an agreement to implement the plans. The Programmatic Agreement was signed on July 11, 2003. Provisions of the Programmatic Agreement would serve as components of mitigation measures.

5.1.5 Aesthetics and Scenic Resources

The aesthetics and scenic resources analysis looked at the construction and operation of facilities described under the No Action Alternative, Proposed Action, and Reduced Operation Alternative and the resulting effects to the visual quality of the ROI. The ROI includes the Livermore Site and Site 300, as well as the view shed immediately surrounding these two areas.

The analysis of impacts to aesthetics and scenic resources used a comparative methodology and included a qualitative examination of potential changes to view sheds and viewpoints. Proposed activities under the No Action Alternative, Proposed Action, and Reduced Operation Alternative that would result in a change to the built environment on the Livermore Site and Site 300 were of particular interest. Construction of new facilities, extensive modification of existing facilities, and demolition of existing facilities associated with each alternative were examined, and any resulting changes were analyzed for potential impact to the existing aesthetic and scenic environment. Analysis focused on site development or modification activities that would alter the visibility of LLNL structures, obscure views of the surrounding landscape, or conflict with aesthetics or scenic resources in the surrounding area.

5.1.6 Geology and Soils

The geology and soils analysis looked at the effects of the construction and operation of facilities and of activities described in the No Action Alternative, Proposed Action, and Reduced Operation Alternative in the ROI. The ROI includes the lands occupied by and immediately surrounding the Livermore Site and Site 300.

The analyses evaluated the amount of disturbance that might affect the geology and/or soils of areas at the Livermore Site and Site 300. Impacts could include erosion and effects to potential geologic economic resources, such as mineral and construction material resources and fossil locations. In general, impacts to soils were defined as taking areas with soils that support agriculture out of production. Impacts to soils were quantified as the amount of area disturbed by construction activities. Impacts are evaluated and the severity of impacts are determined. Possible mitigation is identified for adverse impacts.

The seismicity of the region surrounding each site was evaluated to provide perspective on the probability and severity of future earthquakes in the area. This information was used to provide input to the evaluation of accidents due to natural phenomena.

5.1.7 Biological Resources

A qualitative analysis addresses the impacts of the activities under each alternative to biological resources. The methodology focused on those biological resources with the potential to be appreciably affected, and for which analyses assessing alternative impacts were possible. Biological resources include vegetation, wildlife, protected and sensitive species, and wetlands that are present or use the Livermore Site, Site 300, and contiguous areas. The potential sources of impacts from normal operations and security measures to biological resources that were considered include noise, outdoor tests, erosion, construction, demolition, and prescribed burns.

The biological data from earlier projects, wetlands surveys, and plant and animal inventories of portions of the Livermore Site and Site 300 were reviewed to identify the locations of plant and animal species and wetlands. Lists of sensitive species potentially present on the Livermore Site and Site 300 and areas designated as critical habitat were obtained from the U.S. Fish and Wildlife Service (USFWS). A similar request was made to the California Department of Fish and Game.

Activities and potential releases identified under the No Action Alternative, Proposed Action, and Reduced Operation Alternative were reviewed for their potential to affect plants, animals, and the sensitive species under Federal and state laws and regulations. Potential beneficial and negative impacts to plants and animals were evaluated for gain, loss, disturbance, or displacement. Impacts to wetlands were evaluated to determine if their areal extent would change. Monitoring data on sensitive plants and animals were reviewed for impact to these resources.

5.1.8 Air Quality

5.1.8.1 *Nonradiological Air Quality*

The primary activities that emit air pollutants, associated with current and continued laboratory operations, include fuel combustion in boilers and emergency generators, vehicular activity particularly with employees commuting to and from the site, and construction and maintenance activities. Air pollutant emission rates and potential impacts of these activities were assessed using standard methods endorsed by the U.S. Environmental Protection Agency (EPA) and local air pollution control agencies (BAAQMD 1999, EPA 2003c). As available, site-specific parameters developed by local air quality regulatory agencies were incorporated and conservative assumptions were used so as not to underestimate the potential impact.

The assessment of impacts from increased vehicular activity follows a methodology developed by the Bay Area Air Quality Management District (BAAQMD) in conjunction with the California Air Resources Board (CARB), Association of Bay Area Governments (ABAG), and the Metropolitan Transit Commission. The method took into account the current and projected typical mix of vehicles (fleet type and age), gasoline formulations, ambient temperature, effectiveness of vehicle inspection and maintenance programs, typical driving habits, the impact of planned regulatory program requirements for more efficient engines and cleaner burning fuels, and reduction in vehicle miles traveled resulting from planned transportation demand management. In addition to estimating emissions from vehicles, maximum potential carbon monoxide concentrations are assessed along congested corridors to determine whether increased motor vehicle use associated with new projects would contribute to a carbon monoxide level that would exceed ambient air quality standards. This assessment considered projected peak hourly traffic volumes along Vasco Road and Patterson Pass Road, which serve the major flow of traffic to LLNL.

As a final assessment, total emissions from project operations (including motor vehicle emissions) were compared to significance and conformity levels. Annual and daily significant emission levels are established by local air districts in response to local air quality concerns. By evaluating project emissions as a whole, including motor vehicle emissions, this affords the air district a greater level of control over a project not limited to source permitting. A project that generates criteria air pollutant emissions in excess of the significance levels would be considered to have a significant air quality impact and stringent mitigation would be required. Rules for conformity also consider total project emissions. These rules were established under the Federal *Clean Air Act* (CAA) and pertain specifically to Federal actions. The underlying basis for the conformity demonstration is to preclude actions that would generate growth in air pollutants to a degree that is inconsistent with the local clean air plan, and thereby frustrate regional efforts to attain and maintain the National Ambient Air Quality Standards (NAAQS). Within the Bay Area, projects that generate emissions of precursor organic compounds, oxides of nitrogen, or carbon monoxide in excess of 100 tons per year are required to fully offset or mitigate the emissions caused by the action (BAAQMD 1999).

In addition to operational emissions, construction activities, although generally short-term in duration, can cause substantial increases in localized concentrations of particulates. Particulate emission rates vary greatly depending on the level of activity, the specific operations taking place, the equipment being operated, local soils, weather conditions and other factors. Despite this variability in emissions, experience has shown that there are a number of feasible control measures that can be reasonably implemented to significantly reduce particulate matter emissions from construction. The BAAQMD's approach to analyses of construction impacts relative to signifigance levels is to emphasize implementation of effective and comprehensive control measures rather than detailed quantification of emissions. From the district's perspective, quantification of construction emissions is not necessary; the determination of significance with respect to construction emissions should be based on a consideration of the control measures to be implemented (BAAQMD 1999). However, a conformity analysis requires quantification of construction related emissions.

The BAAQMD has identified a three-tiered set of feasible control measures designed to reduce emissions of respirable sized particulates (PM_{10}) from construction activities: Basic Measures should be implemented at all construction sites, regardless of size; Enhanced Measures should be implemented at larger construction sites (greater than 4 acres) where PM_{10} emissions generally would be higher; and Optional Measures may be implemented if further emission reductions are deemed necessary by local agencies. If all of the control measures depending on the size of the project area would be implemented, then air pollutant emissions from construction activities would be considered a minor impact. Similarly, any demolition, renovation, or removal of asbestos-containing building materials would be considered a minor impact if the activity complies with the requirements and limitations of BAAQMD Regulation 11, Rule 2: Hazardous Materials, Asbestos Demolition, Renovation and Manufacturing (BAAQMD 1999).

5.1.8.2 *Radiological Air Quality*

Routine radiological emissions from LLNL facility operations were evaluated on the basis of dose to the site-wide maximally exposed individual (MEI) and collective dose to the general population within 50 miles of the site (population dose). Section 5.1.14 presents further information on health effects from nonradiological and radiological emissions. The MEI evaluation was compared to the National Emissions Standards for Hazardous Air Pollutants (NESHAP) (40 CFR Part 61). NESHAP limits the radiation dose that a member of the public may receive from radiological material released to the atmosphere from normal operations to 10 millirem per year. Although there is no standard that governs population dose, it is compared with the population dose received from naturally occurring radiation.

The baseline year for radiological emissions was taken as 2002. The effect of perturbations to individual facility emissions on MEI dose for the various alternatives was considered by scaling the baseline facility dose given in the *LLNL NESHAP 2002 Annual Report* (LLNL 2003z). The contribution of new facilities or releases (e.g., the National Ignition Facility [NIF]) on MEI dose and location was calculated using the EPA-approved *Clean Air Assessment Package* (CAP88-PC 2000) computer model. CAP88-PC, used also in the NESHAP annual report, conservatively calculates radiological impacts extending up to 50 miles. Doses from both internal (e.g., inhalation, ingestion of foodstuffs) and external exposure (e.g., standing on ground contaminated with radioactive material) were considered. Spatial population distributions at each site were based on 2000 data. Agricultural data used were for the State of California, as contained in the CAP88-PC database. It was assumed that the entire source of ingested vegetables and meat is grown within the affected area. No milk production was found in the area; all milk was assumed imported from outside the area.

The MEI is a hypothetical member of the public assumed to be located outdoors in a public area where the radiation dose from a particular source is highest. This individual is assumed to be exposed to the entire plume in an unshielded condition. The impacts on the MEI are therefore greater than the impacts that any member of the public can be expected to receive. The site-wide MEI is located where the composite dose from all site sources is greatest. The two LLNL sites, Livermore and Site 300, are far enough apart that the site-wide MEI from each does not affect the other. A separate site-wide MEI is defined for each of the two LLNL sites. Similarly, separate collective doses to the population are noted for each of the two sites. Since there is overlap in the affected site populations, a composite collective dose is also noted.

5.1.9 Water

Surface Water

The affected environment discussion includes a description of local surface water resources at the Livermore Site and Site 300, flow characteristics and relationships, and existing water quality. Data used for impact assessments included rates of water consumption and wastewater discharge. The existing water supply was evaluated to determine if sufficient quantities were available to support an increased demand by comparing projected increases with the capacity of the supplier.

The water quality of potentially affected receiving waters was determined by reviewing current monitoring data for contaminants of concern. Potential impacts from releases of radioactive materials are discussed in Appendix C, Section C.4, Environment, Safety, and Health. Focus was given to parameters that exceeded applicable water quality criteria as determined by the State of California. Monitoring reports for discharges permitted under the National Pollutant Discharge Elimination System (NPDES) were examined for compliance with permit limits and requirements. The assessment of water quality impacts from wastewater (sanitary and process) and stormwater runoff addressed potential impacts to the receiving waters’ average flow during construction and operation. Suitable mitigation measures for potential impacts such as stream channel erosion, sedimentation, and stream bank flooding were identified.

Floodplains were identified to determine whether any of the proposed facilities would be located within the 100-year and 500-year floodplains.

Groundwater

Groundwater resources were analyzed for effects on aquifers, groundwater use and storage, and groundwater quality within the regions. Groundwater resources were defined as the aquifers underlying the site and their extensions downgradient, including discharge points. The affected environment discussion included a description of the local hydrogeology, occurrence, flow, and quality. Groundwater usage was described and projections of future usage were made based on changing patterns of usage and anticipated growth patterns.

Available data on existing groundwater quality were compared to Federal and state groundwater quality standards, effluent limitations, and safe drinking water standards. Additionally, Federal and state permitting requirements for groundwater withdrawal and discharge were identified. Impacts of groundwater withdrawals on existing contaminant plumes due to construction and facility operations were assessed to determine the potential for changes in their rates of migration and the effects of any changes in the plumes on groundwater users. Impacts were assessed by evaluating local hydrogeology, groundwater quality, and groundwater availability.

5.1.10 Noise

Various activities at LLNL result in noise that may be heard in surrounding offsite locations. To understand the potential impact of planned or proposed activities, noise levels attributed to activities such as construction, demolition, and operating equipment were characterized in terms of decibel level and described in relation to comparative noise levels of activities commonly encountered in community settings and land use compatibility guidelines. For noncontinuous sources, such as construction, demolition, and the unique impulse noise associated with explosives firings, activity levels were provided to give a sense of the amount of time that intermittent sources would be operated and contribute to ambient noise levels. Source location is also discussed where proximity to community receptors would result in a higher likelihood that a source would be heard in offsite areas.

5.1.11 Traffic and Transportation

NNSA selected traffic congestion and collective radiation dose and latent cancer fatalities (LCFs) to the general population as analytical endpoints for the transportation analysis. Traffic congestion was determined by qualitatively comparing current traffic levels with projected employment changes for the various alternatives. Radiological doses from transport of radioactive materials and wastes were calculated by computer modeling. The radiological transportation analysis methodology is summarized below. Appendix J, Radiological Transportation Analysis Methodology, provides additional information on methods and assumptions for the radiological transportation analysis.

All transportation of radioactive materials was assumed to take place by truck. LLNL identified origin-destination pairs for each shipment campaign. NNSA then used the Transportation Routing Analysis Geographic Information System (TRAGIS) computer code (ORNL 2000) to determine the most suitable routing. TRAGIS was constrained to only provide routes consistent with the U.S. Department of Transportation's highway route-controlled quantity regulations. Besides identifying the route, TRAGIS provided useful inputs to the remainder of the modeling such as miles per population density category and population within 800 meters of the route for each state and population density category.

NNSA then used the U.S. Department of Energy (DOE) code, RADTRAN 5 (SNL 2000), to calculate incident-free radiological impacts (normal transport without any accident releasing radioactive materials) to a member of the public. Members of the public are those residing within 800 meters of the route, those sharing the route in other vehicles, and those near the shipment at rest stops. Besides route length and demographics, the radiation dose 1 meter from the truck was the most important parameter. NNSA used a dose rate of 1 millirem per hour for shipments of special nuclear material and low-level waste (LLW) and 4 millirem per hour for transuranic (TRU) waste. RADTRAN 5 was used to calculate the collective dose for each type of material shipped between the various origin-destination pairs. The results were then multiplied by the numbers of shipments for each campaign.

For accidents, NNSA used RADTRAN 5 to calculate the collective dose should an accident occur. NNSA conservatively selected the highest consequence accident in the most populated area to report.

Collective doses from incident-free and accident analyses were multiplied by the conversion factor for converting collective dose to numbers of LCFs. This factor is 6×10^{-4} LCFs per person-rem, as determined by the Interagency Steering Committee on Radiation Standards (Lawrence 2002).

5.1.12 Utilities and Energy

Incremental changes to utilities and energy use at both the Livermore Site and Site 300 were assessed by comparing the support requirements of the alternatives to current site utility demands (e.g., water, sewer, electricity, fuel) based on projected square footage requirements and available capacities. Utility usage at each site was adjusted for contributions from the selected facilities and program projections. Three programs, the Advanced Materials Program, the NIF, and the Terascale Simulation Facility, were specifically evaluated for impacts. Impacts of other facilities and programs were evaluated based on average use per square foot.

5.1.13 Materials and Waste Management

Materials include chemicals, radioactive materials, or explosives that were used by LLNL in operations or research. Materials do not include waste. The methodology used to determine environmental impacts of the proposed alternatives on waste and materials management involves a three-step screening analysis as illustrated in Figure 5.1.13–1.

- Step 1 performs an initial screening analysis of new or modified projects or proposals, historical data, projections based on activity levels, permit modifications, changed circumstances, and new regulations. The initial screening analysis determines the specific environmental impact categories (e.g., air quality) that may exceed the bounds of the affected environment (existing conditions), as described in Section 4.15, Materials and Waste Management.

- Step 2 analyzes those impact categories that are likely to exceed the material and waste management existing or No Action Alternative conditions.

- Step 3 assesses the material and waste management to determine the environmental consequences of the increase or decrease to the affected environment or No Action Alternative.

The material management analysis examined potential impacts associated with material handling, management, and storage activities at LLNL, including radioactive materials, explosives, and hazardous chemicals. Impacts from nonhazardous materials are not discussed due to reduced risk to human health and the environment. The ongoing material management practices related to handling, using, and storing materials are described below. The analysis also considered the regulatory framework as it applies to material management and a summary of current and projected material management activities. Selected facilities or activities that use materials were evaluated for changes in the existing or No Action Alternative operations quantity of materials used as a result of the alternatives. LLNL storage capacities were evaluated for any impacts on their capabilities to manage materials before receipt. The analysis of potential impacts considered physical safety, regulatory requirements, and security measures associated with storage capacity, personnel safety, and usage capacity.

The waste management analysis examines potential impacts associated with waste generation activities at LLNL, including LLW, mixed low-level waste (MLLW), TRU, mixed TRU, hazardous waste, *Resource Conservation and Recovery Act* (RCRA) construction waste, decontamination and decommissioning (D&D) waste, municipal solid waste, and process (including domestic) wastewater. The ongoing waste management practices relating to generating, handling, treating, permits modifications, and storing wastes are described. The analysis also presents a summary of the regulatory framework as it applies to waste management and a summary of current and projected waste generation activities. Selected facilities or activities that generate waste were evaluated for changes in the existing or No Action Alternative quantity of waste generated as a result of the alternatives. LLNL treatment and storage facilities were evaluated for any impacts on their capabilities to manage wastes before transportation to offsite disposal. At LLNL, several organizations manage waste at waste management facilities including Plant Engineering, Chemistry and Materials Science Directorate, and the Radioactive and Hazardous Waste Division. For simplicity, the term Radioactive and Hazardous Waste Management (RHWM) covers all of these organizations. The analysis of potential impacts considered physical safety, regulatory requirements, and security measures associated with storage capacity, personnel safety, and treatment capacity.

A quantity projected under the No Action Alternative represents the maximum average quantity reported for any year during the 10-year timeframe 1993-2002. Waste volume and material maximum inventory estimates are considered to be conservative and bounding based on current annual projections.

For each selected facility, the waste and material quantity projected under the Proposed Action represents the maximum possible waste and material generation level, and thus the bounding level of operation. This applies to all waste types including LLW, MLLW, and hazardous waste and all material types including radioactive, explosive, and chemical.

A quantity projected under the Reduced Operation Alternative represents that of waste generated or material used during any given year as a result of maintaining programmatic capabilities across LLNL at minimum operational levels.

5.1.14 Human Health and Safety

LLNL operations that could potentially impact human health and safety include radiological and nonradiological exposures and occupational injuries, illnesses, and fatalities resulting from normal, accident-free operations on site facilities. Impacts are given in LCFs, emergency response planning guideline (ERPG) values, injury and illness recordable cases, and lost/restricted workday cases. The following paragraphs discuss how each of these human health and safety issues is estimated. Impacts are estimated for involved workers, noninvolved workers, and the public. See Appendix C of this LLNL SW/SPEIS for detailed methodology on human health and safety.

Nonradiological Health Impacts

Occupational Safety

Occupational injuries and illnesses are those incidents that result during the performance of an individual's work assignment. Occupational injury, illness, and fatality estimates were evaluated using site-specific occupational incidence rates. DOE Computerized Accident/Incident Reporting System (CAIRS) and LLNL Occupational Accident/Injury/Illness Analysis Support and Information System (OAASIS) data were used. Projected occupational injury and illness cases were calculated using 2002 data. Occupational injury, illness, and fatality categories used in this analysis were in accordance with Occupational Safety and Health Administration (OSHA) definitions. Incident rates were developed for facility operations.

Hazardous Chemicals (Nonradiological)

Health risks from hazardous chemical releases were not assessed for normal (accident free) operations because the LLNL-measured data for workplace concentrations of hazardous materials (see Appendix C for details) did not indicate the potential for adverse health impacts to involved and noninvolved workers.

Radiological Health Impacts

Radiological health impacts from normal operations were evaluated in terms of the probability of a premature fatality. Such impacts were quantified by noting the probability that a given radiation exposure would result in an LCF to an individual. When evaluated over a population, the individual probabilities can be generalized to make a statement as to how many people (but not which people) in the population would be affected.

The Interagency Steering Committee on Radiation Standards (Lawrence 2002) recommended a risk estimator of 6×10^{-4} excess (above those naturally occurring) fatal cancers per person-rem of dose in order to assess health effects to the public and to workers. The probability of an individual worker or member of the public contracting a fatal cancer is 6×10^{-7} per millirem. Radiation exposure can also cause nonfatal cancers and genetic disorders. The probability of incidence of these is one third that of a cancer fatality (Lawrence 2002).

Worker health effects from occupational exposure to radiation are projected based on recent experience with continuing operations and projections of specific additional operation impacts on involved workers. The bulk of the dose to involved workers from current operations, approximately 90 percent of total worker dose, is from operations at Building 332. This trend is expected to continue; changes in involved worker dose at LLNL are due chiefly to increased operations in that building (LLNL 2003az). The only exception to this is for increases due to NIF operations. Worker dose from NIF operations is based on operation-specific studies (LLNL 2003d).

Radiological health impacts to the general population were calculated from radiation exposure to the site-wide MEI and the population as a whole. A similar calculation was performed for the noninvolved worker population dose. These doses were converted to health impacts using the dose to risk estimators. The air transport pathway currently results in almost all of the doses to the public from LLNL, either directly or through deposition and subsequent inhalation and ingestion.

5.1.15 Site Contamination

Site contamination analyses focused on two distinct areas: soil contamination and groundwater quality.

The soil contamination analysis considered the potential for human contact of near-surface (the top 6 inches to 1 foot) contaminated soils and limitations on future land use of these areas. The analysis examined the types of sites where soil contamination could be present (environmental restoration and outdoor testing areas) and site characteristics. Soil contaminant concentrations were considered under each alternative and compared with criteria for future designated land use.

The groundwater quality analysis determined to what extent contamination from LLNL sites in the unsaturated and saturated zones would limit the potential use of groundwater, particularly as drinking water. Unsaturated zone and groundwater contamination sites were characterized in terms of their contaminants, concentrations, and extent.

5.2 IMPACTS FOR THE NO ACTION ALTERNATIVE

The No Action Alternative is the continued operation of the Livermore Site and Site 300, including projects for which NEPA analysis and documentation already exists. Programs and projects would continue at their present levels as described in Section 3.2, but no proposed projects would be added except for those funded, which are those required to maintain the existing infrastructure.

The discussion below follows the order of issues presented in Chapter 4. Each section discusses impacts and mitigation measures as appropriate. These sections also discuss cumulative impacts, both locally and regionally, when applicable. See Chapter 3 and Appendix A, Description of Major Programs and Facilities, for a more detailed discussion of all the projects included in the No Action Alternative.

Cumulative impacts result from impacts of the No Action Alternative in combination with impacts of future development, either in the vicinity or within a regional area appropriate to the resource being analyzed. The Livermore Site cumulative air impacts consider the entire air resource region designated by the BAAQMD. Cumulative impacts discussed in this section analyze impacts that result primarily from implementation of the No Action Alternative at LLNL.

5.2.1 Land Uses and Applicable Plans

This section describes the impacts to land uses and applicable plans under the No Action Alternative. Impacts are analyzed for the Livermore Site and Site 300 based on the methodology presented in Section 5.1.

5.2.1.1 Relationship with Site Operations

This section summarizes the relationship between projects described in Section 3.1 for the No Action Alternative and the land use impact analysis. In general, the effect of projects for the No Action Alternative on land use would be related to the planned construction and D&D of facilities as part of projects that have been funded, but not yet executed. Changes to operations would not alter land use. No land acquisitions are included under the No Action Alternative, therefore land use changes would be confined to onsite areas.

5.2.1.2 Impact Analysis

Livermore Site

Under the No Action Alternative, new facility construction, upgrades, and D&D activities would occur at the Livermore Site. Many of these projects are already underway. While the types of land uses would not change, some infill and modernization would occur. Figure 5.2.1.2–1 shows the locations of new facilities. Most new facilities would be located in the developed portion of the Livermore Site. Table 5.2.1.2–1 provides the estimated area of disturbance for new facility construction in undeveloped areas.

TABLE 5.2.1.2–1.—*Area of Disturbance for New Facility Construction Under the No Action Alternative in Livermore Site Undeveloped Areas*

Facility	Location	Estimated Area of Disturbance
East Avenue Security Upgrade	Southern border of Livermore Site between LLNL and SNL/CA	172,000 ft^2
Extend Fifth Street	West side of Livermore Site from Avenue A to West Perimeter Drive	132,000 ft^2
International Security Research Facility	Southwest side of Livermore Site near developed area	64,000 ft^2 54,000 ft^2 Parking
Remove and Replace Offices	East side of the Livermore Site east of the drainage retention basin	40,000 ft^2
Total		**462,000 ft^2**

Note: This table only includes those facilities with the potential to disturb soil in the undeveloped zones.
LLNL = Lawrence Livermore National Laboratory; SNL/CA = Sandia National Laboratories, California; ft^2 = square feet.

New structures would be used for the same types of uses as existing facilities, namely research and development (R&D), which is the existing land use designation for all Livermore Site facilities. Therefore, it would not represent a change in land uses, nor lead to a conflict with existing and approved future land uses adjacent to the site. Although the Livermore Site is on Federal land and not subject to local zoning ordinances, LLNL’s R&D activities would be compatible with the MP designation (industrial park) in Alameda County and the I-2/I-3 designations (professional and administrative offices/R&D facilities) in the city of Livermore. No new types of land uses would be introduced in the buffer and perimeter areas. Therefore, no change in the site’s compatibility with existing and approved future land uses would result from the No Action Alternative and no additional impacts are expected.

New facilities could have secondary effects on land use due to increased personnel and activity at the site. These effects could include additional traffic, noise, vehicular exhaust emissions, demands for community services, increased consumption of natural resources, effects to wildlife habitat, and increased waste generation. These effects are addressed in the other sections of this chapter.

Site 300

The No Action Alternative at Site 300 would include upgrades and consolidation of existing facilities and a D&D project. No land acquisitions would be included. The types of land uses at Site 300 are not proposed to change, and the open space character of the site would be retained. No major alterations in the types of land uses would result.

Land uses at Site 300 would be compatible with the existing land uses and approved land use designations surrounding the site and with policies regarding open space resources near the site. Because activities under the No Action Alternative represent a continuation of existing land uses, they would be compatible with existing and approved future land uses surrounding the site and no additional impacts are expected to occur.

5.2.1.3 *Cumulative Impacts*

Livermore Site

The cumulative impact study area with regard to land uses and planning programs for the Livermore Site is defined as that area of Alameda County generally east of Tassajara Road in the city of Dublin and Santa Rita Road in the city of Pleasanton, which encompasses the city of Livermore and eastern unincorporated Alameda County. Large undeveloped open space areas in Alameda County exist in the northern, eastern, and southern portions of the county. A majority of the undeveloped areas is used for agricultural purposes, primarily for grazing and viticulture. Agricultural lands in the South Livermore Valley General Plan Amendment area support an active wine industry.

A continuing land use trend in Alameda County has been the encroachment of residential, commercial, and industrial uses on agricultural and open space areas. Developing planned and proposed residential projects would contribute to the cumulative loss of agricultural land and open space. However, the No Action Alternative would not contribute to the cumulative effect on the loss of agricultural land and open space because the Livermore Site is already committed to R&D land uses and no acquisition of open space or agricultural land would be proposed. Minimal impacts to land use are expected to occur.

Site 300

The cumulative impact study area with regard to land uses and planning programs for Site 300 is defined as that portion of San Joaquin County generally south of Interstate 205 (I-205) that encompasses the city of Tracy and southwestern unincorporated San Joaquin County. Land uses in the area south of I-580 in unincorporated San Joaquin County include agricultural (primarily grazing), commercial recreation, and explosives testing facilities, including Site 300.

The city of Tracy, the border of which is located approximately 2 miles northeast of Site 300, has a developed core of residential and commercial uses, which becomes less dense along the outer boundaries of the city. Industrial and agricultural land uses surround the developed part of the city. In 1998, the city of Tracy annexed the Tracy Hills area southwest of I-580, the area of Tracy that is now closest to Site 300. The Tracy Hills planning area is 6,175 acres. In an effort to preserve agricultural land on the valley floor, the city of Tracy Planning Department is encouraging new development in hillside areas such as Tracy Hills (City of Tracy 1993).

A residential community such as Tracy Hills could be compatible with Site 300, depending on the final design and siting of residences. The city of Tracy also has annexed an area of San Joaquin County that is approximately 2 miles from Site 300 and has planned for residential development in this area. The Tracy General Plan (City of Tracy 1993) provides for a conservation or open space area to be established that would be a buffer zone between Site 300 and any potential new development.

Approved and proposed projects in the southwestern San Joaquin County would contribute to a cumulative loss of open space; however, implementation of the No Action Alternative would not contribute to this cumulative loss of open space because no loss of agricultural land or open space would be proposed. No additional impacts are expected to occur.

5.2.2 Socioeconomic Characteristics and Environmental Justice

This section analyzes the socioeconomic impact associated with implementation of the No Action Alternative. The section organizes the impact analysis by employment, and housing and population, with effects delineated by geographic area (counties and cities) within the ROI. Environmental justice issues are also discussed.

5.2.2.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.1 for the No Action Alternative and the socioeconomic impact analysis. In general, the effect of projects on socioeconomics is related to the additional employment opportunities and expenditures, provided as a result of design, construction, and operation of projects under the No Action Alternative. For the socioeconomic analysis, indirect effects of these changes are also evaluated. Important parameters for the socioeconomic analysis are shown in Table 5.2.2.1–1.

TABLE 5.2.2.1–1.—*Input Parameters for Socioeconomic Analysis Under the No Action Alternative*

Parameter	Units	Site	Existing Environment	No Action Alternative
Employment	Number of personnel	LLNL	10,360 (all site workers)	10,650 (all site workers)
		Livermore Site	8,610 (LLNL employees) 17,000 (LLNL employees and indirect)	8,900 (LLNL employees) 17,500 (LLNL employees and indirect)
		Site 300	240 (LLNL employees) 470 (LLNL employees and indirect)	250 (LLNL employees) 490 (LLNL employees and indirect)
Expenditures	Dollars (2001)	LLNL	142 M (Bay Area)	146 M (Bay Area)
Payroll	Dollars (2002)	LLNL	668 M (LLNL employees) 1,100 M (LLNL employees and indirect)	690 M (LLNL employees) 1,130 M (LLNL employees and indirect)

LLNL = Lawrence Livermore National Laboratory; M = million.

5.2.2.2 *Impact Analysis*

LLNL jobs and expenditures generate indirect jobs in the region. The Regional Input-Output Modeling System (RIMS) II economic model produces two multipliers that are useful for the evaluation of economic effects (BEA 2003). The first multiplier is used to calculate worker earnings and the second calculates employment. These multipliers provide information needed to estimate LLNL’s economic impact. Earnings and employment multipliers make possible the identification of not only the direct impacts of an activity on regional income and jobs, but also the indirect effects.

To develop estimates of employment growth, employment projections for the No Action Alternative were based on staffing increases associated with new facilities and initiatives beyond the year 2004. Over the next 10 years, LLNL employment at the Livermore Site is projected to increase by 290 to reach approximately 8,900. Therefore, the No Action Alternative may create an additional 290 direct employment opportunities in Alameda County, generate additional revenue from increased purchases of goods and services, and create increases in population and subsequent increases in housing demand. The employment projections are conservatively high for purposes of evaluating the maximum potential environmental impacts associated with the additional jobs at LLNL.

As of September 2002, approximately 240 personnel were employed by LLNL at Site 300. Over the next 10 years, Site 300 employment is projected to increase by fewer than 10 employees, therefore, socioeconomic impacts would be minimal.

Employment and Expenditures

Region

The No Action Alternative would provide additional employment opportunities in the region and would increase the payroll at LLNL. Assuming a 300-employee increase in payroll and pay rates proportional with 2002 salaries, the additional payroll generated under the No Action Alternative would be an annual increase of $22 million (in 2002 dollars) by 2014. A portion of this increased payroll would enter the local economy as the new workers purchase additional goods and services. The effects of increased employment would result in a combined direct and indirect employment increase of approximately 600 jobs within the region. Likewise, the direct and indirect effect of payroll expenditures would result in a $36 million increase to the regional economy.

In addition, it is anticipated that the No Action Alternative would result in an annual $4 million increase in expenditures by LLNL within the nine-county Bay Area. Additional goods and services would be required to support the additional activities, facilities, and workers generated under the No Action Alternative.

The additional expenditures by new personnel and by LLNL would generate additional income and employment opportunities within the region as the expenditures filter throughout the economy. However, the additional income and employment opportunities generated under the No Action Alternative would have minimal economic impact within the region, given the large employment and economic basis in the ROI.

Alameda County

Total employment in Alameda County was estimated at 751,680 in 2000 (Association of Bay Area Governments 2001). The No Action Alternative is assumed to generate 290 additional jobs at the Livermore Site. Employment projections for Alameda County suggest that employment opportunities would increase 14.1 percent to reach 857,450 by 2010 (Association of Bay Area Governments 2001). The additional jobs created by the No Action Alternative at the Livermore Site would represent 0.3 percent of the projected increase in employment within the county. This minimal increase in employment, less than a 0.1 percent increase over the 2000 employment level, would have minimal economic impact within the county.

San Joaquin County

Total nonfarm employment in San Joaquin County was estimated at 191,700 in 2001 (EDD 2003). The nonfarm employment was used to eliminate seasonal agricultural employment spikes from the analysis. The No Action Alternative would generate a maximum of 10 additional jobs at Site 300. Employment projections for the county estimate that employment opportunities would increase 22.3 percent to 234,430 by 2010 (SJCOG 2000). The additional jobs created by the No Action Alternative at Site 300 would represent 0.02 percent of the projected increase in employment within the county. This minimal increase in employment, a 0.01 percent increase over the 2001 employment level, would have a negligible economic effect on the county.

Population and Housing

For this analysis, increases in population level and housing demand under the No Action Alternative are projected to be conservatively high in order to determine the maximum reasonably foreseeable impact. It was assumed that someone outside of the ROI would fill each new job, that all new LLNL workers (including LLNL employees, contractors, and Federal employees) would migrate to the region, and that each worker would represent a new household. In reality, a percentage of new workers would already reside in the project region, and some households would shelter more than one LLNL worker. While this method may overestimate potential migration of new workers to the project region, it also allows for the “backfilling” of vacancies left as some workers leave their current jobs in the region to work at LLNL. The geographic distribution of future LLNL worker residences is expected to be similar to the 2002 distribution of employee residences (Table 5.2.2.2–1).

Alameda County

Based on the anticipated geographic distribution of worker residences (Table 5.2.2.2–1), the No Action Alternative would result in a migration of 166 LLNL workers to Alameda County over 10 years. This represents 55.5 percent of the 300 new LLNL personnel. Assuming 2.74 persons per household for the county (Census 2003), the population associated with the additional workforce potentially migrating into the county would be 455 persons. This represents 0.03 percent of the 2000 population within the county. Population projections for the county estimate a 16.8 percent increase by 2010 (Association of Bay Area Governments 2001, Census 2003). The incremental population increase associated with the No Action Alternative would be within growth projections for the county.

Assuming one worker per household, housing demand generated by the additional workforce would be 166 dwelling units over 10 years, raising the total number of housing units occupied by LLNL workers to approximately 6,050 within Alameda County. In 2002, the county had 546,735 housing units. The vacancy rate in the county was 3.0 percent, an estimated 16,620 available units (DOF 2002). Demand for housing associated with the project’s additional personnel assumed to live in Alameda County would represent 1.0 percent of the 2002 vacant housing within the county. Impact to housing within the county is expected to be minimal.

City of Livermore

As seen in Table 5.2.2.2–1, the greatest percentage of new LLNL workers (37 percent, or 111 workers) would reside in Livermore, based on the 2002 pattern of employee residence location. Using the person per household figure of 2.81 for the city (Census 2002b), and assuming one worker per household, the population increase associated with the workforce migrating into the city would be 312 persons. This represents 0.4 percent of the city of Livermore's 2000 population. Growth projections for the city anticipate a 23 percent increase in the city's population by 2010 (Association of Bay Area Governments 2001).

TABLE 5.2.2.2–1.—*Anticipated Geographic Distribution of Lawrence Livermore National Laboratory Worker Residences Under the No Action Alternative*

City	Percent of LLNL Workers [a,b]	Number of New Workers Projected to Reside in City [c]
Alameda County		
Livermore	37.0	111
Pleasanton	6.2	19
Castro Valley	4.0	12
Dublin	2.1	6
Oakland	2.1	6
Other Alameda County	4.1	12
Total	**55.5**	**166**
San Joaquin County		
Tracy	8.2	25
Manteca	4.8	14
Stockton	2.6	8
Other San Joaquin County	2.9	9
Total	**18.5**	**56**
Contra Costa County		
Brentwood	2.7	8
San Ramon	2.7	8
Other Contra Costa County	7.4	22
Total	**12.8**	**38**
Stanislaus County		
Modesto	3.2	10
Other Stanislaus County	2.9	9
Total	**6.1**	**19**
Counties Outside the ROI		
Total	**7.2**	**22**

Source: LLNL 2003ak.
[a] Distribution as of September 30, 2002.
[b] May not total 100 because figures are rounded off.
[c] Calculated based on 300-employee increase. May not total 300 because of rounding.
LLNL = Lawrence Livermore National Laboratory; ROI = Region of Influence.

Assuming each new worker migrating into the city creates a demand for one additional housing unit, a total of 111 units over 10 years would be required under the No Action Alternative. In 2000, the city had a housing supply of 26,610 units and a vacancy rate of 1.8 percent (Census 2002b). This represents 487 available housing units. The current city of Livermore Housing Implementation Program, covering the 3-year period from 2002 through 2004, limits housing unit growth to a maximum of 1.5 percent per year (City of Livermore 2001). As this plan is subject to renewal after 2004, the 1.5 percent housing unit growth rate represents the best available estimate for future growth. Assuming an annual growth rate of 1.5 percent, a total of 5,363 new housing units would be available by the year 2014. The demand for housing in the city associated with new employees would represent 2.1 percent of the projected number of new housing units. Because population growth as a result of the No Action Alternative could be accommodated in the current housing market and housing growth is projected to continue, minimal impacts are anticipated.

City of Pleasanton

Nineteen, or 6.2 percent, new workers employed under the No Action Alternative would reside in Pleasanton, based on the anticipated geographic distribution of personnel (Table 5.2.2.2–1). Using the person –per household figure of 2.73 (Census 2002b), the city of Pleasanton population increase associated with new personnel would be 52 persons. This represents 0.1 percent of the 2000 population of 63,654. This increase would be within growth projections for the city, which project a 22 percent population increase by 2010 (Association of Bay Area Governments 2001).

Housing demand generated by new workers as a result of the No Action Alternative would be 19 housing units over 10 years, assuming one household per new employee. The 2000 housing supply within the city was 23,968 units, with a vacancy rate of 2.7 percent (Census 2002b). This represents an available supply of 657 units. The demand for housing units associated with new workers would represent 2.9 percent of the number of available vacant units in 2000. In addition, there is a projected 18 percent increase in the supply of housing by the year 2010 (Association of Bay Area Governments 2001). Because population growth as a result of the No Action Alternative could be accommodated in the current housing market and housing growth is projected to continue, minimal impacts are anticipated.

San Joaquin County

Based on the anticipated geographic distribution of personal residences of currently employed LLNL workers, 56 of the new workers would reside within San Joaquin County (Table 5.2.2.2–1). Based on the person per household figure of 3.17 in San Joaquin County (Census 2003), the population associated with the new employees would be 178 persons. This represents 0.03 percent of the total population within the county in 2001. County growth projections estimate that the population will rise to 727,800 by the year 2010, a 26.2 percent increase (DOF 2001, Census 2003). The incremental population increase associated with the No Action Alternative would be accommodated within county growth projections.

Housing demand generated by new workers, assuming one LLNL worker per household, in the county would total 56 units over 10 years, raising the total number of housing units occupied by

LLNL workers to approximately 2,020 within San Joaquin County. The 2002 housing supply within the county was 197,279 units, with a vacancy rate of 3.9 percent (DOF 2002). The total number of vacant units was 7,767. County projections estimate a 26 percent increase in the number of housing units within the county by the year 2010 (SJCOG 2000). Because the demand generated by the project would be minimal relative to the number of available and planned units, minimal impacts are anticipated.

City of Tracy

Based on the anticipated geographic distribution of new personnel, 25 new workers could move to the city of Tracy over the next 10 years. Based on the person per household figure of 3.23 for the city of Tracy (Census 2002a), the the next population associated with the No Action Alternative would be 81 persons. This represents 0.1 percent of the 2000 population.

Additional housing demand arising from the No Action Alternative within the city of Tracy would be an additional 25 dwelling units. The housing supply within the city in the year 2000 was 18,087 units (Census 2002a). The vacancy rate for the city was 2.7 percent in 2000, which represents 467 available units. The demand generated by the new workers would represent 5 percent of the existing supply of available vacant housing. In addition, the number of housing units in the city is projected to increase 38 percent by the year 2010 (SJCOG 2000). The housing demand under the No Action Alternative could be accommodated in the current and projected housing supply, and minimal impacts are anticipated.

Environmental Justice

As indicated in Sections 5.2.1, 5.2.4, 5.2.5, 5.2.6, 5.2.7, 5.2.9, and 5.2.10, no discernible adverse impacts to land uses, prehistoric and historic cultural resources, aesthetics and scenic resources, geology and soils, biological resources, water, or noise are anticipated under the No Action Alternative. Thus, no disproportionately high and adverse impacts to minority or low-income communities are anticipated for these resource areas. Potential impacts to other resource areas are discussed below.

As indicated earlier in this section, under the No Action Alternative, 10,650 workers would be required at the Livermore Site and 250 workers would be required at Site 300. The number of housing units affected would be proportional to the changes in worker population. There is no indication that distribution of new workers would result in disproportionately high and adverse impacts to minority or low-income populations.

Within community services, as described in Section 5.2.3, the only notable impact would be to the generation and disposal of nonhazardous solid waste. For the No Action Alternative, it is estimated that 4,600 metric tons per year of solid waste would be generated at the Livermore Site for landfill disposal. At Site 300, nonhazardous solid waste generation would increase to 208 metric tons per year. Any impact to landfill capacity or lifespan would be area-wide, and not result in disproportionately high and adverse impacts to minority or low-income populations.

As presented in Section 5.2.8, the MEI for radiological air emissions at the Livermore Site would be located due east of the NIF, once the NIF becomes operational. The MEI dose under the No Action Alternative would be 0.098 millirem per year, and the population dose would be expected to be 1.8 person-rem per year. At Site 300, the MEI would be located west-southwest of Firing Table 851. The MEI dose under the No Action Alternative would be 0.055 millirem per year, and the population dose would be 9.8 person-rem per year. Because areas immediately surrounding both LLNL sites have relatively low proportions of minority and low-income populations, there would be no disproportionately high and adverse impacts to these groups.

As presented in Section 5.2.11, traffic near the Livermore Site would increase slightly as a result of the increase in worker population by 290 workers under the No Action Alternative. At Site 300, the impact to traffic due to the addition of 10 workers would be negligible. Transportation of radioactive materials offsite would increase under the No Action Alternative. The collective radiation dose to the population along the transportation route is calculated at 5.0 person-rem per year, corresponding to 0.003 LCFs. No disproportionately high and adverse impacts to minority or low-income communities would be anticipated based on these estimates.

As presented in Section 5.2.12, the projected peak electrical demand at LLNL would be 82 megawatts and the annual total use would be 446 million kilowatt hours. In 2004, the State of California projects the statewide peak demand to be 53,464 megawatts and projects a growth in peak demand of about 2.4 percent per year. LLNL’s projected peak demand in 2004 is therefore 0.1 percent of the total State demand. The State of California currently projects an adequate supply/demand balance through the year 2008, but has not made supply projections beyond that year. Any impacts related to LLNL’s electricity use would be regional, and would not disproportionately affect minority or low-income populations.

As discussed in Section 5.2.13, waste generation for both routine and nonroutine wastes would be increased under the No Action Alternative. Levels of waste generation are within the capacities for treatment, transportation, or storage either onsite or at waste repositories. There would be no disproportionately high and adverse impacts to minority or low-income populations as a result of this waste generation.

As presented in Section 5.2.14, worker dose due to ionizing radiation would be 90 person-rem per year. The increase from current dose is mainly in new facilities coming online and increased activities in the Superblock. There would be no disproportionately high and adverse impacts to minority or low-income populations as a result of this increased dose.

Areas of soil and groundwater contamination exist at the Livermore Site and Site 300, as presented in Section 5.2.15. Although there is no immediate threat to human health from this contamination, there is localized degradation of groundwater. Appropriate cleanup measures are being implemented with the concurrence of regulators. There would be no disproportionately high and adverse impacts to minority or low-income populations as a result of these actions.

As discussed in Section 5.5, any of the bounding radiological accidents for LLNL would result in less than one LCF. Bounding accident scenarios for chemical, explosive, and biological accidents are unlikely to result in fatalities to the general public. None of these accidents would have disproportionately high and adverse impacts to minority or low-income populations.

Based on the analyses of all the resource areas, the course of operations would not pose disproportionately high and adverse health or environmental impacts on minority and low-income populations.

5.2.2.3 *Cumulative Impacts*

It is assumed that new workers associated with the No Action Alternative would reside in the communities in the same proportion as listed in Table 5.2.2.2–1. More than 220 new hires would reside in these 11 communities, ranging from 111 workers in the city of Livermore to 6 in the cities of Dublin and Oakland. In addition, an estimated 74 workers would be distributed throughout other communities in the Bay Area and central San Joaquin Valley. The No Action Alternative would therefore contribute to the cumulative demand for housing in the region associated with new employment opportunities created by planned and approved projects in the region. However, because vacancy rates are high enough to meet the demand of new employees within Livermore, with the highest concentration of LLNL employees, it is assumed that other parts of the region could meet the housing demand created by the increase in local job opportunities.

5.2.3 Community Services

This section analyzes the impacts to community services associated with implementation of the No Action Alternative. The section organizes the impact analysis by site and type of service.

5.2.3.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.1 for the No Action Alternative and the community services impact analysis. In general, the effects of projects under the No Action Alternative on community services are related to additional employment opportunities and changes in floorspace. Employment under the No Action Alternative is detailed in Section 5.2.2. New construction projects, as listed in Section 3.1, would add to floorspace, but D&D projects, as part of an overall laboratory-wide consolidation, would decrease floorspace. Employment parameters are listed in Table 5.2.3.1–1.

TABLE 5.2.3.1–1.—*Input Parameters for Community Services Analysis Under the No Action Alternative*

Parameter	Units	Site	Existing Environment	No Action Alternative
Employment	Number of personnel	Livermore Site	10,360	10,650
		Site 300	240	250

5.2.3.2 *Impact Analysis*

Livermore Site

Fire Protection and Emergency Services

The No Action Alternative would not affect onsite fire protection and emergency services, or offsite fire protection agencies. The No Action Alternative would result in a 3 percent employment increase and incremental changes in floorspace. Therefore, demands for fire protection and emergency services because of the No Action Alternative would be similar to those under present conditions. The LLNL Fire Department currently provides adequate onsite service. The adequacy of these services would continue to be evaluated on an annual basis, and personnel, equipment, and facilities would be increased or upgraded as necessary.

LLNL interacts infrequently with offsite fire protection agencies. Interaction would remain similar to the current level under the No Action Alternative. Current fire protection and emergency service needs of LLNL do not affect offsite fire protection agencies' ability to provide service within their respective jurisdictions or mutual aid network. Thus, minimal impacts are anticipated.

Police Protection and Security Service

The 3 percent employment increase under the No Action Alternative would not affect onsite security services or offsite police protection agencies. Under the No Action Alternative, demands for security services would remain similar to those under present conditions. The LLNL Safeguards and Securities Department currently provides adequate onsite security protection.

LLNL interacts infrequently with offsite police protection agencies. Under the No Action Alternative, interaction is expected to remain similar to the current levels. Current security needs of LLNL do not affect the ability of offsite police protection agencies to provide service within their respective jurisdictions or emergency response network. Thus, minimal impacts are anticipated.

School Services

Employment at LLNL would increase by approximately 300 under the No Action Alternative; therefore, the number of students associated with this alternative would increase as well. The number of new students is estimated using the current percentage of Livermore residents enrolled in the Livermore Valley Joint Unified School District (19 percent), multiplied by the number of new Livermore residents that would be expected under the No Action Alternative, as discussed in Section 5.2.2. The additional 312 Livermore residents under the No Action Alternative would result in about 60 children expected to enroll in the Livermore Valley Joint Unified School District. Additional students generated from increased employment at LLNL would be expected in the school system incrementally over the next 10 years. Although several district schools are near capacity, there is currently adequate space district-wide (Miller 2003). The 60 student increase represents 0.4 percent of district enrollment. Based on an expected annual enrollment growth rate of 1.5 percent from Livermore's Housing Implementation Plan, the 60 student increase would be 2.2 percent of the total enrollment growth by the year 2014.

Because the district's facilities are adequate to meet current student demand, the addition of 60 students to the existing facilities would result in minimal impact on the district's ability to plan for and provide service within its jurisdiction.

As discussed in Section 5.2.2, the employment of 300 new workers at LLNL under the No Action Alternative would lead to an additional 300 indirect jobs within the ROI. Because of the relatively high proportion of new LLNL workers that would reside in the city of Livermore, some of those additional jobs would likely be created within the community. If the distribution of indirect worker residences were the same as for LLNL workers, 60 students could be added to the Livermore Valley Joint Unified School District in addition to the 60 students projected for LLNL workers, as described above. However, the actual number of students added through indirect jobs would be much less than 60, as many of the additional jobs and worker residences to support LLNL workers residing in Livermore would be created in neighboring communities and other areas throughout the ROI.

Nonhazardous Solid Waste Disposal Services

The No Action Alternative would not result in an adverse impact on the ability of Alameda County to provide solid waste disposal space. The amount of solid waste generated at the Livermore Site for landfill disposal under the No Action Alternative, based on employment increase, would be 4,600 metric tons, or approximately 3 percent more than recent levels. The Altamont Landfill is estimated to have sufficient capacity to receive waste until the year 2038 (Hurst 2003). The current total permitted throughput at the Altamont Landfill is 11,150 tons per day (SWIS 2002). The increase in solid waste under the No Action Alternative would represent less than 0.01 percent of permitted landfill throughput. Therefore, due to the remaining lifespan of this landfill, minimal impacts to solid waste disposal within the county are anticipated.

Site 300

Impacts discussed above for the Livermore Site for fire protection and emergency services, police protection and security services, school services, and nonhazardous solid waste disposal services are also applicable to Site 300. As employment at Site 300 is projected to increase by only 10 employees over current levels, anticipated impacts to community services are minimal.

5.2.3.3 *Cumulative Impacts*

Livermore Site

The 3 percent employment increase and incremental change in floorspace under the No Action Alternative would result in demands on fire protection and emergency services, as well as police protection and security services that are similar to the current level. LLNL fire protection and security staff currently provides adequate service onsite and current needs do not affect the ability of offsite agencies to provide service within their respective jurisdictions. Therefore, the No Action Alternative would not result in a cumulative impact on either onsite or offsite fire protection and emergency services or police protection and security services.

Employment at LLNL would increase by approximately 300 employees, 111 of which would reside in the city of Livermore. The projected 60 student increase in enrollment within the Livermore Valley Joint Unified School District would contribute to the cumulative demand for school services. As new school capacity would be required for the 2,700 additional students arising from non-LLNL-related increases to the expected population increases in the region projected during the next 10 years, the portion of the student increase attributable to the No Action Alternative (2 percent) would be within extra capacity design criteria.

Under the No Action Alternative, the rate of nonhazardous solid waste generated at the Livermore Site and Site 300 for disposal would be within 3 percent of present levels. Thus, this alternative would not contribute to additional cumulative demand for nonhazardous landfill capacity at the Altamont Landfill or impact operations at the Tracy Material Recovery and Solid Waste Transfer Station.

Site 300

Cumulative impacts discussed above for the Livermore Site for fire protection and emergency services, police protection and security services, and nonhazardous waste disposal services are also applicable to Site 300. However, there would only be an increase of 10 employees at Site 300, therefore there would be no measurable additional strain on the local school systems.

5.2.4 Prehistoric and Historic Cultural Resources

This section analyzes the impacts to cultural resources associated with implementation of the No Action Alternative. The impact analysis is organized by location and type of resource. Steps taken to reduce potential impacts are also discussed, as are the measures to be implemented to ensure compliance with the NHPA.

5.2.4.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.2 under the No Action Alternative and the analysis of cultural resources. In general, those projects with the potential to impact these resources include construction of new facilities and infrastructure, as well as D&D, rehabilitation, and renovation of existing facilities.

5.2.4.2 *Impact Analysis*

Livermore Site

The probability of affecting prehistoric resources at the Livermore Site would be very low because: (1) field and archival research have not identified any prehistoric resources; (2) the geomorphic setting of the site makes it unlikely that any such resources exist; and (3) extensive modern horizontal and vertical development has disturbed much of the site. Although no impacts to prehistoric resources would be expected, unrecorded subsurface prehistoric resources still could be inadvertently discovered during construction or other ground-disturbing activities.

The inadvertent discovery of cultural material at the Livermore Site would be addressed as described above. No additional impacts to these resources are expected.

The No Action Alternative would have the potential to impact important historic buildings and structures on the Livermore Site through D&D, rehabilitation, and renovation of existing facilities. However, implementing the Programmatic Agreement (Appendix G) would avoid, reduce, or mitigate any impacts from these actions.

Site 300

Impacts to known prehistoric and historic resources at Site 300 would be unlikely to result from the No Action Alternative. NNSA recognizes the sensitivity of the resources and has established buffer zones to protect them. Implementation of the Programmatic Agreement (Appendix G) and continuation of current management practices would result in protection of these sensitive areas. Although no impacts to known resources would be expected, there is still the possibility that unrecorded subsurface prehistoric or historic resources could be inadvertently discovered during construction or other ground-disturbing activities.

The inadvertent discovery of cultural material at Site 300 would be addressed as described above for the Livermore Site. No additional impacts to these resources are expected.

The No Action Alternative would have the potential to affect important historic buildings and structures on Site 300 through D&D, rehabilitation, and renovation of existing facilities. However, implementing the Programmatic Agreement (Appendix G) would avoid, reduce, or mitigate any impacts from these actions. Therefore, no additional impacts are expected.

5.2.4.3 *Cumulative Impacts*

The Livermore Valley has undergone tremendous growth and development over the past decade. Because preservation measures such as Section 106 are only initiated when Federal agencies are involved, it is likely that the onset of development has caused the irretrievable loss of cultural resources in the region. Since cultural resources exist at both the Livermore Site and Site 300, future program activities could result in resource loss and add to regional attrition of these resources. Any potential impacts to cultural resources at LLNL would be mitigated through implementation of the Programmatic Agreement (Appendix G), thereby reducing LLNL's contribution to resource attrition.

5.2.5 Aesthetics and Scenic Resources

This section analyzes the potential impacts of the No Action Alternative on aesthetics and scenic resources. The existing aesthetics and scenic resources are discussed in detail in Chapter 4, Section 4.6, of this LLNL SW/SPEIS.

5.2.5.1 *Relationship with Site Operations*

This section summarizes the relationship between the projects described in Section 3.2 under the No Action Alternative and the analysis of aesthetics and scenic resources. In general, effects to aesthetics and scenic resources would be limited to construction of buildings and infrastructure located in areas visible to public viewing.

5.2.5.2 *Impact Analysis*

Livermore Site

Activities under the No Action Alternative would include improvements to existing buildings and infrastructure, D&D of existing buildings, and construction of new facilities. Development and modifications would largely occur within the developed portion of the site, would be similar in character to surrounding uses, and would be largely screened from public view by the surrounding fencing and trees. Based on previous LLNL landscaping and development practices, it is anticipated that development of these projects at the Livermore Site under this alternative would be largely consistent with the existing character of the site.

Views of the Livermore Site resemble a campus-like or business park-like setting, including buildings, internal roadways, pathways, and open space. Although construction or modifications under the No Action Alternative may alter these views to some degree, these changes would have no impact on the visual character of the site.

Only two projects would be built in areas open to public viewing and would become a part of existing view sheds. These include the International Security Research Facility/Sensitive Compartmented Information Facility near the southwest side of the site near Vasco Road, and the East Avenue Security Upgrade and construction of new entrance gates at each end of the road. The new facilities would be visible from the adjacent residential areas and Vasco Road, which is a designated scenic route by the route element of the Alameda County General Plan (Alameda County 1994). Construction activities for the new facilities and supporting infrastructure would cause a short-term adverse impact on the views from these roads. Similar to other proposed interior development, the new facilities would be similar in size and character to existing structures at the Livermore Site and would be landscaped to be compatible with the surrounding campus-like setting. Therefore, although the facilities would be more visible from the immediate surrounding area, they would not alter the site's overall appearance or character.

The Livermore Site is also visible in the middle ground and background view sheds from the surrounding residential and rural areas and designated scenic routes. Viewers from these areas would not notice a change in the built environment within the site. While viewers in these areas might perceive a slight increase in the built space at the facility because of the two projects described above, the development would occur within a context of similar development and would be indefinite as a result of the viewing distance. Also, the view of the site would often be obscured by intervening topography, vegetation, and structures. The site would remain compatible with local and county scenic resource plans and policies.

Consequently, the changes to the built environment as a result of the No Action Alternative would have no long-term impacts on the visual character of the Livermore Site, views of the site from pubic viewing areas, or existing view sheds of the surrounding environment. No additional impacts are expected to visual resources.

Site 300

Activities under the No Action Alternative would include improvements to existing buildings and infrastructure. Development and modifications would largely occur within the developed portion of the site in the General Services Area (GSA) and would be similar in character to surrounding uses. Based on previous LLNL landscaping and development practices, it is anticipated that the development of these projects at Site 300 under this alternative would be largely consistent with the existing character of the site. One project would occur outside the developed portion of Site 300. The Wetlands Enhancement Project would be located in low-lying areas not visible to the public. This project would involve modification of wetland areas to be more conducive to California red-legged frog habitat, with no change to the view shed for workers at Site 300. Consequently, there would be no negative impacts to the visual character of the site.

Views of Site 300 resemble a campus-like or business park-like setting in the GSA, and natural undeveloped areas everywhere else. Although construction or modifications under the No Action Alternative might alter these views to some degree, these changes would have no impacts on the visual character of the site.

Site 300 is visible from Tesla Road, Corral Hollow Road, and the Carnegie State Vehicular Recreation Area. Tesla Road is designated as a scenic route by the scenic route element of the Alameda County General Plan (Alameda County 1994). When approaching Site 300 from the west on Tesla Road, views of the site consist of rolling hillsides. No structures or landscaping on Site 300 are presently visible from this roadway, and no construction or upgrade activities are proposed in the southwest corner of the site.

In general, views of Site 300 from Corral Hollow Road are limited due to distance and intervening topography and consist primarily of buildings and infrastructure in the GSA. Changes proposed at Site 300 would either occur in the interior of Site 300, which is not visible from the surrounding area; would have minor effects on aesthetics such as modification of existing facilities or utility upgrades; or would occur in the GSA where such changes would be consistent with the existing visual character of the site. Construction and facility improvement activities in the GSA would be visible from Corral Hollow Road and would have short-term visual impacts. However, these activities would be obscured by intervening topography, fencing, vegetation, or structures, and would be temporary.

Views of Site 300 from the Carnegie State Vehicular Recreation Area consist primarily of undeveloped hillsides. Due to the large size of the site, the few construction and maintenance activities planned for the interior of the site would not be visible from the recreation area and would not change the middle ground and background views of the site. Overall, Site 300 would remain compatible with local and county scenic resource plans and policies.

Consequently, no impacts of Site 300 would occur to the built environment as a result of the No Action Alternative, to views of the site from pubic viewing areas, or to existing view sheds of the surrounding environment.

5.2.5.3 *Cumulative Impacts*

There are no planned projects in the vicinity of the Livermore Site and Site 300 that, in combination with LLNL activities, would have an adverse impact on existing view sheds or the surrounding environment. Under the No Action Alternative, there would be no cumulative impacts to aesthetics and scenic resources in the region.

5.2.6 Geology and Soils

This section analyzes the impacts to geology and soils associated with the implementation of projects described in Section 3.2 under the No Action Alternative. The impact analysis is organized by geologic resources, topography and geomorphology, and geologic hazards.

5.2.6.1 *Relationship with Site Operations*

Under the No Action Alternative, there are future facilities at the Livermore Site that would generally be located in the undeveloped areas (Figure 5.2.6.1–1) and are assessed for potential soils disturbance impacts. These facilities are listed in Table 5.2.1.2–1. In general, any future development in the developed area at the Livermore Site would generally involve areas where soils have already been disturbed and therefore would not involve any impacts to soils.

At Site 300, one future project would be included under the No Action Alternative with potential for disturbing undeveloped soils. Under the Site 300 Wetlands Enhancement Project, artificial wetlands near Buildings 801, 827, 851, and 865 totaling approximately 0.62 acres created by surface water runoff would be terminated. These wetlands would be replaced by enhancing wetland habitat in other locations. Approximately 1.09 acres would be disturbed as part of this project.

5.2.6.2 *Impact Analysis*

Geologic Resources

Livermore Site

No known aggregate, clay, coal, or mineral resources would be adversely affected by the No Action Alternative. None of the activities under the No Action Alternative would take place near or upon any known or exploitable mineral resources, unique geologic outcrops, or other unique geologic features. No impacts to farming or grazing are expected.

Under the No Action Alternative, several facilities would be built in the undeveloped areas at the Livermore Site. Table 5.2.1.2–1 presents these facilities along with the estimated amount of land that would be disturbed by their construction. A total of 462,000 square feet would be disturbed as a result of construction under the No Action Alternative.

As discussed in Section 4.8, fossils were discovered in the peripheral parts of the excavation for the NIF. The fossil localities were found 20 to 30 feet below the present surface. Under the No Action Alternative, the potential would exist for the inadvertent excavation of fossils within this depth range during construction. Should any buried materials be encountered, LLNL would evaluate the materials and proceed with recovery in accordance with the requirements of the *Antiquities Act*.

Site 300

No known aggregate, clay, coal, or mineral resources would be adversely affected by the No Action Alternative. None of the activities that would proceed under the No Action Alternative are near or on any known or exploitable mineral resources, unique geologic outcrops, or other unique geologic features. None of the activities would affect farming or grazing. Under the No Action Alternative, the Site 300 Wetlands Enhancement Project and the connection to the Hetch Hetchy aqueduct would be completed at Site 300. The termination of water flow to the 0.62 acres of wetlands would result in the drying of the soils at the associated locations, but no disturbance would occur. Enhancement of wetland habitat at Mid Elk Ravine and the seep at the former Super High Altitude Research Project (SHARP) Facility would involve the disturbance of 1.09 acres of soils. There would be no impacts to any known or exploitable mineral resources or unique geologic features.

Several vertebrate fossil deposits have been found on Site 300 and in the vicinity of Corral Hollow. The fossil finds are generally widely scattered, and no significant invertebrate or botanical fossil localities have been identified on Site 300 or in the surrounding area (Hansen 1991). Under the No Action Alternative, there are no projects involving the disturbance of those areas, therefore, there would be no impacts to any known fossil deposits.

Topography and Geomorphology

Livermore Site

The No Action Alternative would not include project work that would impact the topography or geomorphology of the Livermore Site, and no construction or excavation projects are planned that would alter these features of the landscape. As only the best management practices would be employed to minimize erosion associated with ongoing operations, no additional impacts are expected.

Site 300

The No Action Alternative would not include project work that would impact the topography or geomorphology of Site 300. No construction or excavation projects are planned that would alter these features of the landscape. As only the best management practices would be employed to minimize erosion associated with ongoing operations. No additional impacts are expected.

Geologic Hazards

The geologic hazards associated with the Livermore region are part of the character of that region. The hazards exist regardless of the presence of human activities, buildings, or facilities. Therefore, there is no difference in the geologic hazards among the alternatives. Potentially strong earthquakes ground motion sources at Livermore Site and Site 300 are discussed briefly below. Detailed discussion is presented in Section 4.8 and Appendix H and includes the major regional fault zones as well as local faults.

The information on geologic hazards is part of the input to the design, engineering, and operation of the LLNL facilities. The risks from geologic hazards are associated with the potential for releases from these facilities of hazardous or radioactive materials due to spills, fires, or explosions resulting from earthquakes or landslides. The discussion of the facilities and the risks from geologic hazards are presented in Section 5.5, Appendix A, and Appendix D.

Livermore Site

The local faults in the Livermore Valley region are the main seismic hazard to the Livermore Site. The Livermore Site Seismic Safety Program recently performed a new assessment of the geologic hazards at the Livermore Site. Although new data and methodologies were used, the most recent study reports essentially the same results as previous studies for the prediction of the peak ground acceleration. Appendix H, Seismicity, presents the results of these seismic hazard analyses and the evaluation of structures. Maximum horizontal peak ground accelerations at the Livermore Site for return periods of 500, 1,000, and 5,000 years are 0.38 *g*, 0.65 *g*, and 0.73 *g*, respectively. The unit *g* is equal to the acceleration due to the gravity of the Earth or 9.8 meters/second/second (32 feet/second/second). The technical basis for these peak ground accelerations values is provided in Appendix H. These peak ground accelerations are evaluated along with other factors to determine the level of ground motion facilities would experience during earthquakes.

A large earthquake on the Greenville Fault is projected to produce the maximum ground-shaking intensities in the Livermore area with a Modified Mercalli (MM) intensity ranging from strong (MM VII) to very violent (MM X). The MM IX level is associated with damage to buried pipelines and partial collapse of poorly built structures (City of Livermore and LSA 2002). Design and location requirements for new facilities, including waste management facilities, must take into account distance from active faults and the ground shaking to be expected within certain probabilities. The level of active seismicity results in the classification of the area as Seismic Risk Zone 4, the highest risk zone in the California Building Code (City of Livermore and LSA 2002). Adverse impacts to proposed structures, related infrastructure, and surrounding communities could occur from hazardous materials release and/or structural failure of buildings and facilities following a major seismic event.

Site 300

A seismic hazard analysis of Site 300 produced peak acceleration estimates of 0.32 *g*, 0.38 *g*, and 0.56 *g* for return periods of 500, 1,000, and 5,000 years, respectively, for the Building 854 Complex near the western boundary of the site, and 0.28 *g*, 0.34 *g*, and 0.51 *g* for the Building 834-836 Complex near the eastern boundary (TERA Corp. 1983). A recent seismic hazard analysis of the Livermore Site (see Appendix H) and surrounding area described the Corral Hollow-Carnegie Fault zone as potentially active and calculated its contribution to seismic risk as just below that for the Calaveras Fault and greater than any other faults in the region. The Elk Ravine Fault was not considered active in that analysis.

There is a potential for surface faulting at Site 300. Buildings 899A and 899B at the pistol range could experience ground deformation during a major earthquake occur on the Carnegie Fault. However, these two structures contain no hazardous or radiological materials and have very low occupancies. A greater number of facilities are located near the Elk Ravine Fault, however, that fault is not considered active.

Additionally, potential exists for seismically induced landslides at Site 300 due to the presence of landslide deposits and relatively steep slopes. The potential for slope instability is greater on northeast-facing slopes underlain by the Cierbo Formation. Buildings 825, M825, 826, M51, 847, 851A, 851B, 854, 855, and 856 are located on old landslides deposits. The potential for ground deformation at these buildings is considered to be moderate to high.

A landslide could result in spills, fire, explosions, or burial of facilities within its path. The hazards and impacts of spills, fire, and explosions, regardless of cause are discussed in Section 5.5 and Appendices A and D. The impacts of burial of materials due to a landslide would be similar to spills and the firing of explosives at these facilities. These facilities have material limits under which they work on batches of materials. The working limits for explosives are close to the amounts detonated at the firing sites. The spread of materials into the environment when the explosives are detonated would be similar to the amount of materials that would be buried in a landslide.

5.2.6.3 *Cumulative Impacts*

SNL/CA projects approximately 100 acres of soil disturbance in connection with their activities and future facilities. A large portion of the disturbance would occur within areas that are already developed. The soils in the vicinity of the LLNL are capable of supporting agriculture. While there is a large amount of undeveloped land in Alameda County, continuing development in the immediate vicinity of the LLNL would contribute to the cumulative loss of agricultural land. The projects associated with the No Action Alternative would not contribute to the overall loss of agricultural land because the LLNL has been committed to R&D/industrial use instead of agriculture for decades.

5.2.7 Biological Resources

This section analyzes the potential impacts of the No Action Alternative on biological resources, including vegetation, wildlife, protected and sensitive species, and wetlands. The current operations and existing biological resources are discussed in detail in Appendices E and F and summarized in Chapter 4, Section 4.9, of this LLNL SW/SPEIS.

5.2.7.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.1 for the No Action Alternative and the ecological impact analysis. In general, the effect of No Action Alternative projects on biological resources would occur primarily in areas that have been previously disturbed at the Livermore Site and Site 300 by construction, maintenance, wildfire prevention, and security activities.

5.2.7.2 *Impact Analysis*

Vegetation

Livermore Site

Under the No Action Alternative at the Livermore Site, approximately 462,000 square feet (10.6 acres) of land disturbance would occur, consisting mainly of building construction, facility upgrades, and operational modifications (Section 5.2.6.3). This equates to approximately 1.6 percent of undeveloped land for new construction. The following projects would be constructed in undeveloped areas: the East Avenue Closure, the Extension of Fifth Street, the International Security Research Facility, and a general office building as noted in Table 5.2.1.2–1. Some of the new facilities that would be constructed in the previously developed areas of the Livermore Site include the BSL-3 and Edward Teller Education Center. A complete list of projects is provided in Appendix A, Section A.1.5.

The No Action Alternative would affect vegetation principally by clearing land for construction projects. Activities include building construction, upgrading existing buildings, road and parking lot repairs, modification of site energy management, and other activities. Projects under the No Action Alternative would occur on land that currently does not support vegetation, that has been landscaped, or that supports an early successional plant community indicating the presence of recent land disturbance. Therefore, the impacts of the No Action Alternative on vegetation would be minimal.

Site 300

The No Action Alternative would affect vegetation at Site 300 principally by clearing land for infrastructure modernization (e.g., new or upgraded facilities; grading and maintaining fire trails; storm drainage system maintenance; culvert maintenance and replacement; termination of surface water releases at several facilities). New facility construction would support the Site 300 Revitalization Project, the Wetland Enhancement Project, and Response Training Center. Under the Site 300 Revitalization Project, vegetation would not likely be disturbed since only distribution of water from the Hetch Hetchy aqueduct infrastructure that has already been built remains under this project. Components of the Response Training Center that might impact biological resources have already been completed. These activities would occur primarily on previously disturbed land occupying less than 350 acres. Areas where buildings and related infrastructure are present do not support vegetation, have been landscaped, or support an early successional plant community indicative of recent land disturbances. Approximately 1.86 acres of disturbance of vegetation would also occur during construction of the Wetland Enhancement Project, which is further discussed in Section 5.2.7.3 and Appendix E, Section E.2.2. The impact of the No Action Alternative on Site 300 vegetation would be minimal.

Prescribed burning would continue to be conducted annually as a means of wildfire control on approximately 2,000 acres. Burning typically would begin at the end of May and last several weeks, though this schedule depends on the length of the growing season and amount of rainfall (LLNL 2003q). Native grassland communities on Site 300 occur almost exclusively in areas with annual prescribed burning (Appendix E, Figure E.1.1.3–1), and researchers have previously noted that frequent fire is required to establish and maintain grasslands dominated by native grasses in lowland California (Barry 1972, BioSystems 1986a, Heady 1972). These annual prescribed burns may have an additional beneficial impact by reducing the presence of certain invasive plants, such as yellow starthistle (Lass et al. 1999, Pollak and Kan 1998).

Tritium Levels in Vegetation and Commodities

LLNL has historically released tritium to the air during routine operations and, occasionally, by accident. Tritium is the only radionuclide released from LLNL activities that occurs in detectable concentrations in vegetation and foodstuffs. In 2001, tritium was measured quarterly in vegetation at 18 fixed locations in the Livermore Valley, San Joaquin County, and Site 300. This monitoring was performed in support of an NNSA commitment to determine if there is a measurable buildup of radionuclides in the environment (LLNL 2002w).

LLNL tritium impacts on vegetation in the Livermore Valley remained minimal in 2001. In the Livermore Valley, the maximum potential dose from ingested tritium is based on the conservative assumptions that an adult's diet consists exclusively of leafy vegetables with the measured tritium concentrations, as well as meat and milk from livestock fed on grasses with the same concentrations. Nevertheless, based on these extremely conservative assumptions, the maximum potential dose from ingestion of vegetables, milk, and meat for 2001 for the Livermore Valley is 0.0069 millirem per year (LLNL 2002w).

With the exception of vegetation from previously identified sites of contamination, the tritium levels at Site 300 were below the limits of detection and comparable to those observed in previous years. The areas where tritium is known to be present in the subsurface soil are well delineated and localized. The calculated maximum potential annual ingestion dose from vegetation, based on the maximum value of 73,000 picocuries per liter, is 1.3 millirem. This dose, based on the conservative modeling assumptions described above, is theoretical, but nevertheless small, because vegetation at Site 300 is not allowed to be harvested for consumption by people or used as feed for livestock (LLNL 2002w).

In 2001, 12 bottles of wine produced in the Livermore Valley, 6 bottles of California wines from outside the Livermore Valley, and 4 bottles of wine from European vineyards were analyzed for tritium. All the wine tritium concentrations were far below drinking water limits. The highest tritium concentration in Livermore Valley wine (70 picocuries per liter) represents only 0.35 percent of the California drinking water standard (20,000 picocuries per liter). Based on the conservative assumption that wine is consumed at the same rate as the average consumption of water (370 liters per year or about 1 liter per day), the annual dose that corresponds to the highest detected 2001 Livermore Valley tritium concentration in wine is 1.7×10^{-3} millirems. For a hypothetical individual consuming 1 liter per week using the median tritium values from the three sampling areas, the annual doses from Livermore, Europe, and California wines would be 1.3×10^{-4} millirem, 1.1×10^{-4} millirem, and 3.7×10^{-5} millirem, respectively (LLNL 2002w).

The LLNL contribution to tritium exposure levels in the Livermore Valley has trended downward by approximately one order of magnitude as evidenced by the decline in the dose to the site-wide MEI at the Livermore Site between 1990 and 2001 (Appendix B, Table B.4.10.1–2). A similar trend was noted for tritium released in air during the same period

(Table 4.10.5–1). In general, the median tritium concentrations in plant water for vegetation at the Livermore Site and Site 300 show a similar downward trend between 1988 and 2001, when one sampling location at the Livermore Site and two sampling locations at Site 300 were excluded where tritium contamination has been identified (LLNL 2002w).

Under the No Action Alternative, it is anticipated that tritium impacts on vegetation and wine might increase slightly as Tritium Facility activities at the Livermore Site would increase. Tritium emissions would increase from approximately 30 curies in 2002 to 210 curies per year for the foreseeable future. In addition, Site 300 and NIF would begin to use tritium. However, any increase in tritium impacts on vegetation and wine may be difficult to detect due to the historically low levels currently being recorded and operational safeguards that are in place.

Wildlife

Livermore Site

The No Action Alternative would result in the clearing of 552,000 square feet of vegetation with a commensurate loss of wildlife habitat at the Livermore Site for proposed projects on land that has been previously disturbed. Any impacts to animals would be minimal and some displaced animals may be able to occupy adjacent habitat.

Site 300

The No Action Alternative would result in minimal clearing of vegetation with little loss of wildlife habitat at Site 300 for the Site 300 Revitalization Project, the Wetland Enhancement Project, and the Response Training Center. Both the Site 300 Revitalization Project and Response Training Center have been completed relative to components that might impact biological resources. Some loss of less mobile animals, such as reptiles and small mammals, could occur during construction of the Wetland Enhancement Project. Any impacts to the animal populations would be very small and some displaced animals would be able to occupy adjacent habitat.

Protected and Sensitive Species

This section discusses species listed as endangered, threatened, or proposed under the Federal *Endangered Species Act* and *California Endangered Species Act* affected by the No Action Alternative as well as unaffected species with similar status or indicated as species of concern. Additionally, species protected by the *Migratory Bird Treaty Act* and certain rare plants listed by the California Native Plant Society found at Site 300 are also discussed. The discussion for Site 300 is more detailed than that for the Livermore Site, which has been more disturbed. The species discussed include those for which information exists. Mitigation measures for listed species discussed below may be modified as a result of subsequent consultation with the USFWS and California Department of Fish and Game (CDFG).

Livermore Site

Under the No Action Alternative, LLNL would continue to fulfill its obligation to maintain Arroyo Las Positas (previously modified to handle a 100-year flood event) and onsite tributaries for flood capacity. The focus of the Las Positas Maintenance Project is to allow the function and needs of onsite drainage capacity of the arroyo to be met in a timely and consistent manner without overlooking the preservation and habitat conservation requirements pertaining to the federally threatened California red-legged frog (LLNL 1998a, USFWS 1997, DOE 2002j, USFWS 2002e). For further details of the Arroyo Maintenance Project and ongoing consultation with the USFWS for this project, see Appendix E, Section E.2.1.

No California red-legged frogs have been identified in 1,800 feet of Arroyo Seco within the Livermore Site boundaries from the Vasco Road bridge to the East Avenue culvert (LLNL 2003ab). However, this segment of Arroyo Seco could be used by populations of that species in the vicinity of the site. A separate Biological Assessment has been prepared to assess the impacts of the proposed Arroyo Seco Management Plan and was submitted to the USFWS in August 2003.

Formerly designated critical habitat for the California red-legged frog at the Livermore Site is shown in Chapter 4, Figure 4.9.3–1. Construction of new structures proposed under the No Action Alternative (e.g., BSL-3 Facility and the Edward Teller Education Center) at the Livermore Site would not be in formerly designated critical habitat for the California red-legged frog or areas where this species typically occurs. Other operations would not be anticipated to result in the loss of formerly designated critical habitat for this species.

In 1997, bullfrogs were noted in the southern sediment basin, a sediment trap south of the Drainage Retention Basin. A bullfrog management program, coordinated with the USFWS, was initiated to minimize the adverse impact of this invasive species, which is a predator of the California red-legged frog (DOE 2002j, USFWS 2002e). See Appendix E for further discussion.

Measures to protect the California red-legged frog during Las Positas Maintenance Plan high-bank mowing and pruning activities would continue. These previously approved USFWS measures (LLNL 1998a, USFWS 1998) include:

- The site wildlife biologist would survey project sites for California red-legged frogs prior to work being initiated.
- Areas identified as having California red-legged frogs would be marked with LLNL special-status species flags, tape, or other visible demarcations. A map would be disseminated to the project crew with the sensitive frog location exclusion zones clearly outlined.
- All vegetation cutting and removal in these areas would be performed in a manner that would not directly impact frogs.
- Vegetation cutting within 50 feet of the frog pool in Reach 1 and the two pools in Reach 2 would be performed using rotary tools and to a height of at least 24 inches. All vegetation cutting within this area would be performed by a qualified wildlife biologist.

Measures to protect the California red-legged frog during Las Positas Maintenance Plan dredging activities in the Las Positas Arroyo and elsewhere would continue. These previously-approved USFWS measures (LLNL 1998a, USFWS 1998) include:

- The site wildlife biologist would survey project sites for California red-legged frogs prior to work being initiated.
- Areas identified as having California red-legged frogs would be marked with LLNL special-status species flags, tape, or other visible demarcations.
- Prior to the project impact activity, these areas would be searched and any frogs found would be collected (by a USFWS-approved biologist) and placed in a ponded enclosure until the annual maintenance procedures of dredging, etc., have been completed; then they would be returned to the arroyo at or near the location where they were collected.
- Prior to new construction or security buffer maintenance activities, construction sites would be surveyed by the site wildlife biologist for California red-legged frogs prior to work being initiated.

In addition to the California red-legged frog management activities discussed above, there are various measures taken at the Livermore Site to protect birds covered by the *Migratory Bird Treaty Act*. The white-tailed kite, a California species of special concern, is known to nest at the Livermore Site. Therefore, construction activities are avoided to the extent practical near active white-tailed kite nests until young are fledged. All trees identified for removal are inspected for active bird nests in order to comply with the *Migratory Bird Treaty Act*.

Site 300

Affected Species

The No Action Alternative would affect three federally listed or proposed species (California red-legged frog, California tiger salamander, and Alameda whipsnake) and rescinded critical habitat for the California red-legged frog and Alameda whipsnake. The first affected species is the California red-legged frog, a federally listed threatened species. Formerly designated critical habitat for the California red-legged frog and its breeding and nonbreeding locations at Site 300 are shown in Figure 4.9.3–3. Proposed termination of surface water releases for an artificial wetland at Building 865 would affect this species, because it has been a known breeding location for 6 years. However, the elimination of these wetlands that were the result of past cooling tower discharges and are now maintained through irrigation with potable water that would return this part of Site 300 closer to its ecological state prior to the discharges and irrigation. Termination of water to a small, artificially maintained wetland at Building 801 would eliminate a potential breeding site for this frog species, although no California red-legged frogs occur at this site. Elimination of very small wetlands associated with the cooling towers at Buildings 851 and 827 would eliminate two low quality habitat locations for the California red-legged frog where frogs have not been observed for the past 6 years. Appendix E, Section E.2.2.6, provides further details on potential impacts of this project and mitigation measures taken to minimize those impacts. Proposed termination of surface releases at Buildings 865, 851, and 827 was coordinated with USFWS. Approval was received contingent upon implementation of mitigation measures in a recent Biological Assessment and related biological opinion (Jones and Stokes 2001, USFWS 2002b). This proposed termination could start as early as 2004 (LLNL 2003ab).

Grading of fire trails disturbs sediment that could directly affect California red-legged frog habitat suitability. However, the use of best management practices could reduce adverse effects to this species by minimizing erosion of fire trails into drainages as discussed in Appendix E, Section E.2.2.6 (Jones and Stokes 2001). Two such practices may include the use of native grasses to reseed disturbed areas that are prone to erosion, and selective installation of erosion control fabrics in areas where applicable.

LLNL is proposing to mitigate the 0.62-acre artificial wetlands at Buildings 801, 865, 851, and 827, removed by continued operations at Site 300 under the No Action Alternative, by enhancing selected areas and increasing breeding opportunities for the California red-legged frog. These designated areas would be managed and protected for the California red-legged frog and California tiger salamander. A minimum of 1.86 acres of wetland habitat would be enhanced and managed for the California red-legged frog and California tiger salamander. Potential mitigation sites for enhancement include the wetlands at the seep at the SHARP Facility and the Mid Elk Ravine. This mitigation measure has been previously addressed in a recent Biological Assessment and related Biological Opinion (Jones and Stokes 2001, USFWS 2002b) (see Appendix E, Section E.2.2.9, for more information).

The second affected species is the California tiger salamander, a federally listed proposed threatened species (68 FR 28649). Chapter 4, Figure 4.9.3–4, shows wetland locations where this species has been observed at Site 300. Grading of fire trails typically occurs mid through late spring. Mortality to individuals is unlikely to occur. Although proposed storm drainage and culvert improvement activities could result in direct mortality of California tiger salamanders, proposed mitigations for the California red-legged frog contained in a recent biological assessment and related biological opinion would greatly minimize the potential for such adverse impacts (Jones and Stokes 2001, USFWS 2002b). Appendix E, Section E.2.2.6, provides further details on mitigation measures taken to minimize impacts of the No Action Alternative on this species.

The third affected species is the Alameda whipsnake, a federally listed threatened species. Figure 4.9.3–5 shows critical habitat and potential habitat for the Alameda whipsnake at Site 300. Grading of fire trails as well as prescribed burns in grasslands adjacent to Alameda whipsnake habitat in sage scrub and rock outcrops have the potential to affect this species. However, a biological assessment and related biological opinion address mitigations that would minimize the potential for adverse effects from these proposed activities (Jones and Stokes 2001, USFWS 2002b). Fire trail maintenance and prescribed burns are annual activities that would continue during the 10-year period covered by this LLNL SW/SPEIS. Section E.2.2.6 provides further details on measures taken to minimize impacts of the No Action Alternative on this species.

Unaffected Species

Activities under the No Action Alternative would not affect the following federally listed endangered, threatened, and candidate species: the large-flowered fiddleneck, the San Joaquin kit fox, and the valley elderberry longhorn beetle. The large-flowered fiddleneck is federally listed as endangered and state listed as endangered (CDFG 2002b). Additionally, a portion of Site 300 has been designated as critical habitat for the large-flowered fiddleneck (Figure 4.9.3–2). Activities included in the No Action Alternative would not affect the large-flowered fiddleneck population at Site 300. The large-flowered fiddleneck population near the Drop Tower would continue to receive protection by maintaining the fence, controlling access, and prohibiting activities that could adversely affect the population.

LLNL has an ongoing monitoring program for the large-flowered fiddleneck at Site 300. This monitoring program would be continued. Additionally, research is being conducted on the natural and experimental populations of the large-flowered fiddleneck to develop techniques to control the cover of exotic annual grasses while developing techniques to restore native perennial grasslands and preserve (or increase) population levels of this plant. The research activities also monitor the status of three other rare plants at Site 300:

- The big tarplant that is extremely rare throughout its range.
- The diamond-petaled poppy, which was presumed extinct and rediscovered in 1993.
- The gypsum-loving larkspur, which is on the California Native Plant Society watch list indicating it is a rare, but with a wide enough distribution so as not to be threatened at this time (LLNL 2002dj).

The 2002-2003 rare plant monitoring program replaced the gypsum-loving larkspur with the round-leaved filaree. Included in this monitoring program is research to determine to what extent burn frequency affects the spread of one-sided bluegrass (LLNL 2002dj). Section E.2.2 provides further details on why these species would not be affected under the No Action Alternative.

The San Joaquin kit fox is federally listed as endangered and state listed as threatened. Protocol level surveys were conducted for this species in 1991, and hundreds of project-specific surveys have been conducted at the site since 1993. No kit fox were recorded at Site 300 in 1991 nor have they been observed there in subsequent surveys, including one in 2002 (Jones and Stokes 2001, CSUS 2003). However, kit fox were observed in nearby properties in the 1990's (Sproul and Flett 1993). A comprehensive mitigation and monitoring plan was developed for this species (LLNL 1992a).

Elderberry bushes are habitat for the federally listed valley elderberry longhorn beetle. The valley elderberry longhorn beetle is federally listed as threatened. In May 1997, USFWS issued Site 300 a biological opinion for pruning elderberry shrubs along the edge of a fire trail in the southeast corner of the site for three separate time periods. One pruning occurred in May/June 1997, and no beetles or evidence of beetles were detected (Jones and Stokes 2001). However, during surveys in 2002, 10 exit holes considered to be from valley elderberry longhorn beetles were found in elderberry plants. Additionally, six adult beetles were observed in a canyon just north of Elk Ravine, with two of the adults clearly exhibiting identifying characteristics of the valley elderberry longhorn beetle (Arnold 2002). No facility construction activities would be allowed to occur within a 300-foot radius of known locations of elderberry bushes without prior consultation with the USFWS. Because of these protective measures, valley elderberry longhorn beetle would not be adversely affected.

The California linderiella fairy shrimp, a Federal species of concern, occurs at Site 300. During a 2001-2002 wet season survey, this branchiopod species was found in a vernal pool (FS-04) in the northwest part of Site 300 (Condor Country Consulting 2002). However, because proposed projects under the No Action Alternative would not affect this seasonal pool, the California linderiella fairy shrimp would not be adversely affected.

The willow flycatcher, a California-listed endangered species was observed for the first time at Site 300 during a constant effort mist netting survey in Elk Ravine in 2003 (LLNL 2003ac). The willow flycatcher would not likely be adversely affected since it was observed in a part of Elk Ravine not affected by continuing operations at Site 300.

Many migratory bird species have been observed at Site 300 (see Table 4.9.1–1). Construction activities would be coordinated with LLNL wildlife biologists to ensure that nests are protected as applicable to the *Migratory Bird Treaty Act*.

The following existing practices would be continued to benefit multiple species:

- The employee awareness program on biological mitigation measures would continue for LLNL employees and contract personnel working at Site 300 in areas where special status species are present.
- The use of rodenticides and other rodent control measures at Site 300 would be minimized to the extent practicable.
- Vehicle traffic would also be confined to existing roads (paved and unpaved) to the extent possible.
- To maintain and promote habitat diversity, the livestock grazing exclusion and annual controlled burning program on Site 300 would continue.
- Fire roads and disked areas would be maintained in the same locations to the extent possible. After evaluation, where possible, duplicate roads paralleling other roads would be eliminated.
- Herbicide use would remain limited to areas around buildings and other facilities, or eliminated, to the extent practicable.
- Consistent with current construction practices, all food-related trash items such as wrappers, cans, bottles, and food scraps would be disposed of in a closed container or removed from the construction site.
- The monitoring program for the San Joaquin kit fox described in the 1992 LLNL EIS/EIR would be continued (LLNL 1992a).
- Sites designated for new construction would be surveyed for the presence of various species or their nests or dens that are protected under Federal and State of California laws, with avoidance or other mitigative measures implemented as deemed appropriate.

Wetlands

Livermore Site

Proposed new construction of buildings under the No Action Alternative would occur in upland areas, so that land clearing would not be anticipated to have direct or indirect impacts on wetlands. New construction projects would include best management practices to avoid runoff that could affect wetlands. Wetlands along Arroyo Las Positas would be impacted if discharged treated water from the environmental restoration program is terminated; such termination is being considered under the No Action Alternative (LLNL 2001ap). Future actions involving these wetlands may require coordination with the U.S. Army Corps of Engineers (USACE), such as ongoing efforts to develop a water management plan for an 1,800-foot segment of Arroyo Seco within Livermore Site boundaries from the Vasco Road bridge to the East Avenue culvert (LLNL 2001ap). Additionally, the State of California has a no net loss policy regarding wetlands, including artificial wetlands (CERES 2002).

Site 300

There are 8.61 acres of wetlands at Site 300 of which 4.39 acres were found to meet criteria for jurisdictional wetlands subject to USACE regulation under Section 404 of the *Clean Water Act* (Jones and Stokes 2002c). Other than the Wetland Enhancement Project, new construction under the No Action Alternative would have minimal direct or indirect impacts on wetlands.

Under the No Action Alternative, artificial wetlands (totaling 0.62 acres) that have been created by surface water runoff near Buildings 801, 827, 851, and 865, would be terminated. A Section 404 permit would be required from the USACE for dredge and fill permit and a Section 401 certification or waiver will need to be obtained from the Regional Water Quality Control Board. Proposed mitigation measures for this action involve the protection and enhancement of a minimum of 1.86 acres of wetland habitat (Jones and Stokes 2001, USFWS 2002b).

5.2.7.3 *Cumulative Impacts*

Under the No Action Alternative, approximately 552,000 square feet (12.7 acres) of terrestrial habitat at the Livermore Site would be disturbed due to proposed construction activities. No terrestrial habitat would be eliminated at Site 300. SNL/CA is managing its section of the Arroyo Seco to enhance California red-legged frog habitat and developing a 30-acre wildlife preserve on the east side of the facility. The incremental effect of the No Action Alternative on biological resources within the area would be positive, particularly in the long term, when taken in the context of continuing conversion of wildlife habitat for agricultural, residential, and commercial and industrial use in the Livermore Valley and near Site 300.

5.2.8 Air Quality

5.2.8.1 *Nonradiological Air Quality*

Relationship with Site Operations

The No Action Alternative will involve some changes at both the Livermore Site and Site 300, but for the most part, it is a continuation of current activities. Facility upgrades, D&D activities, and new facility construction are normal during any 10-year period. Therefore, potential air quality impacts of planned activities associated with the No Action Alternative should be considered in relation to current activity levels, as a means to assess and compare planned actions and bound impacts to the air resources. The general parameters that will be used in the analyses of potential air quality impacts are listed in Table 5.2.8.1–1.

TABLE 5.2.8.1–1.—*Summary of Input Parameters for Air Quality Analysis Under the No Action Alternative*

Parameter	Units	Site	Existing Environment	No Action Alternative
Daily Vehicle Traffic	1,000 vehicles	Livermore	22.0	22.6
		Site 300	0.5	No change
Air emission sources and facility status	-	Livermore	The Livermore Site is rated as a mid-sized facility, subject to offset requirements for nonattainment pollutants POC and NO_x. The site's controls on POC and NO_x sources are rated good by the BAAQMD. The Livermore Site is not rated as a major source for HAPs under NESHAP.	No change
		Site 300	Site 300 is a small source per definition of the SJVUAPCD and also a nonmajor source for HAPs under NESHAP.	No change

BAAQMD = Bay Area Air Quality Management District; NESHAP = National Emission Standards for Hazardous Air Pollutants; HAP = hazardous air pollutant; NO_x = oxides of nitrogen; POC = precursor organic compounds; SJVUAPCD = San Joaquin Valley Air Pollution Control District.

Impact Analysis

Modifications to Facilities or Operations

As described in Section 3.2, the No Action Alternative encompasses not only the continuation of many LLNL activities, but also planned facility and infrastructure improvements and the completion of construction and operation of recently approved facilities with existing NEPA documentation.

Facility and infrastructure renovations (e.g., replacement of ductwork and roofs, installation of seismic and physical security upgrades, and repairs and modifications to roads) and new facility construction are normal during any 10-year period. The projected level for these activities under the No Action Alternative would remain on par with current levels, and LLNL would continue to include standard measures for controlling pollution as part of every design and construction project. With the mitigation measures in place, impacts will be similar to current levels.

Standard mitigation measures related to construction activities include the following:

- Fugitive emissions must be controlled in accordance with stringent air district requirements (discussed in Section 5.1.8.1), which include measures such as water spraying of disturbed areas and covering exposed piles of excavated material.
- LLNL contractors must complete a project-specific task identification process list and project-specific safety plan for all projects. The task identification process lists typical construction hazards and concerns and is used by subcontractors to help identify potential topics to be addressed in their project-specific safety plans.

The LLNL Environmental Protection Department, Hazards Control Department and Plant Engineering staff review all design and provide guidance on construction projects, review the task identification process list prior to commencing construction, and routinely inspect construction work sites to ensure adherence to project-specific requirements.

The No Action Alternative would include the construction and operation of planned and approved facilities. These include administrative and staff offices, a conference center, and training facilities. Together, these would increase the developed area by about 1.5 percent. Space utilization would not differ appreciably from current allocations. In fact, many of the activities to be housed within new, structures are ongoing activities that would be relocated and/or consolidated. Activity relocations would be reviewed for compliance with air permit requirements in relation to their new settings. Where activities would require new air permits or modifications to existing air permits, these would be secured prior to construction or operation.

The planned activities at the Livermore Site would result in some additional fuel use. Natural gas is used in boilers, and diesel fuel is used in generators. Both are tested periodically. Several criteria and toxic air contaminants are emitted from fuel combustion. Oxides of nitrogen are a concern locally as a contributor to ozone formation. The increased fuel use anticipated under the No Action Alternative would result in an incremental increase in oxides of nitrogen emissions, 0.32 tons annually, which would be less than 2 percent of the oxides of nitrogen emissions from this source category under current operating conditions.

Because fuel combustion sources are recognized as potentially significant sources of criteria pollutant emissions, LLNL has enacted standard measures to mitigate emissions from this source category (LLNL 2001s). These include the following:

- Fuels must meet the requirements of the *Clean Air Act Power Plant and Industrial Fuels Use Act*, and applicable DOE orders, and would continue to require that construction equipment and vehicles be inspected daily for leaks of fuel, engine coolant, and hydraulic fluid.
- Contract specifications for boilers require adherence to the American Society of Heating, Refrigerating and Air Conditioning Engineering, Inc., for energy efficiency, and compliance with efficiency standards is tested in accordance with American Society of Mechanical Engineers methods.

Decommissioning/Decontamination and Demolition

The No Action Alternative would include the planned removal of 234,443 gross square feet of excess and legacy facilities at the Livermore Site and 20,202 gross square feet at Site 300, as part of a campaign to reduce the amount of active nonassignable space and optimize the use of existing space. This rate would be similar to that of recent years, and LLNL would continue to employ standard measures to control pollution from D&D activities, and comply with air district requirements to limit fugitive dust emissions. Air emissions and air quality impacts would be similar to existing conditions.

A major concern with demolition of older structures is the disturbance of asbestos containing materials (ACM). For those projects that may involve the disturbance of ACM, LLNL would continue to require that subcontractors be appropriately certified and employ engineering controls, devices, and work practices to isolate the source of asbestos and prevent fiber migration. These include the use of physical barriers (e.g., plastic sheeting) to separate asbestos work areas, keeping the asbestos work area at a negative pressure relative to adjacent areas, and using exhaust fans and vacuum cleaners with high-efficiency particulate air (HEPA) filters for asbestos control and cleanup. Specific requirements related to asbestos removals are detailed in the *Environment, Safety & Health* (ES&H) *Manual* (LLNL 2001t). LLNL also requires that the air district be notified of pending asbestos-related renovation and maintenance work, and planned asbestos-related demolition work above thresholds.

Support Personnel and Vehicular Activity

Planned activities associated with the No Action Alternative involve a projected increase in workforce, adding approximately 290 employees at the Livermore Site by 2014 and possibly 10 employees at Site 300, with corresponding increases in vehicular activity, primarily workers commuting to and from the sites.

Impacts of workforce commute on air quality would be lessened through transportation demand management. A large employment center holds more opportunities for alternatives to the single-employee commute. LLNL has a transportation systems management program that provides and promotes alternative, environmentally responsible options for employee commuting, assists LLNL in complying with transportation-related *Clean Air Act* legislation, and resolves congestion-management issues. LLNL is committed to continuing this program that provides (LLNL 2001s):

- A pre-tax benefit program for transit and vanpool commuters, which enables employees to set aside a fixed amount of their pre-tax salary each month to reduce transportation costs
- Participation in the BAAQMD’s and San Joaquin Valley Unified Air Pollution Control District’s (SJVUAPCD’s) “Spare the Air” programs
- Active participation in meetings with transportation planners from Livermore, Dublin, Pleasanton, other large employers, local school districts, and community outreach programs to mitigate transportation-related air pollution and congestion-management issues

- Participation in DOE's Clean Cities Coalition to increase availability and use of alternative-fueled vehicles for LLNL employees

The additional workforce would include some relocated employees, new to the Bay Area air basin. Activities of the relocated population would contribute to air emissions associated with the commute to the workplace and secondarily from the additional energy consumption, other vehicular use, and goods and services that would be required to support the additional, relocated population. The jobs that would be created under the No Action Alternative at LLNL would represent a very small fraction (less than 1 percent) of the projected increase in employment within Alameda County over the 2000 to 2010 timeframe as described in Section 5.1.2 (Association of Bay Area Governments 2001). The air quality impact of this population growth would be on the same order as that of the growth rate, and this would be well within the projections developed by the Association of Bay Area Governments, Metropolitan Transportation Commission, and BAAQMD, and employed in the clean air plan.

Cumulative Impacts and Conformity

The parameters used to evaluate air quality impacts of the No Action Alternative are listed in Table 5.2.8.1–1. Table 5.2.8.1–2 presents the calculated maximum carbon monoxide concentrations, which would remain within 20 to 30 percent of ambient standards. Projected air pollutant emission rates associated with increased fuel combustion in boilers and engines, and the increased vehicular activity associated with increased workforce under the No Action Alternative are provided in Table 5.2.8.1–3.

Total emissions are also provided in Table 5.2.8.1–3 for comparison with significance levels. As discussed in Section 5.1.8, annual and daily significant emission levels are established by local air districts in response to local air quality concerns. A project that generates criteria air pollutant emissions in excess of significance levels would be considered to have a significant air quality impact and stringent mitigation would be required. By evaluating project emissions as a whole, including motor vehicle emissions, this affords the air district has a greater level of control over a project, i.e., it is not limited to source permitting.

Rules for conformity also consider total project emissions. These rules were established under the Federal *Clean Air Act* and pertain specifically to Federal actions. The underlying basis for the conformity demonstration is to preclude actions that would generate growth in air pollutants to a degree that is inconsistent with the local clean air plan, and thereby frustrate regional efforts to attain and maintain the air quality standards. Within the Bay Area, conformity applies to projects that generate emissions of precursor organic compounds, oxides of nitrogen, or carbon monoxide in excess of 100 tons per year; such projects would be required to fully offset or mitigate the emissions caused by the action (BAAQMD 1999). A conformity review will be conducted and reported in the Final LLNL SW/SPEIS for projects at the central Livermore Site and Site 300 covered by the EIS.

Total emissions associated with the No Action Alternative would be a small fraction of significance levels. Consequently, activities associated with the No Action Alternative would not result in an adverse impact to air resources.

TABLE 5.2.8.1–2.—*Projected Maximum Carbon Monoxide Concentrations Associated with Increased Traffic Conditions in the Environs of the Livermore Site Under the No Action Alternative*

	Existing Environment	No Action Alternative
Traffic Assessment [a]		
Peak hourly background traffic through intersection	3,757	3,757
Additional traffic related to alternative	-	62
Total traffic through intersection	3,757	3,819
Maximum One-Hour Concentrations (ppm)		
Near-roadway CO concentration [b] from:		
Background traffic	1.1	0.66
Increased traffic from alternative	-	0.012
Estimated background concentration [c]	3.9	3.5
Total - traffic plus background	5.0	4.2
% of state ambient air quality standard [d]	25	21
Maximum Eight-Hour Concentrations (ppm)		
Near-roadway CO concentration from:		
Background traffic [c]	0.75	0.46
Increased traffic from alternative [c]	-	0.008
Estimated background concentration	2.0	1.7
Total - traffic plus background	2.7	2.2
% of state ambient air quality standard [d]	30	25

[a] Peak hourly traffic is estimated to be 10 percent of the total daily traffic passing through the intersection of Vasco and Patterson Pass Roads. This value (10 percent) is recommended by the air district for use when hourly values are not available. Local traffic patterns are discussed in Section 4.13.2.

[b] Concentrations are assessed for locations 25 feet from roadway for the year 2004 (existing environment) and year 2014 (No Action Alternative). Assessment methodology is discussed in Section 5.1.8.1, and follows BAAQMD CEQA Guidelines (1999). Emission factors and ambient concentrations of carbon monoxide are expected to decline over time through 2010 due to improved emission controls on newer vehicles and reformulated gasoline.

[c] Background carbon monoxide is defined as that part of the ambient CO concentration that is not attributable to traffic sources from a nearby street or intersection. It is calculated according to procedures recommended by BAAQMD (1999).

[d] National one-hour ambient air quality standard is 35 ppm; more restrictive state standards, 20 ppm, is used. National and state eight-hour ambient air quality standard is 9 ppm.

BAAQMD = Bay Area Air Quality Management District; CEQA = *California Environmental Quality Act*; CO = carbon monoxide; ppm = parts per million.

The No Action Alternative would also result in increased electrical use, which cumulatively contributes to greater demand and some additional air pollution. LLNL and DOE commitments to energy conservation, load management, and increased use of renewable energy sources (discussed in Appendix O, Section O.4.3) would help to offset this impact.

5.2.8.2 *Radiological Air Quality*

This section analyzes the No Action Alternative radiological air quality impacts due to normal releases from ongoing site operations such as R&D and waste management. Impacts in terms of dose related to the Livermore Site and Site 300 are discussed in this section. Health impacts are discussed in Section 5.2.14.2.

Relationship With Site Operations

This section summarizes the relationship between projects described in Section 3.2 for the No Action Alternative and radiological air quality. As noted previously, the dose that would result from exposure to routine air emissions from these projects is used to quantify the impacts. The important incremental impact to the baseline emissions for the No Action Alternative would be due to the addition of NIF operations and increased releases from Building 331.

Impact Analysis

Livermore Site

Annual tritium releases from the Building 331 Tritium Facility would increase to a level of 210 curies per year, still well within historical levels (see Chapter 4, Figure 4.10.5–1). Up to 30 curies of tritium per year could be released during NIF maintenance activities, when equipment is opened up or its contents exposed to air (LLNL 2003d). Activated gases created by NIF experiments with fusion yield, nitrogen-13 (67.8 curies) and argon-41 (26.2 curies), would be released from NIF and would be short-lived nuclides that would affect the site-wide MEI externally by way of air immersion.

The location of the site-wide MEI would change from existing environment due to NIF releases. The NIF MEI dose (as a result of airborne effluents from that facility only) would be about 0.041 millirem per year, at a location due east of the NIF stack, along the eastern site boundary. Conservatively adding the existing environment dose and the increase in Tritium Facility dose at the Credit Union to the NIF airborne effluent dose at this location would result in a No Action Alternative dose estimated at 0.098 millirem per year, 1 percent of the NESHAP limit.

The component of population dose from routine NIF releases would be 0.27 person-rem per year. Adding this dose to the Livermore population dose and the population dose due to the Tritium Facility releases would result in a No Action Alternative dose of 1.8 person-rem per year. The dose to the worker population was estimated by compositing the worker dose from the important contributing sources to the site-wide MEI dose, i.e., NIF and Tritium Facility, and the largest other sources of tritium, i.e., Building 612 Yard and outside Building 331. The No Action Alternative worker population dose would be 0.14 person-rem per year. Section 5.2.14 describes the relationship between these doses and health effects.

Minimal impacts on radiological air quality are expected from the No Action Alternative at the Livermore Site.

Site 300

The important incremental impact to the existing environment emissions under the No Action Alternative is from 20 milligrams per year (194 curies) of tritium released during explosives experiments. Such experiments have historically been performed at Site 300, although none were performed during 2001 (LLNL 2003i). The baseline year of 2001 for Site 300 normal release was chosen because the site-wide MEI dose from that year’s operations were greater than those of 2002. Firing Tables B812 and B850 will not be used for tritium experiments. Firing Table B851 is the only open-air facility that would use tritium. The site-wide MEI location is 1,530 yards west-southwest of Firing Table B851. This location corresponds with the closest site boundary to any individual firing table.

Explosives experiments result in the releases being dispersed as a gaseous cloud (SNL 2002). Although the annual release quantity limits are known, the sizes of each of the experiments to be performed over the period covered by this LLNL SW/SPEIS are not. A single set of cloud parameters, e.g., cloud height, was thus defined that simulates the baseline results. The meteorology during each of these experiments is also unknown a priori. The CAP88-PC program, which models the release as continuous, is useful because it considers all possible meteorological conditions. This method is considered conservative. The resulting annual exposure calculated in the model corresponds to the mean exposure from the possible meteorological conditions. The CAP88-PC computer program was used to calculate the incremental No Action Alternative release of tritium. The dose to the site-wide MEI, which is the sum of the 2001 and incremental release dose, is 0.055 millirem per year, less than 0.6 percent of the NESHAP limit. The resulting population dose of 9.8 person-rem per year. The dose to the worker population would be 0.005 person-rem per year.

Minimal impacts on radiological air quality are expected under the No Action Alternative at Site 300.

Cumulative Impacts

No adverse impacts on radiological air quality are expected under the No Action Alternative. Other than background radiation sources, there are no other known contributors to concentrations of radionuclides in air within 50 miles of the Livermore Site or Site 300. Therefore, there are no cumulative radiological air quality impacts.

5.2.9 Water

This section analyzes impacts to water resources associated with implementation of the No Action Alternative.

5.2.9.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.2 under the No Action Alternative and the water impact analysis. The No Action Alternative would cause increases in water use, impervious surfaces and runoff, and use of materials that are potential contaminants due to construction and operation of projects.

5.2.9.2 *Impact Analysis*

Livermore Site

Surface Water

The addition of new buildings and roads under the No Action Alternative would increase impervious surfaces at the Livermore Site. An increase in surface runoff would occur as a result of increased impervious surface areas. However, because Livermore Site soils are highly permeable and abundant uncovered acreage remains for groundwater recharge, the impact of the reduction in recharge surface area under the No Action Alternative would be minimal.

Surface water resources could be degraded by contaminant releases during construction of some facilities under the No Action Alternative. Contaminant sources could include construction materials; hydraulic fluid, oil, and diesel fuel; and releases from transportation or waste-handling accidents. LLNL stormwater pollution prevention plans have been devised to identify pollutant sources that could affect the quality of industrial stormwater discharges and to describe implementation practices to reduce pollutants in these discharges. In the event of a hazardous spill, necessary equipment to implement cleanup is available, and personnel are trained in proper response, containment, and cleanup of spills. Further guidance on response to hazardous material spills is provided in the ES&H Manual.

In 2002, the Livermore Site used approximately 1.2 million gallons of water per day from the San Francisco Hetch Hetchy Aqueduct system and the Alameda County Flood and Water Conservation District, Zone 7 (DOE 2003b). Under the No Action Alternative, water use is expected to be 1.37 million gallons per day. This increase would be due to the water requirements of the NIF and Terascale Simulation Facility. Buildings and activities in addition to the NIF and Terascale Simulation Facility projected under the No Action Alternative would have a minimal effect on water consumption.

Compliance with an approved erosion and sedimentation control plan during construction would prevent impacts to surface water from construction-induced erosion.

Surface water monitoring would continue under the No Action Alternative in accordance with DOE guidelines to ensure remediation of contamination already present and detection of any hazardous materials in the future. Stormwater monitoring would continue in accordance with NPDES requirements. Wastewater monitoring would continue as discussed in Section 4.14.4. Because of the extensive monitoring program and capability to divert potentially contaminated wastewater, no impacts to the Livermore Water Reclamation Plant (LWRP) or downstream receiving surface waters would be expected.

Because no activities projected under the No Action Alternative would occur within the 100-year floodplain, other than Arroyo Las Positas Maintenance Project, which is covered under an environmental assessment (DOE/EA-1272) (DOE 1998b), no impacts to the floodplain would be expected. None of the No Action Alternative projects would contribute significant amounts of surface water runoff to cause substantial flooding because the 100-year base flood event is contained within all channels. Due to the high infiltration rates and lack of appreciable floodplains on the Livermore Site, hydrologic impacts under the No Action Alternative would be minimal. No facilities would be located in either the 100-year or 500-year floodplain, therefore no impact from flooding would be expected. Impacts to surface water would be minimal.

Groundwater

Currently, the following contaminants exist above drinking water standards in groundwater at the Livermore Site: trichloroethylene, perchloroethylene, 1,1-dichloroethylene, chloroform, 1,2-dichloroethylene, 1,1-dichoroethane, 1,2-dichloroethane, trichlorotrifluoroethane (Freon 113), trichlorofluoromethane (Freon 11), and carbon tetrachloride. LLNL removes contaminants from groundwater and unsaturated zones (soil vapor) at the Livermore Site through a system of 27 treatment facilities located throughout the 6 hydrostratigraphic units containing contaminants of concern. In 2002, almost 248 million gallons of groundwater were removed and treated, yielding approximately 146 kilograms of volatile organic compounds (VOCs). Remediation activities have been successful in containing the VOC plume at the southwest corner of the site. This area is of concern because the plume has migrated offsite, toward a residential area. Groundwater monitoring would continue under the No Action Alternative to ensure that remediation of contamination already present continues to be effective and that contaminant fate and transport is fully understood. Groundwater quality should continue to improve because extracted groundwater would be collected and treated at the treatment facilities.

Groundwater resources could be degraded by contaminant releases during construction of some facilities under the No Action Alternative. Contaminant sources could include construction materials; spills of hydraulic fluid, oil, and diesel fuel; and releases from transportation or waste-handling accidents. The potential for spills of hazardous materials to impact groundwater largely depends on the depth to groundwater where the spill occurs. LLNL would follow prevention and mitigation steps outlined in the spill response chapter of the ES&H Manual in the event of a hazardous material spill. Because the minimum depth to groundwater at the Livermore Site is approximately 30 feet and employees are trained in spill response procedures, spills would likely be cleaned up before they reach the water table.

Impacts to groundwater from leaking underground storage tanks would not be expected since LLNL complies with all underground storage tank regulations which enforce the use of tank and piping primary and secondary containment, detection and monitoring systems, and corrosion protection.

No negative impacts to groundwater at the Livermore Site are expected from operations under the No Action Alternative, because there would be no discharges to groundwater. Impacts to groundwater quality from surface water recharge would be minimal because LLNL would continue to comply with NPDES requirements.

Site 300

Surface Water

Under the No Action Alternative, construction of buildings and roads would contribute incremental additions to impervious surfaces. There would be no noticeable impact to groundwater recharge because Site 300 is largely undeveloped and not covered by impervious surfaces. Stormwater monitoring would continue in accordance with NPDES requirements. Water use is expected to continue at 0.35 million gallons per day under the No Action Alternative.

Stormwater monitoring would continue in accordance with NPDES requirements. Surface water resources could be degraded by contaminant releases during construction of new facilities. Contaminant sources could include construction materials, spills of oil and diesel fuel, and releases from transportation or waste-handling accidents. LLNL would follow mitigation steps outlined in the Spill Prevention Control and Countermeasures (SPCC) Plan in the event of a spill of petroleum products. Hazardous material spill response procedures are outlined in the ES&H Manual.

Compliance with an approved erosion and sedimentation control plan during construction would prevent impacts to surface water from construction-induced erosion.

None of the No Action Alternative projects would contribute significant amounts of surface water runoff to cause substantial flooding. The 100-year base flood event would be contained within all channels except along Corral Hollow Road near the GSA, where parts of the road would be inundated during the 100-year event. Due to the high infiltration rates and lack of appreciable floodplains at Site 300, hydrologic impacts under the No Action Alternative would be minimal. However, due to the steep slopes, high runoff velocities within channels could occur during a storm. No facilities would be located in these areas; therefore, no impact from flooding would be expected.

Groundwater

Groundwater contaminants of concern at Site 300 include VOCs (mainly trichloroethylene), tritium, depleted uranium, explosive compounds, nitrate, and perchlorate. By fall 1999, after 8 years of treatment, the eastern GSA offsite trichloroethylene plume had been restricted to the Site 300 property. Before treatment, the plume had extended more than a mile down the Corral Hollow stream channel in the direction of the city of Tracy. Under the No Action Alternative, groundwater quality would continue to improve with ongoing remediation activities at Site 300.

Groundwater resources could be degraded by contaminant releases during construction. Contaminant sources could include construction materials; spills of hydraulic fluid, oil, and diesel fuel; and releases from transportation or waste handling accidents. LLNL would follow mitigation steps outlined in the SPCC Plan, in the spill response chapter of the ES&H Manual in the event of an oil or hazardous material spill. The potential for spills of hazardous materials to affect groundwater largely depends on the depth to groundwater where the spill occurs. Depths to groundwater in the areas where activities are expected under the No Action Alternative vary from approximately 50 to 180 feet. Because the minimum depth to groundwater at Site 300 in areas where activities are expected under the No Action Alternative is approximately 50 feet and employees are trained in spill response procedures, spills would likely be cleaned up before they reach the water table.

Impacts to groundwater from leaking underground storage tanks would not be expected since LLNL complies with all underground storage tank regulations which enforce the use of tank and piping primary and secondary containment, detection and monitoring systems, and corrosion protection.

No negative impacts to groundwater at Site 300 would be expected from operations under the No Action Alternative because there would be no discharges to groundwater. Potential impacts to groundwater quality from surface water recharge would be minimal because LLNL would continue to comply with NPDES requirements. Groundwater use would continue as described in

Section 4.11, and no impacts to groundwater availability would be expected under the No Action Alternative.

5.2.9.3 *Cumulative Impacts*

Livermore Site

The San Francisco Public Utilities Commission provides water to 2.4 million people in San Francisco, San Mateo, Santa Clara, and Alameda counties, including the Silicon Valley business district. To maintain a reliable water system, the San Francisco Public Utilities Commission initiated regional and local water projects in 2003 to upgrade and repair Hetch Hetchy System facilities. These projects will ensure stability in the case of a seismic event, sufficient water supply for an increasing population, and high quality drinking water that meets all regulatory requirements. The improvements scheduled to be complete by 2016.

San Francisco Bay Area water use is expected to increase by 64 million gallons per day by the year 2030. This is approximately a 25 percent increase over current water usage. The Livermore Site is projected to use 1.37 million gallons per day under the No Action Alternative. This is 0.4 percent of the projected total Hetch Hetchy water supply. Livermore currently uses 0.5 percent of the Hetch Hetchy water supply. Livermore's future contribution to the cumulative Hetch Hetchy water use would remain proportional to current use.

Because much of the land surrounding the Livermore Site is zoned for low-density activities such as grazing, vineyards, and rural residential, and the large residential parcel to the west of the Livermore Site is basically fully developed (see Chapter 4, Figure 4.2.1.1–1), it is expected that most of the surrounding undeveloped land will not be converted to impervious surfaces in future years. Therefore, cumulative impacts on surface water quality and groundwater recharge from increases in impervious surfaces are expected to be minimal.

With the exception of the Livermore Site VOC plumes, no other known contaminant plumes exist in the surrounding area that could cause a cumulative degradation of groundwater quality. Other sources of groundwater contamination in Livermore are described in Section 5.2.15.3. Groundwater quality at SNL/CA, located directly south of the Livermore Site, has improved through completion of remediation that began in 1984 on a 59,000-gallon diesel fuel spill. Similarly, groundwater quality should continue to improve in the Livermore Site vicinity with ongoing remediation at water treatment facilities.

Site 300

Site 300 currently receives water from onsite wells and should receive water from the Hetch Hetchy water supply system by early 2004. Water consumption rates have declined steadily since 1992, down to 25.3 million gallons per year in 2002. The new water system capacity is estimated to be 648,000 gallons per day, with the capability of expanding to 1.2 million gallons per day. Under the No Action Alternative, Site 300 would use 0.1 percent of the Hetch Hetchy water supply. Given the low population and rural character of the area, an indiscernible increase in water use under the No Action Alternative, and the eventual Hetch Hetchy supply, no cumulative impacts to water availability for Site 300 and vicinity would be expected.

The land surrounding Site 300 is designated as general agricultural, recreation, conservation, and wind resource areas (see Figure 4.2.1.2–1). Most of this land is agricultural, however, property immediately east of the site is occupied by a company that packages and stores fireworks. The Carnegie State Vehicular Recreation Area, southwest of the site, is used for off-highway vehicles. Aside from the vehicle recreation area, which likely contributes to sediment runoff during rainstorms, the cumulative impact on surface water quality from activities in surrounding areas would be minimal. Because the area is largely undeveloped and expected to continue in that manner, no cumulative impacts to groundwater recharge would be expected.

Groundwater contamination at Site 300 has been restricted to within the site boundary and groundwater quality is improving through remediation activities. Because these plumes are the only known groundwater contamination in the Site 300 vicinity, no cumulative impacts to groundwater quality would be expected.

5.2.10 Noise

This section presents noise impacts resulting from implementation of the No Action Alternative. The analysis is organized by noise-generating LLNL activities, such as construction, modifications to and removal of facilities, traffic noise, and impulse noise.

5.2.10.1 *Relationship with Site Operations*

Activities associated with the No Action Alternative (Section 3.2) would contribute to noise generation, either directly or indirectly. These noise-generating activities include:

- **Construction Activities and Equipment—**Demolishing, excavating, grading, and building that can result in intermittent noise levels generally higher than background.
- **Operating Equipment—**A variety of machinery and equipment items that generate noise during routine operations including heating, ventilating, and air-conditioning (HVAC) equipment; cooling towers; motors; pumps; fans; generators; and air compressors.
- **Traffic—**The Livermore Site generates about 22,000 vehicle trips per day (counting each vehicle to enter and exit the Livermore Site) and an additional 500 trips per day are generated by Site 300.
- **Explosives Testing—**Explosives testing results in short-burst, impulse-type noise.

The general parameters that will be used to characterize activities with potential to characterize community noise levels are listed in Table 5.2.10.1–1.

5.2.10.2 *Impact Analysis*

As described in Section 3.2, the No Action Alternative would encompass continued operation of many current LLNL activities, but also include planned facility and infrastructure improvements, the completion of several construction projects, additional staffing, operation of planned facilities, and several building removals.

Modifications to Facilities or Operations

Facility and infrastructure renovations and new facility construction are ongoing activities at the Livermore Site and Site 300. The projected level for these construction activities under the No Action Alternative would remain on par with current levels. The impact of these activities would not generally be noticeable beyond the site boundary, owing to the relatively large spatial area of the Livermore Site and perimeter buffer zone. Intervening roadways between Livermore Site, Site 300, and community areas would reduce the impact of onsite generated noise.

Planned new facilities associated with the No Action Alternative would be primarily offices and laboratories, and would not introduce any machinery or equipment that would differ from the current HVAC equipment, cooling towers, motors, pumps, fans, generators, air compressors, and loudspeakers. Noise from this equipment would not be noticeable beyond the site boundary.

At most, during peak activity levels, a person located 100 feet from a noisy construction site would not be exposed to more than 82 A-weighted decibels (dB[A]), for only limited periods of maximum activity. This level is comparable to a pneumatic drill or vacuum cleaner (City of Livermore and LSA 2002) and is not expected be objectionable or to conflict with compatibility guidelines. Impacts are expected to be minimal.

Traffic Noise

The No Action Alternative would result in a slight increase in heavy-duty vehicle activity related to shipments of materials and waste. This equipment is associated with noise levels of 81 to 87 dB(A) at 50 feet. Although intermittent, because they traverse roads outside the site, they are nearer to community receptors and more likely to be noticeable to the offsite community than operations conducted well within the site. As stated in Chapter 4, Section 4.12, vehicles serving LLNL are subject to requirements that they be properly muffled to reduce noise impacts, and their activities are limited to times that are both less noticeable and less objectionable.

Planned activities associated with the No Action Alternative would involve a projected increase in the workforce, adding approximately 290 employees at the Livermore Site by the year 2014, and possibly 10 employees at Site 300, and a corresponding increase in vehicular activity (approximately 3 percent above current levels), primarily workers commuting to and from the sites. The additional traffic would add slightly to ambient noise levels. To help alleviate this impact, LLNL is committed to continue promoting and expanding its Transportation Systems Management Program to aid in providing viable alternatives to employee commuting, thereby reducing traffic congestion and noise (LLNL 2001s).

Impulse Noise

LLNL would continue explosives research testing under the No Action Alternative at both the Livermore Site, within the Building 191 High Explosives Application Facility; and at Site 300, within the Contained Firing Facility and on open firing tables. The number of blasts and intensity would not change; therefore, impacts would be the same as under current operations. LLNL would continue to use blast forecasting as a tool to determine if explosive tests would adversely affect the surrounding community and to restrict operations when peak-impulse noise levels are predicted to exceed the 126-dB[A] level in populated areas. LLNL would also continue to perform meteorological monitoring to provide necessary input data for blast forecasting (LLNL 2001s).

Decommissioning, Decontamination, and Demolition

The No Action Alternative would include removal of 234,443 gross square feet of excess and legacy facilities at the Livermore Site and 20,202 gross square feet at Site 300. This rate would be similar to that of recent years and, with the relatively large spatial area and perimeter buffer zone, noise from these activities would not be discernible in offsite areas.

5.2.10.3 *Cumulative Impacts*

As stated, planned activities associated with the No Action Alternative would include a projected increase in the workforce, adding 290 employees at the Livermore Site and possibly 10 employees at Site 300. Although the jobs that would be created under the No Action Alternative at LLNL represent a very small fraction (less than 1 percent) of the projected increase in employment within Alameda County over the 2000-2010 timeframe (Association of Bay Area Governments 2001), as described in Section 5.1.2, the additional workforce would include some relocated employees new to the Bay Area. Activities and services to support the relocated population would contribute to local noise levels, both short-term in areas of increased construction activities, and long-term, associated with increased development, density of population and commercial activities, and vehicular traffic and congestion.

Local noise ordinances and restrictions on allowable noise levels, as stated in terms of land use compatibility guidelines for community noise environments, discussed in Chapter 4, Section 4.12.1.2, would limit the impact of additional noise sources on the local community. The city of Livermore is currently working on several elements of its General Plan, and may consider additional restrictions based on key findings related to noise (City of Livermore and LSA 2002). With Livermore’s anticipated growth in the future, noise levels are expected to increase due to potential increases in Livermore’s current key noise sources: construction activity, development, vehicular activity, and rail and aviation operations. Noise levels from potential mixeduse and infill development in Livermore, especially in the downtown, could exceed noise level guidelines as a result of land use incompatibilities.

5.2.11 Traffic and Transportation

Traffic congestion and collective dose and LCFs to the general population from radiological shipments were analyzed. The estimate of traffic congestion is based on the change in employment under the No Action Alternative compared to current operations. Radiological consequences were calculated using DOE transportation models as described in Section 5.1.11. Appendix J of this LLNL SW/SPEIS details the methodology and important inputs for radiological transportation analysis.

5.2.11.1 *Relationship with Site Operations*

Section 3.2 describes the projects under the No Action Alternative. These projects, when combined with current LLNL operations, would result in increased radiological transportation.

Although not every individual shipment was accounted for, the larger and more important shipment campaigns analyzed would result in approximately 260 shipments of special nuclear material, 61 shipments of LLW and MLLW, 5 tritium shipments, and 13 TRU waste shipments per year. See Appendix J, Section J.5.2, for more details. These values are considerably larger than for current operations (see Appendix J, Section J.5.1) due to shipment campaigns analyzed under previous national programmatic EISs, but only now beginning to be implemented.

5.2.11.2 *Impact Analysis*

Livermore Site

Under the No Action Alternative, LLNL employment would rise by approximately 300 workers. This 3 percent increase over current operations with 10,350 workers would not have any impact on local traffic. There would be minimal construction under this alternative as well. No Action Alternative projects with large construction activities (such as the NIF and the Terascale Simulation Facility would be completed before the period of analysis for this LLNL SW/SPEIS. Other No Action Alternative construction projects would be small and, in total, would be much less than the current magnitude of construction. However, the level of radiological transportation would increase under the No Action Alternative.

Radiological shipments under the No Action Alternative would include shipments of the following:

- Special nuclear material approved under the *Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (SSM PEIS) (DOE 1996a) and the *Surplus Plutonium Disposition Environmental Impact Statement* (DOE 1999c)

- TRU waste to the Waste Isolation Pilot Plant (WIPP) under *Waste Isolation Pilot Plant Final Supplemental Environmental Impact Statement* (DOE 1997e)

- Shipments of tritium for high-energy density physics target fill and the test readiness program targets for the NIF

- Shipments of LLW under the *Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE 1997f)

- Several other smaller shipment campaigns

Table 5.2.11.2–1 presents the collective dose to the general population from these shipments. The number of LCFs for the No Action Alternative would be much less than one (4×10^{-3}) per year. See Appendix J, Section J.8, of this LLNL SW/SPEIS for calculations of LCFs.

TABLE 5.2.11.2–1.—*Collective Dose to the General Public from Radioactive Shipments Under the No Action Alternative*

	Collective Dose (person-rem per year)			
Shipment Type	**Along Route**	**Sharing Route**	**At Stops**	**Total**
LLW	7.0×10^{-2}	0.86	0.38	1.3
TRU waste	5.4×10^{-2}	0.65	0.30	1.0
Materials[a]	0.21	2.3	1.1	3.6
Total No Action	0.33	3.8	1.8	5.9
Current operations	8.6×10^{-2}	0.98	0. 46	1.5

[a] Nonwaste radioactive materials, including special nuclear materials, tritium, and other materials used in the LLNL mission.
LLW = low-level waste; TRU = transuranic.

Site 300

Under the No Action Alternative, there would be minimal changes in traffic and transportation at Site 300, compared to current operations and no incremental impacts expected from current conditions as described in Chapter 4.

5.2.11.3 *Cumulative Impacts*

Traffic congestion in the Tri-Valley Area is very heavy and will likely increase due to growth in the area. Any increases in LLNL employment under the No Action Alternative would, however small, contribute to this congestion. Given the negligible contribution of the No Action Alternative and current LLNL traffic to the overall congestion problem, detailed analysis of the cumulative traffic impacts is not warranted. However, LLNL's contribution to radiological impacts in the vicinity of LLNL is not a small percentage of overall radiological impacts. Therefore, this cumulative impacts analysis focuses on collective dose from radiological transportation. The analysis considers LLNL radiological transportation cumulative with SNL/CA radiological transportation.

NNSA performed a RADTRAN 5 analysis for 3.5 miles of highway in the Livermore area where all radiological shipments would converge. For conservatism, the shipments were comprised of the larger set of shipments in the Proposed Action resulting in 6.1×10^{-2} person-rem per year and those from SNL/CA resulting in 1.2×10^{-3} person-rem per year. The resulting collective dose is 6.2×10^{-2} person-rem per year, corresponding to 4×10^{-5} LCFs per year. The No Action Alternative cumulative impacts would be less than these values. More information on the calculation is presented in Appendix J, Section J.7. Minimal impacts would be expected as a result of these doses.

5.2.12 Utilities and Energy

This section discusses the potential impacts of the No Action Alternative on utilities and energy supplies. Utility and energy usage are discussed separately for the Livermore Site and Site 300. LLNL-leased properties (i.e., Almond Avenue, Graham Court, Patterson Pass, and Arroyo Mocho Pump Station) are considered part of the Livermore Site in assessing utility and energy impacts.

5.2.12.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.1 for the No Action Alternative and the utilities and energy analysis. In general, the effects of projects for the No Action Alternative on utilities and energy analyses are related to water consumption, sewage discharges, electricity consumption, and fuel consumption resulting from design, construction, and operation of projects under the No Action Alternative.

5.2.12.2 *Impact Analysis*

Water Consumption

Livermore Site

In 2002, the Livermore Site used approximately 212 million gallons of water. As the NIF (110,000 gallons per day) and the Terascale Simulation Facility (60,000 gallons per day) become operational, water use at the Livermore Site would increase by 30 percent to approximately 276 million gallons per year (LLNL 2003an). Accordingly, peak water use would increase from 1.2 million gallons per day to approximately 1.37 million gallons per day. The capacity of the Livermore Site domestic water system in the year 2002 was approximately 2.88 million gallons per day. Because the Livermore Site domestic water system has adequate capacity to meet future water demands under this alternative, impacts would be minimal.

Site 300

Average water consumption at Site 300 is 67,900 gallons per day (LLNL 2003aq). No changes in square footage at Site 300 are planned under this alternative; therefore, the current water use at Site 300 is considered to be representative of future consumption rates for the No Action Alternative. No additional impacts are expected.

Sewer Discharges

Livermore Site

The LWRP currently receives a total of approximately 6.5 million gallons of effluent per day. The capacity of this facility is 8.5 million gallons of effluent per day, which is expected to be sufficient for inflow treatment for the foreseeable future. The Livermore Site discharges approximately 216,400 gallons per day (3.3 percent of the volume received by the LWRP) to the sanitary sewer system based on 2002 estimates.

Under the No Action Alternative, sewer discharge would increase by 3.5 percent over the existing environment to approximately 224,000 gallons per day based on the projected increase in square footage and personnel at the Livermore Site. Impacts from this 3.5 percent increase in sewer discharges from the Livermore Site would be minimal.

Site 300

Site 300 sanitary sewage generated outside the GSA is disposed of through septic tanks and leach fields or cesspools at individual building locations. Sanitary sewage generated within the GSA is piped into an asphalt-membrane-lined oxidation pond east of the GSA at an average rate of 2,100 gallons per day.

Currently, Site 300 discharges approximately 2,100 gallons of sewage per day. No changes in square footage at Site 300 are planned under this alternative; therefore, current discharges are considered to be representative of future rates for the No Action Alternative. No offsite sewage treatment is conducted for Site 300 wastes and no new impacts are expected.

Electricity Consumption

Livermore Site

The projected peak electrical demand at LLNL would be 82 megawatts under the No Action Alternative. Growth at the Livermore Site would result in increased electricity consumption. Electricity consumption at the Livermore Site averages approximately 321 million kilowatt-hours per year and has remained stable over the past 5 years. With the added loads from the NIF and the Terascale Simulation Facility, electric power consumption is expected to increase by 39 percent to approximately 446 million kilowatt-hours per year. The LLNL distribution system and existing capacity for the utilities to supply energy on both a total and a peak load basis would adequately meet the projected increase in consumption, but may limit future development at the site.

Site 300

Electricity consumption at Site 300 is approximately 16.3 million kilowatt-hours per year and has remained stable over the past 5 years (LLNL 2003aq). No changes to Site 300 square footage are planned under this alternative; therefore, current electrical power consumption at Site 300 is considered to be representative of future consumption rates for the No Action Alternative. Therefore, no additional impacts are expected.

Fuel Consumption

Livermore Site

Natural gas consumption for the Livermore Site averages 12,900 therms per day. Consumption rates are expected to increase to approximately 23,300 therms per day as the NIF and Terascale Simulation Facility become operational (LLNL 2003b). The No Action Alternative projects an additional 1.5 percent increase to 23,600 therms per day in natural gas consumption based on the projected increase in gross square footage of developed space at LLNL in the foreseeable future. This would result in minimal additional impact.

No change in diesel fuel or unleaded gasoline is anticipated. Diesel fuel and unleaded gasoline use would remain at 72,200 gallons per year and 451,800 gallons per year, respectively.

Site 300

Site 300 fuel oil consumption is approximately 16,600 gallons per year (LLNL 2003aq). No changes in the gross square footage at Site 300 are planned under this alternative; therefore, current fuel oil consumption is considered to be representative of future consumption rates for the No Action Alternative.

5.2.12.3 *Cumulative Impacts*

Water Consumption

Livermore Site

The No Action Alternative together with other development in the Hetch Hetchy service area would increase demand for and consumption of water. For example, the population in Alameda County is projected to increase by about 17 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other uses in Alameda County are expected to increase proportionally. Other counties in the Hetch Hetchy service area would experience similar growth. This population growth in the Hetch Hetchy service area in conjunction with the 30 percent increase in water use at the Livermore Site would constitute a cumulative impact upon water resources and supply systems.

Site 300

Current water use at Site 300 is considered to be representative of future consumption rates for the No Action Alternative. However, development in the vicinity of Site 300 would increase demand for and consumption of water. Population in San Joaquin County is projected to increase 30 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other uses in San Joaquin County are expected to increase proportionally. This growth would constitute a substantial cumulative impact on groundwater resources. Similarly, population growth in the Hetch Hetchy service area would constitute a cumulative impact upon water resources in the area.

Sewer Discharges

Livermore Site

The No Action Alternative, together with other developments in the area, would increase demand for sewage services. Population in Alameda County is projected to increase by about 17 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other uses in Alameda County are expected to increase proportionally. The LWRP currently receives a total of approximately 6.5 million gallons of effluent per day. While existing LWRP capacity of 8.5 million gallons per day is expected to be sufficient for inflow treatment for the next 10 years, sewage treatment facility improvements are being planned in the region. Population growth would constitute a cumulative impact on sewage systems in the area.

Site 300

Because Site 300 sewer discharge and treatment programs are mostly self-contained, no cumulative impact is expected as a result of the No Action Alternative.

Electricity Consumption

Livermore Site

The No Action Alternative, together with other developments in the area, would increase electric power demand. Population in Alameda County is projected to increase by about 17 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other uses in Alameda County are expected to increase proportionally. This population growth in conjunction with the 39 percent increase in demand for electrical power at the Livermore Site could constitute an adverse cumulative impact on electric power resources in the area. Currently, electric utilities provide approximately 10,605 million kilowatt-hours per year of electricity to Alameda County (CEC 2001). However, more than 10,000 megawatts of new electric generation capacity is planned in the Pacific Gas and Electric (PG&E) service area. Additional generating capacity is planned throughout the State of California and surrounding states (CEC 2000). Expanded electric transmission capability is also planned in the region. If implemented as planned, these additions would provide sufficient capacity to meet Alameda County electrical energy needs for the next 10 years, thus any negative impacts would be mitigated.

Site 300

Current electric power consumption at Site 300 is considered to be representative of future consumption rates for the No Action Alternative. However, the population in San Joaquin County is projected to increase 30 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other electric power uses in San Joaquin County are expected to increase proportionally. This growth could constitute a substantial cumulative impact on electric power resources in the area. Currently, electric utilities provide approximately 5,106 million kilowatt-hours per year of electricity to San Joaquin County (CEC 2001). However, more than 10,000 megawatts of new electric generation capacity is planned in the PG&E service area. Additional generating capacity is planned throughout the State of California and surrounding states (CEC 2000). Expanded electric transmission capability is also planned in the region. If implemented as planned, these additions would provide sufficient capacity to meet San Joaquin County electrical energy needs for the next 10 years and mitigate the impact of growth in the region.

Fuel Consumption

Livermore Site

The No Action Alternative, together with other developments in the PG&E service area, would increase the demand for natural gas. Population in Alameda County is projected to increase by about 17 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other uses in Alameda County are expected to increase proportionally. This population growth could constitute an adverse cumulative impact on natural gas supply systems. However, PG&E's

transmission capacity is approximately 130 percent of the demand for natural gas in its service area (CPUC 2001). As required by the California Public Utilities Commission, PG&E uses a 15-year planning horizon for gas transmission and storage capacity and a 10-year planning horizon for local gas distribution systems. Accordingly, PG&E plans to provide sufficient capacity to meet Alameda County needs for the next 10 years. Therefore, any impacts would be mitigated.

Site 300

Current fuel oil consumption at Site 300 is considered to be representative of future consumption rates for the No Action Alternative. However, the population in San Joaquin County is projected to increase 30 percent by the year 2015 (DOF 2001). Fuel oil use in San Joaquin County is expected to increase as the population increases, but at a lower rate. This growth could constitute an adverse cumulative impact on fuel oil supplies in the county. However, overall fuel oil use in the State of California has declined substantially as air quality regulations concerning greenhouse gas emissions become more stringent. Consequently, fuel oil delivery systems within San Joaquin County have large amounts of excess capacity. This excess capacity is sufficient to meet San Joaquin County requirements for the next 10 years. Therefore, any impacts would be mitigated.

5.2.13 Materials and Waste Management

5.2.13.1 *Materials Management*

This section provides an overview of management responsibilities regarding receipt, transfer, and shipment of radioactive, controlled, and hazardous materials under the No Action Alternative. Appendices A, B, D, M, and N include descriptions of programs and buildings associated with the use of these materials, which historically has resulted in both their planned and inadvertent releases to the environment.

The consequences of using radioactive, controlled, and hazardous materials are discussed in the sections associated with the affected media. For example, releases to the air associated with use of radioactive materials are discussed in Section 5.2.9 and releases affecting vegetation are discussed in Section 5.2.8. The workplace use of these materials and associated occupational exposures are discussed in Section 5.2.14.

Relationship with Site Operations

Several new operations are currently in the planning stages at LLNL. However, they were considered outside of the scope of the existing conditions for this LLNL SW/SPEIS because they had not yet reached operational status. New operations are defined as programmatically planned projects with implementation schedules that will take place in the future, such as the NIF. The No Action Alternative would include all new operations, D&D projects, and other activities identified in Section 3.1. In general, material usage at LLNL would increase consistent with a 3 percent increase in LLNL operations above the existing conditions.

Waste minimization and pollution prevention techniques would be expected to offset a portion of the projected increase. Average maximum quantities would likely remain constant as material storage space remains constant; however, average quantities would be expected to increase to meet demand. Under the No Action Alternative, material projections used for analysis would not exceed existing material management capacities.

Impact Analysis

The No Action Alternative would not cause any major changes in the types of materials used onsite. Material usage at LLNL would increase consistent with a 3 percent increase in laboratory operations over existing conditions. Waste minimization and pollution prevention techniques would offset a portion of the projected increase. Average maximum quantities would likely remain constant as material storage space remains constant; however, average quantities would increase to meet demand. Under the No Action Alternative, material projections used for analysis would not exceed existing material management capacities.

Existing Operations

Under the No Action Alternative, total hazardous material usage would increase for existing facilities. Average quantities would increase by an estimated 3 percent above current conditions. Annually, approximately 171,000 to 192,000 chemical containers, ranging from 210-liter (55-gallon) drums to gram-quantity vials, would be used or stored at LLNL.

Annually, for the Livermore Site, approximately 70,000 gallons of liquids would be managed under the No Action Alternative with an estimated storage capacity of 227,000 gallons. Approximately 1.4 million pounds of solids would be handled with a storage capacity of 2.4 million pounds. Solid material storage would not be expected to fluctuate because metals (e.g., lead used for shielding) are less likely to be consumed and more likely to be reused and reclaimed. Regardless, there would be sufficient capacity to accommodate anticipated operations. Approximately 1.1 million cubic feet of mostly industrial gases (argon, helium, hydrogen, oxygen, nitrogen) would be used annually with a storage capacity of 71.6 million cubic feet. Projections for specific hazardous chemicals for existing Livermore Site operations and Site 300 operations are presented in Tables 5.2.13.1–1 and 5.2.13.1–2, respectively. Additional details are provided in Appendix B.

Increases in overall radioactive materials and explosive materials based on current administrative limits are expected; however, no new material storage facilities would be built as a result of these projected increases. Detailed safety documentation would be required in most cases prior to implementation of increased inventories of these controlled materials. For a discussion of potential accidents, materials limits, and materials-at-risk, see Section 5.5, Bounding Accident Scenarios. Under the No Action Alternative, radioactive material and explosive material requirements would not exceed existing material management capacities (TtNUS 2003); therefore, no additional impacts are expected.

New Operations

LLNL anticipates hazardous material usage rates to increase for the foreseeable future. The majority of the increase would be due to the full implementation of NIF and BSL-3 operations (Table 5.2.13.1–3). New LLNL operations would account for approximately 70,000 gallons of liquids and approximately 20,000 standard cubic feet of industrial gases. Materials expected to support other projects, including D&D projects, are described in Tables 5.2.13.1–3 and

5.2.13.1–4. For new facilities, no additional impacts would be expected since each of the new facilities would be designed to handle expected quantities.

Under the No Action Alternative, several construction projects, D&D projects, renovation projects, and new operations would begin. Site material usage would increase slightly because of the new operations. See Appendices A and B of this LLNL SW/SPEIS for more information.

Cumulative Impacts

The ROI for materials management involves LLNL and its facilities, as presented in Chapter 4 of this LLNL SW/SPEIS.

The ROI for cumulative impacts is larger than that presented in Chapter 4 and considers the contributions of LLNL (Livermore Site and Site 300), SNL/CA, NNSA, local projects and activities, and the State of California. NNSA assessed cumulative impacts by combining the potential effects of the No Action Alternative with the effects of other past, present, and reasonably foreseeable activities in the ROI. The No Action Alternative was chosen to assess and present a bounding scenario of potential cumulative effects. This approach allowed a conservative analysis or a maximum estimation of cumulative impacts (see Section 5.3.13.1).

5.2.13.2 *Waste Management*

This section provides an overview of management responsibilities for generation, storage, treatment, and disposal of radioactive, hazardous, mixed, and other wastes, including biohazardous and D&D wastes at LLNL under the No Action Alternative. Appendices B, M, and N include descriptions of wastes and facilities associated with use, generation, and management of these wastes.

The consequences of managing radioactive and hazardous wastes are discussed in the sections associated with the affected media. For example, releases affecting vegetation are discussed in Section 5.2.7, Biological Resources, and releases (treatment processes) to the air associated with use of radioactive materials are discussed in Section 5.2.8, Air Quality. The workplace use of these materials and associated occupational exposures are discussed in Section 5.2.14, Human Health and Safety.

TABLE 5.2.13.1–4.—*Listing of Materials in Use with Decontamination and Decommissioning Construction, Upgrades, and Other Improvements Under the No Action Alternative* [a, b, c]

Material Usage Description
Acoustical ceiling, acoustical insulation, acrylic, additives, adhesives, asphalt, bonding agent, carpet and padding, caulking, ceramic, cleaners, concrete, coolants, fillers, glazing, glues, gypsum wallboard, insulating paints, insulation, joint compounds, latex, metal ceiling, oils, paints, pipes, primer, putties, quarry and conductive tile, reducers, roofing materials, roofing materials, sealants, sealer, soil, solder, solvents, spackling, sprayed fireproofing, structural metals, tile grout, tubes, wallpaper supplies, waterproofing, wiring, and wood finishing.

Source: TtNUS 2003.
[a] Examples of D&D projects include Buildings U325, 222S, 514, cleanup of 292.
[b] Examples of Construction projects include routinely remove and replace offices throughout LLNL.
[c] Examples of Upgrades include Biological Safety and Security Laboratory project covering Buildings 132N, 151, 154, 235, 241 (for BSL level 1 and 2), Buildings 190, 281, 432, 435, 446 (for BSL level 1 and 2), Building 132S (for BSL level 1 and 2), Buildings 153 and T1527 (for BSL level 1 and 2), reroofing a series of buildings, Building 332 ductwork replacement, Site 300 Revitalization, Site 300 Wetlands Enhancement, East Avenue, Superblock Security Upgrade, Engineering Technology Complex Upgrade, building utilities, seismic, other road upgrades, site utilities upgrades.
D&D = decontamination and decommissioning.

Relationship with Site Operations

Several new operations are currently in the planning stages at LLNL; however, they were considered outside the scope of the existing conditions for this LLNL SW/SPEIS because they had not yet reached operational status. New operations are defined as programmatically planned projects with defined implementation schedules that will take place in the future, such as the NIF. The No Action Alternative would include all new operations, D&D projects, and other activities, including permit modifications, identified in Section 3.1. In general, waste generation at LLNL would increase, consistent with a 3 percent increase in LLNL operations above the existing conditions.

Waste minimization and pollution prevention techniques would be expected to offset a portion of the projected increase assessments. Under the No Action Alternative, waste generation projections used for analysis would not exceed existing waste management capacities.

Impact Analysis

Under the No Action Alternative, ongoing NNSA and interagency programs and activities at LLNL would continue operating at planned levels as reflected in current NNSA management plans for 2004 through 2014 (e.g., recent Class 1 and Class 2 Permit Modification submittals). The Decontamination and Waste Treatment Facility (DWTF) use would increase by implementing planned permit modifications as identified below. In some cases, projected waste generation levels would include increase over current waste generation levels (e.g., NIF contributions). These would include increases for any recent activities that have already been approved by NNSA and have existing NEPA documentation (e.g., BSL-3 contributions). If these planned operations are implemented in the future, they could result in increased activity above present levels. Under the No Action Alternative, the level of activity would increase RHWM operations as defined in Section 5.1.13.2, that would implement current management plans for assigned programs such as RCRA closure of Building 514. The No Action Alternative analysis includes any approved and interim actions and facility expansion, construction or management plans, where detailed design and associated permit documentation were completed. The analysis also includes new construction such as BSL-3, several upgrades, building modifications, and removal of structures totaling approximately 234,000 square feet.

Other plans used to prepare the description of the No Action Alternative include the site development plans for LLNL, Programmatic EISs, and Part B Permit modifications and guidance. Some documents have future projects included for planning purposes; others have been omitted because of schedule constraints or because the projects were not at the point of decisionmaking, or other reasons. The activities reflected in this alternative include planned increases in some LLNL operations and activities over previous years' levels.

Implementation of the No Action Alternative would not cause any major changes in the types of waste streams generated onsite. Waste generation levels for the foreseeable future at LLNL would remain essentially consistent with recent generation quantities experienced during 1993 through 2002. Annually, any increase would be consistent with increases from new operations and normal fluctuations as previously noted. Waste minimization and pollution prevention techniques would be expected to offset projected increases. Onsite waste handling capacities are four to five times expected waste volumes. Waste projections used for analysis would not exceed existing offsite waste management disposal capacities. Wastes associated with existing operations, new operations, and special operations are presented below, including other wastes. The No Action Alternative would include several new operations, D&D projects, and other activities, including permit modifications and RCRA closures. Appendix B provides additional details on waste management activities under each of the alternatives. The No Action Alternative would include the following:

- Generation of routine waste quantities presented in Table 5.2.13.2–1
- Generation of nonroutine waste quantities presented in Table 5.2.13.2–1
- Generation of wastes associated with new operations presented in Table 5.2.13.2–2
- Recently approved and ongoing permit modifications

No additional waste storage, treatment, handling capacity, regulatory requirements, or security requirements would be needed.

Existing Operations

For projection purposes, routine waste generation data for 1993 through 2002 were considered a reasonable range for existing facilities/ operations; an average of these years was used. The amount of waste generated from existing operations anticipated would reflect proportional increases in LLNL activity levels over the foreseeable future. The waste quantities projected represent a site-wide aggregate of quantities for each type of waste category. Table 5.2.13.2–1 presents existing operations estimated annual (routine) waste generation quantities by waste category.

TABLE 5.2.13.2–1.—*Routine and Nonroutine Operations Waste Generation Quantities Under the No Action Alternative and Existing Conditions*

Waste Type	Annual Quantities			
	Existing Conditions[a]		No Action Alternative[b]	
	Routine	Nonroutine	Routine	Nonroutine
LLW	170 m^3/yr	480 m^3/yr	200 m^3/yr	630 m^3/yr
MLLW	67 m^3/yr	44 m^3/yr	61 m^3/yr	72 m^3/yr
Total Hazardous[c]	440 metric tons	880 metric tons	390 metric tons	1,500 metric tons
TRU	35 m^3/yr	4.2 m^3/yr	50 m^3/yr	55 m^3/yr
Mixed TRU	2.6 m^3/yr	0 m^3/yr	1.7 m^3/yr	0 m^3/yr
Sanitary solid	4,700 metric tons	Included in Routine	4,800 metric tons	Included in Routine
Wastewater	300,000 gal/day	Included in Routine	310,000 gal/day	Included in Routine

Source: DOE 2002s, LLNL 2002o, LLNL 2002x.
[a] Based on average quantities since 1992 and one standard deviation.
[b] For routine wastes based on average quantities since 1992 and one standard deviation, expected increase in activity levels, and new operations contributions. No margin was added for nonroutine.
[c] Total hazardous includes RCRA hazardous, state regulated, and *Toxic Substances Control Act*.
gal/day=gallons per day; m^3/yr= cubic meters per year; LLW = low-level waste; MLLW = mixed low-level waste; RCRA = *Resource Conservation and Recovery Act*; TRU = transuranic.

New Operations

New operations wastes, including project-specific information, are considered to be derived from mission-related work. The waste, quantities projected represent a site-wide aggregate of quantities for each type of waste category. Table 5.2.13.2–1 includes new operations and additions to the estimated annual (routine) waste generation quantities by waste category. Table 5.2.13.2–2 presents qualitative and quantitative waste information by project.

Special (Nonroutine) Operations

Special (nonroutine) wastes result from special, limited duration construction projects such as those considered separate from facility operations. Special, limited duration project wastes include those generated from construction, demolition, D&D, and environmental restoration. The amount of waste generated is anticipated to reflect proportional increases in LLNL activity levels over the next 10 years. The waste quantities projected represent a site-wide aggregate of quantities for each type of waste category. Table 5.2.13.2–1 presents estimated annual (nonroutine) waste generation quantities by waste category.

All Other Wastes

LLNL operations would also involve the five additional waste management activity areas discussed below under the No Action Alternative.

Biohazardous (includes Medical Waste Management Act*) Waste*

In 2002, several hundred kilograms of biohazardous wastes were disposed of at an approved offsite facility. Under the No Action Alternative, biohazardous waste generation would increase by 3 percent. The existing waste handling capabilities would be adequate to accommodate this waste. Offsite disposal capacity would continue to be sufficient.

Construction and Decontamination and Decommissioning Waste

To bound impacts, this analysis assumed the construction of 100,000 to 200,000 square feet of new facilities, including specific projects listed in Table 5.2.13.2–2. This would generate 200 to 400 metric tons of construction debris. Approximately two-thirds of wood, concrete, asphalt, soil, metal, and cardboard would be diverted for recycling or reuse (LLNL 2002cc). The existing waste handling capabilities would be adequate to accommodate the remaining waste. Offsite disposal capacity would continue to be sufficient.

Assuming all 255,000 square feet of excess facilities would be removed to bound impacts, D&D would generate approximately 1,530 metric tons of debris, 600 metric tons per 100,000 square feet. Only 350 metric tons would be LLW, MLLW, and hazardous waste (Bisanni 2003). Approximately two-thirds of the debris would be diverted, recycled, or reclaimed (LLNL 2002cc). The existing waste handling capabilities would be adequate to accommodate this waste. Offsite disposal capacity would continue to be sufficient.

Environmental Restoration Waste

Site-wide environmental restoration waste generation trends at LLNL would generally remain a function of treatment units, the number of wells, and the number of hours of operation. Existing waste handling capabilities are already in place.

Explosive Wastes

The Explosive Waste Treatment Facility would handle 2,500 to 3,300 pounds per year. The Explosive Waste Storage Facility would store 5,500 to 6,500 pounds (gross) per year. This represents a 3 percent increase over existing conditions. No additional capacity would be required.

Wastewater

Wastewater would increase to approximately 310,000 gallons per day. The current capacity of 1.69 million gallons per day would be adequate to accommodate this waste. Offsite disposal capacity would continue to be sufficient.

Cumulative Impacts

The ROI for waste management involves LLNL and its facilities as presented in Chapter 4 of this LLNL SW/SPEIS.

The ROI for cumulative impacts is larger than that presented in Chapter 4 and considers the contributions of LLNL (Livermore Site and Site 300), SNL/CA, NNSA activities, local projects and activities, and the State of California. The NNSA assessed cumulative impacts by combining the potential effects of the Proposed Action with the effects of other past, present, and reasonably foreseeable activities in the ROI. The Proposed Action was chosen to assess and present a bounding scenario of potential cumulative effects. This approach allowed a conservative analysis for a maximum estimation of cumulative impacts.

5.2.14 Human Health and Safety

5.2.14.1 *Nonradiological Health Impacts*

Operations at LLNL involve a wide range of activities that have the potential for exposure of involved and noninvolved workers to hazardous materials or conditions. These hazards include non-ionizing radiation, chemicals, biological agents, and industrial hazards. Evaluation of occupational protection issues considered existing ES&H programs that specifically address worker and general population protection measures implemented to control, reduce, or eliminate operational hazards. Appendix C presents a detailed description of LLNL ES&H programs implemented to monitor and ensure that all sectors of the local environment are protected. Hazardous chemicals to which involved and noninvolved workers could be potentially exposed, under the No Action Alternative, at the Livermore Site and Site 300, are listed in Tables 5.2.13.1–1 and 5.2.13.1–2.

Relationship with Site Operations

Section 3.2 describes projects under the No Action Alternative. When combined with current operations, these projects would result in small increases in chemical inventories. There would also be an increase in construction and demolition activities associated with site facility expansion and renovation due to new missions and facility demolition and removal activities. These activities would represent an increase in potential injuries associated with construction safety hazards.

Impact Analysis

Under the No Action Alternative, major changes in the types of occupational, toxic, or physical hazards encountered by site personnel would not be expected. Under the No Action Alternative, an approximate 3 percent site-wide increase in average chemical inventories would be expected. Under this alternative, 11 construction projects, 7 D&D projects, 6 renovation projects and 4 new operations would begin. Site material usage would be expected to increase slightly as a result of the four new operations. However, as the mix of site missions shifts from chemical to mechanical processes, the proportional increase in chemical inventories associated with new operations would be lessened.

During the course of routine operations, the potential exists for some personnel to be exposed to chemical, biological, and physical hazards. The LLNL Integrated Safety Management System (ISMS) minimizes the occurrence and mitigates the consequences of these exposures by identifying and analyzing potential hazards during the planning stages of work activities. Site workers conduct work in accordance with established site-wide programs as well as project-specific programs. Site-specific integration work sheets, facility safety plans, and standard operating procedures are prepared to supplement activities not covered by site safety plans or the LLNL ES&H Manual (LLNL 2000i). As hazards are identified, appropriate control measures are developed for implementation during the performance of work. Workplace monitoring provides data for the characterization of hazards and provides information on personnel exposures (LLNL 2003k). Personnel exposure monitoring data for 2001 indicating the potential for personnel exposures are presented in Appendix C.

Overall site usage of toxic substances and physical hazards would increase under the No Action Alternative as activity levels increase at existing facilities and as new facilities are constructed and begin operation. However, this would not represent an adverse impact. Under the No Action Alternative, the use of additional quantities of chemicals would result in a slight increase in worker exposures. Facility improvements and additions would result in improved control measures for handling hazardous chemicals and controlling physical hazards. Worker exposure to hazardous chemicals would be minimized by the use of improved facilities for handling toxic chemicals and controlling physical hazards. Continued application of site ES&H and ISMS principles would result in minimal impacts to workers and the public.

Tables 4.15.1.2–3 and 4.15.1.2–4 summarize the maximum and average quantities of hazardous chemicals stored at LLNL facilities. At the Livermore Site, the FY2001 chemical inventory indicated average quantities to be 60,902 gallons of liquids, 1.4 million pounds of solids/gases, and 19.4 million cubic feet of compressed gases. Under the No Action Alternative, these quantities would increase by 9,700 gallons and 29,000 pounds, and would decrease by 8.86 million cubic feet, respectively. Projected maximum and average quantities of hazardous chemicals stored at the Livermore Site and Site 300 for the No Action Alternative are presented in Tables 5.2.13.1–1 and 5.2.13.1–2. The corresponding FY2002 quantities for Site 300 are 56,000 gallons of liquids, 42,000 pounds of solids/gases, and 387,000 cubic feet of compressed gases, which would increase by 300 gallons, 1,300 pounds, and 6,100 cubic feet, respectively (TtNUS 2003). Physical hazards such as noise, electrical shock, and workplace injuries/illnesses could also increase under the No Action Alternative.

Employees at Site 300 conduct work in accordance with established site-wide ISMS programs as well as Site 300-specific programs. Site-specific integration work sheets, facility safety plans, and standard operating procedures are prepared to supplement activities not covered by site safety plans or the LLNL ES&H Manual (LLNL 2000i). The No Action Alternative projects are assumed to result in an approximate 3 percent increase in usage of hazardous chemicals. However, this would not increase worker exposure because these projects would include improved facilities for handling toxic chemicals and controlling physical hazards.

Based on the assumption that the increase in the facility footprint associated with the No Action Alternative represents an increase in chemical inventory, worker exposures would slightly increase.

Using the 2001 personnel exposure data, due to the downward trend, the following results would be expected for the peak workforce year during the 10-year period ending in 2014:

- 330 measurable results out of 1,391 analyses from personnel sampling
- 33 results in excess of OSHA Permit Limit Exposure (PEL) or American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV), not corrected for respiratory protection

Corrected for the use of respiratory protection, no personnel exposures above DOE action levels, OSHA PELs, or ACGIH TLV would be expected.

Site injury and illness data for the 7-year period ending in 2002 indicate a decrease from 1996 levels; i.e., recordable case rate of 6.9 in 1996 versus 3.0 in 2002. A slight increase in recordable case rates occurred in 1997 and 1998; in 2000, lost/restricted workday case rates were higher than 1999, 2001, and 2002. Additional information is presented in Appendix C. Using the 2002 injury and illness data as bounding, due to the downward trend, the following results would be expected for the reasonably forseeable workforce year under the No Action Alternative.

- 237 recordable cases
- 71 lost or restricted workday cases
- No fatalities would be expected

The overall decrease from 1996 to 2002 demonstrates the effectiveness of the ES&H program (LLNL 2002ck, LLNL 2003u). This success is also due in part to the implementation of the ISMS. Although an increase in construction, demolition, and renovation activities would occur under the No Action Alternative, these activities would not have a significant impact on site injury and illness rates.

Facility upgrades and continued implementation of site ES&H program components would significantly reduce the risk of personnel exposures. Workplace and personnel monitoring data indicate the effectiveness of the current program (LLNL 2002bk). Several proposed projects would increase levels of protection for both workers and the general public. These include the Building 151 Upgrade, Building 331 renovation and modification, and Building 332 ductwork replacement.

Ongoing and planned D&D activities would reduce overall site hazards by removing chemical and physical hazards from the workplace. Facilities to undergo D&D would include the U235 cooling tower and Building 514.

The planned infrastructure improvements, such as roof replacements, facility renovations and facility and system upgrades, would improve the overall safety. The planned structural and seismic upgrades would result in improved facilities and work areas. Facility roof replacement would provide protective measures for sensitive facility components and increase the protection of potentially hazardous areas from exposure to the environment. Electrical and ventilation upgrades would increase facility control features and reduce the risk of hazardous energy events. Therefore, the overall impact of these activities would be beneficial. Assuming the improved safety system in Building 514 reduces accidents, this could result in a reduction of impacts.

Cumulative Impacts

The occupational health and safety of workers at LLNL is site-specific and would not be affected by other activities occurring within the area. Cumulative effects for workers would be the same as those presented above in the No Action Alternative impact analysis.

5.2.14.2 *Radiological Health Impacts*

This section analyzes the No Action Alternative radiological health impacts from ongoing operations (e.g., R&D, waste management) and facilities under construction (e.g., the NIF). Impacts to workers are given in terms of number of cancer fatalities resulting from employment activities in the worker population. No Action Alternative radiological health impacts to the public from normal releases for the same operations are also described. These impacts are given in terms of the probability of the site-wide MEI contracting a fatal cancer from these operations. The number of fatal cancers expected in the general population from LLNL operations is also described.

Relationship With Site Operations

This section summarizes the relationship between projects described in Section 3.2 for the No Action Alternative and radiological health impacts from normal site operations. The No Action Alternative dose will increase as new and increased operations come on line. The maximum doses and health effects over this timeframe are presented here. The number of cancer fatalities to workers and the general public from exposure to these operations is used to quantify the impacts.

Impact Analysis

Workers

The dose to involved workers, i.e., workers who are directly exposed to radiation in the performance of their jobs, would be 90 person-rem per year. This dose includes 1.43 person-rem per year from the Advanced Materials Program and 15 person-rem per year from the NIF. Most of the remainder of this dose would be from operations in Building 332. Workers would be exposed to an increased risk of cancer as a result of occupational exposure to radiation over an extended period (calculated value of 0.054 fatalities per year of operation). Note that radiation exposure in all radiologically controlled areas are kept as low as reasonably achievable (ALARA) through facility and equipment design and administrative controls.

The dose to noninvolved workers, i.e., exposure to normal site radiological emissions not directly related to performance of their jobs, would be approximately 0.15 person-rem per year (see Section 5.2.8.2). Over 95 percent of this dose is from Livermore Site operations. No cancers (calculated values of 8.9×10^{-5} LCFs per year of operation) are expected among noninvolved workers.

General Public

The No Action Alternative health impacts to the hypothetical offsite site-wide MEI at the Livermore Site and Site 300 are calculated from the radiation dose described in Section 5.2.8.2 (emissions to the atmosphere) plus the radiation dose from neutrons penetrating the roof of the NIF. This is described in Appendix M of this LLNL SW/SPEIS. The dose to the public from LLNL air emissions would be due to exposure, either directly from the plume or through deposition and subsequent inhalation and ingestion. The dose to the site-wide MEI from neutrons produced at the NIF is a result of exposure to these neutrons (and the gamma rays produced) after they collide with the molecules in the air and scatter to the ground (skyshine).

The No Action Alternative dose to the Livermore Site site-wide MEI would be 0.30 millirem per year (0.10 from air effluents, mainly tritium, and 0.2 from skyshine). Such doses are limited by DOE O 5400.5, "Radiation Protection of the Public and the Environment." This order limits doses caused by all pathways of release of radiation or radioactive material to 100 millirem per year for prolonged exposure (DOE 1993a). The probability of a LCF to the site-wide MEI would be 1.8×10^{-7} per year of exposure. The No Action Alternative site-wide MEI dose from Site 300 operations would be 0.055 millirem per year, less than 0.6 percent of the NESHAP standard. The probability of a LCF to this hypothetical individual would be 3.3×10^{-8} per year of exposure.

The population dose from all LLNL operations would be 12 person-rem per year. The skyshine dose from the NIF is not included in the population dose estimate; skyshine is important near the Livermore Site boundary to a hypothetical individual continuously located at the site boundary (i.e., the site-wide MEI). It is less important to the general population whose exposure to it would be either transitory or nonexistent. No LCFs (calculated value of 0.007 LCFs per year of operation) to the public would result from exposure to Livermore Site operations.

Cumulative Impacts

There is a possibility that an individual worker would contract a fatal cancer sometime during that worker's lifetime as a result of extended occupational exposure under the No Action Alternative (calculated value of 0.054 fatalities per year of operation).

No adverse impacts to the general population would occur under the No Action Alternative. Other than background radiation sources, there are no other known contributors to concentrations of radionuclides near the Livermore Site or Site 300. Therefore, there would be no cumulative radiological impacts.

5.2.15 Site Contamination

The following section analyzes impacts to contaminated soils and sediments, and groundwater under the No Action Alternative. For the purpose of this LLNL SW/SPEIS, soils and sediments discussed below include surficial soils, both unconsolidated and consolidated sediments, and unsaturated bedrock.

5.2.15.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.2 under the No Action Alternative and the site contamination impact analysis.

Soil and groundwater contamination at LLNL occurred as the result of past operations and could be occurring from ongoing operations in outdoor testing areas, handling and storage of hazardous materials, waste management activities, and radioactive material management activities. At the Livermore Site, selected remedial actions are expected to be in place by the end of FY2006. The remediation of VOCs will be conducted using soil vapor extraction. Contamination in the unsaturated zone will be remediated only if it is predicted to impact groundwater above the maximum contaminant level (MCL). The cleanup of these soils is not expected to exceed predetermined, risk-based cleanup standards, but concentrations are still expected to exceed background levels. At Site 300, selected remedial actions are expected to be in place by the end of FY2008.

NNSA is concerned with deposition of contaminants on the ground surface during normal operations or accidents. The more frequently activities are undertaken, the greater the probability of an occurrence that results in soil contamination. The No Action Alternative would increase the likelihood of soil contamination over the existing conditions. A 3 percent increase in activity levels across the site is projected; accordingly, an increase in hazardous material management and waste management, and an associated spill or release could occur. LLNL would continue to conduct immediate cleanup actions and periodic site surveys to ensure environmental impacts are minimized.

Chemical, oil, or hazardous material spills or releases would be possible given the variety of materials handled at LLNL. Although substantial quantities of hazardous materials are not present on LLNL, some buildings use a variety of chemicals, acids, bases, solvents, and other hazardous materials. The radioactive and hazardous waste management facilities store and handle hazardous and radioactive wastes being prepared for onsite treatment and shipment offsite for disposal. These facilities are the onsite receiving point for all chemical wastes and have the potential for hazardous spills, releases, or fires. Additionally, most of the onsite research laboratories use small amounts of chemicals for research projects. At LLNL, controls are in place to minimize the potential for soil contamination from any LLNL operations.

5.2.15.2 *Impact Analysis*

As of the end of 2002, 1.9 billion gallons of groundwater have been treated at the Livermore Site (LLNL 2003l). Offsite contamination is being effectively cleaned up and plume sizes are decreasing. A total of 104 of the 120 release sites are in long-term stewardship. Of the remaining sites, further cleanup is ongoing.

By the end of FY2006, NNSA plans to have in place remediation facilities at all currently identified sites scheduled for long-term stewardship, in some cases 50 to 60 years. Cleanup activities scheduled for the Livermore Site during the next 5 years are listed in Chapter 4, Section 4.17.1.3.

As of the end of 2002, 236 million gallons of groundwater have been treated at Site 300 (LLNL 2003l). Offsite contamination has been effectively remediated and contaminant concentrations in source areas are being reduced. A total of 53 of the 73 release sites have completed assessment and remedial action phases are designated for long-term stewardship (DOE 2001b). Of the remaining sites, further investigation and remediation are ongoing.

By the end of FY2008, NNSA plans to have in place remediation facilities at all currently identified sites scheduled for long-term stewardship of contaminated areas, in some cases, 60 to 70 years. Cleanup activities scheduled for Site 300 during the next 5 years are listed in Chapter 4, Section 4.17.2.3.

The No Action Alternative would increase the likelihood of soil contamination over the existing conditions; however, minimal deposition of contaminants from continued operations to soil and continued removal of known contaminants under the cleanup effort would occur. No adverse impacts to future designated land use would be expected. No further adverse impacts on groundwater would be expected. Under the No Action Alternative, continued improvement of water quality and source reduction would occur at both the Livermore Site and Site 300 due to operation of existing remediation facilities, construction of planned remediation facilities, and natural attenuation of contamination already in soils and groundwater.

5.2.15.3 *Cumulative Impacts*

The ROI for site contamination involves LLNL and its remedial sites as presented in Chapter 4 of this LLNL SW/SPEIS. The ROI for analysis of cumulative impacts is larger than that presented in Chapter 4 and considers the contributions of LLNL (Livermore Site and Site 300) and local projects to contamination of nearby groundwater resources. Cumulative impacts could result either from LLNL groundwater contamination commingling with other plumes causing exceedance of water quality criteria in the combined plume, or from a limitation of aquifer/land usability as the volume or areal extent of contaminated groundwater/soil makes the aquifer/land substantially less suitable for its designated purposes.

Sandia National Laboratories/California

SNL/CA Environmental Restoration Program activities began in 1984. By 1991, 23 solid waste management units were identified. Of these locations, nine were identified for further investigation. The largest site, the Navy Landfill, is 2 acres. Investigation of these sites is regulated under RCRA. As of February 2002, environmental restoration activities at SNL/CA had progressed through a series of remedial and closure actions to the point where most sites have attained closure and active environmental monitoring is continuing on three sites: Fuel Oil Spill, Navy Landfill, and the Trudell Auto Repair Shop site. SNL/CA is working with the State of California on full closure requests and monitoring requirements.

Five non-Federal contaminated sites are located in the city of Livermore, none of which are listed on the National Priorities List. Two sites (one Federal) are located in the city of Tracy. The Federal Defense Distribution Center of San Joaquin is on the National Priorities List.

Past, present, and planned activities are designed to minimize contamination at LLNL, SNL/CA, and other sites. The cleanup of these sites has been and will be performed to a level that meets State of California's approved health risk based standards, which vary depending on the contaminants of concern, corresponding to the intended future uses of the sites. As existing contamination at LLNL is being cleaned up under the Environmental Restoration Program, no cumulative impacts would be expected.

5.3 IMPACTS FOR THE PROPOSED ACTION

This section discusses the potential environmental consequences of the Proposed Action. The Proposed Action for this LLNL SW/SPEIS is the continued operation of LLNL, including near-term (5 to 10 years) proposed projects, as well as those projects, activities, and facilities described in the No Action Alternative. Chapter 3 and Appendix A of this document contain detailed descriptions of all projects included in the Proposed Action. The LLNL operations include the Livermore Site and Site 300.

5.3.1 Land Uses and Applicable Plans

This section describes the impacts to land uses and applicable plans under the Proposed Action. Impacts are analyzed for the Livermore Site and Site 300 based on the methodology presented in Section 5.1 of this chapter.

5.3.1.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Chapter 3, Section 3.3, for the Proposed Action and the land use impact analysis. The primary effect on land uses at the Livermore Site would be from the additional development associated with projects requiring new buildings under the Proposed Action. However, existing perimeter open space areas would be retained.

At Site 300, the Proposed Action includes construction of new facilities and upgrading of several existing facilities, roadways, and utilities. Due to proposed D&D, there would be a decrease of the current developed gross square footage. No land acquisitions would be included as part of the Proposed Action. The types of land uses at Site 300 would not change, and the open space character of the site would be retained.

5.3.1.2 *Impact Analysis*

Livermore Site

Under the Proposed Action, facilities would be constructed (Figure 5.3.1.2–1), others would be upgraded, and a number of trailers would be relocated, replaced, or removed as the permanent facilities are completed (see Chapter 3 and Appendix A). These projects are in addition to those planned under the No Action Alternative. While the types of land uses at the Livermore Site would not change under the Proposed Action, some infill and modernization would occur. New facilities that would be located in the undeveloped portions of the Livermore Site are the same as those listed for the No Action Alternative (Table 5.2.1.2–1).

The land use effect would be extremely small because there would be only a small increase in the developed space at the site. New structures would be for the same uses as existing facilities, R&D, which is the existing land use designation for all Livermore Site facilities. Therefore, they would not represent a change in land uses, nor lead to a conflict with existing and approved future land uses adjacent to the site. Although the Livermore Site is on Federal land and not subject to local zoning ordinances, LLNL's R&D facility activities would be compatible with the MP designation (industrial park) in Alameda County and the I-2/I-3 designations (professional and administrative offices/R&D facilities) in the city of Livermore (LLNL 2001r). The Proposed Action would result in additional development at the site to be used for the same types of uses as existing facilities. No changes in land ownership would occur and no new impacts to land use are expected.

New facilities at the site could have secondary effects due to increased personnel and activity at the site. These effects could include additional traffic, noise, vehicular exhaust emissions, demands for community services, increased consumption of natural resources, and increased waste generation. These potential effects are addressed in the applicable parts of Chapter 5 of this LLNL SW/SPEIS.

Site 300

The primary effect on land uses at Site 300 would be from the development of additional square footage associated with certain projects included under the Proposed Action. No major alteration in the types of land uses would result. The Proposed Action would result in additional development at the site for the same uses as existing facilities. No changes in land ownership would occur.

Site 300 is exempt from local plans, policies, and zoning regulations. However, it is NNSA and University of California policy to cooperate with local governmental planning agencies, in this case San Joaquin and Alameda counties and the city of Tracy, whenever possible. Land uses surrounding Site 300 include other explosives testing facilities, undeveloped open space, agricultural land, and an off-road vehicle recreation area (see Chapter 4, Section 4.2). The uses at Site 300 are compatible with the existing land uses and approved land use designations surrounding the site, and with open space policies regarding resources near the site. Because Proposed Action activities would represent a continuation of existing land uses, they would be compatible with existing and approved future land uses surrounding the site.

The Proposed Action would include upgrading several existing facilities, roadways, and utilities, and constructing the Energetic Material Processing Center (EMPC) and the High Explosives Development Center (HEDC). Chapter 3 and Appendix A provide more detailed descriptions of the Proposed Action. Because Site 300 is located on approximately 7,000 acres of largely undeveloped land and the proposed construction projects and upgrades would be dispersed throughout the site, they would not represent a substantial infill of land uses, and the existing character of the site would remain unaltered.

New structures would be for the same types of uses as existing facilities. Therefore, they would not represent a change in land uses, nor lead to a conflict with existing and approved future land uses adjacent to the site. As discussed in Section 4.3, land uses would be compatible with the existing land uses and open space policies of San Joaquin and Alameda counties.

Growth at the site could have secondary effects due to increased personnel and activity at the site, including additional traffic, noise, vehicular exhaust emissions, demands for community services, increased consumption of natural resources, increased waste generation, etc. These potential effects are addressed in the applicable parts of Chapter 5 of this LLNL SW/SPEIS. Thus, minimal impacts to land use are anticipated.

5.3.1.3 *Cumulative Impacts*

Livermore Site

The cumulative impact study area with regard to land uses and planning programs for the Livermore Site is defined as that area of Alameda County generally east of Tassajara Road in the city of Dublin, and Santa Rita Road in the city of Pleasanton, which encompasses the city of Livermore and eastern unincorporated Alameda County. Large undeveloped open space areas exist in the northern, eastern, and southern portions of Alameda County. The majority of the undeveloped areas are used for agricultural purposes, primarily for grazing and viticulture. Agricultural lands in the South Livermore Valley General Plan Amendment area support an active wine industry.

A continuing land use trend in Alameda County has been the encroachment of residential, commercial, and industrial uses upon agricultural and open space areas. Development of planned and proposed residential projects would contribute to the cumulative loss of agricultural land and open space. However, the Proposed Action would not directly contribute to the cumulative effect on the loss of agricultural land and open space because the Livermore Site is already committed to R&D land uses and no acquisition of open space or agricultural land is proposed.

Site 300

The cumulative impact study area with regard to land uses and planning programs for Site 300 is defined as that portion of San Joaquin County generally south of I-205 that encompasses the city of Tracy and southwestern unincorporated San Joaquin County. Land uses in the area south of I-580 in unincorporated San Joaquin County include agricultural (primarily grazing), commercial recreation, and explosives testing facilities (including Site 300).

The city of Tracy, the border of which is located approximately 2 miles northeast of Site 300, has a developed core of residential and commercial uses, which becomes less dense along the outer boundaries of the city. Industrial and agricultural land uses surround the developed part of the city. In 1998, the city of Tracy annexed the Tracy Hills area (6,175 acres) southwest of I-580, the area of Tracy that is now closest to Site 300. In an effort to preserve agricultural land on the valley floor, the City of Tracy Planning Department is encouraging new development in hillside areas, such as Tracy Hills (City of Tracy 1993).

A residential community such as Tracy Hills could be compatible with Site 300 depending on the final design and siting of residences. The city of Tracy also has annexed an area of San Joaquin County that is approximately 2 miles from Site 300 and has planned for residential development in this area. The Tracy General Plan provides for a conservation, or open space, area to be established that would be a buffer zone between Site 300 and any potential new development.

5.3.2 Socioeconomic Characteristics and Environmental Justice

This section analyzes the socioeconomic impacts associated with implementation of the Proposed Action. This analysis is organized by employment, and housing and population, with effects delineated by geographic area (counties and cities within the ROI). Environmental justice issues are also discussed.

5.3.2.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.3 under the Proposed Action and the socioeconomic impact analysis. In general, the effect of projects under the Proposed Action on socioeconomics would be limited to the additional employment opportunities provided because of design, construction, and operation of these projects, as described below, and the effects of the additional secondary or indirect employment opportunities. Projected staffing changes are shown in Table 5.3.2.1–1.

TABLE 5.3.2.1–1.—*Input Parameters for Socioeconomic Analysis Under the Proposed Action*

Parameter	Units	Site	No Action Alternative	Proposed Action
Employment	Number of personnel	LLNL	10,650 (all site workers)	11,150 (all site workers)
		Livermore Site	8,900 (LLNL employees) 17,500 (LLNL employees and indirect)	9,410 (LLNL employees) 18,500 (LLNL employees and indirect)
		Site 300	250 (LLNL employees) 490 (LLNL employees and indirect)	250 (LLNL employees) 490 (LLNL employees and indirect)
Expenditures	Dollars (2001)	LLNL	146 M (Bay Area)	153 M (Bay Area)
Payroll	Dollars (2002)	LLNL	690 M (LLNL employees) 1,130 M (direct and indirect)	729 M (LLNL employees) 1,200 M (direct and indirect)

LLNL = Lawrence Livermore National Laboratory; M = million.

5.3.2.2 *Impact Analysis*

LLNL jobs and expenditures generate indirect jobs in the region. The RIMS II economic model produces two multipliers that are useful for the evaluation of economic effects (BEA 2003). The first multiplier is used to calculate worker earnings, and the second calculates employment. These multipliers provide information needed to estimate LLNL's economic impact. Earnings and employment multipliers make possible the identification of not only the direct impacts of an activity on regional income and jobs, but also the indirect effects.

Under the Proposed Action, LLNL employment at the Livermore Site would increase by approximately 500 above the No Action Alternative to 9,410. This increase, multiplied by a factor of 1.97, would increase employment by approximately 1,000 within the four-county ROI. LLNL payroll would increase by $39 million above the No Action Alternative. This increase multiplied by a factor of 1.64 would generate approximately $64 million of overall economic effect within the ROI. Therefore, the Proposed Action would generate additional revenue from increased purchases of goods and services, and create additional increases in population and subsequent increases in housing demand. The employment projections are conservatively high for purposes of evaluating reasonably foreseeable socioeconomic impacts associated with employment growth.

Based on the FY2002 LLNL payroll of $668 million, the regional earnings multiplier of 1.64 yields an overall economic effect of $1.096 billion within the ROI. Based on the total LLNL direct employment and the regional employment multiplier of 1.97, an estimated total of 17,400 jobs in the ROI are attributable to LLNL. In effect, one out of every 95 jobs (or 17,400 out of 1,644,500) in the ROI is directly or indirectly attributable to LLNL.

Under the Proposed Action, Site 300 total employment would remain at approximately 250 as projected for the No Action Alternative. There would be no additional socioeconomic impacts under the Proposed Action for Site 300 beyond those described for the No Action Alternative in Section 5.2.2. Therefore, socioeconomic impacts specific to Site 300 are not addressed in this section.

Employment and Expenditures

Region

The Proposed Action would provide additional employment opportunities in the region and would increase the payroll at LLNL. Assuming approximately a 500-employee increase in payroll and pay rates proportional with 2002 salaries, the additional annual payroll generated by the Proposed Action would be $39 million higher than the No Action Alternative in 2002 dollars. A portion of this increased payroll would enter the local economy as the new workers purchase additional goods and services. The combined direct and indirect effects of increased employment would result in an employment increase of approximately 1,000 within the region. Likewise, the direct and indirect effect of payroll expenditures would result in a $70 million increase to the regional economy.

In addition, the Proposed Action would result in an increase in expenditures by LLNL. Additional goods and services would be required to support the additional activities, facilities, and workers required by the Proposed Action.

Spending by both the additional LLNL personnel and the LLNL increased activity would generate additional revenue and employment opportunities within the ROI as monies filter throughout the economy. The additional income and employment opportunities generated by the Proposed Action would represent a beneficial economic impact to the region.

Alameda County

Total employment in Alameda County was estimated at 751,680 in 2000 (Association of Bay Area Governments 2001). The Proposed Action would generate approximately 500 more jobs at the Livermore Site than the No Action Alternative. Employment projections for the county estimate employment opportunities would increase 14.1 percent to 857,450 by the year 2010 (Association of Bay Area Governments 2001). The additional jobs created by the Proposed Action at LLNL would represent 0.5 percent of the projected increase in employment within the county. This increase in employment, less than a 0.1 percent increase over the 2000 county employment level, would have a minimal impact to the county.

Population and Housing

For this analysis, increases in population level and housing demand from the Proposed Action are projected to be conservatively high in order to determine the maximum expected impact. It was assumed that someone outside of the project region would fill each new job, that all new LLNL workers (including LLNL employees, contractors, and Federal employees) would migrate to the region, and that each worker would represent a new household. In reality, a percentage of new workers would already reside in the project region, and some households would shelter more than one employee. While this method overestimates migration of new workers to the project region, it also allows for the backfilling of vacancies left as some workers leave their current jobs in the region to work at LLNL. The geographic distribution of future LLNL workers would be similar to the 2002 distribution of employee residences (Table 5.3.2.2–1).

TABLE 5.3.2.2–1.—*Anticipated Geographic Distribution of Lawrence Livermore National Laboratory Worker Residences Under the Proposed Action*

City	Percent of LLNL Workers [a,b]	Additional New Workers Projected to Reside in City under No Action Alternative[c]
Alameda County		
Livermore	37.0	185
Pleasanton	6.2	31
Castro Valley	4.0	20
Dublin	2.1	11
Oakland	2.1	11
Other Alameda County	4.1	21
Total	**55.5**	**279**
San Joaquin County		
Tracy	8.2	41
Manteca	4.8	24
Stockton	2.6	13
Other San Joaquin County	2.9	14
Total	**18.5**	**92**
Contra Costa County		
Brentwood	2.7	14
San Ramon	2.7	14
Other Contra Costa County	7.4	37
Total	**12.8**	**65**
Stanislaus County		
Modesto	3.2	16
Other Stanislaus County	2.9	14
Total	**6.1**	**30**
Counties Outside the ROI		
Total	**7.2**	**36**

Source: LLNL 2003ak.
[a] Distribution as of September 30, 2002.
[b] May not total 100 because figures are rounded off.
[c] Calculated based on 500-employee increase. May not total 500 because of rounding.
ROI = region of influence.

Alameda County

Based on the anticipated geographic distribution of personnel residences (Table 5.3.2.2–1), the Proposed Action would result in an in-migration of 279 more workers to Alameda County over the next 10 years than under the No Action Alternative. This represents 56 percent of new LLNL personnel. Assuming 2.74 persons per household for the county (Census 2003), the population associated with the additional workforce migrating into the county would be 764 persons more than the No Action Alternative. This represents less than 0.1 percent of the 2001 population within the county. The county population is projected to increase 16.8 percent from 2001 to 2010 (Association of Bay Area Governments 2001, Census 2003). The incremental population increase associated with the Proposed Action would be within population growth projections for the county.

Assuming one worker per household, housing demand generated by the additional workforce would be 279 more dwelling units over 10 years than under the No Action Alternative, raising the total number of housing units occupied by LLNL workers to approximately 6,327 within Alameda County. In 2002, Alameda County had 546,735 housing units. The vacancy rate in the county was 3.0 percent, an estimated 16,620 available units (DOF 2002). Demand for housing associated with LLNL's additional personnel under the Proposed Action would be 1.7 percent of the unoccupied housing in 2001 within the county. Minimal impacts on housing in Alameda County is expected.

City of Livermore

As shown in Table 5.3.2.2–1, the majority of new LLNL workers (37 percent, or 185 more than the No Action Alternative) is projected to reside in Livermore, based on the 2002 pattern of employee residence location. Using the year 2000 person per household figure of 2.81 for the city of Livermore (Census 2002b), and assuming one worker per household, the population increase associated with the workforce migrating into the city would be 520 persons. This represents a 0.7 percent increase over the city of Livermore's 2000 population. The city's population is projected to increase by 23 percent from the year 2000 to 2010 (Association of Bay Area Governments 2001).

Assuming each new worker migrating into the city creates a demand for one additional housing unit, 185 units more than the No Action Alternative over 10 years would be required under the Proposed Action. In 2000, the city had a housing supply of 26,610 units, and a vacancy rate of 1.8 percent (Census 2002b). This represents 487 available housing units. The current city of Livermore Housing Implementation Program, covering the 3-year period 2002 through 2004, limits housing unit growth to a maximum of 1.5 percent per year (City of Livermore 2001). Assuming an annual growth rate of 1.5 percent, 5,363 new housing units would be available by the year 2014. The demand for housing associated with new employees needed under the Proposed Action would represent 3.4 percent of the projected number of new housing units, and 0.6 percent of the total projected housing stock. Population growth under the Proposed Action could be accommodated in the current housing market and housing growth is projected to continue; minimal impacts are anticipated.

City of Pleasanton

Under the Proposed Action, 31 more new workers employed would reside in Pleasanton, based on the existing geographic distribution of personnel (Table 5.3.2.2–1). Using the year 2000 person per household figure of 2.73 (Census 2002b), the city of Pleasanton population increase associated with new personnel would be 85 persons more than the No Action Alternative. This represents a 0.1 percent increase over the 2000 population of 63,654. This population increase would be within the 22 percent population growth estimate by the year 2010 as projected by the local planning unit (Association of Bay Area Governments 2001).

Housing demand generated by new workers because of the Proposed Action would be 31 housing units more than the No Action Alternative over 10 years, assuming one household per new employee. The year 2000 housing supply within the city was 23,968 units, with a vacancy rate of 2.7 percent (Census 2002b). This represents an available supply of 657 units. The demand for housing units associated with new workers would represent 4.7 percent of the number of available units in the year 2000. In addition, local planning governments project an 18 percent increase in the supply of housing by 2010 (Association of Bay Area Governments 2001). Because population growth under the Proposed Action could be accommodated in the current housing market and housing growth is projected to continue, minimal impacts are anticipated.

San Joaquin County

Under the Proposed Action, based on the anticipated geographic distribution of personnel, 92 more of the new workers would reside within San Joaquin County than under the No Action Alternative (Table 5.3.2.2–1). Based on the person per household figure of 3.17 (Census 2003), the San Joaquin County population increase associated with the new employees would be 292 persons. This represents less than 0.1 percent of the total 2001 population within the county. San Joaquin County's population projection is 727,800 by the year 2010, a 26.2 percent increase (DOF 2001). The incremental population increase associated with the Proposed Action would be accommodated within county growth projections.

Housing demand generated by new workers, assuming one worker per household, in the county would be 92 units over 10 years, raising the total number of housing units occupied by LLNL workers to approximately 2,109 within San Joaquin County. Housing supply within the county for the year 2002 was 197,279 units, with a vacancy rate of 3.9 percent (DOF 2002). The total number of vacant units was 7,767. The county projects a 26 percent increase in the number of housing units by the year 2010 (SJCOG 2000). Because the demand generated by the project would be small relative to the number of available and planned units, minimal impacts are anticipated.

City of Tracy

Based on the anticipated geographic distribution of new personnel under the Proposed Action, 41 more new workers would choose to live in the city of Tracy over 10 years than under the No Action Alternative. Based on the person per household figure of 3.23 (Census 2002a), the city of Tracy population increase associated with the Proposed Action would be 132 persons. This represents 0.2 percent of the 2000 population.

Housing demand within the city of Tracy due to Proposed Action implementation would be an additional 41 dwelling units over the No Action Alternative. The housing supply within the city in 2000 was 18,087 units (Census 2002a). In 2000, the vacancy rate for the city was 2.7 percent, which represents 467 available units. The demand generated by the new workers would represent 8.8 percent of the year 2000 supply of available housing. In addition, the number of housing units in the city is projected to increase 38 percent by the year 2010 (SJCOG 2000). Thus, under the Proposed Action, the housing demand could be accommodated in the current and projected housing supply, and minimal impacts are anticipated.

Environmental Justice

In general, LLNL operations under the Proposed Action would have no anticipated disproportionately high and adverse health or environmental impacts on low-income or minority populations. Effects would be qualitatively equivalent to those described for the No Action Alternative in Section 5.2.3.2. A number of quantitative differences exist between the data presented in Section 5.2.3.2 and the Proposed Action:

- As indicated earlier in this section, 11,150 workers would be required at the Livermore Site, 500 more than under the No Action Alternative.
- As presented in Section 5.3.3, an estimated 4,900 metric tons per year of nonhazardous solid waste would be generated at the Livermore Site for disposal, 300 metric tons per year more than under the No Action Alternative.
- As presented in Section 5.3.8, the MEI dose from radiological air emissions at the Livermore Site would be 0.13 millirem per year, higher than the No Action Alternative estimate of 0.098 millirem per year.
- As discussed in Section 5.3.11, the collective radiation dose to the population along the transportation route is calculated at 5.9 person-rem per year with 0.004 LCFs per year, higher than the No Action Alternative estimates of 5.0 person-rem per year and 0.003 LCFs per year.
- As presented in Section 5.3.12, the projected peak electrical demand at LLNL would be 81 megawatts with an annual use of 442 million kilowatt-hours, compared with 82 megawatts and 446 million kilowatt-hours.
- As presented in Section 5.3.14, worker dose to ionizing radiation would be 125 person-rem per year, higher than the 90 person-rem per year under the No Action Alternative.

None of these changes would result in disproportionately high and adverse impacts on low-income or minority populations under the Proposed Action.

5.3.2.3 *Cumulative Impacts*

Approximately 380 more new LLNL workers would elect to live in the various communities listed in Table 5.3.2.2–1 under the Proposed Action than the No Action Alternative, in the same proportion that existing workers have selected communities for their residences. In addition, approximately 120 workers and their families would be distributed throughout other communities in the Bay Area and central San Joaquin Valley. The Proposed Action would contribute to the cumulative demand for housing in the region associated with new employment opportunities. However, because vacancy rates are high enough to accommodate the demands of new employees for housing in the city of Livermore, the community with the highest current and anticipated concentration of LLNL employees, it is assumed that other parts of the region could also meet the housing demand created by the increase in local job opportunities.

5.3.3 Community Services

This section evaluates the effect of the Proposed Action on the provision of fire, police, school, and nonhazardous solid waste facilities and services to adjacent and nearby communities. Estimates of the increased levels of service needed as a result of the Proposed Action were made and evaluated.

Personnel statistics for employees at the Livermore Site and Site 300 are combined; thus, some of the projections and analyses in this section discuss impacts of employee growth at the Livermore Site and Site 300 as a single entity.

5.3.3.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.3 for the Proposed Action and the community services impact analysis. In general, the effect of projects under the Proposed Action on community services is related to additional employment opportunities and changes in floorspace. Employment under the Proposed Action is detailed in Section 5.3.2. New construction projects, as listed in Section 3.3, would add to floorspace, but D&D projects, as part of an overall consolidation program, would decrease floorspace. Employment parameters are listed in Table 5.3.3.1–1.

TABLE 5.3.3.1–1.—*Input Parameters for Community Services Analysis Under the Proposed Action*

Parameter	Units	Site	No Action Alternative	Proposed Action
Employment	Number of personnel	Livermore Site	10,650	11,150
		Site 300	250	250

5.3.3.2 *Impact Analysis*

Livermore Site

Fire Protection and Emergency Services

The Livermore Site has its own onsite fire protection services. Currently the Livermore Site Fire Department participates in an automatic aid agreement with the Livermore-Pleasanton Fire Department and a mutual aid agreement with the Alameda County Fire Patrol to serve the Livermore Site.

For purposes of evaluating impacts of the Proposed Action, square footage at the Livermore Site was assumed to decrease by 1 percent from the No Action Alternative. Under their automatic aid agreement, the Livermore-Pleasanton Fire Department responds to an average of three calls per year at the Livermore Site. No increase in the number of calls to the Livermore-Pleasanton Fire Department would be anticipated because of the Proposed Action. The average of three calls per year at the Livermore Site for the Livermore-Pleasanton Fire Department, would not impact that agency's ability to provide fire protection and mutual and automatic aid service under the No Action Alternative. Because the Proposed Action would not increase the number of calls, there would be no impacts on the Livermore-Pleasanton Fire Department.

The Alameda County Fire Patrol did not respond to any Livermore Site Fire Department calls from 1999 to 2001. Implementation of the Proposed Action would not increase the number of calls for assistance over the No Action Alternative. Therefore, the Proposed Action would not affect the Alameda County Fire Patrol's ability to provide fire protection within its service area or carry out its mutual aid responsibilities with other agencies.

Police Protection and Security Services

The Livermore Site provides onsite security services and participates in emergency response agreements with the city of Livermore Police Department and Alameda County Sheriff's Department for additional police protection services at the Livermore Site. The 5 percent increase in Livermore Site employees could raise the number of calls for assistance by one to two per year. This would be less than 0.01 percent of total calls to the Livermore Police and Alameda County Sheriff's departments, and would not impact the ability of the departments to provide service to the community.

School Services

A secondary effect of the Proposed Action would be an increase in student enrollment in those school districts where Livermore Site employees reside. Some of these school districts could accommodate the increase in student enrollment generated by the Proposed Action. However, other school districts in the region could have more limited enrollment capacity and would be subject to an enrollment demand that could be considered an adverse impact.

Due to the high proportion of new hires and their families projected to reside in the Livermore area, further evaluation of the demand for school services focuses on the Livermore Valley Joint Unified School District.

The Livermore Valley Joint Unified School District encompasses approximately 240 square miles of service area, including the city of Livermore, portions of unincorporated Alameda County, and a small portion of unincorporated Contra Costa County. Because the unincorporated areas served have a relatively low population density, the vast majority of the population served by the school district resides within the city of Livermore. This analysis makes the simplifying and conservative assumption that all district students are city of Livermore residents.

Approximately 37 percent of the new personnel under the Proposed Action would reside in Livermore. Based on the 2001 ratio in the Livermore Valley Joint Unified School District enrollment per Livermore resident (13,899 students for 73,345 residents, or 19 percent), approximately 100 more new students would be enrolled under the Proposed Action than under the No Action Alternative (19 percent of the 520 new residents, as explained in Section 5.3.2.2).

Additional students generated from increased employment at the Livermore Site would be added to the school system incrementally from the year 2004 to 2014. Though several district schools are near capacity, there is currently adequate space district-wide (Miller 2003). The Livermore Draft General Plan (City of Livermore 2003) states "[f]uture growth shall not exceed the community's capability to provide services" and notes school classroom facilities as one of the principal factors considered. The 100 student increase represents 0.7 percent of district enrollment. Based on an expected annual enrollment growth rate of 1.5 percent based on Livermore's Housing Implementation Plan, the 100 student increase would be 3.7 percent of the total enrollment growth by 2014. Because the district's facilities are adequate to meet current student demand, the addition of 100 students to the existing facilities would have minimal impact on the district's ability to plan for and provide service within its jurisdiction.

Under the Proposed Action, the employment of 500 new workers at LLNL would lead to creation of an additional 500 indirect jobs within the ROI as discussed in Section 5.3.2. Because of the relatively high proportion of new LLNL workers that would reside in the city of Livermore, some of those additional jobs would likely be created within the community. If the distribution of indirect worker residences were the same as for LLNL workers, 100 students could be added to the Livermore Valley Joint Unified School District in addition to the 100 students projected for LLNL workers described above. However, the actual number of students added through indirect jobs would be much less than 100, as many of the additional jobs and worker residences to support LLNL workers residing in Livermore would be created in neighboring communities and other areas throughout the ROI.

Nonhazardous Solid Waste Disposal

Projections for nonhazardous solid waste generation were based on the estimated personnel increases associated with the Proposed Action. This method of analysis was used because existing data on the volume of nonhazardous solid waste generated by the Livermore Site are aggregate figures that do not distinguish waste generated by building type or by program. Thus, the most accurate measure of the increase in nonhazardous solid waste generation was assumed more closely associated with the increase in personnel generated by the Proposed Action.

Estimated increases in nonhazardous solid waste are related to the assumed increases in site employment. Based on an existing workforce level of approximately 10,350 persons and a generation rate of solid waste for disposal of approximately 4,700 metric tons per year, the Livermore Site generates 0.5 metric tons of solid waste per worker per year, which is disposed of at the Altamont Landfill. The estimated increase in the workforce of 500 personnel over the No Action Alternative would result in an increase of approximately 300 metric tons of solid waste per year taken to the landfill. This increase would occur gradually over the timeframe of 2004 to 2014; the projected increase accounts for current source reduction and recycling strategies, but not future strategies or technologies.

The projected lifespan of the Altamont Landfill under current conditions extends to the year 2038 (Hurst 2003). While the Livermore Site is a major generator of solid waste within the county, the additional 300 metric tons of solid waste generated at the Livermore Site under the Proposed Action could be accommodated by the existing landfill. The increase in solid waste under the Proposed Action would represent only 0.01 percent of permitted landfill throughput. Therefore, due to the remaining lifespan and capacity of the Altamont Landfill, there would be minimal impacts to solid waste disposal within the county.

Site 300

Fire Protection and Emergency Services

Site 300 has its own onsite fire protection services. Currently, the Site 300 Fire Department participates in mutual aid agreements with the city of Tracy Fire Department, Tracy Rural Fire Protection District, and State of California Department of Forestry.

During the years 2000 through 2002, the Site 300 Fire Department and the city of Tracy Fire Department did not respond to any calls in each other's jurisdictions under their mutual aid agreement. The number of mutual aid responses would not increase for either agency under the Proposed Action, which would include no increase in building gross square footage at Site 300. Therefore, the Proposed Action would have no impact on the city of Tracy Fire Department's ability to provide fire protection services or mutual aid services.

Through mutual aid, the Tracy Rural County Fire Protection District currently responds to an average of one call per year at Site 300. The Site 300 Fire Department has never received a request for assistance from the Tracy Rural County Fire Protection District. The number of responses for each agency would not increase under the Proposed Action. Therefore, the Proposed Action would not impact the Tracy Rural County Fire Protection District's ability to provide fire protection within its service area or to fulfill its mutual aid responsibilities with other agencies.

Site 300 also participates in a mutual aid network with the California Department of Forestry. The Proposed Action would not impact the California Department of Forestry's ability to provide fire protection and mutual aid service.

The Proposed Action would not impact fire protection services onsite. There would be no need for increased interaction with offsite agencies.

Police Protection and Security Services

Site 300 provides onsite security services and participates in an emergency response agreement with the San Joaquin County Sheriff's Department for additional police protection services. Because the number of employees at Site 300 would be the same as projected under the No Action Alternative, the Proposed Action would not result in a need for increased security services onsite. No additional impacts are expected.

School Services

The existing setting and impact analysis for school services is combined for the Livermore Site and Site 300. Minimal impacts are expected. (See the discussion of school services under the Livermore Site heading above.)

Nonhazardous Solid Waste Disposal

The number of Site 300 employees under the Proposed Action is the same as under the No Action Alternative. No additional impacts to nonhazardous solid waste disposal would be anticipated.

5.3.3.3 *Cumulative Impacts*

Cumulative effects associated with planned and approved projects in the area would contribute to the cumulative demand for fire and police services in the jurisdictions for which LLNL has mutual aid agreements. However, because fire and security services at LLNL are independent departments at the Livermore Site and Site 300 and do not rely on offsite community agencies to provide primary responses to fire and police emergency calls, additional demand for these onsite services associated with the Proposed Action would not add to the cumulative demand for offsite fire and police services.

The Proposed Action would contribute to the cumulative demand for school services in the region. Existing school facilities cannot accommodate student generation from cumulative development within the district's jurisdiction. The Proposed Action would contribute approximately 100 students to the cumulative student population. As new school capacity will be required for the 2,700 additional students projected during the next 10 years, the portion of the student increase attributable to the Proposed Action (3.7 percent) would be within extra capacity design criteria.

The Proposed Action would contribute to the cumulative demand for solid waste disposal service associated with planned and approved projects in the area. The Livermore Site sends solid waste to the Altamont Landfill. The landfill operator has projected that the lifespan of this landfill will extend to the year 2038. With existing landfill capacity in Alameda County, the additional solid waste generated under the Proposed Action would not affect solid waste disposal services.

5.3.4 Prehistoric and Historic Cultural Resources

This section presents an evaluation of the impacts to cultural resources resulting from implementation of the Proposed Action. The impact analysis is organized by location and type of resource. Steps taken to reduce impacts are also discussed, as are the measures to be implemented to ensure compliance with the NHPA.

5.3.4.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Chapter 3, Section 3.6, under the Proposed Action and the analysis of cultural resources. In general, those projects with the potential to impact these resources include construction of new facilities and infrastructure; and D&D, rehabilitation, and renovation of existing facilities.

5.3.4.2 *Impact Analysis*

Livermore Site

The probability of impacting prehistoric resources at the Livermore Site would be very low because: (1) field and archival research have not identified any prehistoric resources; (2) the geomorphic setting of the site makes it unlikely that any such resources exist; and (3) extensive modern horizontal and vertical development has disturbed much of the site. Although no impacts to prehistoric resources would be expected, unrecorded subsurface prehistoric resources still could be inadvertently discovered during construction or other ground-disturbing activities.

To address the inadvertent discovery of cultural material, LLNL would require its employees and contractors to report any evidence of cultural resources unearthed during ground-disturbing activities at the Livermore Site. Work within the immediate vicinity of the discovery would cease until a qualified archaeologist had the opportunity to assess the discovery. If the discovery were deemed potentially significant, work would be stopped until an appropriate treatment plan was developed according to DOE guidelines. NNSA expects no impacts to these resources.

Implementation of the Proposed Action would have the potential to affect important historic buildings and structures on the Livermore Site through D&D, rehabilitation, and renovation of existing facilities. However, implementing the Programmatic Agreement (Appendix G) would avoid, reduce, or mitigate any impacts from these actions.

Site 300

Impacts to known prehistoric and historic resources at Site 300 would be unlikely to result from the Proposed Action. NNSA recognizes the sensitivity of the resources and has established buffer zones to protect them. Implementation of the Programmatic Agreement (Appendix G) and continuation of current management practices would result in protection of these sensitive areas. Although no impacts to known resources would be expected, unrecorded subsurface prehistoric or historic resources still could be inadvertently discovered during construction or other ground-disturbing activities.

The inadvertent discovery of cultural material, at Site 300 would be addressed as described above for the Livermore Site. NNSA expects no additional impacts to these resources.

The Proposed Action would have the potential to affect important historic buildings and structures on Site 300 through D&D, rehabilitation, and renovation of existing facilities. However, implementing the Programmatic Agreement (Appendix G) with responsible state and Federal agencies would avoid, reduce, or mitigate any impacts from these actions.

5.3.4.3 *Cumulative Impacts*

The Livermore Valley has undergone tremendous growth and development over the past decade. Because preservation measures such as Section 106 are only initiated when Federal agencies are involved, it is likely that the onset of development has caused the irretrievable loss of cultural resources in the region. Because cultural resources exist at both the Livermore Site and Site 300, future program activities could result in resource loss and add to regional attrition of these resources. Any potential impacts to cultural resources at LLNL would be mitigated through implementation of the Programmatic Agreement (Appendix G), thereby reducing LLNL's contribution to resource attrition.

5.3.5 Aesthetics and Scenic Resources

This section analyzes the impact to aesthetics and scenic resources associated with implementation of the Proposed Action.

5.3.5.1 *Relationship with Site Operations*

This section summarizes the relationship between the projects described in Section 3.3 under the Proposed Action and the analysis of aesthetics and scenic resources. In general, effects to aesthetics and scenic resources would be limited to construction of buildings and infrastructure located in areas visible to public viewing.

5.3.5.2 *Impact Analysis*

Livermore Site

Activities under the Proposed Action that would change the built environment at the Livermore Site would include improvements to existing buildings and infrastructure, D&D of existing buildings, and construction of new facilities. Developments and modifications would largely occur within the developed portion of the site, would be similar in character to surrounding uses, and would be largely screened from public view by the surrounding fences and trees. Developments and modifications would be largely consistent with the existing character of the site. Therefore, no additional impacts to visual resources are expected.

Site 300

Activities under the Proposed Action that would change the built environment at Site 300 would include improvements to existing buildings and infrastructure, and construction of new facilities. Development and modifications would largely occur within the developed portion of the site in the GSA and would be similar in character to surrounding uses. Although many specifics of these developments under the Proposed Action are not presently known, based on previous LLNL landscaping and development practices, development of these projects at Site 300 would be largely consistent with the existing character of the site.

Under the Proposed Action, the location, type, and extent of improvement activities at Site 300 would be similar to the No Action Alternative. The site would remain compatible with local and county scenic resource plans and policies. Two new buildings, the HEDC and the EMPC, would be constructed under the Proposed Action; however, both buildings would be located within areas that already contain buildings or structures. Consequently, the changes to the built environment because of the Proposed Action would still have no impacts on the visual character of Site 300, views of the site from public viewing areas, or existing view sheds of the surrounding environment.

5.3.5.3 *Cumulative Impacts*

There are no planned projects near the Livermore Site and Site 300 that, in combination with LLNL activities, would have an adverse effect on existing view sheds or the surrounding environment. There would be no cumulative impacts to aesthetics and scenic resources in the region under the Proposed Action.

5.3.6 Geology and Soils

This section analyzes the impact to geology and soils associated with implementation of the projects described in Section 3.3 under the Proposed Action. The impact analysis is organized by geologic resources, topography and geomorphology, and geologic hazards. The Proposed Action includes those actions and facilities described under the No Action Alternative.

5.3.6.1 *Relationship with Site Operations*

Under the Proposed Action, future facilities would be located in the undeveloped areas at the Livermore Site in addition to those facilities described under the No Action Alternative (Figure 5.3.6.1–1). These facilities are listed in Table 5.2.1.2–1. Any future development in the developed areas would affect soils that have already been disturbed.

Under the Proposed Action, the EMPC would be built at Site 300 in addition to the Wetlands Enhancement Project and the connection to the Hetch Hetchy aqueduct (see Section 5.2.6). The EMPC would replace facilities that are more than 40 years old and allow for the continued support of the Stockpile Stewardship Program.

5.3.6.2 *Impact Analysis*

Geologic Resources

Livermore Site

No known aggregate, clay, coal, or mineral resources would be adversely affected by the Proposed Action. None of the activities under the Proposed Action would take place on or upon known or exploitable mineral resources, unique geologic outcrops, or other unique geologic features. No impacts from farming or grazing activities are expected.

No new facilities would be built in the undeveloped zone at the Livermore Site under the Proposed Action. A total of 462,000 square feet of land would be disturbed because of the construction that would proceed under the No Action Alternative, which would also proceed under the Proposed Action.

As discussed in Chapter 4, Section 4.8, fossils were discovered in the peripheral parts of the excavation for the NIF. The fossil localities were found 20 to 30 feet below the present surface. Under the Proposed Action, the potential would exist for the inadvertent excavation of fossils within the depth range during construction. Should any buried fossil materials be encountered, LLNL would evaluate the materials and proceed with recovery in accordance with requirements of the *Antiquities Act*.

Site 300

No known aggregate, clay, coal, or mineral resources would be adversely affected by the Proposed Action. The impacts would be the same as described in the No Action Alternative, except the proposed construction of the EMPC. Under the Proposed Action, the EMPC, a 40,000-square-foot facility, would be constructed in the southeast quadrant of Site 300 to replace Buildings 805, 806, and 813. An additional building and three new magazines would also be built (see Appendix A). The total area to be disturbed would be approximately 100,000 square feet, only one third or about 33,000 square feet of which would occur in previously undisturbed soils. No projects would involve disturbing new areas. The EMPC would involve the disturbance of a larger area in a previously disturbed site. Therefore, there would be minimal impacts to soils at Site 300.

Several vertebrate fossil deposits have been found on Site 300 near Corral Hollow. The fossil finds are generally widely scattered, and no significant invertebrate or botanical fossil locales have been identified on Site 300 or in the surrounding area (Hansen 1991). Under the Proposed Action, there would be no impacts to any known fossil deposits. There would be no impacts to any known or exploitable mineral resources or unique geologic features.

Topography and Geomorphology

Livermore Site

The Proposed Action would not include project work that would impact the topography or geomorphology of the Livermore Site and no construction or excavation projects are planned that would alter the overall character of the landscape. Only the best management practices would be employed to minimize erosion resulting from ongoing operations; no additional impacts are expected.

Site 300

The Proposed Action would not include project work that would impact the topography or geomorphology of Site 300, and no construction or excavation projects would alter the character of the landscape. Only the best management practices would be employed to minimize erosion resulting from ongoing operations; no additional impacts are expected.

Geologic Hazards

The geologic hazards associated with the Livermore region are part of the character of that region. The hazards exist regardless of the presence of human activities, buildings, or facilities. Therefore, there is no difference in the geologic hazards among the alternatives. Chapter 4, Section 4.8, and Appendix H, Seismicity, include information regarding potentially strong earthquake ground motion sources and the major regional fault zones and local faults. Potential impacts expected from an earthquake generating a horizontal peak acceleration of 0.73 *g* are discussed as part of the evaluation of accidents in Section 5.5 and Appendix D, Accident Analysis. The unit *g* is equal to the acceleration due to the gravity of the earth or 9.8 meters/second/second (32 feet/second/second).

Livermore Site

Adverse impacts to proposed structures, related infrastructure, and surrounding communities could occur from hazardous materials releases and/or structural failure of buildings and facilities following a major seismic event. Design and location requirements for new facilities built under the Proposed Action would take into account distance from active faults and the ground shaking to be expected within certain probabilities.

Site 300

There is potential for seismically induced landslides at Site 300 due to steep slopes and existing landslide deposits. The potential for slope instability is greater on northeast-facing slopes that are underlain by the Cierbo Formation. Buildings 825, M825, 826, M51, 847, 851A, 851B, 854, 855, and 856 are located on old landslides deposits. The potential for ground deformation at these buildings is considered to be moderate to high. The EMPC location is not underlain by landslide deposits and therefore, has low potential for ground deformation.

A landslide could result in spills, fire, explosions, or burial of facilities within its path. The hazards and impacts of spills, fire, and explosions, regardless of cause are discussed in Section 5.5 and Appendices A and D. The impacts of burial of materials due to a landslide would be similar to spills and the firing of explosives at these facilities. These facilities have material limits under which they work on batches of materials. The working limits for explosives are close to the amounts detonated at the firing sites. The spread of materials into the environment when the explosives are detonated would be similar to the amount of materials that would be buried in a landslide.

5.3.6.3 *Cumulative Impacts*

SNL/CA projects approximately 100 acres of soil disturbance in connection with their activities and future facilities. A large portion of this disturbance would occur within areas that are already developed. The soils near LLNL are capable of supporting agriculture. While there is a large amount of undeveloped land in Alameda County, continuing development in the immediate vicinity of LLNL is contributing to the cumulative loss of agricultural land. The projects associated with the Proposed Action would not contribute to the overall loss of agricultural land since LLNL has been committed to R&D/industrial use instead of agriculture for decades.

5.3.7 Biological Resources

This section describes the impacts to biological resources under the Proposed Action. Chapter 4, Section 4.9, describes the existing biological conditions and current operations that impact or may impact biological resources. A more detailed discussion of the biological resources and the impacts of current operations appears in Appendix E, Ecology and Biological Assessment, and Appendix F, Floodplain and Wetlands Assessment.

5.3.7.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Chapter 3, Section 3.3, for the Proposed Action and the ecological impact analysis. In general, the effect of Proposed Action projects on biological resources would occur primarily in areas that have been previously disturbed at the Livermore Site and Site 300 by construction, maintenance, wildfire prevention, and security activities.

5.3.7.2 *Impact Analysis*

Vegetation and Wildlife

Livermore Site

Under the Proposed Action, no additional facilities would be constructed in undeveloped areas in addition to those described in the No Action Alternative. The impacts of the Proposed Action on vegetation and wildlife would be minimal and similar to those for the No Action Alternative.

Site 300

Site 300 vegetation and wildlife consist of a wide range of plant and animal species. The impacts of the Proposed Action on vegetation and wildlife would occur primarily in previously disturbed areas representing less than 5 percent of the total site acreage. Under the Proposed Action, the EMPC would be constructed in the southeast quadrant of Site 300. This planned facility would result in the disturbance of approximately 40,000 square feet (approximately 0.9 acres) of soil and associated vegetation. The loss of less mobile animals such as small mammals and reptiles could occur. The facility would replace Buildings 805, 806, and 813. The operations of Building 807 would move to the EMPC, but Building 807 would be retained and waste packaging operations from Building 805 would be moved to Building 807. The EMPC would house modern explosives machining, pressing, assembly, inspection, and some radiography. An additional building would provide an inert machine, offices, and shower/change room facilities. Three magazines capable of storing 1,000 pounds of explosives each would also be built (LLNL 2002ap). A number of routine operations such as road grading and culvert maintenance would occur and include protective measures as detailed in Appendix E, Section E.2.2.

Tritium Levels in Vegetation and Commodities

The Proposed Action projects no releases of tritium above that in the No Action Alternative. A detailed discussion of tritium levels for the No Action Alternative is presented in Section 5.2.7.2.

Protected and Sensitive Species

Livermore Site

Under the Proposed Action, LLNL would continue to fulfill its obligation to maintain Arroyo Las Positas (previously modified to handle a 100-year flood event) and onsite tributaries for flood capacity. The objective of the Las Positas Maintenance Project is to allow the function and needs of onsite drainage capacity of the arroyo to be met in a timely and consistent manner without overlooking the preservation and habitat conservation requirements pertaining to the federally threatened California red-legged frog (LLNL 1998a, USFWS 1997, USFWS 2002e). For further details of the Arroyo Maintenance Project and ongoing consultation with the USFWS for this project, see Appendix E, Section E.2.1.

No California red-legged frogs have been identified in 1,800 feet of the Arroyo Seco within the Livermore Site boundaries from the Vasco Road bridge to the East Avenue culvert (LLNL 2003ab). However, this segment of Arroyo Seco could be used by populations of that species in the vicinity of the site. A separate Biological Assessment prepared to assess the impacts of the proposed Arroyo Seco Management Plan was submitted to the USFWS in August 2003.

Formerly designated critical habitat for the California red-legged frog at the Livermore Site is shown in Chapter 4, Figure 4.9.3–1. Construction of new structures under the Proposed Action would include No Action Alternative projects, such as BSL-3, the Edward Teller Education Center, an Emergency Operations Center, and a Community Gateway Science and Education Lecture Hall. The proposed projects at the Livermore Site would not be in or affect formerly designated critical habitat for the California red-legged frog, or areas where this species typically occurs.

Measures to protect the California red-legged frog during Las Positas Maintenance Project activities would continue using the same USFWS-approved protection and conservation measures discussed in Section 5.2.7.3. Impacts are expected to be beneficial.

Site 300

Threatened, endangered, and other sensitive flora and fauna species of concern reside at Site 300. Under the Proposed Action, No Action Alternative projects described in Section 3.2 would be completed, as well as other projects described in Section 3.3 for the Proposed Action.

Affected Species and Habitat

The Proposed Action would affect three species: the California red-legged frog, the California tiger salamander, and the Alameda whipsnake, and would involve construction or maintenance activities in formerly designated critical habitat for two of these. The first affected species is the California red-legged frog, a federally listed threatened species. Formerly designated critical habitat for the California red-legged frog at Site 300 is shown in Chapter 4, Figure 4.9.3–3, together with its breeding and nonbreeding locations. Proposed termination of surface water releases for an artificial wetland at Building 865 would impact this species since it has been a known breeding location for 6 years. Termination of water to a small, artificially maintained wetland at Building 801 would eliminate a potential breeding site for this frog species, although no California red-legged frogs occur at this site. Elimination of very small wetlands associated with the cooling towers at Buildings 851 and 827 would eliminate two low-quality habitat locations for the California red-legged frog where frogs have not been observed for the past 6 years. Appendix E, Section E.2.2.6.1, provides further details on potential impacts of this project and mitigation measures taken to minimize those impacts. Proposed termination of surface releases at Buildings 865, 851, and 827 was coordinated with the USFWS and received approval contingent upon implementation of mitigation measures in a recent Biological Assessment and related Biological Opinion (Jones and Stokes 2001, USFWS 2002b). This proposed termination may start as early as 2004 (LLNL 2003ab). Grading of fire trails disturbs sediment that could indirectly affect California red-legged frog habitat suitability. However, the use of best management practices could reduce adverse effects to this species by minimizing erosion of fire trails into drainages as discussed in Appendix E, Section E.2.2.6.1.

Under the Proposed Action, the EMPC would be constructed in the southeast quadrant of Site 300. A field reconnaissance of the proposed EMPC site was performed in March 2002 to detect the presence of special-status wildlife species and/or their habitats at Site 300. No California red-legged frogs or related breeding areas were detected in the proposed construction area (LLNL 2003cg). The proposed construction location would be within an area where designated critical habitat for the California red-legged frog has been rescinded by court order until further notice (USDCDC 2002). Depending on the outcome of ongoing critical habitat litigation, it is possible that the USFWS may reinstate this area as critical habitat for the California red-legged frog. The proposed EMPC site would impact low-quality California red-legged frog habitat. However, this location is within the dispersal capability of California red-legged frogs from known breeding and nonbreeding areas in the southeast quadrant of Site 300. Therefore, a pre-activity survey would be conducted prior to the groundbreaking for the EMPC to minimize the potential for injury or mortality to California red-legged frogs.

The second affected species is the California tiger salamander, a federally listed proposed threatened species. Figure 4.9.3–4 shows wetland locations where this species has been observed at Site 300. Although proposed grading of fire trails, and storm drainage and culvert improvement activities could result in direct mortality of California tiger salamanders, proposed mitigations contained in a recent Biological Assessment and related Biological Opinion would minimize the potential for such adverse impacts (Jones and Stokes 2001, USFWS 2002b). The avoidance and mitigation measures discussed above for the California red-legged frog would also provide protection for the California tiger salamander and its habitat (Jones and Stokes 2001). The California tiger salamander was not observed during a field reconnaissance of the proposed EMPC site performed in March 2002 (LLNL 2003ag). Avoidance measures discussed above for the California red-legged frog would also minimize potential for damage or mortality to the California tiger salamander if the EMPC were constructed.

LLNL is proposing to mitigate the 0.62-acre artificial wetland removed by continued operations at Site 300 under the Proposed Action, by enhancing selected areas and increasing breeding opportunities for the California red-legged frog. A minimum of 1.86 acres of wetland habitat would be enhanced and managed for these two species. Mitigation sites for potential enhancement include the wetlands at the seep at the SHARP Facility and Mid Elk Ravine. This mitigation measure has been previously addressed in a recent Biological Assessment and related

Biological Opinion (Jones and Stokes 2001, USFWS 2002b) (see Appendix E, Section E.2.2.9 for more information on this mitigation measure).

The third affected species is the Alameda whipsnake, a federally listed threatened species. Figure 4.9.3–5 shows critical habitat and potential habitat for the Alameda whipsnake at Site 300. Grading of fire trails and prescribed burns in grasslands adjacent to Alameda whipsnake habitat in sage scrub and rock outcrops have the potential to affect this species. However, a Biological Assessment and related Biological Opinion address mitigations that would minimize the adverse effects from these proposed activities (Jones and Stokes 2001, USFWS 2002b). Fire trail maintenance and prescribed burns are annual activities that would continue during the 10-year period covered by this LLNL SW/SPEIS. Appendix E, Section E.2.2.6.2, provides further details on measures taken to minimize impacts of the Proposed Action on this species. Impacts are expected to be minimal.

Unaffected Species

Activities associated with the Proposed Action would not occur in areas that would affect the following federally listed endangered, threatened, or candidate species: the large-flowered fiddleneck, the San Joaquin kit fox, the valley elderberry longhorn beetle, and the willow flycatcher. Protection and conservation measures discussed in Section 5.2.7.3 would also be conducted under the Proposed Action. Impacts are expected to be minimal, if any.

Wetlands

Livermore Site

Under the Proposed Action, No Action Alternative projects and additional projects would be constructed. Construction of new buildings under the Proposed Action would occur in upland areas so that land clearing would not be anticipated to have direct or indirect impacts on natural wetlands. Wetlands along Arroyo Las Positas could be impacted if discharged treated water from the Environmental Restoration Program is terminated; although such termination is not being considered under the Proposed Action during the time period covered by the LLNL SW/SPEIS (LLNL 1998a). Future actions involving these wetlands may require consultation with the USACE and the San Francisco Bay Regional Water Quality Control Board, such as ongoing efforts to develop a water management plan for an 1,800-foot segment of Arroyo Seco within Livermore Site boundaries from the Vasco Road bridge to the East Avenue culvert (LLNL 2001ap). Additionally, the State of California has a no net loss policy regarding wetlands, including artificial wetlands. No impacts are expected.

Site 300

Under the Proposed Action, construction of the EMPC would occur using best management practices to avoid runoff that could affect wetlands. Additionally, a No Action Alternative wetland enhancement project would be constructed to protect and enhance a minimum of 1.86 acres of wetland habitat in association with the termination of artificial wetlands, totaling approximately 0.62 acres, that have been created by cooling tower runoff near Buildings 801, 827, 851, and 865 (Jones and Stokes 2001, USFWS 2002b). This project is discussed in Section 5.2.7. Impacts are expected to be minimal.

5.3.7.3 *Cumulative Impacts*

Under the Proposed Action, approximately 732,000 square feet (approximately 16.8 acres) of terrestrial habitat at the Livermore Site would be disturbed due to proposed construction activities, a 34 percent increase over soil disturbance under the No Action Alternative (see Section 5.3.6.2). Approximately 40,000 square feet (approximately 0.9 acres) of soil disturbance would be required for construction of the EMPC in the more developed part of Site 300, and some additional soil disturbance would occur for continuing operations, such as road grading and culvert maintenance (see Appendix E). SNL/CA is managing its section of Arroyo Seco to protect California red-legged frog habitat and create a 30-acre wildlife reserve on the east side of that facility. The incremental effect of the Proposed Action on biological resources within the area would be positive, particularly in the long term.

5.3.8 Air Quality

5.3.8.1 *Nonradiological Air Quality*

Relationship with Site Operations

Similar to the discussion in Section 5.2.8.1, the Proposed Action is for the most part a continuation of current activities. In addition, there are a number of new projects such as facility upgrades, D&D activities, and new facility construction. The scope of these activities under the Proposed Action would be somewhat greater than under the No Action Alternative. Because these types of activities are normal during any 10-year period, potential air quality impacts of planned activities associated with the Proposed Action are considered in relation to current activity levels and are compared to those of the No Action Alternative. The general parameters that will be used in the analyses of potential air quality impacts are listed in Table 5.3.8.1–1.

Impact Analysis

Modifications to Facilities or Operations

Facility and infrastructure renovations (e.g., replacement of ductwork, roofs, installation of seismic and physical security upgrades, and repairs and modifications to roads) and new facility construction are normal during any 10-year period. Many such activities are planned under the No Action Alternative, but under the Proposed Action, the activity level and potential air quality emissions would be about three times that of the No Action Alternative. As discussed earlier, LLNL adheres to stringent requirements to ensure that air emissions are mitigated to the extent practicable, throughout the design, review, and implementation phases of modification activities. While the increased activity would result in a comparable increase in air emissions, primarily fugitive dust and combustion exhaust from increased vehicular activity and employment of construction equipment, with the use of stringent measures to control construction emissions as discussed in Section 5.1.8.1, the impact would not be significant.

New Facilities

The No Action Alternative includes some new facilities such as the NIF, Terascale Simulation Facility, and International Security Research Facility. The Proposed Action would additionally consolidate several programs within new structures. At the Livermore Site, these new facilities would increase utilized space by about 10 percent over that planned under the No Action Alternative. At Site 300, planned new space would be offset by the removal of a similar amount of obsolete space. At both sites, however, space utilization would not differ appreciably from current allocations. In fact, many of the activities to be housed within new structures are ongoing activities that would be relocated and/or consolidated. Activity relocations would be reviewed for compliance with air permit requirements in relation to their new settings. Where activities would require new air permits or modifications to existing air permits, these would be secured prior to construction or operation.

The increase in facility space at the Livermore Site would result in some additional fuel use. Natural gas is used in boilers, and diesel fuel is used in generators. Both are tested periodically. Several criteria and toxic air contaminants are emitted from fuel combustion. Oxides of nitrogen are a concern locally as a contributor to ozone formation. The increased fuel use anticipated under the Proposed Action would result in an increase in oxides of nitrogen emissions by 2.8 tons annually (over the No Action Alternative). Actual oxides of nitrogen emission levels may be limited by site-wide emission caps under the Synthetic Minor Operating Permit discussed in Chapter 4, Section 4.10.4.3. Impacts would be limited by air district offset requirements. Because fuel combustion sources are recognized as potentially significant sources of criteria pollutant emissions, LLNL has enacted standard measures, as described in Section 5.2.8.1, to mitigate emissions from this source category.

Decommissioning, Decontamination, and Demolition

As discussed in Section 5.2.8.1, LLNL has pursued removal of substandard space as part of a campaign to reduce the amount of active nonassignable space and optimize the use of existing space. The Proposed Action would include removal of an additional 456,456 gross square feet at the Livermore Site, and 109,333 additional gross square feet at Site 300. Although this rate would be higher than recent years, strict compliance with air district requirements to limit fugitive dust emissions, and continuing to employ standard measures to control pollution from D&D activities would limit the impact of these activities.

Support Personnel and Vehicular Activity

The Proposed Action requires a projected increase in workforce, adding 500 employees at the Livermore Site by the year 2014, and a corresponding increase in daily vehicular activities, primarily workers commuting to and from the site. Impacts of workforce commute on air quality would be lessened through transportation demand management. A large employment center holds more opportunities for alternatives to the single-employee commute. LLNL's transportation systems management program provides and promotes alternatives and environmentally responsible options for employee commuting. LLNL is committed to continuing this program.

The additional workforce would include some relocated employees new to the Bay Area air basin. Activities of the relocated population would contribute to air emissions associated with the commute to the workplace and secondarily from the additional energy consumption, other vehicular use, and goods and services that would be required to support the additional, relocated population. The jobs created under the Proposed Action at LLNL represent a small fraction (less than 1 percent) of the projected increase in employment within Alameda County over the 2000 to 2010 timeframe (Association of Bay Area Governments 2001). The air quality impact of this population growth would be on the same order as that of the growth rate, and this is well within the projections developed by the Association of Bay Area Governments, Metropolitan Transportation Commission and BAAQMD, and employed in the Clean Air Plan. Therefore, impacts are expected to be minimal.

Cumulative Impacts and Conformity

The parameters used to evaluate air quality impacts under the Proposed Action are listed in Table 5.3.8.1–1. Table 5.3.8.1–2 presents the calculated maximum carbon monoxide concentrations, which would remain within 20 to 30 percent of ambient standards. These levels do not differ appreciably from those under the No Action Alternative because the No Action Alternative and Proposed Action represent very minor contributors to the carbon monoxide concentration, which is dominated by current traffic levels and background sources.

Projected air pollutant emission rates associated with increased fuel combustion in boilers and engines, and increased vehicular activity associated with increased workforce under the Proposed Action are provided in Table 5.3.8.1–3. Total emissions are also provided in Table 5.3.8.1–3 for comparison with significance levels. As discussed in Section 5.1.8, annual and daily significant emission levels are established by local air districts in response to local air quality concerns. A project that generates criteria air pollutant emissions in excess of these levels would be considered to have a significant air quality impact and stringent mitigation would be required. By evaluating project emissions as a whole, including motor vehicle emissions, the air district has a greater level of control over a project, i.e., it is not limited to stationary source permitting.

Rules for conformity also consider total project emissions. These rules were established under the Federal *Clean Air Act* and pertain specifically to Federal actions. The underlying basis for the conformity demonstration is to preclude actions that would generate growth in air pollutants to a degree that is inconsistent with the local clean air plan, and thereby frustrate regional efforts to attain and maintain the ambient air quality standards. Within the Bay Area, conformity applies to projects that generate emissions of precursor organic compounds, oxides of nitrogen, or carbon monoxide in excess of 100 tons per year; such projects would be required to fully offset or mitigate the emissions caused by the action (BAAQMD 1999). A conformity review will be conducted and reported in the Final LLNL SW/SPEIS for projects at the central Livermore Site and Site 300 covered by the EIS.

Total emissions associated with the Proposed Action would be a small fraction of significance levels. Consequently, activities associated with the Proposed Action are not expected to result in an adverse impact to air resources.

The Proposed Action would also result in increased electrical use, which cumulatively contributes to greater demand and some additional air pollution. LLNL and DOE commitments to energy conservation, load management, and increased use of renewable energy sources (discussed in Appendix O, Section O.4.3) would help to offset this impact.

5.3.8.2 *Radiological Air Quality*

This section analyzes radiological air quality impacts under the Proposed Action due to normal releases from site operations such as R&D and waste management. Impacts in terms of dose related to the Livermore Site and Site 300 are discussed in this section.

Relationship with Site Operations

This section summarizes the relationship between projects described in Section 3.3 for the Proposed Action and radiological air quality. The dose resulting from exposure to routine air emissions from these projects is used to quantify the impacts. The incremental impact for the Proposed Action over the No Action Alternative would be due to additional tritium releases from Building 331 and additional fission products (most importantly, iodine-131) from the NIF. See Appendix M, Table M.5.3.8.4–1, for information on fission products.

Impact Analysis

Livermore Site

Building 331 annual tritium releases would remain 210 curies for the Proposed Action. The NIF releases of tritium, nitrogen-13, and argon-41, would remain the same as under the No Action Alternative, but additional fission products, including xenon, krypton and iodine isotopes, most importantly 0.93 curies per year of iodine-131, would also be released as a result of the NIF experiments.

The site-wide MEI location would be unchanged from the No Action Alternative, but the dose received from atmospheric emissions would be approximately 0.13 millirem per year, less than 1.5 percent of the NESHAP limit. Fifty-four percent of this dose would be from the NIF.

The population dose from the Proposed Action would be 1.8 person-rem per year, 84 percent of that from Building 331. The NIF would have relatively less affect on the population dose than on the site-wide MEI dose because many of the important nuclides released are short-lived and will decay prior to reaching the general population. The dose to the worker population would be 0.16 person-rem per year. No health impacts are expected to occur from exposure to normal radiological releases under this alternative (see Section 5.3.14.4).

Site 300

The releases from Site 300 would be the same for the Proposed Action as for the No Action Alternative. The site-wide MEI dose of 0.055 millirem per year, less than 0.6 percent of the NESHAP limit, and population dose of 9.8 person-rem per year and dose to worker population of 0.005 person-rem per year would therefore remain unchanged from the No Action Alternative.

No health impacts from radiological air releases are expected from the Proposed Action at Site 300 (see Section 5.3.14.4).

Cumulative Impacts

No adverse impacts on radiological air quality are expected under the Proposed Action. Other than background radiation sources, there are no other known contributors to concentrations of radionuclides in air within 50 miles of the Livermore Site or Site 300. Therefore, there would be no cumulative radiological air quality impacts.

5.3.9 Water

5.3.9.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.3 for the Proposed Action and the water impact analysis. The effect of projects for the Proposed Action on water resources is related to impervious surfaces and runoff from buildings, roads, and their associated site drainage measures, as well as increased use of potential contaminants resulting from construction and operation of projects under the Proposed Action.

5.3.9.2 *Impact Analysis*

Livermore Site

Surface Water

Surface water monitoring would continue under the Proposed Action in accordance with NNSA guidelines to ensure remediation of contamination already present and detection of hazardous materials in the future. Stormwater monitoring would continue in accordance with NPDES requirements.

Surface water resources could be degraded by contaminant releases during construction of some facilities under the Proposed Action. Contaminant sources could include construction materials; hydraulic fluid, oil, and diesel fuel; and releases from transportation or waste-handling accidents. LLNL stormwater pollution prevention plans have been devised to identify pollutant sources that could affect the quality of industrial stormwater discharges and to describe implementation practices to reduce pollutants in these discharges. In the event of a hazardous spill, necessary equipment to implement cleanup is available, and personnel are trained in proper response, containment, and cleanup of spills. Further guidance on response to hazardous material spills is provided in the ES&H Manual.

Compliance with an approved erosion and sedimentation control plan during construction would prevent impacts to surface water from construction-induced erosion.

The Livermore Site’s primary water source is the San Francisco Hetch Hetchy Aqueduct system. The secondary or emergency water source is the Alameda County Flood and Water Conservation District, Zone 7. Approximately 1.37 million gallons per day would be used at the Livermore Site under the Proposed Action, the same as under the No Action Alternative. At the Livermore

Site, water would be used primarily for industrial cooling processes, sanitary systems, and irrigation. Minor amounts of water would be used for drinking, manufacturing, washing, system filters, boilers, and a swimming pool.

Under the Proposed Action, the square footage of impervious surfaces at the Livermore Site, primarily roads and buildings, would be approximately 370,000 square feet greater than under the No Action Alternative. Impervious surface area would be 29 percent, a 2 percent increase from the No Action Alternative. An increase in surface runoff would occur because of increased impervious surface areas. However, because Livermore Site soils are relatively permeable and abundant uncovered acreage remains for groundwater recharge, the impact of the reduction in recharge surface area under the Proposed Action would be minimal.

Because no activities under the Proposed Action would occur within the 100-year floodplain, other than the Arroyo Las Positas Maintenance Project, which is covered under an Environmental Assessment (DOE/EA-1272) (DOE 1998b), a separate NEPA document, no impacts to the floodplain would be expected. None of the Proposed Action projects would contribute significant amounts of surface water runoff to cause substantial flooding because the 100-year base flood event would be contained within all channels. Due to the high infiltration rates and lack of appreciable floodplains on the Livermore Site, hydrologic impacts from the Proposed Action would be minimal. No facilities would be located in either the 100-year or 500-year floodplain; therefore, no impact from flooding would be expected.

Groundwater

Groundwater monitoring would continue under the Proposed Action to ensure that remediation of contamination already present continues to be effective and that contaminant fate and transport is fully understood. Groundwater quality should continue to improve because extracted groundwater would be collected and treated at the treatment facilities.

Groundwater resources could be degraded by contaminant releases during construction. Contaminant sources include construction materials, spills of oil and diesel fuel, and releases from transportation or waste-handling accidents. LLNL follows prevention and mitigation steps outlined in the spill response chapter of the ES&H Manual in the event of a hazardous material spill. Because the minimum depth to groundwater at the Livermore Site is approximately 50 feet and employees are trained in emergency spill response procedures, spills would likely be cleaned up before they reach the water table.

Impacts to groundwater from leaking underground storage tanks would not be expected since LLNL complies with all underground storage tank regulations.

Groundwater quality would continue to improve from ongoing remediation at treatment facilities. No negative impacts to groundwater are expected from operation because there would be no discharges to groundwater. Impacts to groundwater quality from surface water recharge would be minimal because LLNL would continue to comply with NPDES requirements.

Site 300

Surface Water

Stormwater monitoring would continue in accordance with NPDES requirements. Surface water resources could be degraded by contaminant releases during construction of new facilities. Contaminant sources could include construction materials, spills of oil and diesel fuel, and releases from transportation or waste-handling accidents. LLNL would follow mitigation steps outlined in the SPCC Plan in the event of a spill of petroleum products. Hazardous material spill response procedures are outlined in the ES&H Manual.

Compliance with an approved erosion and sedimentation control plan during construction would prevent impacts to surface water from construction-induced erosion.

Site 300's No Action Alternative water usage of 0.35 million gallons per day would continue under the Proposed Action.

Under the Proposed Action, developed space at Site 300 would be 80,000 square feet less than under the No Action Alternative, likely decreasing the amount of impervious surfaces. Less development would allow for increased surface area for groundwater recharge. Approximately 1 percent of Site 300 would be covered with impervious surfaces. Because Site 300 is largely undeveloped and contains permeable soils, there would be no noticeable impact to groundwater recharge.

Because no activities under the Proposed Action would occur within the 100-year floodplain, no impacts to the floodplain would be expected. None of the Proposed Action projects would contribute significant amounts of surface water runoff to cause substantial flooding because the 100-year base flood event would be contained within all channels. Due to the high infiltration rates and lack of appreciable floodplains at Site 300, hydrologic impacts from the Proposed Action would be minimal. However, due to the steep slopes, high runoff velocities within the channels could occur during a storm. No facilities would be located in these areas; therefore, no impact from flooding would be expected.

Groundwater

Although the eastern GSA offsite trichloroethylene plume has recently been restricted to Site 300, the plume had extended more than a mile down the Corral Hollow stream channel in the direction of the city of Tracy. Groundwater monitoring would continue under the Proposed Action to ensure that remediation of contamination already present continues to be effective and that contaminant fate and transport is fully understood. Groundwater quality should continue to improve because extracted groundwater would be collected and treated at the treatment facilities.

Groundwater resources could be degraded by contaminant releases during construction. Contaminant sources could include construction materials; spills of hydraulic fluid, oil, and diesel fuel; and releases from transportation or waste-handling accidents. LLNL follows prevention and mitigation steps outlined in the spill response chapter of the ES&H Manual in the event of a hazardous material spill. In all but one area where contamination activity could occur under the Proposed Action, depth to groundwater ranges from approximately 50 feet to more than 180 feet below ground surface. Because the minimum depth to groundwater at Site 300 is approximately 50 feet in areas where activity is expected under the Proposed Action and employees are trained in emergency spill response procedures, spills would likely be cleaned up before they reach the water table.

Impacts to groundwater from leaking underground storage tanks would not be expected since LLNL complies with all underground storage tank regulations.

Groundwater quality should continue to improve from ongoing remediation at treatment facilities. No negative impacts to groundwater are expected from operation because there would be no discharges to groundwater.

Groundwater use would continue as under the No Action Alternative, and no impacts to groundwater availability would be expected under the Proposed Action. If Site 300 gets its water supply from the Hetch Hetchy system as planned, groundwater would no longer be used as the primary water source for Site 300. In this case, more groundwater would be available for other users in the area, thus no impacts would be expected.

5.3.9.3 *Cumulative Impacts*

Livermore Site

The San Francisco Public Utilities Commission provides water to 2.4 million people in San Francisco, San Mateo, Santa Clara, and Alameda counties, including the Silicon Valley business district. To maintain a reliable water system, the San Francisco Public Utilities Commission initiated regional and local water projects in 2003 to upgrade and repair Hetch Hetchy system facilities. These projects will ensure stability in the case of a seismic event, sufficient water supply for an increasing population, and high-quality drinking water that meets all regulatory requirements. The improvements are scheduled to be completed by the year 2016.

San Francisco Bay Area water use is expected to increase by 64 million gallons per day by the year 2030. This is approximately a 25 percent increase over current water usage. Livermore is projected to use 1.37 million gallons per day under the Proposed Action. This is 0.4 percent of the projected total Hetch Hetchy water supply. Livermore currently uses 0.5 percent of the Hetch Hetchy water supply. Livermore's future contribution to the cumulative Hetch Hetchy water use would remain proportional to current use.

Because much of the land surrounding the Livermore Site is zoned for low-density activities, such as grazing, vineyards, and rural residential, and the large residential parcel to the west of the Livermore Site is basically fully developed (see Chapter 4, Figure 4.2.1.1–1), it is expected that most of the surrounding undeveloped land would not be converted to impervious surfaces in the future. Therefore, cumulative impacts on surface water quality and groundwater recharge from increases in impervious surfaces would be minimal.

With the exception of Livermore Site VOC plumes, no other known contaminant plumes exist in the surrounding area that could cause a cumulative degradation of groundwater quality. Sources of groundwater contamination in Livermore are described in Section 5.2.15.3. Groundwater quality at SNL/CA, located directly south of the Livermore Site, has improved through completion of remediation that began in 1984 on a 59,000-gallon diesel fuel spill. Similarly, groundwater quality should continue to improve in the Livermore Site vicinity with ongoing remediation at water treatment facilities.

Site 300

Site 300 currently receives water from onsite wells and should receive water from the Hetch Hetchy water supply system by early 2004. Water consumption rates have declined steadily since 1992, down to 25.3 million gallons per year in 2002. The new water system capacity is estimated to be 648,000 gallons per day, with the capacity expanding to 1.2 million gallons per day. Under the Proposed Action, Site 300 would use 0.1 percent of the Hetch Hetchy water supply. Given the low population and rural character of the area, an indiscernible increase in water use under the Proposed Action, and the eventual Hetch Hetchy supply, no cumulative impacts to water availability for Site 300 and the vicinity would be expected.

The land surrounding Site 300 is designated as general agricultural, recreational, conservational, and wind resource areas (see Figure 4.2.1.2–1). Most of this land is agricultural, however, property immediately east of the site is occupied by a company that packages and stores fireworks. The Carnegie State Vehicular Recreation Area, southwest of the site, is used for off-highway vehicles. Aside from the vehicular recreation area, which likely contributes to sediment runoff during rainstorms, the cumulative impact on surface water quality from activities in surrounding areas would be minimal. Because the area is largely undeveloped and expected to continue in that manner, no cumulative impacts to groundwater recharge would be expected.

Groundwater contamination at Site 300 has been restricted to within the site boundary and groundwater quality is improving through remediation activities. Because these plumes are the only known groundwater contamination in the Site 300 vicinity, no cumulative impacts to groundwater quality would be expected.

5.3.10 Noise

This section presents noise impacts resulting from implementation of the Proposed Action. The analysis is organized by noise-generating LLNL activities such as construction, modifications to and removal of facilities, traffic noise, and impulse noise.

5.3.10.1 *Relationship with Site Operations*

Activities associated with the Proposed Action (Section 3.3) would contribute to noise generation, either directly or indirectly. The general parameters that were used to characterize community noise levels under the Proposed Action are listed in Table 5.3.10.1–1.

5.3.10.2 *Impact Analysis*

The Proposed Action would be a continuation of current activities. There would be a number of new projects including facility upgrades, D&D activities, and new facility construction. The scope of activities under the Proposed Action would include all planned No Action Alternative activities, as well as several additional projects at both the Livermore Site and Site 300 and increased staffing requirements.

Modifications to Facilities or Operations

Noise generated during construction activities supporting facility and infrastructure renovations at the Livermore Site and Site 300 would not generally be noticeable in nearby communities, owing to the relatively large spatial area, perimeter buffer zone, and intervening roadways. However, because the Proposed Action would include a higher level of activity, about two to three times that planned under the No Action Alternative, there would be higher likelihood of a discernible impact in offsite areas. At most, during peak activity levels, a person located 100 feet from a noisy construction site would not be exposed to more than 82 dB(A) and for only limited periods of maximum activity. These levels are similar to the No Action Alternative, and no additional noise impacts are expected for the Proposed Action.

New facilities associated with the Proposed Action would be primarily offices and laboratories and would not introduce any machinery or equipment that would differ from the current HVAC equipment, cooling towers, motors, pumps, fans, generators, air compressors, and loudspeakers. Noise from this equipment would not be noticeable beyond the site boundary. No additional noise impacts are expected.

Livermore Site

At the Livermore Site, two near-fenceline construction projects, the Consolidated Security Facility and a Science and Education Lecture Hall near the West Gate, would have a higher likelihood of discernible impacts in areas offsite; however, even at their peak, these construction projects would not result in a community member being exposed to more than 82 dB(A) and that for only limited periods of maximum activity. These sources are not expected to be objectionable nor would they conflict with compatibility guidelines.

Site 300

Two construction projects would be included under the Proposed Action at Site 300. Construction activities would occur over a limited time and, other than construction-related vehicles accessing the site, would not result in a discernable impact to areas offsite.

Traffic Noise

The Proposed Action would result in a slight increase in heavy-duty vehicle activity at both the Livermore Site and Site 300, and a corresponding increase in the frequency of associated peak noise levels. Vehicles serving LLNL would be subject to requirements that they be properly muffled to reduce noise impacts, and activities would be limited to those times that would be less noticeable and less objectionable.

The Proposed Action would require a workforce increase, adding 500 employees at the Livermore Site by the year 2014, and a corresponding increase in vehicular activity. The additional traffic would add slightly to ambient noise levels, and would be a small increase from the No Action Alternative. To help alleviate this impact, LLNL would continue promoting and expanding its Transportation Systems Management Program to aid in providing viable alternatives to employee commuting, thereby reducing traffic congestion and noise (LLNL 2001s). Only incremental additions to the workforce, approximately 10 employees, would be required for Site 300; vehicular activity would be the same as under the No Action Alternative.

Impulse Noise

LLNL would continue explosives research testing under the Proposed Action at both the Livermore Site in the Building 191 High Explosive Application Facility, and at Site 300 within the Contained Firing Facility and on open firing tables. No additional noise impacts are expected. LLNL would continue to use blast forecasting as a tool to determine if explosive tests would adversely affect the surrounding community and to restrict operations when peak-impulse noise levels are predicted to exceed the 126-dB(A) level in populated areas. LLNL would also continue to perform meteorological monitoring to provide necessary input data for blast forecasting (LLNL 2001s). No additional noise impacts are expected.

Decommissioning, Decontamination, and Demolition

The Proposed Action would include the removal of 820,000 gross square feet of excess and legacy facilities. This is 456,456 square feet at the Livermore Site and 109,333 square feet at Site 300 greater than the No Action Alternative. Although this rate would be higher than that of recent years, with the relatively large spatial area and perimeter buffer zone, noise from demolition activities would not be discernible in offsite areas. No additional noise impacts are expected.

5.3.10.3 *Cumulative Impacts*

As stated, planned activities associated with the Proposed Action would include a projected increase in workforce, adding approximately 500 employees at the Livermore Site. Although the jobs that would be created under the Proposed Action represent a very small fraction (less than 1 percent) of the projected increase in employment within Alameda County and San Joaquin counties (described in Section 5.1.2), activities and services to support the relocated population would contribute to local noise levels, both short-term, in areas of increased construction activities, and long-term, associated with increased development, density of population and commercial activities, and vehicular traffic and congestion.

Local noise ordinances and restrictions on allowable noise levels, as stated in terms of land use compatibility guidelines for community noise environments (discussed in Section 4.12.1.2), would limit the impact of additional noise sources on the local community. The city of Livermore is currently working on several elements of its General Plan and may consider additional restrictions based on key findings related to noise (City of Livermore and LSA 2002). With Livermore's anticipated growth in the future, noise levels are expected to increase due to potential increases in Livermore's current key noise sources: construction activity, development, vehicular activity, and rail and aviation operations. Noise levels from potential mixed use and infill development in Livermore, especially in the downtown, could exceed noise level guidelines as a result of land use incompatibilities.

5.3.11 Traffic and Transportation

Traffic congestion and the collective dose and LCFs to the general population from radiological shipments were analyzed. The estimate of traffic congestion is based on the change in employment under the Proposed Action compared to the No Action Alternative. Radiological consequences were calculated using DOE transportation models as described in Section 5.1.11. Appendix J presents more information on the methodology and important inputs for radiological transportation analysis.

5.3.11.1 *Relationship with Site Operations*

Section 3.3 describes the projects under the Proposed Action. These projects, when combined with the No Action Alternative, would result in increased radiological transportation. The major shipments in the Proposed Action would result in 290 shipments of special nuclear material, 82 shipments of LLW and MLLW, 5 shipments of tritium, and 9 TRU waste shipments in the maximum year (see Appendix J, Section J.5.3 for more details).

5.3.11.2 *Impact Analysis*

Livermore Site

Under the Proposed Action, site employment would increase from the No Action Alternative of approximately 10,650 to 11,150 personnel. This increase would affect traffic near the Livermore Site. Although construction employment would rise and fall over the period of analysis for this LLNL SW/SPEIS, the average contractor employment level (including construction and operations contract employees) at the Livermore Site would not vary significantly from the current level. Any variations in construction employment for the Proposed Action would be small, compared to overall site employment, and temporary. Under the Proposed Action, offsite transportation of radioactive materials would increase from that under the No Action Alternative. The impacts of bounding radiological transportation accidents are described in Section 5.5.5. Chapter 4, Section 4.13, describes the existing traffic and transportation levels.

Operations traffic would be comprised of commuting workers and deliveries of materials needed for the operation of the facilities. The number of new Livermore Site workers under the Proposed Action would be approximately 500, representing a 5 percent increase in the Livermore Site workforce. This is a small fraction of the current traffic level near LLNL, as described in Section 4.13. Traffic in the Tri-Valley Area is heavily congested. Although LLNL traffic contributes to this congestion, its overall percent contribution is small, and the incremental contribution from the Proposed Action over the No Action Alternative would be negligible; very small impacts would be expected.

The increase in the site workforce could also affect the availability of parking spaces. Site planners working under the Parking Master Plan (LLNL 2002bv) would ensure that newly constructed facilities would have adequate parking for the facility's workforce.

Under the Proposed Action, shipments of radioactive materials would increase over the No Action Alternative because of the additional projects described in Section 3.2 that require radiological shipments. These would include nuclear material, tritium, LLW, MLLW, TRU waste (including Berkeley drums), and miscellaneous radioactive shipments (see Appendix J, Section J.5.3). Table 5.3.11.21 presents the collective dose under the Proposed Action. The number of LCFs for the Proposed Action would be much less than one (4×10^{-3}) per year.

TABLE 5.3.11.2–1.—*Collective Dose to the General Public From Radioactive Shipments Under the Proposed Action*

Shipment Type	Collective Dose (person-rem per year)			
	Along Route	**Sharing Route**	**At Stops**	**Total**
LLW	0.10	1.2	0.55	1.9
TRU waste	3.7×10^{-2}	0.45	.21	0.69
Materials[a]	0.20	2.3	1.1	3.7
Total	**0.34**	**4.0**	**1.9**	**6.2**
No Action Alternative	0.33	3.8	1.8	5.9

[a] Nonwaste radioactive materials, including special nuclear materials, tritium, and other materials used for the LLNL mission.
LLW = low-level waste; TRU = transuranic.

All radioactive materials would be shipped in certified containers and in accordance with U.S. Department of Transportation and DOE regulations. These regulations specify package integrity during normal transport and accident conditions, limit dose rate from the packages and vehicles, and specify special precautions for the more radioactive shipments, including operational procedures such as reduced speed limits, limited routes, special vehicle maintenance, and escort during transport.

Site 300

The Proposed Action would result in very small changes to the workforce at Site 300. Construction of the EMPC and the HEDC would create small and temporary increases in construction-related traffic. Site 300 does not engage in any significant transport of radioactive materials; however, explosives are often transported. Under the Proposed Action, the number of explosives shipments would not significantly increase from those under the No Action Alternative and very small incremental impacts are expected.

Operations traffic would comprise of commuting workers and deliveries of materials needed for the operation of the facilities. The number of new Site 300 workers under the Proposed Action would not be expected to increase over the No Action Alternative. Traffic in the Site 300 area is generally not heavy due to its rural location. Any incremental increase in traffic could be readily accommodated by the local road system and no impacts are expected.

5.3.11.3 *Cumulative Impacts*

Livermore Site

Traffic congestion in the Tri-Valley Area is very heavy and would likely increase due to growth in the area. Any increases in LLNL employment under the Proposed Action would, however small, contribute to this congestion. Because the contribution of the Proposed Action plus current LLNL traffic to the overall congestion problem would be small, detailed analysis of the cumulative impacts is not warranted. However, LLNL's contribution to radiological impacts near LLNL would not be a small percentage of overall radiological impacts. Therefore, this cumulative impacts analysis focuses on collective dose from radiological transportation. The analysis considers LLNL's radiological transportation cumulative with SNL/CA's radiological transportation.

A RADTRAN 5 analysis for 3.5 miles of highway near the Livermore area where all radiological shipments would converge were performed. The shipments were comprised of those in the Proposed Action (6.1×10^{-2} person-rem per year) and those from SNL/CA (1.2×10^{-3} person-rem per year). The resulting collective dose would be 6.2×10^{-2} person-rem per year, corresponding to 4×10^{-5} LCFs per year. Impacts are expected to be minimal. More information on the calculation is presented in Appendix J, Section J.7.

Site 300

Traffic between Corral Hollow Road and I-580, and along Tesla Road between the Livermore Site and Site 300, is strongly affected by Site 300 traffic during shift changes. Nevertheless, the Site 300 contribution would be small compared to the capacity of the roads. Local traffic could increase slightly over the years as pressures for residential and commercial development increase for land near Site 300. Residential areas are few and sparsely populated, although, a Tracy Hills residential development near the site has been planned for many years. Currently, the Carnegie State Vehicular Recreation Area along the southwest side of the site, across Corral Hollow Road, and private ranching operations are the only commercial operations near Site 300. Commuters on I-580 occasionally use Corral Hollow Road as an alternative route when I-580 is heavily congested. Any small increases in employment at Site 300 under the Proposed Action would have minimal impact on this overall traffic condition.

5.3.12 Utilities and Energy

This section discusses the potential impacts of the Proposed Action on utilities and energy supplies. Utility and energy usage are discussed separately for the Livermore Site and Site 300. LLNL-leased properties (i.e., Almond Avenue, Graham Court, Patterson Pass, and Arroyo Mocho Pump Station) are considered part of the Livermore Site in assessing utility and energy impacts.

5.3.12.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.3 for the Proposed Action and the utilities and energy analysis. In general, the effects of projects for the

Proposed Action on utilities and energy analyses are related to water consumption, sewer discharges, electricity consumption, and fuel consumption resulting from design, construction, and operation of projects.

As discussed in Section 5.1.12, the utilities and energy analysis is based on projected square footage requirements and available system capacities. Under the Proposed Action, total facility space at the Livermore Site would decrease approximately 1.0 percent from the projections under the No Action Alternative, and total facility space at Site 300 would remain the same as that projected under the No Action Alternative. A number of facility and utility system upgrades are also planned under the Proposed Action. The impact categories for the utilities and energy analysis are discussed in depth in the following sections.

5.3.12.2 Impact Analysis

Water Consumption

Livermore Site

Under the Proposed Action, the Livermore Site would experience a 1.0 percent decrease in facility space and a corresponding decrease in water consumption from the No Action Alternative. Annual water consumption at the Livermore Site is estimated to be approximately 276 million gallons per year under the No Action Alternative (see Section 5.2.12.3). Annual water consumption under the Proposed Action is projected to decrease to approximately 273 million gallons per year. Peak water use at the Livermore Site would be the same as under the No Action Alternative, approximately 1.37 million gallons per day. The existing capacity of the Livermore Site domestic water system is approximately 2.88 million gallons per day. Because the Livermore Site domestic water system has adequate capacity to meet future water demand under this alternative, impacts would be minimal.

Site 300

Site 300 is supplied with water from a system of wells. The existing capacity of usable wells is approximately 930,000 gallons per day. A project to connect Site 300 with water pumped from the city of San Francisco’s Hetch Hetchy water supply system is expected to be complete by early 2004. The capacity of this new water supply is estimated to be 648,000 gallons per day, with the capability of expanding to 1.2 million gallons per day (LLNL 2000a). Average water consumption at Site 300 is 67,900 million gallons per day (LLNL 2003aq). Under the Proposed Action, NNSA would demolish approximately 129,500 square feet of obsolete building space and replace it with an equal amount of modern building space. Therefore, the No Action Alternative water use at Site 300 is considered to be representative of future consumption rates for the Proposed Action. No new impacts are expected.

Sewer Discharges

Livermore Site

An increase in the volume of sewage discharges would result from implementation of the Proposed Action at the Livermore Site. The Livermore Site would discharge approximately 224,000 gallons of sewage per day under the No Action Alternative (See Section 5.1.12.3). Under the Proposed Action, sewage production would decrease by 1.0 percent to approximately 222,000 gallons per day. The LWRP currently receives a total of approximately 6.5 million gallons of effluent per day. The capacity of this facility is 8.5 million gallons of effluent per day, which is expected to be sufficient for inflow treatment for the next 10 years. Impacts from this increase in sewer discharges from the Livermore Site would be minimal.

Site 300

Site 300 sanitary sewage generated outside the GSA is disposed of through septic tanks and leachfields or cesspools at individual building locations. Sanitary sewage generated within the GSA is piped into an asphalt membrane-lined oxidation pond east of the GSA.

Under the No Action Alternative, Site 300 discharges approximately 2,100 gallons of sewage per day. Under the Proposed Action, NNSA would demolish approximately 129,500 square feet of obsolete building space and replace it with an equal amount of modern building space. Therefore, the No Action Alternative sewage discharge rates at Site 300 are considered to be representative of future consumption rates for the Proposed Action. No offsite sewage treatment is conducted for Site 300 wastes, therefore no impacts are expected.

Electricity Consumption

Livermore Site

The projected peak electrical demand under the Proposed Action would be 81 megawatts. The current system capacity is 125 megawatts. Growth at the Livermore Site would result in increased electricity consumption. This would have an impact on electrical power supply and distribution systems. The Livermore Site would consume approximately 446 million kilowatt-hours per year under the No Action Alternative. Under the Proposed Action, electric power consumption is expected to decrease by 1.0 percent to approximately 442 million kilowatt-hours per year. The LLNL distribution system and existing capacity for the utilities to supply energy on both a total and a peak load basis would adequately meet the projected increase in consumption, but may limit future development at the site.

Site 300

Electricity consumption at Site 300 decreased from an average of 21.75 million kilowatt-hours per year in 1992 to approximately 16.3 million kilowatt-hours per year (LLNL 2003aq). Electricity consumption at Site 300 has remained stable over the past 5 years.

Under the Proposed Action, NNSA would demolish approximately 129,500 square feet of obsolete building space and replace it with an equal amount of modern building space. Therefore, No Action Alternative electrical power consumption at Site 300 is considered to be representative of future consumption rates for the Proposed Action. No new impacts are expected.

Fuel Consumption

Livermore Site

PG&E supplies natural gas to the Livermore Site. Natural gas consumption for the Livermore Site would average 23,300 therms per day under the No Action Alternative. Based on the projected increase in gross square footage of developed space at the Livermore Site, fuel consumption under the Proposed Action would decrease by 1.0 percent to approximately 23,000 therms natural gas per day. This would result in minimal impact upon supply.

There is no planned change in diesel fuel or unleaded gasoline use for the Proposed Action. Consumption of approximately 72,200 gallons diesel fuel per year and 451,800 gallons unleaded gasoline per year is anticipated.

Site 300

Under the No Action Alternative, Site 300 fuel oil consumption is approximately 16,600 gallons per year (LLNL 2003aq). Under the Proposed Action, NNSA would demolish approximately 129,500 square feet of obsolete building space and replace it with an equal amount of modern building space. Therefore, fuel oil consumption under the No Action Alternative is considered to be representative of future consumption rates for the Proposed Action.

5.3.12.3 *Cumulative Impacts*

Water Consumption

Livermore Site

The Proposed Action together with other developments in the Hetch Hetchy service area would increase demand for and consumption of water. For example, the population in Alameda County is projected to increase by about 17 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other uses in Alameda County are expected to increase proportionally. Other counties in the Hetch Hetchy service area would experience similar growth. This population growth in the Hetch Hetchy service area in conjunction with water use at the Livermore Site would constitute a cumulative impact upon water resources and supply systems.

Site 300

Current water use at Site 300 is considered to be representative of future consumption rates for the Proposed Action. However, development in the vicinity of Site 300 would increase demand for and consumption of water. Population in San Joaquin County is projected to increase by 30 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other water demands in San Joaquin County are expected to increase proportionally. This population growth would constitute an adverse cumulative impact on groundwater resources. Similarly, population growth within the Hetch Hetchy service area in conjunction with water use at Site 300 would constitute an impact upon water resources in the Hetch Hetchy service area.

Sewer Discharges

Livermore Site

The Proposed Action together with other developments in the area would increase demand for sewage services. Population in Alameda County is projected to increase by about 17 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other uses in Alameda County are expected to increase proportionally. This growth in conjunction with sewer discharges from the Livermore Site would constitute a cumulative impact on sewage systems in the area. The LWRP currently receives approximately 6.5 million gallons of effluent per day. While existing LWRP capacity of 8.5 million gallons per day is expected to be sufficient for inflow treatment for the next 10 years, sewage treatment facility improvements are being planned in the region.

Site 300

Because Site 300 sewer discharge and treatment programs are mostly self-contained, no cumulative impact is expected as a result of the Proposed Action.

Electricity Consumption

Livermore Site

The projected peak electrical demand under the Proposed Action would be 81 megawatts. The Proposed Action together with other developments in the area would increase electric power demand. Population in Alameda County is projected to increase by about 17 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other uses in Alameda County are expected to increase proportionally. This growth in conjunction with the demand for electrical power at the Livermore Site could constitute a cumulative impact on electric power resources in the area. Currently, electric utilities provide approximately 10,605 million kilowatt-hours per year of electricity to Alameda County (CEC 2001). However, more than 10,000 megawatts of new electric generation capacity is planned in the PG&E service area, which includes Alameda County. Additional generating capacity is planned throughout California and surrounding states (CEC 2000). Expanded electric transmission capability is also planned in the region. If implemented as planned, these additions would provide sufficient capacity to meet Alameda County electrical energy needs for the next 10 years. Therefore, any impact would be mitigated.

Site 300

Current electric power consumption at Site 300 is considered to be representative of future consumption rates for the Proposed Action. However, the population in San Joaquin County is projected to increase by 30 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other electric power uses in San Joaquin County are expected to increase proportionally. This growth could constitute a cumulative impact on electric power resources in the area. Currently, electric utilities provide approximately 5,106 million kilowatt-hours per year of electricity to San Joaquin County (CEC 2001). However, more than 10,000 megawatts of new electric generation capacity is planned in the PG&E service area, which includes San Joaquin County. Additional generating capacity is planned throughout California and surrounding states (CEC 2000). Expanded electric transmission capability is also planned in the region. If implemented as planned, these additions would provide sufficient capacity to meet San Joaquin County electrical energy needs for the next 10 years. Therefore, any impacts would be mitigated.

Fuel Consumption

Livermore Site

The Proposed Action together with other developments in the PG&E service area would increase the demand for natural gas. Population in Alameda County is projected to increase by about 17 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other uses in Alameda County are expected to increase proportionally. This growth could constitute a cumulative impact on fuel supply systems. However, PG&E's transmission capacity is approximately 130 percent of the demand for natural gas in its service area (CPUC 2001). As required by the California Public Utilities Commission, PG&E uses a 15-year planning horizon for gas transmission and storage capacity and a 10-year planning horizon for local gas distribution systems. Accordingly, PG&E plans to provide sufficient capacity to meet Alameda County needs for the next 10 years. Diesel fuel and unleaded gasoline delivery systems in Alameda County are adequate and sufficient to meet fuel requirements for the next 10 years. Therefore, any impacts would be mitigated.

Site 300

Current fuel oil consumption at Site 300 is considered to be representative of future consumption rates for the Proposed Action. However, the population in San Joaquin County is projected to increase by 30 percent by the year 2015 (DOF 2001). Fuel oil use in San Joaquin County is expected to increase as the population increases, but at a lower rate. This growth could constitute a cumulative impact on fuel oil supplies in the county. Overall fuel oil use in California has declined substantially as air quality regulations concerning greenhouse gas emissions become more stringent. Consequently, fuel oil delivery systems within San Joaquin County have large amounts of excess capacity sufficient to meet San Joaquin County requirements for the next 10 years. Therefore, any impacts would be mitigated.

5.3.13 Materials and Waste Management

5.3.13.1 *Materials Management*

This section provides an overview of management responsibilities regarding receipt, transfer, and shipment of radioactive, controlled, and hazardous materials at LLNL under the Proposed Action. Appendices A, B, D, M, and N of this LLNL SW/SPEIS include descriptions of programs and buildings associated with use of these materials. The use of these materials historically has resulted in their planned and inadvertent releases to the environment.

The consequences of using radioactive, controlled, and hazardous materials are discussed in the sections associated with the affected media. For example, releases to the air associated with use of radioactive materials are discussed in Section 5.3.9, and releases affecting vegetation are discussed in Section 5.3.8. The workplace use of these materials and associated occupational exposures are discussed in Section 5.3.14.

Relationship with Site Operations

Several new operations are currently in the planning stages at LLNL. However, they were considered outside of the scope of the existing conditions for this LLNL SW/SPEIS because they had not yet reached operational status. New operations are defined as programmatically planned projects with implementation schedules that will take place in the future (e.g., the NIF). In general, material usage at LLNL would increase, consistent with a 7 percent increase in LLNL operations above the No Action Alternative.

Under all conditions, existing waste minimization and pollution prevention techniques would be expected to offset a portion of the projected increase. Average maximum quantities would likely remain constant as material storage space remains constant; however, average quantities would be expected to increase to meet demand. Under the Proposed Action, material projections used for analysis would not exceed existing material management capacities.

Impact Analysis

The Proposed Action would not cause any major changes in the types of materials used onsite. Material usage at LLNL would increase, consistent with a 7 percent increase in laboratory operations above the No Action Alternative. However, existing waste minimization and pollution prevention techniques would offset a portion of the projected increase. Average maximum quantities would likely remain constant as material storage space remains constant; however, average quantities would be expected to increase to meet demand. Under the Proposed Action, material projections used for analysis would not exceed existing material management capacities.

Existing Operations

The Proposed Action total hazardous material usage would increase for existing facilities. Under the Proposed Action, average quantities would increase by an estimated 7 percent (Table 5.3.13.1–1) above the No Action Alternative. Annually, approximately 183,000 to 204,000 chemical containers, ranging from 210-liter (55-gallon) drums to gram-quantity vials, would be used or stored at LLNL.

Annually, for the Livermore Site, approximately 75,000 gallons of liquids would be managed under the Proposed Action with an estimated storage capacity of 227,000 gallons. Approximately 1.5 million pounds of solids would be handled with a storage capacity of 2.4 million pounds. Solid material storage would not be expected to fluctuate because metals (e.g., lead used for shielding) would be less likely to be consumed and more likely to be reused and reclaimed. Regardless, there would be sufficient capacity to accommodate anticipated operations. Approximately 1.2 million cubic feet of mostly industrial gases (argon, helium, hydrogen, oxygen, nitrogen) would be used annually with a storage capacity 71.6 million cubic feet.

Technology Program operations (Table 5.3.13.1–3). New LLNL operations would account for approximately 70,000 gallons of liquids and solids and approximately 20,000 standard cubic feet of industrial gases). Materials that would be expected to support other projects, including the new Office of Science Laboratories and typical D&D projects, are described in Tables 5.3.13.1–3 and 5.3.13.1–4. For new facilities, no impacts would be expected because each of the new facilities would be designed to handle expected quantities.

TABLE 5.3.13.1–3.—*Types of Hazardous Materials in Use with New Operations Under the Proposed Action*

Project Title	Hazardous Materials Expected
Increased Admin limits for plutonium in Superblock	Plutonium limits increased.
Integrated Technology Program	See Appendix N
Energetic Materials Processing Center	Explosives, other explosive materials, solvents, acids, bases, other chemicals. Project replaces existing operations at Site 300 (see general information in Table 5.3.13.1.2–2)
Increase in Tritium Facility material limits	Tritium increases
Materials Science modernization project	Materials would be similar to those at existing Materials Science facilities
High Explosives Development Center	Explosives, other explosive materials, solvents, acids, bases, other chemicals. Project replaces some existing operations at Site 300 (see general information in Table 5.3.13.1.2–2)
Berkeley waste drums	No materials associated with this project
Increased worker population	Included in Table 5.3.13.1.2–1
Use of court-ordered materials at NIF	Plutonium targets and other materials (See Appendix M)
Petawatt laser prototype	No new materials
Building 696 Mixed Waste Permit	Limited materials, primary function would be waste management
Deactivation and D&D projects	Limited materials, primary function would be D&D
Increase MAR for Superblock	No new materials; only MAR increase
NIF Neutron Spectrometer	No new materials
CBNP expansion	Small samples og RG-1 and RG-2 nonselect biological agents
Consolidated Security Facility	No new materials
Waste management	Waste management activities only
Building 625 waste storage	Waste management activities only
Direct shipment of TRU from plutonium facility	Waste management activities only
Building utilities upgrade	No new materials
Building seismic upgrades	No new materials

Source: TtNUS 2003.
CBNP = Chemical and Biological National Security; D&D = decontamination and decommissioning; MAR = material-at-risk; NIF = National Ignition Facility; TRU = transuranic.

TABLE 5.3.13.1–4.—*Listing of Materials for Use with Decontamination and Decommissioning, Construction, Upgrades, and Other Improvements Under the Proposed Action*[a, b, c]

Material Usage Description
Acoustical ceiling, acoustical insulation, acrylic, additives, adhesives, asphalt, bonding agent, carpet and padding, caulking, ceramic, cleaners, concrete, coolants, fillers, glazing, glues, gypsum wallboard, insulating paints, insulation, joint compounds, latex, metal ceiling, oils, paints, pipes, primer, putties, quarry and conductive tile, reducers, roofing materials, sealants, sealer, soil, solder, solvents, spackling, sprayed fireproofing, structural metals, tile grout, tubes, wallpaper supplies, waterproofing, wiring, and wood finishing.

Source: TtNUS 2003.
[a] Examples of D&D projects include Buildings 808, 412, 175N, 212, 251, 419, 171.
[b] Examples of construction projects include Office of Science Lab, EMPC, and other new buildings listed in Table 5.3.13.1—3.
[c] Examples of Upgrades include building utilities, seismic, site utilities upgrades.
D&D = decontamination and decommissioning; EMPC = Energetic Material Processing Center.

Along with the projects identified under the No Action Alternative (see Section 5.2.13.1), the Proposed Action would include four construction projects, nine D&D projects, five miscellaneous projects, six renovation/modernization/consolidation projects, and six new operations (see Appendices A and B for additional details). Site material usage would increase because of the new operations. Overall radioactive materials and explosive materials, based on current administrative limits, would increase. Under the Proposed Action, radioactive material and explosive material requirements used for analysis would not exceed material management capacities.

Cumulative Impacts

The ROI for materials management involves LLNL and its facilities as presented in Chapter 4 of this LLNL SW/SPEIS. The ROI for cumulative impacts is larger than that presented in Chapter 4 and considers the contributions of LLNL (Livermore Site and Site 300), SNL/CA, NNSA, local projects and activities, and the State of California. Where appropriate, qualitative information has been provided in tabular form.

Livermore Site

Under the Proposed Action, approximately 183,000 to 204,000 chemical containers, ranging from 210-liter (55-gallon) drums to gram-quantity vials, would be used or stored at LLNL annually. For the Livermore Site, approximately 75,000 gallons of liquids would be managed with an estimated storage capacity of 227,000 gallons (remaining capacity of 67 percent) annually. Approximately 1.5 million pounds of solids would be handled with a storage capacity of 2.4 million pounds (remaining capacity of 38 percent). Solid material storage would not be expected to fluctuate because metals (e.g., lead used for shielding) would less likely be consumed and more likely be reused and reclaimed. Regardless, there would be sufficient capacity to accommodate anticipated operations. Approximately 1.2 million cubic feet of mostly industrial gases (argon, helium, hydrogen, oxygen, nitrogen) would be used annually with a storage capacity of 71.6 million cubic feet. Table 5.3.13.1–5 lists some commonly used chemicals at LLNL.

TABLE 5.3.13.1–5.—*Commonly Used Chemicals at Lawrence Livermore National Laboratory*[a]

Hazardous material	Quantity in Pounds
Paints (varies assumed 1-2% glycol ethers)	8,000
Sulfuric acid	5,016
Hydrochloric acid	3,500
Toluene	3,500
Methanol	700

Source: TtNUS 2003.
[a] The commonly used chemicals listed above were derived during comparisons of chemicals reported in LLNL, EPA, and DOE databases.

LLNL uses explosives in various R&D and test applications. Explosive quantities used per activity range from milligrams to several kilograms. Overall, the quantities of explosive material maintained onsite are restricted by the approved explosive capacity of various storage areas. No increases in storage capacity were projected.

Sandia National Laboratories/California

SNL/CA maintains a small inventory of radioactive materials used in laboratory and radiation monitoring activities. All radioactive material used by SNL/CA is obtained from offsite sources. Individual sources at SNL/CA generally have small quantities of radioactive material and most are sealed. Radioactive material inventories are maintained at mission-essential levels, and all attempts are made to reduce inventories of surplus legacy material. No increases in radioactive material would be expected since most radioactive sources are sealed and not consumed (NNSA 2003a).

Like LLNL, SNL/CA uses a wide variety of chemicals in small-scale laboratory operations. Using the Maximum Operations Alternative from the January 2003 *Final Site-Wide Environmental Assessment of SNL/CA Environmental Information Document* and projecting a 53 percent increase in operations, more than 12,000 different chemicals would be in use or stored at SNL/CA at any given time in more than 52,000 different containers.

SNL/CA uses explosives in various R&D and test applications. Explosive quantities used per activity range from milligrams to several kilograms. Overall, the quantities of explosive material maintained onsite are restricted by the approved explosive capacity of various storage areas. No increases in storage capacity were projected.

California (including Alameda and San Joaquin Counties)

Annually, over 340 million tons of hazardous materials are used in California. The U.S. EPA online Toxics Release Inventory (TRI) database was queried for specific materials (indirectly related to release) in California. The data extracted are presented in Table 5.3.13.1–6. In 2000, over 178 hazardous materials totaling 77.5 million pounds were managed.

TABLE 5.3.13.1–6.—*Toxics Release Inventory Database*

Hazardous Material	Quantity in Pounds
Top Five	
Asbestos (friable)	8,312,561
Aluminum oxide (fibrous forms)	4,257,079
Lead compounds	4,479,859
Zinc compounds	4,042,183
Methanol	3,905,599
Other Chemicals	
Glycol ethers	3,184,791
Hydrochloric acid	1,085,636
Sulfuric acid	853,968
Xylenes	616,644
Total of over 178 materials	77.5 million pounds

Source: TtNUS 2003.
Note: In Alameda County, 59 materials totaling 3.76 million pounds were released. In San Joaquin County, 46 chemicals totaled 1.5 million pounds.

National Nuclear Security Administration

NNSA maintains large inventories of radioactive materials in a variety of forms such as used fuels, source material, components, and laboratory and radiation monitoring equipment. Surplus weapons-grade plutonium inventories were estimated at 40 metric tons; surplus highly enriched uranium totaled approximately 180 metric tons. Accident analysis associated with NNSA tritium supply considered approximately 40 million curies source term. NNSA maintains large inventories of other radioactive materials including depleted uranium, natural uranium, and thorium. Radioactive material inventories are maintained at mission-essential levels and all attempts are made to reduce inventories of surplus legacy material.

Over 6 million tons of hazardous materials are managed by DOE. To estimate the amount of use (indirectly related to released) by DOE (NNSA was not an agency during the most recently available report), the U.S. EPA online TRI database was queried. The data extracted are presented in Table 5.3.13.1–7. DOE released 750,000 pounds of hazardous materials in 2000.

TABLE 5.3.13.1–7.—*Top Five Hazardous Materials and Other Chemicals of Interest Releases by DOE Based on the Environmental Protection Agency's Toxics Release Inventory Database*

Hazardous Material	Quantity in Pounds
Top Five Chemicals	
Hydrochloric acid	170,000
Zinc compounds	170,000
Nitrate compounds	92,000
Sulfuric acid	72,000
Methanol	59,000
Other Chemicals of Interest	
Xylenes	17,000
Toluene	13,000

Source: TtNUS 2003.

All States

In the U.S., over 3 billion tons of hazardous materials are used annually. In 2001, U.S. explosives production was 2.38 million metric tons, 7 percent less than that in 2000; sales of explosives were reported in all states. Coal mining, with 69 percent of total consumption, continued to be the dominant use for explosives in the U.S. Kentucky, West Virginia, Indiana, Wyoming, and Virginia, in descending order, were the largest consuming states, with a combined total of 46 percent of U.S. sales.

Cumulative Impacts

In general, LLNL manages less than 1 percent of hazardous material used in California. For example, LLNL uses 0.35 percent of the hydrochloric acid used in California. Similarly, LLNL uses 0.59 percent of sulfuric acid. Overall, LLNL hazardous material use would not result in critical shortages or other cumulative impacts.

5.3.13.2 *Waste Management*

This section provides an overview of management responsibilities for generation, storage, treatment, and disposal of radioactive, hazardous, mixed, and other wastes, including biohazardous and D&D wastes at LLNL under the Proposed Action. Appendices B, M, and N include a description of wastes and facilities associated with the use, generation, and analyses of these wastes.

Relationship with Site Operations

In general, waste generation increases proportionately from the No Action Alternative to the Proposed Action.

Waste minimization and pollution prevention techniques would offset a portion of the projected increases. Under the Proposed Action, waste generation projections used for analysis would not exceed existing waste management capacities.

Impact Analysis

Implementation of the Proposed Action would not cause any major changes in the types of waste streams generated onsite. No additional waste storage, treatment, handling capacity, regulatory requirements, or security requirements would be needed. Although increasing over current conditions, waste generation levels over the next 10 years at LLNL would remain essentially consistent with recent generation quantities experienced during 1993 to 2002. Annually, any increase would be consistent with increases from new operations and normal fluctuations as previously noted. Waste minimization and pollution prevention techniques would be expected to offset a portion of the projected increases. Between 1993 and 2002, overall (routine and nonroutine) TRU waste, LLW, MLLW, and hazardous waste generation, as reported by DOE, were reduced by 91, 57, 89, and 57 percent, respectively (DOE 2002s). Onsite waste handling capacities are four to five times the expected waste volumes. Waste projections used for analysis would not exceed existing offsite waste management disposal capacities. Wastes associated with existing operations, new operations, and special operations are presented below, including other wastes.

The Proposed Action would include all new operations, D&D projects, and other activities, including permit modifications and RCRA closures, identified in the No Action Alternative. See Section 5.2.13.2 for a list of activities under the No Action Alternative. The Proposed Action differs from the No Action Alternative in:

- Generation of routine waste quantities presented in Table 5.3.13.2–1
- Generation of nonroutine waste quantities presented in Table 5.3.13.2–1
- Generation of wastes associated with new operations presented in Table 5.3.13.2–2
- Additional permit modifications as discussed below

Existing Operations

For projection purposes, the CY1993 to CY2002 routine waste generation data were considered a reasonable range for existing facilities (existing operations); an average of these years was used. The amount of waste generated from existing operations would reflect proportional increases in LLNL activity levels. A margin (standard deviation) was added to differentiate the Proposed Action, account for normal fluctuations experienced since 1992, and bound any operational increases. The waste quantities projected represent a site-wide (Livermore Site and Site 300) aggregate of quantities for each type of waste category. Table 5.3.13.2–1 presents existing operations that are included in the estimated annual (routine) waste generation quantities by waste category. Current waste management infrastructure is adequate to manage this waste.

TABLE 5.3.13.2–1.—*Routine and Nonroutine Operations Waste Generation Quantities Under the Proposed Action and No Action Alternative*

	Annual Quantities			
	No Action [a]		Proposed Action [b]	
Waste Type	**Routine**	**Nonroutine**	**Routine**	**Nonroutine**
LLW	200 m^3/yr	630 m^3/yr	340 m^3/yr	710 m^3/yr
MLLW	61 m^3/yr	72 m^3/yr	88 m^3/yr	81 m^3/yr
Total Hazardous[c]	390 metric tons	1,500 metric tons	510 metric tons	1,700 metric tons
TRU	50 m^3/yr	55 m^3/yr	60 m^3/yr	10 m^3/yr
Mixed TRU	1.7 m^3/yr	0	2.8 m^3/yr	0
Sanitary solid	4,800 metric tons	Included in Routine	5,100 metric tons	Included in Routine
Wastewater	310,000 gal/day	Included in Routine	330,000 gal/day	Included in Routine

Source: TtNUS 2003.

[a] For nonroutine wastes based on average quantities since 1992 and one standard deviation, expected increase in activity levels, and new operations contributions. No margin was added for nonroutine.

[b] Based on average quantities since 1992 and one standard deviation, expected increase in activity levels (approximately 5 percent), and new operations contributions.

[c] Total Hazardous includes RCRA hazardous, State-Regulated, and TSCA.

gal/day = gallons per day; m^3/yr = cubic meters per year; LLW = low-level waste; MLLW = mixed low-level waste; RCRA = *Resource Conservation and Recovery Act*; TRU = transuranic; TSCA = *Toxic Substance Control Act*.

New Operations

New operations (including project-specific information) wastes would be derived from mission-related work. The waste quantities projected represent a site-wide aggregate of quantities for each type of waste category and are included in routine projections included in Table 5.3.13.2–1. Table 5.3.13.2–2 presents qualitative and quantitative waste information for each new operation. Existing waste management infrastructure can accommodate the predicted waste quantities.

Special (Nonroutine) Operations

Special (nonroutine) operations wastes are a result of special, limited duration projects such as construction that are considered separate from facility operations. Special, limited duration wastes include those generated from construction, demolition, D&D activities, and environmental restoration. The amount of waste generated would reflect proportional increases in LLNL activity levels for the foreseeable future. The waste quantities projected represent a site-wide aggregate of quantities for each type of waste category and are included in Table 5.3.13.2–1. Table 5.3.13.2–2 presents additional qualitative and quantitative waste information for each D&D and construction project.

All Other Wastes

LLNL operations involve the five additional waste management activity areas discussed below.

Biohazardous (includes Medical Waste Management Act*) Waste*

In 2002, several hundred pounds of medical wastes were disposed of at an approved offsite facility. Under the Proposed Action, biohazardous waste generation would increase by 7 percent. The existing waste handling capabilities would be adequate to accommodate this waste. No offsite impacts would occur because offsite disposal capacity would continue to be sufficient.

Construction and Decontamination and Decommissioning Waste

To bound impacts, this analysis assumed the construction of 100,000 to 200,000 square feet of new facilities, including specific projects listed in Table 5.3.13.2–2. This would generate 200 to 400 metric tons of construction debris. Approximately two-thirds of wood, concrete, asphalt, soil, metal, and cardboard would be diverted for recycling or reuse (LLNL 2002cc). The existing waste handling capabilities would be adequate to accommodate this waste. No additional offsite impacts would occur because offsite disposal capacity would continue to be sufficient.

With approximately 820,000 square feet of excess facilities to bound impacts, this analysis assumed the removal of all excess facilities. This would generate approximately 4,920 metric tons of debris (600 metric tons per 100,000 square feet). Only 350 metric tons would be of the LLW, MLLW, and hazardous waste variety (Bisanni 2003). Approximately two-thirds of the debris total would be diverted, recycled, or reclaimed (LLNL 2002cc). The existing waste handling capabilities would be adequate to accommodate the remaining waste. No new offsite impacts would occur because offsite disposal capacity would continue to be sufficient.

Environmental Restoration Waste

Site-wide environmental restoration waste generation trends at LLNL would generally remain a function of treatment units, the number of wells, and the number of hours of operation. Existing waste handling capabilities are already in place.

Explosive Wastes

The Explosives Waste Treatment Facility would handle 2,800 to 3,000 pounds per year of explosive wastes. Explosives Waste Storage Facility would store (gross) 6,000 to 7,200 pounds per year. This represents a 7 percent increase over No Action. No additional capacity would be required.

Wastewater

Wastewater would increase to approximately 330,000 gallons per day. The current capacity of 1.69 million gallons per day (or 80 percent remaining capacity) would be adequate to accommodate this waste. Offsite disposal capacity would continue to be sufficient.

Permit Modifications, RCRA Closures, Permit Renewal, and Other Planned Activities

The Proposed Action includes all permit modifications, RCRA Closures, and a permit renewal identified in the No Action Alternative (see Section 5.2.13.2 for a list of activities under the No Action Alternative). The Proposed Action differs from the No Action Alternative in that it includes:

- Submit 100 Class 1 permit modification requests (may include more than one item per submittal) over the next 10 years (see Appendix B for details).
- Submit approximately 10 to 20 Class 2 permit modification requests (may include more than one item per submittal) over the next 10 years (see Appendix B for details).
- Submit approximately 1 to 2 Class 3 permit modifications over the next 10 years (see Appendix B for details).
- Obtain RCRA Part B permit for Building 696 operations.
- Relocate a 3,000-cubic-foot-liquid storage capacity at Building 696.
- Begin storage of hazardous and mixed wastes in Building 696.

These changes would enhance existing operations and would likely result in beneficial environmental impacts through improved technology and efficiency.

Cumulative Impacts

The ROI for waste management involves LLNL and its facilities as presented in Chapter 4 of this LLNL SW/SPEIS. The ROI for cumulative impacts is larger than that presented in Chapter 4 and considers the contributions of LLNL (Livermore Site and Site 300), SNL/CA, NNSA, local projects and activities, and the State of California.

The waste generation impact of the Proposed Action would be larger than impacts of FY2002 operations, but still generally small, as compared to DOE/NNSA operations nationally or total wastes in California annually. For radioactive waste, LLNL would generate 99 percent of NNSA operations locally (or 1,700 cubic meters) and approximately 4 percent of DOE/NNSA operations nationally (or 40,000 cubic meters per year). SNL/CA would generate 10 cubic meters of LLW per year and 118 tons of hazardous waste per year. For hazardous waste, LLNL generation (1,365 metric tons) would only be 0.31 percent of total generation within California (427,302 tons hazardous waste). For municipal solid waste, the U.S. EPA determined that California has more than 10 years of remaining landfill capacity. NNSA recognizes landfill space can have a cumulative impact; however, land disposal would not result in critical shortages.

5.3.14 Human Health and Safety

5.3.14.1 *Nonradiological Health Impacts*

Operations at LLNL involve a wide range of activities with the potential for exposures of involved and noninvolved workers and the public to hazardous materials or conditions. These hazards include non-ionizing radiation, chemicals, biological agents, and industrial hazards. Evaluation of occupational protection issues considered existing ES&H programs that specifically address worker and general population protection measures implemented to control, reduce, or eliminate operational hazards. Hazardous chemicals to which involved and noninvolved workers could potentially be exposed, under the Proposed Action at the Livermore Site and Site 300, are listed in Table 5.3.13.1–1 and Table 5.3.13.1–2, respectively.

Relationship with Site Operations

Section 3.3 describes projects under the Proposed Action, that when combined with the No Action Alternative and current operations would result in a moderate increase in chemical inventories. There would also be an increase in construction and demolition activities associated with site facility expansion and renovation due to new missions and facility demolition and removal activities. These activities represent an increase in potential injuries associated with construction safety hazards.

Impact Analysis

The Proposed Action would not cause any major changes in the types of occupational, toxic, or physical hazards encountered by site personnel. Material usage at LLNL would increase. For purposes of this LLNL SW/SPEIS, it was assumed that the net percentage increase in laboratory operations would be accompanied by an increase in the amounts of hazardous substances used and stored onsite. However, as the mix of site missions shifts from chemical to mechanical and technological processes (i.e., computer modeling, computational research, etc.), the proportional increase in chemical inventories associated with new operations would be lessened.

Overall site usage of toxic substances and physical hazards would increase under the Proposed Action as activity levels increase at existing facilities and as new facilities are constructed and begin operation. However, this would not represent an adverse impact. Under the Proposed Action, the use of additional quantities of chemicals would result in a slight increase in worker exposures. Facility improvements and additions would result in improved control measures for handling hazardous chemicals and controlling physical hazards. Worker exposure to hazardous chemicals would be minimized by the use of improved facilities for handling toxic chemicals and controlling physical hazards, such as the EMPC. Continued application of site ES&H and ISMS principles would result in minimal impacts to workers and the public.

LLNL has strict safety guidance and procedures in place. The site injury and illness rates have been declining as a result. Therefore, an increase in construction, demolition, and renovation activities that would occur under the Proposed Action would not significantly increase site injury and illness rates.

Based on the assumption that the increase in facility operations associated with the Proposed Action would represent an increase in chemical inventory, worker exposures would slightly increase. Facility upgrades and continued implementation of the site ES&H Program components would significantly reduce the risk of personnel exposures. Several proposed projects would result in increased levels of protection for both workers and the public. These would include:

- Building 151 upgrade
- Building 331 renovation and modification
- Building 332 ductwork replacement
- EMPC operations consolidation
- Building utilities upgrade
- Site utilities upgrade

Ongoing and proposed D&D activities would reduce overall site hazards by removing chemical and physical hazards from the workplace. These facilities would include:

- U235 cooling tower
- Building 514
- Building 419
- Building 412
- Building 171
- Building 175 north section
- Building 194 line-of-flight tube
- Building 212 ITC Accelerator Building

- Building 251

The proposed infrastructure improvements, such as roof replacements, facility renovations and facility and system upgrades, improve the overall safety envelope for the site. The proposed structural and seismic upgrades would result in improved facilities and work areas. Facility roof replacement would provide protective measures for sensitive facility components and increase the protection of potentially hazardous areas from exposure to the environment. Electrical and ventilation upgrades would increase facility control features and reduce the risk of hazardous energy events. Therefore, the reduction of impacts from these proposed activities would be beneficial.

Relocation of some existing explosives operations to the EMPC would consolidate higher hazard activities in a compliant facility. Likewise, the consolidation of operations currently conducted in Buildings 825, 826, and the Building 827 Complex into the planned HEDC would provide a similar increase in process and worker safety. Improvements could reduce worker exposure to chemicals and physical hazards relative to the facilities that are currently being used. This would represent a reduction in impacts and could be beneficial.

Cumulative Impacts

The occupational health and safety of workers at LLNL is site-specific and would not be affected by other activities occurring within the area. Cumulative effects for workers would be the same as those presented in the Proposed Action impact analysis above.

5.3.14.2 *Radiological Health Impacts*

This section analyzes the radiological health impacts from Proposed Action operations such as ongoing and proposed R&D and waste management. Impacts to workers are given in terms of the number of cancer fatalities resulting from employment activities in the worker population. Impacts to the public from normal releases are given in terms of the probability of the site-wide MEI contracting a fatal cancer from these operations. The number of fatal cancers expected in the general population because of LLNL operations is also described.

Relationship with Site Operations

This section summarizes the relationship between projects described in Section 3.3 for the Proposed Action and radiological health impacts from normal site operations. The Proposed Action dose would increase as new and increased operations come online. The maximum doses and health effects over this timeframe are presented here. The number of cancer fatalities to the workers and the public from exposure to these operations is used to quantify the impacts.

Impact Analysis

Workers

The dose to involved workers, such as those directly exposed to radiation in the performance of their jobs, would be 125 person-rem per year. This dose includes 32 person-rem per year from the ITP and 19 person-rem per year from the NIF. Most of the remainder of this dose would be from operations in Building 332. Workers would be exposed to an increased risk of cancer as a result of occupational exposure to radiation over an extended period (calculated value of 0.075 fatalities per year of operation). Note that radiation exposure in all radiologically controlled areas are kept ALARA through facility and equipment design and administrative controls.

The dose to noninvolved workers, those exposed to normal site radiological emissions not directly related to performance of their jobs, would be approximately 0.16 person-rem per year (see Section 5.3.8.2). Ninety-seven percent of this dose is from Livermore Site operations. No cancers (calculated value of 9.6×10^{-5} LCFs per year of operation) are expected among noninvolved workers.

General Public

The Proposed Action health impacts to the general public result from the radiation dose from atmospheric emissions, described in Section 5.3.8.2, and skyshine from neutrons produced during the NIF yield operations and scattering off of the atmosphere (skyshine). The latter would be unchanged from the No Action Alternative. The Proposed Action dose to the Livermore Site site-wide MEI would be 0.33 millirem per year (0.13 from air emissions and 0.2 from skyshine). This dose is less than 0.4 percent of the DOE standard of 100 millirems per year (DOE O 5400.5). The probability of a fatal cancer to this site-wide MEI would be 2.0×10^{-7} per year of exposure.

The Proposed Action site-wide MEI dose from Site 300 operations would be 0.055 millirem per year, less than 0.6 percent of the NESHAP standard. This dose is unchanged from the No Action Alternative. The probability of a cancer fatality to this hypothetical individual would be 3.3×10^{-8} per year of operation.

The population dose from all LLNL operations would be 12 person-rem per year. Skyshine effects are limited to locations in close proximity to the Livermore Site boundary next to the NIF and are not included in the population dose. No cancer fatalities (calculated value of 0.007 fatalities per year of operation) to the public would result from exposure to LLNL operations.

Cumulative Impacts

There is a possibility that an involved worker would contract a fatal cancer sometime during that worker's lifetime as a result of extended occupational exposure under the Proposed Action (calculated value of 0.075 fatalities per year of operation).

No adverse impacts to the general population would occur under the Proposed Action. Other than background radiation sources, there are no other known contributors to concentrations of radionuclides near the Livermore Site or Site 300. Therefore, there are no additional cumulative radiological impacts.

5.3.15 Site Contamination

This section analyzes impacts of contaminated soils and sediments, surface water, and groundwater under the Proposed Action. For the purpose of this LLNL SW/SPEIS, soils and sediments discussed below include surficial soils, both unconsolidated and consolidated sediments, and unsaturated bedrock. Hydrologic impacts not related to surface or groundwater quality are presented in Section 5.3.9.

5.3.15.1 *Relationship with Site Operations*

The Proposed Action, as described in Section 3.3, includes continued operations of investigation, cleanup, long-term stewardship, other activities (including treatment system modifications and reporting), plus actions identified for the No Action Alternative. A general increase in activity levels across LLNL is projected; accordingly, an increase in hazardous material management and waste management and an associated spill or release could occur. LLNL would conduct immediate cleanup actions and periodic site surveys to ensure environmental impacts would be minimized.

5.3.15.2 *Impact Analysis*

The Proposed Action would result in minimal deposition of contaminants to soil from continued operations and continued removal of known contaminants under the cleanup effort would occur. No adverse impacts to future designated land use would be expected. No adverse effect on groundwater would be expected. Continued improvement of water quality and source reduction would occur.

5.3.15.3 *Cumulative Impacts*

The ROI for site contamination involves LLNL and its remedial sites as presented in Chapter 4 of this LLNL SW/SPEIS. The ROI for cumulative impacts is larger than that presented in Chapter 4 and considers the contributions of LLNL (Livermore Site and Site 300) and local projects.

Since the Proposed Action and No Action Alternative begin with the same level of existing contamination, present substantially the same opportunities for future contamination, and remediation activities would be the same under each, cumulative impacts would be the same as those described in Section 5.2.15.4, combining the potential effects of the No Action Alternative with the effects of other past, present, and reasonably foreseeable activities in the ROI.

Within the ROI, soil contamination and groundwater contamination have occurred from various operations. However, past, present, and planned activities are designed to minimize contamination at LLNL, SNL/CA, and other sites. The cleanup of these sites has been and will be performed to a level that meets State of California approved health risk-based standards, which vary depending on the contaminants of concern, corresponding to the intended future uses of the sites. As existing contamination at LLNL is being cleaned up under the Environmental Restoration Program, no cumulative impacts would be expected.

5.4 IMPACTS FOR THE REDUCED OPERATION ALTERNATIVE

This section discusses the potential environmental consequences of the Reduced Operation Alternative. Chapter 3 and Appendix A contain detailed descriptions of all projects included under the Reduced Operation Alternative. The LLNL operations include the Livermore Site and Site 300.

5.4.1 Land Uses and Applicable Plans

This section describes the impacts to land uses and applicable plans under the Reduced Operation Alternative. Impacts are analyzed for the Livermore Site and Site 300 based on the methodology presented in Section 5.1.

5.4.1.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.4 for the Reduced Operation Alternative and the land use impact analysis. In general, the effect of projects under the Reduced Operation Alternative on land use are related to the planned construction and D&D of facilities as part of projects that have been funded, but not yet executed. Changes to operations would not alter land use. No land acquisitions would be included under the Reduced Operation Alternative, so land use changes would be confined to onsite areas.

5.4.1.2 *Impact Analysis*

Livermore Site

Under the Reduced Operation Alternative, new facility construction, upgrades, and D&D activities would occur at the Livermore Site. Many of these projects are already underway. While the types of land uses would not change, some infill and modernization would occur. New facilities that would be located in the undeveloped portions of the Livermore Site are the same as those listed for the No Action Alternative (Table 5.2.1.2–1).

New structures would be for the same uses as existing facilities, R&D, which is the existing land use designation for all Livermore Site facilities. Therefore, they would not represent a change in land uses, nor lead to a conflict with existing and approved future land uses adjacent to the site. Although the Livermore Site is on Federal land and not subject to local zoning ordinances, the Livermore Site R&D activities would be compatible with the MP designation (industrial park) in Alameda County and the I-2/I-3 designations (professional and administrative offices/R&D facilities) in the city of Livermore (LLNL 2001r). No new types of land uses would be introduced in the buffer and perimeter areas. No change in the site's compatibility with existing and approved future land uses would result from the Reduced Operation Alternative. No new impacts are expected.

Secondary effects on land use could occur due to decreased personnel and activity at the site. These effects could include reduced traffic, noise, vehicular exhaust emissions, demands for community services, reduced consumption of natural resources, and reduced waste generation. These effects are addressed in the other parts of Chapter 5 in this LLNL SW/SPEIS.

Site 300

The Reduced Operation Alternative at Site 300 would include upgrades and a D&D project. No land acquisitions would be included. The types of land uses at Site 300 would not change, and the open space character of the site would be retained. No major alteration in the types of land uses would result.

Land uses at Site 300 are compatible with the existing land uses, approved land use designations surrounding the site, and with open space policies regarding open space resources near the site. Because activities under the Reduced Operation Alternative would be a continuation of existing land uses, they would be compatible with existing and approved future land uses surrounding the site. No new impacts are anticipated.

5.4.1.3 *Cumulative Impacts*

Livermore Site

The cumulative impact study area, with regard to land uses and planning programs for the Livermore Site, is defined as that area of Alameda County generally east of Tassajara Road in the city of Dublin and Santa Rita Road in the city of Pleasanton. This area encompasses the city of Livermore and eastern unincorporated Alameda County. Large undeveloped open space areas exist in the northern, eastern, and southern portions of Alameda County. The majority of the undeveloped areas are used for agricultural purposes, primarily for grazing and viticulture. Agricultural lands in the South Livermore Valley General Plan Amendment area support an active wine industry.

A continuing land use trend in Alameda County has been the encroachment of residential, commercial, and industrial uses upon agricultural and open space areas. Development of planned and proposed residential projects would contribute to the cumulative loss of agricultural land and open space. However, the Reduced Operation Alternative would not directly contribute to the cumulative effect on the loss of agricultural land and open space because the Livermore Site is already committed to R&D land uses and no acquisition of open space or agricultural land is proposed.

Site 300

The cumulative impact study area with regard to land uses and planning programs for Site 300 is defined as that portion of San Joaquin County generally south of I-205 that encompasses the city of Tracy and southwestern unincorporated San Joaquin County. Land uses in the area south of I-580 in unincorporated San Joaquin County include agricultural (primarily grazing), commercial recreation, and explosives testing facilities (including Site 300).

The city of Tracy, the border of which is located approximately 2 miles northeast of Site 300, has a developed core of residential and commercial uses, which becomes less dense along the outer boundaries of the city. Industrial and agricultural land uses surround the developed part of the city. In 1998, the city of Tracy annexed the Tracy Hills area southwest of I-580, the area of Tracy that is now closest to Site 300. The Tracy Hills planning area is 6,175 acres. In an effort to preserve agricultural land on the valley floor, the city of Tracy Planning Department is encouraging new development in hillside areas, such as Tracy Hills (City of Tracy 1993).

Such residential communities could be compatible with Site 300, depending on the final design and siting of residences. The city of Tracy also has annexed an area of San Joaquin County that is approximately 2 miles from Site 300 and has planned for residential development in this area. The Tracy General Plan provides for a conservation, or open space, area to be established that would be a buffer zone between Site 300 and any potential new development.

5.4.2 Socioeconomic Characteristics and Environmental Justice

This section analyzes the socioeconomic impacts associated with implementation of the Reduced Operation Alternative. The section organizes the impact analysis by employment and housing and population, with effects delineated by geographic area (counties and cities). Environmental justice issues are also discussed.

5.4.2.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.4 under the Reduced Operation Alternative and the potential socioeconomic impacts. In general, the effect of projects under the Reduced Operation Alternative on socioeconomics would be limited to the reduction in employment opportunities and accompanying reduction in payroll dollars and the need for housing resulting from curtailed operation of these projects as described below. Projected staffing changes are shown in Table 5.4.2.1–1.

TABLE 5.4.2.1–1.—*Input Parameters for Socioeconomic Analysis Under the Reduced Operation Alternative*

Parameter	Units	Site	No Action Alternative	Reduced Operation Alternative
Employment	Number of personnel	LLNL	10,650 (all site workers)	9,770 (all site workers)
		Livermore Site	8,900 (LLNL employees) 17,500 (LLNL employees and indirect)	8,180 (LLNL employees) 16,100 (LLNL employees and indirect)
		Site 300	250 (LLNL employees) 490 (LLNL employees and indirect)	230 (LLNL employees) 450 (LLNL employees and indirect)
Expenditures	Dollars (2001)	LLNL	146 M (Bay Area)	134 M (Bay Area)
Payroll	Dollars (2002)	LLNL	690 M (LLNL employees) 1,130 M (direct and indirect)	635 M (LLNL employees) 1,040 M (direct and indirect)

LLNL = Lawrence Livermore National Laboratory; M = million.

5.4.2.2 *Impact Analysis*

To develop estimates of employment levels, employment projections for the Reduced Operation Alternative were based on staffing decreases associated with reduction of activities at existing facilities. Over the next 10 years, LLNL employment at the Livermore Site is projected to decrease by approximately 700 from the No Action Alternative level to 8,180 employees. Therefore, the Reduced Operation Alternative would eliminate 700 direct employment opportunities in Alameda County, and would reduce the growth rate of population and subsequent housing demand. Combined direct and indirect employment loss would be approximately 1,400 within the four-county ROI.

Over the next 10 years, Site 300 employment would decrease by 20 employees from the No Action Alternative level. Combined direct and indirect employment loss would be approximately 40 within the four-county ROI.

Employment and Expenditures

Region

Assuming a 740 combined employee decrease at Livermore Site and Site 300, the payroll under the Reduced Operation Alternative would be $55 million less than under the No Action Alternative in 2002 dollars. This would result in fewer dollars within the local economy for workers to purchase goods and services. The combined direct and indirect effects of decreased employment would result in an employment decrease of approximately 1,400 within the region. Likewise, the direct and indirect effect of payroll loss would result in a $90 million decrease from the No Action Alternative in the regional economy.

In addition, the Reduced Operation Alternative would result in reduced expenditures by LLNL. Fewer goods and services would be required to support the activities, facilities, and workers under the Reduced Operation Alternative.

The reduced payroll and other reductions in spending by LLNL would slow the rate of growth in personal income and employment opportunities within the ROI. However, the slower growth in expected personal income and employment under the Reduced Operation Alternative would have a very small economic impact on the region.

Alameda County

Total employment in Alameda County was estimated at 751,680 in the year 2000 (Association of Bay Area Governments 2001). The Reduced Operation Alternative would reduce employment at the Livermore Site by approximately 700 from the No Action Alternative employment level. Employment projections for the county estimate that opportunities would increase 14.1 percent to 857,450 by the year 2010 (Association of Bay Area Governments 2001). The reduction in jobs caused by the Reduced Operation Alternative at LLNL would represent 0.8 percent of the projected increase in employment within the county. This minimal decrease in LLNL employment, a 0.1 percent decrease from the year 2000 employment level, would have a minimal impact to the Alameda County economy.

San Joaquin County

Total nonfarm employment in San Joaquin County was estimated at 191,700 in the year 2001 (EDD 2003). The Reduced Operation Alternative would result in a 20 employee staff reduction at Site 300. Employment projections for the county estimate that employment opportunities will increase 22.3 percent to 234,430 by the year 2010 (SJCOG 2000). The jobs lost under the Reduced Operation Alternative at Site 300 would represent 0.05 percent of the projected increase in employment within the county. This minimal decrease in employment, a 0.01 percent decrease from the 2001 employment level, would have a negligible impact to the San Joaquin County economy.

Population and Housing

For this analysis, to determine the maximum potential impact, it was assumed that any positions eliminated under the Reduced Operation Alternative would result in a family leaving the project region, and that each LLNL worker (including LLNL employees, contractors, and Federal employees) would represent one household. In reality, a significant percentage of workers in positions eliminated would remain in the region, and some households have more than one LLNL worker. The geographic distribution of future LLNL workers would be similar to the current distribution (Table 5.4.2.2–1).

Alameda County

Based on the current geographic distribution of LLNL worker residences (Table 5.4.2.2–1), the Reduced Operation Alternative would result in a net migration of 500 more workers out of Alameda County over 10 years as compared with the No Action Alternative. Assuming 2.74 persons per household for the county (Census 2003), the population associated with the workforce migrating out of the county would be 1,370 persons. This would represent 0.1 percent of the 2000 population within the county. Population projections for the county estimate a 16.8 percent increase from 2001 to 2010 (Association of Bay Area Governments 2001, Census 2003).

Assuming one worker per household, the reduction in housing demand caused by the reduced workforce would be 500 dwelling units less than the No Action Alternative over 10 years, lowering the total number of housing units occupied by LLNL workers to approximately 5,550 within Alameda County. In 2002, the county had 546,735 housing units. The vacancy rate in the county was 3.0 percent, an estimated 16,620 available units (DOF 2002). Reduction in housing demand associated with project personnel leaving Alameda County would represent 3.0 percent of the 2001 housing supply within the county. The slower growth in population increase associated with the Reduced Operation Alternative would have minimal impact on population and housing demand within the county.

City of Livermore

The greatest percentage of LLNL workers leaving the region (333 more than the No Action Alternative or 37 percent of workers expected to leave the ROI) would move from the city of Livermore based on the current pattern of employee residence location. Using the year 2000 person –per household figure of 2.81 for the city (Census 2002b), and assuming one worker per household, the population associated with the workforce migrating out of the city would be 936 persons as compared with the No Action Alternative. This would represent 1.3 percent of the city's 2000 population. The projection of population growth for the city is 23 percent from the year 2000 to 2010 (Association of Bay Area Governments 2001). Given the demand for housing within the city of Livermore (development and additional demand for housing limited by the Housing Implementation Plan), the reduced pressure for available housing would have minimal impact to the community or housing market.

TABLE 5.4.2.2–1.—*Anticipated Geographic Loss of Lawrence Livermore National Laboratory Worker Residences Under the Reduced Operation Alternative*

City	Percent of LLNL Workers [a,b]	Decrease in Number of Workers from No Action Alternative[c]
Alameda County		
Livermore	37.0	333
Pleasanton	6.2	56
Castro Valley	4.0	36
Dublin	2.1	19
Oakland	2.1	19
Other Alameda County	4.1	37
Total	**55.5**	**500**
San Joaquin County		
Tracy	8.2	74
Manteca	4.8	43
Stockton	2.6	24
Other San Joaquin County	2.9	26
Total	**18.5**	**167**
Contra Costa County		
Brentwood	2.7	24
San Ramon	2.7	24
Other Contra Costa County	7.4	66
Total	**12.8**	**114**
Stanislaus County		
Modesto	3.2	29
Other Stanislaus County	2.9	26
Total	**6.1**	**55**
Counties Outside the ROI		
Total	**7.2**	**65**

Source: LLNL 2003ak.
[a] Distribution as of September 30, 2002.
[b] May not total 100 because figures are rounded off.
[c] Calculated based on 900-employee decrease. May not total 900 because of rounding.
ROI = Region of Influence.

City of Pleasanton

Based on the anticipated geographic distribution of personnel leaving the region, it is estimated that 56 LLNL workers would leave the city of Pleasanton over 10 years as compared with the No Action Alternative. Based on the person per household figure of 2.73 in the city for the year 2000 (Census 2002b), the decrease in city population associated with the Reduced Operation Alternative would be 153 persons. This would represent 0.2 percent of the population for the year 2000. Given the high demand for housing within the city of Pleasanton, the out-migration of workers would have a very small impact on the expected demand for housing within the city.

San Joaquin County

Based on the current geographic distribution of personnel, 167 fewer LLNL workers would live in San Joaquin County than under the No Action Alternative (Table 5.4.2.2–1). Based on the person per household figure of 3.17 for the year 2001 in the county (Census 2003), the San Joaquin County decreased population associated with these employees would be 529 persons. This would represent a reduction of 0.1 percent of the total population within the county for the year 2000. The slightly slower growth in population associated with the Reduced Operation Alternative would have only a very small impact to population growth within the county.

Projected housing demand associated with the loss of workers (assuming one worker per household) in the county would total 167 units less than under the No Action Alternative over 10 years, lowering the total number of housing units occupied by LLNL workers to approximately 1,850 within San Joaquin County. The 2002 housing supply within the county was 197,279 units, with a vacancy rate of 3.9 percent (DOF 2002). The total number of vacant units was 7,767. County projections estimate a 26 percent increase in the number of housing units within the county by the year 2010 (SJCOG 2000). The Reduced Operation Alternative would be expected to have a very small impact on the demand for housing within the county.

City of Tracy

Based on the anticipated geographic distribution of personnel leaving the region, 74 fewer workers would be located in the city of Tracy over 10 years than under the No Action Alternative (Table 5.4.2.2–1). Based on the person per household figure of 3.23 for the city in the year 2000 (Census 2002a), the difference in city population associated with the Reduced Operation Alternative would be 239 fewer persons than under the No Action Alternative. This represents 0.4 percent of the population in the year 2000. The Reduced Operation Alternative would be expected to result in a very small impact on the demand for housing in the city of Tracy.

Environmental Justice

In general, LLNL operations under the Reduced Operation Alternative would have no anticipated disproportionately high and adverse health or environmental impacts on low-income or minority populations. Effects would be qualitatively equivalent to those described for the No Action Alternative in Section 5.2.3.2. A number of quantitative differences exist between the data presented in Section 5.2.3.2 and the Reduced Operation Alternative:

- As indicated earlier in this section, 9,770 workers would be required at the Livermore Site, 880 less than under the No Action Alternative. A total of 230 workers would be required at Site 300, 20 less than under the No Action Alternative.

- As presented in Section 5.4.3, an estimated 4,200 metric tons per year of nonhazardous solid waste would be generated at the Livermore Site for disposal, 400 metric tons per year less than under the No Action Alternative. Site 300 generation would decrease by 17 metric tons per year to 191 metric tons per year.

- As presented in Section 5.4.8, the MEI dose from radiological air emissions would be 0.087 millirem per year, lower than the No Action Alternative estimate of 0.098 millirem per year. At Site 300, the MEI dose would be 0.054 millirem per year, slightly lower than the No Action Alternative dose of 0.055 millirem per year.

- As discussed in Section 5.4.11, the collective radiation dose to the population along the transportation route is calculated at 1.1 person-rem per year with 0.0006 LCFs, lower than the No Action Alternative estimates of 5.0 person-rem per year and 0.003 LCFs.

- As presented in Section 5.4.12, the projected peak electrical demand at LLNL would be 81 megawatts, slightly lower than the 82 megawatts under the No Action Alternative.

None of these changes would result in disproportionately high and adverse impacts on low-income or minority populations under the Reduced Operation Alternative.

5.4.2.3 *Cumulative Impacts*

Approximately 680 fewer LLNL workers would live in the various communities listed in Table 5.4.2.2–1 under the Reduced Operation Alternative than under the No Action Alternative, in the same proportion that existing workers have selected communities for their residences. In addition, approximately 220 workers and their families would leave other communities in the Bay Area and central San Joaquin Valley. The Reduced Operation Alternative would slow the rate of increase in cumulative demand for housing in the region associated with new employment opportunities. However, because of high housing demands within the city of Livermore and the region, the increase in available housing would not impact the community or housing market.

5.4.3 Community Services

The following section evaluates the effects of the Reduced Operation Alternative on providing fire, police, school, and nonhazardous solid waste facilities and services to surrounding communities.

Personnel statistics for employees at the Livermore Site and Site 300 are combined; thus, some of the projections and analyses in this section discuss impacts of employee reductions at the Livermore Site and Site 300 as a single entity.

5.4.3.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.4 for the Reduced Operation Alternative and the community services impact analysis. In general, the effects of projects under the Reduced Operation Alternative on community services would be related to reduction in employment opportunities and changes in floorspace. Employment changes under the Reduced Operation Alternative are detailed in Section 5.4.2. Under the Reduced Operation Alternative, floorspace would increase slightly as construction would not be offset by equal amounts of D&D. Employment parameters are listed in Table 5.4.3.1–1.

TABLE 5.4.3.1–1.—*Input Parameters for Community Services Analysis Under the Reduced Operation Alternative*

Parameter	Units	Site	No Action Alternative	Reduced Operation Alternative
Employment	Number of personnel	Livermore Site Site 300	10,650 250	9,770 230

5.4.3.2 *Impact Analysis*

Livermore Site

Fire Protection and Emergency Services

Under their automatic aid agreement, the Livermore-Pleasanton Fire Department responds to an average of three calls per year at the Livermore Site. The incremental change in Livermore Site floorspace would result in no change in the number of calls to the Livermore-Pleasanton Fire Department and would be anticipated because of the Reduced Operation Alternative. The Livermore-Pleasanton Fire Department's current average of three calls per year at the Livermore Site does not affect that agency's ability to provide fire protection and mutual and automatic aid service to its constituency. Because the Reduced Operation Alternative would not change the number of calls, there would be minimal impacts on the Livermore-Pleasanton Fire Department.

The Alameda County Fire Patrol did not respond to any LLNL Fire Department calls during the 2000-2002 timeframe. Implementation of the Reduced Operation Alternative would not change the number of calls for assistance. Therefore, the Reduced Operation Alternative would not impact the Alameda County Fire Patrol's ability to provide fire protection within its service area or to carry out its mutual aid responsibilities with other agencies.

Police Protection and Security Services

The Livermore Site provides onsite security services and participates in emergency response agreements with the city of Livermore Police Department and Alameda County Sheriff's Department for additional police protection services at the Livermore Site. The decrease of 880 employees at the Livermore Site under the Reduced Operation Alternative would not affect the need for assistance, as the number of incidents where additional police protection is typically requested (for example, demonstrations near the facility) would not be expected to change.

School Services

It was assumed that personnel associated with workforce reduction under the Reduced Operation Alternative would leave the communities listed in Table 5.4.2.2–1 and other communities throughout the Bay Area and central San Joaquin Valley. Thus, a secondary or indirect effect of the Reduced Operation Alternative would be a decrease in student enrollment in those school districts where LLNL employees would otherwise reside. A small decrease in the projected enrollment (180 fewer students over 10 years in the Livermore Valley Joint Unified School District) would not be expected to affect school services.

Nonhazardous Solid Waste Disposal

The Livermore Site currently generates approximately 11,000 metric tons of nonhazardous solid waste per year, of which 4,700 metric tons are disposed of at the Altamont Landfill; the remainder is diverted for recycling or reuse. Assuming decreases in nonhazardous solid waste would be proportional to the anticipated decreases in site employment, the Reduced Operation Alternative would result in a decrease of approximately 400 metric tons of nonhazardous solid waste per year to be disposed of at the landfill.

The projected lifespan of the Altamont Landfill under current conditions extends to the year 2038 (Hurst 2003). The 400-metric-ton reduction in solid waste generated at LLNL for disposal under the Reduced Operation Alternative would not affect the Altamont Landfill lifespan. The decrease in solid waste under the Reduced Operation Alternative would represent only 0.01 percent of permitted landfill throughput; thus minimal impacts are expected.

Site 300

Fire Protection and Emergency Services

The Site 300 fire station and the city of Tracy Fire Department did not respond to any calls in each other’s jurisdictions during the 2000-2002 timeframe under their mutual aid agreement. The number of mutual aid responses would not change for either agency under the Reduced Operation Alternative, which assumes no change in building gross square footage at Site 300. Therefore, no new impacts would be expected to the city of Tracy Fire Department’s ability to provide fire protection services or mutual aid services.

Through a mutual aid agreement, the Tracy Rural County Fire Protection District currently responds to an average of one call per year at Site 300. The fire station at Site 300 has never received a request for assistance from the Tracy Rural County Fire Protection District. It is anticipated that the number of responses for each agency would not change under the Reduced Operation Alternative. Therefore, there would be no impact to the Tracy Rural County Fire Protection District’s ability to provide fire protection within its service area or to fulfill its mutual aid responsibilities with other agencies.

Site 300 participates in a mutual aid network with the California Department of Forestry. No additional impact is projected on the California Department of Forestry’s ability to provide fire protection and mutual aid service.

The Reduced Operation Alternative would not result in a change in the need for fire protection services onsite. There would be no impact to offsite agencies with whom LLNL has mutual aid and response agreements.

Police Protection and Security Services

Site 300 provides onsite security services and participates in an emergency response agreement for additional police and security services with the San Joaquin County Sheriff's Department. There would be no change in the demand for police protection and security services; therefore, there would be no additional impacts to onsite security services or on the San Joaquin County Sheriff's Department's ability to provide services to its constituency.

School Services

The impact analysis for school services is combined for the Livermore Site and Site 300 (see the discussion of school services under the Livermore Site heading above). Only a very small impact is expected.

Nonhazardous Solid Waste Disposal

The most accurate measure of the decrease in nonhazardous solid waste generation would be associated with the decrease in personnel generated by the Reduced Operation Alternative.

Under the No Action Alternative, Site 300 is projected to dispose of approximately 208 metric tons of solid waste per year at the Tracy Material Recovery and Solid Waste Transfer Station. A generation rate of 0.83 metric tons per employee per year can be assumed based on the current amount of solid waste generated and disposed of each year by the existing 240 persons at the site. Therefore, based on a projected decrease of 20 workers over the next 10 years, the Reduced Operation Alternative would result in a maximum decrease of approximately 16.6 metric tons per year of solid waste to be disposed of at the Tracy Material Recovery and Solid Waste Transfer Station, or another landfill if necessary. This would not be a substantial reduction and would have no impact on the Tracy Material Recovery and Solid Waste Transfer Station.

5.4.3.3 *Cumulative Impacts*

Changes in the number of employees associated with activities in the ROI would contribute to changes in the cumulative demand for fire and police services in the jurisdictions where these activities occur. However, fire and security services at LLNL are independent departments that do not rely on offsite community agencies to provide primary responses to fire and police emergency calls. No changes demanding these onsite services or is associated with the Reduced Operation Alternative are anticipated. There would be no new impacts to the cumulative demand for offsite fire and police services.

The Reduced Operation Alternative would not significantly alter the cumulative demand for school services in the region. Existing school facilities cannot accommodate student generation from non-LLNL-related development projected within the Livermore Valley Joint Unified School District's jurisdiction. The Reduced Operation Alternative would eliminate approximately 180 students from the anticipated increase in student enrollment; however, this would not alter the district's ability to plan for and provide school services within its jurisdiction.

The Reduced Operation Alternative would lessen the cumulative demand for solid waste disposal services. The Livermore Site sends solid waste to the Altamont Landfill. The landfill operator projects the lifespan of this landfill will extend to the year 2038. This closure date would not be affected under the Reduced Operation Alternative.

5.4.4 Prehistoric and Historic Cultural Resources

This section presents an evaluation of impacts to cultural resources resulting from implementation of the Reduced Operation Alternative. The impact analysis is organized by location and type of resource. Steps taken to reduce impacts are also discussed, as are the measures to be implemented to ensure compliance with the NHPA.

5.4.4.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.4 for the Reduced Operation Alternative and the analysis of cultural resources. In general, those projects with the potential to impact these resources include construction of new facilities and infrastructure, in addition to D&D, rehabilitation, and renovation of existing facilities.

5.4.4.2 *Impact Analysis*

Livermore Site

The probability of impacting prehistoric resources at the Livermore Site would be very low because: (1) field and archival research have not identified any prehistoric resources; (2) the geomorphic setting of the site makes it unlikely that any such resources exist; and (3) extensive modern horizontal and vertical development has disturbed much of the site. Although no impacts to prehistoric resources would be expected, unrecorded subsurface prehistoric resources still could be inadvertently discovered during construction or other ground-disturbing activities.

To address the inadvertent discovery of cultural material, LLNL would require its employees and contractors to report any evidence of cultural resources unearthed during ground-disturbing activities at the Livermore Site. Work within the immediate vicinity of the discovery would cease until a qualified archaeologist had the opportunity to assess the discovery. If the discovery were deemed potentially significant, work would be stopped until an appropriate treatment plan was developed according to DOE guidelines. NNSA expects no impacts to these resources.

The Reduced Operation Alternative would have the potential to affect important historic buildings and structures on the Livermore Site through D&D, rehabilitation, or renovation of existing facilities. However, implementing the Programmatic Agreement (Appendix G) would avoid, reduce, or mitigate any impacts from these actions.

Site 300

Impacts to known prehistoric and historic resources at Site 300 would be unlikely to result from the Reduced Operation Alternative. NNSA recognizes the sensitivity of the resources and has established buffer zones to protect them. Implementation of the Programmatic Agreement (Appendix G) and continuation of current management practices would result in protection of these sensitive areas. Although no impacts to known resources are expected, there is still the possibility that unrecorded subsurface prehistoric or historic resources still could be inadvertently discovered during construction or other ground-disturbing activities.

To address the inadvertent discovery of cultural material at Site 300 would be addressed as described above for the Livermore Site. NNSA expects no additional impacts to these resources.

The Reduced Operation Alternative would have the potential to affect important historic buildings and structures on Site 300 through D&D, rehabilitation, and renovation of existing facilities. However, implementing the Programmatic Agreement (Appendix G) with responsible state and Federal agencies would avoid, reduce, or mitigate any impacts from these actions.

5.4.4.3 *Cumulative Impacts*

The Livermore Valley has undergone tremendous growth and development over the past decade. Because preservation measures such as Section 106 are only initiated when Federal agencies are involved, it is likely that the onset of development has caused the irretrievable loss of cultural resources in the region. Because cultural resources exist at both the Livermore Site and Site 300, future program activities could result in resource loss and add to regional attrition of these resources. Any potential impacts to cultural resources at LLNL would be mitigated through implementation of the Programmatic Agreement (Appendix G), thereby reducing LLNL's contribution to resource attritions.

5.4.5 Aesthetics and Scenic Resources

This section presents an evaluation of impacts to aesthetics and scenic resources resulting from implementation of the Reduced Operation Alternative.

5.4.5.1 *Relationship with Site Operations*

This section summarizes the relationship between the projects described in Section 3.4 for the Reduced Operation Alternative and the analysis of aesthetics and scenic resources. In general, effects to aesthetics and scenic resources would be limited to the construction of buildings, demolition of existing structures, and infrastructure located in areas visible to public viewing.

5.4.5.2 *Impact Analysis*

Livermore Site

Activities under the Reduced Operation Alternative that would change the built environment at the Livermore Site would include improvements to existing buildings and infrastructure, D&D of existing buildings, and construction of new facilities. As with the No Action Alternative, developments and modifications would largely occur within the developed portion of the site, would be similar in character to surrounding uses, and would be largely screened from public view by the surrounding fences and trees. Like the No Action Alternative, developments and modifications would be largely consistent with the existing character of the site, and the site would remain compatible with local and county scenic resource plans and policies.

Construction of new facilities would be the same as for the No Acton Alternative. The changes to the built environment as a result of the Reduced Operation Alternative would have no impact on the visual character of the Livermore Site, views of the site from public viewing areas, or existing view sheds of the surrounding environment.

Site 300

Activities under the Reduced Operation Alternative that would change the built environment at Site 300 would include improvements to existing buildings and infrastructure. Development and modifications would largely occur within the developed portion of the site in the GSA and would be similar in character to surrounding uses. Although many specifics of these developments under the Reduced Operation Alternative are not currently known, based on previous LLNL landscaping and development practices, it is anticipated that development of these projects at Site 300 under this alternative would be largely consistent with the existing character of the site.

The locations, types, and extents of construction and improvement activities at Site 300 would be the same as under the No Action Alternative. The site would remain compatible with local and county scenic resource plans and policies. Consequently, the changes to the built environment because of the Reduced Operation Alternative would have no impacts on the visual character of Site 300, views of the site from public viewing areas, or existing view sheds of the surrounding environment.

5.4.5.3 *Cumulative Impacts*

There are no planned projects near the Livermore Site and Site 300 that, in combination with LLNL activities, would have an adverse effect on existing view sheds or the surrounding environment. There would be no cumulative impacts to aesthetics and scenic resources in the region under the Reduced Operation Alternative.

5.4.6 Geology and Soils

This section analyzes the impact to geology and soils associated with implementation of the project described in Section 3.4 under the Reduced Operation Alternative. The impact analysis is organized by geologic resources, topography and geomorphology, and geologic hazards.

5.4.6.1 *Relationship with Site Operations*

Under the Reduced Operation Alternative, the future facilities described under the No Action Alternative would be built. The difference between the alternatives lies exclusively in the level of operation only. The facilities for the Livermore Site are listed in Table 5.2.1.2–1.

Future development in the developed area at the Livermore Site would involve areas where soils have already been disturbed and therefore, would not involve any impacts to soils.

At Site 300, the Wetlands Enhancement Project artificial wetlands would be constructed as described under the No Action Alternative.

5.4.6.2 *Impact Analysis*

Geologic Resources

Livermore Site

No known aggregate, clay, coal, or mineral resources would be adversely affected by the Reduced Operation Alternative. None of the activities proceeding under the Reduced Operation Alternative would take place near or upon known or exploitable mineral resources, unique geologic outcrops, or other unique geologic features. None of the Reduced Operation Alternative activities would affect farming or grazing activities.

The Reduced Operation Alternative would include the same facilities to be built in the undeveloped zone at the Livermore Site as part of the No Action Alternative (Figure 5.2.6.1–1). Table 5.2.1.2–1 presents these facilities along with the estimated amount of land that would be disturbed by their construction. A total of 462,000 square feet would be disturbed because of the construction that would proceed under the Reduced Operation Alternative. No additional impacts are expected.

As discussed in Chapter 4, Section 4.8, of the LLNL SW/SPEIS fossils were discovered in the peripheral parts of the excavation for the NIF. The fossil localities were found 20 to 30 feet below the surface. Under the Reduced Operation Alternative, the potential would exist for the inadvertent excavation of fossils within this depth range during construction. Should any buried fossil materials be encountered, LLNL would evaluate the materials and proceed with recovery in accordance with the requirements of the *Antiquities Act*.

Site 300

No known aggregate, clay, coal, or mineral resources would be adversely affected by the Reduced Operation Alternative. Under the Reduced Operation Alternative, the Site 300 Wetlands Enhancement Project and the connection to the Hetch Hetchy aqueduct would be built at Site 300 as described under the No Action Alternative. There would be no impacts to any known or exploitable mineral resources, or unique geologic features.

Enhancement of the wetland habitat at Mid Elk Ravine and the area of the seep at the former SHARP Facility would involve disturbing 1.09 acres of soil. The connection to the Hetch Hetchy aqueduct would involve the disturbance of soils along the line of connection. The amount of disturbance would be dependent on the exact path and the engineering of the connection.

Several vertebrate fossil deposits have been found on Site 300 and near Corral Hollow. The fossil finds are generally widely scattered, and no significant invertebrate or botanical fossil localities have been identified on Site 300 or in the surrounding area (Hansen 1991). No projects under the Reduced Operation Alternative would involve the disturbance of these areas. Therefore, there would be no impacts to any known fossil deposits.

Topography and Geomorphology

Livermore Site

The Reduced Operation Alternative would not include project work that would affect the topography or geomorphology of the Livermore Site. No construction or excavation projects would be planned that would alter the character of the landscape. Only the best management practices would be employed to minimize erosion resulting from ongoing operations; no additional impacts are expected.

Site 300

The Reduced Operation Alternative would not include project work that would affect the topography or geomorphology of Site 300. No construction or excavation projects would be planned that would alter the character of the landscape. Only the best management practices would be employed to minimize erosion resulting from ongoing operations; no additional impacts are expected.

Geologic Hazards

The geologic hazards associated with the Livermore region are part of the character of that region. The hazards exist regardless of the presence of human activities, buildings, or facilities. Therefore, there is no difference in the geologic hazards among the alternatives. Detailed discussion is presented in Section 4.8 and Appendix H of the LLNL SW/SPEIS and includes the major regional fault zones and local faults.

Potentially strong earthquake ground motion sources at the Livermore Site and Site 300 are discussed in Section 4.8 and Appendix H. Potential impacts expected from an earthquake generating horizontal peak acceleration of 0.73 *g* are discussed as part of the evaluation of accidents in Section 5.5 and Appendix D.

Livermore Site

Adverse impacts to proposed structures and related infrastructure and surrounding communities could occur from hazardous materials releases and/or structural failure of buildings and facilities following a major seismic event. Design and location requirements for new facilities, including waste management facilities, must take into account distance from active faults, and the ground shaking to be expected within certain probabilities.

Site 300

Buildings 899A and 899B at the pistol range could experience ground deformation during a major earthquake on the Carnegie Fault. However, these two structures contain no hazardous or radiological materials and have very low occupancies. A greater number of facilities are located near the Elk Ravine Fault; however, that fault has not been considered active.

There is potential for seismically induced landslides at Site 300 due to the presence of landslide deposits and steep slopes. The potential for slope instability is greater on northeast-facing slopes that are underlain by the Cierbo Formation. Buildings 825, M825, 826, M51, 847, 851A, 851B, 854, 855, and 856 are located on old landslides. The potential for ground deformation at these buildings located on landslide deposits is considered moderate to high.

A landslide could result in spills, fire, explosions, or burial of facilities within its path. The hazards and impacts of spills, fire, and explosions, regardless of cause are discussed in Section 5.5 and Appendices A and D. The impacts of burial of materials due to a landslide would be similar to spills and the firing of explosives at these facilities. These facilities have material limits under which they work on batches of materials. The working limits for explosives are close to the amounts detonated at the firing sites. The spread of materials into the environment when the explosives are detonated would be similar to the amount of materials that would be buried in a landslide.

5.4.6.3 *Cumulative Impacts*

SNL/CA projects approximately 100 acres of soil disturbance in connection with their activities and future facilities. A large fraction of this is within areas that are already developed. The soils in the vicinity of LLNL are capable of supporting agriculture. While there is a large amount of undeveloped land in Alameda County, continuing development in the immediate vicinity of LLNL is contributing to the cumulative loss of agricultural land. The projects associated with the Reduced Operation Alternative do not contribute to the overall loss of agricultural land since LLNL has been committed to R&D/industrial use instead of agriculture for decades.

5.4.7 Biological Resources

This section analyzes the potential impacts of the Reduced Operation Alternative on biological resources, including vegetation, wildlife, protective and sensitive species, and wetlands.

5.4.7.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.3 for the Reduced Operation Alternative and the ecological impact analysis. In general, the effect of the Reduced Operation Alternative projects on biological resources would occur primarily in areas that have been previously disturbed at the Livermore Site and Site 300 by construction, maintenance, wildfire prevention, and security activities.

5.4.7.2 *Impact Analysis*

Vegetation and Wildlife

Livermore Site

It is anticipated that approximately the same land disturbance activities described for the No Action Alternative would occur under the Reduced Operation Alternative. Up to 462,000 square feet (10.6 acres) of land disturbance may occur under this alternative with remaining vegetation consisting of landscaped areas, fields dominated by early successional plant communities indicative of recent disturbance, annual grasslands in the security zone, and remnant wooded riparian vegetation along Arroyo Seco. The wildlife in the plant communities at the Livermore Site consists of species adapted to living in areas of high human activity or species adapted to living in grassland habitat. Therefore, the impacts of this alternative on vegetation and wildlife at the Livermore Site would be minimal.

Site 300

Site 300 vegetation and wildlife consist of a wide range of plant and animal species. The impacts of the Reduced Operation Alternative on vegetation and wildlife would occur primarily in previously disturbed areas representing less than 5 percent of the total site acreage. Under the Reduced Operation Alternative, no new facility construction would involve soil disturbance in new areas, although a number of routine operations such as road grading and culvert maintenance would occur and include protective measures as discussed in Appendix E, Section E.2.2.

Tritium Levels in Vegetation and Commodities

In 2001, as noted in Section 5.2.7, the No Action Alternative maximum potential dose from ingestion of vegetables, milk, and meat for the Livermore Valley was 0.0069 millirem (LLNL 2002cc). With the exception of vegetation from previously identified sites of contamination, the tritium levels at Site 300 were below the limits of detection and comparable to those exposed in previous years. Assuming a hypothetical average wine consumption and using the medium tritium values from the three sampling areas, the annual doses from Livermore, Europe, and California wines in 2001 would have been 0.13 microrem, 0.11 microrem, and 0.037 microrem, respectively (LLNL 2002cc).

No modeling was conducted to estimate tritium levels under the Reduced Operation Alternative in vegetation and other commodities. However, the tritium levels in vegetation and wine would be proportional to the annual release of tritium. These levels would be anticipated to be the same as those for the No Action Alternative, or lower depending on the level that operations at LLNL are reduced. A detailed discussion of tritium levels is presented for the discussion of the No Action Alternative in Section 5.2.7.3. No impacts are expected.

Protected and Sensitive Species

Livermore Site

Under the Reduced Operation Alternative, LLNL would continue to fulfill its obligation to maintain Arroyo Las Positas (previously modified to handle a 100-year flood event) and onsite tributaries for flood capacity. The objective of the Las Positas Maintenance Project is to allow the function and needs of onsite drainage capacity of the arroyo to be met in a timely and consistent manner without overlooking the preservation and habitat conservation requirements pertaining to the federally threatened California red-legged frog (LLNL 1998a, USFWS 1997, USFWS 2002c). For further details of the Arroyo Maintenance Project and ongoing consultation with the USFWS for this project, see Appendix E, Section E.2.1, of this LLNL SW/SPEIS.

No California red-legged frogs have been identified in the 1,800 feet of Arroyo Seco within the Livermore Site boundaries from the Vasco Road bridge to the East Avenue culvert (LLNL 2003ab). However, this segment of Arroyo Seco could be used by populations of this frog in the vicinity of the site. A separate Biological Assessment is being prepared to assess the impacts of the proposed Arroyo Seco Management Plan.

Formerly designated critical habitat for the California red-legged frog at the Livermore Site is shown in Figure 4.9.3–1. Construction of most, but not necessarily all, No Action Alternative structures would occur under the Reduced Operation Alternative. The Reduced Operation Alternative projects at the Livermore Site would not be designated critical habitat for the California red-legged frog or in areas where this species currently occurs.

In 1997, bullfrogs were noted in the southern sediment basin, a sediment trap south of the Drainage Retention Basin. A bullfrog management program, coordinated with the USFWS, was initiated to minimize the adverse impacts of this invasive species, which is a predator of the California red-legged frog (USFWS 2002e). See Appendix E for further discussion.

Measures to protect the California red-legged frog during Las Positas Maintenance Project activities would continue using the same USFWS-approved protection and conservation measures discussed in Section 5.2.7.3. Impacts are expected to be beneficial.

Site 300

Threatened, endangered, and other sensitive flora and fauna species of concern reside at Site 300. Under the Reduced Operation Alternative, most, but not necessarily all, No Action Alternative projects described in Section 3.2 would be completed.

Affected Species

The Reduced Operation Alternative would affect three species: California red-legged frog, California tiger salamander, and Alameda whipsnake, as well as rescinded critical habitat for the California red-legged frog and Alameda whipsnake. The California red-legged frog is a federally listed threatened species. Critical habitat for the California red-legged frog and its breeding and nonbreeding locations at Site 300 are shown in Figure 4.9.3–3. Proposed termination of surface water releases for an artificial wetland at Building 865 would impact this species since it has been a known breeding location for 6 years. Termination of water to a small, artificially maintained wetland at Building 801 would eliminate a potential breeding site for this frog species, although no California red-legged frogs occur at this site. Elimination of very small wetlands associated with the cooling towers at Buildings 851 and 827 would eliminate two low-quality habitat locations for the California red-legged frog where frogs have not been observed for the past 6 years. Appendix E, Section E.2.2.6.1, of this LLNL SW/SPEIS provides further details on potential impacts of this project and mitigation measures that would be taken to minimize those impacts. Proposed termination of surface releases at Buildings 865, 851, and 827 has been coordinated with the USFWS and has received approval contingent upon implementation of mitigations measures in a recent Biological Assessment and related Biological Opinion (Jones and Stokes 2001, USFWS 2002b). This proposed termination could start as early as 2004 (LLNL 2003ab). Grading of fire trails disturbs sediment that could directly affect

California red-legged frog habitat suitability. However, the use of best management practices could reduce negative effects to this species by minimizing erosion of fire trails into drainages as discussed in Appendix E, Section E.2.2.6.1.

LLNL is proposing to mitigate the 0.62-acre artificial wetland removed by continued operations at Site 300 under the Reduced Operation Alternative by enhancing selected areas and increasing breeding opportunities for the California red-legged frog. A minimum of 1.86 acres of wetland habitat would be enhanced and managed for this species. Two mitigation sites for potential enhancement include the wetlands at the seep at the SHARP Facility and Mid Elk Ravine. This mitigation measure has been previously addressed in a recent Biological Assessment and related Biological Opinion (Jones and Stokes 2001, USFWS 2002b). (See Appendix E, Section E.2.2.9, for more information on this mitigation measure).

The second affected species is the California tiger salamander, a federally listed proposed threatened species. See Chapter 4, Figure 4.9.3–4, for wetland locations where this species has been observed at Site 300. Although proposed storm drainage and culvert improvement activities could result in direct mortality of California tiger salamanders, proposed mitigations contained in a recent Biological Assessment and related Biological Opinion would greatly minimize the potential for such impacts (Jones and Stokes 2001, USFWS 2002b). Appendix E, Section E.2.2.6.3, provides further details on mitigation measures taken that would be to minimize potential impacts of the Reduced Operation Alternative on this species. Measures designed to mitigate impacts of the Reduced Operation Alternative on the California red-legged frog would also ameliorate impacts on the California tiger salamander. Minimal impacts are expected.

The third affected species is the Alameda whipsnake, a federally listed threatened species. Figure 4.9.3–5 shows critical habitat and potential habitat for the Alameda whipsnake at Site 300. Grading of fire trails as well as prescribed burns in grasslands adjacent to Alameda whipsnake habitat in sage scrub and rock outcrops have the potential to affect this species. However, a Biological Assessment and related Biological Opinion address mitigations that would minimize the adverse effects from these proposed activities (Jones and Stokes 2001, USFWS 2002b). Fire trail maintenance and prescribed burns are annual activities that would continue during the 10-year period covered by this LLNL SW/SPEIS. Appendix E, Section E.2.2.6.2, provides further details on measures taken to minimize impacts of the Reduced Operation Alternative on this species.

Unaffected Species

Approximately the same level of impacts from land disturbance and continued operations would occur under the Reduced Operations Alternative as under the No Action Alternative. Therefore, the Reduced Operation Alternative would not impact the following federally listed endangered, threatened, or candidate species (for the reasons discussed in Section 5.2.7.3): the large-flowered fiddleneck, the San Joaquin kit fox, the valley elderberry longhorn beetle and the willow flycatcher. Protection and conservation measures discussed in Section 5.2.7.3 would also be conducted under the Reduced Operation Alternative.

Wetlands

Livermore Site

Under the Reduced Operation Alternative, it is anticipated that most, but not necessarily all, No Action Alternative projects would be completed. Construction of new buildings under the Reduced Operation Alternative would occur in upland areas, so that land clearing would not be anticipated to have direct or indirect impacts on natural wetlands. Wetlands along Arroyo Las Positas could be impacted if discharged treated water from the Environmental Restoration Program is terminated; although such termination is not being considered during the time period covered by the LLNL SW/SPEIS. Future actions involving these wetlands could require consultation with the USACE, such as ongoing efforts to develop a water management plan for an 1,800-foot segment of Arroyo Seco within Livermore Site boundaries from the Vasco Road bridge to the East Avenue culvert (LLNL 2001ap). Additionally, the State of California has a no net loss policy regarding wetlands, including artificial wetlands. No impacts are expected.

Site 300

Under the Reduced Operation Alternative, a No Action Alternative Wetlands Enhancement Project would also be constructed to protect and enhance a minimum of 1.86 acres of wetland habitat in conjunction with the termination of artificial wetlands (totaling 0.62 acres) that have been created by cooling tower runoff near Buildings 801, 827, 851, and 865. A Section 404 permit would be required from the USACE and a Section 401 certification of waiver would need to be obtained from the Regional Water Quality Control Board.

5.4.7.3 *Cumulative Impacts*

Under the Reduced Operation Alternative, cumulative impacts would be essentially the same as under the No Action Alternative, except that a smaller amount of land disturbance would likely occur at the Livermore Site and Site 300. SNL/CA is managing their section of Arroyo Seco to protect California red-legged frog habitat and create a 30-acre wildlife preserve of the east side of that facility.

5.4.8 Air Quality

5.4.8.1 *Nonradiological Air Quality*

Relationship with Site Operations

The Reduced Operation Alternative allows for continued operation of most LLNL functions, although some planned activities would go forward at a scaled-back rate (i.e., a reduction in operating levels). Scaling back activities would result in a reduction in workforce levels at both sites and therefore, some reduction in vehicular activity and fuel demand. The general parameters that will be used in the analyses of potential air quality impacts are listed in Table 5.4.8.1–1. Impacts are expected to be minimal.

Impact Analysis

Modifications to Facilities or Operations

The Reduced Operation Alternative is similar to the No Action Alternative in that facility and infrastructure renovation (e.g., replacement of ductwork, roofs, installation of seismic and physical security upgrades, and repairs and modifications to roads) activity levels would remain on par with current levels. LLNL would continue to include standard measures for controlling pollution as part of every design and construction project. With the mitigation measures in place as discussed in Sections 5.1.8 and 5.2.8.1, impacts would be similar to current levels.

This alternative would allow the construction and operation of planned and recently approved facilities as discussed under the No Action Alternative, resulting in a 1 percent increase in developed space. While the increase in facility space would result in some additional fuel use, this would be compensated by the scale back in some operating levels, providing a net reduction in demand. Several criteria and toxic air contaminants would be emitted from fuel combustion. Oxides of nitrogen are a concern locally as a contributor to ozone formation. The decreased fuel use anticipated under the Reduced Operation Alternative would result in a small reduction in oxides of nitrogen emissions, about 0.39 tons annually, which would be less than 2 percent of the oxides of nitrogen emissions from this source category under current operating conditions.

Decommissioning, Decontamination, and Demolition

The Reduced Operation Alternative would include the planned removal of excess and legacy facilities at the Livermore Site. The total space planned for removal and potential air quality impacts would equal that of the No Action Alternative. Mitigation measures that would be used to reduce air emissions associated with D&D actions are discussed in Section 5.2.8.1.

Support Personnel and Vehicular Activity

Scaling back activities would result in a reduction of approximately 900 workers at LLNL. The reduced workforce would result in a corresponding decrease in vehicular activity and therefore, slight reductions in vehicular emissions.

Cumulative Impacts

The Reduced Operation Alternative would result in a small reduction in air pollutant loading and a net positive impact on air quality. The parameters used to evaluate air quality impacts under the Reduced Operation Alternative are listed in Table 5.4.8.1–1. Table 5.4.8.1–2 presents the calculated maximum carbon monoxide concentrations, which would remain within 20 to 30 percent of ambient standards. These levels would not differ appreciably from those under the No Action Alternative because both the No Action and Reduced Operation Alternatives would represent minor contributors to the carbon monoxide concentration, which is dominated by current traffic levels and background sources. Projected air pollutant emission rate reductions associated with decreased fuel combustion in boilers and engines and the decreased vehicular activities associated with reduced workforce requirements under the Reduced Operation Alternative are provided in Table 5.4.8.1–3.

5.4.8.2 *Radiological Air Quality*

This section analyzes the Reduced Operation Alternative radiological air quality impacts due to normal releases from ongoing site operations (e.g., R&D, waste management). Impacts in terms of dose are related to either the Livermore Site or Site 300.

Relationship with Site Operations

This section summarizes the relationship between projects described in Section 3.4 for the Reduced Operation Alternative and radiological air quality. The dose resulting from exposure to routine air emissions from these projects is used to quantify the impacts. The important incremental impact to the No Action Alternative is due to reductions in NIF operations.

Impact Analysis

Livermore Site

The reduction in radiological air emissions and corresponding dose reductions from the No Action Alternative to the Reduced Operation Alternative would be a result of a one-third decrease in NIF releases other than tritium. Tritium emissions from the Tritium Facility would remain 210 curies per year. The resulting site-wide MEI dose from atmospheric emissions, at the same location as for the No Action Alternative, would be 0.1 millirem per year. This dose would be less than 0.9 percent of the NESHAP limit. Thirty-four percent of this dose would be from NIF emissions.

The corresponding population dose would be 1.8 person-rem per year, 86 percent would be a result of Tritium Facility operations. The NIF would have relatively less effect on the population dose than it would on the site-wide MEI dose because many of the important nuclides released are short-lived and would decay prior to reaching the general population. The dose to worker population would be 0.13 person-rem per year.

No adverse health impacts from normal radiological air emissions would be expected under the Reduced Operation Alternative at the Livermore Site (see Section 5.4.14.4).

Site 300

The reduction in impact from the No Action Alternative to the Reduced Operation Alternative would be a result of a decrease of tritium releases during explosives experiments to 15 milligrams (or 145 curies). The site-wide MEI dose, at the same location as under the No Action Alternative, would be 0.055 millirem per year, less than the 0.6 percent of NESHAP limit. The population dose would be 9.8 person-rem per year. The dose to the worker population would be 0.005 person-rem per year.

No adverse health impacts from normal radiological air releases would be expected under the Reduced Operation Alternative at Site 300.

Cumulative Impacts

No adverse impacts on radiological air quality would be expected under the Reduced Operation Alternative at either the Livermore Site or Site 300. Other than background radiation sources, there are no other known contributors to concentrations of radionuclides in air within 50 miles of the Livermore Site or Site 300. Therefore, there would be no cumulative radiological air quality impacts.

5.4.9 Water

5.4.9.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.4 under the Reduced Operation Alternative and the water impact analysis. The effect of projects under the Reduced Operation Alternative on water resources would be related to decreased water use, impervious surfaces and runoff, and decreased use of potential contaminants as a result of construction and operation of projects.

5.4.9.2 *Impact Analysis*

Livermore Site

Under the Reduced Operation Alternative, impacts to water resources would be expected to be similar to, but slightly less than, those described under the No Action Alternative. This is because similar, but fewer, activities would occur at the Livermore Site under the Reduced Operation Alternative. Due to reductions in activities at the NIF, the Terascale Simulation Facility, and other facilities, as described in Section 3.4, water consumption under the Reduced Operation Alternative would decrease by 16.8 percent from the level estimated under the No Action Alternative. Similarly, increases in impervious surfaces would be less than expected under the No Action Alternative. The surface water and stormwater monitoring program would not change and no impacts to surface water quality would be expected. Because no facilities would be located in either the 100-year or 500-year floodplain, no impact from flooding would be expected, nor would impacts to floodplains occur.

Impacts to groundwater would be similar to those described in the No Action Alternative. Groundwater remediation at the Livermore Site would continue and, therefore, groundwater quality would continue to improve. No discharges to groundwater would occur and potential impacts to groundwater quality from surface water recharge would be minimal because LLNL would continue to comply with NPDES requirements.

Site 300

Under the Reduced Operation Alternative, impacts to water resources would be expected to be similar to, but slightly less than, those described under the No Action Alternative. This is because similar, but fewer, activities would occur at Site 300 under the Reduced Operation Alternative. Water consumption for Site 300 would remain at 0.35 million gallons per day. Similarly, increases in impervious surfaces would be less than expected under the No Action Alternative. The surface water and stormwater monitoring program would not change and no impacts to surface water quality would be expected. Because no facilities would be located in either the 100-year or 500-year floodplain, no impact from flooding would be expected, nor would impacts to floodplains occur.

Impacts to groundwater would be similar to those described in the No Action Alternative. Groundwater remediation at Site 300 would continue and, therefore, groundwater quality would continue to improve. No discharges to groundwater would occur and potential impacts to groundwater quality from surface water recharge would be minimal because LLNL would continue to comply with NPDES requirements.

5.4.9.3 *Cumulative Impacts*

Livermore Site

Under the Reduced Operation Alternative, cumulative impacts to water use, surface and groundwater contaminants, and impervious surfaces would be expected to be similar to, but slightly less than, those described under the No Action Alternative. A complete discussion of cumulative impacts can be found in Section 5.2.9.4.

Site 300

Under the Reduced Operation Alternative, cumulative impacts to water use, surface and groundwater contaminants, and impervious surfaces would be expected to be similar to, but slightly less than, those described under the No Action Alternative. A complete discussion of cumulative impacts can be found in Section 5.2.9.4.

5.4.10 Noise

This section presents noise impacts resulting from implementation of the Reduced Operation Alternative. The analysis is organized by noise-generating LLNL activities such as construction, modifications to and removal of facilities, traffic noise, and impulse noise.

5.4.10.1 *Relationship with Site Operations*

Activities associated with the Reduced Operation Alternative (Section 3.4) would contribute to noise generations, either directly or indirectly.

The general parameters that were used to characterize community noise levels are listed in Table 5.4.10.1–1.

5.4.10.2 *Impact Analysis*

The Reduced Operation Alternative would allow for continued operation of most LLNL functions, although some planned activities at both the Livermore Site and Site 300 would go forward at a scaled-back rate; i.e., a reduction in the planned number of demonstration projects or planned operating levels. Scaling back activities would also result in a reduction in workforce levels at both sites.

Modifications to Facilities or Operations

The Reduced Operation Alternative is similar to the No Action Alternative in that the projected level for construction activities related to facility and infrastructure renovations would remain on par with current levels, and the effect of these activities would not be noticeable beyond the site boundary, owing to the relatively large spatial area of LLNL sites and perimeter buffer zone common to both the Livermore Site and Site 300. Intervening roadways between the sites and community areas also would reduce the impact of onsite-generated noise. These improvements would not introduce any machinery or equipment that would differ from the current HVAC equipment, cooling towers, motors, pumps, fans, generators, air compressors, and loudspeakers. Noise from this equipment would not be noticeable beyond the site boundary. Impacts are expected to be similar to the No Action Alternative.

Traffic Noise

Scaling back activities would result in a reduction in workforce. Approximately 880 fewer workers would be required at the Livermore Site and 20 fewer at Site 300. The reduced workforce would translate into a corresponding decrease in vehicular activity and a slight, although probably not discernible, decrease in ambient noise.

Impulse Noise

LLNL would continue explosives research testing under the Reduced Operation Alternative at both the Livermore Site, within the HEAF Building, and at Site 300, within the Contained Firing Facility and on open firing tables. The shot frequency (blasts per year) would be scaled back to some extent, although the intensity would remain unchanged and impacts would be the same as under the No Action Alternative. LLNL would continue to use blast forecasting as a tool to determine if explosive tests would affect the surrounding community and to restrict operations when peak impulse noise levels are predicted to exceed 126 dB(A) in populated areas. LLNL would also continue to perform meteorological monitoring to provide necessary input data for blast forecasting (LLNL 2001s).

Decommissioning, Decontamination, and Demolition

The Reduced Operation Alternative would include the removal of excess and legacy facilities at the Livermore Site equal to that under the No Action Alternative. With the relatively large spatial area and perimeter buffer zone, noise from demolition activities would not be expected to be discernible in offsite areas.

5.4.10.3 *Cumulative Impacts*

The scale back of activities under the Reduced Operation Alternative would not be expected to contribute to cumulative impacts on community noise levels.

5.4.11 Traffic and Transportation

The estimate of traffic congestion is based on the change in employment under the Reduced Operation Alternative compared to the No Action Alternative. Radiological consequences were calculated using DOE transportation models as described in Section 5.1.11. Appendix J of this LLNL SW/SPEIS presents more detail on the methodology and important inputs for radiological transportation analysis.

5.4.11.1 *Relationship with Site Operations*

Section 3.4 describes the projects under the Reduced Operation Alternative. These projects, when combined with current operations, would result in decreased radiological transportation. The major shipments under the Reduced Operation Alternative would result in approximately 265 shipments of special nuclear material, 55 shipments of LLW and MLLW, 3 tritium shipments, and 7 TRU waste shipments (see Section J.5.4 for more details).

5.4.11.2 *Impact Analysis*

Livermore Site

Under the Reduced Operation Alternative, LLNL employment would decrease slightly from the No Action Alternative of 10,650 to approximately 9,770 workers. Radiological transportation under this alternative would slightly decrease from the No Action Alternative. This small percent decrease would result in a small benefit.

Radiological shipments would include reduced numbers of shipments of LLW (39), TRU (11), and special nuclear material (11). Potential impacts from these shipments are presented in Table 5.4.11.2–1. The number of LCFs under the Reduced Operation Alternative would be much less than one (1×10^{-3}) per year.

TABLE 5.4.11.2–1—*Collective Dose to the General Public From Radioactive Shipments Under the Reduced Operation Alternative*

Shipment Type	Collective Dose (person-rem per year)			
	Along Route	**Sharing Route**	**At Stops**	**Total**
LLW	6.5×10^{-2}	0.79	0.35	1.2
TRU waste	2.9×10^{-2}	0.35	0.16	0.54
Materials[a]	0.15	1.9	1.1	3.1
Total	**0.25**	**3.1**	**1.6**	**4.9**
No Action Alternative	0.33	3.8	1.8	5.9

[a] Nonwaste radioactive materials, including special nuclear materials, tritium, and other materials used for the LLNL mission.
LLW = low-level waste; TRU = transuranic.

Site 300

Under the Reduced Operation Alternative, a reduction in the number of hydroshots and a small potential decrease in the number of workers would result in a small decrease in traffic and parking requirements. This impact is expected to be negligible.

5.4.11.3 *Cumulative Impacts*

Cumulative transportation impacts under the Reduced Operation Alternative would be less than those from either the No Action Alternative or the Proposed Action for both the Livermore Site and Site 300.

5.4.12 Utilities and Energy

This section discusses the potential impacts of the Reduced Operation Alternative on utilities and energy supplies. Utility and energy usage is discussed separately for the Livermore Site and Site 300. LLNL-leased properties (i.e., Almond Avenue, Graham Court, Patterson Pass, and Arroyo Mocho Pump Station) are considered part of the Livermore Site in assessing utility and energy impacts.

5.4.12.1 *Relationship with Site Operations*

This section summarizes the relationship between projects described in Section 3.4 for the Reduced Operation Alternative and the utilities and energy analysis. In general, the effect of projects for the Reduced Operation Alternative on utilities and energy analyses are related to water consumption, sewage discharges, electricity consumption, and fuel consumption resulting from reductions in the quantity of surveillance and test activity performed under the Reduced Operation Alternative.

5.4.12.2 *Impact Analysis*

Water Consumption

Livermore Site

The existing capacity of the Livermore Site domestic water system is approximately 2.88 million gallons per day. Under the No Action Alternative, water use at the Livermore Site would be approximately 276 million gallons per year (see Section 5.2.12.3).

Due to reductions in activities at the NIF, the Terascale Simulation Facility, and other facilities, as described in Section 3.4, water consumption under the Reduced Operation Alternative would decrease to approximately 230 million gallons per year, a 17 percent reduction from the level estimated under the No Action Alternative. Because the Livermore Site domestic water system has excess capacity and water use would decrease under the Reduced Operation Alternative, no new impacts are expected.

Site 300

Water consumption at Site 300 is expected to be 67,900 gallons per day under the No Action Alternative Consumption under the Reduced Operation Alternative would remain at this level. No new impacts are expected.

Sewer Discharges

Livermore Site

Under the No Action Alternative, the Livermore Site would discharge approximately 224,000 gallons per day to the sanitary sewer system (see Section 5.1.12.2). Under the Reduced Operation Alternative, LLNL would scale back operations at the NIF and the Terascale Simulation Facility by 33 percent and 40 percent, respectively. However, both facilities would maintain full operations and facility support staff. Therefore, sewer discharges under the Reduced Operation Alternative would remain at the level estimated under the No Action Alternative. No new impacts are expected.

Site 300

Site 300 will discharge approximately 2,100 gallons of sewage per day under the No Action Alternative. Discharges under the Reduced Operation Alternative would remain at these levels. No offsite sewage treatment is conducted for Site 300 wastes and no new impacts are expected.

Electricity Consumption

Livermore Site

The projected peak electrical demand under the Reduced Operation Alternative would be 81 megawatts. Under the No Action Alternative, electricity consumption at the Livermore Site would be approximately 446 million kilowatt-hours per year. Based on reduction activities at the NIF, the Terascale Simulation Facility, and other facilities, as described in Section 3.4, consumption under the Reduced Operation Alternative would decrease by 17 percent from the level estimated under the No Action Alternative to 371 million kilowatt-hours per year. No new impacts are expected.

Site 300

PG&E supplies electrical power to Site 300. Electricity consumption at Site 300 is approximately 16.3 million kilowatt-hours per year under the No Action Alternative. Consumption under the Reduced Operation Alternative would remain at these levels. No new impacts are expected.

Fuel Consumption

Livermore Site

PG&E supplies natural gas to the Livermore Site. Natural gas consumption for the Livermore Site would average 23,300 therms per day under the No Action Alternative. Consumption under the Reduced Operation Alternative would decrease by 3 percent from the level estimated under the No Action Alternative, or approximately 22,600 therms per day. No new impacts are expected.

Diesel fuel and unleaded gasoline usage would remain constant even under the Reduced Operation Alternative. Consumption of approximately 72,200 gallons diesel fuel per year and 451,800 gallons per year unleaded gasoline is anticipated.

Site 300

Site 300 fuel oil consumption is approximately 16,600 gallons per year under the No Action Alternative. Consumption under the Reduced Operation Alternative would remain at these levels. No new impacts are expected.

5.4.12.3 *Cumulative Impacts*

Water Consumption

Livermore Site

The Reduced Operation Alternative, together with other developments in the Hetch Hetchy service area, would increase demand for and consumption of water. For example, the population in Alameda County is projected to increase by about 17 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other uses in Alameda County are expected to increase proportionally. Other counties in the Hetch Hetchy service area would experience similar growth. This population growth would constitute cumulative impact upon water resources and supply systems in the Hetch Hetchy service area.

Site 300

Current water use at Site 300 is considered to be representative of future consumption rates for the Reduced Operation Alternative. However, development in the vicinity of Site 300 would increase demand for and consumption of water. Population in San Joaquin County is projected to increase by 30 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other uses in San Joaquin County are expected to increase proportionally. This population growth would constitute a cumulative impact on groundwater resources and supply systems. Similarly, population growth in the Hetch Hetchy service area would constitute a cumulative impact on the Hetch Hetchy system.

Sewer Discharges

Livermore Site

The Reduced Operation Alternative, together with other developments in the area, would increase demand for sewage services. Population in Alameda County is projected to increase by about 17 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other uses in Alameda County are expected to increase proportionally. This growth in conjunction with sewer discharge from the Livermore Site could constitute a substantial cumulative impact on sewage systems in the area. The LWRP currently receives a total of approximately 6.5 million gallons of effluent per day. While existing LWRP capacity of 8.5 million gallons per day is expected to be sufficient for inflow treatment for the next 10 years, sewage treatment facility improvements are being planned in the region.

Site 300

Because Site 300 sewer discharge and treatment programs are mostly self-contained, no cumulative impact is expected as a result of the Reduced Operation Alternative.

Electricity Consumption

Livermore Site

The Reduced Operation Alternative, together with other developments in the area, would increase electric power demand. Population in Alameda County is projected to increase by about 17 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other uses in Alameda County are expected to increase proportionally. This growth in conjunction with the demand for electrical power at the Livermore Site could constitute a substantial cumulative impact on electric power resources in the area. However, electric utilities provide approximately 10,605 million kilowatt-hours per year of electricity to Alameda County (CEC 2001). More than 10,000 megawatts of new electric generation capacity is planned in the PG&E service area, additional generating capacity is planned throughout California and surrounding states (CEC 2000). Expanded electric transmission capability is also planned in the region. If implemented as planned, these additions would provide sufficient capacity to meet Alameda County electrical energy needs for the next 10 years. Therefore, no new impacts are expected.

Site 300

Current electric power consumption at Site 300 is considered to be representative of future consumption rates for the Reduced Operation Alternative. However, the population in San Joaquin County is projected to increase by 30 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other electric power uses in San Joaquin County are expected to increase proportionally. This growth in conjunction with Site 300 electricity use could constitute a substantial cumulative impact on electric power resources in the area. Currently, electric utilities provide approximately 5,106 million kilowatt-hours per year of electricity to San Joaquin County (CEC 2001). However, more than 10,000 megawatts of new electric generation capacity is planned in the PG&E service area, additional generating capacity is planned throughout California and surrounding states (CEC 2000). Expanded electric transmission capability is also planned in the region. These additions would provide sufficient capacity to meet San Joaquin County electrical energy needs for the next 10 years. Therefore, no new impacts are expected.

Fuel Consumption

Livermore Site

The Reduced Operation Alternative, together with other developments in the PG&E service area, would increase the demand for natural gas. Population in Alameda County is projected to increase by about 17 percent by the year 2015 (DOF 2001). Residential, commercial, industrial, and other uses in Alameda County are expected to increase proportionally. This growth could constitute a cumulative impact on natural gas supply systems. However, PG&E's transmission capacity is approximately 130 percent of the demand for natural gas in its service area (CPUC 2001). As required by the California Public Utilities Commission, PG&E uses a 15-year planning horizon for gas transmission and storage capacity and a 10-year planning horizon for local gas distribution systems. Accordingly, PG&E plans to provide sufficient capacity to meet Alameda County needs for the next 10 years. Therefore, no new impacts are expected.

Site 300

Current fuel oil consumption at Site 300 is considered to be representative of future consumption rates for the Reduced Operation Alternative. However, the population in San Joaquin County is projected to increase by 30 percent by the year 2015 (DOF 2001). Fuel oil use in San Joaquin County is expected to increase as the population increases, but at a lower rate. This growth could constitute a cumulative impact on fuel oil supplies in the county. However, overall fuel oil use in California has declined substantially as air quality regulations concerning greenhouse gas emissions become more stringent. Consequently, fuel oil delivery systems within San Joaquin County have large amount of excess capacity. This excess capacity is sufficient to meet San Joaquin County requirements for the next 10 years. Therefore, no new impacts are expected.

5.4.13 Materials and Waste Management

5.4.13.1 *Materials Management*

This section provides an overview of management responsibilities regarding receipt, transfer, and shipment of radioactive, controlled, and hazardous materials under the Reduced Operation Alternative. Appendices A, B, D, M, and N of this LLNL SW/SPEIS include descriptions of programs and buildings associated with use of these materials. The use of these materials historically has resulted in both their planned and inadvertent releases to the environment.

Relationship with Site Operations

New operations are defined as programmatically planned projects with defined implementation schedules that would take place in the future (e.g., the NIF). The Reduced Operation Alternative could include all new operations, D&D projects, and other activities identified in Section 3.4. In general, material usage at LLNL would decrease, consistent with an 8 percent decrease in LLNL operations from the No Action Alternative.

Waste minimization and pollution prevention techniques would further reduce material usage. Average maximum quantities would likely remain constant as material storage space remains constant; however, average quantities would increase to meet demand. Under the Reduced

Operation Alternative, material projections used for analysis would not exceed existing material management capacities.

Impact Analysis

The Reduced Operation Alternative would not cause any major changes in the types of materials used onsite. Material usage at LLNL would decrease, consistent with an 8 percent decrease in laboratory operations from the No Action Alternative. Waste minimization and pollution prevention techniques would be expected to increase reductions in material usage. Average maximum quantities would likely remain constant as material storage space remains constant; however, average quantities would be expected to decrease as demand decreases. Under the Reduced Operation Alternative, material projections used for analysis would not exceed existing material management capacities.

Existing Operations

The Reduced Operation Alternative total hazardous material usage would decrease for existing facilities. Under the Reduced Operation Alternative, average quantities would decrease by an estimated 8 percent (Table 5.4.13.1–1) below the No Action Alternative. Annually, approximately 158,000 to 177,000 chemical containers, ranging from 210-liter (55-gallon) drums to gram-quantity vials would be used or stored at LLNL.

For the Livermore Site, approximately 64,000 gallons of liquids would be managed annually with an estimated storage capacity of 227,000 gallons under the Reduced Operation Alternative. Approximately 1.3 million pounds of solids would be handled with a storage capacity of 2.4 million pounds. Solid material storage would not be expected to fluctuate because metals (e.g., lead used for shielding) are less likely to be consumed and more likely to be reused and reclaimed. Regardless, there would be sufficient capacity to accommodate anticipated operations. Approximately 1.1 million cubic feet of mostly industrial gases (argon, helium, hydrogen, oxygen, nitrogen) would be used annually with a storage capacity of 71.6 million cubic feet. Projections for specific hazardous chemicals for existing Livermore Site operations and Site 300 operations are presented in Table 5.4.13.1–1 and Table 5.4.13.1–2, respectively. Additional detail is provided in Appendix B.

New Operations

The Reduced Operation Alternative would include new operations under the No Action Alternative that would offset decreases in annual hazardous material usage rates over the next 10 years. The majority of the offset would be due to the full implementation of NIF and BSL-3 operations. New operations would account for approximately 70,000 gallons of liquids and solids and approximately 20,000 standard cubic feet of industrial gases. Materials expected to support other projects, including the new projects, are described in Tables 5.2.13.1–3 and 5.3.13.1–3. For new facilities, no impacts would be expected because each of the new facilities would be designed to handle expected quantities.

Under the Reduced Operation Alternative, seven facility initiatives would be undertaken, all of which would reduce operations. Site material usage would be expected to decrease slightly because of these facility initiatives. See Appendix B for more information.

5.4.13.2 *Waste Management*

This section provides an overview of generation, storage, treatment, and disposal of radioactive, hazardous, mixed, and other wastes, including biohazardous and D&D wastes at LLNL under the Reduced Operation Alternative. Appendices B, M, and N include descriptions of wastes and facilities associated with their use, generation, and management.

Relationship with Site Operations

New operations are defined as programmatically planned projects with defined implementation schedules that will take place in the future, such as the NIF. The Reduced Operation Alternative would include all new operations, D&D projects, and other activities, including permit modifications, identified under the No Action Alternative. In general, waste generation at LLNL would decrease, consistent with an 8 percent decrease in LLNL operations from the No Action Alternative.

Under the Reduced Operation Alternative, waste generation projections used for analysis would not exceed existing waste management capacities.

Impact Analysis

Implementation of the Reduced Operation Alternative would not cause any major changes in the types of waste streams generated onsite. No additional waste storage, treatment, handling capacity, regulatory requirements, or security requirements would be needed. Overall waste generation levels at LLNL would remain essentially consistent with recent generation quantities experienced since 1992. Annually, any increase would be consistent with increases from new operations and normal fluctuations as previously noted. Waste minimization and pollution prevention techniques would be expected to offset a portion of the projected wastes. Between 1993 and 2001, overall (routine and nonroutine) TRU waste, LLW, MLLW, and hazardous waste generation, as reported by DOE, were reduced by 91, 57, 89, and 57 percent, respectively (DOE 2002s). Onsite waste handling capacities are four to five times expected waste volumes. Waste projections used for analysis would not exceed existing offsite waste management disposal capacities. Wastes associated with existing operations, new operations, and special operations are discussed later in this section, including other wastes.

The Reduced Operation Alternative would not eliminate assigned missions or capabilities, but could entail not consolidating, enhancing, or upgrading operations. However, RHWM operations would not be reduced beyond those required to maintain safety, permit requirements, or other agreements, such as the Site Treatment Plan. Several project initiatives would be implemented under the Reduced Operation Alternative, as shown in Table 5.4.13.2–1. The associated waste generation would not change overall generation rates. The Reduced Operation Alternative would allow only partial fulfillment of the RHWM mission by limiting future permit modifications and delaying RCRA closures and would not fully satisfy the purpose and need for agency action.

TABLE 5.4.13.2–1.—*Planned Projects Under the Reduced Operation Alternative and Associated Waste Projections*

Project Title	Project Description	Expected Waste Streams
Terascale Operations Reduction Simulation Facility	Scale back of operations to reduce use of electricity and cooling load.	Minimal changes to routine waste generation.
Integrated Technology Program	Reduce from No Action by canceling system demonstration.	Minimal changes to routine waste generation.
Reduce Number of Hydro Shots at S300	Scale back from the No Action planned number of hydroshots at Site 300 with corresponding decrease in CMS activity.	Minimal changes to routine waste generation.
Reduce Number of EDUs	Reduction in planned number of engineering demonstration.	Minimal changes to routine waste generation.
Reduce Number of Subcritical Assemblies	Reduce number of assemblies for subcritical experiments.	Minimal changes to routine waste generation.
Reduce Pit Surveillance	Reduction in planned number of surveyed pits.	Minimal changes to routine waste generation.
NIF Operations Reduction	Reduce ignition yield from 1,200 MJ/y to 800 MJ/yr.	Minimal changes to routine waste generation.

Sources: LLNL 2002y, TtNUS 2003.
CMS = chemicals and materials science, EDU = Engineering Demonstration Units; MJ/yr = megajoules per year; NIF = National Ignition Facility.

The Reduced Operation Alternative would include all new operations, D&D projects, and other activities, including permit modifications and RCRA closures, identified under the No Action Alternative, as discussed in Section 5.2.13.2. This alternative would differ from the No Action Alternative in generation of routine waste quantities (Table 5.4.13.2–2) and nonroutine waste quantities (Table 5.4.13.2–2).

Existing Operations

For projection purposes, CY1993-CY2002 routine waste generation data were considered a reasonable range for existing facilities; an average of these years was used. The amount of waste generated from existing operations would reflect proportional decreases in LLNL activity levels. The waste quantities would represent a site-wide aggregate of quantities for each type of waste category. Table 5.4.13.2–2 includes existing operations contributions to the estimated annual (routine) waste generation quantities by waste category. No new impacts are expected.

New Operations

New operations (including project-specific information) wastes are considered to be derived from mission-related work and additive. The waste quantities would represent a site-wide aggregate of quantities for each type of waste category. Table 5.4.13.2–2 includes new operations contributions to the estimated annual (routine) waste generation quantities by waste category. Table 5.4.13.2–2 includes new operations under the Reduced Operation Alternative. Table 5.4.13.2–1 presents qualitative waste information by project. No impacts are expected.

TABLE 5.4.13.2–2.—*Routine and Nonroutine Operations Waste Generation Quantities Under the Reduced Operation Alternative and No Action Alternative*

Waste Type	Annual Quantities			
	No Action Alternative[a]		Reduced Operation Alternative	
	Routine	Nonroutine	Routine[b]	Nonroutine
LLW	200 m^3/yr	630 m^3/yr	180 m^3/yr	550 m^3/yr
MLLW	61 m^3/yr	72 m^3/yr	42 m^3/yr	63 m^3/yr
Total Hazardous[c]	390 metric tons	1,500 metric tons	300 metric tons	1,300 metric tons
TRU	50 m^3/yr	55 m^3/yr	45 m^3/yr	5 m^3/yr
Mixed TRU	1.7 m^3/yr	0 m^3/yr	0.7 m^3/yr	0 m^3/yr
Sanitary solid	4,800 metric tons	Included in Routine	4,400 metric tons	Included in Routine
Wastewater	310,000 gal/day	Included in Routine	290,000 gal/day	Included in Routine

Sources: TtNUS 2003.
[a] For routine wastes based on average quantities since 1992 and one standard deviation, expected increase in activity levels, and new operations contributions. No margin was added for nonroutine.
[b] Based on average quantities since 1992, expected decrease in activity levels (approximately 8 percent), and new operations (No Action only) contributions.
[c] Total Hazardous includes RCRA hazardous, State-Regulated, and TSCA.
gal/day = gallons per day; LLW = low=level waste; MLLW = mixed low-level waste; m^3/yr = cubic meters per year; TRU = transuranic.

Special (Nonroutine) Operations

Waste generation levels for special (nonroutine) program waste, such as for unused chemicals or laboratory closeout, are derived separately from 1993 to 2002 nonroutine waste generation. The amount of waste generated would reflect proportional decreases in LLNL activity levels. The waste quantities would represent a site-wide aggregate of quantities for each type of waste category. Table 5.4.13.2–2 presents estimated annual (nonroutine) waste generation quantities by waste category. No impacts are expected.

All Other Wastes

LLNL operations would also involve the five additional waste management activity areas discussed below.

Biohazardous (includes Medical Waste Management Act*) Waste*

In 2002, several hundred pounds of biohazardous waste were disposed of at an approved offsite facility. Under the Reduced Operation Alternative, biohazardous waste generation would decrease by 8 percent. The existing waste handling capabilities would be adequate to accommodate this waste. No impacts would occur because offsite disposal capacity would continue to be sufficient.

Construction and D&D Waste

No new construction would occur under the Reduced Operation Alternative.

With approximately 700,000 square feet of excess facilities, to bound impacts, this analysis assumed the removal of all excess facilities. This would generate approximately 4,200 metric tons of debris (600 metric tons per 100,000 square feet). It is estimated that only 350 metric tons would be of the LLW, MLLW, and hazardous variety (Bisanni 2003). Approximately two-thirds of the debris total would be diverted, recycled, or reclaimed (LLNL 2002cc). The existing waste treatment facilities would occur because existing waste handling capabilities are already in handling capabilities would be adequate to accommodate this waste. No impacts would occur because offsite disposal capacity would continue to be sufficient.

Environmental Restoration Waste

Site-wide environmental restoration waste generation trends at LLNL would generally remain a function of treatment units, the number of wells, and the number of hours of operation. No impacts to treatment facilities would occur because existing waste handling capabilities are already in place.

Explosive Waste

The Explosives Waste Treatment Facility would handle 2,400 to 2,800 pounds per year. The Explosive Waste Storage Facility would store (gross) 5,200 to 6,200 pounds per year. This would represent an 8 percent decrease from the No Action Alternative. No additional capacity would be required. No impacts are expected.

Wastewater

Wastewater would decrease to approximately 290,000 gallons per day. The current capacity of 1.69 million gallons per day would be adequate to accommodate this waste. No impacts would occur because offsite disposal capacity would continue to be sufficient.

Permit Modifications, RCRA Closures, Permit Renewal, and Other Planned Activities

The Reduced Operation Alternative would include all permit modifications and a permit renewal identified in the No Action Alternative, as discussed in Section 5.2.13.2. This alternative would differ from the No Action Alternative as follows:

- Submit 50 Class 1 permit modification request (may include more than one item per submittal) over the next 10 years (see Appendix B for details).

- Submit no Class 2 or Class 3 permit modifications over the next 10 years.

These Class 1 permit modifications would enhance existing operations and would likely result in beneficial environmental impacts through improved efficiency. The Reduced Operation Alternative would allow only partial fulfillment of the RHWM mission by limiting future permit modifications and would not fully satisfy the purpose and need for agency action.

Cumulative Impacts

The ROI for waste management involves LLNL and its facilities as presented in Chapter 4 of this LLNL SW/SPEIS. The ROI for cumulative impacts is larger than that presented in Chapter 4 and considers the contributions of LLNL (Livermore Site and Site 300), SNL/CA, other NNSA activities, local projects and activities, and the State of California. NNSA assessed cumulative impacts by combining the potential effects of the Proposed Action with the effects of other past, present, and reasonably foreseeable activities in the ROI. The Proposed Action was chosen to assess and present a bounding scenario of potential cumulative effects. This approach allowed a conservative analysis or a maximum estimation of cumulative impacts, as discussed in Section 5.3.13.2.

5.4.14 Human Health and Safety

5.4.14.1 *Nonradiological Health Impacts*

Operations at LLNL would involve a wide range of activities with the potential for exposures of involved and noninvolved workers and the public hazardous materials or conditions. These hazards would include radioactive material, ionizing and non-ionizing radiation, chemicals, biological agents, and industrial hazards. Hazardous chemicals to which involvewd and noninvolved workers could potentially be exposed, under the Reduced Operation Alternative at the Livermore Site and Site 300, are listed in Table 5.4.13.1–1 and Table 5.4.13.1–2.

Relationship with Site Operations

Section 3.4 describes projects under the Reduced Operation Alternative. These projects, when combined with current operations, would result in a decrease in chemical inventories. Construction or demolition activities associated with this alternative would reduce overall site hazards by removing chemical and physical hazards from the workplace. These activities would represent a decrease in potential injuries associated with industrial safety hazards.

Impact Analysis

Under the Reduced Operation Alternative, six facility initiatives would be undertaken, all of which would reduce operations. Site material usage would decrease slightly because of these initiatives. Under the Reduced Operation Alternative, some construction, renovation, or modification of facilities would occur. Although no specific D&D projects were identified under the Reduced Operation Alternative, the potential for completing a D&D project would exist. Under the Reduced Operation Alternative, decreases in average chemical inventories would be expected. The level of exposure to occupational, toxic, or physical hazards encountered by site personnel would be expected to decrease slightly. Impacts are expected to be decreased under the Reduced Operation Alternative.

During the course of routine operations, the potential would exist for some personnel to be exposed to radiological, chemical, biological, and physical hazards. Implementation of the LLNL ISMS would minimize the risk of personnel exposures through characterization and control measures during the planning stages of work activities.

Overall, site usage of toxic substances and physical hazards would decrease under the Reduced Operation Alternative. The reduced use of chemicals is also projected under the Reduced Operation Alternative. This should result in a reduction in the potential for worker exposures. Continued application of site ES&H and ISMS principles would result in minimal impacts to workers and the public. Thus, the impacts of this alternative would not be considered adverse.

Employees at Site 300 perform work in accordance with established site-wide programs as well as Site 300-specific programs. Site-specific integration work sheets, facility safety plans, and standard operating procedures are prepared to supplement activities not covered by site safety plans or the LLNL ES&H Manual (LLNL 2000i). The projects under the Reduced Operation Alternative would result in a decrease in usage of hazardous chemicals.

The proposed decrease in construction, demolition, and renovation activities should represent a moderate impact on the reduction of site injury and illness rates. Additionally, scaling back operations at seven facilities would result in reducing site staff. Injury and illness case rates applied to a reduced staff should lead to an overall reduction in site recordable incidents making these impacts beneficial. Using the 2002 injury and illness data from the year 2002 as bounding, due to the downward trend, the following results would be expected for the lowest site population year under the Reduced Operation Alternative:

- 219 recordable cases
- 66 last or restricted workday cases
- No fatalities would be expected

Facility upgrades and continued implementation of the site ES&H program components would significantly reduce the risk of personnel exposures. Workplace and personnel monitoring data indicate the effectiveness of the current program (LLNL 2002bk).

The proposed decrease in construction, demolition, and renovation activities should lead to a moderate reduction in site injury and illness rates and would have a beneficial impact.

Cumulative Impacts

The occupational health and safety of workers at LLNL is site-specific and would not be affected by other activities occurring within the area. Cumulative effects for workers would be the same as those presented in the Reduced Operation Alternative impact analysis above.

5.4.14.2 *Radiological Health Impacts*

This section analyzes the radiological health impacts from the Reduced Operation Alternative. Impacts to workers are given in terms of number of cancer fatalities resulting from employment activities in the worker population. Impacts to the public from normal releases are given in terms of the probability of the site-wide MEI contracting a fatal cancer from these operations. The number of fatal cancers expected in the general population because of LLNL operations is also described.

Relationship with Site Operations

This section summarizes the relationship between projects described in Section 3.4 for the Reduced Operation Alternative and radiological health impacts from normal site operations. The number of cancer fatalities to the workers and general public from exposure to these operations is used to quantify the impacts.

Impact Analysis

Worker

The dose to involved workers, those directly exposed to radiation in the performance of their jobs, would be 38 person-rem per year versus 90 person-rem per year in the No Action Alternative. This dose includes 10 person-rem per year from the NIF. Most of the remainder of this dose would be from operations in Building 332. Workers would be exposed to an increased risk of cancer as a result of occupational exposure to radiation over an extended period (calculated value of 0.023 fatalities per year of operation). Note that radiation exposure in all radiologically controlled areas would be kept ALARA through facility and equipment design and administrative controls.

The dose to noninvolved workers, those exposed to normal site radiological emissions not directly related to performance of their jobs, would be approximately 0.14 person-rem per year, as discussed in Section 5.4.8.2. Over 95 percent of this dose is from Livermore Site operations. No cancers (calculated value of 8.2×10^{-5} fatalities per year of operation) are expected to noninvolved workers.

General Public

The Reduced Operation Alternative impacts to the public would be a result of the radiation dose from atmospheric emissions described in Section 5.4.8.2. The dose to the Livermore Site site-wide MEI would be 0.22 millirem per year (0.09 from airborne effluents and 0.13 from skyshine). This dose is 0.2 percent of the DOE standard at 100 millirem per year (DOE O 5400.5). The probability of a fatal cancer to this site-wide MEI would be 1.3×10^{-7} per year of exposure versus 1.8×10^{-7} for the No Action Alternative.

The Reduced Operation Alternative site-wide MEI dose from Site 300 operations would 0.054 millirem per year, less than 0.6 percent of the NESHAP standard. This dose is essentially the same as for the No Action Alternative. The probability of a cancer fatality to this hypothetical individual would be 3.3×10^{-8} per year of exposure.

The population dose from all LLNL operations would be 12 person-rem per year. Skyshine effects are limited to locations in close proximity to the Livermore Site boundary next to the NIF and are not included in the population dose. No cancer fatalities (calculated value of 0.007 fatalities per year of operation) to the public would result from exposure to LLNL operations.

Cumulative Impacts

There is a possibility that an involved worker would contract a fatal cancer at some point during his or her lifetime as a result of extended occupational exposure under the Reduced Operation Alternative per year of operation (calculated value of 0.023 fatalities per year of operation versus 0.054 fatalities).

No adverse impacts to site workers or the general population would occur under the Reduced Operation Alternative. Other than background radiation sources, there would be no other known contributors to concentrations of radionuclides near the Livermore Site or Site 300. Therefore, there would be no new cumulative radiological impacts.

5.4.15 Site Contamination

The following section analyzes impacts of contaminated soils and sediments, surface water, and groundwater under the Reduced Operation Alternative.

5.4.15.1 *Relationship with Site Operations*

The Reduced Operation Alternative would include continued operations of investigation, cleanup, long-term stewardship, other activities including treatment system modifications and reporting and new actions identified under the No Action Alternative, as discussed in Section 5.2.13.2.

A general decrease in activity levels across the site is projected. Accordingly, a decrease in hazardous material and waste management and the potential for associated spill or release could occur. LLNL would conduct immediate cleanup actions and periodic site surveys to ensure environmental impacts would be minimized.

5.4.15.2 *Impact Analysis*

The Reduced Operation Alternative would result in minimal deposition of contaminants from continued operations to soil and continued removal of known contaminants under the cleanup effort would occur. No adverse impacts to future designated land use would be expected. No adverse effect on groundwater would be expected. Continued improvement of water quality and source reduction would occur.

5.4.15.3 *Cumulative Impacts*

The ROI for site contamination involves LLNL and its remedial sites as presented in Chapter 4 of this LLNL SW/SPEIS. The ROI for cumulative impacts is larger than that presented in Chapter 4 and considers the contributions of LLNL (Livermore Site and Site 300) and local projects.

Since the Reduced Operation Alternative and No Action Alternative begin with the same level of existing contamination, opportunities for future contamination and remediation activities would be the same. Cumulative impacts would be the same as those described in Section 5.2.15.4, combining the potential effects of the No Action Alternative with the effects of other past, present, and reasonably foreseeable activities in the ROI.

Within the ROI, soil contamination and groundwater contamination have occurred from various operations. However, past, present, and planned activities are designed to minimize contamination at LLNL, SNL/CA, and other sites. The cleanup of these sites has been and will be performed to a level that meets State of California approved health risk-based standards (which vary depending on the contaminants of concern) corresponding to the intended future uses of the sites. As existing contamination at LLNL is being cleaned up under the Environmental Restoration Program, no cumulative impacts would be expected.

5.5 BOUNDING ACCIDENT SCENARIOS

NEPA requires that an agency evaluate reasonably foreseeable adverse effects on the human environment in an EIS. This LLNL SW/SPEIS informs the decisionmaker and the public about the chances that reasonably foreseeable accidents associated with the No Action Alternative, Proposed Action, and Reduced Operation Alternative could occur, as well as the potential adverse consequences. An accident is considered bounding if no reasonably foreseeable accident can be found with greater consequences. An accident is reasonably foreseeable if the analysis of occurrence is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason (40 CFR §1502.22[b][4], DOE O 5400.5, DOE 1993b, DOE 2002t).

This section presents the potential impacts on workers, both involved and noninvolved, and the public due to potential accidents associated with operation of LLNL. Additional details supporting the information presented here, as well as approach to the analysis, are provided in Appendix D. Offsite transportation accidents are presented in Appendix J.

Many research activities at LLNL require the use of radioactive materials, hazardous chemicals, and explosives, all of which have the potential, under certain circumstances, to be involved in an accident. These materials are received at the sites, transferred onsite, and often shipped offsite. Activities using these materials onsite involve specialized facilities with appropriate safety equipment and procedures to reduce the possibility or the severity of accidents.

An accident is a sequence of one or more unplanned events with potential outcomes that endanger the health and safety of workers and the public. An accident can involve a combined release of energy and hazardous materials (radiological or chemical) that might cause prompt or latent health effects. The sequence usually begins with an initiating event, such as human error, equipment failure, or earthquake, followed by a succession of other events that could be dependent or independent of the initial event, which dictate the accident's progression and the extent of materials released. Initiating events are presented in Appendix D of this LLNL SW/SPEIS.

If an accident were to occur involving the release of radioactive, chemical, or biological materials, workers, members of the public, and the environment would be at risk. Workers in the facility where the accident occurs would be particularly vulnerable to the effects of the accident because of their location. The offsite public and noninvolved workers would also be at risk of exposure to the extent that meteorological conditions exist for the atmospheric dispersion of released hazardous materials. Using approved computer models, NNSA predicted the dispersion of released hazardous materials and their effects. However, prediction of latent potential health effects becomes increasingly difficult to quantify for facility workers as the distance between the accident location and the worker decreases. This is because the individual worker exposure cannot be precisely defined with respect to the presence of shielding and other protective features. The facility worker also may be injured or killed by physical effects of the accident itself.

5.5.1 Radiological Accident Scenarios

5.5.1.1 *Methodology*

Selection Process

The selection process for radiological accident scenarios used a multistep screening process to identify bounding events. For accidents associated with specific LLNL facilities, the screening process began with a review of all LLNL facilities with emphasis on building hazard classification, radionuclide inventories, including type, quantity, and physical form, and storage and use conditions. The selection process described in Appendix D reduced this list to 23 existing facilities and 5 proposed facilities and projects.

For each of these facilities, the next step was to identify the most current documentation describing and quantifying the risks associated with its operation. Current safety documentation was obtained for all of these facilities. From these documents, the next step was to identify potential accident scenarios and source terms (release rates and frequencies) associated with those facilities. Table D.2.4–1 in Appendix D lists the results of this process and serves as the basis for the subsequent consequence analysis described below.

Consequence Analysis

Consequences of accidental radiological releases were determined using the MACCS2 computer code (Chanin and Young 1997). MACCS2 is a DOE/Nuclear Regulatory Commission-sponsored computer code that has been widely used in support of probabilistic risk assessments for the nuclear power industry and in support of safety and NEPA documentation for facilities throughout the DOE complex.

Because of assumptions used in this LLNL SW/SPEIS analysis, not all of the code's capabilities were used. It was conservatively assumed that there would be no evacuation or protection of the surrounding population following an accidental release of radionuclides. This assumption is not expected to significantly affect the calculated doses.

NNSA estimated radiological impacts to four receptors: (1) the MEI at the LLNL boundary, (2) the offsite population within 50 miles of LLNL, (3) a noninvolved worker 100 meters from the accident location, and (4) the population of noninvolved workers.

Ten radial rings and 16 uniform direction sectors were used to calculate the collective dose to the offsite population. The radial rings were every 1 mile to 5 miles, a ring at 10 miles, and a ring every 10 miles for the initial 10 to 50 miles starting at the distribution center. The MEI was assumed to be located along the site boundary. The shortest distance to the boundary from each release location in all 16 directions was identified for the MEI analysis. Similarly, the noninvolved onsite worker location was taken as 100 meters from the release in any direction.

The calculated radiation doses were converted into LCFs using the factor of 6×10^{-4} LCFs per person-rem for both members of the general public and workers (Lawrence 2002).

5.5.1.2 *Results*

Table 5.5.1.2–1 presents the bounding radiological accident scenario for each of the evaluated facilities. Table D.2.4–1 in Appendix D presents all of the analyzed scenarios for each LLNL facility, which provides the basis for the bounding facility accident scenarios presented in Table 5.5.1.2–1. Detailed descriptions of the accident scenarios are presented in Appendix D.

Tables 5.5.1.2–1 and 5.5.1.2–2 show the building number and name, the scenario description, frequency, and results for the Proposed Action and the No Action Alternative. The values for the Reduced Operation Alternative are the same as for No Action Alternative. The results presented include estimates of radiation dose and corresponding incremental LCFs for both median (Table 5.5.1.2–1) and unfavorable (Table 5.5.1.2–2) meteorological conditions. The term "unfavorable" meteorological conditions means those conditions that result in radiation doses that would be exceeded only 5 percent of the time. Detailed discussion on meteorological conditions is presented in Appendix D, Section D.2.1 of this LLNL SW/SPEIS.

The bounding accident for each receptor is shaded in Table 5.5.1.2–1 and 5.5.1.2–2. The Reduced Operation Alternative scenarios are the same as for the No Action Alternative. Detailed descriptions of all accident scenarios are provided in Appendix D.

For median meteorology, the bounding accident scenarios for each receptor are as follows:

- For the offsite population, the bounding accident for the Proposed Action is an aircraft crash into Building 625. This accident is estimated to result in 2,020 person-rem to this population, which would result in an additional 1.21 LCFs in this population. For the No Action Alternative, the bounding accident is an aircraft crash into Building 696R, which is estimated to result in 1,290 person-rem (0.77 LCFs)

- For the MEI, the bounding accident for the Proposed Action and the No Action Alternative is an aircraft crash into Building 696R. This accident is estimated to result in 0.861 rem to the MEI, which would result in a probability of 5.17×10^{-4} of the development of a fatal cancer.

- For the population of noninvolved workers, the bounding accident for the Proposed Action is a room fire (unfiltered) in Building 332. The accident is estimated to result in 930 person-rem to this population, which would result in an additional 0.558 LCFs in this population. For the No Action Alternative, the bounding accident is an evaluation basis fire in Building 251, which is estimated to result in 826 person-rem (0.5 LCFs).

- For an individual noninvolved worker for the Proposed Action and the No Action Alternative, the bounding accident is an evaluation basis fire in Building 251. This accident is estimated to result in 5.7 rem to the noninvolved worker, which would result in a probability of 3.42×10^{-3} of the development of a fatal cancer.

For unfavorable meteorology, the bounding accident scenarios for each receptor are as follows:

- For the offsite population, the bounding accident for the Proposed Action is an aircraft crash into Building 625. This accident is estimated to result in 17,600 person-rem to this population, which would result in an additional 10.6 LCFs in this population. For the No Action Alternative, the bounding accident is an aircraft crash into Building 696R, which is estimated to result in 10,600 person-rem (6.4 LCFs).

- For the MEI, the bounding accident for the Proposed Action is an aircraft crash into Building 625. This accident is estimated to result in 23.1 rem to the MEI, which would result in a probability of 0.014 of the development of a fatal cancer. For the No Action Alternative, the bounding accident is an aircraft crash into Building 696R, which is estimated to result in a dose of 16.6 rem to the MEI (LCF probability of 0.0099).

- For the population of noninvolved workers, the bounding accident for the Proposed Action is a room fire (unfiltered) in Building 332. This accident is estimated to result in 7,800 person-rem to this population, which would result in an additional 4.68 LCFs in this population. For the No Action Alternative, the bounding accident is an evaluation basis fire in Building 251, which is estimated to result in 452 person-rem (2.7 LCFs).

- For an individual noninvolved worker, the bounding accident for the Proposed Action is an aircraft crash into Building 625. This accident is estimated to result in 82.3 rem to the noninvolved worker, which would result in a probability of 0.049 of the development of a fatal cancer. For the No Action Alternative, the bounding accident is an evaluation basis fire in Building 251 which is estimated to result in a dose of 64.6 rem to the noninvolved worker (LCF probability of 0.039)

Bounding Case Radiological Accident for Involved Workers

The bounding case radiological accident for involved workers is a plutonium criticality for a powder, slurry, or solution system in a workstation in Building 332. This accident has an estimated frequency of 3.2×10^{-5} per year. Severe worker exposures could occur inside the facility as a result of a criticality, due primarily to the effects of prompt neutrons and gammas. The methodology for determining these effects is presented in Appendix D, Section D.2.5, of this LLNL SW/SPEIS.

Personnel close to the criticality event (within the building) may incur prompt external exposures. Depending on distance and the amount of intervening shielding material, lethal doses composed of neutron and gamma radiation could be delivered. Some dose reduction could be achieved by immediate evacuation; however, most of the dose would be delivered within the response time of alarm instrumentation.

At a distance of 33 feet, the combined prompt gamma and neutron radiation dose to personnel from a plutonium powder criticality would be approximately 867 rem with no shielding and no evacuation. This dose is greater than the average lethal radiation dose to humans of approximately 450 rem. Thus, subsequent to a plutonium powder criticality, the potential for lethal exposure exists, and on average, there may be two workers in a room who could be exposed to this radiation.

In the event of a criticality, the shielding of the laboratory interior walls and rapid evacuation from the laboratories would reduce doses to personnel not in the immediate vicinity of the criticality excursion.

5.5.2 Chemical Accident Scenarios

5.5.2.1 *Methodology*

Selection Process

The selection process for chemical accident scenarios used the same multistep screening process as described for radiological accidents in Section 5.5.1.1. Appendix D, Table D.2.5–1 of this LLNL SW/SPEIS, lists the results of this process and serves as the basis for the subsequent consequence analysis described below. The chemical accident scenarios analyzed are the same under the No Action Alternative, Proposed Action, and Reduced Operation Alternative.

Protective and Emergency Response Planning Guidelines

The adverse effects of exposure vary greatly among chemicals. They range from physical discomfort and skin irritation to respiratory tract tissue damage and, at the extreme, death. For this reason, allowable exposure levels differ from substance to substance. None of the chemicals of concern in the bounding accidents are known carcinogens. The standards used to evaluate bounding case scenarios are the Emergency Response Planning Guideline (ERPG) values established for each chemical by the American Industrial Hygiene Association. The ERPGs provide emergency response planners with estimates of the potential hazards associated with accidental releases of various toxic chemicals from LLNL facilities. The comparison to ERPGs is made when possible to provide estimates of the area where health effects would be the greatest. These ERPGs are intended to provide estimates of concentration ranges at which adverse effects can be expected if exposure to a specified chemical lasts more than 1 hour. The ERPG levels are defined as follows:

- ERPG-1 – The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odor.

- ERPG-2 – The maximum airborne concentration below which it is believed that nearly all individuals could be exposed to up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual’s ability to take protective action.

- ERPG-3 – The maximum airborne concentration below which it is believed that nearly all individuals could be exposed to up to 1 hour without experiencing or developing life-threatening health effects.

If a chemical did not have published ERPG values, the temporary emergency exposure limits were used.

Consequence Analysis

Consequences of accidental chemical releases were determined using the ALOHA computer code (EPA 1999). ALOHA is an EPA/National Oceanic and Atmospheric Administration-sponsored computer code that has been widely used in support of chemical accident responses and in support of safety and NEPA documentation for DOE facilities.

The ALOHA code uses a constant set of meteorological conditions (e.g., wind speed, stability class) to determine the downwind atmospheric concentrations. The sequential meteorological data sets 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.

ALOHA contains physical and toxicological properties for approximately 1,000 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 (e.g., ERPG-2) are used to define the footprint of concern. Because the meteorological conditions specified do not account for wind direction, since it is not known *a priori* in which direction the wind would be blowing in the event of an accident, the areas of concern are defined by a circle of radius equivalent to the downwind distance at which the concentration decreases to levels less than the level of concern.

5.5.2.2 *Results*

Tables 5.5.2.2–1 and 5.5.2.2–2 present the bounding chemical accident scenario for each of the evaluated facilities for median and unfavorable meteorological conditions, respectively. Table D.2.5–1 in Appendix D presents all of the analyzed scenarios for each LLNL facility, which provides the basis for the bounding facility accident scenarios presented in Tables 5.5.2.2–1 and 5.5.2.2–2.

Tables 5.5.2.2–1 and 5.5.2.2–2 show the building number and name, the scenario description, and results. The results presented include estimates of airborne concentrations of chemicals released during an accident and a comparison of these concentrations to the ERPGs. The results presented in Tables 5.5.2.2–1 and 5.5.2.2–2 apply to the No Action Alternative, the Proposed Action, and the Reduced Operation Alternative. Frequencies are presented in Appendix D, Table D.3.2–1 of this LLNL SW/SPEIS.

TABLE 5.5.2.2–1.—*Potential Chemical Accident Consequences (Median Meteorology)*

		Noninvolved Worker		Site Boundary		
ERPG-2 Concentration (ppm)	**ERPG-3 Concentration (ppm)**	**Average Predicted Concentration (ppm)**	**Fraction of ERPG-2**	**Average Predicted Concentration (ppm)**	**Fraction of ERPG-2**	**ERPG-2 Distance (meters)**
Building 191, High Explosives Application Facility – Chemical Dispersion (1,2-Dichloroethane)						
200	300	0.108	5.4×10^{-4}	0.0175	8.8×10^{-5}	11
Building 239, Radiography Facility – Toxic gas release (NO_2)						
5	20	27.5	5.5	0.81	016	246
Building 322, Plating Shop – Multiple Container Liquid Spill (Hydrofluoric Acid)						
20	50	371	18.6	4.86	0.24	475
Building 331, Tritium Facility actinide activities – Nitric acid spill						
6	78	24	4	0.24	0.04	205
Building 332, Plutonium Facility – Chlorine release						
3	20	593	198	11.6	3.9	1,700
Building 334, Hardened Engineering Test Building – Toxic gas release (NO_2)						
5	20	110	22	2.02	0.40	529
Building 514/612/625/693, Radioactive and Hazardous Waste Management Complex – Earthquake release of Freon-22						
7,500	7,500	415	0.06	169	0.023	19
Building 581, National Ignition Facility – Material Spill, Release of Nitric acid solution						
6	78	130	21.7	12.3	2.1	536
Site 300 Materials Management Facility – Hazardous materials release by fire (LiOH)						
1	102	1.42	1.42	0	0	119
Site 300 Explosive Waste Treatment Facility – Fire release of hydrogen fluoride						
20	50	28.1	1.41	0.097	0.049	119

[a] These consequences apply to the No Action Alternative, the Proposed Action, and the Reduced Operation Alternative.
ERPG = Emergency Response Planning Guideline.

TABLE 5.5.2.2–2.—*Potential Chemical Accident Consequences (Unfavorable Meteorology)*[a]

		Noninvolved Worker		MEI		
ERPG-2 Concentration (ppm)	**ERPG-3 Concentration (ppm)**	**Average Predicted Concentration (ppm)**	**Fraction of ERPG-2**	**Average Predicted Concentration (ppm)**	**Fraction of ERPG-2**	**ERPG-2 Distance (meters)**
Building 191, High Explosives Application Facility – Chemical Dispersion (1,2-Dichloroethane)						
200	300	1.41	7.1×10^{-3}	0.272	1.4×10^{-3}	11
Building 239, Radiography Facility – Toxic gas release (NO_2)						
5	20	1,430	286	35.2	7.04	1,600
Building 322, Plating Shop – Multiple Container Liquid Spill (Hydrofluoric Acid)						
20	50	4,680	234	46.4	2.32	1,400
Building 331, Tritium Facility actinide activities – Nitric acid spill						
6	78	68	11.3	1.1	0.18	358
Building 332, Plutonium Facility – Chlorine release						
3	20	5,220	1,740	16.9	5.64	1,900
Building 334, Hardened Engineering Test Building – Toxic gas release (NO_2)						
5	20	5,720	1,140	77.8	15.6	2,900
Building 514/612/625/693 Hazardous Waste Management Complex – Earthquake release of Freon-22						
7,500	7,500	4,080	0.54	1,312	0.17	75
Building 581, National Ignition Facility – Material Spill, Release of Nitric Acid Solution						
6	78	438	73	51.4	8.57	1,400
Site 300 Materials Management Facility – Hazardous materials release by fire (LiOH)						
1	102	59	59	0.151	0.15	865
Site 300 Explosive Waste Treatment Facility – Fire release of hydrogen fluoride						
20	50	1,168	58.4	2.98	0.15	860

[a] These consequences apply to the No Action Alternative, the Proposed Action, and the Reduced Operation Alternative.
ERPG = Emergency Response Planning Guideline; MEI = Maximally Exposed Individual.

Bounding Accident Involving Chemical Releases and Impacts

The bounding accident for the onsite and offsite population for median meteorological conditions is the chlorine release from Building 332. For this accident, concentrations above the ERPG-2 level would exist as far out at 1.7 kilometers from Building 332, which would extend about 600 meters beyond the site boundary (the largest distance of any of the facility accident scenarios). At the site boundary, the concentration would be below ERPG-3 values, but above ERPG-2 values, indicating that members of the public exposed to this concentration could experience irreversible or other serious health effects or symptoms that could impair their ability to take protective action. At the noninvolved worker location, the concentration would be above ERPG-3 values, indicating that individuals exposed to this concentration could experience or develop life-threatening health effects. The workers inside the facility would be protected by the intact building structure and safety systems and thus would be unaffected by this incident.

For unfavorable meteorological conditions, the bounding accident is the toxic gas release (NO_2) from Building 334. For this accident, concentrations above the ERPG-2 level would exist as far out as 2.9 kilometers from Building 334, which would extend about 2,000 meters beyond the site boundary. At the site boundary and at the noninvolved worker location, the concentration would be above ERPG-3 values, indicating that individuals exposed to this concentration could experience or develop life-threatening health effects.

5.5.3 High Explosive Accident Scenarios

5.5.3.1 *Selection Process*

The selection process for explosive accident scenarios used the same multistep screening process as described for radiological accidents in Section 5.5.1.1. Section D.4 in Appendix D, Section D.4, lists the results of this process and serves as the basis for the subsequent consequence analysis described below.

5.5.3.2 *Results*

Table 5.5.3.2–1 presents the bounding explosive accident scenario for each of the evaluated facilities. Appendix D, Section D.4, presents all of the analyzed scenarios for each LLNL facility, which provides the basis for the bounding facility accident scenarios presented in Table 5.5.3.2–1.

Table 5.5.3.2–1 shows the building number and name, the scenario description, frequency, and an indication of the potential adverse impacts of the scenario. The impacts presented include estimates of the number of persons who might reasonably be present in the area near the accidental detonation and an indication of the acute impacts to these personnel. Also, where applicable, Table 5.5.3.2–1 provides a description of any impacts to personnel outside of the facility.

Bounding Case Accident Involving High Explosives

The bounding explosive accident is an accidental detonation at the Contained Firing Facility or on an open air firing table. This accident would result in severe or fatal injury to personnel (normally 2 to 20) and could result in significant damage to the service building and equipment. This robust building is designed to confine the effects of this level of explosion, thus preventing any impact to noninvolved workers or the public.

TABLE 5.5.3.2–1.—*High Explosive Accident Scenario Summary*

Building and Name	Scenario Description	Frequency (per year)	Results
Site 300 Materials Management Facilities	Accidental detonation in an explosives assembly storage magazine.	10^{-6} to 10^{-4}	Severe injury or death to the immediate workers (normally two) and the destruction of the magazine, with possible injuries to nearby personnel within intraline and fragment distance, and damage to nearby facilities. Additionally, low-level environmental releases and low-level exposures of personnel to airborne hazardous materials would be lesser consequences. Onsite exposure to the resulting plumes would be below ERPG-3 levels. Offsite consequences would be limited to overpressures (impulse noise) and the potential for hazardous material exposures below ERPG-2 levels.
Site 300 Weaponization Program	Accidental bare explosives detonation in a test building with personnel present.	10^{-6} to 10^{-4}	Severe or fatal injuries to the immediate workers (normally two to five) and damage to the test equipment and building. Injuries to nearby personnel subjected to blast effects are also possible.
Site 300 B-Division Firing Areas	Accidental detonation at the CFF or on an open-air firing table.	10^{-6} to 10^{-4}	Severe or fatal injury to personnel (normally 2 to 20). An accidental detonation could result in significant damage to the service building and equipment.
EMPC	Accidental detonation in an EMPC Assembly Bay.	10^{-6} to 10^{-4}	Severe or fatal injury to personnel (normally two to six) involved in assembling explosives and other components. Other personnel within the EMPC would not be injured.
Building 191 High Explosives Application Facility	Accidental detonation of explosives during contact operations.	10^{-6} to 10^{-4}	Personnel inside the room of occurrence (up to six people) could receive fatal injuries. Personnel outside the room of occurrence could also receive injury from overpressure effects (walls, mazes, and doors would preclude fragment hazards). Overpressure predictions outside the room of occurrence (but inside the facility) would be expected to result in some eardrum rupture. Lung damage would also be possible. There would be no blast effects (overpressure or fragments) outside the facility.

Source: Original
EMPC = Energetic Materials Processing Center.

5.5.4 Biological Accident Scenario

Microbiology laboratories are unique work environments that may pose special risks to personnel working within that environment. For purposes of this section, NNSA has selected a representative facility accident that has been previously analyzed by the U.S. Army in their *Final Programmatic Environmental Impact Statement Biological Defense Research Defense Program* (Army 1989). NNSA believes that this accident scenario is comparable to and bounds any potential scenarios associated with the proposed BSL-3, Building 368 at LLNL. Appendix D provides further details on this accident scenario.

The organism selected for this scenario is *Coxiella burnetii*, the rickettsial agent causing Q fever, a disease of varying degrees of incapacitation. *Coxiella burnetii* grows to high concentrations in chick embryos. It is a hardy organism that withstands laboratory manipulation with little or no loss in viability. It is highly stable in aerosol and undergoes a biological decay rate of about 1 percent per minute over a wide range of humidities. *Coxiella burnetii* is extremely infectious in a small particle aerosol.

This accident scenario involves an immunized laboratory worker processing *Coxiella burnetii*. In this scenario, the laboratory worker fails to use rubber O-rings to seal the centrifuge tubes, and all six bottles leak, allowing some of the slurry into the rotor, with some of the slurry also escaping into the centrifuge compartment that houses the rotor. The leakage of six bottles is highly improbable.

As shown in Appendix D, approximately 5×10^4 HID_{50} (the term "HID_{50}" refers to the dose causing infection 50 percent of the time for man) could escape from the building exhaust stack. This is a conservative assumption as the facility would likely be required to have HEPA filters on the exhaust system. The quantity of human infectious doses, by simple Gaussian plume dispersion models, would dissipate to less than 1 HID_{50} per liter of air in less than 2 meters from the stack, less than 0.1 HID_{50} per liter of air at 16 meters, and less than 0.01 HID_{50} per liter of air at 38 meters. Thus, this level of escape of *Coxiella burnetii* from the containment laboratory, even under the worst-case meteorological conditions, does not represent a credible risk to the noninvolved worker or offsite population.

The centrifuge operator would be at the greatest risk of becoming ill with Q fever. In opening the centrifuge, the infectious aerosol would be released initially and momentarily into a very confined area. The concentration of airborne infectious doses, seconds after the lid was opened, was calculated as 1.3×10^3 HID_{50} per liter of air. Assuming that the centrifuge operator was in the area for no more than 5 minutes, the operator could have inhaled approximately 100,000 infectious doses. Previous studies cited reported that previously vaccinated men, when exposed to defined aerosols of 150 or 150,000 infectious doses of virulent *Coxiella burnetii*, did not consistently become ill (Army 1989). Since the centrifuge operator received about the same dose reported in these studies, it is uncertain whether the operator would become sick, since he was, by required procedures, immunized.

5.5.5 Offsite Transportation Accident Scenarios

Under the No Action Alternative, Proposed Action, and Reduced Operation Alternative, NNSA would transport radioactive materials, hazardous chemicals, explosives, and biological agents that could potentially be involved in accidents that release the cargo for exposure of the public. NNSA considers these accidents in this section to identify the bounding offsite transportation accident, its consequences, and its probability. The onsite transportation accidents are presented in Section 5.5.1.2 and Appendix D.

5.5.5.1 *Radiological Transportation Accidents*

Appendix J, Section J.4, of this LLNL SW/SPEIS examines the transport of special nuclear material, TRU waste, LLW, and tritium. For the Proposed Action, the bounding accident scenario involves special nuclear material (in this case, a fine oxide powder consisting primarily of plutonium isotopes). This accident was calculated to result in 2.7×10^{4} person-rem, which corresponds to 16 LCFs. The probability of this accident is 5.3×10^{-11} per year and is not considered reasonably foreseeable. For the No Action Alternative and Reduced Operation Alternative, the bounding accident scenario involves 10 grams of gaseous tritium. This scenario is estimated to result in 338 person-rem, which is equivalent to 0.2 LCFs. The probability of this accident is 9.9×10^{-10} per year, which is also not reasonably foreseeable. Appendix J describes the methods by which these values were calculated.

5.5.5.2 *Hazardous Chemical Transportation Accidents*

Based on information in Appendix D, Section D.3, a transportation accident involving chlorine gas is likely to be the most severe, with the potential to cause death to individuals in the immediate vicinity. However, NNSA is examining only accidents involving transport by LLNL vehicles and personnel, i.e., those not involving materials delivered by common carrier or local vendors. For hazardous chemicals transported by LLNL, shipments of paint and lithium hydride are the most frequent. NNSA does not believe that these accidents would result in serious consequences other than those directly from the impact.

5.5.5.3 *Explosives Transportation Accidents*

Although LLNL does ship explosives offsite, the great majority of shipments with quantities sufficiently large to create a bounding accident are between Site 300 and the Livermore Site. Over 500 one-way shipments between the two LLNL locations per year are common. Approximately 30 shipments to the Nevada Test Site occur per year. LLNL uses packaging and operational controls to limit the probability of an accident occurring.

Should a sufficiently severe accident occur to detonate the explosives, potential impacts could be death or severe injury to the driver(s) and passengers in adjacent vehicles. Nearby buildings could be affected with projectiles providing the greatest hazard to any inhabitants. Secondary traffic accidents could affect individuals in vehicles not adjacent to the transport conveyance. Appendix D, Section D.4, examines explosives accidents in LLNL facilities for comparison.

5.5.5.4 *Biological Agent Transportation Accidents*

NNSA considered biological agent transportation accidents in its Environmental Assessment and Finding of No Significant Impact on the BSL-3 facility (NNSA 2002e). This EA/FONSI concludes that accidents due to transportation of micro-organisms are not expected to increase over those under current conditions. The addition of milliliter-quantity samples shipped to and from the BSL-3 facility through commercial or private courier would not be expected to change the overall incidence of risk of transportation accidents. Samples could consist of cells in media contained within U.S. Department of Transportation-certified packages. The consequences of such accidents would be anticipated to be minor.

5.5.6 Multiple Building Accident Scenario

5.5.6.1 *Methodology*

This section addresses the potential releases and consequences of a situation involving multiple source terms (both radiological and chemical) stemming from a single event affecting LLNL. The consequences of these releases will be assessed in the same manner as described previously.

An earthquake with a return period of 5,000 years (i.e., 2×10^{-4} per year) was postulated as the initiator for this accident scenario. This earthquake has an effective peak ground acceleration of approximately 0.8 *g*. As a rough comparison, the Livermore earthquakes on January 24 and January 27, 1980, recorded as 5.4 and 5.6 Richter Magnitude events, generated maximum measured peak ground accelerations of 0.26 *g* at a distance of 18 kilometers from the epicenter.

5.5.6.2 *Results*

This section provides a description of the radiological and chemical releases that may occur as a direct result of an earthquake. Scenarios and consequences are discussed in general terms only. For specific information concerning individual scenarios, refer to the referenced sections.

Radiological Releases

Under the multiple-building release scenario for the Proposed Action, the risk to the offsite MEI and to the population within 50 miles of LLNL is primarily attributable to releases from Buildings 251, 331, and 334. The offsite MEI for releases from these would not be at the same location. Therefore, summing the doses for each of the individual facilities is conservative. Taking this conservative approach results in a total radiation dose at the site boundary nearest to the release of 1.03 rem. Using the dose-to-risk conversion factor of 6×10^{-4} LCFs per person-rem, the MEI dose results in a 6.2×10^{-4} LCF probability.

The collective radiation dose to the approximately 6,900,000 people living within 50 miles of LLNL under the multiple-building release scenario was calculated to be 420 person-rem. Using the dose-to-risk conversion factor of 6×10^{-4} per person-rem, the collective population dose is estimated to result in an additional 0.25 fatal cancers to this population. The dose to the individual noninvolved worker was calculated to be 11.7 rem. This dose is estimated to have a 6.35×10^{-3} LCF probability (or 1 chance in 157) of the development of a fatal cancer.

The collective radiation dose to the population of noninvolved workers under the multiple-building release scenario was calculated to be 1,380 person-rem using the dose-to-risk conversion factor of 6×10^{-4} per person-rem. This collective dose is estimated to result in an additional 0.83 fatal cancers in this worker population.

Chemical Releases

Under the multiple-building release scenario, the risk at the site boundary would be dominated by the chlorine rupture and release from Building 332. For this accident, concentrations above the ERPG-2 level would exist as far out at 1.7 kilometers from Building 332, which would extend about 600 meters beyond the site boundary. At the site boundary, the concentration would be below ERPG-3 values, but above ERPG-2 values, indicating that persons exposed to this concentration could experience irreversible or other serious health effects or symptoms that could impair their ability to take protective action. At the noninvolved worker location, 100 meters from the release point, the concentration would be above ERPG-3 values, indicating that individuals exposed to this concentration could experience or develop life-threatening health effects. Health effects to involved workers are also anticipated to be life threatening.

The location of the highest site boundary concentration for releases from other facilities as a result of this earthquake would be at a different location than that for Building 332. The contribution from these other facilities at the location of highest site boundary concentration for Building 332 would be small and would provide a negligible contribution to the overall risk to an individual at this location.

5.5.7 Impacts of Postulated Accidents on Each Alternative

Under the No Action and Reduced Operation Alternatives, the potential exists for the accidental release of radioactive materials and hazardous chemicals, and the accidental detonation of explosives at several facilities during ordinary operations, during transportation, and as a result of an event affecting more than one facility. These accidents are summarized in Section 5.5 and detailed further in Appendix D. The Proposed Action described in Chapter 3 of this LLNL SW/SPEIS can affect the postulated accident scenarios for some of the facilities analyzed in this section.

For Building 331, under the Proposed Action, the material-at-risk value would increase from the current 3.5 grams of tritium to 30 grams. As described in Appendix D, during an aircraft crash with subsequent fire, the entire material–at-risk is assumed to be released to the environment. For the 30-gram material-at-risk under the Proposed Action, the collective dose to the population within 50 miles of LLNL was calculated to be 113 person-rem, which is estimated to result in an additional 0.068 LCFs in this population of approximately 6,900,000 people. Under the No Action Alternative, this collective dose would be approximately 13 person-rem, which is estimated to result in an additional 7.8×10^{-3} LCFs to the 50-mile population. Radiation dose and adverse health effects to the offsite MEI and the noninvolved worker would be similarly increased under the Proposed Action (i.e., from 0.019 rem [1.1×10^{-5} LCF probability] to 0.163 rem [9.8×10^{-5} LCF probability] and from 0.25 rem [1.5×10^{-4} LCF probability] to 2.11 rem [1.27×10^{-3} LCF probability], respectively).

Under the Proposed Action, the Building 332 material-at-risk limit would increase from the current 20 kilograms of 30-year fuel-grade equivalent plutonium to 60 kilograms for each of two rooms that support the ITP and plutonium casting. For the Proposed Action, the bounding accident scenario is a room fire (unfiltered). For the No Action Alternative, the bounding accident scenario is an aircraft crash. Under the Proposed Action, the collective dose to the population within 50 miles of LLNL for the room fire (unfiltered) accident scenario was calculated to be 280 person-rem under median meteorological conditions, which is estimated to result in an additional 0.168 LCF in this population. Under the No Action Alternative, for an aircraft crash accident, the collective dose would be approximately 97 person-rem, which is estimated to result in an additional 0.058 LCF to the 50-mile population. Radiation dose to the offsite MEI and the noninvolved worker would be similarly increased under the Proposed Action (i.e., from 0.148 rem [8.9×10^{-5} LCF probability] to 0.44 rem [2.6×10^{-4} LCF probability] and from 1.84 rem [1.1×10^{-3} LCF probability] to 4.94 rem [2.9×10^{-3} LCF probability], respectively).

For the NIF, under the Proposed Action, tests would be conducted using plutonium targets. As shown above, the bounding accident for the NIF under the Proposed Action is an earthquake during a plutonium shot without yield shot. As described above, under the Proposed Action, the collective dose to the population within 50 miles of LLNL for this accident was calculated to be 0.55 person-rem, which is estimated to result in an additional 3.3×10^{-4} LCFs in this population. Under the No Action Alternative, this collective dose would be approximately 0.20 person-rem, which is estimated to result in an additional 1.20×10^{-4} LCFs to the 50-mile population. Radiation dose to the offsite MEI and the noninvolved worker would be similarly increased under the Proposed Action (i.e., from 4.78×10^{-4} rem [2.87×10^{-7} LCF probability] to 1.65×10^{-3} rem [9.9×10^{-7} LCF probability] and from 1.43×10^{-3} rem [8.58×10^{-7} LCF probability] to 4.99×10^{-3} rem [3.00×10^{-6} LCF probability], respectively).

For Building 625, under the Proposed Action, the source term for the bounding accident aircraft crash would increase from 0.46 plutonium-equivalent curies to 1.40 plutonium-equivalent curies. As described above, under the Proposed Action, the collective dose to the population within 50 miles of LLNL for the aircraft crash accident was calculated to be 2,020 person-rem, which is estimated to result in an additional 1.2 LCFs in this population. Under the No Action Alternative, this collective dose would be approximately 662 person-rem, which is estimated to result in an additional 0.40 LCF to the 50-mile population. Radiation dose to the offsite MEI and the noninvolved worker would be similarly increased under the Proposed Action (i.e., from 0.24 rem [1.44×10^{-4} LCF probability] to 0.73 rem [4.38×10^{-4} LCF probability] and from 0.65 rem [3.9×10^{-4} LCF probability] to 1.97 rem [1.18×10^{-3} LCF probability], respectively).

5.6 MITIGATION MEASURES

The regulations promulgated by the CEQ to implement the procedural provisions of NEPA (42 U.S.C. §4321) require that an EIS include a discussion of appropriate mitigation measures (40 CFR §1502.14[f] and 16[h]). The term "mitigation" includes the following (40 CFR §1508.20):

- Avoiding an impact by not taking an action or parts of an action
- Minimizing impacts by limiting the degree or magnitude of an action and its implementation
- Rectifying an impact by repairing, rehabilitating, or restoring the affected environment
- Reducing or eliminating the impact by preservation and maintenance operations during the life of the action
- Compensating for the impact by replacing or providing substitute resources or environments

This section describes mitigation measures by resource area, along with descriptions and key proactive initiatives. These mitigation measures and proactive initiatives address the range of potential impacts of the Proposed Action.

5.6.1 Defining Mitigation Measures

NNSA and LLNL operate under existing laws, programs, and controls, including regulations, policies, and contractual requirements. A list of laws, categorized by resource area, is presented in Chapter 7 of this LLNL SW/SPEIS. LLNL has numerous existing procedures that provide controls to mitigate potential impacts. Examples include the ES&H Manual, emergency plans, ISMS, Cultural Resources Management Plan, several protected species programs, and energy conservation and water reduction programs. In general, these procedures and controls effectively reduce the need for additional mitigation measures for resource areas evaluated in the LLNL SW/SPEIS.

This section summarizes potential impacts determined for each resource area and highlights major applicable laws, programs, procedures, and controls. If impacts are determined to be significant, mitigation measures are presented. Mitigation measures that are part of existing procedures and controls are not repeated. A more detailed description and implementation plan would be presented in a mitigation action plan published following the ROD. Agreements may be revised or amended based on future circumstances or changes in regulatory requirements.

5.6.2 Land Uses and Applicable Plans

LLNL does not plan to buy, sell, or transfer any property under the No Action Alternative, Proposed Action, or the Reduced Operation Alternative. All new construction would occur within the Livermore Site and Site 300, and the new facilities would be used for office space or R&D, as are all facilities at LLNL. Thus, there would be no changes in land use at LLNL, and no conflict with existing and approved future land uses adjacent to the site. Therefore, no additional mitigation measures would be required.

5.6.3 Socioeconomic Characteristics and Environmental Justice

The alternatives analyzed would cause changes in employment at LLNL ranging from a 5 percent increase under the Proposed Action to an 8 percent decrease under the Reduced Operation Alternative, as compared to the No Action Alternative. Commensurate changes in

LLNL direct expenditures, employee expenditures, and housing demand would result primarily within Alameda, San Joaquin, Contra Costa, and Stanislaus counties. Because of the large regional economy and the relatively small changes in employment under the alternatives, there would be minimal socioeconomic impacts from implementation of any alternative; no mitigation measures would be required.

LLNL operations analyzed would have minimal impact to resource areas analyzed, including human health effects to offsite residents or onsite workers. Therefore, no disproportionately high and adverse impacts to minority or low-income populations are anticipated and no mitigation measures would be required.

5.6.4 Community Services

LLNL operations under the alternatives analyzed would have minimal impact to the ability of nearby communities to provide fire protection, emergency services, police protection, school services, and nonhazardous solid waste disposal. The limited increase in the potential number of new laboratory workers would have minimal impact. Therefore, no mitigation measures would be required.

5.6.5 Prehistoric and Historical Cultural Resources

Mitigation measures to address impacts to prehistoric and historic cultural resources resulting from proposed LLNL activities are specific to each circumstance. The measures are determined by a number of factors, including the nature of the resource, the location of the resource, and the nature of the proposed activity. The Programmatic Agreement (see Appendix G) between NNSA, University of California, and the California SHPO describes the process to be followed to determine if specific proposed activities conducted at LLNL would have an effect on important prehistoric or historic cultural resources. If it is determined that a resource would be adversely affected, the Programmatic Agreement describes the process to be undertaken to address that impact, which can result in specific actions to avoid, reduce, or mitigate the adverse effect.

Unanticipated effects to resources can occur when previously unknown resources, namely subsurface cultural remains, are discovered during the activity. The Programmatic Agreement also addresses these “discovery” situations. It is unlikely that subsurface remains are present at the Livermore Site due to the disturbed nature of the area. Because of the undisturbed nature of Site 300, there is a greater potential for subsurface remains. If such remains are encountered during ground-disturbing activities, work within the immediate vicinity of the discovery would cease until consultation between NNSA and SHPO regarding the discovery has been completed. Through that consultation, a determination would be made of the resource’s importance, the extent of the effect, and appropriate actions required to avoid, reduce, or mitigate further adverse effect. The inadvertent discovery of Native American human remains or funerary objects (associated or unassociated) on LLNL would require adherence to the *Native American Graves Protection and Repatriation Act* (25 U.S.C. §3001).

No traditional cultural properties or Native American sacred sites have been identified on the Livermore Site or Site 300. If any are identified in the future, access to these properties or sites could become restricted. If access is desired, NNSA would consult with the appropriate Native American tribe to develop an agreement or procedures for access to the particular site.

5.6.6 Aesthetics and Scenic Resources

No impacts to aesthetics or scenic resources would occur under any of the alternatives addressed in this LLNL SW/SPEIS. Maintaining the visual quality of LLNL is accomplished through adherence to the Landscape Architecture Master Plan (LLNL 2002d). This Plan helps to create a cohesiveness of image for LLNL, and is intended to ensure that all site improvements are compatible with their immediate surroundings and that aesthetic qualities are enhanced. Any changes to LLNL and its built environment under the alternatives would be conducted in compliance with this Plan. Therefore, no additional mitigation measures would be required.

5.6.7 Geology and Soils

No known aggregate, clay, coal, or mineral resources would be adversely affected by any of the alternatives at either the Livermore Site or Site 300. None of the activities proceeding under any of the alternatives would take place near or upon any known or exploitable mineral resources, unique geologic outcrops, or other unique geologic features. None of the alternatives would impact farming or grazing. No mitigation measures would be required.

Under the alternatives analyzed, several facilities would be built in the undeveloped areas at the Livermore Site. A total of 700,000 square feet would be disturbed as a result of the construction that would proceed under the Proposed Action, including 240,000 square feet under the No Action Alternative. The soils that would be disturbed are not considered prime farmlands nor are they used for agriculture. Best management practices would be used to control runoff and soil loss. No additional mitigation measures would be required.

Under all of the alternatives, the wetland enhancement, described in Section 5.6.8, would involve the disturbance of 1.09 acres of soils at Site 300. Additionally, under the Proposed Action, approximately 33,000 square feet of previously undisturbed soils would be disturbed by the construction of the 40,000-square-foot EMPC. No additional mitigation measures would be required for disturbance of these soils.

5.6.8 Biological Resources

At the Livermore Site, measures would be taken to protect the California red-legged frog during Las Positas Arroyo Maintenance Project activities, as described in previously approved plans and the USFWS Biological Opinion (LLNL 1998a, USFWS 1998). These measures are summarized in Appendix E. A Bullfrog Management Program at the Livermore Site would continue to minimize the adverse impact of this known predator species of the California red-legged frog. A detailed description of this program coordinated with and approved by the USFWS is also provided in Appendix E. No additional mitigation measures would be required.

For Site 300, LLNL is proposing to mitigate the 0.62-acre artificial wetland, removed by continued operations at Site 300 under the No Action Alternative, Proposed Action, and Reduced Operation Alternative, by enhancing selected areas and increasing breeding opportunities for the California red-legged frog. A minimum of 1.86 acres (i.e., 3:1 replacement ratio) of wetland habitat would be enhanced and managed for these two species. Mitigation sites for enhancement include the wetlands at Mid Elk Ravine and the seep at the SHARP Facility. This mitigation measure has been previously addressed in a Biological Assessment and related Biological Opinion (Jones and Stokes 2001, USFWS 2002b). See Appendix E, Section E.2.1.9, for more information.

Measures to minimize impacts to the Alameda whipsnake at Site 300 are contained within a recent Biological Assessment and Biological Opinion (Jones and Stokes 2001, USFWS 2002b). Mitigation measures to minimize impacts to the California tiger salamander are provided in Appendix E. Continuing or proposed new activities at Site 300 are not anticipated to adversely affect the large-flowered fiddleneck, San Joaquin kit fox (which has not been observed since at least 1986), or the valley elderberry longhorn beetle as discussed in Appendix E. Therefore, no additional mitigation measures would be required.

5.6.9 Air Quality

Both the Bay Area and San Joaquin air basins are designated as nonattainment areas for ozone and respirable-sized particulates (PM_{10}). Because of this designation, emissions of particulate matter and ozone precursors such as oxides of nitrogen and precursor organic compounds are strictly regulated. Both the BAAQMD and SJVUAPCD have enacted "no net increase" programs, and are required to implement all feasible measures to reduce emissions of these pollutants. These include measures to control emissions from stationary sources (industrial, commercial, government, and research facilities), and offset any proposed increase in emissions by an equal or greater reduction in emissions. Site 300 is rated as a small source, and is not subject to offset requirements, which are generally placed on larger emitting sources. The Livermore Site is a mid-sized facility eligible for participation in BAAQMD's offset management program.

LLNL has mitigation measures in place governing construction activities and fuel use to minimize air emissions including: water spraying of disturbed areas and covering exposed piles of excavated material; engineering controls, devices, and work practices during work with asbestos to isolate the source of asbestos and prevent fiber migration; and requirements that construction equipment and vehicles be inspected daily for leaks of fuel, engine coolant, and hydraulic fluid.

LLNL has a transportation systems management program that provides and promotes alternative, environmentally responsible, options for employee commuting, assists LLNL in complying with transportation-related *Clean Air Act* legislation, and resolves congestion management issues (LLNL 2001s). LLNL would continue this program. No additional mitigation measures would be required.

5.6.10 Water

Water resources could be degraded by contaminant releases during construction of some facilities. Contaminant sources include construction materials; hydraulic fluid, oil, and diesel fuel; and releases from transportation of waste handling accidents. If a spill occurred, LLNL stormwater pollution prevention plans are in place to identify pollutant sources that affect the quality of industrial stormwater discharges and to describe implementation practices to reduce pollutants in the discharges. Necessary equipment to implement cleanup is available, and personnel are trained in proper response, containment, and cleanup of spills. Further guidance on response to hazardous material spills is provided in the ES&H Manual.

Compliance with the California General Construction Stormwater NPDES Permit (or other individual NPDES permit) for construction projects disturbing one acre or more, including developing and implementing a project-specific stormwater pollution prevention plan, would minimize impacts to surface waters from construction-induced erosion.

LLNL will continue to remove contaminants from groundwater and unsaturated zones (soil vapor) through a series of treatment facilities at the Livermore Site and Site 300. Groundwater quality should continue to improve because extracted groundwater will be collected and treated at the treatment facilities. No additional mitigation measures would be required.

5.6.11 Noise

At the Livermore Site, noise-generating activity levels and conditions are not expected to be significantly different from the No Action Alternative. With the relatively large spatial area and perimeter buffer zone, noise from most activities would not be expected to be discernible in offsite areas. Noise levels are not expected to conflict with land use guidelines, or adversely impact the offsite community. No additional mitigation measures would be required.

At Site 300, LLNL plans to continue high explosives research testing within the Contained Firing Facility and on open firing tables. The number of blasts and intensity are not expected to change, and therefore, impacts would be the same as the No Action Alternative. LLNL would continue to use blast forecasting as a tool to determine if explosive tests would adversely impact the surrounding community, and to restrict operations when peak impulse noise levels are predicted to exceed the 126 dB(A)-level in populated areas. LLNL would continue to perform meteorological monitoring to provide necessary input data for blast forecasting (LLNL 2001s). No additional mitigation measures would be required.

5.6.12 Traffic and Transportation

The traffic impacts for the No Action Alternative, Proposed Action, and Reduced Operation Alternative are not likely to be measurably different. Onsite and offsite radiological transportation impacts are very small, much less than one LCF over the period of analysis. NNSA will continue to conduct transportation operations in accordance with Federal and state regulations and will maintain procedures to ensure operations are safe, with radiological doses will be ALARA. Accordingly, no additional mitigation measures would be required.

5.6.13 Utilities and Energy

LLNL utilities and energy infrastructure is capable of accommodating demand under any of the alternatives. No mitigation measures would be anticipated.

Energy consumption is a particular concern in California based on past energy shortages. The California Independent System Operator forecasts adequate resources available to meet forecasted power demand and meet minimum operating reserves. The Independent System Operator also anticipates that the transmission should demonstrate adequate reliability performance during the projected peak demand periods. No mitigation measures beyond the energy management practices described in Appendix O would be required.

5.6.14 Materials and Waste Management

Under the Proposed Action, there would not be any major changes in the types of waste streams generated or materials used at LLNL. Waste generation projects would not exceed waste treatment and disposal capacities. Waste would continue to be managed in accordance with existing Federal and state regulations and with DOE/NNSA orders and guidance, and LLNL procedures. Therefore, waste management operations would be conducted in a manner to ensure protection of the environment and the safety of LLNL workers. LLNL has a waste minimization and pollution prevention program, described in Appendix O. This program has been effective in reducing the levels of waste generation and has established goals for future reductions of waste levels. No additional mitigation measures would be required.

5.6.15 Human Health and Safety

Under the No Action Alternative, the occupational worker dose would be 90 person-rem per year. This includes new facilities coming on line such as the NIF, and increased activities in the Superblock. The Proposed Action increases the total occupational dose to 125 person-rem per year, with the largest increase coming from the ITP. The Reduced Operation Alternative occupational worker dose would be 38 person-rem per year. Adverse human health effects to LLNL employees are not expected under any of the alternatives. Annual LCFs calculated for these levels of exposure are 0.054, 0.075, and 0.023, under the No Action Alternative, Proposed Action, and Reduced Operation Alternative, respectively.

LLNL has an ALARA program to minimize worker dose. Worker exposures are reviewed and trended quarterly. These trends provide the basis for control measures such as automating processes, adding remote operations, changed administrative procedures, and shielding improvements. Worker doses are monitored at frequent periods and evaluated to ensure that ALARA goals are being achieved or that timely corrective action is required.

It is the policy of DOE/NNSA and LLNL to operate in a manner that protects the health and safety of employees and the public. ES&H is a priority consideration in the planning and execution of all work activities at LLNL. LLNL complies with applicable ES&H laws, regulations, and requirements, and with directives promulgated by DOE regarding ES&H. LLNL ISMS provides a formal, organized process whereby LLNL personnel plan, perform, assess, and improve the safe conduct of work. The system defines a process for identifying, planning, and performing work that provides for early identification of hazards and associated control measures for hazards mitigation or elimination. The ISMS process also forms the basis for work authorization and provides for both internal and external assessment that provides a continuous feedback and improvement loop for identifying both shortcomings and successes for incorporation into subsequent activities. No additional mitigation measures would be required.

5.6.16 Site Contamination

Continued operation of LLNL under any of the alternatives carries the possibility of soil contamination and subsequent groundwater contamination; however, LLNL operational procedures minimize this potential. LLNL is required to continue its cleanup of existing contamination at both the Livermore Site and Site 300. Groundwater treatment and soil vapor extraction systems are in place to achieve these requirements. These systems will continue operation under the alternatives. Other than implementation of LLNL operational procedures, continued remediation, and cleanup milestones and goals already committed to by NNSA, no additional mitigation measures would be required.

5.6.17 Accidents

As detailed in Section 5.5, Bounding Accident Scenarios, there are postulated chemical and radiological accidents that potentially could result in onsite and offsite consequences. These accidents are similar for all alternatives. Management controls in the form of facility and operational safety procedures are used to minimize the probability of an accident and to reduce its consequences. However, in the event of an accident, LLNL has detailed response plans to further mitigate both the onsite and offsite consequences. DOE has developed an ISMS, a comprehensive approach to improving safety. The ISMS includes: defining the scope of the work, identifying the hazards, establishing suitable controls, safely performing the work, and providing feedback for improvement. This ISMS is described in detail in Appendix C. The response activities would be closely coordinated with those of appropriate offsite emergency response organizations. Refer to Appendix I, Emergency Planning and Response, for further details. LLNL personnel are trained and drilled in the protective actions to be taken if a release of radioactive or toxic material should occur. These protective actions comply with protective action guides established by EPA (see Appendix I). The underlying principle for the protective action guides is that under emergency conditions all reasonable measures should be taken to minimize the radiation and chemical exposure to the general public and emergency workers. No additional mitigation measures would be required.

5.6.17.1 *Emergency Response and Protective Actions*

LLNL has detailed plans for responding to accidents of the type described here, and the response activities would be closely coordinated with those of local communities such as Alameda County. LLNL personnel are trained and drilled in the protective actions to be taken if a release of radioactive or otherwise toxic material occurs. Refer to Appendix I for further details on LLNL emergency planning and response information.

Protective Action Guide

A predetermined projected dose level at which specified actions should be taken to protect the public from exposure to radiation.

The underlying principle for the protective action guides is that under emergency conditions all reasonable measures should be taken to minimize the radiation exposure of the general public and emergency workers. In the absence of significant constraints, protective actions could be implemented when projected doses are lower than the ranges given in the protective action guides. No credit was taken from emergency response and protective actions in the consequence analysis. No additional mitigation measures would be required.

5.6.17.2 *High Efficiency Particulate Air Filtration*

In all areas where unconfined plutonium or other radioactive materials can be handled and can exist in a dispersible form, HEPA filters provide a final barrier against the inadvertent release of radioactive aerosols into the outside environment. However, these filters would not trap volatile fission products such as the noble gases and iodine; such gases would be released into the outside environment.

HEPA filter efficiencies are 99.99 percent or greater with the minimum efficiency of 99.97 percent for 0.3 micron particles, the size most easily passed by the filter. To maximize containment of particles and provide redundancy, two HEPA filters in series are used. Actual data from HEPA filter replacement records in Building 332 show that none of the filters used to prevent a potential for release of plutonium to the atmosphere have degraded to the overall efficiencies assumed for the accident scenarios (LLNL 2003t). These HEPA filters are protected by building design features against the consequences of an earthquake or fire. Credit was taken for filtration in the consequence analysis when ventilation and building containment were shown by analysis to survive during the accident.

CHAPTER 6: UNAVOIDABLE ADVERSE IMPACTS

During normal operations at the Lawrence Livermore National Laboratory (LLNL), a minimal amount of radioactive material and activation products would be released to the environment. However, any radiation dose received by a member of the public from emissions from LLNL would be too small to distinguish from naturally occurring background radiation. During normal operations, even with a strong as-low-as-reasonably-achievable (ALARA) program, workers would be exposed to an increased risk of cancer as a result of occupational exposure to radiation over an extended period.

In addition, because hazardous and toxic chemicals would be routinely handled at LLNL facilities, worker exposure to these chemicals would be unavoidable. However, no onsite chemical concentrations would exceed the Occupational Exposure Limit guidelines. Analysis has shown that chemical pollutant emissions would be of minimal consequence and would not pose a danger to the public.

LLNL operations would generate a variety of wastes (including radioactive, hazardous, mixed, and sanitary) as an unavoidable result of normal operations. Although LLNL uses pollution prevention and waste avoidance measures, generation of chemical and radioactive wastes would be unavoidable. LLNL would continue to further reduce hazards and potential exposures through the continued success of pollution prevention and waste avoidance measures. Details regarding waste generation impacts are presented in Sections 5.2.13.2, 5.3.13.2, and 5.4.13.2 for each alternative. Appendix B contains expanded information on LLNL operations regarding waste generation.

CHAPTER 7: ENVIRONMENTAL COMPLIANCE AND INADVERTENT RELEASES

7.1 LAWS, REGULATIONS, AND PERMITS

The Lawrence Livermore National Laboratory (LLNL) must comply with all applicable Federal, state, and local environmental laws and regulations implemented by a variety of agencies including the U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, California Department of Toxic Substances Control (DTSC), California Department of Fish and Game, regional water quality control boards, local air pollution control districts, county health departments, and the city of Livermore Water Reclamation Plant (LWRP). Table 7.1–1 lists the laws and regulations related to these and other regulatory agencies. LLNL performs numerous activities to comply with these environmental laws and regulations as well as internal requirements and applicable U.S. Department of Energy (DOE) orders.

The Environmental Protection Department of LLNL conducts programs to assess compliance with applicable environmental regulations and to estimate the impacts of operations on the environment, including the effectiveness of effluent control measures. The results of these internal monitoring programs are reported annually to the National Nuclear Security Administration and other appropriate Federal, state, and local regulatory agencies. The results are published and available to the general public in LLNL's annual environmental reports.

Environmental analysts from the Environmental Protection Department assist LLNL program staff in implementing environmental requirements and maintaining compliance with regulations. They do so by communicating and working closely with program staff and by keeping informed of existing and planned activities, reviewing construction and environment, safety, and health documents, inspecting facilities, and auditing waste management procedures.

LLNL conducts facility inspections to scrutinize proper handling and management of hazardous and radioactive wastes, as well as other critical aspects of waste generation and handling, in an effort to minimize environmental impacts. Trained personnel investigate, sample, and evaluate all potentially hazardous spills and leaks to the environment. After clean-up operations are conducted, the affected areas are sampled to verify that cleanup has been successful. All spills, leaks, and releases that are required to be reported are detailed in reports sent to the appropriate regulatory agencies. Table 7.1–2 lists the permits held by LLNL for both the Livermore Site and Site 300 for 2002.

TABLE 7.1–1.—*Selected Federal and State Environmental Laws and Regulations with Permit Approval, Consultation, and Notification Requirements*

General			
Law or Regulation	**Citation**	**Responsible Agency**	**DOE/NNSA Responsibilities**
Atomic Energy Act of 1954	42 U.S.C. §2011	DOE	NNSA shall follow its own standards and procedures to ensure the safe operation of its facilities.
NEPA	42 U.S.C. §4321 et seq.	CEQ	Establishes requirements for environmental impact statements. Statutory requirements for preparation of EISs apply to all major Federal actions significantly affecting the environment. NNSA shall comply with NEPA implementing procedures in accordance with 10 CFR Part 1021.
Regulations for Implementing the Procedural Provisions of NEPA	40 CFR Parts 1500-1508	CEQ	These regulations seek to integrate the NEPA process into the early planning phase of a project to insure appropriate consideration of NEPA policies and to eliminate delays, emphasize cooperative consultation among agencies before the environmental document is prepared, identify at an early stage the significant environmental issues deserving of study, provide a mechanism for putting appropriate time limits on the environmental documentation process, and provide for public participation in the NEPA process.
NEPA Implementing Procedures	10 CFR Part 1021	DOE	DOE established its NEPA implementing procedures to meet the requirements of Section 102(2)(c) of NEPA, CEQ implementing regulations, and EO 11514, Protection and Enhancement of Environmental Quality (35 FR 4247). DOE's implementing procedures formalize DOE's policy to follow the letter and spirit of NEPA, comply fully with the CEQ regulations, and apply the NEPA review process early in the planning stages for DOE proposals. The Site-wide Environmental Impact Statement is being prepared under 10 CFR §§1021.330, programmatic (including site-wide) NEPA documents, requiring preparation of site-wide environmental documentation for certain of its large, multiple-facility sites.
EO 11514: Protection and Enhancement of Environmental Quality	3 CFR Parts 1966 – 1970 Comp., p. 902	CEQ	Requires Federal agencies to demonstrate leadership in achieving the environmental quality goals of NEPA; provides for DOE consultation with appropriate Federal, state, and local agencies in carrying out their activities as they affect the environment.

TABLE 7.1–1.—*Selected Federal and State Environmental Laws and Regulations with Permit Approval, Consultation, and Notification Requirements (continued)*

Law or Regulation	Citation	Responsible Agency	DOE Responsibilities
Ecology			
Fish and Wildlife Coordination Act	16 U.S.C. §661 et seq.	USFWS	Requires consultation on the possible effects on wildlife if there is construction, modification, or control of bodies of water in excess of 10 acres in surface area.
Bald and Golden Eagle Protection Act	16 U.S.C. §668 et seq.	USFWS	Consultations should be conducted to determine if any protected birds are found to inhabit the area. If so, DOE must obtain a permit prior to moving any nests due to mission requirements.
Migratory Bird Treaty Act	16 U.S.C. §703 et seq.	USFWS	Requires consultation to determine if there are any impacts on migratory bird populations due to mission requirements. If so, DOE will develop mitigation measures to avoid adverse effects.
Endangered Species Act of 1973	16 U.S.C. §1531 et seq.	USFWS/National Marine Fisheries Service	Requires consultation to identify endangered or threatened species and their habitats, assess DOE impacts thereon, obtain necessary biological opinions, and, if necessary, develop mitigation measures to reduce or eliminate adverse effects of construction or operation.
California Endangered Species Act	Fish and Game Code §2050 et seq.	CDFG	The *California Endangered Species Act* generally parallels the main provisions of the Federal *Endangered Species Act*. Under the *California Endangered Species Act* , the term “endangered species” is defined as a species of plant, fish, or wildlife that is “in serious danger of becoming extinct throughout all, or a significant portion of its range” and is limited to species or subspecies native to California. The Act prohibits the “taking” of listed species except as otherwise provided in state law. Unlike its Federal counterpart, the Act applies the take prohibitions to species petitioned for listing (state candidates).
Natural Community Conservation Planning Act	Fish and Game Code §2800 et seq.	CDFG	The NCCP program of the CDFG is an effort by the State of California and numerous private and public partners to take a broad-based ecosystem approach to planning for the protection and perpetuation of biological diversity. The goal of NCCP programs is to identify and provide for the regional or area-wide protection of plants, animals, and their habitats, while allowing compatible and appropriate economic activity. The NCCP program applies statewide, although there is currently no NCCP region near LLNL.

TABLE 7.1–1.—*Selected Federal and State Environmental Laws and Regulations with Permit Approval, Consultation, and Notification Requirements (continued)*

Law or Regulation	Citation	Responsible Agency	DOE Responsibilities
Air Quality			
Air Pollution Control Rules and Regulations	N/A	BAAQMD, jurisdiction includes Alameda County. SJVUAPCD jurisdiction includes San Joaquin County. Oversight agencies include both CalEPA Air Resources Board and U.S. EPA	Establishes requirements for the control of air pollutants from stationary (nonmobile) sources, including permit requirements and prohibitory rules associated with activities or equipment with the potential to emit air pollutants. Includes requirements for the control of criteria, toxic and hazardous air pollutants, which are at least as stringent as applicable Federal and state requirements. Source-specific requirements are incorporated into enforceable permit conditions. Establishes air district authority and responsibility to routinely inspects and enforce applicable regulations.
Water			
Clean Water Act	33 U.S.C. §1251 et seq.	EPA	Requires EPA- or state-issued permits and compliance with provisions of permits regarding discharge of effluents to surface waters.
Safe Drinking Water Act (SDWA) of 1944, as amended	42 U.S.C. §300f	EPA	The *Safe Drinking Water Act* sets national standards for contaminant levels in public drinking water systems, regulates the use of underground injection wells, and prescribes standards for groundwater aquifers that are a sole source of drinking water. The Act applies to Federal facilities that own or operate a public water system. A public water system is defined as a system for the provision of piped water for human consumption that has at least 15 service connections or regularly serves at least 25 individuals. LLNL provides drinking water to its employees. LLNL is required to monitor drinking water quality for organic and inorganic compounds, radionuclides, metals, turbidity, and total coliform bacteria.
Porter-Cologne Water Quality Control Act	California Water Code, Division 7, §13000 et seq.	State Water Resources Control Board	The *Porter-Cologne Act* gives jurisdiction of water rights to the State Water Resources Control Board. Nine Regional Water Quality Control Boards manage water quality within their regions. The regional boards determine beneficial uses of water for bodies of water in their areas, establish and enforce water quality standards for both surface and groundwater, and take actions to maintain standards by controlling pollution sources.
NPDES Stormwater Permit	33 U.S.C. §1342	State Water Resources Control Board/Central Valley Regional Water Quality Control Board/San Francisco Bay Regional Water	The NPDES Stormwater Program requires operators of construction sites, industrial facilities, and municipal separate storm sewer systems to obtain authorization to discharge stormwater under an appropriate NPDES permit for construction, industrial, or municipal operations. Federal facilities have been defined by regulation to be a municipal separate storm sewer system. The NPDES program at the Livermore Site is enforced by the State Water Resources Control Board; at Site 300, it is enforced by the Central Valley Regional Water Quality Control Board.

TABLE 7.1–1.—*Selected Federal and State Environmental Laws and Regulations with Permit Approval, Consultation, and Notification Requirements (continued)*

Law or Regulation	Citation	Responsible Agency	DOE Responsibilities
		Quality Control Board	
Dredged or Fill Material (Section 404 of *the Clean Water Act*)/*Rivers and Harbors Appropriations Act* of 1899	33 U.S.C. §1344/33 U.S.C. §401 et seq.	U.S. Army Corps of Engineers	Requires permits to authorize the discharge of dredged or fill material into navigable waters or wetlands and to authorize certain structures or work in or affecting navigable waters.
Compliance with Floodplain/ Wetlands Environmental Review Requirements	10 CFR Part 1022	DOE	Requires DOE to comply with all applicable floodplain/wetlands environmental review requirements.
Noise			
East (Alameda) County Area Plan (Alameda County 1994)	Alameda County General Code, Title 6 Health and Safety, Chapter 6.60 Noise	Alameda County	Sets limits on the allowable amount of noise (maximum decibels) that can be heard from one property to another to protect certain noise-sensitive land uses.
City of Livermore General Plan (City of Livermore 1975)	Chapter 9: Noise Element	City of Livermore	Provides acceptable noise levels for certain land uses, based on state guidelines.
City of Tracy Noise Control Ordinance	Tracy Municipal Code, Section 4.12.750 – 840	City of Tracy	Provides explicit noise level limits for various zoning types and provides methods for addressing noise problems.
San Joaquin County Noise Control Ordinance	Ordinance Code of San Joaquin County for Zoning and Subdivision Regulations (Ordinance Nos. 2831 and 3005)	San Joaquin County	Provides guidelines for noise levels associated with various land uses within unincorporated areas not to exceed 75 decibels day-night average level at property lines within commercial-manufacturing zones.

TABLE 7.1–1.—*Selected Federal and State Environmental Laws and Regulations with Permit Approval, Consultation, and Notification Requirements (continued)*

Law or Regulation	Citation	Responsible Agency	DOE Responsibilities
Self-Imposed Limit on Impulse Noise	NA	LLNL	Self-imposed maximum allowable sound pressure level of 126 decibels, not to be exceeded in nearby populated areas. At Site 300, for open air detonations LLNL uses "blast forecasting" to determine the maximum explosive weight that can be detonated without an irritant effect on the nearby populated areas.
Traffic and Transportation			
Hazardous Materials Transportation Act	49 U.S.C. §1801 et seq.	DOT	DOE shall comply with the requirements governing hazardous materials and waste transportation.
Hazardous Materials Transportation Uniform Safety Act of 1990	49 U.S.C. §1801	DOT	Restricts shippers of highway route-controlled quantities of radioactive materials to use only permitted carriers.
Materials and Waste Management			
TSCA	15 U.S.C. §2601 et seq.	EPA	DOE shall comply with inventory reporting requirements and chemical control provisions of TSCA to protect the public from the risks of exposure to chemicals; TSCA imposes strict limitations on use and disposal of polychlorinated biphenyl-contaminated equipment.
Emergency Planning and Community Right-To-Know Act of 1986	42 U.S.C. §11001 et seq.	EPA	Requires the development of emergency response plans and reporting requirements for chemical spills and other emergency releases, and imposes right-to-know reporting requirements covering storage and use of chemicals that are reported in toxic chemical release forms.
Pollution Prevention Act of 1990	42 U.S.C. §§11001 – 11050	EPA	Establishes a national policy that pollution should be reduced at the source and requires a toxic chemical source reduction and recycling report for an owner or operator of a facility required to file an annual toxic chemical release form under section 313 of the SARA.
Nuclear Waste Policy Act of 1982	42 U.S.C. §10101 et seq.	EPA	DOE shall dispose of radioactive waste per standards of 40 CFR Part 191.
Federal Facility Compliance Act of 1992	42 U.S.C. §6961	Department of Toxic Substances Control	Eliminates *Resource Conservation and Recovery Act* waiver of sovereign immunity for Federal facilities and requires DOE to develop plans and enter into agreements with states as to specific management actions for specific mixed waste streams.
RCRA/ Hazardous and Solid Waste Amendments of 1984	42 U.S.C. §6901 et seq./Public Law (PL) 98- 616	EPA	Requires proper management and, in some cases, permits for current operations involving hazardous waste and remediation of contamination from past activities (not addressed by the *Comprehensive Environmental Response, Compensation, and Liability Act*); changes to site hazardous waste operations could require amendments to *Resource Conservation and Recovery Act* hazardous waste permits involving public hearings.
Site Contamination and Remediation			
CERCLA/ SARA	42 U.S.C. §9601 et	EPA	Requires cleanup and notification if there is a release or threatened release of a hazardous substance; requires DOE to pursue interagency agreements with EPA and state to control

TABLE 7.1–1.—*Selected Federal and State Environmental Laws and Regulations with Permit Approval, Consultation, and Notification Requirements (continued)*

Law or Regulation	Citation	Responsible Agency	DOE Responsibilities
	seq./PL 99- 499		the cleanup of each DOE site on the National Priorities List.
Community Environmental Response Facilitation Act	PL 102-426	EPA	Amends *Comprehensive Environmental Response, Compensation, and Liability Act* (40 CFR Part 300) to establish a process for identifying, prior to the termination of Federal activities, property that does not contain contamination. Requires prompt identification of parcels that will not require remediation to facilitate the transfer of such property for economic redevelopment purposes.
California Hazardous Waste Control Law and other California hazardous waste laws	Health and Safety Code, Division 20, Chapter 6.5 California Code of Regulations, Title 22	DTSC	Sets requirements for managing hazardous waste in California.

BAAQMD = Bay Area Air Quality Management District; CDFG = California Department of Fish and Game; CEQ = Council on Environmental Quality; CFR = Code of Federal Regulations; DOE = U.S. Department of Energy; DOT = U.S. Department of Transportation; EIS = environmental impact statement; EO = Executive Order; EPA = Environmental Protection Agency; FR = Federal Register; NA = not available; N/A = not applicable; NCCP = Natural Community Conservation Planning; NEPA = *National Environmental Policy Act*; NNSA = National Nuclear Security Administration; NPDES = National Pollution Discharge Elimination System; SJVUAPCD = San Joaquin Valley Unified Air Pollution Control District; PCB = polychlorinated biphenyl; SARA = *Superfund Amendment and Reauthorization Act*; TSCA = *Toxic Substances Control Act*; U.S.C. = United States Code; USFWS = U.S. Fish and Wildlife Service.

TABLE 7.1–2.—*Summary of Permits Active in 2002* [a,b]

Livermore Site	Site 300
Air	
BAAQMD issued 199 permits for operation of various types of equipment, including boilers, emergency generators, cold cleaners, ultrasonic cleaners, degreasers, printing press operations, manual wipe-cleaning operations, metal machining and finishing operations, silk-screening operations, silk-screen washers, paint spray booths, adhesives operations, image tube fabrication, optic coating operations, storage tanks containing volatile organic compounds in excess of 1.0%, plating tanks, drum crusher, semiconductor operations, diesel air-compressor engines, groundwater air strippers/dryers, material-handling equipment, sewer diversion system, oil and water separator, fire test cells, gasoline dispensing operation, paper-pulverizer system, and firing tanks.	SJVUAPCD issued 44 permits for operation of various types of equipment, including boilers, emergency generators, paint spray booth, groundwater air strippers, soil vapor extraction units, woodworking cyclone, gasoline dispensing operation, explosive waste treatment units, and drying ovens, and the Contained Firing Facility.
Water	
WDR Order No. 88-075 for discharges of treated groundwater from Treatment Facility A to percolation pits and recharge basin. WDR Order No. 95-174, NPDES Permit No. CA0030023 for discharges of stormwater associated with industrial activities and low-threat nonstormwater discharges to surface waters. WDR Order No. 99-08-DWQ, NPDES California General Construction Activity Permit No. CAS000002; Terascale Simulation Facility, Site ID No. 201S317827; Sensitive Compartmented Information Facility, Site ID No. 201S317621; Soil Reuse Project, Site ID No. 2015305529; and National Ignition Facility, Site ID No. 201S306762, for discharges of stormwater associated with construction activities affecting two hectares or more. WDR Order No. 99-086 for the Arroyo Las Positas Maintenance Project. Nationwide Permits 18 and 33 for the Arroyo Las Positas Maintenance Project. One offsite project (at Arroyo Mocho) completed under a streambed alteration agreement. FFA for groundwater investigation/remediation.	WDR Order No. 93-100 for post-closure monitoring requirements for two Class I landfills. WDR Order No. 96-248 for operation of two Class II surface impoundments, a domestic sewage lagoon, and percolation pits. WDR Order No. 97-03-DWQ, NPDES California General Industrial Activity General Permit No. CAS000001 for discharge of stormwater associated with industrial activities. WDR Order No. 97-242, NPDES Permit No. CA0082651 for discharges of treated groundwater from the eastern General Services Area treatment unit. WDR Order No. 5-00-175, NPDES Permit No. CAG995001 for large volume discharges from the drinking water system that reach surface waters. FFA for groundwater investigation/remediation. 57 registered Class V injection wells.

TABLE 7.1–2.—*Summary of Permits Active in 2002* [a,b]

Livermore Site	Site 300
Hazardous waste	
EPA ID No. CA2890012584. Authorization to mix resin in Unit CE231-1 under conditional exemption tiered permitting. Final Closure Plan submitted to DTSC for the Building 419 interim status unit (February 2001). Authorizations to construct the permitted units of Building 280, Building 695, and additions to Building 693. Authorization under hazardous waste permit to operate 18 waste storage units and 14 waste treatment units. Continued authorization to operate seven waste storage units and eight waste treatment units under interim status. Final Closure Plans submitted to DTSC for the Building 233 and Building 514 interim status units (May 2000). Notified DTSC on 3/31/01 that LLNL will not construct and operate Building 280 as a permitted unit as described in our Hazardous Waste Facility permit.	EPA ID No. CA2890090002. Part B Permit—Container Storage Area (Building 883) and Explosives Waste Storage Facility (issued May 23, 1996). Part B Permit—Explosives Waste Treatment Facility (issued October 9, 1997). Docket HWCA 92/93-031. Closure and Post-Closure Plans for Landfill Pit 6 and the Building 829 Open Burn Facility.
Medical waste	
One permit for large quantity medical waste generation and treatment covering the Biology and Biotechnology Research Program, Health Services Department, Forensic Science Center, Medical Photonics Lab, Tissue Culture Lab, and Chemistry and Materials Science Department.	Limited Quantity Hauling Exemption for small quantity medical waste generator.
Sanitary sewer	
Discharge Permit No. 1250 (2001/2002 and 2002/2003 [c]) for discharges of wastewater to the sanitary sewer. Permit 1510G (2001/2002 [d]) for discharges of groundwater from CERCLA restoration activities.	
Storage tanks	
Eight operating permits covering 11 underground petroleum product and hazardous waste storage tanks: 111-D1U2 Permit No. 6480; 113-D1U2 Permit No. 6482; 152-D1U2 Permit No. 6496; 271-D2U1 Permit No. 6501; 321-D1U2 Permit No. 6491; 322-R2U2 Permit No. 6504 [e]; 365-D1U2 Permit No. 6492; and 611-D1U1, 611-G1U1, 611-G2U1, and 611-O1U1 Permit No. 6505.	One operating permit covering five underground petroleum product tanks assigned individual permit numbers: 871-D1U2 Permit No. 008013; 875-D1U2 Permit No. 006549; 879-D1U1 Permit No. 006785; 879-G3U1 Permit No. 007967; and 882-D1U1 Permit No. 006530

[a] Permit numbers are based on actual permitted units or activities maintained and renewed by LLNL during 2002.
[b] See Acronyms and Abbreviations for list of acronyms.
[c] The Discharge Permit No. 1250 period is from May 15 to May 14; therefore, two permits were active during the 2002 calendar year.
[d] Permit 1510G is a two-year (January to December) permit.
[e] LLNL received permit exemption in October 2002.

7.2 LIVERMORE SITE—REGULATORY INSPECTIONS AND AUDITS

Table 7.2–1 summarizes the regulatory agency inspections and audits conducted at the Livermore Site during 2002. Findings resulting from these activities are summarized below and are representative of the type of regulatory oversight that may be expected to continue into the future. Recent inspections have not identified new compliance concerns at the Livermore Site.

TABLE 7.2–1.—*Compliance Summary for 2002, Livermore Site*

Audits/Inspections	Date	Regulatory Agency
Annual inspection of permitted units	February 8, 2002; March 13, 2002; June 6, 2002; September 6, 2002; October 24, 2002	BAAQMD
Annual compliance sampling	October 7-8, 2002	LWRP
Categorical sampling	October 21, 2002	LWRP
Hazardous waste facilities	May 22-24, 30, 2002; June 4, 2002	DTSC
Medical waste	September 25, 2002	ACDEH
Compliance with underground storage tank upgrade requirements and operating permits	October 15-16, 2002	ACDEH

ACDEH = Alameda County Department of Environmental Health; BAAQMD = Bay Area Air Quality Management District; DTSC = Department of Toxic Substances Control; LWRP = Livermore Water Reclamation Plant; SFBRWQCB = San Francisco Bay Regional Water Quality Control Board;

Air Inspections

The Bay Area Air Quality Management District conducted five inspections at the Livermore Site during 2002. Inspections were conducted to review startup of new equipment and operation of existing equipment with permits. No notices of violation were issued.

Hazardous Waste Inspections

The DTSC inspected LLNL hazardous waste storage and treatment facilities on May 22 through 24, May 30, and June 4, 2002. On August 21, 2002, LLNL received an inspection report and notification of a Summary of Violations resulting from the May inspection. LLNL received a Summary of Violations from DTSC for alleged violations observed during the 2002 compliance evaluation inspection of permitted hazardous waste handling operations. The alleged violations and resolutions were as follows:

- Storage of one container of waste for greater than 90 days in the B612-4 90-day generator area. This waste container was moved to a permitted storage location.

- Storage of two waste containers for greater than one year in the B693 Container Storage Unit. This waste was transferred to an offsite transfer, storage, and disposal facility.

- Inadequate aisle spacing in the Area 514-3 portable tank area. LLNL maintained that adequate aisle spacing was provided.

- Failure of an individual to take a required refresher training course. LLNL maintained that the individual met the training requirements until he was transferred to a different position where the training was no longer required.

Later, LLNL received notice from DTSC that the agency had rescinded the last two alleged violations. Receiving a Summary of Violations meets the requirements of an Off-Normal Occurrence (OR 2002-0012) (LLNL 2003cb).

Medical Waste

LLNL is registered with the Alameda County Department of Environmental Health as a generator of medical waste and has a treatment permit. The September 25, 2002, inspection of buildings at Health Services, the Biology and Biotechnology Research Program, and the Medical Photonics Lab did not result in any compliance issues or violations.

Tank Inspections

Inspections of underground storage tanks for upgrade requirements and operating permits were conducted by the Alameda County Department of Environmental Health on October 15-16, 2002; no violations were found.

Sewer Discharge Inspections

Monitoring results for sewer discharges from LLNL are reported monthly to the LWRP. The monitoring results for the LLNL effluent are reported monthly to the LWRP. In 2002, LLNL sanitary effluent monitoring identified five events that were at or slightly above effluent limitations contained in Permit No. 1250. Two of these events resulted in a Letter of Warning from the LWRP. Daily effluent samples collected on August 3 and 6 contained lead at concentrations of 0.226 milligrams per liter and 0.208 milligrams per liter, respectively, exceeding the discharge limit of 0.2 milligrams per liter. The LWRP issued a Letter of Warning dated October 10, 2002, for these discharges. The other three events were brief pH monitoring fluctuations, reported to the LWRP. Following LWRP's evaluation of each event, they decided formal enforcement action was not appropriate.

On October 7 and 8, 2002, LWRP and Environmental Protection Department personnel collected split samples of site effluent as part of routine annual compliance sampling. Sample results confirmed compliance with effluent discharge limits. LLNL and LWRP also inspected and sampled categorical processes and their waste streams on October 21, 2002. No facility deficiencies were noted during any of the inspections LLNL monitors discharges from groundwater treatment facilities to the sanitary sewer under Permit 1510G (2002) as they occur. Data are reported annually to the LWRP. In 2002, LLNL complied with all the terms and conditions of Permit 1510G.

7.3 SITE 300—REGULATORY INSPECTIONS AND AUDITS

Table 7.3–1 summarizes the regulatory agency inspections and audits conducted at Site 300 during 2002. Findings resulting from these activities are summarized below and are representative of the types of regulatory oversight that may be expected to continue into the future. The more recent inspections have not identified new compliance concerns at Site 300.

TABLE 7.3–1.—*Compliance Summary for 2002, Site 300*

Audits/Inspections	Date	Regulatory Agency
Emission sources – startup inspection of Contained Firing Facility and Central GSA air stripper	June 4, 2002	SJVUAPCD
Permitted operations	November 11, 2002	CVRWQCB
Permitted hazardous waste and accumulation and generator facilities	November 20-21, 2002	DTSC

CVRWQCB = Central Valley Regional Water Quality Control Board; DTSC = Department of Toxic Substances Control; GSA = General Services Area; SJVUAPCD = San Joaquin Valley Unified Air Pollution Control District.

Air Inspections

On June 4, 2002, the San Joaquin Valley Unified Air Pollution Control District conducted an inspection of various operating emission sources and a startup inspection of the Contained Firing Facility and the Central General Services Area air stripper; no discrepancies were found.

Hazardous Waste Inspections

On November 20 and 21, DTSC conducted the 2002 compliance evaluation inspection of Site 300 hazardous waste generator areas, Building 883 Waste Accumulation and Container Storage Areas, and Explosives Waste Treatment and Storage Facilities. No violations were found.

Water Inspections

The Central Valley Regional Water Quality Control Board inspected the Site 300 permitted facilities in November 2002. No violations were found during these inspections.

7.4 SUMMARY OF INADVERTENT EVENTS

Table 7.4–1 summarizes inadvertent events that occurred at LLNL during 2002. The information in these tables has been obtained from the unusual occurrence reports that have been reported to DOE by LLNL (LLNL 2003l).

TABLE 7.4–1.—*Lawrence Livermore National Laboratory Inadvertent Events with the Potential for Environmental Impacts*

Date (2002)	Material Released	Description of Event	Consequences and/or Actions Taken
August 3 and August 6	Lead	Lead in the August 3 and August 6 daily effluent samples exceeded the permit limit	No worker exposures
April 5	Shell Diala insulating oil	LLNL was notified by a scrap metal company on April 4 that equipment (a pulse-electron beam generator) shipped to them by LLNL that day contained a large volume of liquid. Before shipping the equipment, LLNL removed approximately 3,000 gallons of Shell Diala insulating oil from the equipment. Upon receiving the equipment, the scrap metal company discovered that additional liquid was contained in a separate reservoir. Representatives from LLNL were sent to the scrap metal facility with a container truck to remove the remaining liquid. LLNL removed 2,766 gallons of Shell Diala insulating oil from the equipment and shipped the oil to an outside company for recycling. Equipment containing liquid violates the definition of "scrap metal" as defined in California Code of Regulations, Title 22. Shipping scrap metal containing Shell Diala insulating oil violated the offsite facility acceptance criteria and meets the definition of an Off-Normal Occurrence.	No worker exposures
June 6	None	LLNL received a Summary of Violation from DTSC for alleged violations observed during the 2002 Compliance Evaluation Inspection of permitted hazardous waste handling operations. The alleged violations and resolutions were as follows: • Storage of one container of waste for greater than 90 days in the B612-4 90-day generator area. This waste container was moved to a permitted storage location. • Storage of two waste containers for greater than one year in the B693 Container Storage Unit. This waste was transferred to an offsite treatment, storage, and disposal facility. • Inadequate aisle spacing in the Area 514-3 portable tank area. LLNL maintained that adequate aisle spacing was provided. • Failure of an individual to take a required refresher training course. LLNL maintained that the individual met the training requirements until he was transferred to a different position where the training was no longer required. Later, LLNL received notice from DTSC that the agency had rescinded the last two alleged violations. Receiving a Summary of Violation meets the requirements of an Off-Normal Occurrence.	Notice of violation issued

TABLE 7.4–1.—*Lawrence Livermore National Laboratory Inadvertent Events with the Potential for Environmental Impacts (continued)*

Date (2002)	Material Released	Description of Event	Consequences and/or Actions Taken
November 5	None	LLNL received a field inspection report from the San Joaquin County Environmental Health Department listing three minor violations: • Lack of documentation for tank alarms at Buildings 871, 875, and 879. • Line leak detector at Building 879 was not functioning at the required rate. • Lack of documentation of line leak test or positive turbine pump shutdown due to lack of dispenser pan sensors at Building 879. To address the observations, LLNL has developed logbooks at the tank system alarm panels and instituted documentation requirements for documenting alarms. In addition, the B879 line leak detector was replaced and the unleaded line system was leak tested and the results submitted to the San Joaquin County Environmental Health Department as requested. Receiving a notice of violation meets the requirements of an Off-Normal Occurrence. OR 2002-0033.	Notice of violation issued.

DTSC = Department of Toxic Substances Control.

TABLE 7.4–1.—*Lawrence Livermore National Laboratory Inadvertent Events with the Potential for Environmental Impacts (continued)*

Date (2002)	Material Released	Description of Event	Consequences and/or Actions Taken
November 5	None	LLNL received a field inspection report from the San Joaquin County Environmental Health Department listing three minor violations: • Lack of documentation for tank alarms at Buildings 871, 875, and 879. • Line leak detector at Building 879 was not functioning at the required rate. • Lack of documentation of line leak test or positive turbine pump shutdown due to lack of dispenser pan sensors at Building 879. To address the observations, LLNL has developed logbooks at the tank system alarm panels and instituted documentation requirements for documenting alarms. In addition, the B879 line leak detector was replaced and the unleaded line system was leak tested and the results submitted to the San Joaquin County Environmental Health Department as requested. Receiving a notice of violation meets the requirements of an Off-Normal Occurrence. OR 2002-0033.	Notice of violation issued.

DTSC = Department of Toxic Substances Control.

CHAPTER 8: SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

In accordance with the *National Environmental Policy Act* (NEPA) requirements, this section discusses the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity. It also examines long-term adverse cumulative impacts, with a focus on impacts that may narrow the range of options for future use. Impacts of the proposed action at the Lawrence Livermore National Laboratory (LLNL) are discussed in Section 5.1; unavoidable adverse environmental impacts are identified in Chapter 6.

Return of the Livermore Site to agricultural or other nonindustrial use may be precluded by the presence of the existing structures, roads, and utilities, and the existing soil contamination problems. Based on the general plans of the City of Livermore and the County of Alameda, both jurisdictions have designated these sites, as well as much of the surrounding area, for industrial uses. The long-term productivity of LLNL would be optimized by its continued use for research and design or as industrial facilities.

Because much of the land at Site 300 is undeveloped, it is conceivable that the site could be used for wind energy development or returned to an agricultural use, such as livestock grazing. The site could also be returned to an open area or wildlife refuge. These uses of the site would be compatible with existing Alameda and San Joaquin counties land use and applicable land use plans. However, it is possible that the remediation of contaminated areas and the protection of sensitive habitats would be required before such uses could take place.

Long-term cumulative impacts described above would be mitigated somewhat by a change to agricultural use. The LLNL contributions to future noise levels, traffic, and water consumption would be reduced.

The long-term benefits of continuing to operate LLNL must include fulfilling national defense missions, together with laser, biomedical, energy, education, and other research and development, and also including technology transfer to academia and industry. If LLNL were shut down and the properties were to return to other uses, for example agriculture or urban development, the short-term benefits of such a transfer would be different from the long-term loss to the Nation of a major technical research facility with diversified research, particularly in the fields of biomedicine, energy development, and national defense.

Environmental remediation activities currently occurring and scheduled to continue under the proposed action will, in the long term, improve the options for alternative uses of the Livermore and Site 300. Cleanup of the sites increases the options for future use of the property rather than narrowing it.

CHAPTER 9: IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Operations at the Livermore Site and Site 300 under the No Action Alternative, Proposed Action, and Reduced Operation Alternative would require an irreversible and irretrievable commitment of resources. A commitment of resources is irreversible when its primary or secondary impacts limit the future options for a resource. For example, as a landfill receives waste, the primary impact is a limit on waste capacity. The secondary impact is a limit on future land use options. An irretrievable commitment refers to the use or consumption of a resource that is neither renewable nor recoverable for use by future generations. This section discusses four major resources–land, energy, material, and water–that have the potential to be committed irreversibly or irretrievably under the No Action Alternative, Proposed Action, and Reduced Operation Alternative.

9.1 LAND

Past activities at Site 300 have led to soil contamination. Soil contaminants include volatile organic compounds, metals, polychlorinated biphenyls, dioxins, furans, high explosives compounds, and depleted uranium. Although some areas of legacy contamination are in the process of investigation or remediation, testing activities planned under the No Action Alternative, Proposed Action, or Reduced Operation Alternative could lead to further contamination in some areas. These areas of contamination are essentially unavailable for use for other purposes due to a variety of factors. These include construction-related criteria involving soil compacting, regulatory restrictions, and compatibility issues related to DOE missions. The total acreage removed from future or unrestricted use is yet-to-be-determined because some sites could require continued monitoring, limited access, limited use, and potentially require other future corrective actions for an extended period of time.

Nonhazardous waste from the Lawrence Livermore National Laboratory (LLNL) would occupy landfill space, thus limiting future land use options. However, landfill capacity for the Altamont Landfill is estimated to be sufficient for disposal needs until the year 2038; disposal land is already committed to this purpose.

9.2 ENERGY

The irretrievable commitment of resources during construction and operation of the facilities would include nonrenewable fuels to generate heat and power, and fuels used to operate motor vehicles and heavy equipment. Energy resources consumed at LLNL would include electricity, natural gas, diesel fuel, fuel oil, and unleaded gasoline.

Electricity consumption would be 462.3 million kilowatt-hours per year under the No Action Alternative, the highest for any of the alternatives analyzed. About 76 percent of the electricity used would be generated using nonrenewable resources. Other nonrenewable resources consumed, with corresponding quantities under the No Action Alternative, the highest of any of the alternatives analyzed, are natural gas (841.8 million cubic feet per year), diesel fuel (72,000 gallons per year), fuel oil (16,600 gallons per year), and unleaded gasoline (451,800 gallons per year).

9.3 MATERIAL

Resources irreversibly and irretrievably committed for the operation of LLNL include construction, maintenance, and operational support materials. Consumption of these widely available materials would not be expected to result in critical shortages. The amount of materials required for construction maintenance, and operational support under all alternatives is small compared to the materials used in the local economy.

9.4 WATER

All Livermore Site water needs are met by the Hetch Hetchy system. Site 300 is scheduled to convert to the Hetch Hetchy system in 2004. Regional demand on the water supply is increasing, but improvements to the system should keep up with demand at least through the next 10 years. Because water from the Hetch Hetchy Reservoir is naturally replenished at a rate equal to usage, LLNL's water use is not considered to be an irreversible and irretrievable commitment of resources.

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CHAPTER 11: GLOSSARY

Ablation: The removal of material from a surface illuminated by intense laser light or x rays. On the NIF scattered laser light or x rays produced from the interactions of the laser beams with targets can be intense enough to remove thin (typically measured in fractions of a micron) layers of material from exposed objects and surfaces.

Absorbed dose: The amount of energy imparted to matter by ionizing radiation per unit mass of irradiated material, in which the absorbed dose is expressed in units of rad or gray (l rad = 0.01 gray).

Accelerator: An apparatus for imparting high velocities to charged particles.

Acoustic: Containing, producing, carrying, arising from, actuated by, related to, or associated with sound.

Activation products: Radionuclides formed by bombardment and adsorption in material with neutrons, protons, or other nuclear particles. For example, cobalt-60 is an activation product resulting from neutron activation of cobalt-59.

Action level: Defined by regulatory agencies, the level of pollutants which, if exceeded, requires regulatory action.

Acute: With respect to dose or toxicity, one that occurs in a short time.

Acute exposure: The absorption of a relatively large quantity of radiation or intake of radioactive or toxic material over a short period of time.

Activity: The number of nuclear transformations occurring in a given quantity of material per unit time.

Administrative limit: A limit imposed by procedure on the quantity of a radionuclide permitted in a building or part of a building.

Aerosol: A gaseous suspension of very small particles of liquid or solid

Air Quality Control Region (AQCR): An interstate or intrastate area designated by the Environmental Protection Agency for the attainment and maintenance of National Ambient Air Quality Standards.

Air quality: Measure of the health-related and visual characteristics of the air, often derived from quantitative measurements of the concentrations of specific injurious or contaminating substances. Air quality standards are the prescribed level of constituents in the outside air that are regionally mandated during a specific time in a specified area.

Air quality maintenance area: An area, which due to current air quality or projected residential and industrial growth, has the potential for exceeding a national ambient air quality standard.

Air stripper: A groundwater treatment system in which volatile organic compounds are removed from soil by aeration.

Airborne Release Fraction (ARF): The coefficient used to estimate the amount of radioactive material that can be suspended in air and made available for airborne transport under a specific set of induced physical stresses. ARF is used, along with other factors, to determine the source term for an accident or event.

Alameda County Flood Control and Water Conservation District: Also known as Zone 7, the water management agency for the Livermore-Amador Valley with responsibility for water treatment and distribution, and responsible for management of agricultural and surface water and the groundwater basin.

Alluvial fan: Cone-shaped deposits of alluvium made by a stream. Fans generally form where streams emerge from mountains onto the lowland.

Alluvium: Sediment deposited by flowing water.

Alpha particle: A positively charged particle emitted from the nucleus of an atom, having mass and charge equal to those of a helium nucleus (two protons and two neutrons).

Ambient air: The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures; not considered in monitoring purposes when immediately adjacent to emission sources.

Ambient noise: The residual (background) sound in the absence of specific identifiable noise sources.

Ambient sound level (LDN): The 24-hour equivalent continuous sound level with a night-time penalty added, i.e., the time-averaged A-weighted sound level, in decibels, from midnight to midnight, obtained after the addition of 10 dB to sound levels from midnight to 7:00 a.m. and from 10:00 p.m. to midnight.

American Indian Religious Freedom Act of 1978**:** This Act establishes national policy to protect and preserve for Native Americans their inherent right of freedom to believe, express, and exercise their traditional religions, including the rights of access to religious sites, use and possession of sacred objects, and the freedom to worship through traditional ceremonies and rites.

Americium: An artificial radioactive element of atomic number 95. Am-241 is produced by the beta decay of Pu-241.

Analyte: The specific component measured in a chemical analysis.

Anion: A negatively charged ion, such as Cl (chloride).

Anticline: A fold in rocks in which the strata dip outward from both sides of the axis, where the oldest strata are in the core of the fold.

AP-42: An EPA compilation of air pollution emission factors and other technical data pertaining to air quality *see* “emission factors”.

Aquifer: A saturated layer of rock or soil below the ground surface that can supply usable quantities of groundwater to wells and springs, and be a source of water for domestic, agricultural, and industrial uses.

Aquitard: Low-permeability geologic formation that bounds an aquifer.

Archival research: Examination of records at the regional offices of the State Historic Preservation Office for evidence of recorded historic and/or prehistoric sites; the use of other archival sources (libraries, private collections, museums) to gather information on historic and prehistoric sites that have not been formally recorded or that have not been completely documented.

Aromatic hydrocarbons: Volatile organic compounds characterized by unsaturated ring structures; in this EIS/EIR, benzene, toluene, ethylbenzene, and xylenes.

Arithmetic mean: The average of a set of terms, computed by dividing their sum by the number of terms. *See* “geometric mean”.

Arroyo: A gully or channel cut by an intermittent stream.

Arsenic (As): A trivalent and pentavalent solid poisonous element of atomic number 33. Arsenic is commonly metallic steel-gray, crystalline, and brittle.

As low as reasonably achievable (ALARA): An approach to radiation protection to manage and control worker and public exposures (both individual and collective) and releases of radioactive material to the environment to as far below applicable limits as social, technical, economic, practical, and public policy considerations permit. ALARA is not a dose limit, but a process for minimizing doses to as far below limits as possible.

Atmospheric dispersion: The spreading downwind of airborne material due to wind speed and atmospheric turbulence; the greater the spread, the greater the dilution and the smaller the airborne material concentrations.

Attainment area: An area considered to have air quality as good as or better than the national ambient air quality standards as defined in the Clean Air Act. An area may be an attainment area for one pollutant and a nonattainment area for others (*see* “nonattainment area”).

Atom: The smallest particle of an element capable of entering into a chemical reaction.

AVLIS: See U-AVLIS

Background radiation: Radiation from 1) cosmic sources; 2) naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material); 3) global fallout as it exists in the environment (e.g., from the testing of nuclear explosive devices); 4) air travel; 5) consumer and industrial products; and 6) diagnostic x rays and nuclear medicine.

Basement rocks: The undifferentiated complex of rocks that underlies the rocks of interest in an area. The crust of the earth below sedimentary deposits, extending downward to the Mohorovicic discontinuity. In many places the rocks of the complex are igneous and metamorphic and of Precambrian age.

Bay Area Air Quality Management District (BAAQMD): The local agency responsible for regulating stationary air emission sources (including the LLNL Livermore Site) in the San Francisco Bay Area.

Beamlets: Independent laser beams.

Becquerel (Bq): The SI unit of activity of a radionuclide, equal to the activity of a radionuclide having one spontaneous nuclear transition per second. 1 Bq = 2.7^{-11} curies. Also *see* "Metric units."

Bedrock mortar: Depression worn in the floors of rock shelters or on the flat portions of exposed bedrock where prehistoric peoples ground grass seeds and acorns into meals. The depression is created by the continual grinding motion of a stone pestle, which is alternately used to pound and grind from side to side.

Beryllium (Be): A toxic and extremely lightweight element with the atomic number 4. It is metallic and used in reactors as a neutron reflector.

Beryllium Chronic Disease: Acute or chronic lung disease caused by inhalation of beryllium particulate. Skin irritation may result from direct contact with soluble beryllium compounds and healing is impaired in beryllium-contaminated wounds.

Best Available Control Technology (BACT): A term used in the Federal Clean Air Act that means the most stringent level of air pollutant control considering economics for a specific type of source based on demonstrated technology.

Best estimate: An estimate made with the numerical inputs that are believed to be representative of the real situation, not biased conservatively.

Best Management Practices: Activities, procedures, or physical structures for reducing the amount of pollution entering the surface water and groundwater.

Bioassay: Measurement of the amount or concentration of radioactive material in the body or in biological material excreted from or removed from the body and analyzed for purposes of estimating the quantity of radioactive material in the body. This typically includes analysis of urine samples and whole-body scans or lung counts.

Biological Resources Evaluations Team (BRET): The team within the Environmental Protection Group of Los Alamos National Laboratory responsible for biological assessments.

Bioremediation: Cleanup of contaminated groundwater by bacteria.

Biota: The plant and animal life of a region.

Blowdown: Water discharged from cooling towers in order to control total dissolved solids concentrations by allowing make-up water to replenish cooling apparatuses.

Bounding: An accident is bounding if no reasonably foreseeable, equally probable accident can be found with greater consquences. A bounding envelope consists of a set of individual bounding accidents that cover the range of probablilites and possible consequences. The term is also used to identify conservative assumptions that will likely overestimate actual risks or consequences.

British thermal unit (Btu): A unit of heat; the quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit. One British thermal unit equals 1,055 joules (or 252 calories).

Budgeted construction: Construction for which Congress has not yet appropriated the necessarey funds, but that appears in the proposed FY DOE budget.

Cadmium (Cd): A bluish white malleable ductile toxic bivalent metallic element of atomic number 48. Used especially in protective plating and in bearing metals.

California Code of Regulations (CCR): Codification of regulations promulgated by the State of California.

***California Environmental Quality Act* of 1970 (CEQA):** Statute that requires that all California state, local, and regional agencies document, consider, and disclose to the public the environmental implications of their actions.

Cancer: A group of diseases characterized by uncontrolled cellular growth. Increased incidence of cancer can be caused by exposure to radiation or to certain chemicals at sufficient concentrations and exposure durations.

Candidate species: Species being reviewed by the United States Fish and Wildlife Service for possible listing as endangered or threatened, but for which substantial biological information to support a listing is lacking and legal protection is not provided.

CAP88-PC: Computer code required by EPA for modeling air emissions of radionuclides.

Carbon monoxide (CO): A colorless, odorless gas that is toxic if breathed in high concentration over a period of time.

Carcinogen: A substance that directly or indirectly causes cancer.

Change-out: A procedure by which components affected by induced radioactivity are periodically rotated between in-service and out-of-service status to allow the induced radioactivity to decay below predetermined limits and thus maintain a lower total level of radioactivity or a longer useful life. In some cases, decontamination cleaning may also be done during the out-of-service period.

Chlorocarbon: A compound of carbon and chlorine, or carbon, hydrogen, and chlorine, such as carbon tetrachloride, chloroform, and tetrachloroethene.

Chlorofluorocarbon (CFC): Any of several simple gaseous compounds that contain carbon, chlorine, fluorine, and sometimes hydrogen, that are used as refrigerants, cleaning solvents, and aerosol propellants and in the manufacture of plastic foams.

Chromium (Cr): A blue-white metallic element of atomic number 24 found naturally only in molecular combination with other elements and used especially in alloys and in electroplating.

Chronic exposure: The absorption of radiation or intake of radioactive and/or chemical materials over a long period of time.

Class I area: Pristine areas in the United States whose air quality requires special protection from pollution from new sources.

Class II area: Areas in the United States with acceptable air quality levels where moderate increases in air pollutant concentrations from new sources are allowed.

Class III area: Areas in the United States with acceptable air quality levels where larger increases in air pollutant concentrations from new sources are allowed than in Class II areas.

Class I substance: One of several groups of chemicals with an ozone depletion potential of 0.2 or higher. Class I ozone-depleting substances have the highest ozone depleting potential and include chlorofluorocarbon, halons, carbon tetrachloride, methyl chloroform, hydrobromofluorocarbon, and methyl bromide.

***Clean Air Act* Amendments of 1990:** Expands the Environmental Protection Agency's enforcement powers and adds restrictions on air toxins, ozone-depleting chemicals, stationary and mobile emissions sources, and emissions implicated in acid rain and global warming.

***Clean Air Act*:** Federal Act that mandates the promulgation and enforcement of air pollution control standards for stationary sources and motor vehicles.

***Clean Water Act* of 1972, 1987:** Federal Act regulating the discharge of pollutants from a point source into navigable waters of the United States in compliance with a National Pollution Discharge Elimination System permit as well as regulating discharges to or dredging of wetlands.

Climatology: The science that deals with climates and investigates their phenomena and causes.

Code of Federal Regulations (CFR): A codification of all regulations promulgated by Federal government agencies.

Collective dose equivalent and collective committed effective dose equivalent: The sums of the dose equivalents or effective dose equivalents to all individuals in an exposed population within 80 km (50 miles) of the radiation source. These are evaluated by multiplying the dose received by an individual at each location by the number of individuals receiving that dose, and summing over all such products for locations within 80 km of the source. They are expressed in units of person-rem or person-sievert. The collective EDE is also referred to as the "population dose."

Colluvium: A general term applied to any loose, heterogeneous, and incoherent mass of soil material and/or rock fragments deposited by rainwash, sheetwash, or slow continuous downslope creep, usually collecting at the base of gentle slopes or hillsides. Deposition by a combination of gravity and water.

Committed effective dose equivalent (CEDE): The calculated effective dose to an individual after exposure to radiation summed over the life of the individual. CEDE assumes a 70 year lifetime for the general population and a 50 year lifetime for the worker population.

Communicator: For this SWEIS, a PC-based, digital system that activates both telephones and pagers located in the Fire Dispatch Center at LLNL.

Community Noise Level: A time-weighted 24-hour average noise level based on the A-weighted decibel scale. The community noise level scales includes an additional 5-dB adjustment to sounds occurring in the evening (7:00 P.M. to 10:00 P.M.) and a 10-dB adjustment to sounds occurring in the late evening and early morning hours (10:00 P.M. to 7:00 A.M.).

Composite noise rating: *see* "Modified Composite Noise Rating" (CNR).

***Comprehensive Environmental Response, Compensation and Liability Act* of 1980 (CERCLA):** Administered by EPA, this program, also known as Superfund, requires private parties to notify EPA after the release of hazardous substances or conditions that threaten to release hazardous substances, and undertake short-term removal and long-term remediation.

Computational modeling: Using a computer to develop a mathematical model of a complex system or process and to provide conditions for testing it.

Confined aquifer: An aquifer bounded above and below by impermeable beds, or beds of distinctly lower permeability than that of the aquifer itself.

Conservative: Having consequences that are greater than the most likely consequences; using assumptions that tend to overestimate consequences and err on the safe side.

Containment barrier: In the context of a high-level waste repository, a barrier to release of radioactivity made by man, such as a corrosion-resistant container.

Controlled material: Material designated by DOE, LLNL, or SNL, Livermore for special control because they are classified, hazardous, of national interest, or of high monetary value.

Conventional weapon: A non-nuclear weapon.

Copper (Cu): A common reddish metallic element of atomic number 29 that is ductile and malleable and is one of the best conductors of heat and electricity

Cosmic radiation: Radiation with very high energies originating outside the earth's atmosphere; it is one source contributing to natural background radiation.

Criteria air pollutant: An air quality pollutant for which EPA has established criteria documents and for which concentration standards exist. These pollutants are sulfur dioxide (SO_2), particulates, carbon monoxide (CO), ozone (O_3), hydrocarbons, nitrogen dioxide (NO_2), and lead.

Critical habitat: "Specific area within the geographical area occupied by [an endangered or threatened] species…, essential to the conservation of the species and which may require special management considerations or protection; and specific areas outside the geographical area occupied by the species… that are essential for the conservation of the species" (Endangered Species Act section 3).

Criticality: The state of a mass of fissile and/or fissionable material when it is sustaining a nuclear fission chain reaction.

Cryogenic target positioner: The system that is composed of a telescoping arm that is used to insert and withdraw the complete target cryogenic system and target, and allows aiming, alignment, and engagement by the NIF laser.

Cultural resources (historic): Material remains, such as trash dumps and architectural features, including structures, foundations, basements, and wells; any other physical alteration of the landscape, such as ponds, roads, landscaping, and fences.

Cultural resources (prehistoric): Any material remains of items used or modified by people, such as artifacts of stone, bone, shellfish, or wood. Animal bone, fish remains, bird bone, or shellfish remains used for foods are included. Physical alteration of the landscape, such as hunting blinds, remains of structures, excavated house pits, and caches of artifacts or concentrations of stones (such as cooking stones) are also prehistoric cultural resources.

Cumulative impacts: As defined by CEQA, "…two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts. (a) The individual effects may be changes resulting from a single project or a number of separate projects. (b) The cumulative impact from several projects is the change in the environment, which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future project. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time".

Curie (Ci): A unit of measurement of radioactivity defined as the amount of radioactive material in which the decay rate is 3.7×10^{10} disintegrations per second or 2.22×10^{12} disintegrations per minute; one curie is approximately equal to the decay rate of one gram of pure radium.

Damage Ratio (DR): The fraction of the material-at-risk impacted by accident-generated conditions.

Day-night average level (LDN): The average noise level in dBA over a 24-hour period with a 10 dB adjustment for events occurring during the night (10:00 P.M. to 7:00 A.M.), and ignoring an evening-hour adjustment.

Decibel (dB): A unit measure of a sound pressure ratio. The reference sound pressure is 0.0002 dynes per square centimeter, or the equivalent of 200 microbar or 20 Pascal (Pa). This is the smallest sound human can hear.

Decibel, A-weighted (dBA): A frequency correction that correlates overall sound pressure levels with the frequency response of the human ear; measured by the use of a metering characteristic and the “A” weighting specified by the American National Standard Institute S1.41971(R176)

Decommissioning: The process of removing a facility from operation, followed by decontamination, entombment, dismantlement, or conversion to another use.

Decontamination: The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment—such as radioactive contamination from facilities, soil, or equipment—by washing, chemical action, mechanical cleaning, or other techniques.

Deflagration: To burn or cause to burn with great heat and intense light.

De minimis: Shortened form of “de minimis non curat lex,” which means, “The law does not care for, or take notice of, very small or trifling matters,” meaning a level that is so inconsequential that it cannot be cause for concern.

Depleted uranium: Uranium having a lower proportion of the fissile isotope uranium-235 than is found in naturally occurring uranium.

Derived Concentration Guide: Concentrations of radionuclides in water and air that could be continuously consumed or inhaled for one year and not exceed the DOE primary radiation standard to the public (100 mrem/y EDE).

Deterministic: With results determined by input assumptions and data, but without the probability of occurrence.

Deuterium: The hydrogen isotope that is twice the mass of ordinary hydrogen and that occurs in water; also called heavy hydrogen.

Diatomaceous: Composed of or containing numerous diatoms or their siliceous remains.

Dip: The angle at which a stratum or other planar feature is inclined from the horizontal.

DOE Orders: Rules indicating the procedures and responsibilities of the various units of DOE. DOE orders give details on how overall federal rules and regulations apply to DOE operations and indicates who shares responsibilities for administering them.

Dose: The energy imparted to matter by ionizing radiation; the unit of absorbed dose is the rad, equal to 0.01 joules per kilogram for irradiated material in any medium. Various technical terms—such as dose equivalent, effective dose equivalent, and collective dose—are used to evaluate the amount of radiation an exposed individual or population receives.

Dose equivalent: The product of absorbed dose in rad (or gray) in tissue and a quality factor representing the relative damage caused to living tissue by different kinds of radiation, and perhaps other modifying factors representing the distribution of radiation, etc. expressed in units of rem or sievert (l rem = 0.01 sievert).

Dosimeter: a portable detection device for measuring the total accumulated exposure to ionizing radiation.

Dosimetry: The theory and application of the principles and techniques of measuring and recording radiation doses.

Downgradient: In the direction of groundwater flow from a designated area; analogous to downstream.

Drainage Retention Basin (DRB): Man-made, lined pond used to capture stormwater runoff and treated water at the LLNL Livermore Site.

Driver: A device for supplying the primary source of energy to an inertial fusion energy target; drivers can be lasers, ion beams, or intense gamma ray sources.

Dynamic test: A non-nuclear scientific experiment that shows how materials react to high-explosive shocks.

Effective dose equivalent (EDE): An estimate of the total risk of potential effects from radiation exposure, it is the summation of the products of the dose equivalent and weighting factor for each tissue. The weighting factor is the decimal fraction of the risk arising from irradiation of a selected tissue to the total risk when the whole body is irradiated uniformly to the same dose equivalent. These factors permit dose equivalents from nonuniform exposure of the body to be expressed in terms of an effective dose equivalent that is numerically equal to the dose from a uniform exposure of the whole body that entails the same risk as the internal exposure (ICRP 1980). The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent caused by penetrating radiation from sources external to the body, and is expressed in units of rem (or sievert).

Effluent: A liquid or gas discharged to the environment.

Emission factors: An average value that relates to the quantity of an air pollutant released to the atmosphere by an activity associated with the release of the pollutant and usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity that emits the pollutant. Emission factors are widely used for estimating air pollutant emissions and are often acceptable by regulatory authorities as an appropriate estimation of air pollution emissions to determine compliance with regulations.

Emission offsets: Emission credits used to offset the pollutants to be generated from a new air emission source. Areas that allow no net increase in air pollution emissions require that a new source offset emission increases by decreasing an equivalent amount of emissions from an existing source. In some cases emission offsets or credits can be obtained from a depository that collects emission credits from retired sources.

***Emergency Planning and Community Right-to-Know Act* of 1986 (EPCRA):** act that requires facilities that produce, use, or store hazardous substances to report releases of reportable quantities or hazardous substances to the environment.

Emergency Response Planning Guidelines: Estimates of concentration ranges at which adverse effects can be expected if exposure to a specific chemical lasts more than 1 hour.

Endangered species: Species of plants and animals that are threatened with either extinction or serious depletion in their range and that are formally listed as such by the United States Fish and Wildlife Service and that are legally protected.

Enduring stockpile: The United States nuclear stockpile of the foreseeable future, consisting of about seven nuclear weapon systems. No new weapon systems will be added to the United States stockpile during this period. Many weapons within the enduring stockpile are older than their design lifetime.

Energetic material: Term that includes high explosives and propellants.

Enriched uranium: Uranium, found in natural uranium, with content of the fissile isotope uranium-235 being greater than 0.7 percent (by weight).

Environmental Assessment (EA): A concise public document that provides sufficient evidence and analysis for determining whether to prepare an environmental impact statement (EIS) or a finding of no significant impact for a proposed action. An EA includes brief discussions of the need for the proposed action, the features of alternatives, the environmental impacts of the proposed action and alternatives, and a listing of agencies and persons consulted.

Environmental impact report (EIR): A detailed report prepared pursuant to CEQA on the environmental impacts from any action carried out, approved, or funded by a California state, regional, or local agency.

Environmental Impact Statement (EIS): A detailed report, required by the National Environmental Policy Act, on the environmental impacts from a federally approved or funded project. An EIS must be prepared by a federal agency when a “major” federal action that may have “significant” environmental impacts is proposed.

Environmental justice: The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no population of people should be forced to shoulder a disproportionate share of the negative environmental impacts of pollution or environmental hazards due to a lack of political or economic strength.

Epicenter: The point on the earth’s surface directly over the point at which earthquake motion starts.

Ergonomic factors: Environmental stresses such as repetitive motion and mental or physical fatigue that can create health concerns when uncontrolled. Ergonomics is also known as human engineering.

Emergency Response Planning Guidelines-1 (ERPG-1): The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient and adverse health effects or perceiving a clearly defined, objectionable odor.

Emergency Response Planning Guidelines-2 (ERPG-2): The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.

Emergency Response Planning Guidelines-3 (ERPG-3): The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

Eutrophic: Rich in dissolved nutrients.

Evapotranspiration: A process by which water is transferred from the soil to the air by plants that take the water up through their roots and release it through their leaves and other aboveground tissue.

Explosives: *See* "High explosives."

Exponential notation: A means of expressing large or small numbers in powers of ten. For instance, 4.3×10^6 = 4,300,000 and 4.3×10^{-5} = 0.000043. This relationship is also sometimes expressed in the form 4.3E+6 = 4,300,000, and 4.3E-5 = 0.000043.

Exposure: The condition of being made subject to the action of radiation or toxic material. Sometimes also used as a generic term to refer to the dose of radiation absorbed by an individual or population.

Exposure assessment: The determination of the magnitude, frequency, duration, and route of exposure.

Exposure pathways: The course a chemical or physical agent takes from the source to the exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a release site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium such as air is also included.

External exposure: Radiation exposure from sources outside of the body: cloud passage, material deposited on the ground, and nearby surfaces.

Extirpate: The local disappearance of a species, as opposed to extinction, which is global disappearance.

Fault: A fracture in the earth's crust accompanied by displacement of one side of the fracture with respect to the other and in a direction parallel to the fracture.

Federal facility: A facility that is owned or operated by the federal government, subject to the same requirements as other responsible parties when placed on the Superfund National Priorities List.

Federal facility agreement (FFA): A negotiated agreement that specifies required actions at a federal facility as agreed upon by various agencies (e.g., EPA, RWQCB, and DOE).

Federal Register: A document published daily by the Federal government containing notification of government agency actions, including notification of EPA and DOE decisions concerning permit applications and rule making.

Federally listed species: *see* "threatened, endangered, candidate, or rare species".

Fiscal year: LLNL's fiscal year is from October 1 through September 30.

Fissile material: Pu239, U233, U235 or any material containing any of these.

Fission: The splitting of a heavy atomic nucleus into two nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons. Fission can occur spontaneously or be induced by neutron bombardment.

Flash x-ray: An x-ray apparatus that emits short pulses of x rays useful for examining the behavior of rapidly changing mechanical systems.

Flood, 100-year: A flood event of such magnitude it occurs, on average, every 100 years (equates to a 1 percent probability of occurring in any given year).

Flood, 500-year: A flood event of such magnitude it occurs, on average, every 500 years (equates to a 0.2 percent probability of occurring in any given year).

Floodplain: The valley floor adjacent to the incised channel of a stream, which may be inundated during high water.

Fold: A bend in strata or any other planar structure.

Footprint: The layout of a facility on the ground; also refers to an area affected by release of radioactive materials.

Forbs: Herbs other than grasses.

Freon 11: Trichlorofluoromethane.

Freon 113: 1,1,2-trichloro-1,2,2-trifluoroethane; also known as CFC 113.

Frequency: Number of complete oscillation cycles per unit of time. The unit of frequency is the hertz (Hz).

Fuel-grade plutonium: Plutonium with a high enough content of other plutonium isotopes other than plutonium 239 (such as plutonium-240) that it cannot be used in weapons although it can be used in reactors.

Fugitive dust: The dust released from activities such as construction, manufacturing, or transportation.

Fugitive emissions: Uncontrolled emissions to the atmosphere from pumps, valves, flanges, seals, and other process points not vented through a stack. Also includes emissions from area sources such as ponds, lagoons, landfills, and piles of stored material.

Funded construction: Construction for which Congress has already appropriated the necessary funds.

Fusion: The energy releasing process in which atoms of very light elements such as deuterium and tritium combine to produce heavier elements.

Fusion fuel: Mixture of deuterium and tritium contained in a small capsule called the target.

Fusion reaction: When two nuclei of lighter elements are brought into close enough proximity, they can undergo thermonuclear fusion forming a single nucleus and releasing energy at the slight expense in mass of the original constituents. Typically, a deuterium and tritium nucleus are fused in such a reaction to produce a helium nucleus plus one free neutron. The released energy of 17.6 MeV (million electron volts) is carried mostly as kinetic energy by the neutron (14 MeV).

***g* notation:** Accelerations measured relative to the acceleration of gravity at the earth’s surface. Thus, 0.1g = 3.2 ft/sec^2 or 98.3 cm/sec^2.

Gamma radiation: Short-wavelength electromagnetic radiation emitted from the atomic nucleus with typical energies ranging from 10 keV to 9 MeV. Individual gammas considered as particles are also called photons. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded against by dense materials such as lead or uranium. Gamma rays are similar to x rays, but are usually more energetic.

Gamma ray: High-energy, short-wavelength, electromagnetic radiation emitted from the nucleus of an atom, frequently accompanying the emission of alpha or beta particles

Gaussian plume: A plume of contaminants is said to be Gaussian when the contaminant concentrations are greatest at the centerline and decrease to either side as exp $[-(x/\sigma)^2/2]$, where x is the distance from the centerline and σ is the distance to the point where the concentration is down to 37 percent of the centerline concentration. *See* “Standard deviation.”

General Plan: A compendium of city or county policies regarding long-term development in the form of maps and accompanying text. The General Plan is a legal document required of each local agency by California Government Code section 65301 and adopted by the City Council or Board of Supervisors. The General Plan may also be called "City Plan," "Comprehensive Plan," or "Master Plan."

Geometric mean: For a set of n terms, the nth root of their product. For a set of positive numbers, the geometric mean is always less than or equal to the arithmetic mean (*see* "arithmetic mean").

Glovebox: A sealed box in which workers, while remaining outside and using gloves attached to and passing through openings in the box, can safely handle and work with radioactive materials, other hazardous materials, and non-hazardous air-sensitive compounds.

Gram (g): The standard metric measure of weight approximately equal to 0.035 ounce.

Gravinory: The act of feeding on seeds or grain (e.g., Birds may be responsible for high levels of *gravinory* in burned, open plots of *Amsinckia grandiflora*).

Gross alpha: The concentration of all alpha-emitting radionuclides in a sample.

Gross beta: The concentration of all beta-emitting radionuclides in a sample.

Ground acceleration: The intensity of the strong phase of ground shaking in units of *g*(earth's gravitational attraction).

Groundwater: Water below the ground surface in the saturated zone.

Habitat: Area where a plant or animal lives.

Half-life (biological): The time required for the body to eliminate one-half of an administered dosage of any substance by regular processes of elimination.

Half-life (ecological): The time required for removal of one-half of the amount of a material deposited in the local environment.

Half-life (radiological): The time required for one-half the radioactive atoms in a given amount of material to decay; for example, after one half-life, half of the atoms will have decayed; after two half-lives, three-fourths; after three half-lives, seven-eighths; and so on, exponentially.

Hazard Index (HI): The ratio between the intake of a chemical and an acceptable health-based reference level. A hazard index of less than 1 indicates a safe level of intake.

Hazardous chemical: Any chemical that is a physical hazard or a health hazard as defined by the Occupational Safety and Health Administration (29 CFR 1910.1201). For Superfund Amendments and Reauthorization Act (SARA) Title III, Section 311, the term is defined the same with certain named exceptions.

Hazardous waste: Hazardous wastes exhibit any of the following characteristics: ignitability, corrosivity, reactivity, or EP-toxicity (yielding toxic constituents in a leaching test), but other wastes that do not necessarily exhibit these characteristics have been determined to be hazardous by EPA. Although the legal definition of hazardous waste is complex, according to EPA the term generally refers to any waste that, if managed improperly, could pose a threat to human health and the environment. The word is defined as under the Resource Conservation and Recovery Act, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Source, special nuclear material, and byproduct material, as defined by the Atomic Energy Act, are specifically excluded from the definition of solid waste.

(*California) Hazardous Waste Control Act* (HWCA): Legislation specifying requirements for hazardous waste management in California.

Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX): A high-explosive compound.

High-efficiency particulate air (HEPA) filter: An extended-media, dry type filter used to capture particulates in an air stream; HEPA collection efficiencies are at least 99.97% for 0.3 micrometer diameter particles.

High explosives: Materials that release large amounts of chemical energy when detonated.

High-level waste: Radioactive waste resulting from the reprocessing of spent nuclear fuel. Discarded, unreprocessed spent fuel is also high-level waste. It characterized by intense penetrating radiation and by high heat-generation rates.

Highly enriched uranium: Uranium enriched to 20 percent or greater in uranium 235.

Historic resources: The sites, districts, structures, and objects considered limited and nonrenewable because of their association with historic events or persons, or social or historic movements.

Hohlraum: The metal case surrounding the target on indirect-drive inertial confinement fusion.

Holocene: A standard epoch of geological time, from 10,000 years ago until the present.

Hood: An enclosure of canopy provided with a draft to remove toxic or other noxious vapors or aerosols from the workplace.

Human genome: A set of chromosomes with the genes they contain.

Hydraulic gradient: In an aquifer, the rate of change of total head (water-level elevation) per unit distance of flow at a given point and in a given direction.

Hydric soils: Soils that are saturated, flooded, or ponded long enough (7 days or longer) during the growing season to develop anaerobic conditions in their upper layer.

Hydrology: The science dealing with the properties, distribution, and circulation of natural water systems.

Hydrodynamic test or hydrotest: A non-nuclear scientific experiment that shows how materials react to high-explosives detonation. “Hydro” refers to the fluid-like flow of solids at the center of an explosion. Results are used to investigate hydrodynamic aspects of primary function during pit implosion.

Hydrophytic vegetation: Vegetation that grows in water, soil, or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content.

Igneous: Refers to a rock or mineral that solidified from molten or partly molten material, i.e., from a magma; also, applied to processes leading to, related to, or resulting from the formation of such rocks. Igneous rocks constitute one of the three main classes into which rocks are divided, the others being metamorphic and sedimentary.

Ignition: Self-sustained thermonuclear reaction.

Ignitron switch: A high current switch used to discharge energy storage capacitors, which are used to fire laser flashlamps.

Immediately-Dangerous-to-Life-or-Health (IDLH): Immediately dangerous to life or health concentrations (IDLHs) represents the maximum concentration from which, in the event of respirator failure, one could escape within 30 minutes without a respirator and without experiencing any escape-impairing (e.g., severe eye irritation) or irreversible health effects.

Impact: The effect, influence, or imprint of an activity on the environment. Impacts include direct or primary effects, which are caused by the project and occur at the same time and place, and indirect or secondary effects, which are caused by the project and are later in time or farther removed in distance, but still reasonably foreseeable. Indirect or secondary effects may include growth-inducing and other effects related to induced changes in the pattern of land use, population density, or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Implosion: Sudden inward compression and reduction in volume of fissionable material inside a nuclear weapons brought about by the detonation of conventional explosives.

Inertial confinement fusion (ICF): An energetic driver beam (laser, x ray, or charged particle) initiated nuclear fusion using the inertial properties of the reactants as a confinement mechanism.

Inertial fusion energy (IFE): The use of high-repetition-rate lasers or ion drivers (about 10 pulses per second) to accomplish laboratory and commercial thermonuclear fusion.

Infrastructure: Utilities and other physical support systems needed to operate a laboratory or test facility. Included are electric distribution systems, water supply systems, sewage disposal systems, roads, and so on.

Ingestion dose: An internal dose that results from the oral intake of food, water, soil, or other media contaminated with radioactive material.

Inorganic compounds: Compounds that either do not contain carbon or do not contain hydrogen along with carbon, including metals, salts, and various carbon oxides (e.g., carbon monoxide and carbon dioxide).

Input parameters: Values of variables needed to run a computer model.

In situ: Refers to the treatment of contaminated areas in place without excavation or removal, as in the in situ treatment of onsite soils through biodegradation of contaminants.

Integrated Safety Management System (ISMS). A system is a systematic approach to defining the scope of work, identifying the hazards, establishing controls, performing the work, and concluding with feedback and improvement. The system defines a process for identifying, planning and performing work that provides for early identification of hazards and associated control measures for hazards mitigation or elimination. The ISMS process also forms the basis for work authorization and provides for both internal and external assessment that provides a continuous feedback and improvement loop for identifying both shortcomings and successes for incorporation into subsequent activities.

Interim Action: An action concerning a proposal that is subject of an ongoing EIS and that DOE proposes to take before a record of decision is issued, and is permissible under 40 CFR 1506.1: Limitation on actions during the NEPA process.

Interim status: A legal classification allowing hazardous waste incinerators or other hazardous waste management facilities to operate while EPA considers their permit applications, provided that they were under construction or in operation by November 19, 1980 and can meet other interim status requirements.

Internal exposure: Radiation exposure from sources inside the body: from materials ingested, inhaled, or (in the case of tritium) absorbed through the skin.

International Commission on Radiological Protection (ICRP): An international organization that studies radiation, including its measurement and effects.

Inventory: The amount of a radioactive or hazardous material present in a building or facility.

Involved worker: Workers that would be involved in a proposed action as opposed to workers that would be on the site of a proposed action but not involved in the action.

Isoconcentration map: A map showing contours of equal concentration of contaminant.

Isotopes: Forms of an element having the same number of protons in their nuclei, but differing numbers of neutrons.

Juniper-oak cismontane woodland: An open woody plant community dominated by California juniper with a shrubby understory of coastal shrubby species.

Joule: The basic SI unit of work or energy. A joule is equal to the kinetic energy of a two-kilogram mass moving at the speed of one meter per second.

Jurassic: A standard period of geologic time, from about 181 million to 135 million years ago.

Laboratories, heavy: Laboratories characterized by high-bay construction, overhead cranes, and in some cases, shielding. Heavy laboratories are typically used for large research apparatus or large mechanical test equipment.

Laboratories, light: Laboratories characterized by small equipment and apparatus. Light laboratories are typically used for direct bench-scale research.

Lagomorphs: Rabbits, conies, and hares.

Land use: The purpose or activity for which a piece of land or its buildings is designed, arranged, or intended, or for which it is occupied or maintained.

Laser: A device that produces a beam of monochromic (single-color) "light" in which the waves of light are all in phase. This condition creates a beam that has relatively little scattering and has a high concentration of energy per unit area of the beam.

Latent cancer fatality: Term used to indicate the estimated number of cancer fatalities which may result from exposure to a cancer-causing element. Latent cancer fatalities are similar to naturally occurring cancers and may occur at any time after the initial exposure.

L_{dn}: *see* "ambient sound level".

Leaching test: A test conducted to determine the leach rate of a waste form. The test results may be used for judging and comparing different types of waste forms, or may serve as input data for a long-term safety assessment of a repository.

Lead (Pb): Lead is a bluish-white lustrous metal. It is very soft, highly malleable, ductile, and a relatively poor conductor of electricity. It is very resistant to corrosion but tarnishes upon exposure to air.

Leak Path Factor (LPF): The fraction of airborne materials transported from containment or confinement deposition or filtration mechanism (e.g., fraction of airborne material in a glovebox leaving the glovebox under static conditions, fraction of material passing through a HEPA filter). LPF is one of the factors used to calculate the source term for an accident or event.

Level of concern: The concentration of an extremely hazardous substance (EHS) in the air above which there may be serious irreversible health effects or death as a result of a single exposure for a relatively short period of time.

Level of service (LOS): The extent of community, healthcare and educational services provided by local jurisdictions in the vicinity of the proposed sites. LOS is measured in terms of per capita expenditures on services in each of these categories. In traffic studies, LOS means the different operating conditions that occur in a lane or roadway when accommodating various traffic volumes. A qualitative measure of the effect of traffic flow factors such as special travel time, interruptions, freedom to maneuver, driver comfort, convenience, and (indirectly) safety and operating cost. Levels of service are described by a letter rating system of A through F, with LOS A indicating stable traffic flow with little or no delays and LOS F indicating excessive delays and jammed traffic conditions.

Limited-lifetime component: A weapon component that decays with age and must be replaced periodically.

Liquefaction: A type of soil failure in which a mass of saturated soil is transformed from a solid to a liquid state.

Liter (L): The SI measure of capacity approximately equal to 1.057 quart.

Lithic scatter: Concentrations of stone once used for the manufacture of artifacts. The stone includes finished artifacts, roughly formed artifacts, the cores of the stone from which they were made, and the wastes flakes from the manufacturing process.

Livermore Water Reclamation Plant (LWRP): The City of Livermore's municipal wastewater treatment plant, which accepts discharges from the LLNL Livermore Site

Low-income status: Based on Census data definitions of individuals below the poverty line. For the 1990 Census, for example, low-income status included individuals in 4-person families with 1989 income at or below $12,674. Other poverty thresholds are provided by the Census Bureau for larger and smaller family sizes.

Low-level waste (LLW): Waste defined by DOE O 5820.2A, which contains transuranic nuclide concentrations less than 100 nCi/g. LLW is radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in section 11e.(2) of the Atomic Energy Act of 1954, as amended), or naturally occurring radioactive material" as defined by DOE O 435.1 , Radioactive Waste Management. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranic waste is less than 100 nanocuries per gram.

Magazine: An approved structure designed for the storage of explosives, excluding operating buildings.

Maintenance pollutants: Criteria air pollutants in an Air Quality Maintenance Area that may exceed the ambient air quality standard over time.

Magnitude: A measure of the strength of an earthquake or the strain energy released by it; the logarithm of the amplitude of motion recorded on a seismograph.

Master Oscillator Room (MOR): A self-contained special-purpose room that would house the NIF Master Oscillators and their supporting equipment. The purpose of this facility is to supply the 192 individually shaped and timed low-level laser pulses to the Preamplifier Modules located beneath the Spatial Filters at the NIF main laser hall.

Material-at-Risk: A material-at-risk limit is defined as the maximum amount of the referenced material that is involved in the process and thus at risk in the event of a postulated accident. Material locked in a secure storage is not considered material-at-risk.

Maximally exposed individual (MEI): A hypothetical member of the public at a fixed location who, over an entire year, receives the maximum effective dose equivalent (summed over all pathways) from a given source of radionuclide releases to air. Generally, the MEI is different for each source at a site.

Maximum Contaminant Level (MCL): The highest level of a contaminant in drinking water that is allowed by the United States Environmental Protection Agency regulation.

Maximum credible accident: An accident that has the greatest offsite consequences from hazardous material release and that has a frequency of occurrence greater than 10^{-6} per year, when credit for mitigation is allowed. Such an accident is one of the set of reasonably foreseeable accidents.

Maximum design yield: The maximum theoretical yield expected from a NIF experiment.

Maximum yield experiment: A fusion ignition experiment that generates maximally expected fusion energy.

Metamorphic rock: Any rock derived from preexisting rocks by mineralogical, chemical, and/or structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment, generally at depth in the earth's crust.

Mercury (Hg): A metallic element mostly obtained by reduction from cinnabar, one of its ores. It is a heavy, opaque,glistening liquid (commonly called quicksilver), and is used in barometers, thermometers, etc.

Meteorology: The science dealing with the atmosphere and its phenomena, especially as it relates to weather.

Metric units: Metric system and United States customary units and their respective equivalents are shown in the table below. Except for temperature for which specific equations apply, United States customary units can be determined from metric units by multiplying the metric units by the United States customary equivalent. Similarly, metric units can be determined from United States customary equivalent units by multiplying the United States customary units by the metric equivalent.

Metric and United States Customary Unit Equivalents

Metric Unit	United States Customary Equivalent Unit	United States Customary Unit	Metric Equivalent Unit
Length			
1 centimeter (cm)	0.39 inches (in)	1 inch (in)	2.54 centimeters (cm)
1 millimeter (mm)	0.039 inches (in)		25.4 millimeters (mm)
1 meter (m)	3.28 feet (ft)	1 foot (ft)	0.0254 meters (m)
	1.09 yards (yd)	1 yard (yd)	0.9144 meters (m)
1 kilometer (km)	0.62 miles (mi)	1 mile (mi)	1.6093 kilometers (km)
Volume			
1 liter (L)	0.264 gallons (gal)	1 gallon (gal)	3.7853 liters (L)
1 cubic meter (m^3)	264 gallons	1 cubic foot (ft^3)	0.028 cubic meters (m^3)
	35.32 cubic feet (ft^3)	1 cubic yard (yd^3)	0.765 cubic meters (m^3)
	1.35 cubic yards (yd^3)		
Weight			
1 gram (g)	0.035 ounces (oz)	1 ounce (oz)	28.6 gram (g)
1 kilogram (kg)	32.2 ounces (oz) 2205 pounds (lb)	1 pound (lb)	0.373 kilograms (kg)
1 metric ton (MT)	1.10 short ton (2000 pounds)	1 short ton (2000 pounds)	0.90718 metric ton (MT)
Geographic area			
1 hectare	2.47 acres	1 acre	0.405 hectares
Radioactivity			
1 becquerel (Bq)	2.7×10^{-11}curie(Ci)	1 curie (Ci)	3.7×10^{10} becquerel (Bq)
Radiation dose			
1 rem	0.01 sievert (Sv)	1 sievert (Sv)	100 rem
Temperature			
°C = (°F–32)/1.8		°F = (°C × 1.8) + 32	

MeV: A unit of energy equal to 1.6×10^{-6} ergs or 1.6×10^{-13} joules. Short for “million electron volts,” an electron volt being the energy acquired by an electron when it is accelerated through a potential drop of one volt.

Midden: Characteristic soil containing cultural resources and other evidence of use of an area, such as the decomposed organic remains of vegetal foods, animals, and evidence of fires (e.g., ash, carbon, charcoal). Because of the organic content, midden soils tend to differ from surrounding soils in texture and color.

Millirem (mrem): One-one-thousandth of a rem (*see* “rem”).

Minority populations: Includes individuals who report themselves as belonging to any of the following racial groups: Black (reported their race as “Black or Negro,” or reported entries such as “African American, Afro-American, Black Puerto Rican, Jamaican, Nigerian, West Indian, or Haitian”); American Indian, Eskimo, or Aleut; Asian or Pacific Islander, or “Other Race.” In addition, individuals identifying themselves as Hispanic origin are also included in the minority category. Hispanics can be of any race, however. To avoid double-counting minority Hispanic individuals, only white Hispanics were included in the number of racially based minorities in a tabulation, since nonwhite Hispanics had already been counted under their minority racial classification.

Miocene: A standard epoch of geologic time between the Pliocene and Oligocene, from about 28 million to 5.3 million years ago.

Mitigation: CEQA defines as: “(a) Avoiding the impact altogether by not taking a certain action or parts of an action. “(b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation. “(c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment. “(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action. “(e) Compensating for the impact by replacing or providing substitute resources or environments” (40 CFR. 1508.20; CEQA Guidelines 15370). NEPA also says regarding alternatives: “…Include appropriate mitigation measures not already included in the proposed action or alternatives” (40 CFR. 1502.14(f)).

Mixed fission products: The ensemble of fission products resulting from the fission of a heavy element such as uranium. *See* “Fission.”

Mixed waste: Waste that contains both nonradioactive hazardous waste and radioactive waste.

Mock nuclear material: Material that is nonradioactive and nonfissile, but similar in density and other characteristics to nuclear material. Mock nuclear material is substituted for a weapon’s nuclear parts in hydrodynamic experiments and flight tests.

Model: A conceptual, mathematical, or physical system obeying certain specified conditions, whose behavior is used to understand the physical system to which it is analogous.

Modified Composite Noise Rating (CNR): Noise rating system that determines impacts from a fixed noise source using objective and subjective factors. Noise ranked A through D is generally considered to be acceptable with "A" representing essentially no impacts. Rankings above "D" are usually addressed with mitigative measures unless the source is temporary.

Modified Mercalli Scale: An earthquake intensity scale, with 12 divisions ranging from I (not felt by people) to XII (damage nearly total).

Molecular sieve: A material with a rigid, uniform pore structure that completely excludes molecules larger than the structure pore openings and that can absorb certain classes of small molecules from a fluid in contact with the material.

MOR: *see* "Master Oscillator Room".

Mutagen: A substance that causes genetic or inheritable defects.

NAAQS: *see* "National Ambient Air Quality Standards".

National Ambient Air Quality Standards (NAAQS): Air quality standards established by the Clean Air Act, as amended. The primary National Ambient Air Quality Standards are intended to protect the public health with an adequate margin of safety, and the secondary National Ambient Air Quality Standards are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Emission Standards for Hazardous Air Pollutants (NESHAP): A set of national emission standards for listed hazardous pollutants emitted from specific classes or categories of new and existing sources. These were implemented in the Clean Air Act Amendments of 1977.

***National Environmental Policy Act* (NEPA):** Federal legislation enacted in 1969 that requires all Federal agencies to document and consider environmental impacts for federally funded or approved projects and the legislation under which DOE is responsible for NEPA compliance at LLNL.

***National Historic Preservation Act of 1966,* as amended:** This Act provides that property resources with significant national historic value be placed on the National Register of Historic Places. It does not require any permits but, pursuant to Federal code, if a proposed action might impact an historic property resource, it mandates consultation with the proper agencies.

National Ignition Facility (NIF): The laser facility to be used to achieve ignition of fusion fuel and energy gain in a laboratory. The NIF's primary mission is to perform stockpile stewardship experiments.

National Pollutant Discharge Elimination System (NPDES): Federal regulation under the Clean Water Act that requires permits for discharges into surface waterways.

National Register of Historic Places (NRHP): A register of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, engineering, and culture. It is in the Department of Interior and was established pursuant to the National Historic Preservation Act of 1966, as amended (16 USC § 470a).

Natural uranium: Uranium as it occurs in nature. The natural substance is 99.28 percent uranium-238, 0.72 percent uranium-235, and 0.0055 percent uranium-234.

Neodymium: A rare-earth metal listed in the periodic table of elements with an atomic number of 60 and an atomic weight of 144.24.

Neodymium glass laser: A type of solid-state laser that uses neodymium-doped optical fibers, rods, or glass slabs, with small amounts neodymium added, in which laser generation and amplification equipment are made.

NEPA: *see* "*National Environmental Policy Act*."

Neutron: An uncharged elementary particle with a mass slightly greater than that of the proton, found in the nucleus of every atom heavier than hydrogen-1; a free neutron is unstable and decays with a half-life of about 13 minutes into an electron and a proton.

Nitrogen oxides (NO_x): Refers to the oxides of nitrogen, primarily NO (nitrogen oxide) and NO2 (nitrogen dioxide). These are produced in the combustion of fossil fuels and are considered major air pollutants. When nitrogen dioxide combines with volatile organic compounds, in sunlight, ozone is produced.

Noise Control Act of 1972: This Act directs all Federal agencies to carry out programs in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health or welfare.

Nonattainment area: An air quality control region (or portion thereof) in which the Environmental Protection Agency has determined that ambient air concentrations exceed national ambient air quality standards for one or more criteria pollutants.

Nonhazardous wastes: Routinely generated, nonhazardous wastes include general facility refuse such as paper, cardboard, glass, wood, plastics, scrap, metal containers, dirt, and rubble.

Non-invasive imaging: Imaging methods that do not damage the test specimen, including radiography, computed tomography, and other techniques.

Noninvolved worker: Workers in a fixed population outside the day-to-day process safety management controls of a given facility area. In this SWEIS, this term includes both individual noninvolved workers (an LLNL worker not directly involved with operation of the facility, but located 100 meters from the facility), and the population of noninvolved workers (the LLNL employee population, plus the population at Sandia National Laboratories/California).

Non-ionizing radiation: Electromagnetic radiation of wavelengths greater than 10^{-7} m (1000Å), such as laser, thermal, or radio frequency radiation.

Nonpoint source: Any nonconfined area from which pollutants are discharged into a body of water (e.g., agricultural runoff, construction runoff, and parking lot drainage), or into air (e.g., fugitive dust from construction sites).

Normal operations: All normal conditions and those abnormal conditions that frequency estimation techniques indicate occur with a frequency of more than 0.1 event per year.

NPDES: *see* "National Pollutant Discharge Elimination System".

Nuclear assembly: The collective term for the primary, secondary, and radiation case in a nuclear weapon. Same as "physics package".

Nuclear component: A nuclear weapon part that contains fissionable or fusionable material.

Nuclear reaction: A reaction in which an element's atomic nucleus is transformed into another isotope of the same element or into another element altogether. The process always is accompanied by the release of particles or energy.

Nuclear Regulatory Commission (NRC): The Federal agency charged with oversight of nuclear power and nuclear machinery and applications not regulated by DOE or the Department of Defense.

Nuclear warhead: A device that contains fissionable and fusionable material, the nuclear assembly, and the non-nuclear components.

Nuclear weapon: A warhead that contains fissionable and fusionable material, the nuclear assembly, and the non-nuclear components packaged as a deliverable weapon.

Nuclear weapons complex: The network of laboratories and fabrication plants involved in the design, production, testing, surveillance, and maintenance of United States, nuclear weapons.

Nuclide: A species of atom characterized by the constitution of its nucleus. The nuclear constitution is specified by the number of protons, number of neutrons, and energy content; or, alternatively, by the atomic number, mass number, and atomic mass. To be regarded as a distinct nuclide, the atom must be capable of existing for a measurable length of time.

Numerical simulation: The use of mathematical formulas and models of physical processes to simulate through calculations, the behavior or performance of a device or complex system.

Occupational Safety and Health Administration (OSHA): Oversees and regulates workplace health and safety, created by the Occupational Safety and Health Act of 1970.

Obligate plant species: Species that occur in wetlands most of the time (99 percent).

Offsite: Outside the boundaries of the LLNL Livermore Site and Site 300 properties.

Onsite: Within the boundaries of the LLNL Livermore Site or Site 300 properties.

Opacity restrictions: Visible-emission regulations that are based on the light-scattering properties of suspended matter in the ambient atmosphere and apply to near-field emissions of fixed sources.

Open space: Any area of land or body of water set aside and left essentially unimproved that is dedicated, designated, or reserved for public or private use or enjoyment, or for the use and enjoyment of owners and occupants of land adjoining or neighboring such open house.

Oralloy: Enriched uranium.

Order of magnitude: A factor of ten. When a measurement is made with a result such as 3×10^7, the exponent of 10 (here 7) is the order of magnitude of that measurement. To say that this result is known to within an order of magnitude is to say that the true value lies (in this example) between 3×10^6 and 3×10^8.

Ozone (O_3): The triatomic form of oxygen. In the stratosphere, ozone protects the Earth from the sun's ultraviolet rays; in lower levels of the atmosphere, ozone is considered an air pollutant.

Ozone-Depleting Substance(s) (ODS): A compound that contributes to stratospheric ozone depletion. ODS include chlorofluorocarbons, hydrochlorofluorocarbon, halon, methyl bromide, carbon tetrachloride, and methyl chloroform. They are generally very stable in the troposphere and only degrade under intense ultraviolet light in the stratosphere. When they breakdown, they release chlorine or bromine atoms, which then deplete ozone.

Packaging: In the NRC regulations governing the transportation of radioactive materials (10 CFR part 71), the term "packaging" is used to mean the shipping container together with its radioactive contents.

Paleontology: The study of fossils.

Paleontological resources: Fossils.

Part B permit: The second, narrative section submitted by generators in the RCRA permitting process that covers in detail the procedures followed at a facility to protect human health and the environment.

Particulate (airborne): Small particles that are emitted from fixed or mobile sources and dispersed in the atmosphere.

Parts per billion (ppb): A unit of measure for the concentration of a substance in its surrounding medium; for example, one billion grams of water containing one gram of salt has a salt concentration of one part per billion.

Parts per million (ppm): A unit of measure for the concentration of a substance in its surrounding medium; for example, one million grams of water containing one gram of salt has a salt concentration of one part per million.

Pasquill stability categories: Classification scheme that describes the degree of atmospheric turbulence. Categories range from extremely unstable (A) to extremely stable (F). Unstable conditions promote the rapid dispersion of atmospheric contaminants and result in lower air concentrations as compared with stable conditions.

Perched aquifer: Aquifer that is separated from another water-bearing stratum by an impermeable layer.

Perennial stream: A watercourse that flows year-round.

Performance: Essentially equivalent to “reliability”, a nuclear weapon, weapon system, or weapon component’s ability to perform its required function in terms of yield, range, accuracy, and radiation spectrum under stated conditions for a specified period.

Performance standards (incinerators): Specific regulatory requirements established by EPA limiting the concentrations of designated organic compounds, particulate matter, and hydrogen chloride in incinerator emissions.

Permissible Exposure Limit (PEL): Occupational exposure limit regulations endorsed by OSHA. May be for short term or 8-hour duration exposure.

Person-rem: A unit of collective dose commitment to a given population; the sum of individual doses received by a population group.

Petroglyph: Art that was carved or inscribed into bedrock by historic or prehistoric people.

pH: The negative logarithm of the concentration of hydrogen ions in a liquid measured in gram equivalents per liter. A pH of 7 is neutral; smaller numbers indicate an acidic condition, while larger numbers indicate a basic condition.

Photochemical oxidant: A class of compounds typified by ozone that represents oxidizing compounds created in the atmosphere with sunlight as a catalyst under low wind conditions.

Physics package: A collective term for the primary, secondary, and radiation case in a nuclear weapon. Same as “nuclear assembly”.

Piedmont: An area, plain, slope glacier, or other feature at the base of a mountain.

Piezometer: Instrument for measuring fluid pressure used to measure the elevation of the water table in a small, non-pumping well.

Pit: A nuclear weapon’s central core, containing Pu239 and/or highly enriched uranium, that undergoes fission when compressed by high explosives. The pit and the high explosive are known as the nuclear weapon’s “primary”.

Plasma: A cloud of charged particles containing about equal number of positive ions and electrons and exhibiting some properties of a gas but differing from a gas in being a good conductor of electricity and being affected by magnetic fields.

Plate tectonics: A theory of global-scale dynamics involving the movement of rigid plates of the earth’s crust.

Playa: Level area at the bottom of a desert basin that at times is temporarily covered with water; a dry lake bed.

Pleistocene: A standard epoch of geological, from about 1.6 million to 10,000 years ago.

Pliocene: Geological epoch of the Tertiary period, starting about 12 million years ago.

Plume: The spatial distribution of a release of airborne or waterborne material as it disperses in the environment.

Plutonium (Pu): An artificial fissile element of atomic number 94. Defined as a heavy, radioactive, metallic element, with atomic number 94, that produces ionization radiation in the form of alpha particles. Produced in a reactor by bombarding uranium with neutrons, plutonium is used in nuclear weapons and also can be used as fuel in fission reactors. The 15 radioactive plutonium isotopes have half-lives ranging from less than a second to thousands of years.

PM_{10}: Fine particulate matter with an aerodynamic diameter equal to or less than 10 microns.

Point source: Any confined and discrete conveyance (e.g., pipe, ditch, well, or stack).

Population dose (population exposure): Summation of individual radiation doses received by all those exposed to the source or event being considered. The collective radiation dose received by a population group, usually measured in units of person-rem.

Precambrian: Dating from before the Cambrian geologic period more than 570 million years ago.

Precursor pollutants: Pollutants that must be present in the atmosphere before chemical reactions take place and form the pollutant of interest. For example, nitrogen oxides, and volatile organic compounds are precursor pollutants to the formation of ozone.

Prehistoric resources: *See* “Cultural resources (prehistoric).”

Prevention of Significant Deterioration (PSD): Regulations established by the 1977 *Clean Air Act* Amendments to limit increases in criteria air pollutant concentrations above baseline.

Primary and secondary containment: Primary containment is that set of engineered safety features immediately around a radioactive or hazardous material designed to prevent its release; secondary containment is the set of backup features outside the primary containment.

Priority pollutants: A set of organic and inorganic chemicals identified by EPA as indicators of environmental contamination.

Probabilistic: With results taking into account the probability of occurrence. Probabilistic calculations sometimes combine the results of several deterministic calculations, weighting their results by their probabilities. *See* “Deterministic.”

Programmatic EIS: An EIS that, when complete, will examine a nationwide issue.

Prompt radiation: Gamma or neutron radiation emitted during the fission process is said to be prompt (within microseconds) as distinguished from delayed (as much as seconds).

Protective (Preventive) Action Guide: FDA-recommended levels of radiation exposure above, which action should be taken to prevent or reduce the radioactive contamination of human food or animal feeds.

PSD: *see* “Prevention of Significant Deterioration”.

Public: Anyone outside the boundary of a DOE site at the time of an accident or during normal operations.

Quality assurance (QA): A system of activities whose purpose is to provide the assurance that standards of quality are attained with a stated level of confidence.

Quality control (QC): Procedures used to verify that prescribed standards of performance are attained.

Quality factor: The factor by which the absorbed dose (rad) is multiplied to obtain a quantity that expresses (on a common scale for all ionizing radiation) the biological damage to exposed persons, usually used because some types of radiation, such as alpha particles, are biologically more damaging than others. Quality factors for alpha, beta, and gamma radiation are in the ratio 20:1:1.

Quaternary: The geologic era encompassing the last 2–3 million years.

Rad: The unit of absorbed dose and the quantity of energy imparted by ionizing radiation to a unit mass of matter such as tissue, and equal to 0.01 joule per kilogram, or 0.01 gray.

Radiation: The emitted particles or photons from the nuclei of radioactive atoms; including alpha, beta, gamma, and neutrons. Some elements are naturally radioactive; others are induced to become radioactive by bombardment in a reactor. Naturally occurring radiation is indistinguishable from induced radiation.

Radioactive decay: The spontaneous transformation of one radionuclide into a different nuclide (which may or may not be radioactive), or de-excitation to a lower energy state of the nucleus by emission of nuclear radiation, primarily alpha or beta particles, or gamma rays (photons).

Radioactive material: Any material having a specific activity greater than 0.002 microcuries per gram, as defined by 49 CFR parts 173.4-3 (y).

Radioactive waste: Material that contains radionuclides regulated under the *Atomic Energy Act* of 1954, as amended, and is of negligible economic value given the cost of recovery.

Radioactivity: The spontaneous emission of nuclear radiation, generally alpha or beta particles, or gamma rays, from the nucleus of an unstable isotope.

Radiological risk: The product of the accident consequence (dose) and the probability of the accident occurring; calculated by considering a wide range of accidents, from high-probability low-consequence events to low-probability high-consequence events.

Radionuclide: An unstable nuclide. *See* "nuclide and radioactivity." Standard practice for naming a radionuclide is to use the name or atomic symbol of an element followed by its atomic weight (e.g., cobalt-60 or Co-60, a radionuclide of cobalt).

RADTRAN 5: An NRC-approved code for estimating the radiological impacts of transportation of radioactive materials.

Rare species: Populations and/or individuals occurring in very low numbers relative to other similar taxa in the state, although common or regularly occurring throughout much of their range. They may be found in a restricted geographic region or occur sparsely over a wider area. Although rare, populations are apparently stable.

RCRA Part B permit: A permit issued by EPA under the Resources Conservation and Recovery Act (RCRA) that have allowed LLNL to operate landfills at LLNL Site 300 for the disposal of debris from high explosives tests.

Reasonably foreseeable: An accident or action whose impacts "may have large or catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason" (10 CFR part 1502.22(b) (4)).

Refraction: The change in direction of propagation of a sound upon passage into a medium with different sound speed.

Region of influence (ROI): A geographic area within which LLNL activities may affect a particular resource.

Regional Water Quality Control Board (RWQCB): The California regional agency responsible for water quality standards and the enforcement of state water quality laws within its jurisdiction. California is divided into a number of RWQCBs; the Livermore Site is regulated by the San Francisco Bay Region, and Site 300 is regulated by the Central Valley Region.

Release fraction: The fraction of the material at risk that is released in an accident.

Relevé: A descriptive technique for sampling vegetation.

Rem: A unit of radiation dose equivalent and effective dose equivalent describing the effectiveness of a type of radiation to produce biological effects; coined from the phrase "roentgen equivalent man." The product of the absorbed dose (rad) and a quality factor (Q).

***Resource Conservation and Recovery Act* of 1976 (RCRA):** A program of Federal laws and regulations that govern the management of hazardous wastes, and applicable to all entities that manage hazardous wastes.

Respirable Fraction (RF): The fraction of airborne radionuclides as particles that can be transported through air and inhaled into the human respiratory system. This term is commonly assumed to include particles 10-µm (micron) Aerodynamic Equivalent Diameter and less.

Resuspension: The process by which material deposited on the ground is again made airborne, such as by wind or vehicle disturbance.

Resuspended inhalation: Exposure route in which radioactive materials enter the body through inhalation of air contaminated with radioactive particulates that were previously deposited on the ground following an accidental release.

Retention tanks: Tanks in which liquid wastes and other effluents are held pending determination of what, if any, treatment they require before disposal.

Riparian: Located along the banks of streams, rivers, lakes, and other bodies of water.

Risk assessment: The use of established methods to measure the risks posed by an activity or exposure by evaluating the relationship between exposure to radioactive substances and the subsequent occurrence of health effects and the likelihood for that exposure to occur.

Risk estimator: A number used to convert the measured or calculated effective dose equivalent to estimates of latent fatal cancers that can be attributed to the exposure.

Risk factor: Numerical estimate of the severity of harm associated with exposure to a particular risk agent.

Risk Group (RG): NIH classification of agents known to infect humans as selected animal agents that may pose theoretical risks if inoculated into humans. There are four groups for the classification of biohazardous agents, RG1, RG2, RG3, and RG4.

Basis for the Classification of Biohazardous Agents

RG1	Agents are not associated with disease in healthy adult humans
RG2	Agents are associated with human disease which is rarely serious and for which prevent therapeutic interventions are *often* available
RG3	Agents are associated with serious or lethal human disease for which preventative or therapeutic interventions *may* be available.
RG4	Agents are likely to cause serious or lethal human disease for which preventive or therapeutic interventions are *not usually* available.

Rock shelter: An opening in exposed rock of sufficient size to allow people to be sheltered from the weather. Used by both historic and prehistoric people, rock shelters contain midden deposits, grinding holes, evidence of fires, artifacts, and sometimes artwork carved or inscribed onto the walls of the shelters.

Roentgen: a unit of exposure to ionizing x- or gamma radiation equal to or producing 1 electrostatic unit per cubic centimeter of air. It is approximately equal to 1 rad.

***Safe Drinking Water Act*, as amended:** This Act protects the quality of public water supplies, water supply and distribution systems, and all sources of drinking water.

San Francisco Bay Regional Water Quality Control Board (SFBRWCB): The local agency responsible for regulating stationary air emission sources (including the Livermore Site) in the San Francisco Bay Area.

San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD): The local agency responsible for regulating stationary air emission sources (including Site 300) in San Joaquin County.

Sanitary waste: Most simply, waste generated by routine operations that is not regulated as hazardous or radioactive by state or Federal agencies.

SARA: *see "Superfund Amendments and Reauthorization Act."*

Saturated zone: A subsurface zone below which all rock pore-space is filled with water; also called the phreatic zone.

Scenario: A particular chain of hypothetical circumstances that could, in principle, release radioactivity or hazardous chemicals from storage and handling site, or during a transportation accident.

Scenic corridor: A long, axial vista formed by regularly placed buildings or landscaping.

Sealed source: A manufactured source of radioactive material that is contained in such a way that the material is not easily dispersed or altered chemically under normal use. Sealed sources are generally used to provide a known intensity of a specific type of radiation (e.g., a small gamma-ray source used to calibrate radiation survey instruments).

Section 106 process: A process under the *National Historic Preservation Act* for identifying, evaluating, and nominating historic properties for inclusion in the National Register.

Sedimentary rock: A rock resulting from the consolidation of loose sediment that has accumulated in layers.

Seeps: A spot where water or petroleum oozes from the earth, often forming the source of a small trickling stream.

Sedimentary rock: A rock resulting from the consolidation of loose sediment that has accumulated in layers, consisting of mechanically formed fragments of older rock transported from its source and deposited in water or from air or ice.

Seismic zone: An area defined by the Uniform Building Code (1991), designating the amount of damage to be expected as the result of earthquakes. The United States is divided into six zones: (1) Zone 0 - no damage; (2) Zone 1 - minor damage; corresponds to intensities V and VI of the modified Mercalli intensity scale; (3) Zone 2A - moderate damage; corresponds to intensity VII of the modified Mercalli intensity scale (eastern United States); (4) Zone 2B - slightly more damage than 2A (western United States); (5) Zone 3 - major damage; corresponds to intensity VII and higher of the modified Mercalli intensity scale; (6) Zone 4 - areas within Zone 3 determined by proximity to certain major fault systems.

Seismicity: The tendency for the occurrence of earthquakes.

Select Agents: A select agent is defined as an agent, virus, bacteria, fungi, rickettsiae or toxin listed in Appendix A of *Federal Register 29327* (42 CFR Part 72) titled, *Additional Requirements for Facilities Transferring or Receiving Select Agents*. Select Agents also includes (a) genetically modified micro-organisms or (b) genetic elements that contain nucleic acid sequences associated with pathogenicity from organisms listed in Appendix A, (c) genetically modified micro-organisms listed in Appendix A, and (d) genetically modified micro-organisms or genetic elements that contain nucleic acid sequences coding for any of the toxins in Appendix A, or their toxic subunits.

Sensitivity: The capability of methodology or instrumentation to discriminate between samples having differing concentrations or containing varying amounts of analyte.

Severity: Function of the magnitudes of the mechanical forces (impact) and thermal forces (fire) to which a package may be subjected during an accident; any sequence of events that results in an accident in which a transport package is subjected to forces within a certain range of values is assigned to the accident severity category associated with that range.

Sewerage: The system of sewers.

Shear: Force or motion tangential to the section on which it acts.

Shielding: Any material or obstruction (bulkheads, walls, or other constructions) that absorbs radiation in order to protect personnel or equipment.

Site: In this SWEIS, the term “site” refers to a DOE-controlled Federal site, such as Los Alamos National Laboratory or the Nevada Test Site.

Site-Wide Maximally Exposed Individual (site-wide MEI): A hypothetical person who receives, at the location of a given publicly accessible facility (such as a church, school, business, or residence), the greatest LLNL-induced effective dose equivalent (summed over all pathways) from all sources of radionuclide releases to air at a site. Doses at this receptor location caused by each emission source are summed, and yield a larger value than for the location of any other similar public facility. This individual is assumed to continuously reside at this location 24 hours per day, 365 days per year.

Slip: To move or displace; a movement dislocation adjacent blocks of crust separated by a fault.

Sludge: Precipitated solid matter produced by water and sewage treatment processes. In the context of this EIS/EIR, also the moist precipitate resulting from the dewatering of hazardous waste.

Socioeconomics (analyses): Analyses of those parts of the human environment in a particular location that are related to existing and potential future economic and social conditions. The welfare of human beings as related to the production, distribution, and consumption of goods and services.

Solid waste: Any nonhazardous garbage, refuse, or sludge that is primarily solid; but may also include, semisolid, or contained gaseous material resulting from residential, industrial, commercial, agricultural, or mining operations, and community activities.

Solid Waste Management Unit (SWMU): Any discernible unit at which solid wastes have been placed at any time regardless of whether the unit was intended for solid or hazardous waste management.

Sound level: The quantity in decibels measured by a sound level meter satisfying requirements of the American National Standard Specifications for Sound Level Meters SI.4-1971. Sound level is the frequency-weighted sound pressure level obtained with the standardized dynamic characteristic "fast" or "slow" and weighting A or C.

Sound pressure level (SPL): The level of the A-weighted sound pressure referenced to 20 level micropascal (for air).

Source: Any physical entity that may cause radiation or chemical exposure, for example by emitting ionizing radiation or releasing radioactive or hazardous material.

Source term: In a calculation of contaminant dispersion, the amount of that contaminant assumed available to be dispersed. Source term is calculated as the product of material at risk (MAR), damage ratio (DR), respirable fraction (RF), airborne release fraction (ARF), and leak path factor (LPF).

Special nuclear material: Plutonium, uranium enriched in the isotope U-233 or in the isotope U-235, and any other material that, pursuant to the provisions of section 51 of the Atomic Energy Act of 1954, as amended, has been determined to be special nuclear material, but does not include source material, or any other material enriched by any of the foregoing.

Species of concern: Plants and animals whose conservation status may be of concern to the United States Fish and Wildlife Service, but do not have official or legal protection status.

Specific activity: The amount of radioactivity per unit volume or mass.

Specific conductance: Measure of the ability of a material to conduct electricity; also called conductivity.

Stability class: *see* "Pasquill stability categories."

Standard deviation: A measure of dispersion used in statistical theory for the average variation of a random quantity. The root-mean-square deviation from an average value.

Stockpile management: The specific tasks and functions including production, routine surveillance and servicing, assembly and dismantlement, and disposal of weapons-related parts and materials.

Stockpile stewardship: The science and technology aspects of ensuring the safety, security, and reliability of the stockpile, including research and development to provide technologies required for stockpile management.

Stockpile Stewardship and Management Program: A single, highly integrated technical program for maintaining the safety and reliability of the United States nuclear stockpile in an era without nuclear testing and without new weapons development and production.

Stockpile surveillance: Routine and periodic examination, evaluation and testing of stockpile weapons and weapon components to ensure that they conform toe performance specifications, and to identify and evaluate the effect of unexpected or age-related changes.

Stormwater Pollution Prevention Plan: A plan required by an NPDES permit for controlling stormwater pollution resulting from construction or industrial activities.

Strata: Plural of stratum, which is a single sedimentary, bed or layer.

Strike (of a stratum or fault): The direction of the line of intersection of a horizontal plan with an uptilted geologic stratum or fault plane.

Strike-slip fault: A fault in which the net slip is horizontal, parallel to the strike of the fault.

Subcritical experiment: A dynamic scientific experiment involving special nuclear material in which none of the materials reaches criticality or involves self-sustaining chain-reaction.

Sulfur oxides (SOx): A general term used to describe the oxides of sulfur; pungent, colorless gases formed primarily by the combustion of fossil fuels. Sulfur oxides, which are considered major air pollutants, may damage the respiratory tract as well as vegetation.

Superfund: The common name used for the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA). California has also established a "State Super-fund" under provisions of the California Hazardous Waste Control Act.

***Superfund Amendments and Reauthorization Act* (SARA):** Act enacted in 1986, which amended and reauthorized CERCLA for five years at a total funding level of $8.5 billion. SARA more stringently defines hazardous waste cleanup standards and emphasizes remedies that permanently and significantly reduce the mobility, toxicity, or volume of wastes. Title III of SARA, the *Emergency Planning and Community Right-to-Know Act*, mandates establishment of community emergency planning programs, emergency notification, reporting of chemicals, and emission inventories.

Surface faulting: As opposed to a thrust fault, a fault that does intersect the surface of the earth; the displacement of ground along the surface trace of a fault.

Surface impoundment: A facility or part of a facility that is a natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials, although it may be lined with man-made materials. The impoundment is designed to hold an accumulation of liquid wastes, or wastes containing free liquids, and is not an injection well. Examples of surface impoundments are holding, storage, settling and aeration pits, ponds, and lagoons.

Surrogate material: A material, such as tungsten, used to simulate the characteristics of actual weapons materials so tests can be conducted more cost-effectively.

Système International d'Unités (SI): An international system of physical units which include meter (length), kilogram (mass), kelvin (temperature), becquerel (radioactivity), gray (radioactive dose), and sievert (dose equivalent).

Targets: Refers to a microstructure containing a tiny fuel capsule at which the lasers are directed.

Tectonic: Pertaining to the processes causing, and the rock structures resulting from, deformation of the earth's crusts.

Temporary Emergency Exposure Limits: The Temporary Emergency Exposure Limits were developed by the DOE Subcommittee on Consequences Assessment and Protective Actions (SCAPA) for chemicals where ERPG values are not available and serve as a temporary guidance until ERPGs can be developed.

Terawatt (TW): The equivalent of one trillion watts (1012).

Terraces: Relatively horizontal or gently inclined surfaces or deposit sometimes long and narrow, which are bounded by a steeper ascending slope on one side and by a steeper descending slope on the opposite side.

Terrestrial: Pertaining to plants or animals living on land rather than in water.

Tertiary: The period of geologic time between the Cretaceous and the Pleistocene, comprising the Pliocene, Miocene, Oligocene, Eocene, and Paleocene, from about the 65 million to 1.6 million years ago.

Test readiness: Maintaining the essential technologies, staff; skills and infrastructure to resume nuclear testing, if mandated by the president.

Thermoluminescent dosimeter (TLD): A device used to measure external beta or gamma radiation levels, and which contains a material that, after exposure to beta or gamma radiation, emits light when processed and heated.

Thermonuclear: The process by which very high temperatures are used to bring about the fusion of light nuclei-such as deuterium and tritium-with an accompanying release of energy.

Threatened species: A species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range that is legally protected.

Threshold limit Values/Time-Weighted Average (TLV®/TWA): Guidelines or recommendations that refer to airborne concentrations of potentially hazardous substances. A time-weighted average TLV® is an average for a normal 8-hour workday or 40-hour workweek, to which it is believed all workers may be repeatedly exposed, day after day, without adverse effect.

Thrust fault: A fault dipping less than 45°, in which the block above appears to have moved upward relative to the block below.

Tiger Team: A team set up by the Secretary of Energy in 1989 to assess the environment, safety, and health operations at all DOE facilities to determine whether changes were needed to improve the protection of the environment, safety, and health.

Time-weighted average (TWA): Time-weighted average representing 8 or 10 hours of work per day during a 40-hour work week.

Total dissolved solids (TDS): The portion of solid material in a waste stream that is dissolved and passed through a filter.

Total suspended solids (TSS): The total mass of particulate matter per unit volume suspended in water and wastewater discharged that is large enough to be collected by a 0.45-micron filter.

Toxicity assessment: Identification of the types of adverse health effects associated with exposures and the relationship between the magnitude of the exposure and of the adverse effects.

***Toxic Substances Control Act* of 1976 (TSCA):** Act authorizing the Environmental Protection Agency to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by the Environmental Protection Agency before they are manufactured for commercial purposes.

Trace: A line on one plane representing the intersection of another plane with the first one (e.g., a fault trace).

Transect: A sample area (as of vegetation), usually in the form of a long continuous strip.

Transportainer: A portable container usually constructed of metal that is typically used as temporary storage space.

Transuranic waste (TRU): Material contaminated with alpha-emitting transuranium nuclides, which have an atomic number greater than that of uranium (i.e. 92); including neptunium, plutonium, americium, and curium; with half-lives longer than 20 years, except for: (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; or (3) waste that the

Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61, and are present in concentrations greater than 100 nCi/g of waste.

Trend (of a fault): If the fault intersects the surface, the general direction of that intersection.

Tritiated water: Water in which one of the hydrogen atoms has been replaced by a tritium atom; sometimes shown as HTO.

Tritium: The radioactive isotope of hydrogen, containing one proton and two neutrons in its nucleus, which decays at a half-life of 12.3 years by emitting a low-energy beta particle. Common symbols for this isotope are H-3 and T.

TRUPACT-II: The package designed to transport contact-handled transuranic waste to the WIPP site. (TRUPACT=Transuranic Package Transporter)

Tuff: A rock formed of compacted volcanic fragments, generally smaller than 4 mm in diameter.

Type A packaging: “A packaging designed to retain the integrity of containment and shielding…under normal conditions of transport as demonstrated by” a water spray test, a free-drop test, a compression test, and a penetration test (40 CFR parts 173.403(gg), 173.465).

Type B packaging: A DOE, DOT, and NRC certified container that must be used for the transport of transuranic waste containing more than 20 curies of plutonium per package. Type B packaging must be able to withstand both normal and accident conditions without releasing its radioactive contents. These containers are tested under severe, hypothetical-accident conditions that demonstrates resistance to impact, puncture, fire, and submersion in water (49 CFR part 173).

U-AVLIS: At LLNL, the process of Atomic Vapor Laser Isotope Separation applied to uranium.

Unsaturated zone: That portion of the subsurface in which the pores are only partially filled with water and the direction of water flow is vertical; is also referred to as the vadose zone.

Uranium: *See* “Natural uranium.” A naturally occurring, heavy metallic element. Designated atomic number 92, uranium has many radioactive isotopes. Enriched uranium is most commonly used as a fuel for nuclear fission, while uranium 238 is the most abundant isotope in nature.

United States Department of Energy (DOE): The Federal agency responsible for conducting energy research and regulating nuclear materials used for weapons production.

United States Environmental Protection Agency (EPA): The Federal agency responsible for enforcing Federal environmental laws. Although some of this responsibility may be delegated to state and local regulatory agencies, EPA retains oversight authority to ensure protection of human health and the environment.

Vacuum-induced stripping or venting: A groundwater treatment system in which a vacuum in the subsurface soil draws off volatile organic contaminants for treatment and/or disposal.

Vadose zone: The partially saturated or unsaturated region above the water table that does not yield water to wells.

Valley fever (coccidioidomycosis): A fungal disease of the lungs endemic to the southwest United States characterized in severe cases by high fever and extreme fatigue.

Vernal pool: A wetland created from standing water, typically in the spring, hence its name.

Viewpoint: A location from which a site is visible.

Viewshed: The geographic area from which a site is visible; a collection of viewpoints.

Volatile organic compound (VOC): Liquid or solid organic compounds that have a high vapor pressure at normal pressures and temperatures and thus tend to spontaneously pass into the vapor state.

Volcanic rock: A generally finely crystalline or glassy igneous rock resulting from volcanic action at or near the Earth's surface either ejected explosively or extruded as lava (e.g., basalt). The term also included near-surface intrusions that form a part of the volcanic structure.

Waste accumulation area (WAA): An officially designated area that meets current environmental standards and guidelines for temporary (less than 90 days) storage of hazardous waste before pickup by the Hazardous Waste Management Division for offsite disposal.

Waste Generator: Any individual or group of individuals that generate radioactive, mixed, or hazardous wastes at LLNL or SNL, Livermore. Waste generator responsibilities are discussed in Section B.3.1.1.

Waste Isolation Pilot Plant (WIPP): A facility in southeastern New Mexico which was developed as the disposal site for transuranic and transuranic mixed waste. Operations began on March 26, 1999.

Waste management: The planning, coordination, and direction of those functions related to generation, handling, treatment, storage, transport, and disposal of waste, as well as associated surveillance and maintenance activities.

Waste management facilities: One or more of the waste management units for LLNL Livermore Site, LLNL Site 300, and SNL, Livermore respectively.

Waste minimization: Actions that economically avoid or reduce the generation of waste by source reduction, reducing the toxicity of hazardous waste, improving energy usage, or recycling. These actions will be consistent with the general goal of minimizing current and future threats to human health, safety, and the environment.

Wastewater treatment plant: A collection of treatment processes and facilities designed and built to reduce the amount of suspended solids, bacteria, oxygen-demanding materials, and chemical constituents in wastewater.

Water table: The water-level surface below the ground at which the unsaturated zone ends and the saturated zone begins, and the level to which a well that is screened in the unconfined aquifer would fill with water.

Weapons effects: Deals with outputs of nuclear weapons and the associated effects on materials, components, systems, and the environment.

Weapons of mass destruction: Umbrella term that includes nuclear, chemical, and biological weapons.

Weapons-grade: Any fissionable material in which the abundance of fissile isotopes is high enough that the material is suitable for use in thermonuclear weapons.

Wetland: An area that has water at or near the surface of the ground during the growing season (wetland hydrology). It supports or is capable of supporting plants that are adapted to wet habitats (hydrophytic vegetation) and has soils that have developed under wet conditions (hydric soils).

Wetland hydrology: Permanent or periodic inundation for at least 7 days during the growing season.

Whole-body radiation: Radiation to the whole body, as opposed to individual organs or parts of the body.

Wind rose: A diagram that shows the frequency and intensity of wind from different directions at a specific location.

X-rays: Penetrating electromagnetic radiations with wavelengths shorter than those of visible light, usually produced by irradiating a metallic target with large numbers of high-energy electrons. In nuclear reactions, it is customary to refer to photons originating outside the nucleus as x rays and those originating in the nucleus as gamma rays, even though they are the same.

Yield: The energy released from a thermonuclear reaction.

Yield experiments: A measure of fusion energy/neutron production in experiments that use a mixture of deuterium and tritium isotopes as fuel.

Zinc (Zn): A bluish white crystalline metallic element of atomic number 30. Zinc has low to intermediate hardness and is ductile when pure but in the commercial form is brittle at ordinary temperatures and becomes ductile on slight heating. It occurs abundantly in minerals, is an essential micronutrient for both plants and animals, and is used especially as a protective coating for iron and steel.

Zone 7: The common name for the Alameda County Flood Control and Water Conservation District.

Zoning: The division of city or county by legislative regulations into areas, or zones, that specify allowable uses for real property and size restrictions for buildings within these areas; a program that implements the policies of the General Plan.

Zoning District: A designated section of a city or county wherein prescribed land use requirements and building and development standards are uniform.

CHAPTER 12: INDEX

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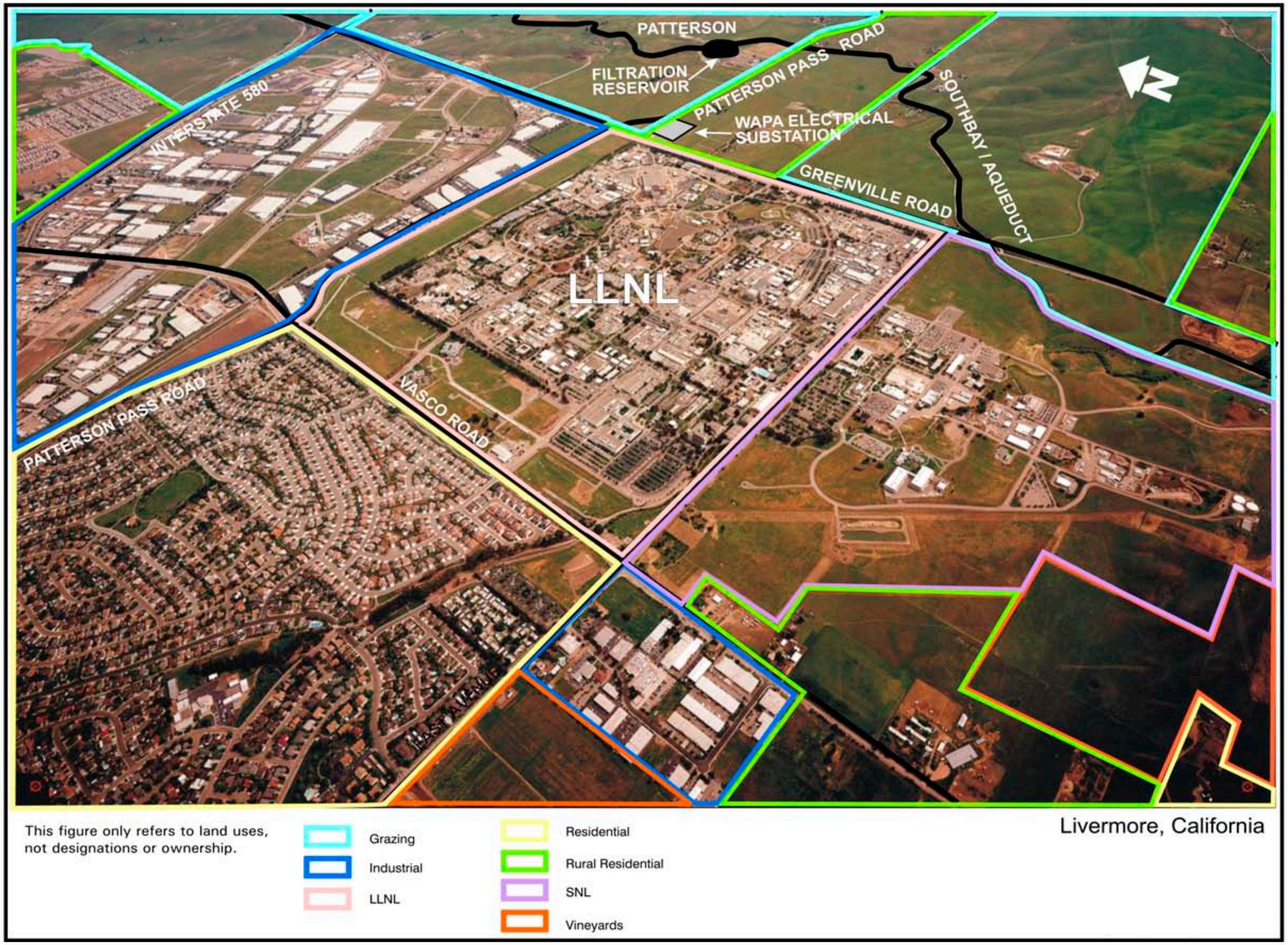
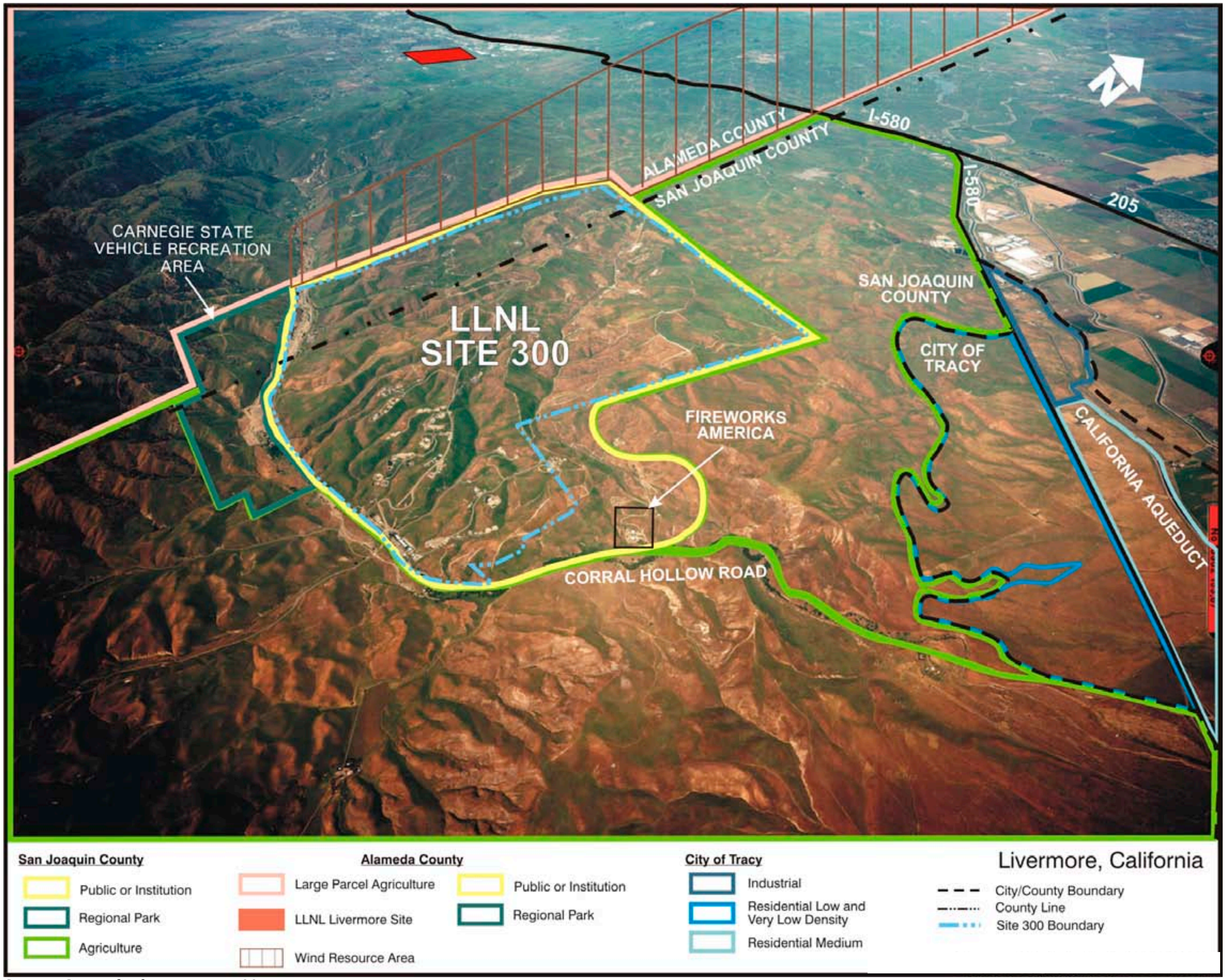


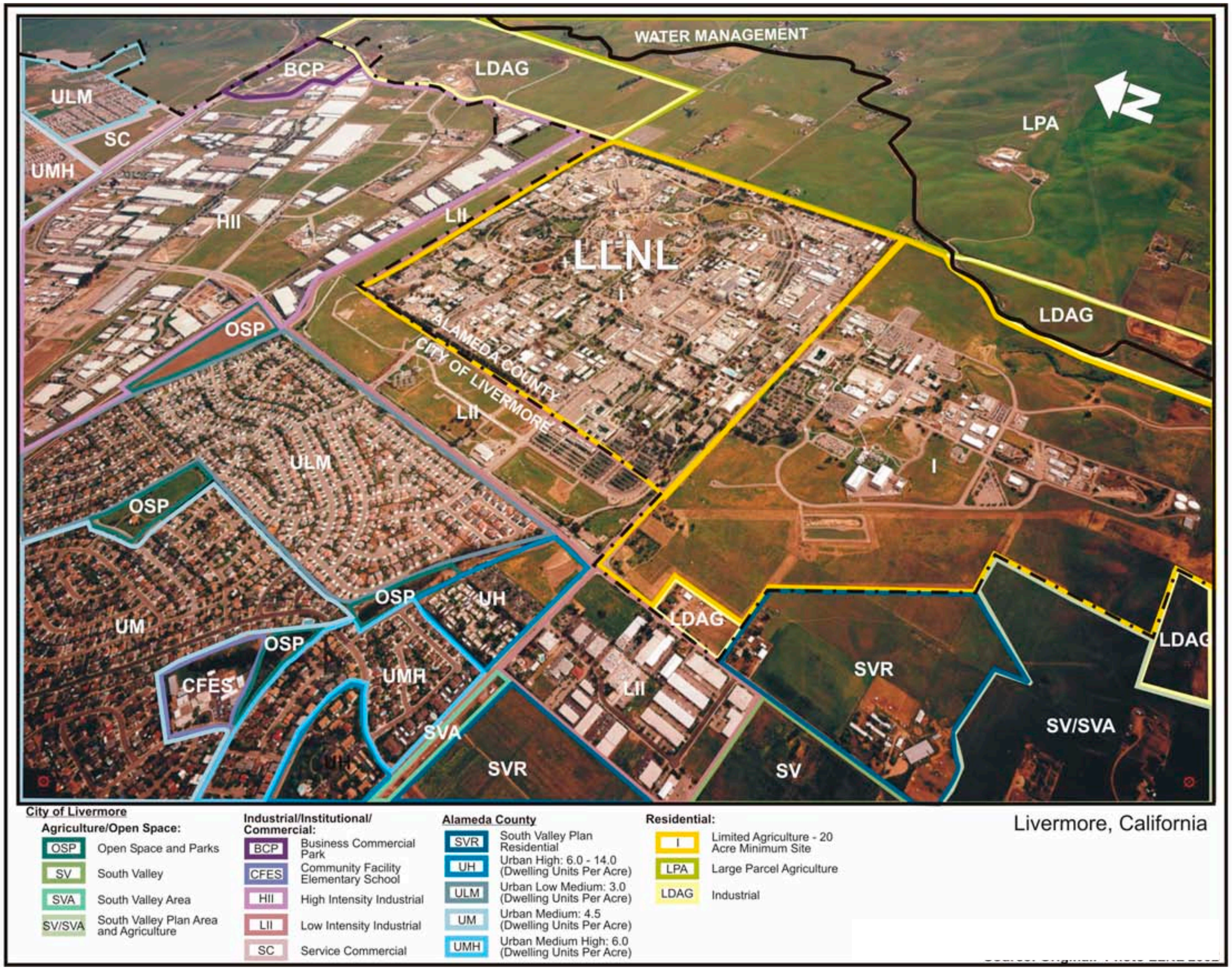
Source: Original; Photo, LLNL 2002.

FIGURE 4.2.1.1–1.—*Livermore Site Surrounding Land Uses*



Source: Original; Photo, LLNL 2002.

FIGURE 4.2.1.2–1.—*Site 300 Surrounding Land Uses and Land Use Designations*



Source: Original; Photo, LLNL 2002.

FIGURE 4.2.2.1–1.—*Livermore Site Surrounding Land Use Designations*

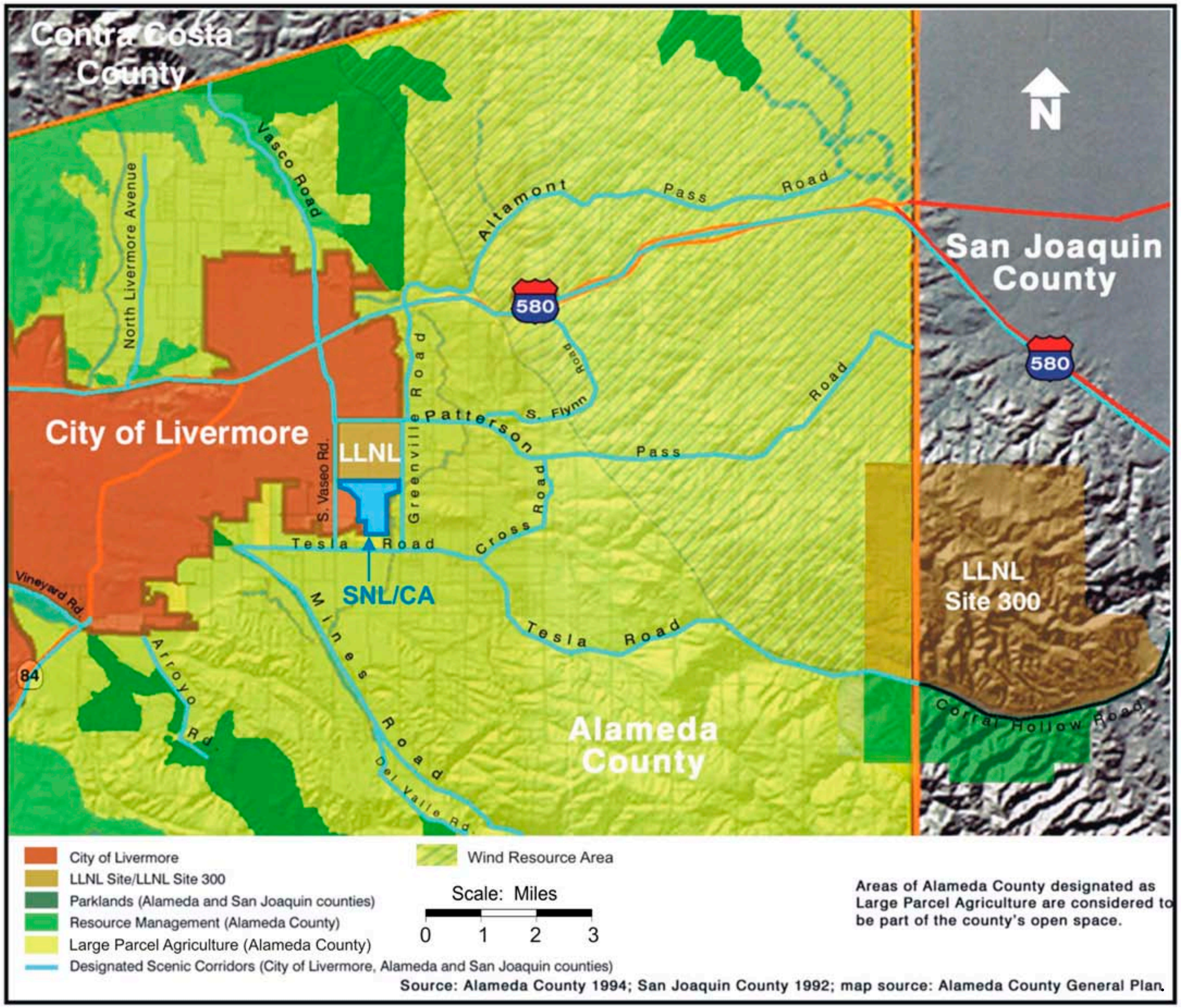


FIGURE 4.2.2.1–2.—*Designated Open Space Areas and Scenic Routes*

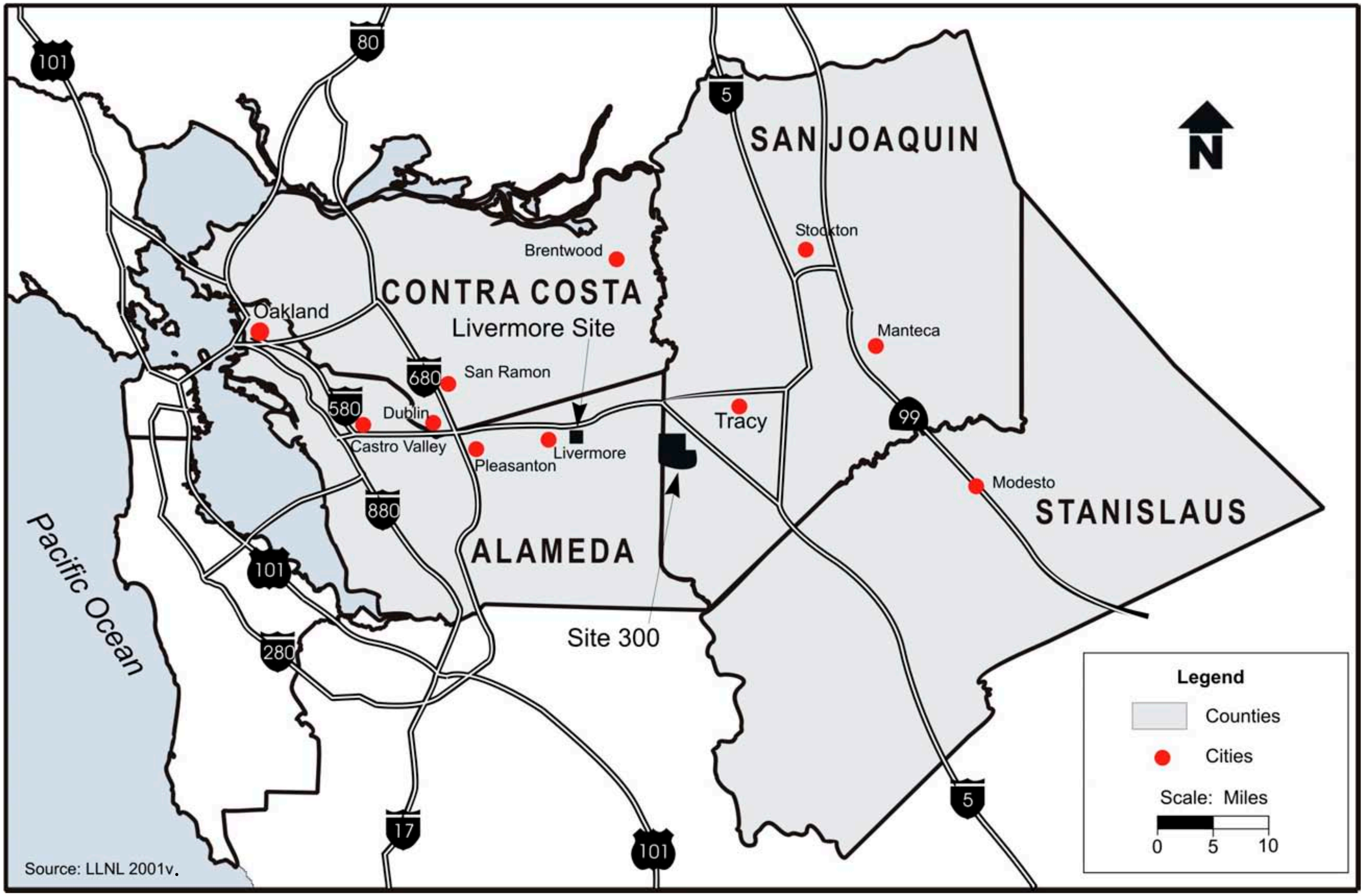


FIGURE 4.3–1.—*Four-County Lawrence Livermore National Laboratory Region of Influence*

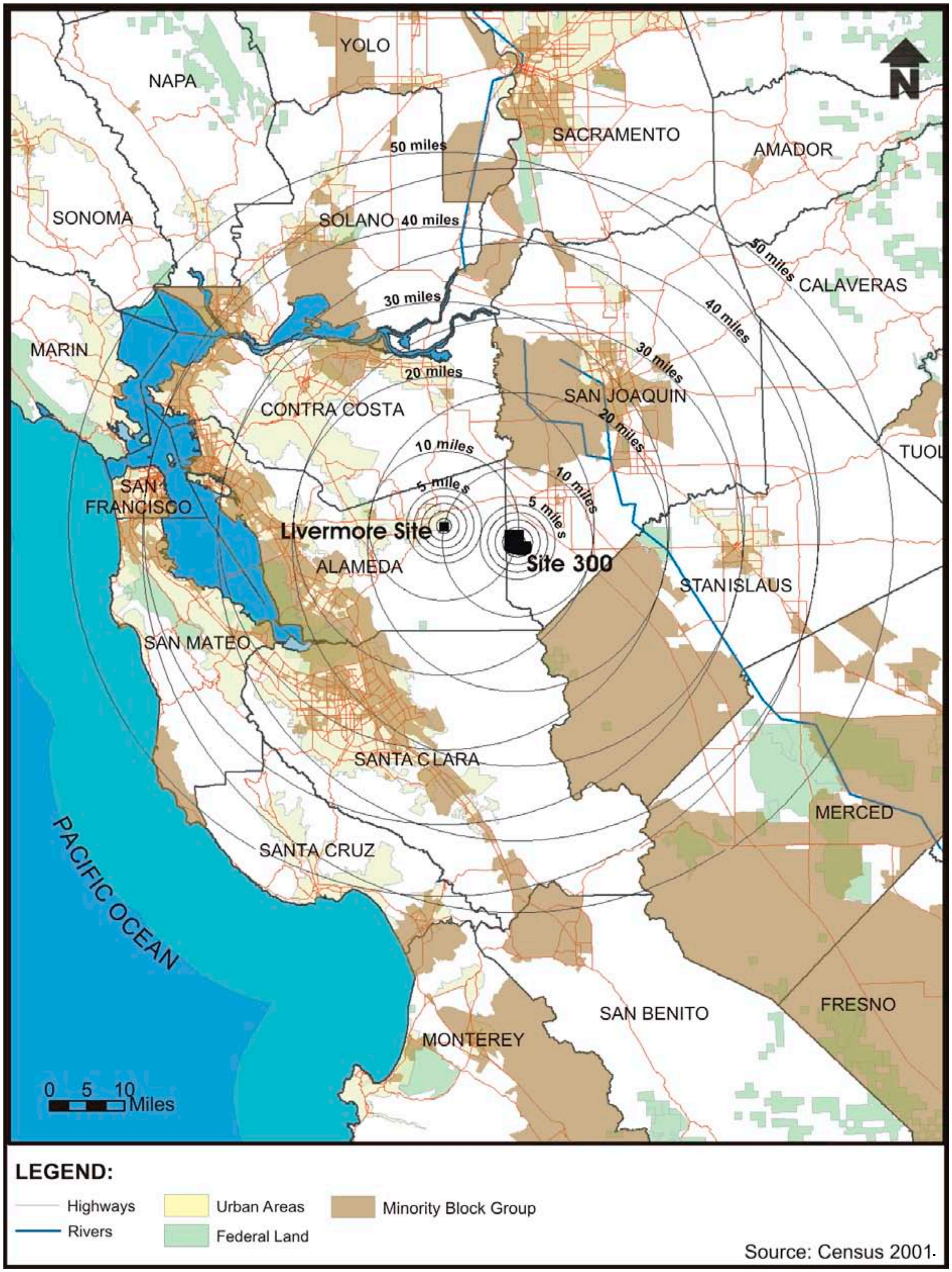


FIGURE 4.3.5–1.—*Minority Populations within 50 Miles of the Livermore Site and Site 300*

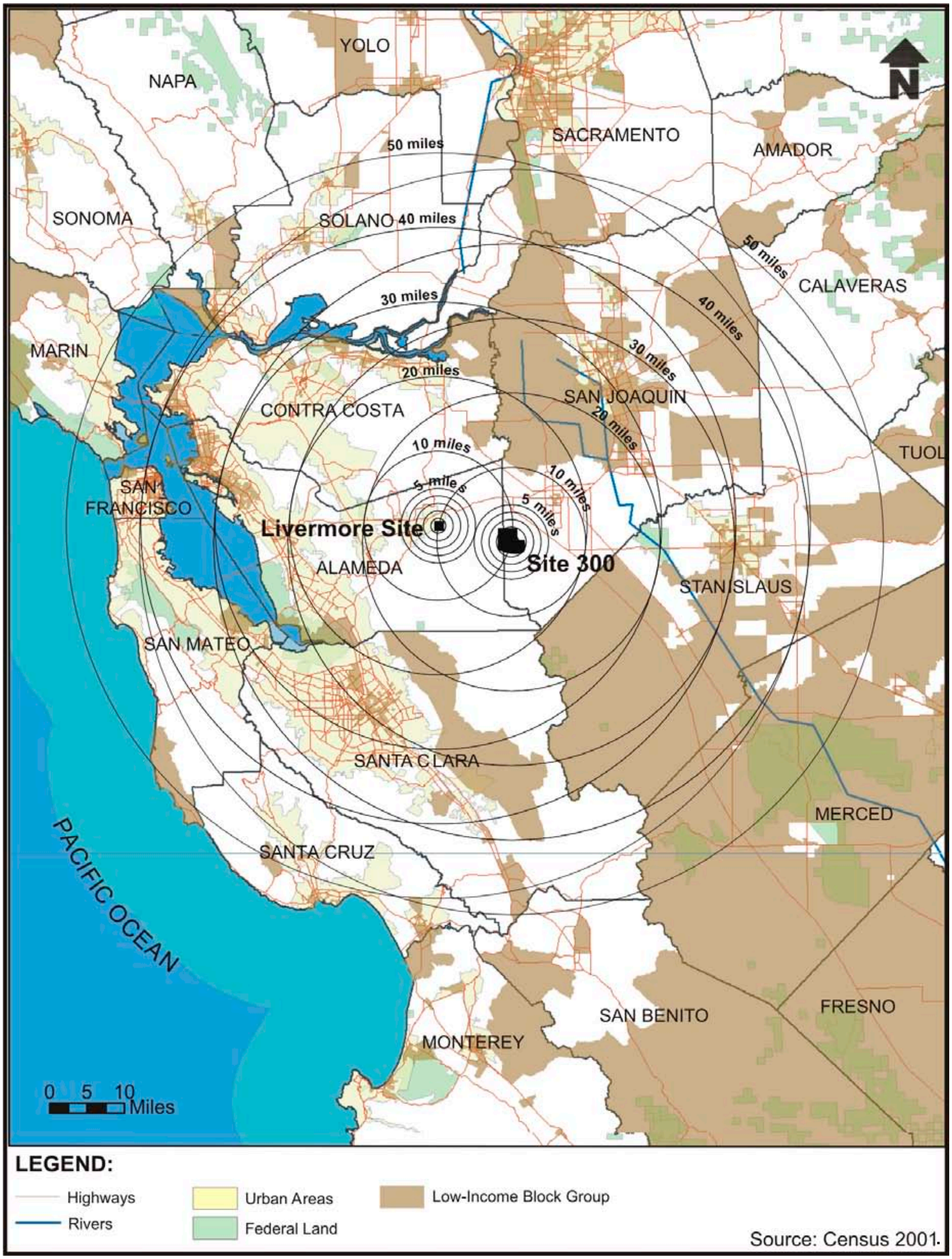
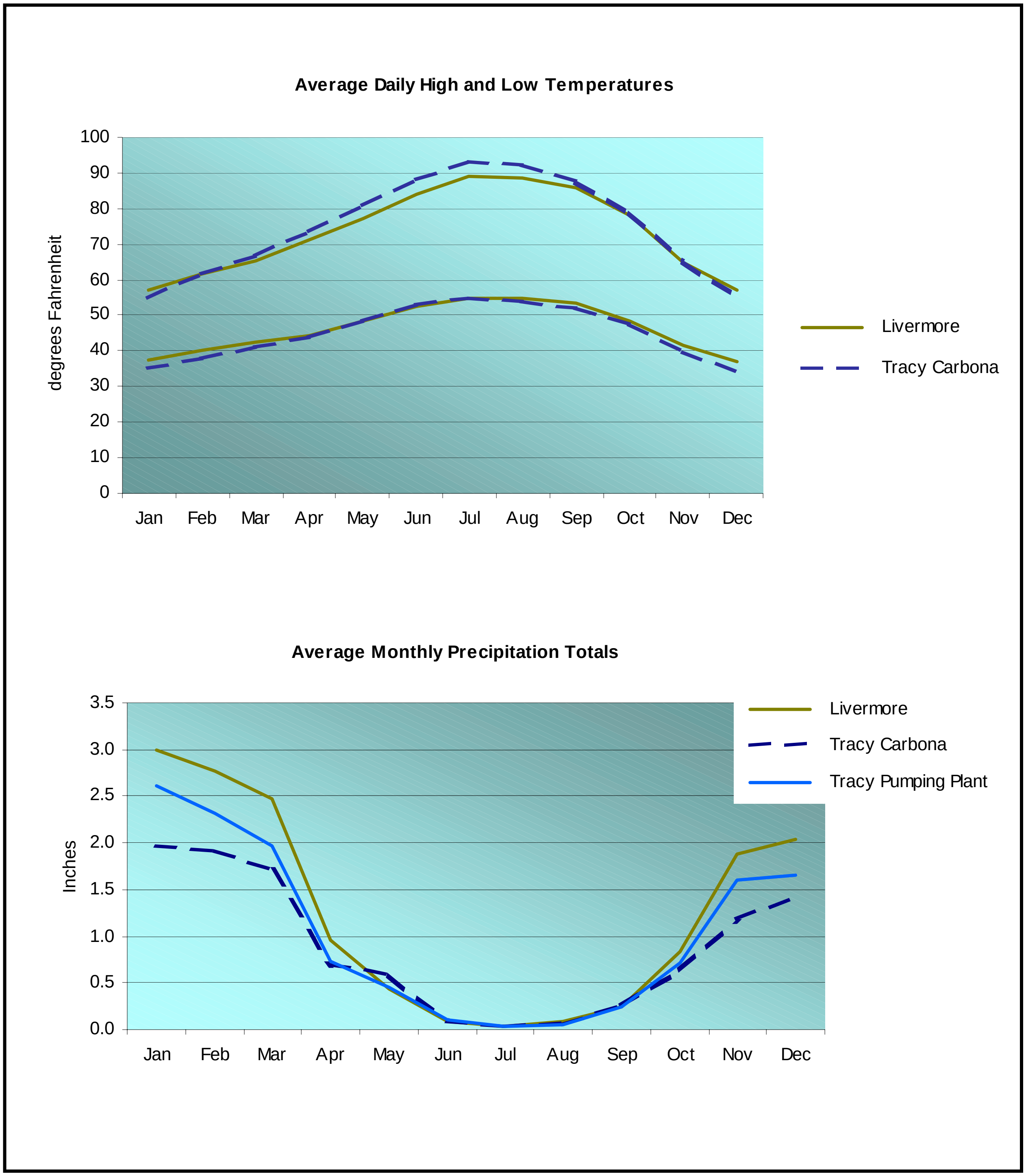
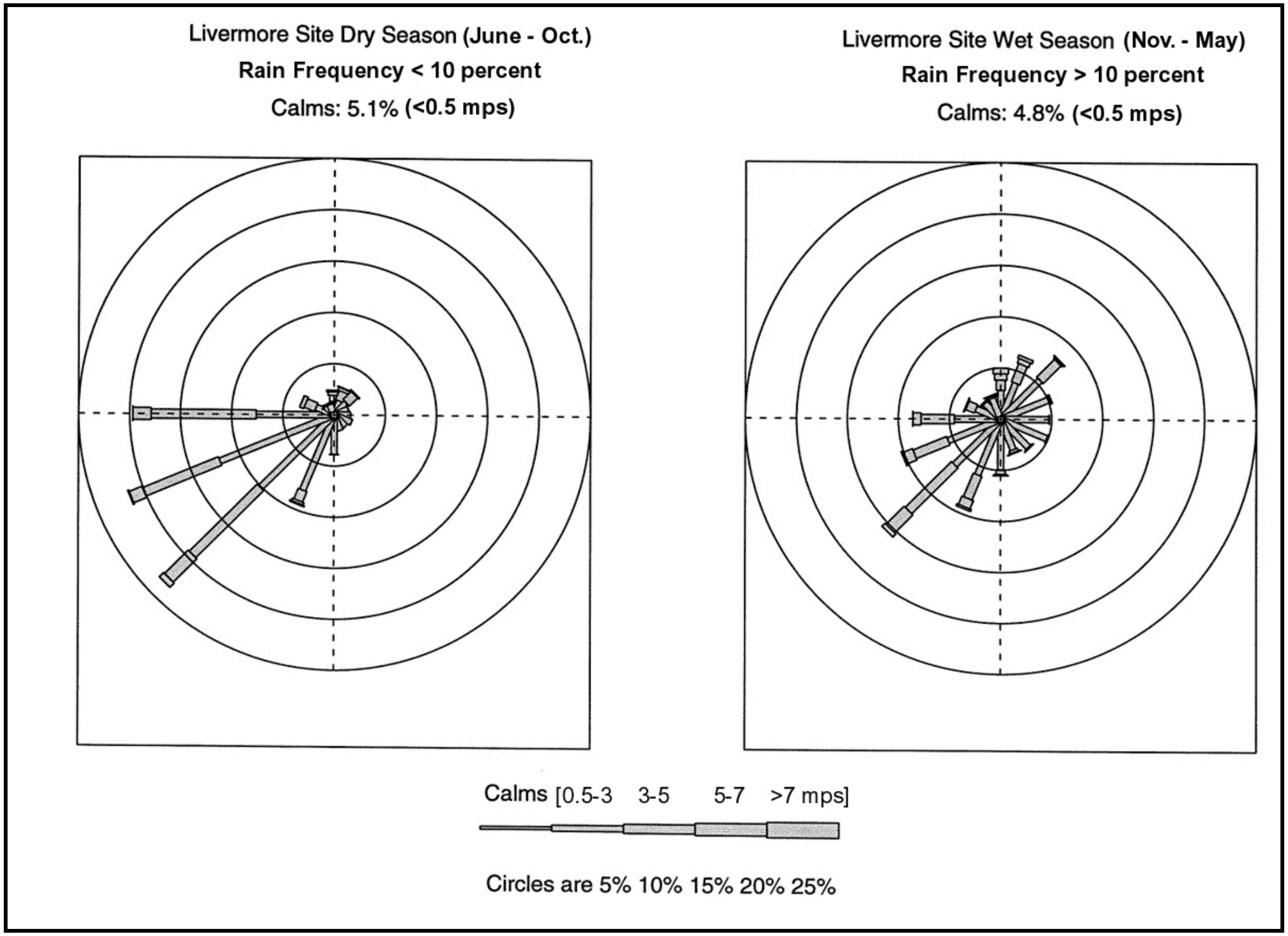


FIGURE 4.3.5–2.—*Low-Income Populations within 50 Miles of the Livermore Site and Site 300*



Source: NCDC 2002a.

FIGURE 4.7.1–1.—*Average Temperature and Precipitation Totals for Livermore and Tracy*



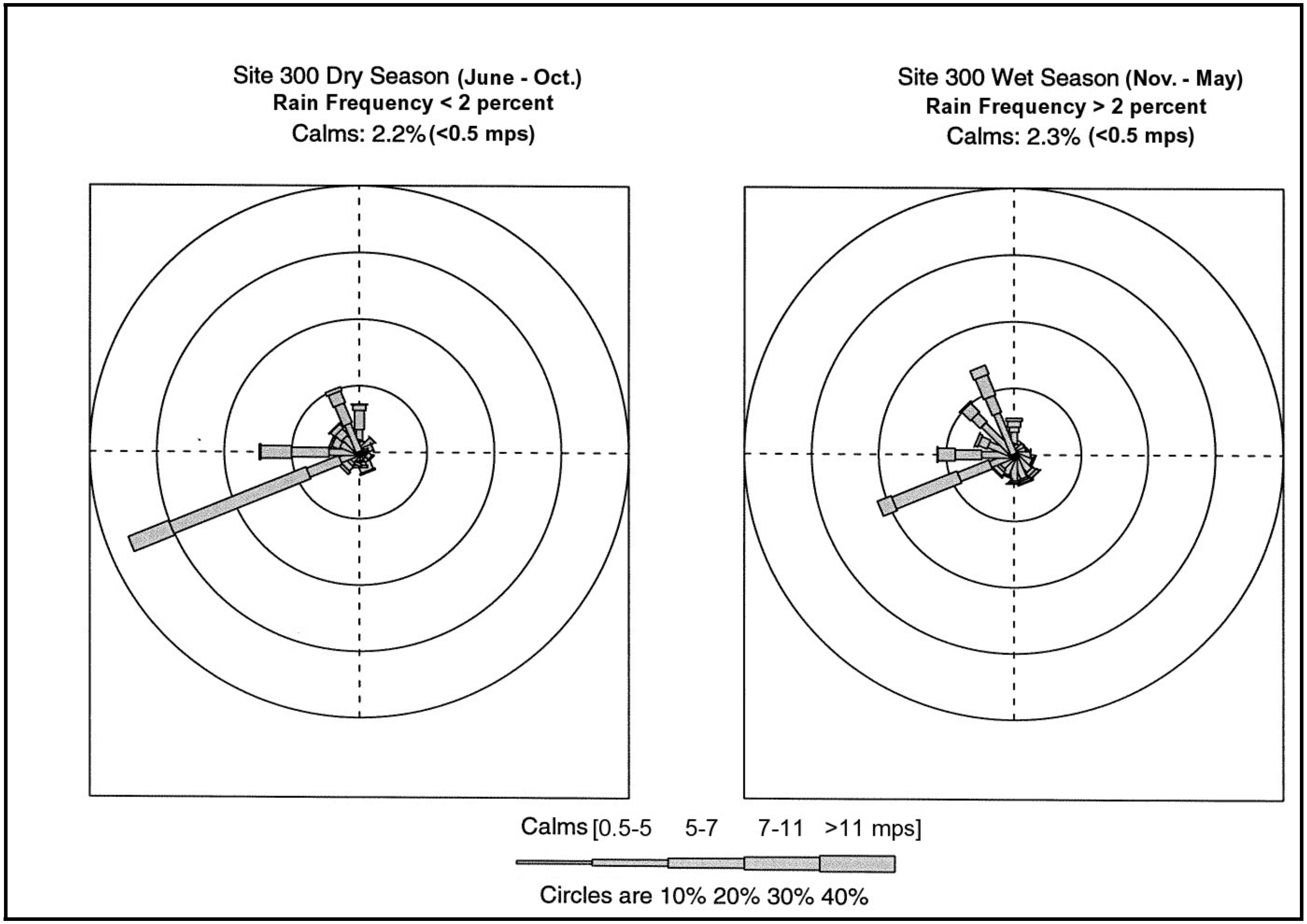
Source: LLNL 2002bx.

Notes: Data from monitoring stations located at Livermore and Site 300.

The absolute length of each directional "telescope," in relation to the percent frequency radials, indicate the frequency of occurrence of each wind direction (direction from which the wind is blowing). Each of the directional telescopes is further segmented to indicate the frequency of individual wind speed classes. Each directional telescope consists of up to four segments relating to wind speed categories, with wider segments corresponding to increasingly higher wind speeds. The relative lengths of individual "telescope segments" are used to infer the frequency of occurrence of wind speed classes for each of the 16 compass wind directions.

One meter per second (mps) equals 2.2 miles per hour.

FIGURE 4.7.3–1.—*Seasonal Wind Roses for the Livermore Site (1997 – 2001)*



Source: LLNL 2002ci.
[a] See notes for Figure 4.7.3-1.

FIGURE 4.7.3–2.—*Seasonal Wind Roses for Site 300 (1997 – 2001)*[a]

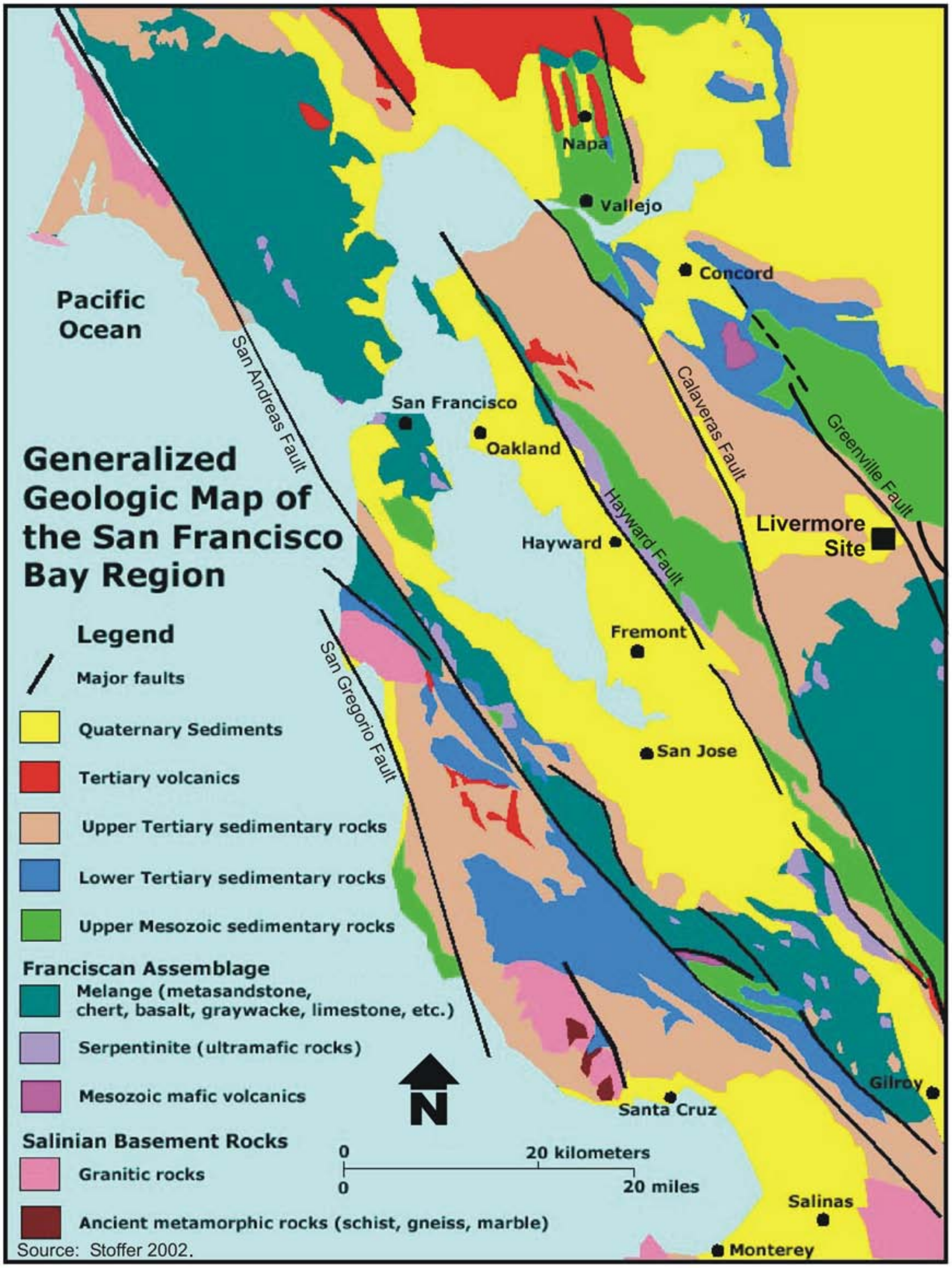
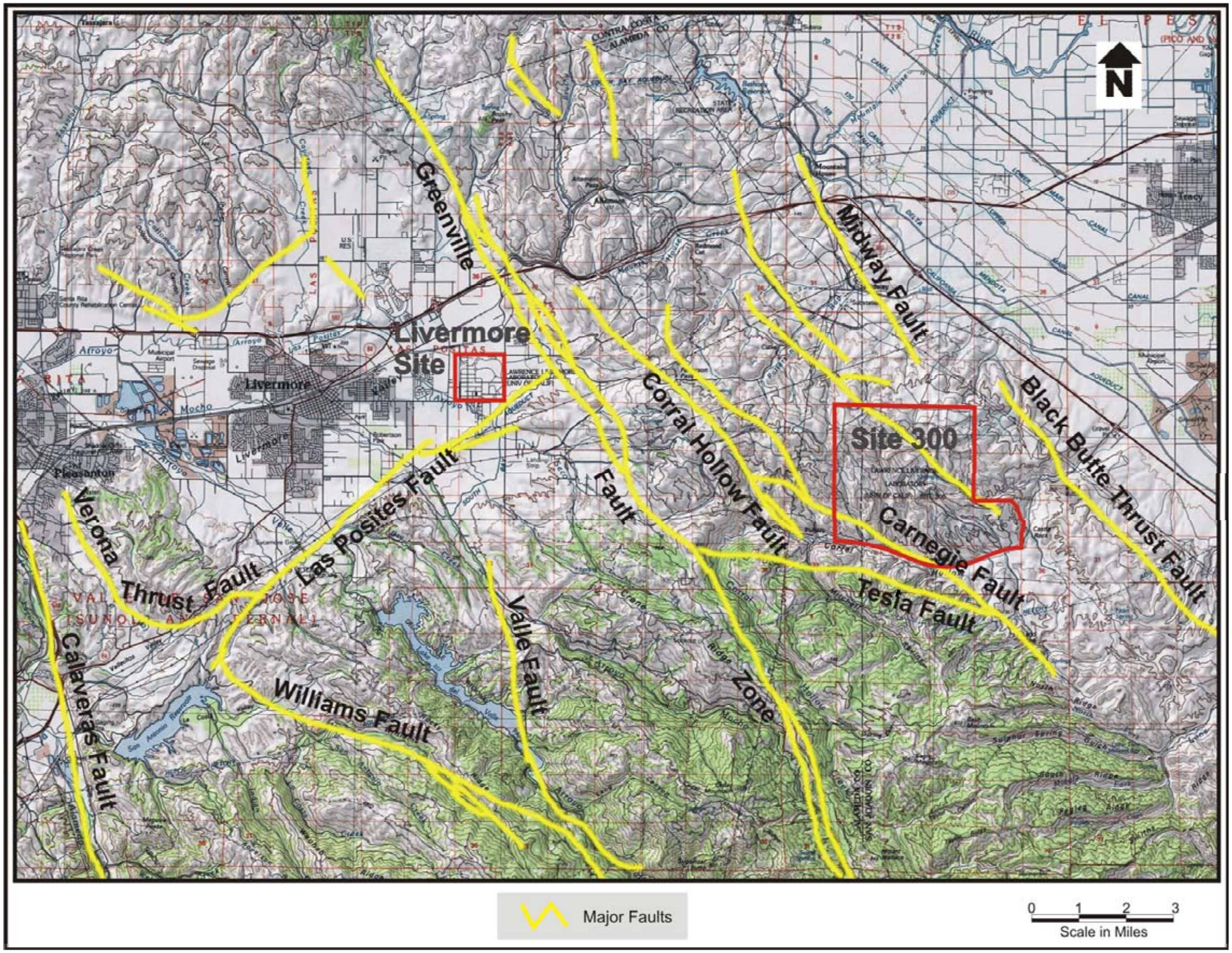
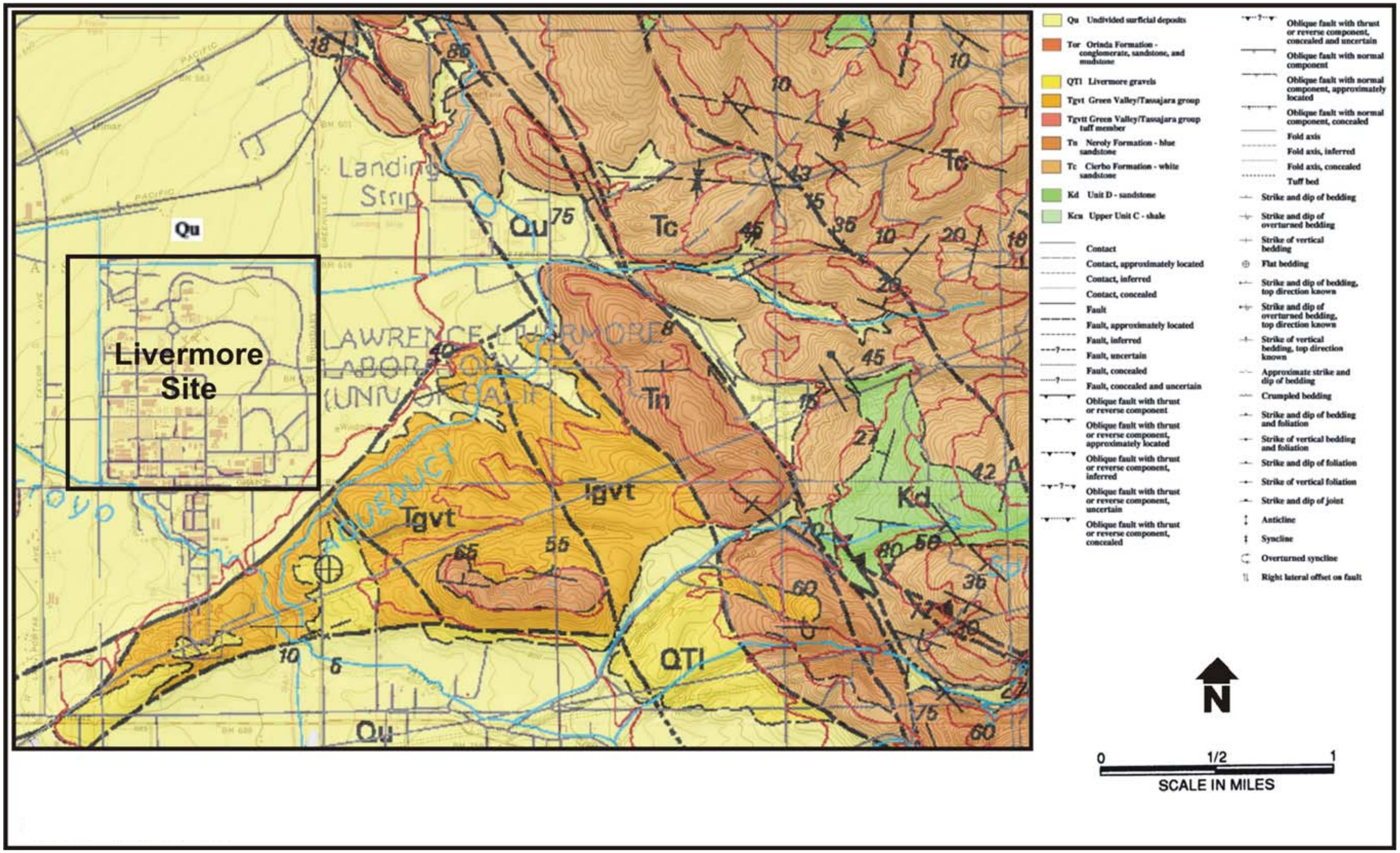


FIGURE 4.8.1–1.—*Generalized Geologic Map of the San Francisco Bay Area Showing the Location of the Livermore Site*



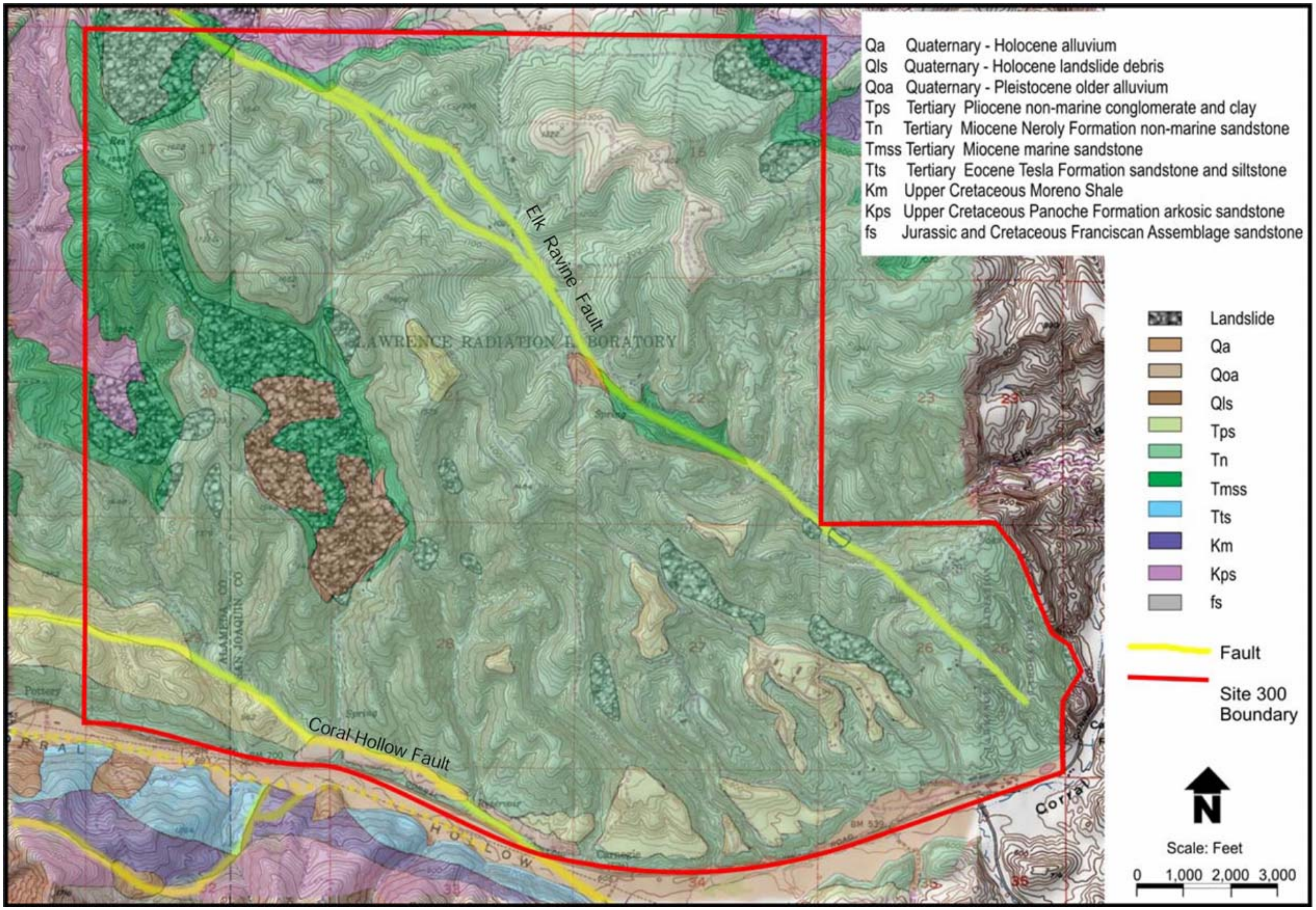
Source: LLNL 1992a.

FIGURE 4.8.1–2.—*Location of the Major Faults Adjacent to the Livermore Site and Site 300*



Source: Graymer et al. 1996.

FIGURE 4.8.1–3.—*Geological Map of the Southeast Livermore Valley*



Source: LLNL 1992a.

FIGURE 4.8.1–4.—*Geological Map of Site 300*

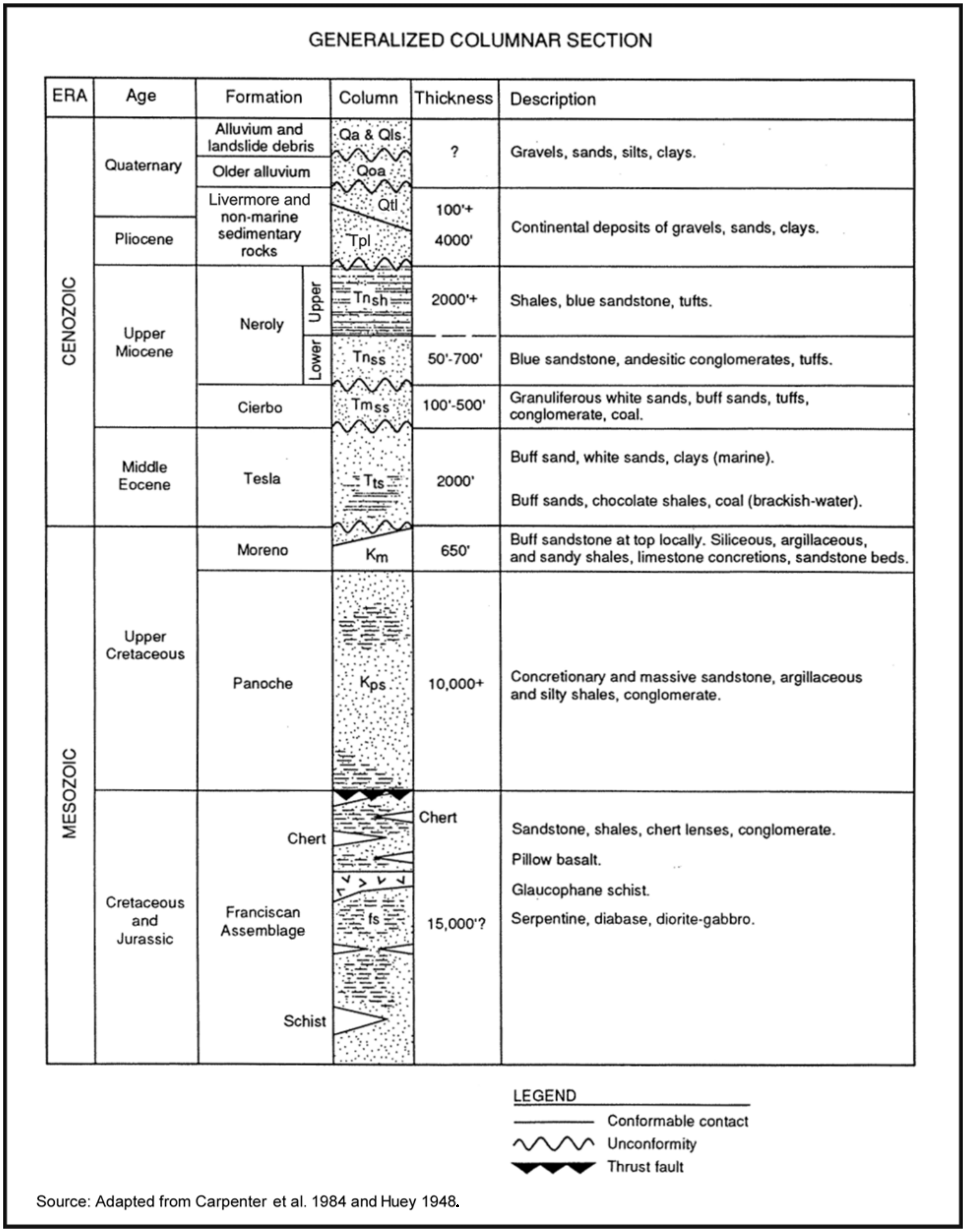
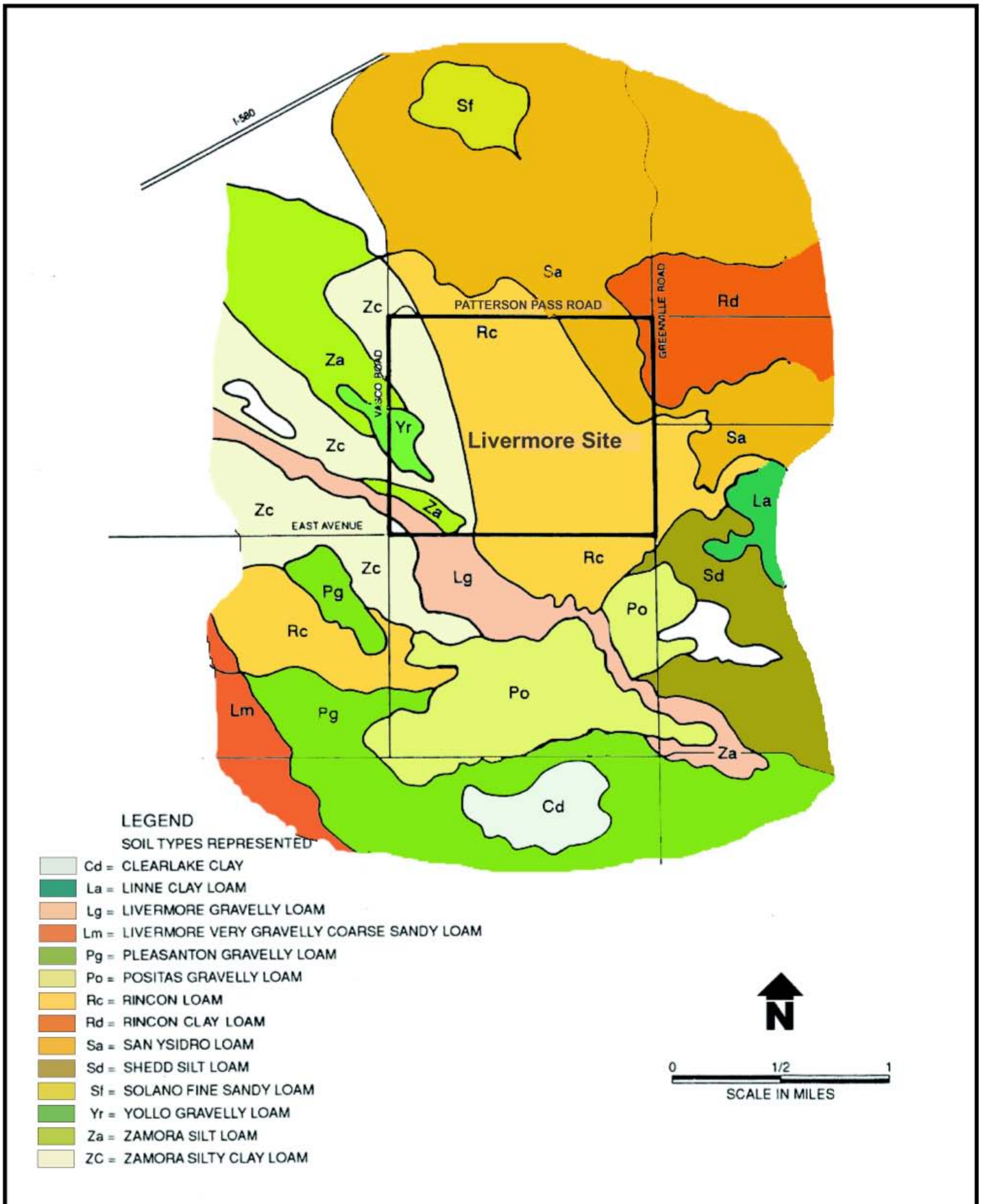
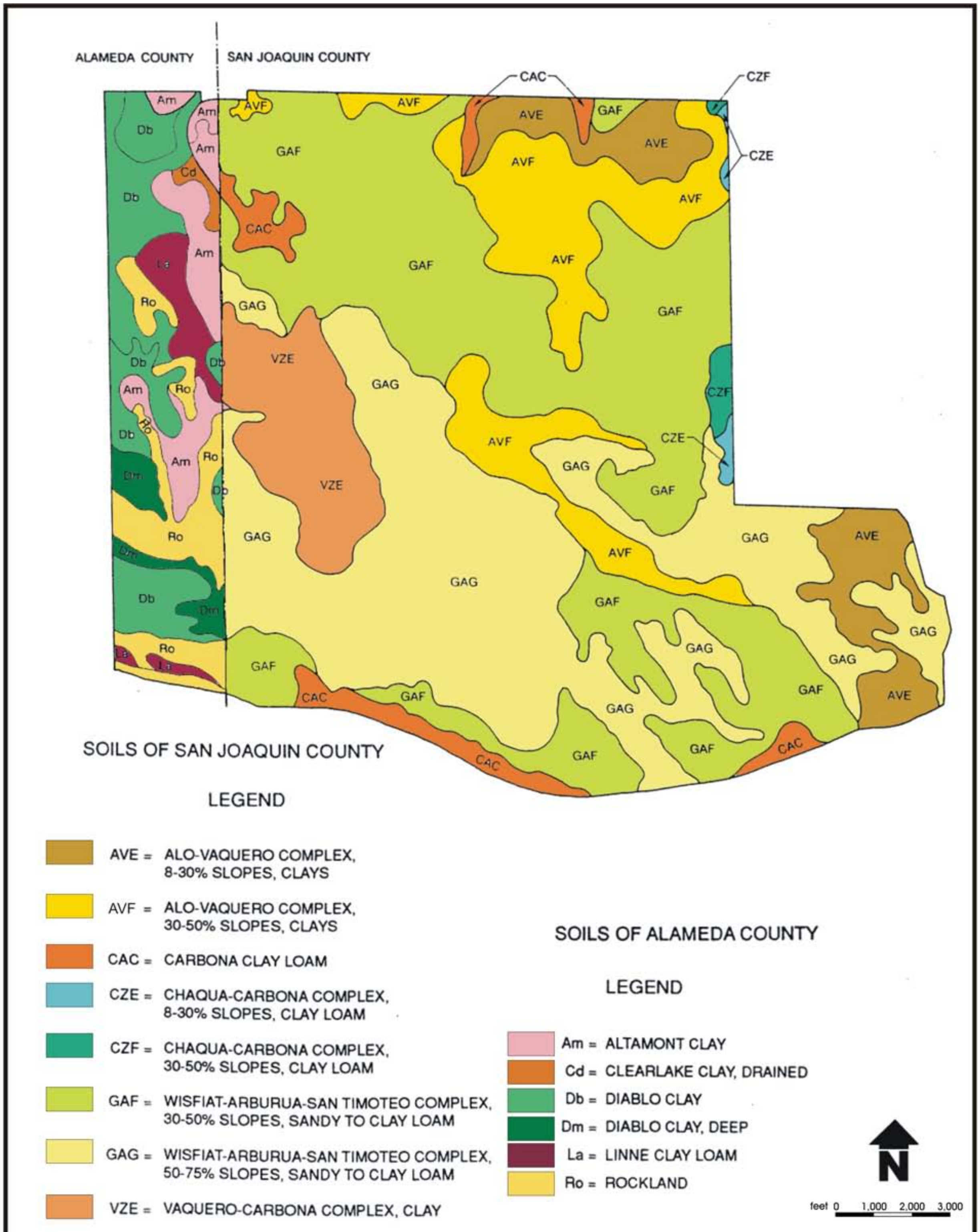


FIGURE 4.8.1–5.—*Stratigraphic Column for the Livermore Site and Site 300*



Source: USDA 1966.

FIGURE 4.8.1–6.—*Soil Map of the Southeast Livermore Valley*



Source: USDA 1966, 1990.

FIGURE 4.8.1–7.—*Soil Map of Site 300*

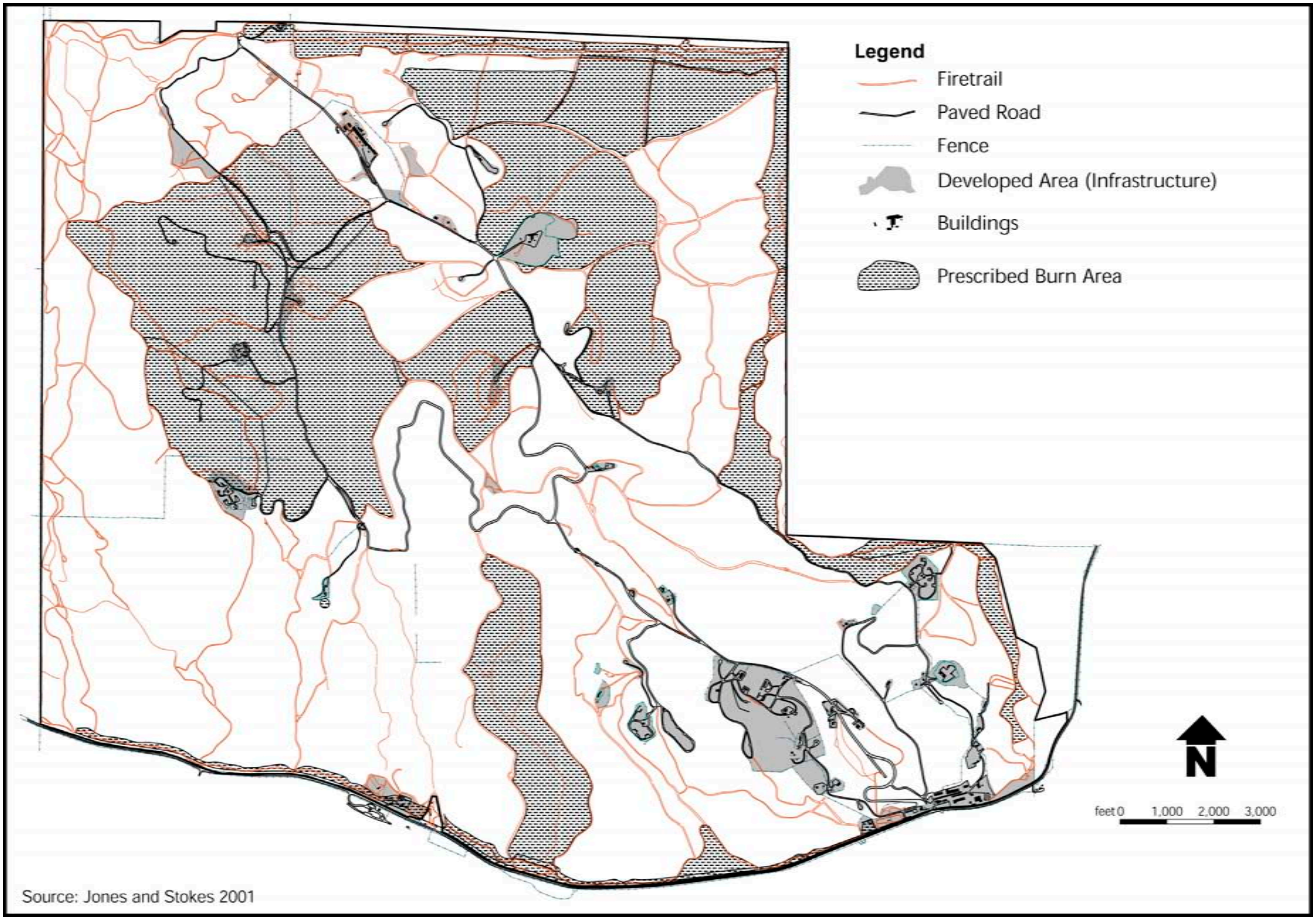


FIGURE 4.9.1–1.—*Annual Prescribed Burn Areas at Site 300*

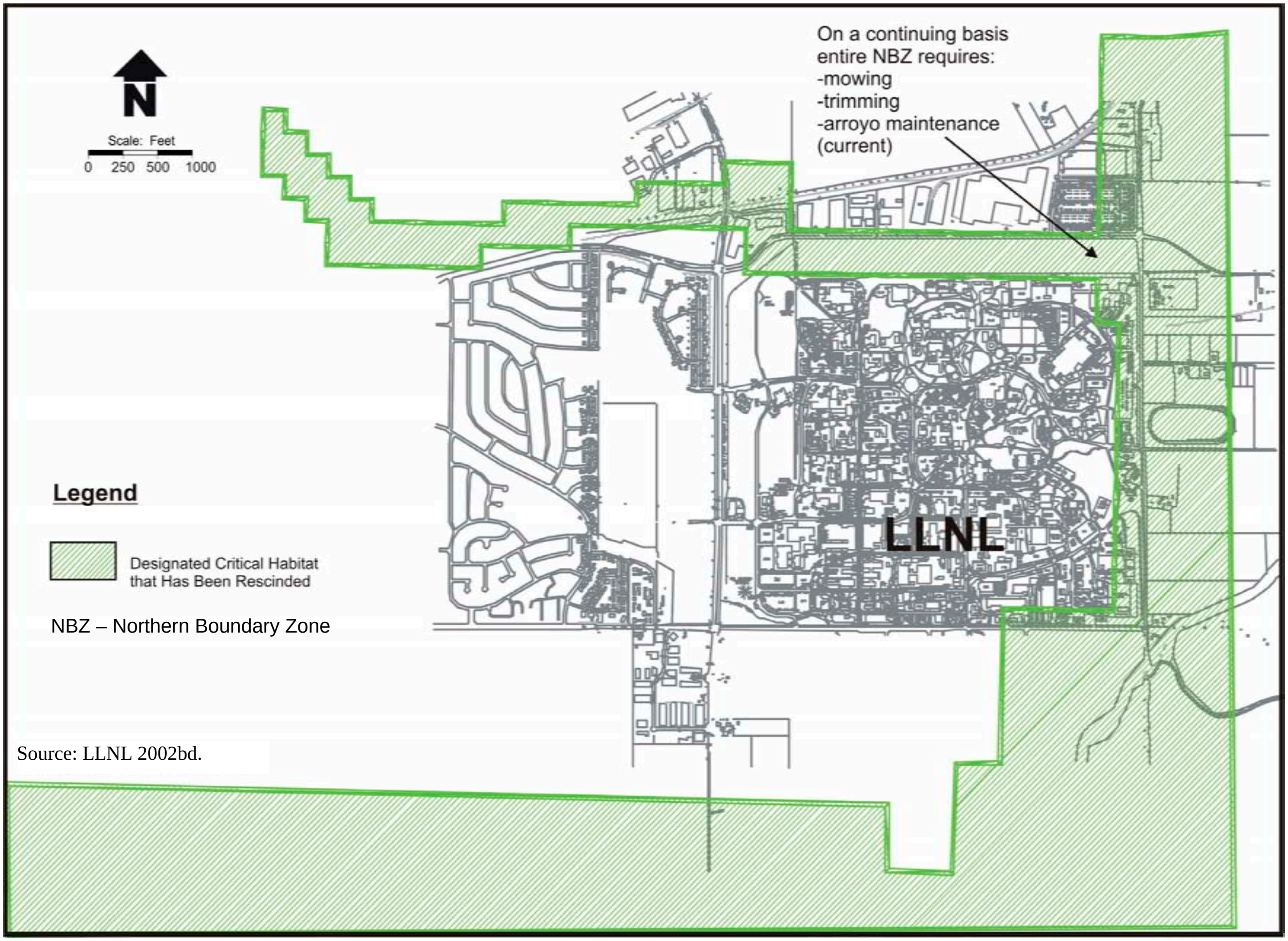
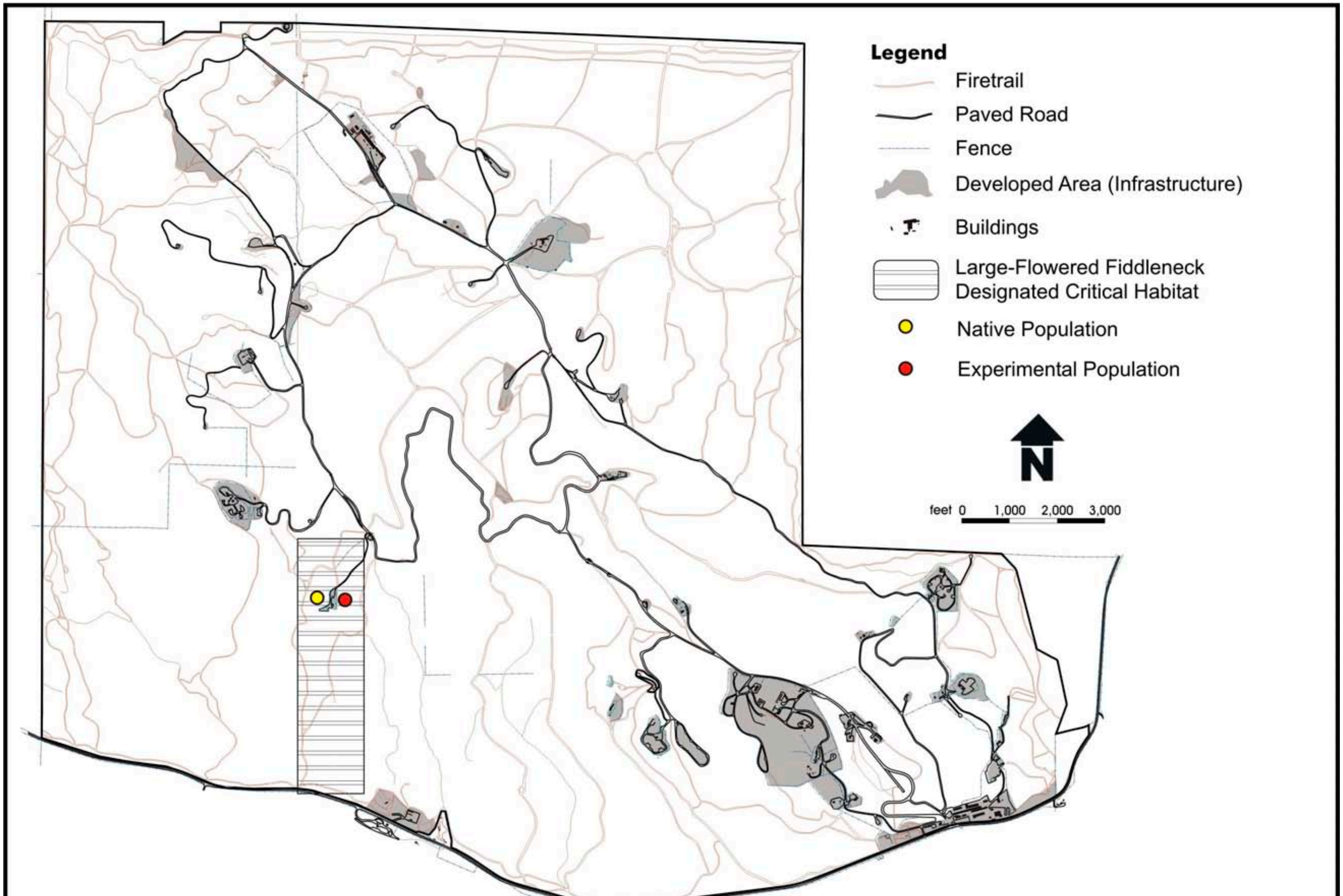
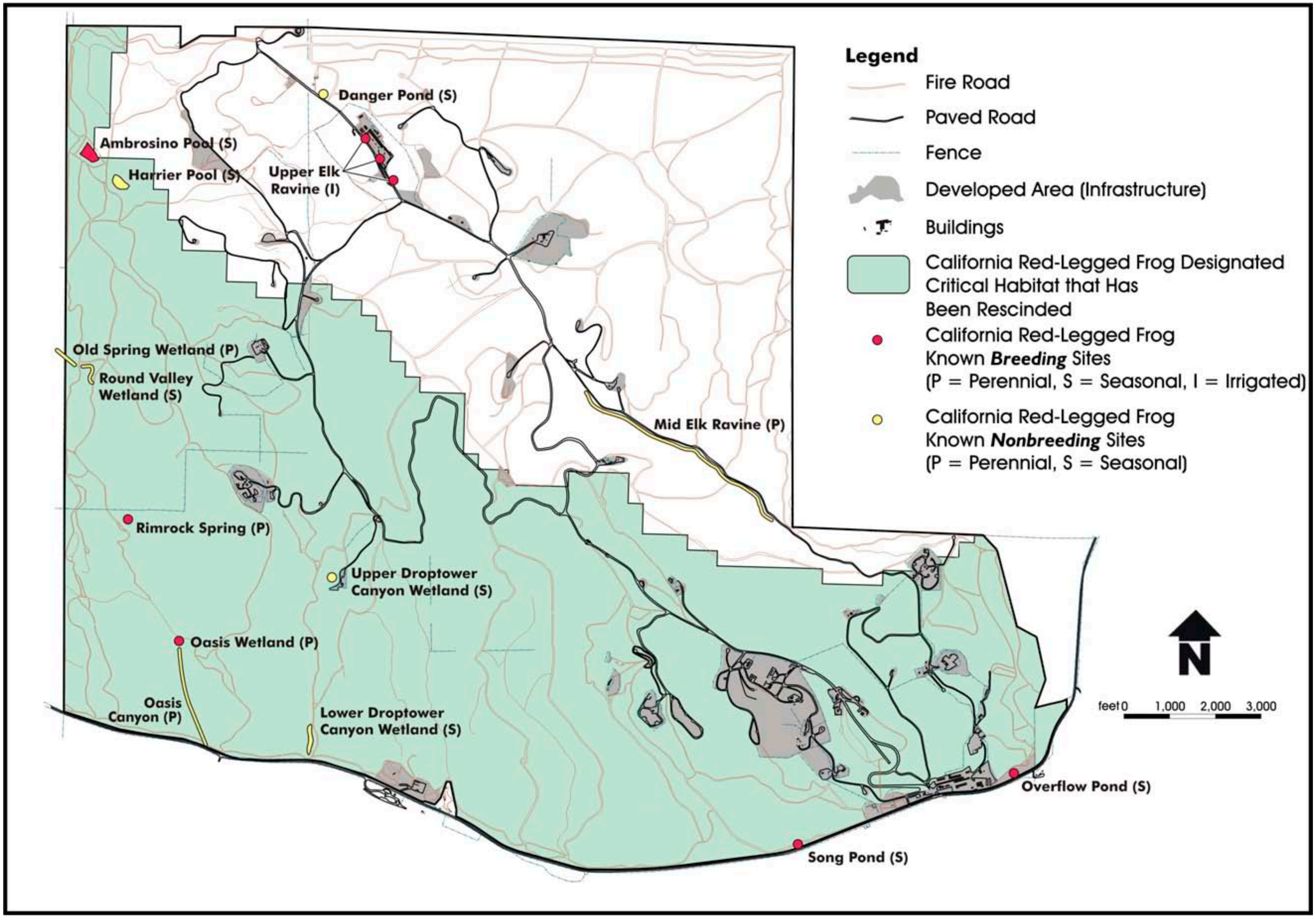


FIGURE 4.9.3–1.—*Location of California Red-Legged Frog Designated Critical Habitat at and near the Livermore Site that Has Been Rescinded*



Source: Jones and Stokes 2001, LLNL 2002dj.

FIGURE 4.9.3–2.—*Location of Large-Flowered Fiddleneck and Critical Habitat at Site 300*



Source: Jones and Stokes 2001.

FIGURE 4.9.3–3.—*Breeding and Nonbreeding Locations for the California Red-Legged Frog at Site 300*

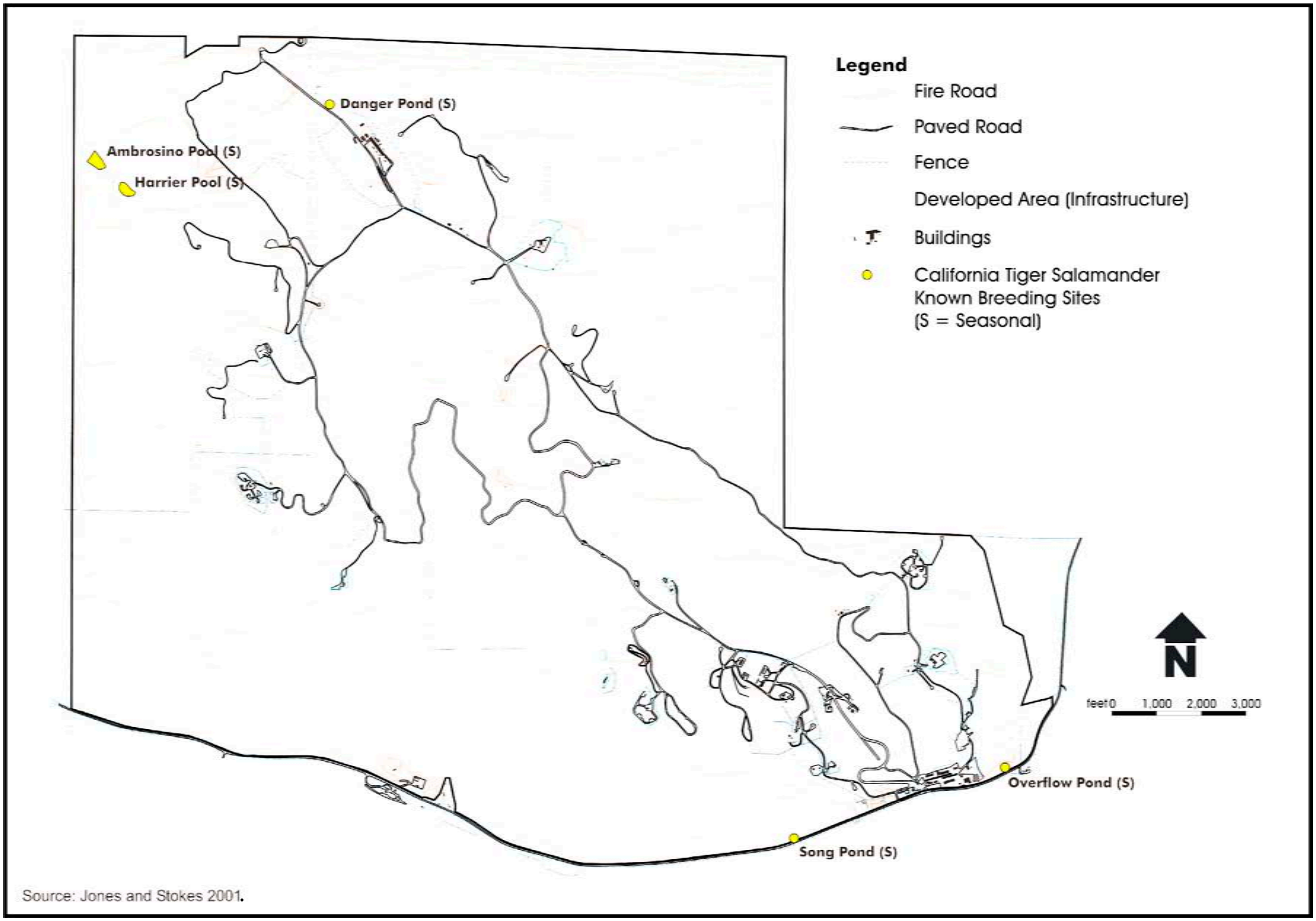


FIGURE 4.9.3–4.—*Breeding Locations for the California Tiger Salamander at Site 300*

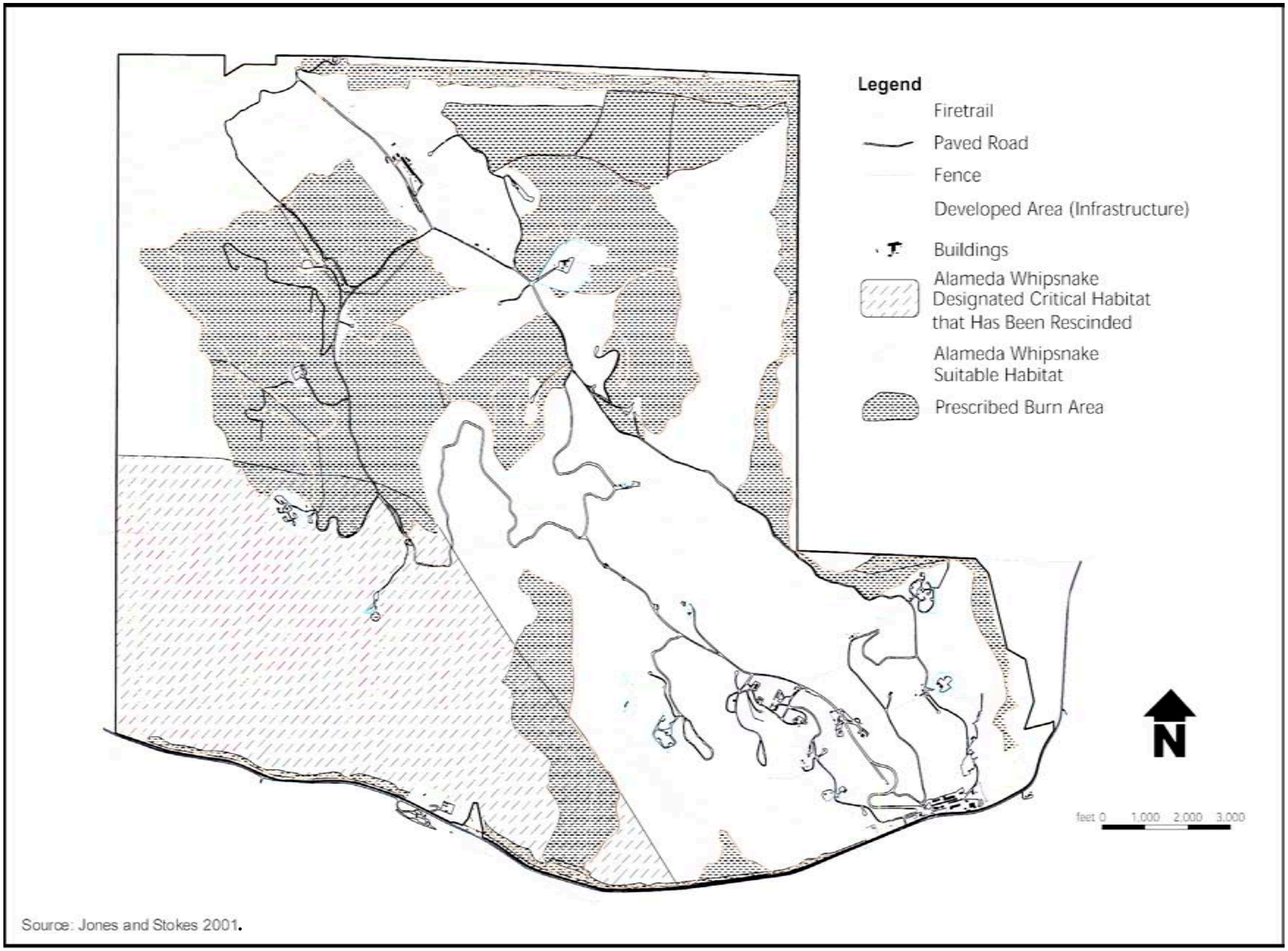
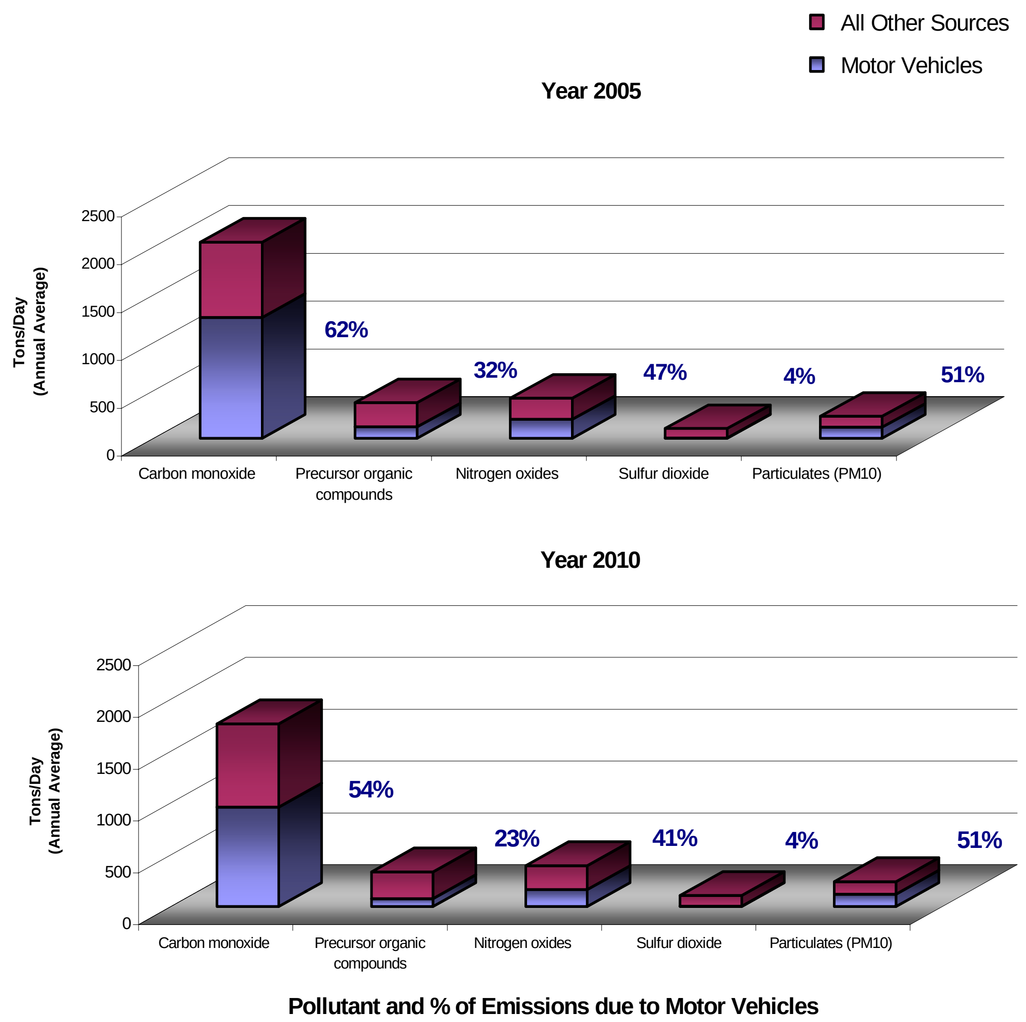
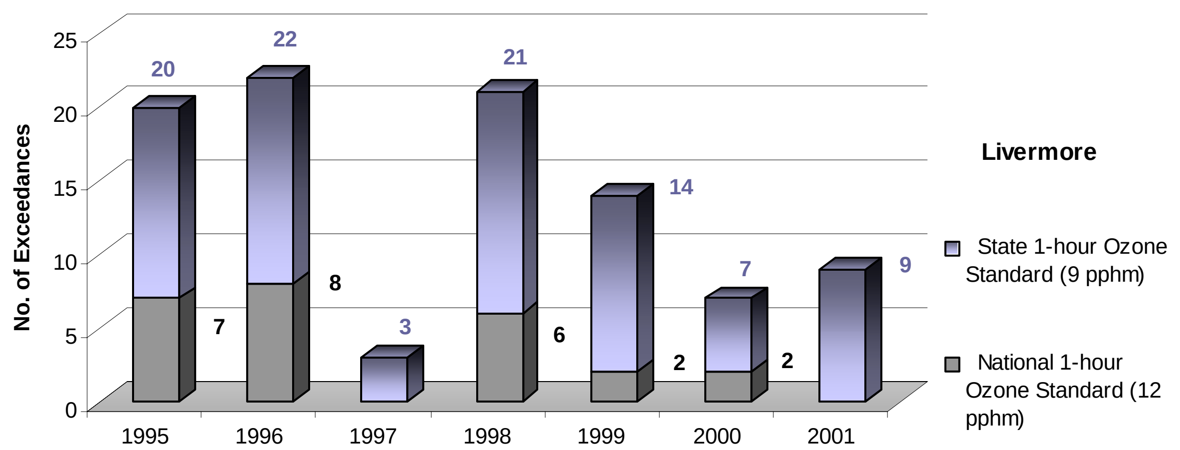


FIGURE 4.9.3–5.—*Formerly Designated Critical Habitat and Potential Habitat for Alameda Whipsnake at Site 300*



Source: BAAQMD 1999.
Note: Projections are based on the district base year 1996 emissions inventory. The category of precursor organic compounds excludes emissions from natural vegetation. Particulate matter emission rate includes entrained road dust.

FIGURE 4.10.2–1.—*Projected Criteria Pollutant Emission Rates for the Bay Area Air Basin Showing Portion Due to Motor Vehicles*



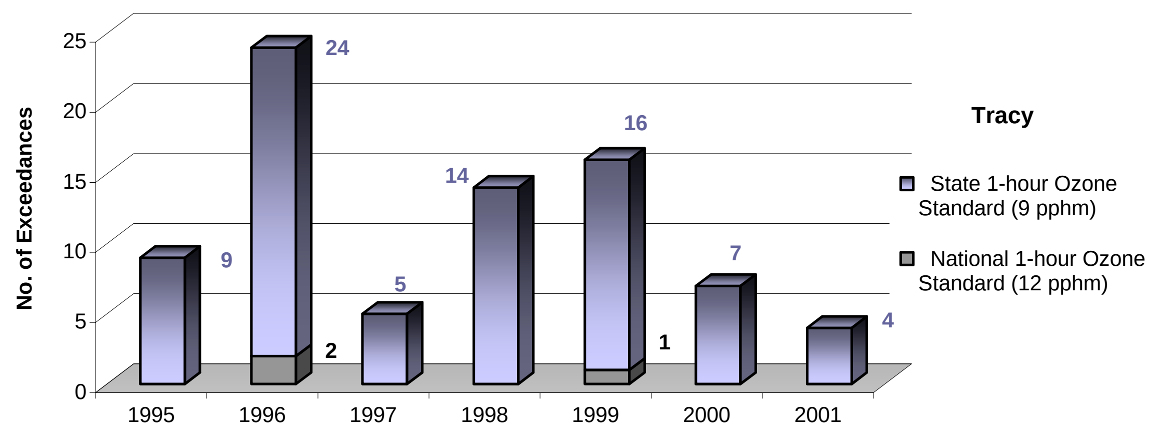
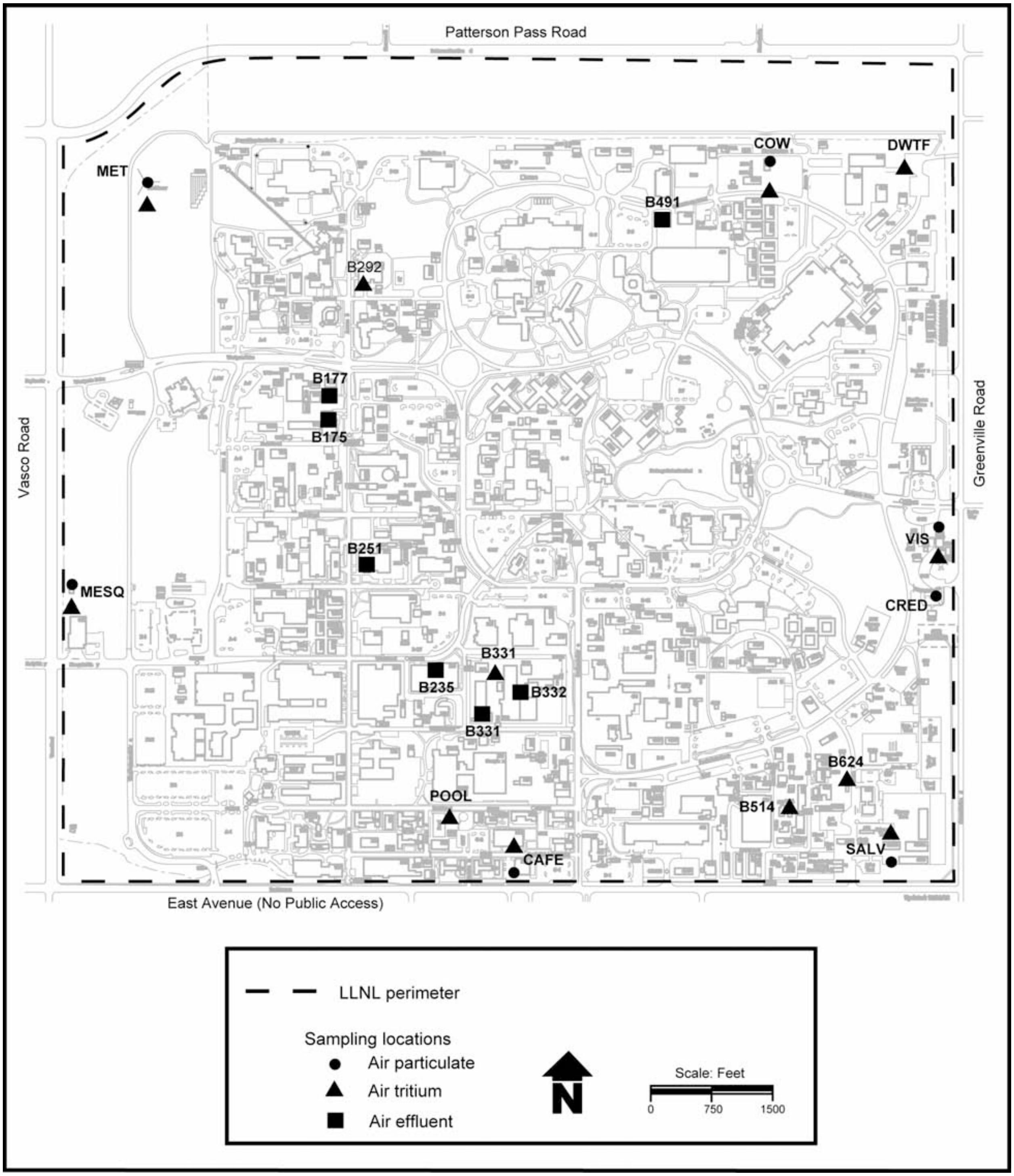


FIGURE 4.10.2–2.—*Tabulation of Exceedances of Ambient Air Quality Standards*



Source: LLNL 2001v.

FIGURE 4.10.5–2.—*Livermore Site Radiation Effluent Air Sampling Locations*

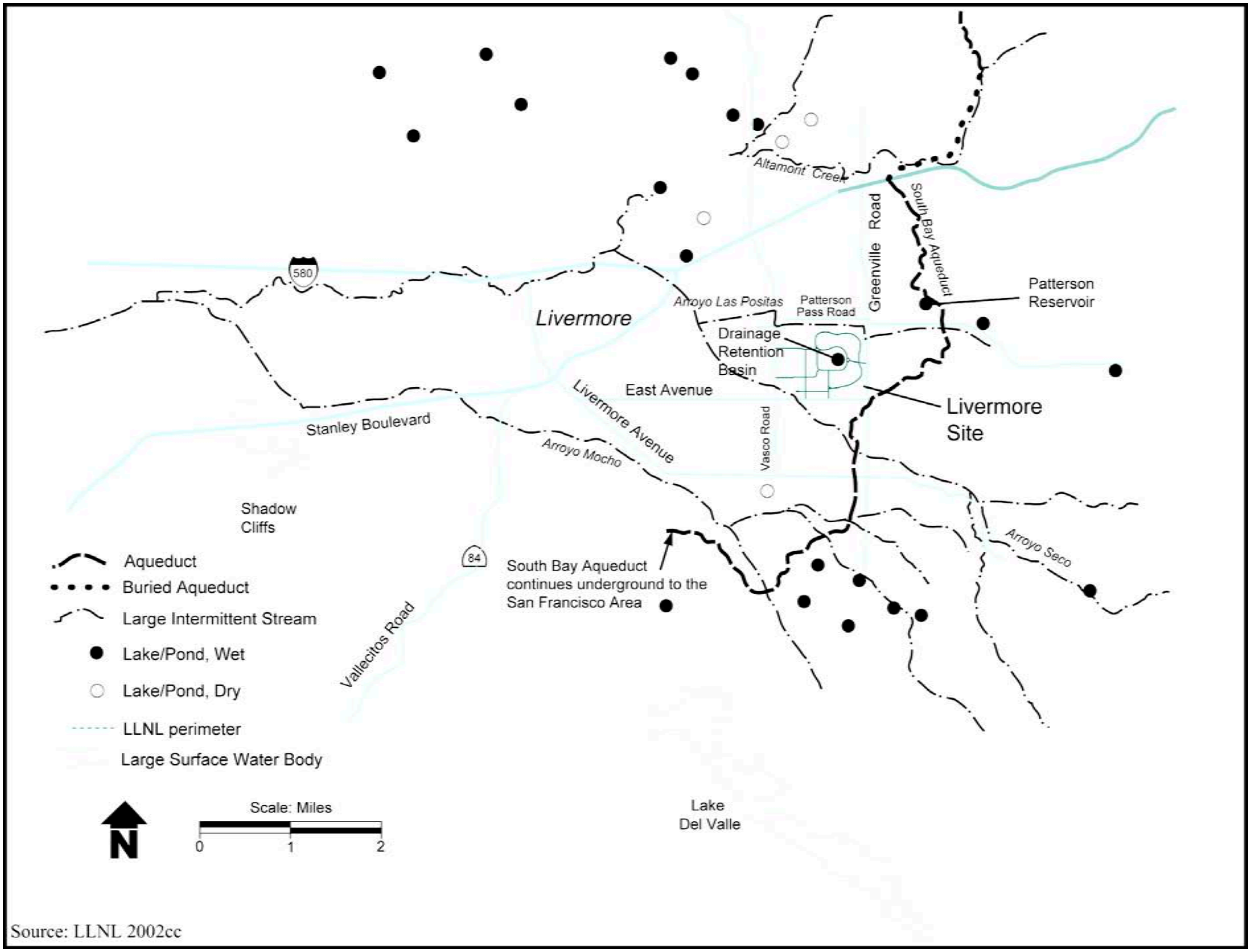


FIGURE 4.11.1–1.—*Livermore Valley Surface Water Features*

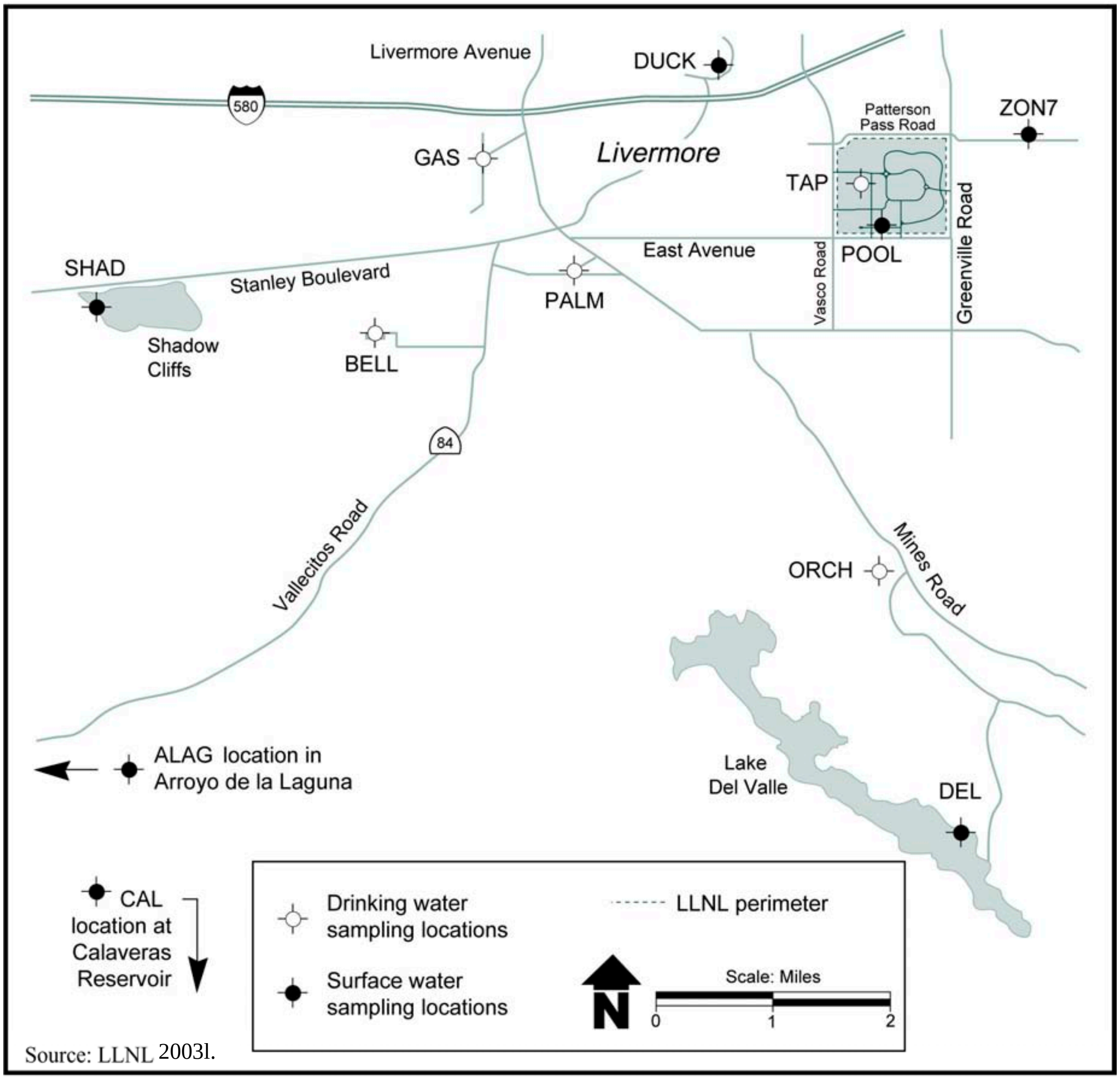
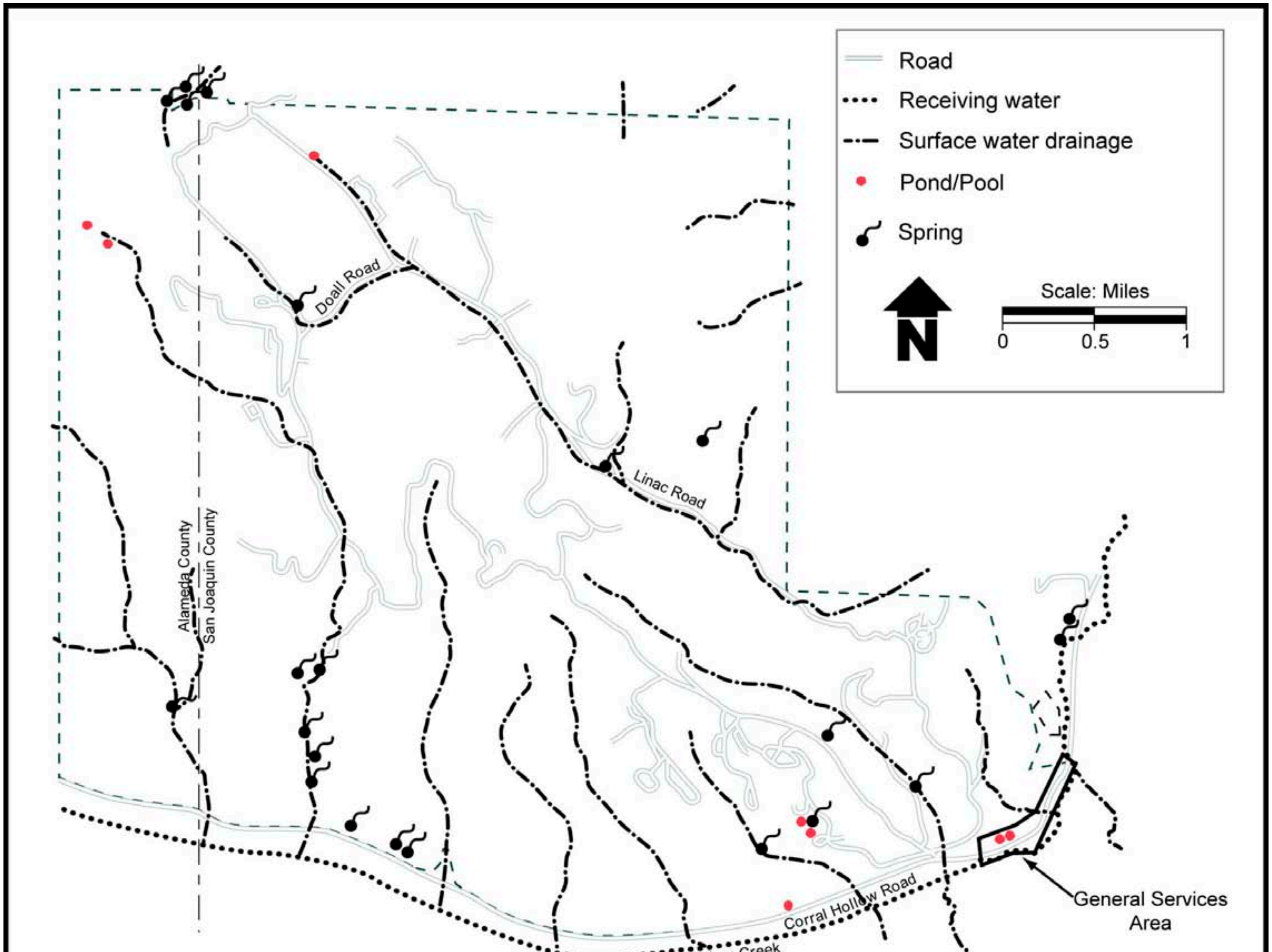


FIGURE 4.11.1–2.—*Livermore Site and Surrounding Area Surface and Drinking Water Sampling Locations*



Source: LLNL 2002cc, LLNL 2003bb.

FIGURE 4.11.1–3.—*Site 300 Surface Water Features*

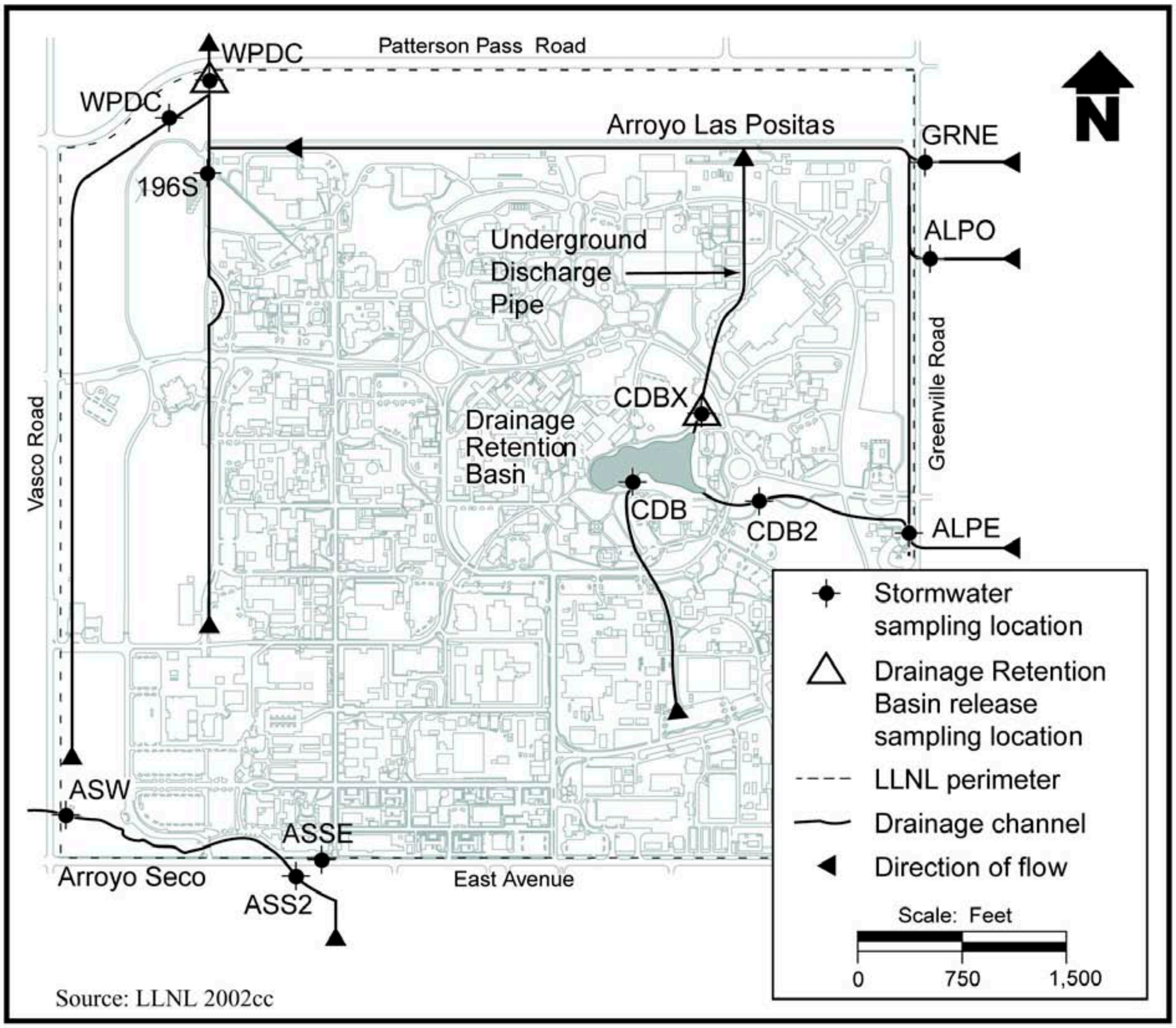


FIGURE 4.11.2–1.—*Livermore Site Stormwater Runoff and Drainage Retention Basin Sampling Locations*

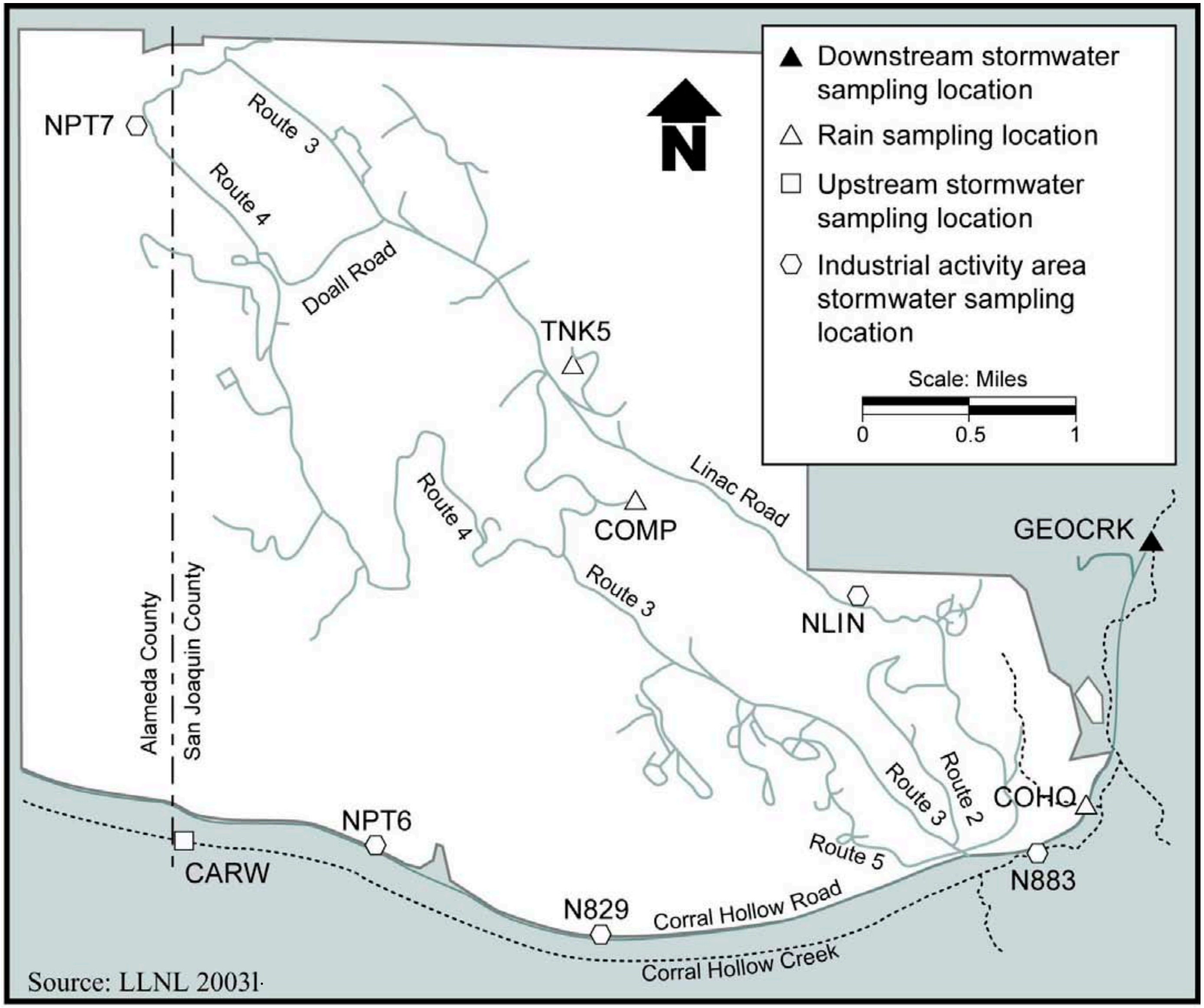


FIGURE 4.11.2–2.—*Site 300 Stormwater and Rainwater Sampling Locations*

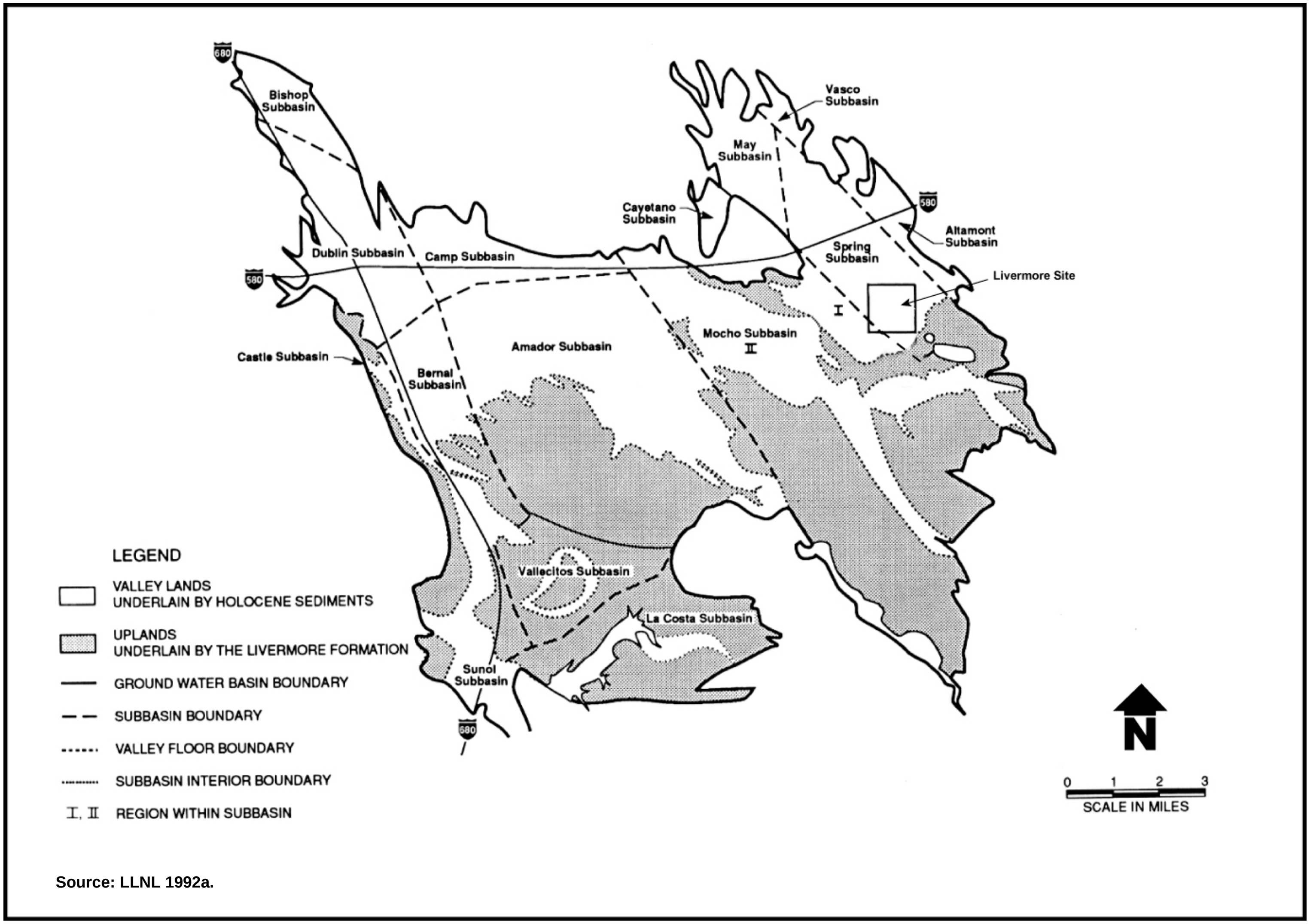
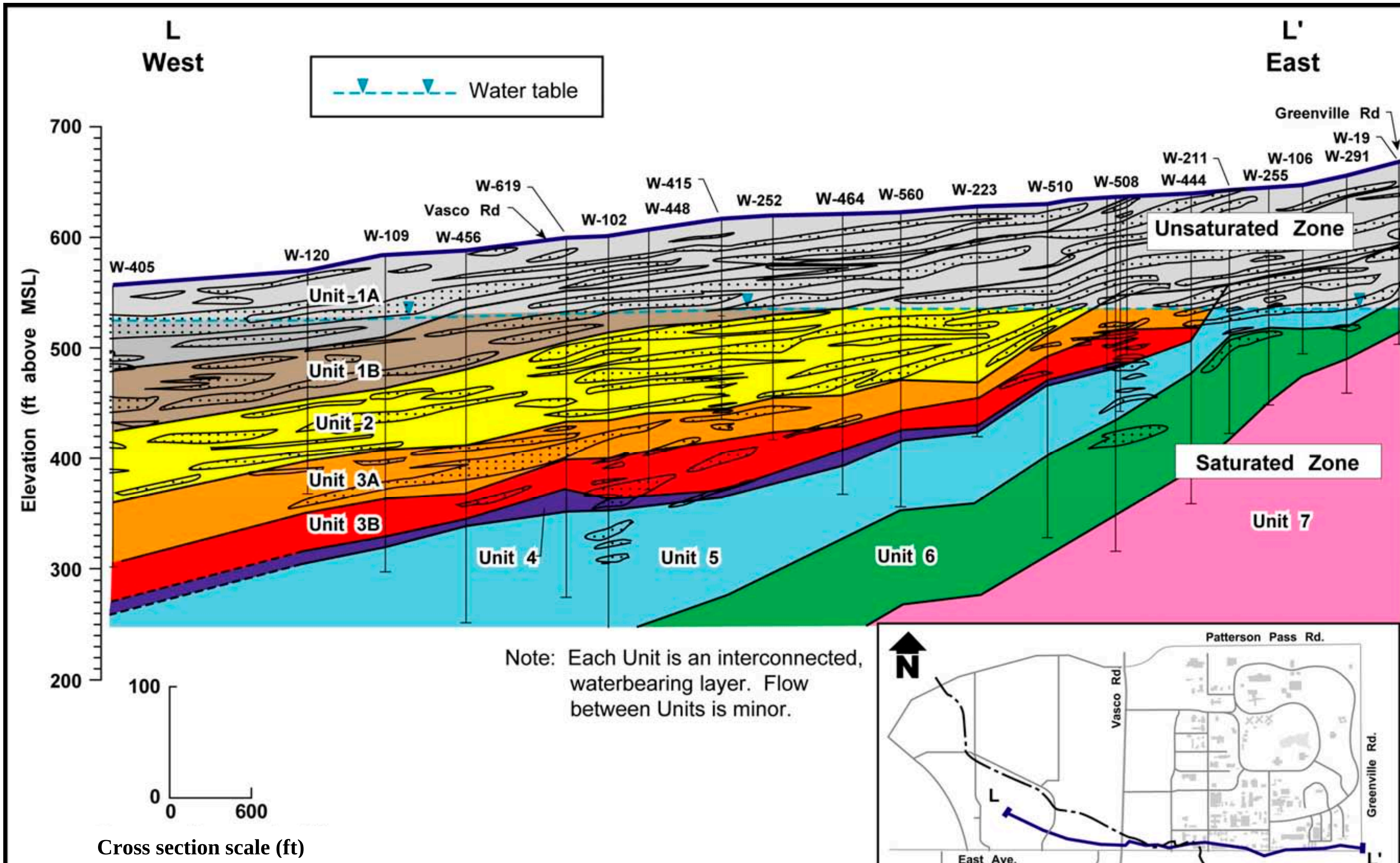


FIGURE 4.11.3.1–1.—*Location of Subbasins and Physiographic Features of the Livermore Valley*



Source: LLNL 2002cc.

FIGURE 4.11.3.2–1.—*Hydrogeologic Cross Section of the Livermore Site*

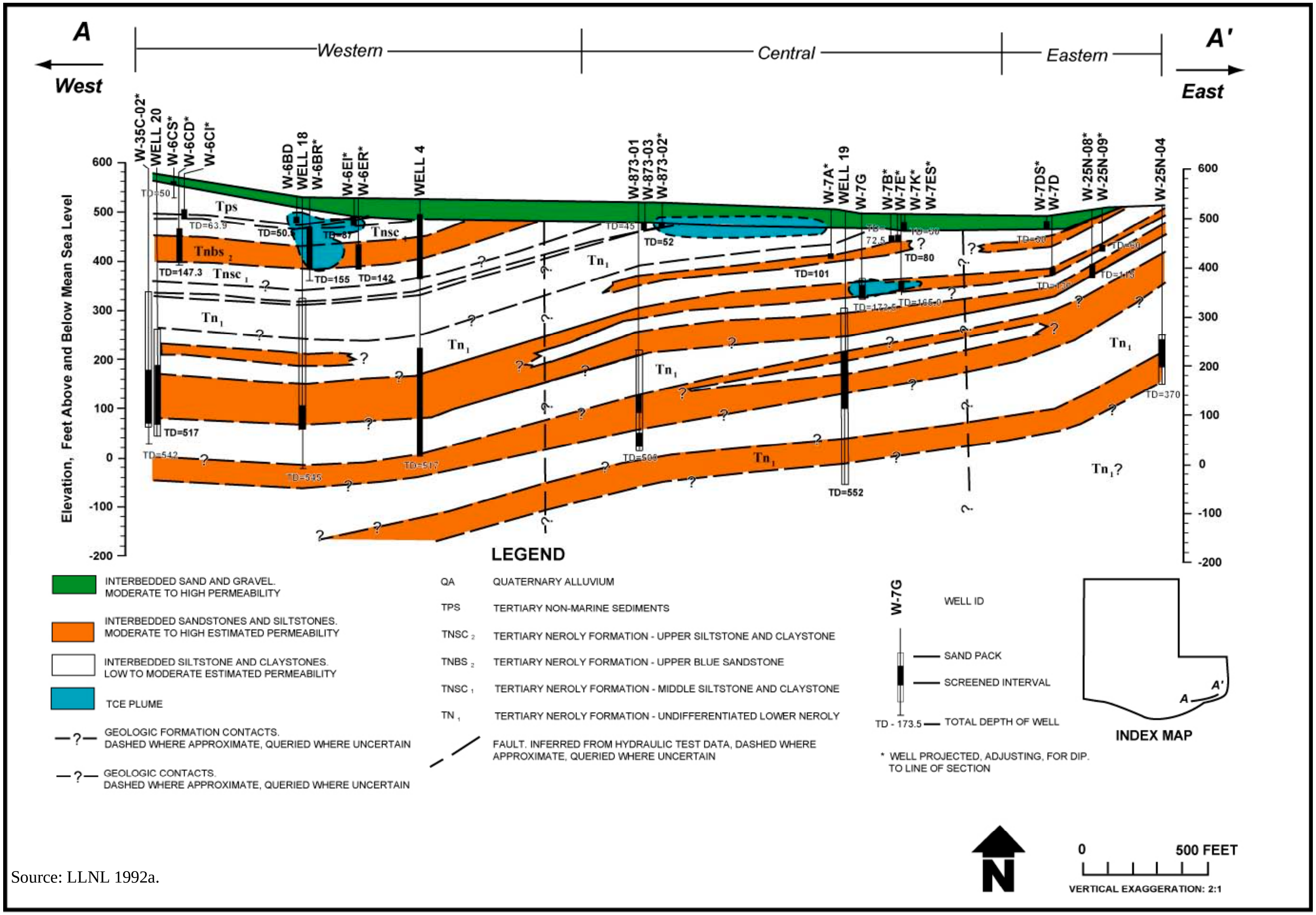
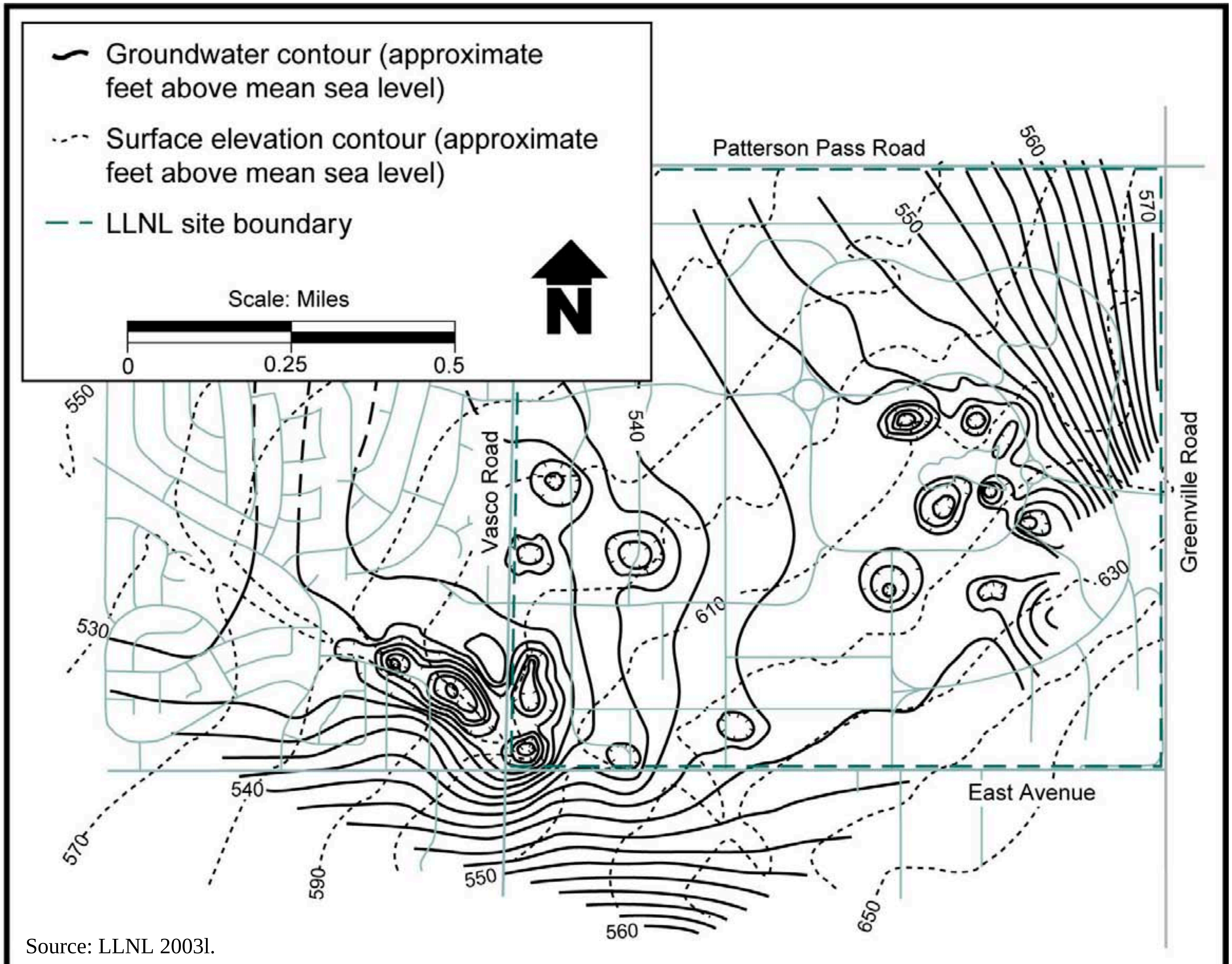


FIGURE 4.11.3.2–2.—*Geologic Cross Section of Site 300 Under the General Services Area*



Source: LLNL 2003l.

FIGURE 4.11.3.2–3.—*Livermore Site and Vicinity Approximate Groundwater and Surface Elevation Contours*

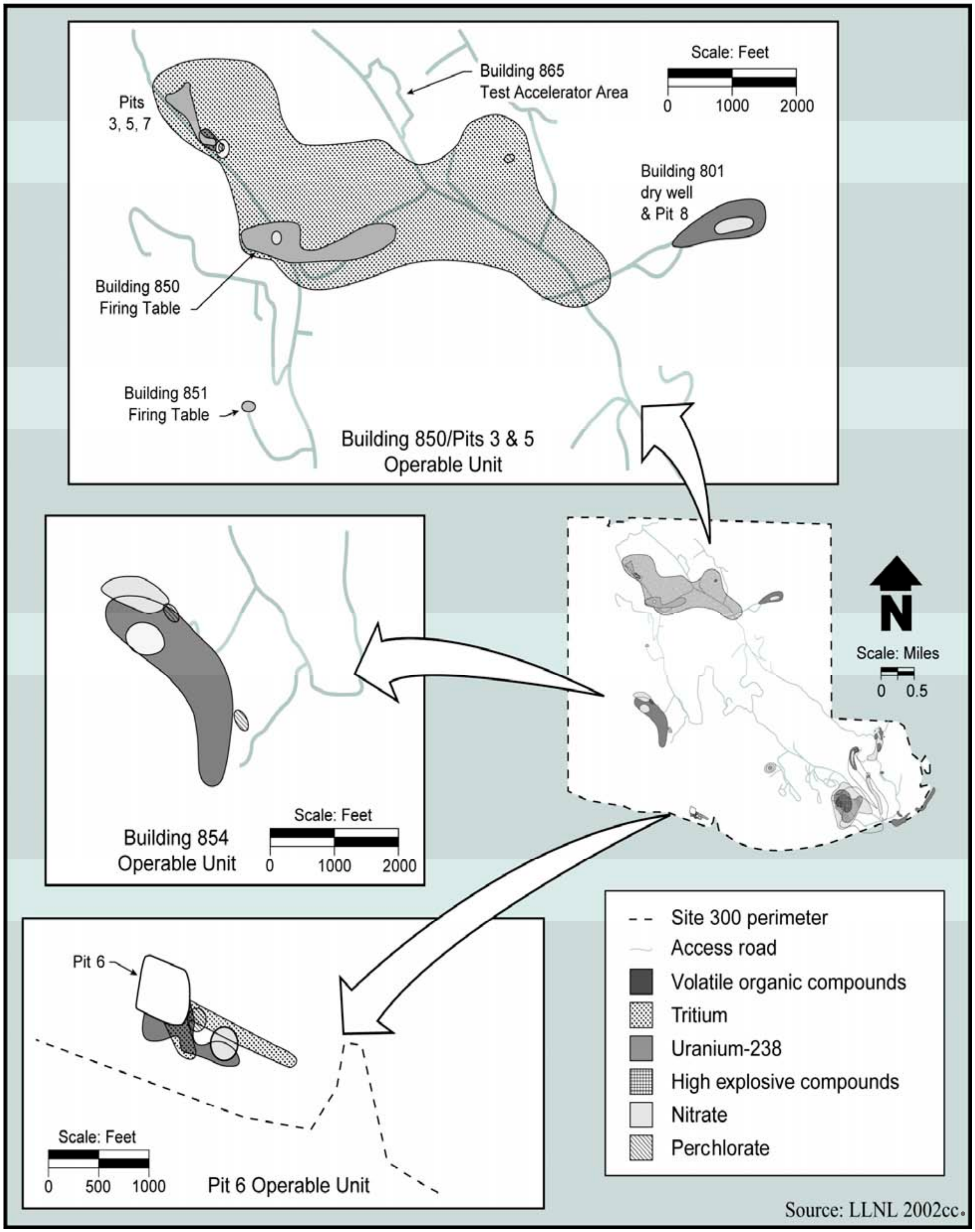


FIGURE 4.11.3.4–2.—*Extent of Groundwater Contamination at Site 300*

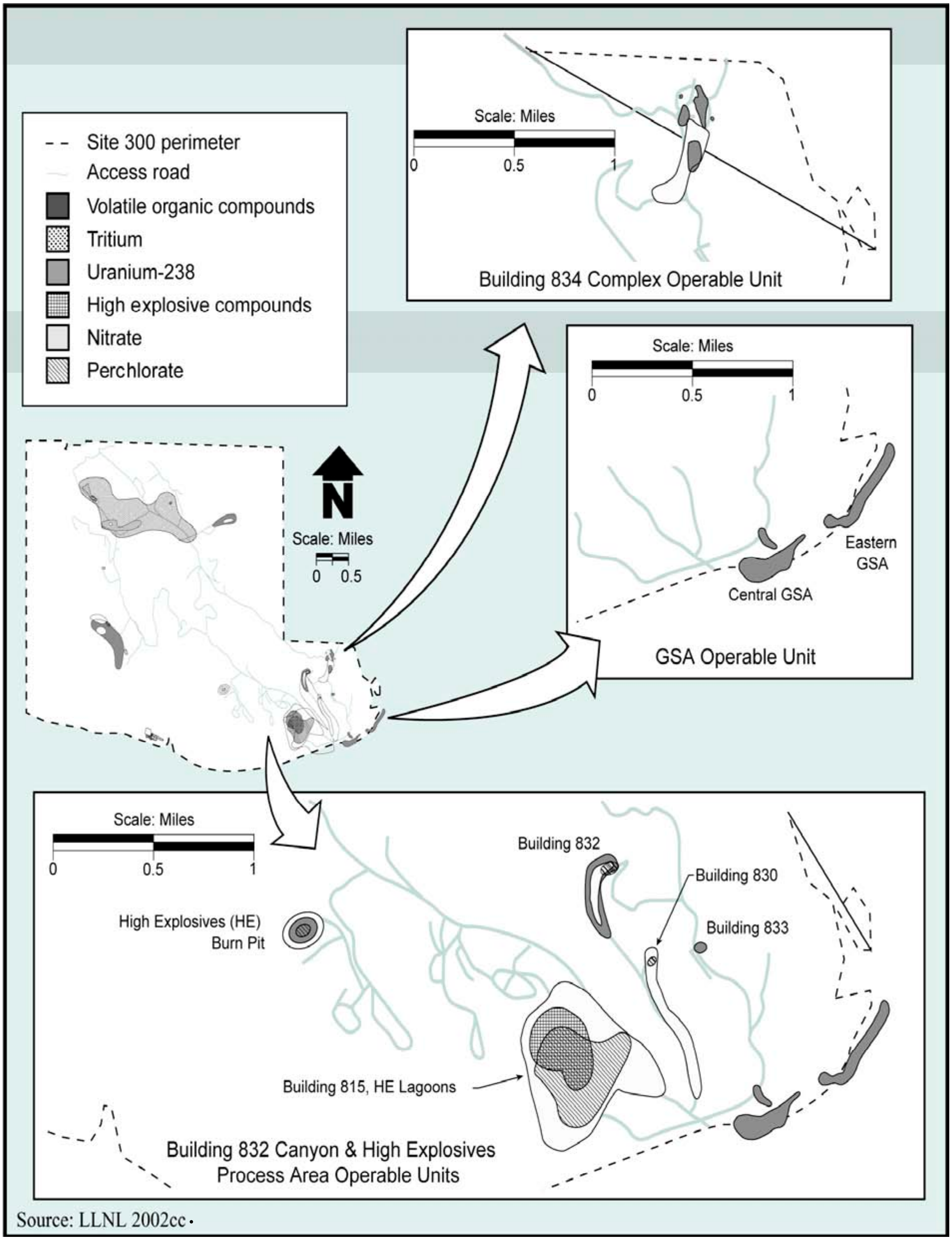


FIGURE 4.11.3.4–2.—*Extent of Groundwater Contamination at Site 300 (continued)*

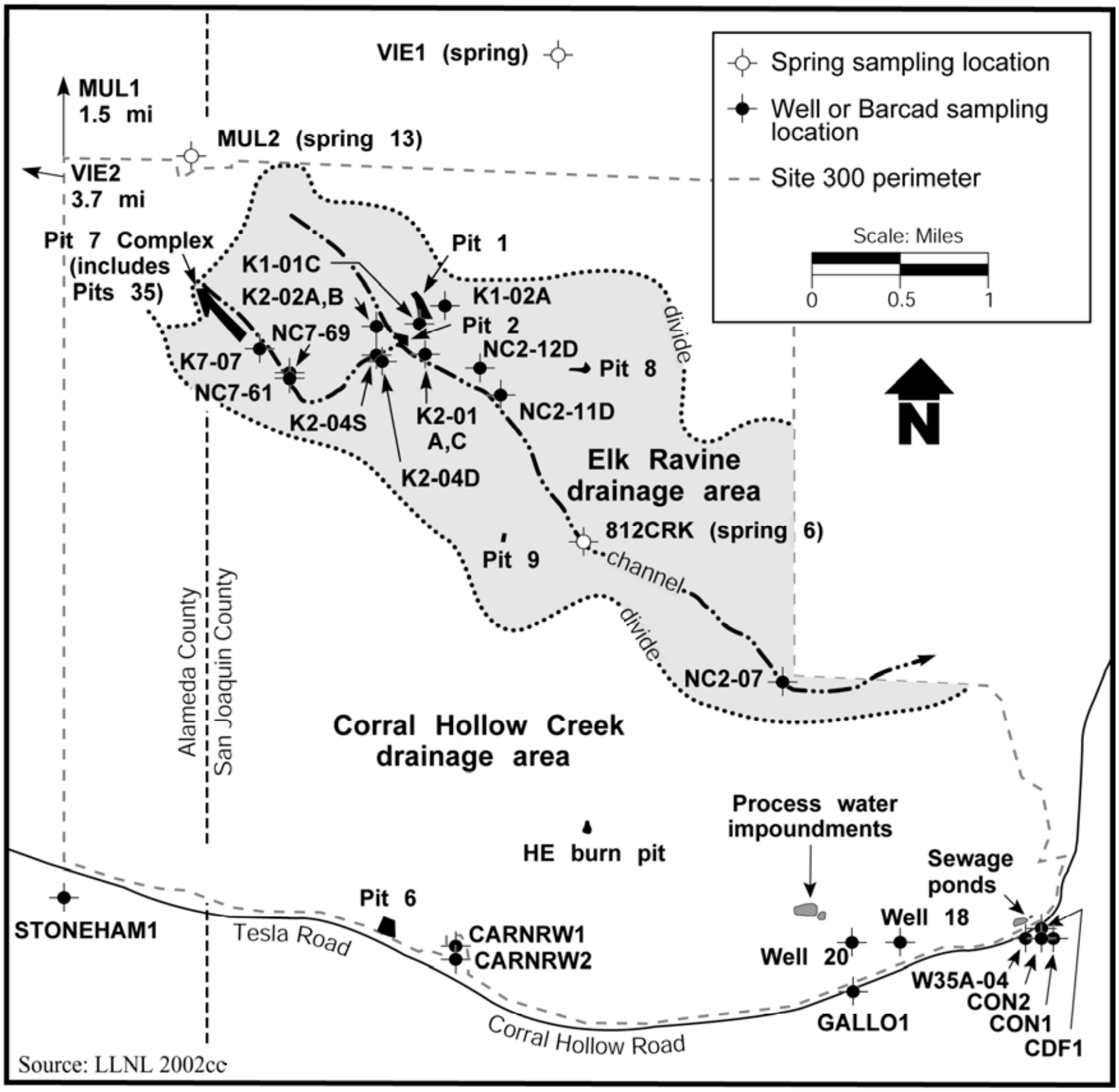
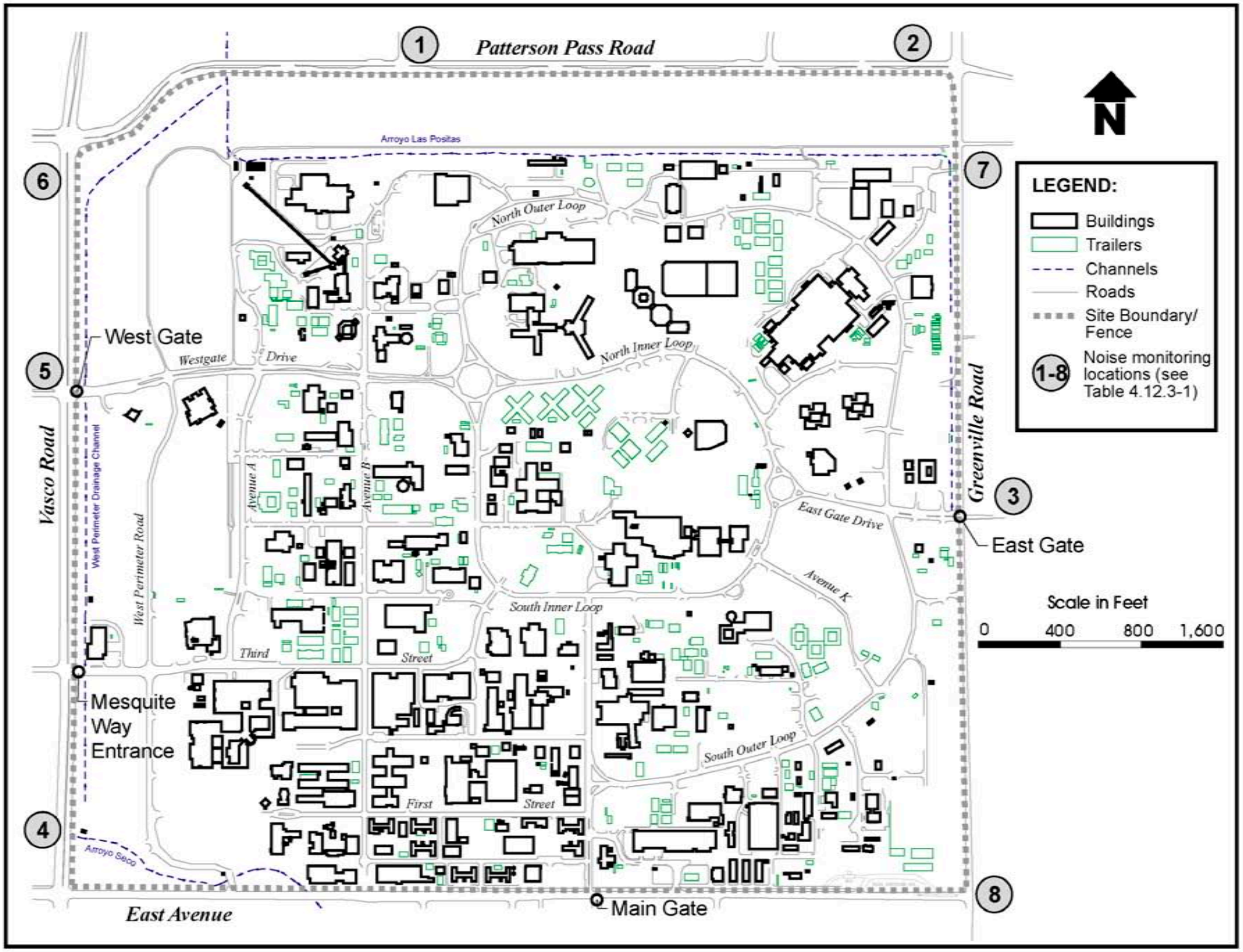
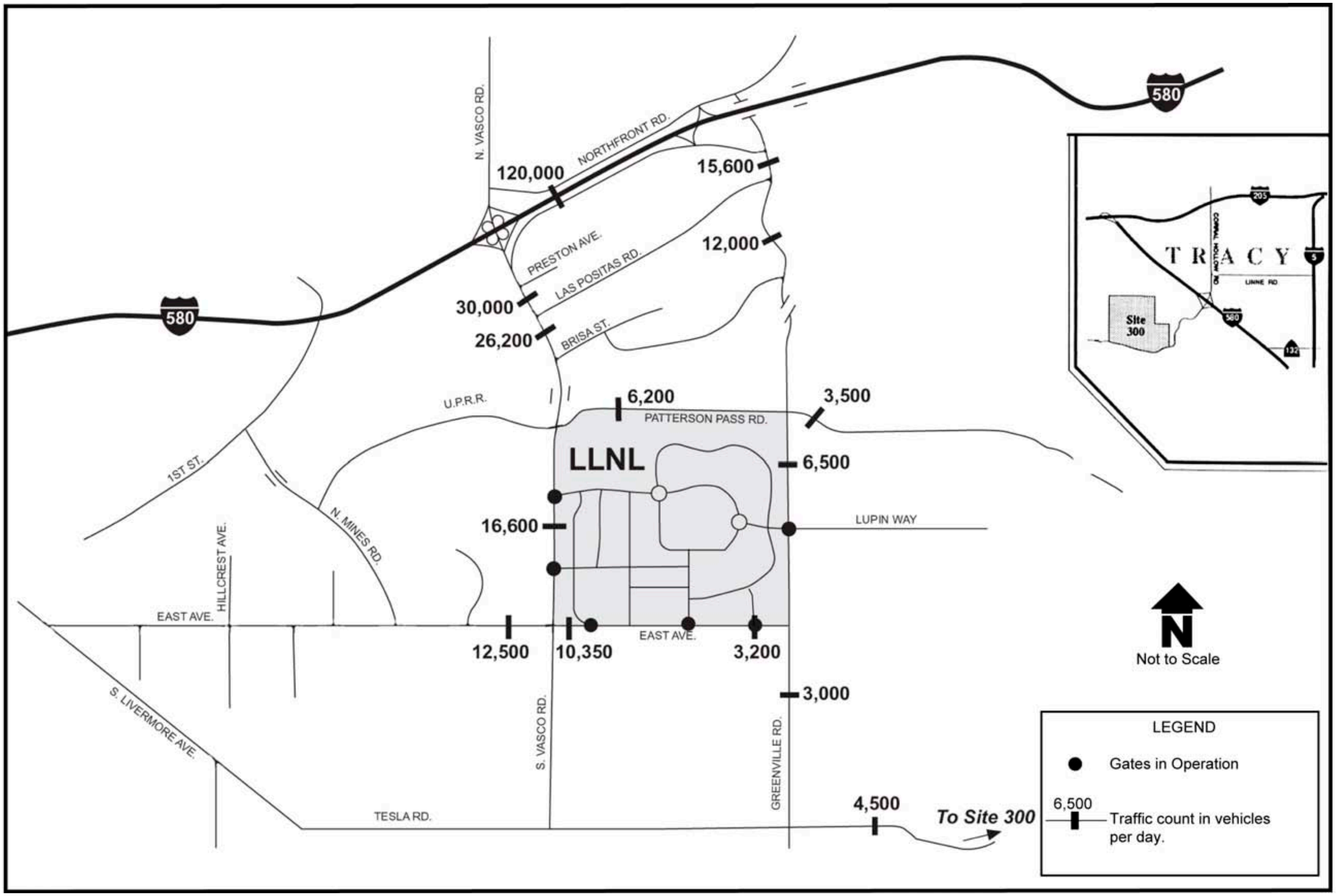


FIGURE 4.11.3.4–3.—*Site 300 Monitoring and Supply Well Locations*



Source: Original.

FIGURE 4.12.3–1.—*Noise Monitoring Locations Near the Livermore Site*



Source: Harrison 2003.

FIGURE 4.13.1–1.—*Regional Transportation Network with Traffic Counts*

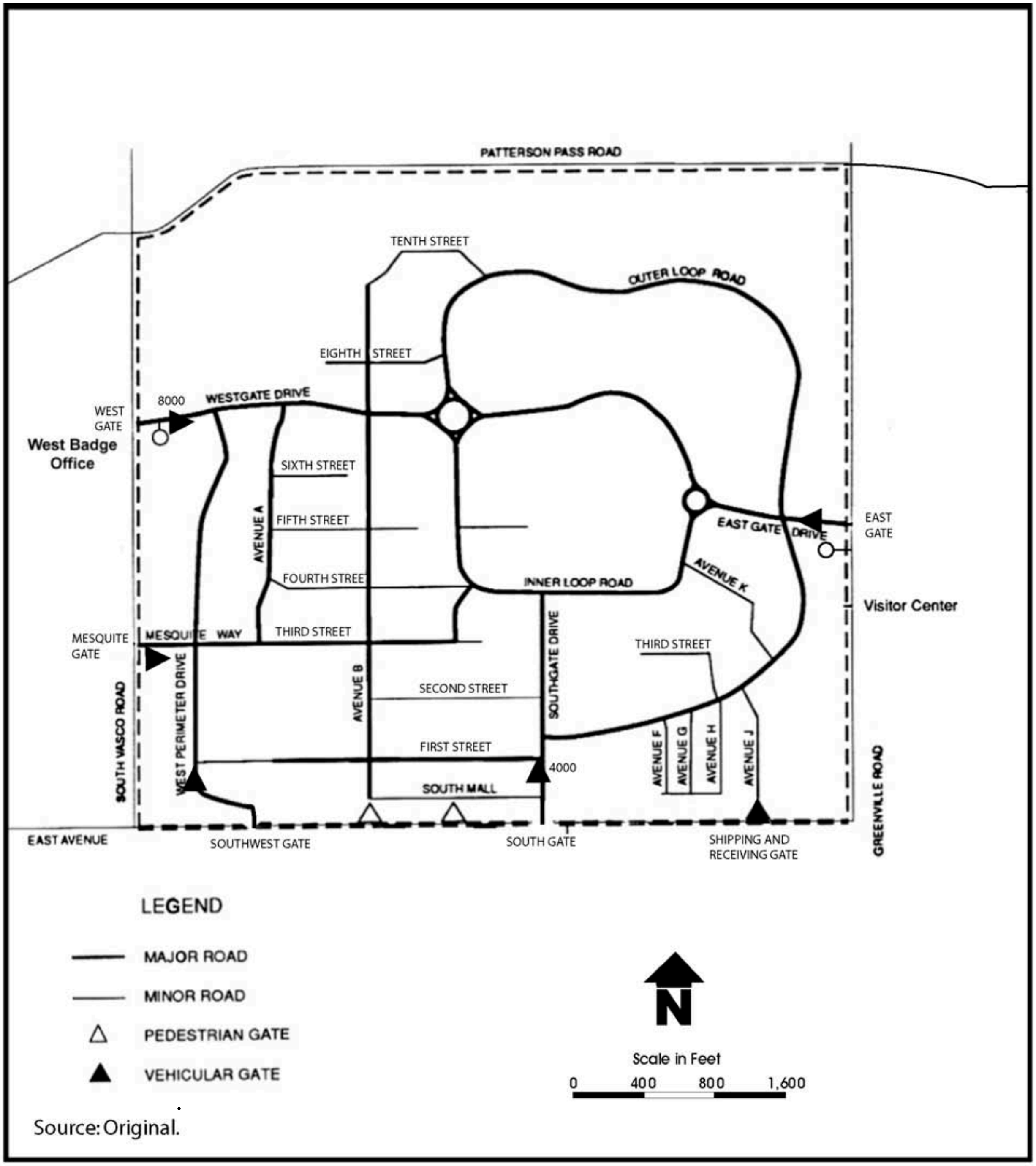
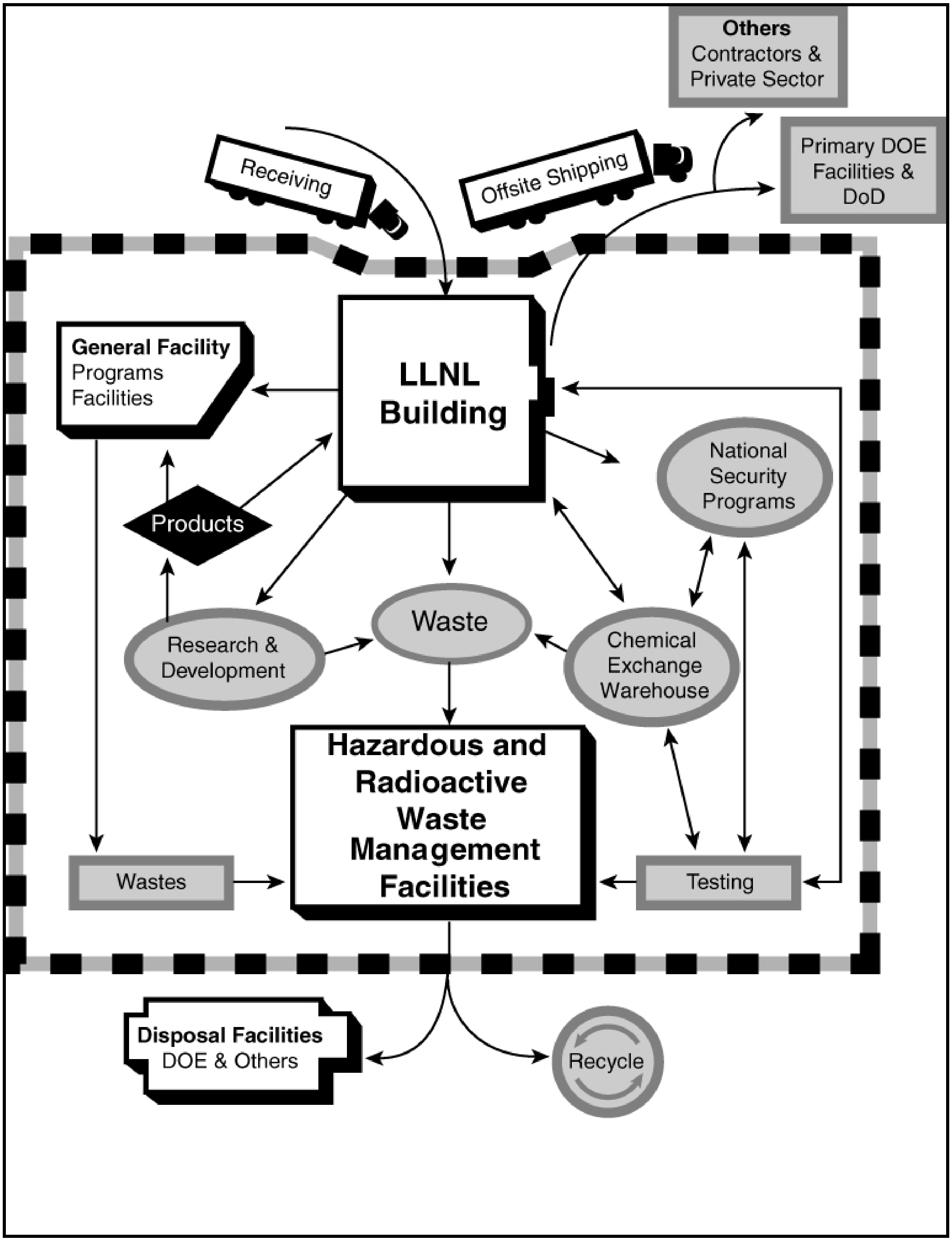
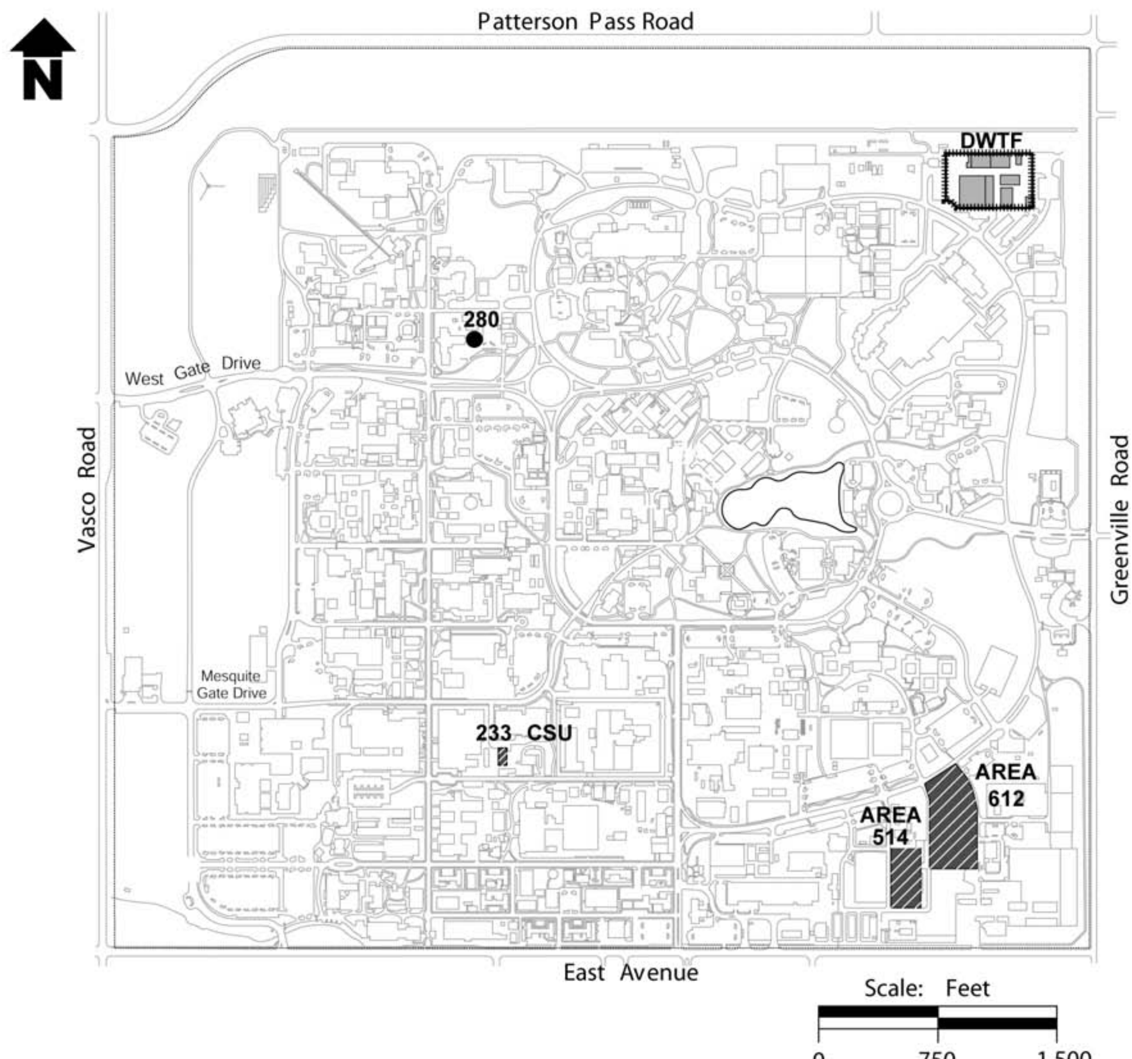


FIGURE 4.13.4–1.—*Livermore Site Transportation Network*



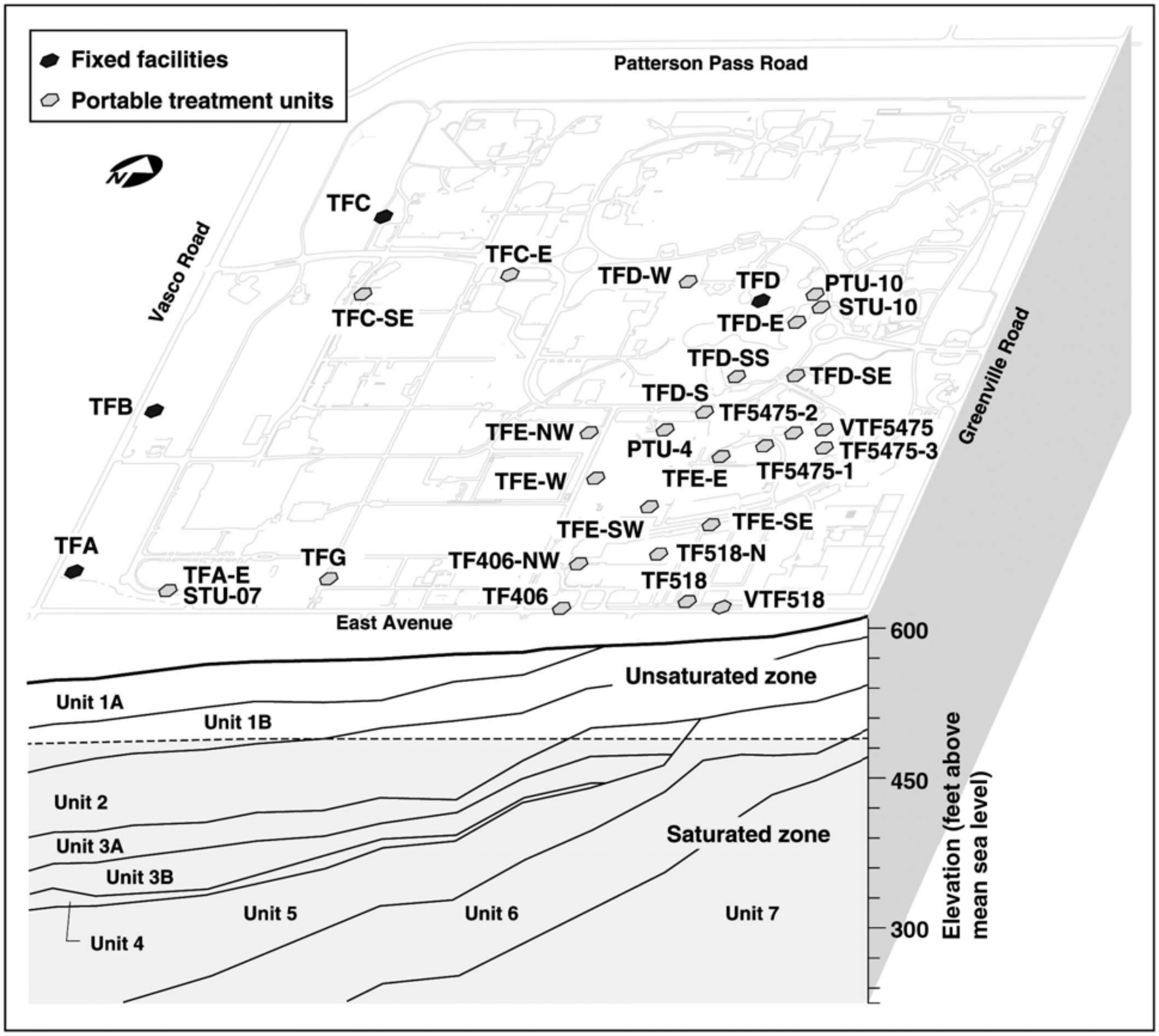
Source: Original.

FIGURE 4.15.1.2–1.—*Conceptual Illustration of Material Movement at Lawrence Livermore National Laboratory*



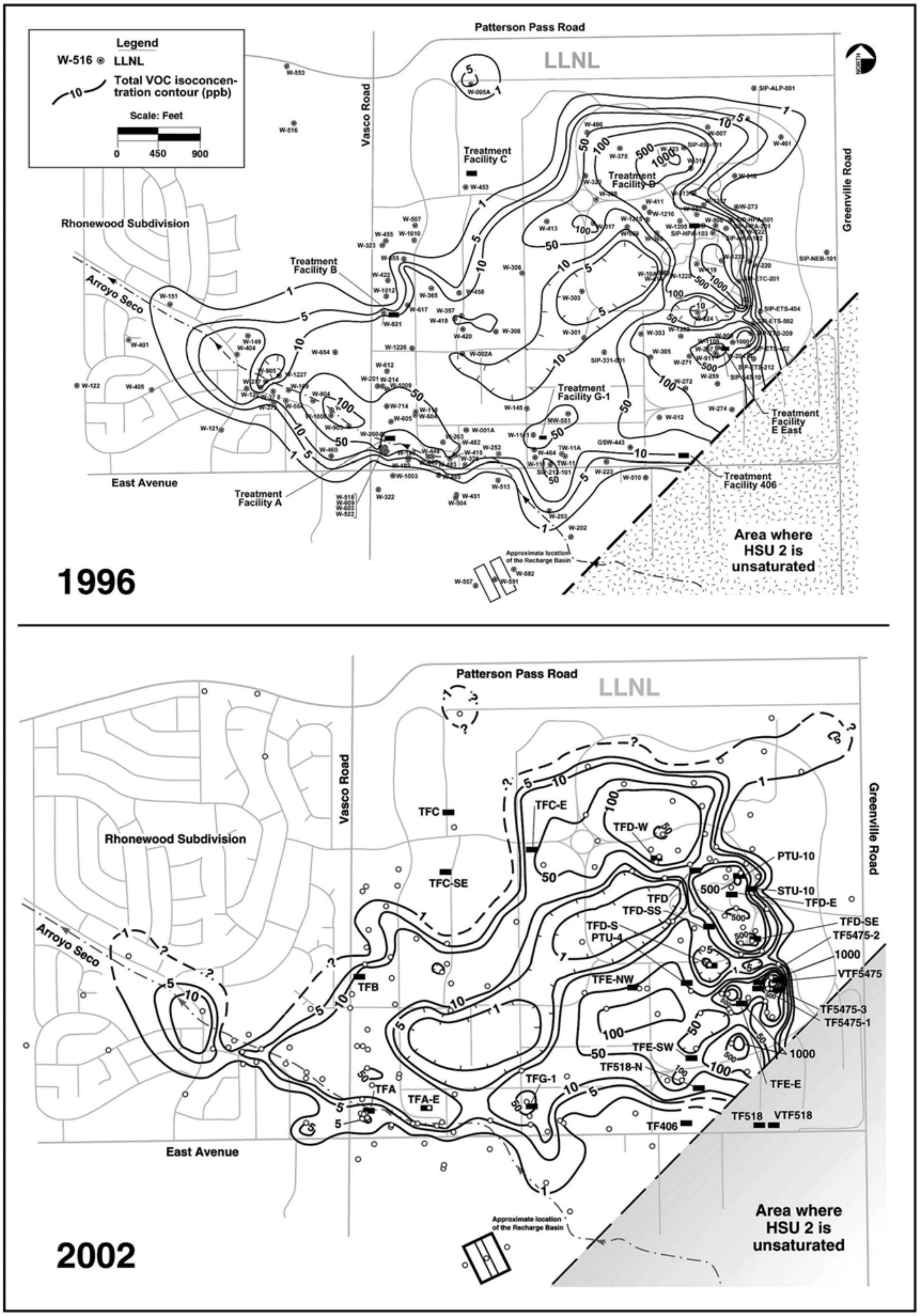
Source: LLNL 2002d.

FIGURE 4.15.2–1.—*Livermore Site Map Showing Locations of the Decontamination and Waste Treatment Facility and Other Permitted Waste Management Facilities*



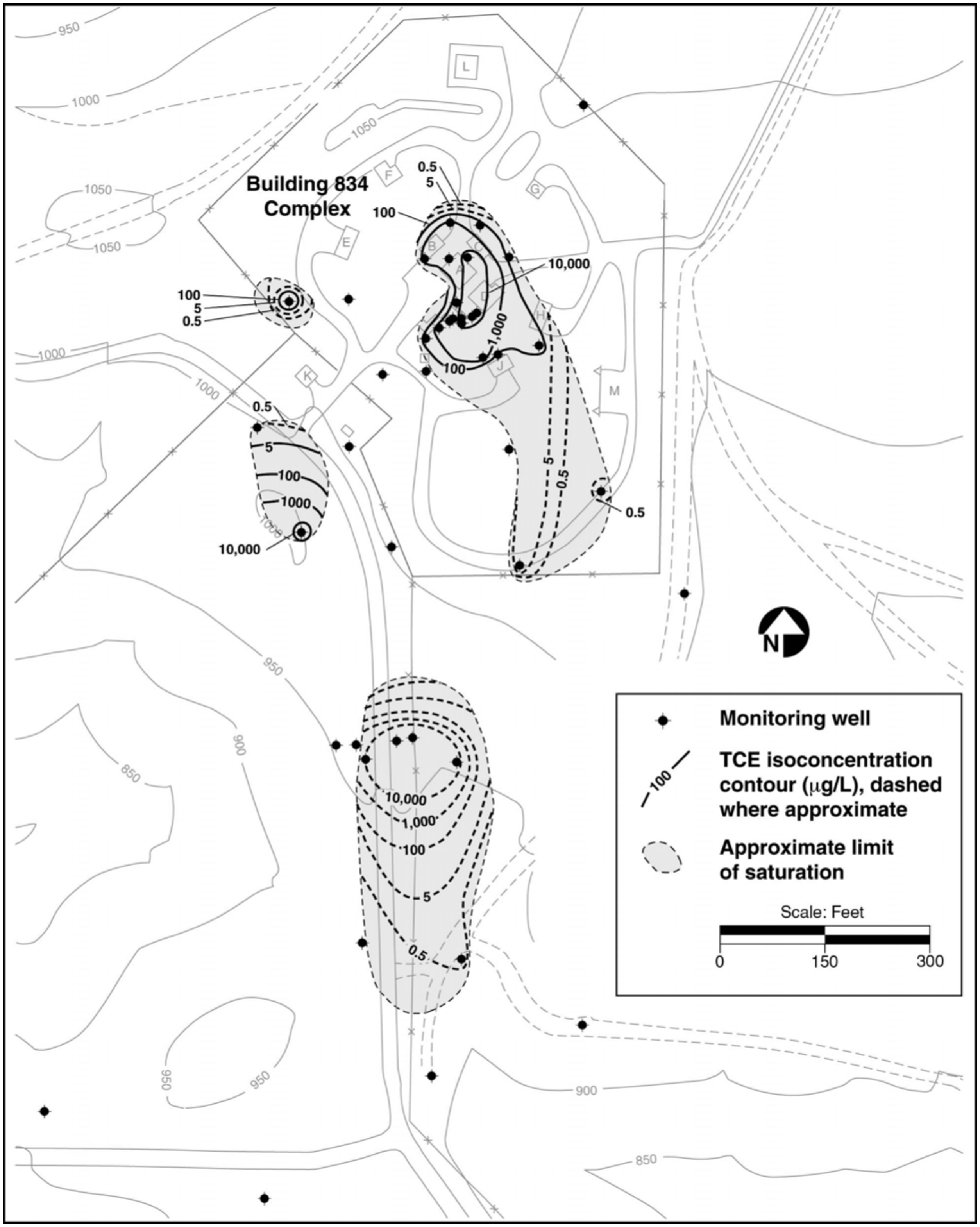
Source: LLNL 2003l.

FIGURE 4.17.1.1–1.—*Map and Cross Section of the Livermore Site Showing Hydrostratigraphic Units and the Locations of Treatment Facilities as of 2002*



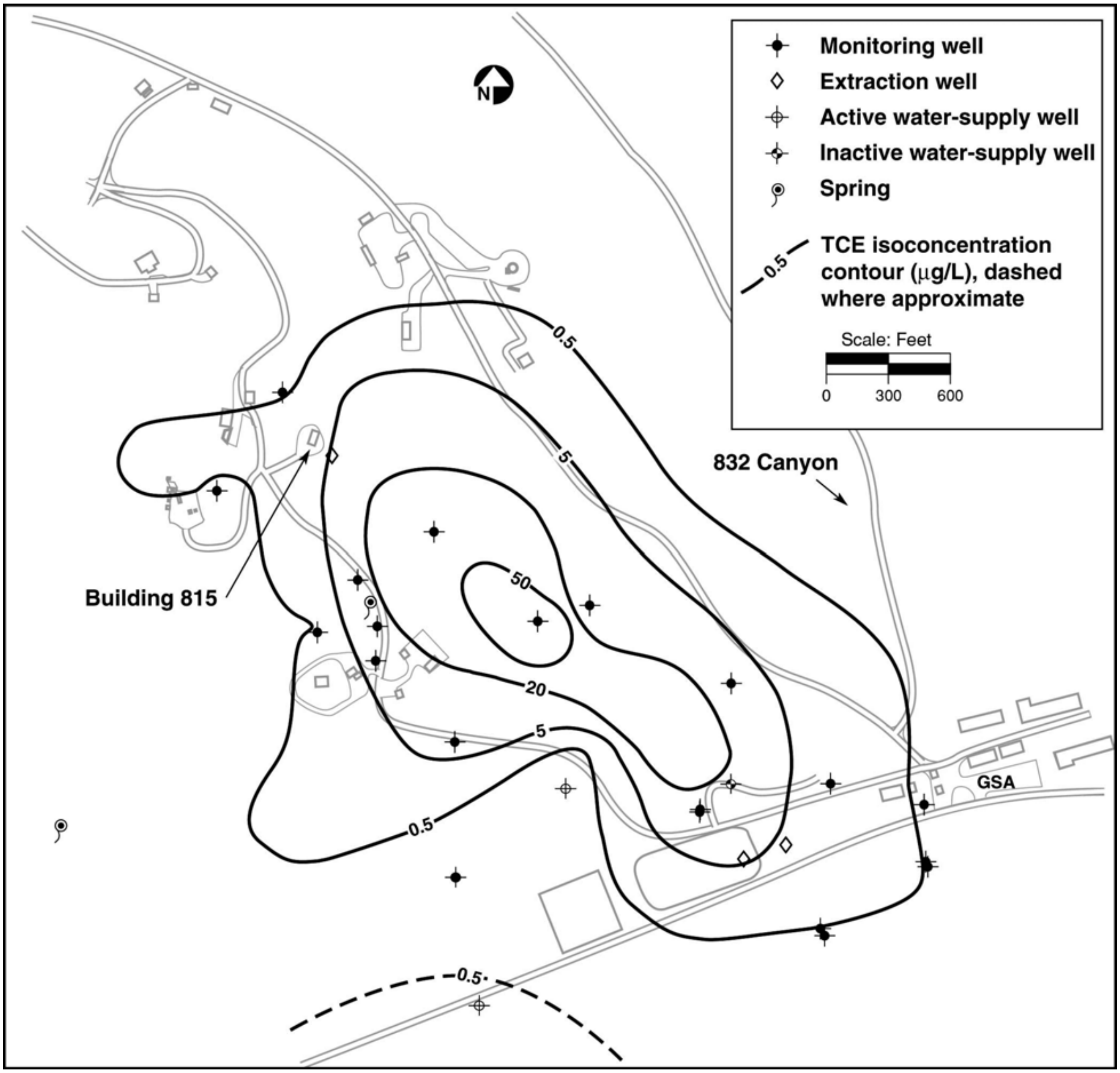
Sources: LLNL 1997e, LLNL 2003l.

FIGURE 4.17.1.3–1.—LLNL *Comparison of Total VOC Concentrations between 1996 and 2002 at the Livermore Site (Hydrostratigraphic Unit 2)*



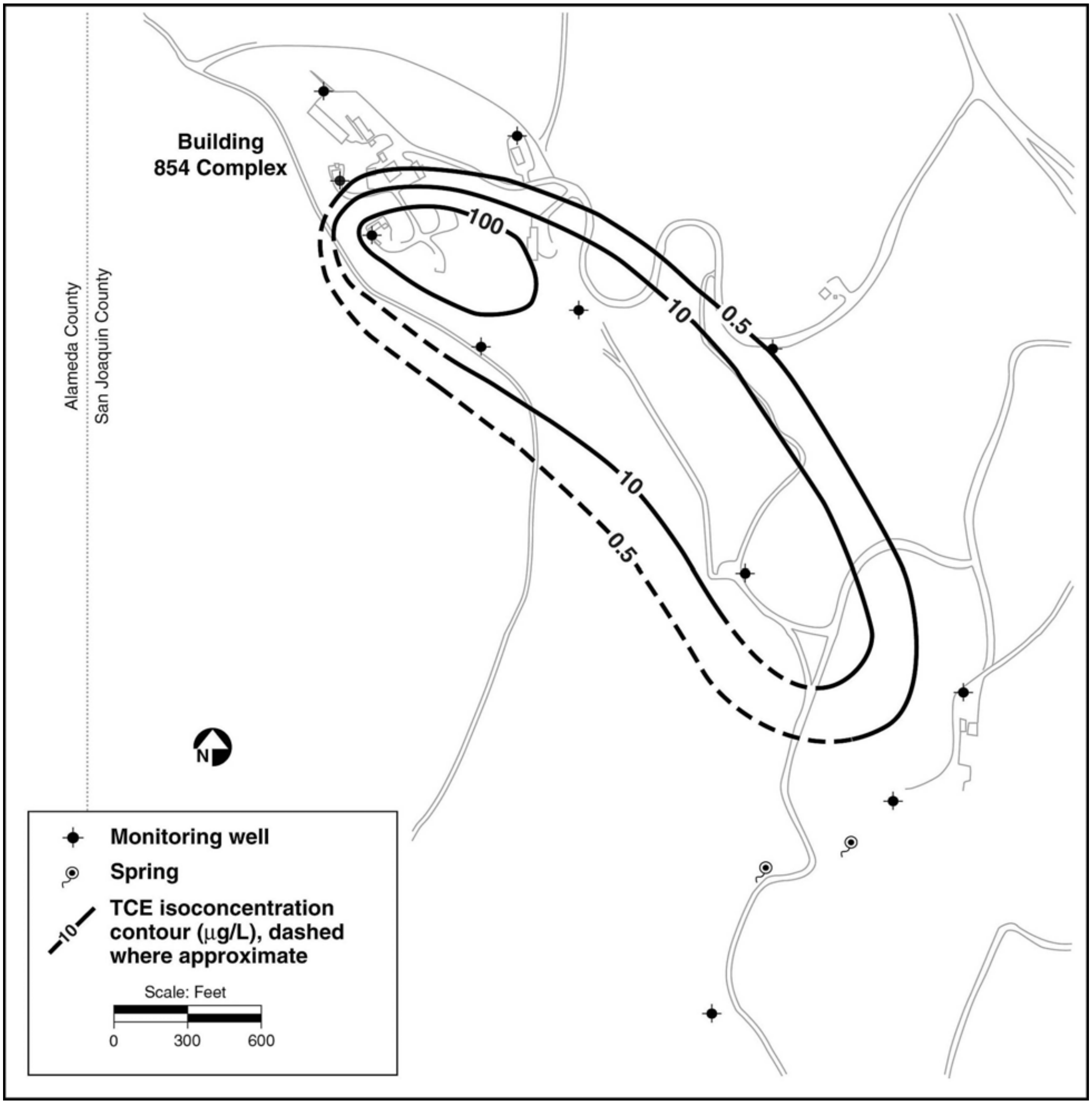
Source: LLNL 2003l.

FIGURE 4.17.2.2–3.—*Distribution of TCE in Groundwater at the Building 834 Complex (Second Quarter, 2002)*



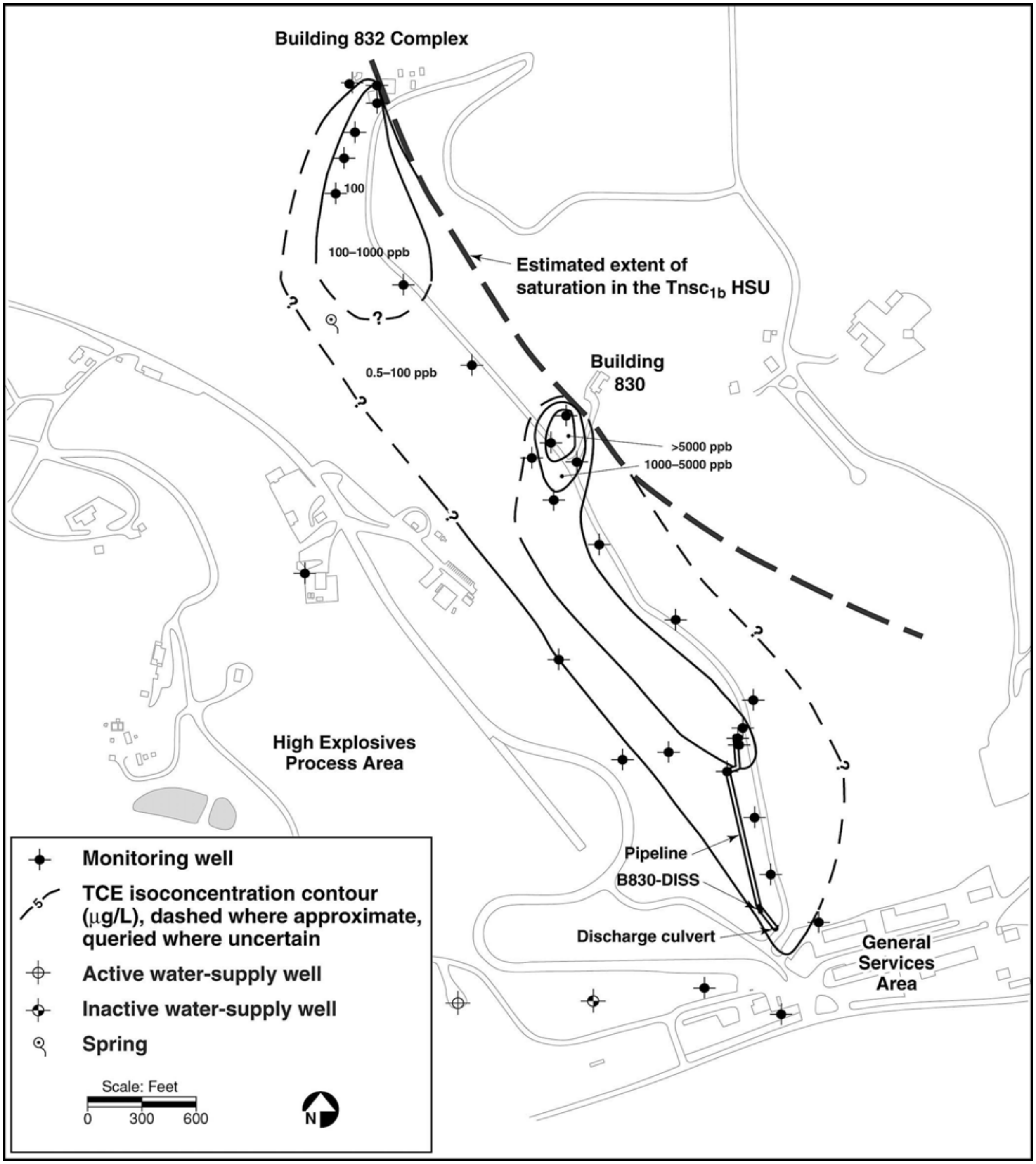
Source: LLNL 2003l.

FIGURE 4.17.2.2–4.—*Distribution of TCE in Groundwater in the High Explosives Process Area (Second Quarter, 2002)*



Source: LLNL 2003l.

FIGURE 4.17.2.2–6.—*Distribution of TCE in Groundwater in the Building 854 Area (Second Quarter, 2002)*



Source: LLNL 2003l.

FIGURE 4.17.2.2–8.—*Distribution of TCE in Groundwater in the Building 832 Canyon*

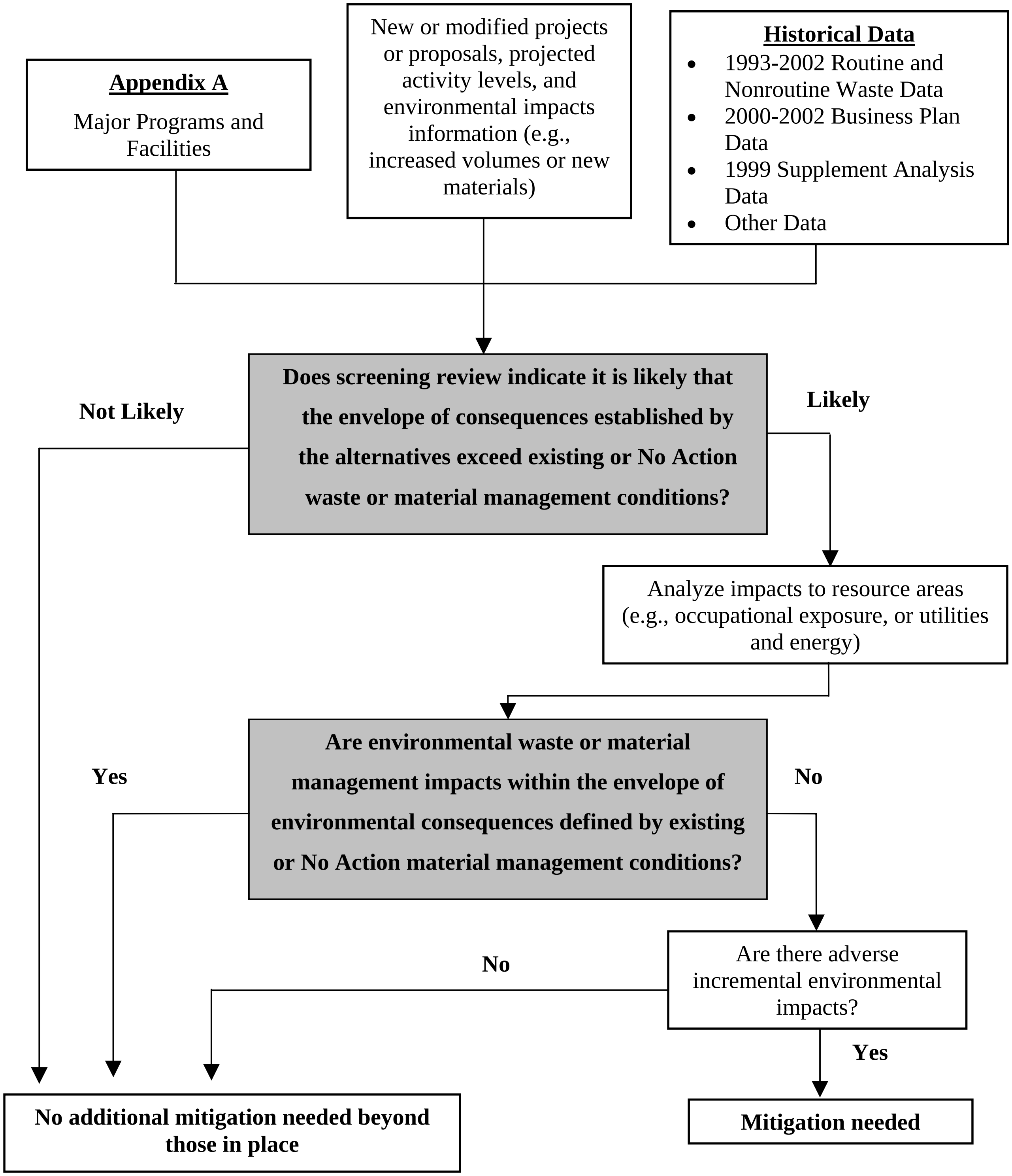
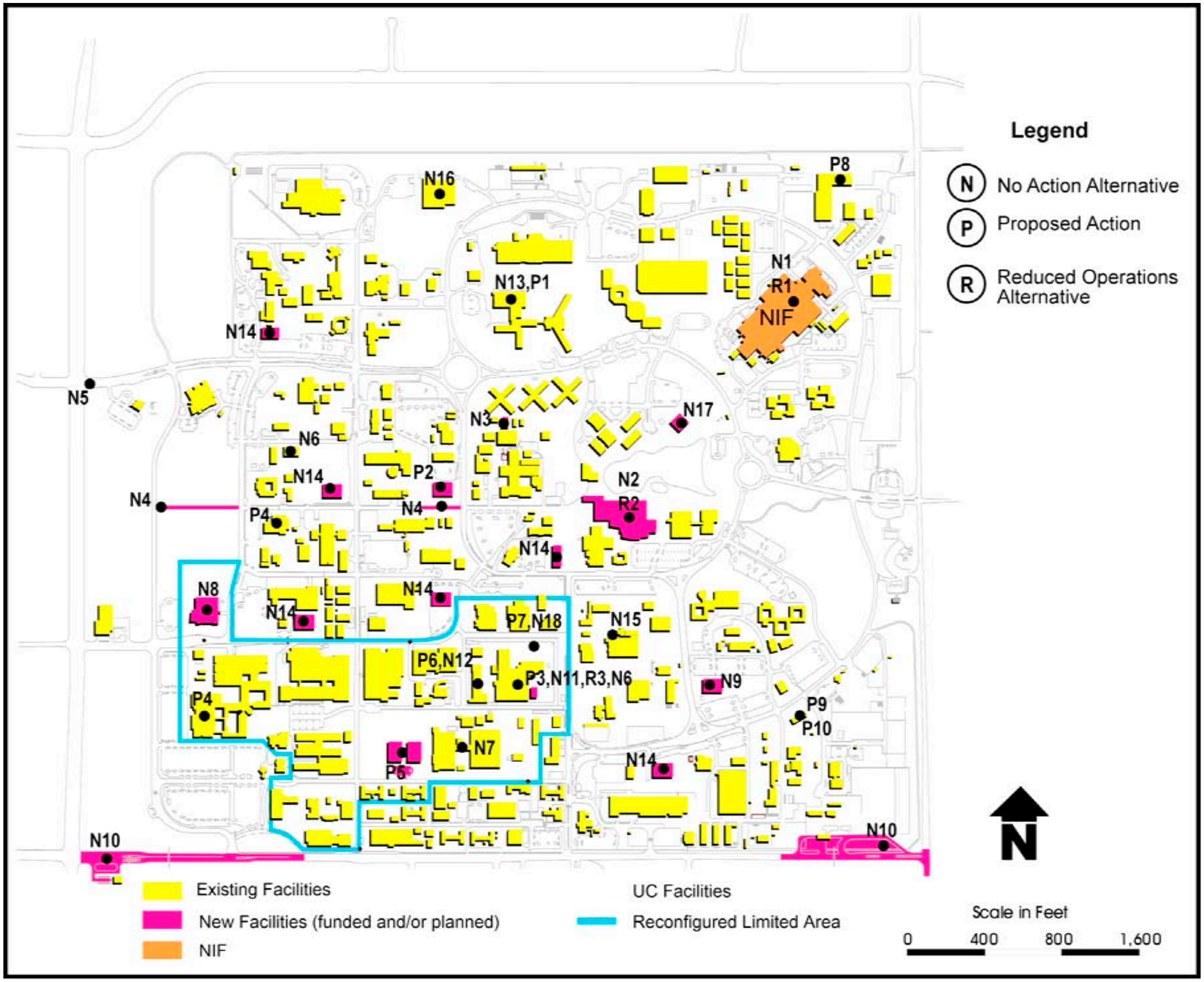
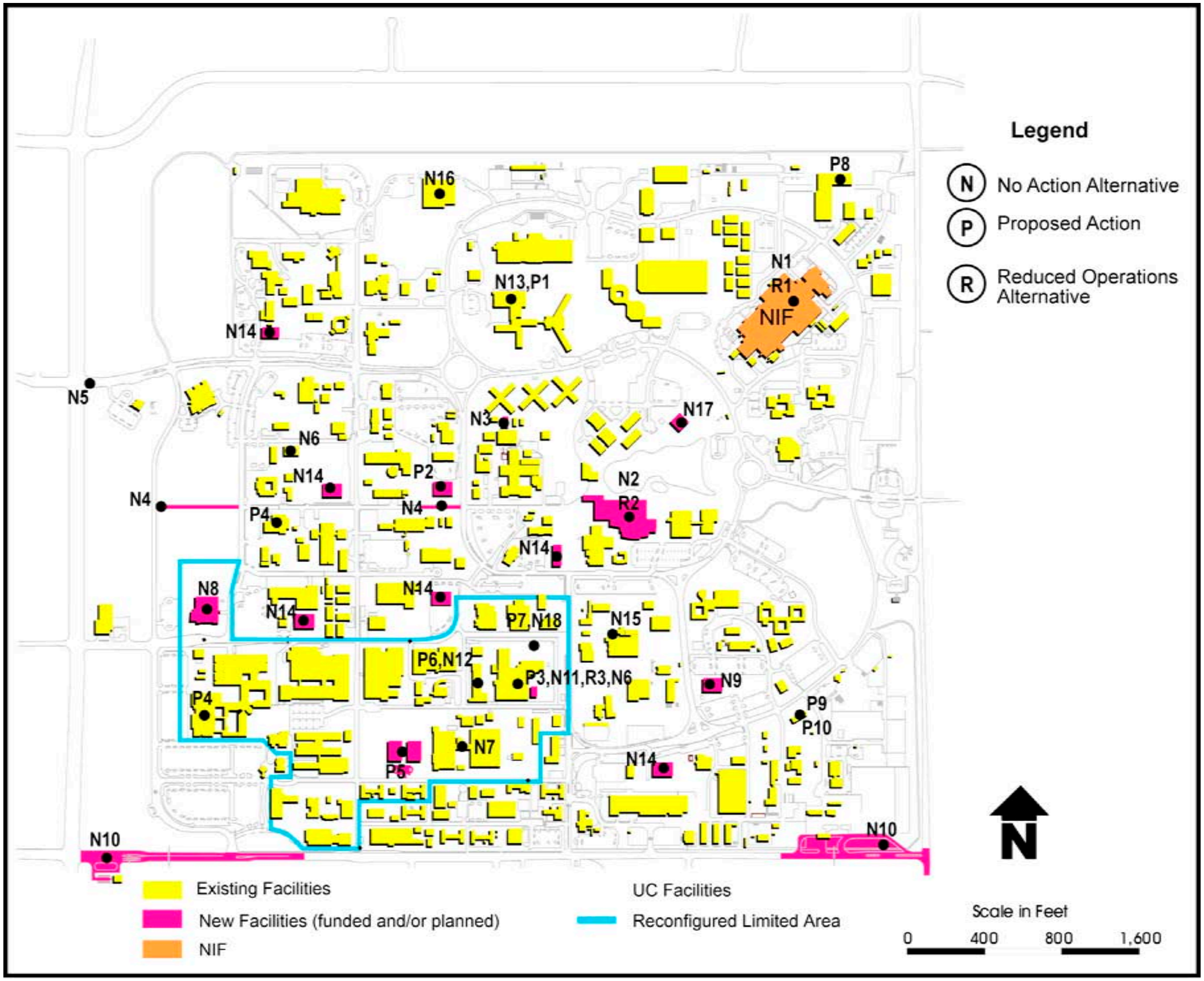


FIGURE 5.1.13–1.—*Waste and Materials Management Methodology Flowchart*



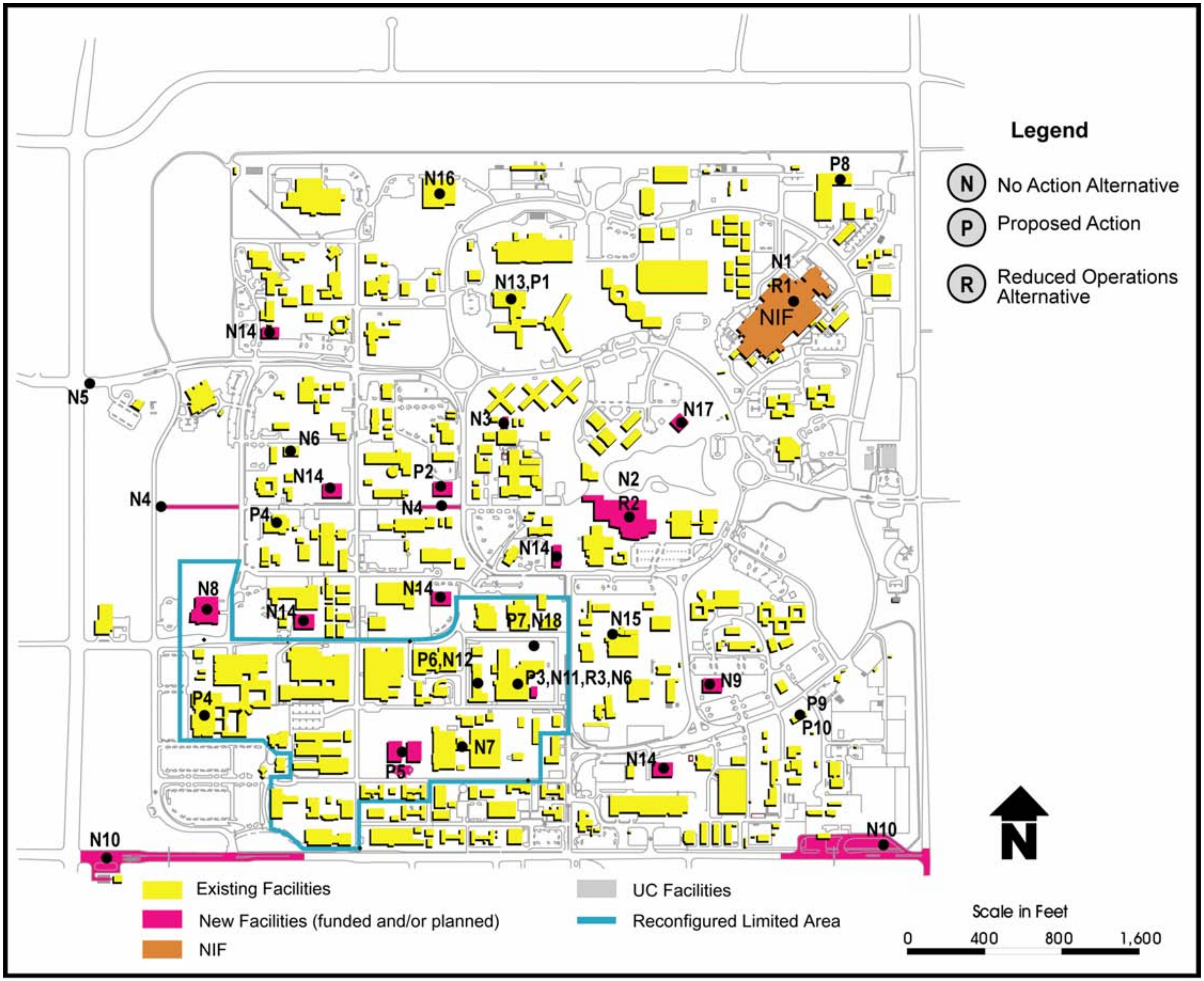
Source: LLNL 2003o

FIGURE 5.2.1.2–1.—*Locations of New Facilities Under the No Action Alternative*



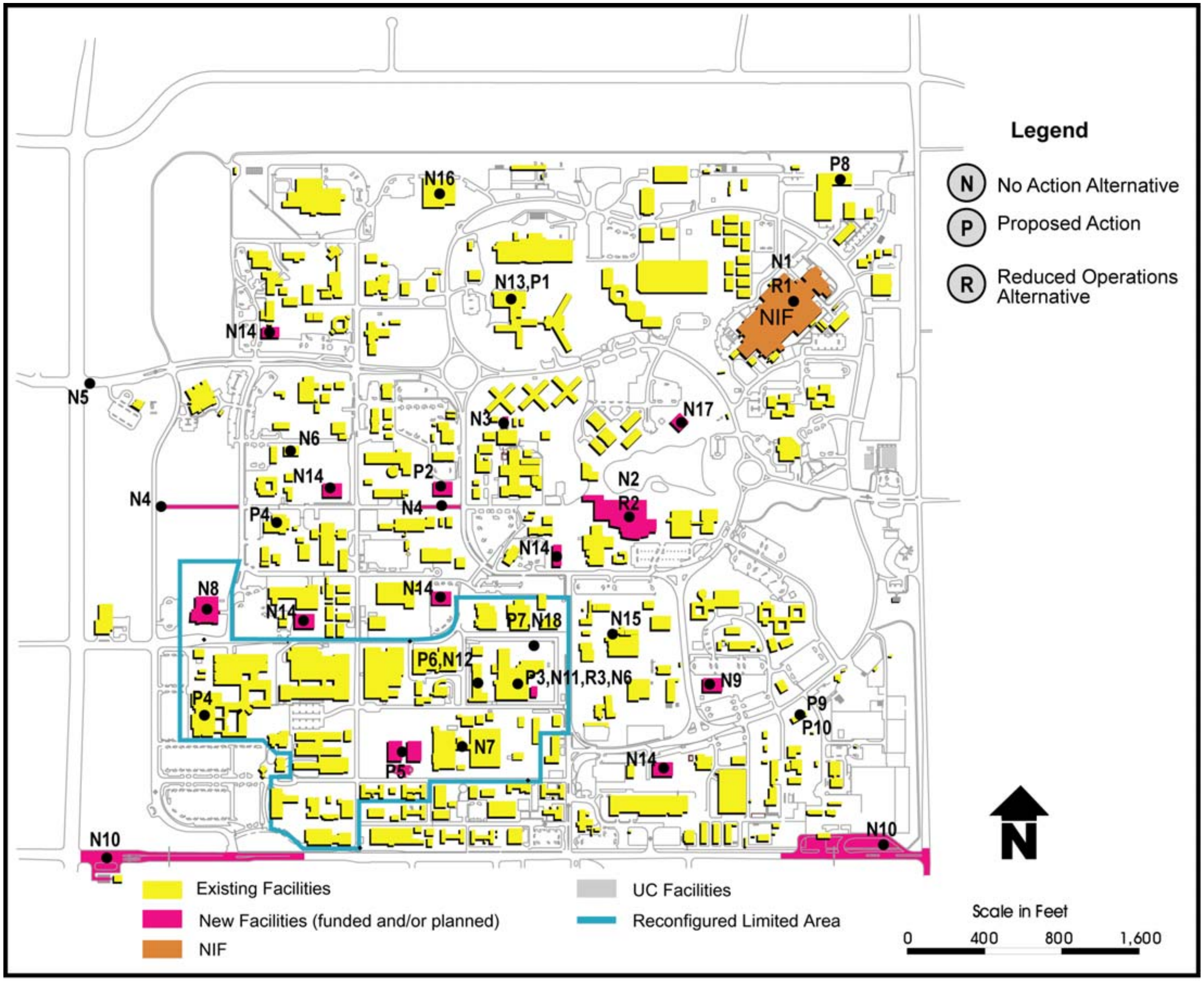
Source: LLNL 2003o.

FIGURE 5.2.6.1–1.—*Location of New Facilities Under the No Action Alternative, Including Those in Undeveloped Areas*



Source: LLNL 2003o.

FIGURE 5.3.1.2–1.—*Location of New Facilities Under the Proposed Action*



Source: LLNL 2003o.

FIGURE 5.3.6.1–1.—*Location of New Facilities in Undeveloped Areas Under The Proposed Action*

TABLE 4.9.3–1.—*Federal and California Species with Protected or Sensitive Status Known to Occur at the Livermore Site and Site 300 in 2001 and 2002*

	Site		Status	
Common Name	**Livermore Site**	**Site 300**	**Federal Status Code**	**State Status Code**
Plants				
Big tarplant[a]	-	X	-	CNPS List 1 B
Hogwallow starfish	-	X	-	CNPS List 4
Large-flowered fiddleneck	-	X	FE (CH)	CNPS List 1 B
Round-leaved filaree	-	X	-	CNPS List 2
Stinkbells	-	X	-	CNPS List 4
Diamond-petaled poppy	-	X	FSC	CNPS List 1 B
Gypsum rock jasmine	-	X	-	CNPS List 4
Gypsum loving larkspur	-	X	-	CNPS List 4
Invertebrates				
Valley elderberry longhorn beetle	-	X	FT	-
California linderiella fairy shrimp	-	X	FSC	-
Amphibians				
California tiger salamander	-	X	FPT	CASSC
California red-legged frog	X	X	FT (CH rescinded)	CASSC
Western spadefoot toad	-	X	FSC	CASSC
Reptiles				
Alameda whipsnake	-	X	FT (CH rescinded)	ST
California horned lizard	-	X	-	CASSC
Silvery legless lizard	-	X	FSC	CASSC
San Joaquin coachwhip	-	X	FSC	CASSC

TABLE 4.9.3–1.— *Federal and California Species with Protected or Sensitive Status Known to Occur at the Livermore Site and Site 300 in 2001 and 2002 (continued)*

	Site		Status	
Common Name	**Livermore Site**	**Site 300**	**Federal Status Code**	**State Status Code**
		Birds		
Cooper's hawk	X	X	MBTA	CASSC
Sharp-shinned hawk	-	X	MBTA	CASSC
Golden eagle	X	X	MBTA	CASSC
Red-tailed hawk	X	X	MBTA	-
Rough-legged hawk	-	X	MBTA	-
Red-shouldered hawk	X	X	MBTA	-
Ferruginous hawk	-	X	FSC, MBTA	CASSC
Swainson's hawk	-	X	MBTA	ST
Northern harrier	-	X	MBTA	CASSC
White-tailed kite	X	X	MBTA	CASSC
Osprey	-	X	MBTA	CASSC
Bushtit	X	X	MBTA	-
American kestrel	X	X	MBTA	-
Prairie falcon	-	X	MBTA	CASSC
Horned lark	-	X	MBTA	CASSC
Northern shoveler	-	X	MBTA	-
Cinnamon teal	-	X	MBTA	-
Mallard	X	X	MBTA	-
Bufflehead	X	X	MBTA	-
Common goldeneye	-	X	MBTA	-
Pied-billed grebe	X	X	MBTA	-
Common snipe	X	X	MBTA	-
Greater yellowlegs	X	X	MBTA	-

TABLE 4.9.3–1.— *Federal and California Species with Protected or Sensitive Status Known to Occur at the Livermore Site and Site 300 in 2001 and 2002 (continued)*

	Site		Status	
Common Name	**Livermore Site**	**Site 300**	**Federal Status Code**	**State Status Code**
Birds (cont.)				
Ring-necked duck	X	-	MBTA	-
Coot	X	-	MBTA	-
Great blue heron	-	X	MBTA	-
Green heron	-	X	MBTA	-
Black-crowned night heron	-	X	MBTA	-
Canada goose	X	-	-	-
White-throated swift	-	X	MBTA	-
Great egret	X	X	MBTA	-
Snowy egret	X	-	MBTA	-
Belted king fisher	X	-	MBTA	-
Cedar waxwing	X	X	MBTA	-
Common poorwill	-	X	MBTA	-
Blue-grosbeak	-	X	MBTA	-
Lazuli bunting	-	X	MBTA	-
Killdeer	X	X	MBTA	-
Mourning dove	X	X	MBTA	-
Rock dove	X	X	MBTA	-
Western scrub jay	X	X	MBTA	-
American crow	X	X	MBTA	-
Common raven	X	X	MBTA	-
Greater roadrunner	-	X	MBTA	-
Bell’s sage sparrow	-	X	FSC, MBTA	-
Black-throated sparrow	-	X	MBTA	-

TABLE 4.9.3–1.— *Federal and California Species with Protected or Sensitive Status Known to Occur at the Livermore Site and Site 300 in 2001 and 2002 (continued)*

	Site		Status	
Common Name	**Livermore Site**	**Site 300**	**Federal Status Code**	**State Status Code**
		Birds (cont.)		
Rufous crowned sparrow	-	X	MBTA	-
Grasshopper sparrow	-	X	FSC, MBTA	-
Vesper sparrow	-	X	MBTA	-
Lark sparrow	-	X	MBTA	-
California towhee	-	X	MBTA	-
Oregon junco	X	X	MBTA	-
Lincoln’s sparrow	-	X	MBTA	-
Song sparrow	X	X	MBTA	-
Fox sparrow	-	X	MBTA	-
Savannah sparrow	-	X	MBTA	-
Golden-crowned sparrow	X	X	MBTA	-
White-crowned sparrow	X	X	MBTA	-
House finch	X	X	MBTA	-
Lesser goldfinch	X	X	MBTA	-
American gold finch	X	X	MBTA	-
Cliff swallow	X	X	MBTA	-
Northern rough winged swallow	X	X	MBTA	-
Tree swallow	-	X	MBTA	-
Red-winged blackbird	X	X	MBTA	-
Tricolored blackbird	-	X	FSC, MBTA	CASSC
Brewer’s blackbird	X	X	MBTA	-
Bullock’s oriole	-	X	MBTA	-
Brown-headed cowbird	X	X	MBTA	-
Western meadowlark	X	X	MBTA	-

TABLE 4.9.3–1.— *Federal and California Species with Protected or Sensitive Status Known to Occur at the Livermore Site and Site 300 in 2001 and 2002 (continued)*

	Site		Status	
Common Name	**Livermore Site**	**Site 300**	**Federal Status Code**	**State Status Code**
Birds (cont.)				
Loggerhead shrike	X	X	FSC, MBTA	CASSC
Northern mockingbird	X	X	MBTA	-
California thrasher	-	X	FSC, MBTA	-
California quail	-	X	MBTA	-
Oak titmouse	-	X	FSC, MBTA	-
Yellow-rumped warbler	X	X	MBTA	-
Black-throated gray warbler	-	X	MBTA	-
Yellow warbler	-	X	MBTA	CASSC
Common yellowthroat	-	X	MBTA	CASSC
MacGillivary's warbler	-	X	MBTA	-
Orange-crowned warbler	-	X	MBTA	-
Wilson's warbler	-	X	MBTA	-
Double-crested cormorant	X	X	MBTA	CASSC
Northern flicker	X	X	MBTA	-
Acorn woodpecker	X	X	MBTA	-
Nuttall's woodpecker	X	X	FSC, MBTA	-
Phainopepla	-	X	MBTA	-
Ruby-crowned kinglet	X	X	MBTA	-
Barn owl	-	X	MBTA	-
Burrowing owl	-	X	FSC, MBTA	CASSC
Short-eared owl	-	X	FSC, MBTA	CASSC
Great horned owl	X	X	MBTA	-
Western screech owl	-	X	MBTA	-
Western tanager	-	X	MBTA	-

TABLE 4.9.3–1.— *Federal and California Species with Protected or Sensitive Status Known to Occur at the Livermore Site and Site 300 in 2001 and 2002 (continued)*

	Site		Status	
Common Name	**Livermore Site**	**Site 300**	**Federal Status Code**	**State Status Code**
		Birds (cont.)		
Aliens' hummingbird	-	X	MBTA	-
Anna's hummingbird	X	X	MBTA	-
Costa's hummingbird	-	X	FSC, MBTA	-
Rufous hummingbird	X	X	FSC, MBTA	-
Rock wren	-	X	MBTA	-
Bewick's wren	X	X	MBTA	-
House wren	-	X	MBTA	-
Hermit thrush	-	X	MBTA	-
Swainson's thrush	-	X	MBTA	-
Varied thrush	-	X	MBTA	-
Mountain bluebird	-	X	MBTA	-
Western bluebird	-	X	MBTA	-
American robin	X	X	MBTA	-
Western wood pewee	X	X	MBTA	-
Willow flycatcher	-	X	MBTA	SE
Pacific-slope flycatcher	-	X	MBTA	-
Ash-throated flycatcher	-	X	MBTA	-
Black phoebe	X	X	MBTA	-
Say's phoebe	X	X	MBTA	-
Western kingbird	-	X	MBTA	-
Cassin's kingbird	-	X	MBTA	-

TABLE 4.9.3–1.— *Federal and California Species with Protected or Sensitive Status Known to Occur at the Livermore Site and Site 300 in 2001 and 2002 (continued)*

	Site		Status	
Common Name	**Livermore Site**	**Site 300**	**Federal Status Code**	**State Status Code**
Mammals				
Pallid bat	-	X	-	CASSC
Long-legged myotis	-	X	FSC	-
Yuma myotis	-	X	FSC	-
San Joaquin pocket mouse	-	X	FSC	-
San Joaquin kit fox[b]	-	-	FE	ST

Sources: Jones and Stokes 2001, CDFG 2002a, CDFG 2002b, LLNL 2003ab, bz, by.
[a] The scientific names of all plant and animal species in this table are provided in Table E.2-1 in Appendix E.
[b] Although the San Joaquin kit fox has not been observed onsite in surveys from 1986 to the present, monitoring efforts continue to watch for the presence of this species onsite, due to confirmed sightings near Site 300.

-: Indicates the absence of a species at the Livermore Site or Site 300.
CASSC: California Species of Special Concern; CH: Critical Habitat (The USFWS may establish critical habitat for threatened or endangered species with the CH consisting of geographic area determined essential for the conservation of the species); CNPS List 1A: Plants presumed extinct in California; CNPS List 1B: Plants rare, threatened, or endangered in California and elsewhere; CNPS List 2: Plants rare, threatened, or endangered in California, but more common elsewhere; CNPS List 3: Plants about which we need more information – a review list; CNPS List 4: Plants of limited distribution – A watch list; FC: federally listed candidate (plant and animal species for which the USFWS has on file sufficient information on biological vulnerability and threat to support issuance of a proposed rule for listing as threatened or endangered); MBTA: *Migratory Bird Treaty Act*; FE: federally listed endangered (any species that is in danger of extinction throughout all or a significant portion of its range); FPT: federally listed proposed threatened (A proposal to list a species as likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range pending release of a final rule); FSC: Federal Species of Concern for Alameda and San Joaquin Counties. May be endangered or threatened. Not enough biological information has been gathered to support listing at this time; FT: federally listed threatened (any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range); ST: state listed threatened; X: Indicates the presence of a species at the Livermore Site or Site 300.

TABLE 4.10.1–1.—*Sources, Potential Health Effects, and Strategies for the Prevention and Control of Air Pollutants*[a]

Examples of Sources	Health and Related Effects[b]	Local Concerns	Prevention and Control Strategies
		Ozone	
Ozone is formed when POCs and nitrogen oxides react in the presence of sunlight. POC sources include any source that burns fuels (e.g., gasoline, natural gas, wood, oil), solvents, petroleum processing and storage, pesticides, and many consumer products (paint, ink, etc.). The greatest source of ozone precursors is the automobile. In the Bay Area, more than 50 percent of the POCs and nitrogen oxides come from cars and trucks.	Breathing difficulties, lung tissue damage, damage to rubber and some plastics. Contributes to visibility reduction.	Ozone is a major concern locally. Both the Bay Area and San Joaquin Valley air basins have been designated as nonattainment for state and Federal ozone standards. San Joaquin has been further ranked as serious, the highest, or most problematic, ranking. After having been designated as attainment for the 1-hour ozone standard, more recently the Bay Area was redesignated to nonattainment (August 1998), but has not yet been further ranked.	Reduce motor vehicle POCs and nitrogen oxide emissions through emissions standards, reformulated fuels, inspections programs, and reduced vehicle use. Limit POC emissions from commercial operations and consumer products. Limit POC and nitrogen oxide emissions from industrial sources such as power plants and refineries. California's automobile emissions control program, together with the district's regulatory controls, has sharply reduced ozone levels.
		Carbon Monoxide	
Any source that burns fuel such as automobiles, trucks, heavy construction equipment and farming equipment, and residential heaters and stoves. Almost 70 percent of the Bay Area's carbon monoxide comes from motor vehicles, and a large fraction of the remainder is from burning wood in fireplaces and woodstoves.	Chest pain in heart patients, headaches, reduced mental alertness, death at very high levels.	Both districts are in attainment of the state and Federal ambient air quality standards. Maximum levels monitored in Livermore are approximately one-third of the standard.	Control motor vehicle and industrial emissions. Use oxygenated gasoline during winter months. Conserve energy.

TABLE 4.10.1–1.—*Sources, Potential Health Effects, and Strategies for the Prevention and Control of Air Pollutants*[a] *(continued)*

Examples of Sources	Health and Related Effects[b]	Local Concerns	Prevention and Control Strategies
		Nitrogen Dioxide	
Automobiles, trucks, heavy construction equipment and farming equipment, and residential heaters and stoves.	Lung irritation and damage. Reacts in the atmosphere to form ozone and acid rain. Contributes to brown haze. At higher concentrations, damage has been noticed in sensitive crops such as beans and tomatoes.	It is a major contributor to ozone formation. Both districts are in attainment of the state and Federal ambient air quality standards; however, at concentrations experienced in the Bay Area, nitrogen dioxide can be seen as a brown haze on days with otherwise good visibility.	Control motor vehicle and industrial combustion emissions.
		Sulfur Dioxide and Sulfates	
Coal- or oil-burning power plants and industries, refineries, and diesel engines.	Increases lung disease and breathing problems, particularly for asthmatics. Reacts in the atmosphere to form acid rain. Sulfates also contribute to reduced visibility. Sulfates and sulfuric acid can damage vegetation and affect the health of both humans and animals.	Both districts are classified attainment of the state and Federal ambient air quality standard for sulfur dioxide and the state ambient air quality standard for sulfates. Maximum levels monitored in Livermore are approximately one-third of the standard. No state or Federal excesses have been recorded at district monitoring stations since 1976.	Limit use of high sulfur fuels (e.g., use low sulfur reformulated diesel or natural gas).

TABLE 4.10.1–1.—*Sources, Potential Health Effects, and Strategies for the Prevention and Control of Air Pollutants*[a] *(continued)*

Examples of Sources	Health and Related Effects[b]	Local Concerns	Prevention and Control Strategies
Particulate Matter			
Coarse particles (referred to as PM_{10}, i.e., particle diameter of 10 microns or less)[c] come from sources such as windblown dust from the desert or agricultural fields and dust kicked up on unpaved roads by vehicle traffic. The major human-generated (anthropogenic) sources in the Bay Area include motor vehicle travel over paved and unpaved roads, demolition and construction activity, and wood burning in fireplaces and stoves. Agricultural operations and burning also contribute significantly to particulate concentrations in rural areas. PM_{10} emissions are expected to increase in future years. Fine particles ($PM_{2.5}$) are generally emitted from activities such as industrial and residential combustion and from vehicle exhaust. $PM_{2.5}$ are also formed in the atmosphere when gases such as sulfur dioxide and nitrogen oxide, and volatile organic compounds, emitted by combustion activities, are transformed by chemical reactions in the air.	PM_{10} can accumulate in the respiratory system and aggravate health problems such as asthma. $PM_{2.5}$ is more likely to be associated with premature death and increased hospital admissions and emergency room visits (primarily with elderly and individuals with cardiopulmonary disease); increased respiratory symptoms and disease (primarily children and individuals with cardiopulmonary disease such as asthma); decreased lung function (particularly in children and individuals with asthma); and alterations in lung tissue and structure and in respiratory tract defense mechanisms. $PM_{2.5}$ is also linked with reduced visibility (e.g., obscures mountains and other scenery) because it scatters and absorbs light, reduces airport safety, and contributes to surface soiling.	The Bay Area air district is classified as nonattainment with respect to California standards, attainment for the annual Federal PM_{10} standard, and unclassified for $PM_{2.5}$ and 24-hour PM_{10} Federal standards. The San Joaquin Valley air district is classified as nonattainment for state standards and as a serious nonattainment area for Federal PM_{10}. The designation for Federal $PM_{2.5}$ standard has not yet been determined.	Reduce combustion emissions from motor vehicles, equipment, industries, and agriculture and residential burning. Precursor controls, like those for ozone, reduce $PM_{2.5}$ formation in the atmosphere. Control dust sources, industrial particulate emissions, and wood burning stoves and fireplaces. Reduce secondary pollutants that react to form PM_{10}.

TABLE 4.10.1–1.—*Sources, Potential Health Effects, and Strategies for the Prevention and Control of Air Pollutants*[a] *(continued)*

Examples of Sources	Health and Related Effects[b]	Local Concerns	Prevention and Control Strategies
	Lead		
Metal smelters, resource recovery, leaded gasoline, deterioration of lead paint.	Learning disabilities and brain and kidney damage.	No specific information. Areas are in attainment of both state and Federal ambient air quality standards.	Control metal smelters, no lead in gasoline. Replace leaded paint with non-lead substitutes.
	Hydrogen Sulfide		
Geothermal power plants, petroleum production and refining, sewer gas.	Nuisance odor (rotten egg smell), headache and breathing difficulties at higher concentrations.	No specific information. Both areas are unclassified with respect to the state ambient air quality standard.	Control emissions from geothermal power plants, petroleum production and refining, sewers, and sewage treatment plants.
	Toxic Air Contaminants		
Cars and trucks, especially diesels; industrial sources such as chrome plating; neighborhood businesses, such as dry cleaners and service stations; and building materials and products. Over 50 percent of the public's total exposure to toxic air contaminants in the Bay Area comes from the carcinogens benzene and 1,3-butadiene, two organic compounds found in automobile exhaust.	Cancer; chronic eye, lung, or skin irritation; and neurological and reproductive disorders.	Within the city of Livermore, there are approximately 20 facilities that must report emissions of toxic air contaminants, i.e., emissions exceeding de minimis levels. The individual excess cancer risk due to average ambient concentrations of toxic air contaminants measured in the Bay Area during 2000 is approximately 170 in a million (See Section 4.10.2.2). Toxic air contaminants are regulated under various state and local programs.	See general discussions under ozone and particulate matter and other pollutant subgroups (lead, hydrogen sulfide, etc.) for control of gaseous and particulate air pollutants.

TABLE 4.10.1–1.—*Sources, Potential Health Effects, and Strategies for the Prevention and Control of Air Pollutants*[a] *(continued)*

Examples of Sources	Health and Related Effects[b]	Local Concerns	Prevention and Control Strategies
Stratospheric Ozone-Depleting Substances			
Non-POCs include methylene chloride, 1,1,1-trichloroethane, halons and the family of chemicals referred to as freons or chlorofluorocarbons, and chlorine and bromine compounds. Refrigerants, air conditioners, fire suppressants, certain aerosols, and solvents.	Increased incidence of harmful health consequences of ultraviolet radiation, particularly squamous cell carcinomas of the skin.	No additional local concerns stratospheric on ozone depletion.	Substitute formulations with lower ozone-depleting potential. Good maintenance.

Source: See table notes.

[a] Extracted from information provided in multiple sources including: EPA Ozone Depletion and Climate Protection Partnerships Division Websites (EPA 2002b); EPA Revised Particulate Matters Fact Sheet (EPA 1997); CARB Website Fact Sheets on Air Pollution and Air Pollution and Health (CARB 2002a, CARB 2002b); and BAAQMD Website, Attainment Website Status, General Pollutant Information and Toxic Air Contaminant Control Program Annual Report, and CEQA Guidelines for Assessing the Air Quality Impacts of Projects and Plans (BAAQMD 2003, 2002, 2001, 1999); and SJVUAPCD Website Attainment Status (SJVUAPCD 2002).

[b] Although air pollutants can cause health problems for everyone, certain people are especially vulnerable. These “sensitive populations” include children, the elderly, exercising adults, and those suffering from asthma or bronchitis. Of greatest concern are recent studies that link PM_{10} exposure to the premature death of people who already have heart and lung disease, especially the elderly.

[c] One micron (also referred to as a micrometer or µm) = 1×10^{-6} meters.

BAAQMD = Bay Area Air Quality Management District; CARB = California Air Resources Board; CEQA = *California Environmental Quality Act* of 1970; EPA = U.S. Environmental Protection Agency; POC = precursor organic compounds; SAAQS = State Ambient Air Quality Standard

TABLE 4.10.5–1.—*Radionuclide Releases From LLNL, 1998-2002*

Release Location (Operation)	Predominant Radionuclides Released	Curies Emitted per Year (Numbers in parentheses indicate percent contribution to site-wide maximally exposed individual dose from that facility)				
		1998	**1999**	**2000**	**2001**	**2002**
		Livermore Site				
Building 612 Yard (Low Level Waste Storage)	H-3	4.6 (35)	4.4 (15)	3.6 (40)	2.0 (48)	2.3 (4.8)
Building 331 Stacks (Tritium R&D + Parts Decontamination)	H-3	110 (53)	276 (72)	39.8 (25)	19.7 (25)	36 (35)
Building 514 Tank Farm (Process Liquid)	H-3, C-14, Sr-90 and others				5.5×10^{-6} (8)	
Southeast Quadrant Diffuse Sources (Resuspension)	Pu-239				DS (5)	
Building 612, Room 102 (Laboratory Analysis)	H-3, C-14, Sr-90 and others				2.0×10^{-6} (4)	1.5×10^{-5} (5)
Building 514 Evaporator (Waste Consolidation)	H-3, P-32, U-238 and others			7.2×10^{-7} (16)	1.0×10^{-7} (3)	9.6×10^{-6} (5)
Outside Building 331 (Contaminated Parts Storage)	H-3	6 (7)	7.3 (5)	5.2 (12)		1.0 (4)
		Site 300				
Building 851 Firing Table (Explosive Tests)	U238 U235 U234 H-3		2.4×10^{-2} 3.1×10^{-4} 2.3×10^{-3} 19 (61)	1.5×10^{-2} 3.1×10^{-4} 2.3×10^{-3} 0 (79)	6.2×10^{-2} 3.1×10^{-4} 2.3×10^{-3} 0 (93)	1.5×10^{-2} 2.0×10^{-4} 1.4×10^{-3} 0 (85)
Entire Site (Soil Resuspension)	U238 U235 U234	DS DS DS (22)	DS DS DS (3)	DS DS DS (21)	DS DS DS (7)	DS DS DS (15)
Building 801 Firing Table (Explosive Tests)	U238 U235 U234	7.2×10^{-2} 9.3×10^{-4} 6.8×10^{-3} (70)	4.8×10^{-2} 6.1×10^{-4} 4.4×10^{-3} (36)			

Source: LLNL 1999a, LLNL 2000h, LLNL 2001v, LLNL 2002cc, LLNL 2003l.
Note: Entry of blank curies per year indicates a source that did not contribute to the 90th percentile releases.
DS: Doses from diffuse source are calculated from measured ambient concentrations rather than release rates.

TABLE 4.13.3–1.—*Three-Year Accident Rates for Roads Adjacent to the Livermore Site and Site 300 (1999 through 2001)*

Segment Location	Segment Distance (miles)	No. of Accidents	ADT	3-year Volumes	Vehicle Miles of Travel	Accidents per MVM	Average Statewide Accidents per MVM
S. Vasco Rd (South of I-580 to Las Positas)[a]	0.5	39	30,000	31,455,901	15,727,951	2.48	2.18[a]
S. Vasco Rd (South of Las Positas to Patterson Pass)[a]	0.6	40	26,200	27,471,487	16,482,892	2.43	2.18[a]
S. Vasco Rd (South of Patterson Pass to East Ave)[a]	1.0	7	16,600	17,405,599	17,405,599	0.40	2.18[a]
Greenville Rd (South of I-580 to Las Positas)[a]	0.3	3	15,600	16,357,069	4,907,121	0.61	2.18[a]
Greenville Rd (South of Las Positas to Patterson Pass)[a]	1.2	11	12,000	12,582,361	15,098,833	0.73	1.93[a]
Greenville Rd (South of Patterson Pass to East Ave) [a]	1.1	2	6,500	6,815,445	7,496,990	0.27	1.93[a]
Patterson Pass Rd (East of S. Vasco to West of Greenville)[a]	1.2	6	6,200	6,500,886	7,801,064	0.77	1.93[a]
East Ave (East of S. Vasco to West of Greenville)[a]	1.2	1	7,000	7,339,710	8,807,652	0.11	1.93[a]
Greenville Rd (South of East Ave to Tesla Rd)[a]	1.0	0	3,000	3,145,590	3,145,590	0.00	1.21[a]
Tesla Rd (Greenville to Site 300 Entrance)[a]	13.1	55	4,500	4,718,385	661,810,846	0.89	1.21[a]

Source: CA DOT 1999, CHP 1999, CHP 2000, CHP 2001.
[a] Urban 4-lane divided roadway.
[b] Two- and three-lane urban roadways.
[c] Two-lane rural roadway.
ADT = average daily traffic; MVM = million vehicle miles.

TABLE 4.15.1.1–1.—*Summary of Major Laws, Regulations, and Orders Associated with Materials Management*

Laws, Regulations, and Orders	Description
Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 (42 U.S.C. §11001)	This Act includes emergency planning, notification requirements for unplanned releases of extremely hazardous substances, annual chemical inventory/material safety data sheet reporting, and annual toxic release inventory (TRI) reporting requirements. LLNL does not currently meet the standard industrial code (SIC) criteria that require reporting; however, it has assisted DOE in preparing TRI reports consistent with the directive of Executive Order (EO) 12856, superceded by EO 13148.
Greening the Government through Leadership in Environmental Management (EO 13148)	This EO directs all Federal agencies to develop and implement environmental management systems to support environmental compliance, right-to-know and pollution prevention; reducing toxic chemical releases, reducing use of toxic chemicals, hazardous substances, and other pollutants; reducing ozone depleting substances; and promoting environmentally and economically beneficial landscaping.
Atomic Energy Act (42 U.S.C. §2011)	The *Atomic Energy Act* (AEA) of 1954 makes the Federal government responsible for regulatory control of the production, possession, and use of three types of radioactive material: source, special nuclear, and byproduct (including waste).
29 CFR §§1910.1200, Hazard Communication	This regulation requires employers to keep a list of the hazardous chemicals maintained in the workplace.
40 CFR Part 302, Designation, Reportable Quantities, and Notification; and 40 CFR Part 370, Hazardous Chemical Reporting: Community Right to Know	This regulation requires the reporting of hazardous chemicals in quantities exceeding federally prescribed thresholds to safety and health officials in the state and local community.
California Health and Safety Code Division 20, Section 6.7 and 6.75, Subpart 25280-25299.7	This regulation establishes standards for concentration, maintenance, inspection, and testing of underground storage tanks.
California AB 2185, Hazardous Materials Release Response Plans and Inventory Law	The law covers the management of hazardous and acutely hazardous materials.
DOE O 5480.4, Environmental Protection, Safety, and Health Protection Standards	This order requires DOE facilities to comply with 29 CFR Part 1910, Subpart Z, Toxic and Hazardous Substances.
DOE O 460.2, Departmental Materials Transportation And Packaging Management	This order establishes DOE policies and requirements to supplement applicable laws, rules, regulations, and other DOE orders for materials transportation and packaging operations.
DOE O 460.1A, Packaging and Transportation Safety	This order establishes safety requirements for the proper packaging and transportation of DOE offsite shipments and onsite transfers of hazardous materials and for modal transport. (Offsite is any area within or outside a DOE site to which the public has free and uncontrolled access; onsite is any area within the boundaries of a DOE site or facility to which access is controlled.)

Source: LLNL 2002cc.
CFR = *Code of Federal Regulations*; DOE = U.S. Department of Energy; U.S.C. = *United States Code.*

TABLE 4.15.1.2–1.—*Facilities Managing Radionuclides at LLNL*

Building Number	Radionuclide	Approximate[a] Quantity (kg, lb, or curies)	Status[b]
Building 131 Highbay	Natural thorium Uranium-238 Natural uranium Depleted uranium 4 sealed sources	0.5 kg 115 kg 12 kg 7,525 kg	Inventory maintained below Category 3 quantities.
Building 151	15-Cat 3 radionuclides	Varies	Inventory maintained below Category 3 quantities.
Building 231	Natural thorium Natural uranium Depleted uranium Rhenium	9 kg 2,200 kg 2,000 kg 60 kg	
Building 235	10-Cat 3 radionuclides	Varies	Low Hazard Radiological Facility
Building 239	Fuel-grade plutonium Weapons-grade Plutonium Highly Enriched Uranium Depleted Uranium Tritium	6 kg 6 kg 50 kg 25 kg 500 kg 0.02 kg	Varies, resident inventory maintained below Category 3 levels.
Building 241	Depleted Uranium 5-Cat 3 radionuclides	2,650 kg Varies	Low Hazard Radiological Facility
Building 251	42-Cat 2 Radionuclides	Varies	Inventory maintained as Category 2.
Building 261/262	16-Cat 3 radionuclides Thorium Natural uranium Depleted uranium	Varies 100 lbs 100 lbs 300 lbs	Inventory maintained below Category 3 quantities. Metal
Building 322	Depleted uranium	30 kg	
Building 327	Depleted uranium Natural uranium 10-Cat 3 Radionuclides	95 kg 0.13 kg	Inventory maintained below Category 3 quantities. Sealed Sources.
Building 331	Tritium	30 g	Inventory is distributed between two segments. Small quantities of other radionuclides may be present, but the facility will remain a Category 3 Facility.
Building 332	Plutonium (fuel grade-equivalent) Enriched uranium Depleted or natural uranium	1,500 kg 700 kg 500 kg 3,000 kg	Category 2 Facility
Building 334	Fuel grade plutonium Weapons grade plutonium Highly enriched uranium Depleted uranium Tritium	18 kg 18 kg 100 kg 500 kg 0.0001 kg	Inventory maintained below Category 2 quantities.
Building 361	Phosphorus-32 Sulphur-35 Carbon-14 Tritium	0.027 Ci 0.008 Ci 0.13 Ci 0.29 Ci	

TABLE 4.15.1.2–1.—*Facilities Managing Radionuclides at LLNL (continued)*

Building Number	Radionuclide	Approximate[a] Quantity (kg, lb, or curies)	Status[b]
Building 364	Cesium- 137	3.43×10^{-3} Ci	Sealed Source

Source: LLNL 1999b, LLNL 1999c, LLNL 2000d, LLNL 2000l, LLNL 2001e, LLNL 2001ag, LLNL 2001h, LLNL 2001x, LLNL 2001f, LLNL 2002k, LLNL 2002an.
[a] Inventories are snapshots in time and provided in the units found in the reference document. To convert from kg to pounds multiply kg by 2.2034. The information is to provide a degree of scale and is not (unless otherwise stated) a limit.
[b] See text box in this section (4.15.1.2) for definitions of material categories. These categories are defined in DOE-STD-1027-92, Attachment 1.
Ci = curies; DOE = U.S. Department of Energy; g = grams; kg = kilograms; lb = pounds.

LLNL Material Categories

Category 1 materials are hazardous or other materials that are also “controlled materials” because of their security classification, high value, or special hazards. Examples are:

- Accountable nuclear materials
- Carcinogens (if accountable or classified)
- Classified parts and materials (other than documents)
- Explosives
- Material contaminated with accountable amounts of controlled material
- Mock explosives
- Precious metals, gems, and other valuable materials
- Radioactive materials
- Special reactor materials

Category 2 materials are unclassified hazardous wastes (e.g., asbestos, spent acids) of negligible economic value, such as radioactive and mixed waste.

Category 3 materials are all hazardous materials other than those that fall into Category 1 or 2. Category 3 includes most industrial and laboratory chemicals that are not wastes (LLNL 1996a).

TABLE 4.15.1.2–2.—*Approximate Radioactive Quantities Managed at Site 300*

Material	Use	Allowed Quantities[a, b]
Depleted uranium	Assembly components	4.2 Ci
		10,640 kg
Thorium-232	Assembly components	0.1 Ci
		910 kg
Tritium	Assembly components	955 Ci
		100 mg

Source: LLNL 2002l.
[a] Units presented are those found in the reference document.
[b] Quantities cure snapshots in time.
Ci = curies; kg = kilograms; mg = milligrams.

TABLE 4.15.1.2–3.—*Partial List[a] of Hazardous Chemicals in Use at the Livermore Site Under Existing Conditions*

Chemical	Chemical Abstract Number	Average Maximum/Average Quantity[b]
Paints/Solvents		
Paint (variety)	NA	700,000/320,296 lb
Thinner, lacquer	NA	3,000/500 gal
Methylene chloride	75-09-2	2,000/55 gal
Methyl alcohol	67-56-1	1,800/500 gal
Acetone	67-64-1	1,200/740 gal
Metals		
Lead bricks or ingots	NA	1,000,000 lb
Tantalum	7440-25-7	75,000/20,000 lb
Cobalt	7440-48-4	16,500/14,000 lb
Aluminum	7429-90-5	5,000/800 lb
Chrome or chromium	7440-47-3	4,700/1,500 lb
Beryllium	7440-41-7	1,600/1,000 lb
Acids/Bases/Oxidizers		
Oxygen, compressed	7782-44-7	870,000/75,000 ft^3
Hydrogen peroxide<52%	7722-84-1	42,000/18,000 gal
Ammonium hydroxide	1336-21-6	30,000/1,600 lb
Sodium hydroxide	1310-73-2	25,500/14,000 lb
Potassium hydroxide	1310-58-3	15,000/400 lb
Sulfuric acid	7664-93-9	11,000/4,500 lb
Nitric acid	7697-37-2	7,810/5,000 lb
Phosphoric acid	7664-38-2	3,600/1,000 lb
Cyanuric acid	108-80-5	2,500/500 lb
Hydrofluoric acid	7664-39-3	1,500/850 lb
Industrial Gases		
Argon, compressed	7440-37-1	25,000,000/160,000 ft^3
Helium	7440-59-7	5,000,000/300,000 ft^3
Hydrogen, compressed	1333-74-0	1,500,000/50,000 ft^3
Nitrogen, compressed (Liquified, gaseous)	7727-37-9	500,000/130,000 ft^3
Carbon dioxide	124-38-9	176,000/124,000 ft^3
Refrigerants		
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	76-13-1	170,000/16,000 lb
Refrigerant, 123 SUVA, (2,2-Dichloro-1,1,1-trifluoroethane)	306-83-2	35,000/1,500 lb
Freon 22 (Chlorodifluoromethane)	75-45-6	9,000/5,000 lb
Freon 11 (Trichlorofluoromethane)	75-69-4	10,000/5,000 lb
Freon 12 (Dichlorodifluoromethane)	75-71-8	6,300/4,000 lb
Freon 14 (Tetrafluoromethane)	75-73-0	2,000/500 ft^3

Source: NNSA 2002c.
[a] For a comprehensive list covering other chemicals like chlorine, please refer to Appendix B.
[b] Represents average maximum and average quantity based on one or more buildings as reported in 2001 and 2002. The information represents a snapshot and is intended to give the reader an understanding of the variety and relative quantities.
ft^3 = cubic feet ; gal = gallons; lb = pounds; NA = not available.

TABLE 4.15.2–1.—*Livermore Site Waste Management Facilities and Capacities*[a]

Facility	Unit Type	Waste Type	Capacity
		Area 612 Facility	
Building 625 CSU	S	H, M, R, TSCA, CT	42,416 gal
Area 612 Tank Trailer Storage Unit	S	CT, H, M, R	5,000 gal
Area 612 Portable Tank Storage Unit	S	CT, H, M, R	10,000 gal
Area 612-1 CSU	S	CT, H, M, R	38,400 ft^3
Area 612-2 CSU	S	CT, H, M, R	10,560 gal
Area 612-4 Receiving, Segregation, and CSU	S	H, M, R, TSCA, CT	NA
Area 612-5 CSU	S	CT, H, M, R	26,900 ft^3
Building 612 Size Reduction Unit	T	CT, H, M, R	250 short tons/yr
Building Lab Packing/Packaging	T	CT, H, M, R	NA
Building Drum/Container Crushing Unit	T	CT, H, M, R	600 short tons/yr
Building 612 CSU	T	CT, H, M, R	7,150 gal
Building 614 West Cells CSU	S	CT, H, M, R	168 gals/cell (4 cells)
Building 614 East Cells CSU	S	CT, H, M, R	880 gals/cell (4 cells)
		DWTF Complex	
Building 693 CSU	S	CT, H, M, R	141,240 gal
Building 693 Annex	S	CT, H, M, R	3,060 ft^3
Building 693 Yard—Freezer Storage Unit	S	CT, H, M, R	30 gal
Building 693 Yard—Roll-Off Bin Storage Unit	S	CT, H	2,160 ft^3
Building 695 Airlock	S	H, M	12,000 gal
Building 695 LWPA Waste Blending Station, Tank Blending Unit	T	CT, H, M, R	Part of 695 Tank Farm capacity
Building 695 LWPA Waste Blending Station, Portable Blending Unit	T	CT, H, M, R	Part of 695 Tank Farm capacity
Building 695 LWPA Cold Vapor Evaporation Unit	T	CT, H, M, R	Part of 695 Tank Farm capacity
Building 695 LWPA Centrifuge Unit	T	CT, H, M, R	55,000 gal/yr
Building 695 LWPA Solidification Unit	T	CT, H, M, R	115 short tons/yr
Building 695 LWPA Shredding Unit	T	CT, H, M, R	180 short tons/yr
Building 695 LWPA Filtration Unit	T	CT, H, M, R	2,750 gal/yr
Building 695 LWPA Drum Rinsing Unit, Bulking Station	T	CT, H, M, R	182 short tons/yr
Building 695 LWPA Debris Washer Unit	T	CT, H, M, R	45 short tons/yr
Building 695 LWPA Gas Adsorption Unit	T	CT, H, M, R	0.09 short tons/day
Building 695 LWPA Radwaste Evaporator	T (non RCRA)	R	
Building 695 LWPA Air Lock	(non RCRA)	R	
Building 695 RWPA/SSTL Water Reactor			0.09 short tons/day
Building 695 RWPA/SSTL Pressure Reactor			0.09 short tons/day
Building 695 RWPA/SSTL Amalgamation Reactor			0.09 short tons/day
Building 695 RWPA/SSTL Uranium Bleaching Unit			0.09 short tons/day

TABLE 4.15.2–1.—*Livermore Site Waste Management Facilities and Capacities[a] (continued)*

Facility	Unit Type	Waste Type	Capacity
Small Scale Treatment Laboratory	T	H, M, R	0.04 short tons/day
Reactive Waste Storage Room	S	CT, H, M, R	12,400 gal
DWTF Tank Farm	S, T	CT, H, M, R	45,000 gal (storage), 325,000 gals/yr (treatment)
DWTF Portable Tank Storage Pad	S	CT, H, M, R	22,000 gal
Building 280 (Permitted, never operational)[b]			
Building 280 CSU	S	CT, H, M, R	18,140 ft^3
Area 514 [b]			
Area 514-1 CSU/Treatment Unit Group:	S, T	R, M, TSCA	NA[c]
Area 514-2 CSU	S	R, M, TSCA	NA[c]
Area 514-3 CSU	S	H, R, M, TSCA	NA[c]
Area 514 Wastewater Treatment Tank Farm Unit	T		NA[c]
Building 514 Silver Recovery Unit	Recycle	H	
Building 513 CSU	S	H, M, R	NA[c]
Building 513 Shredding Unit	T	H, M, R	NA[c]
Building 513 Solidification Unit	T	H, M, R	
EWTF-Site 300			
Open Burn Unit -Pan	T	H	150 lb/event
Open Burn Unit -Cage	T	H	260 lb/event
Open Detonation Unit	T	H	350 lb/event
S1	S	H	275 gal
S2	S	H	110 gal
EWSF-Site 300			
Magazine 1	S	H	1,622 lb (net explosive weight)
Magazine 2	S	H	3,209 lb (net explosive weight)
Magazine 3	S	H	5,592 lb (net explosive weight)
Magazine 4	S	H	4,291 lb (net explosive weight)
Magazine 5	S	H	2,744 lb (net explosive weight)
Magazine 816	S	H	9,240 gal (no liquids)
Building 883-Site 300			
Building 883 CSU	S	H	3,300 gal
Building 804-Site 300			
Building 804	Staging and Storage Area	R - only	N/A

[a] Typically an operational limit including a combination of hazardous, radioactive, and mixed waste unless otherwise restricted by permit or LLNL management practice.
[b] Under all alternatives, this facility would undergo RCRA closure and operational capabilities would be transferred to the DWTF.
[C] Values are included with those for B-695 Part B Permit.
CSU = container storage unit; CT = California Toxic (A non-RCRA hazardous waste defined by State of California, pursuant to Title 22, California Code of Regulations); R = radioactive (may include LLW and TRU); S = storage; T = treatment; TSCA = *Toxic Substance Control Act*; H = hazardous; M = mixed; NA = not available; EWTF = Explosive Waste Treatment Facility; ft^3 = cubic feet; gal = gallons; lbs = pounds; N/A = not applicable; SWSF = Solid Waste Storage Facility; RWPA/SSTL = Reactive Waste Packing Area / Small Scale Treatment Laboratory; DWTF = Decontamination and Waste Treatment Facility;LWPA = Liquid Waste Processing Area; RCRA = *Resource Conservation and Recovery Act*.

TABLE 4.15.2.1–1.—*Inspections and Findings of the Livermore Site and Site 300 by External Agencies in 2002 Relevant to Waste Management*

Medium	Description	Agency	Date	Finding
		Livermore Site		
Sanitary sewer	Annual compliance sampling	LWRP	October 7, 8	No violations
	Categorical sampling		October 21	No violations
Waste	Hazardous waste facilities	DTSC	May 22-24, 30 June 4	Received an inspection report and summary of violations. The alleged violations were storage of one container of waste more than 90 days in a 90-day generator area and storage of two waste containers for more than one year in a permitted storage area. The container in the 90-day area was subsequently moved to a permitted storage area and the two stored containers were shipped offsite.
	Medical waste	ACDEH	September 25	No violations
Storage tanks	Compliance with underground storage tank upgrade requirements and operating permits.	ACDEH	October 15, 16	No violations
		Site 300		
Waste	Permitted Hazardous Waste facilities (EWTF, EWSF, B883 CSA), Waste Accumulation Area B883 North, and Generator Areas.	DTSC	November 20, 21	No violations
Storage tanks	Compliance with underground storage tank upgrade requirements and operating permits	SJCEHD	October 17 November 25-27 December 13	Received notification of three minor violations concerning tank alarm and line leak testing documentation and an improperly functioning line leak detector. LLNL addressed these observations by instituting documentation requirements replacing the line leak detectors and conducting line leak testing.

Source: LLNL 2003l.
ACDEH = Alameda County Department of Environmental Health; CSA: Container Storage Area; DTSC: Department of Toxic Substances Control; EWSF: Explosives Waste Storage Facility; EWTF: Explosives Waste Treatment Facility; HW: hazardous waste; LLNL = Lawrence Livermore National Laboratory; LWRP = Livermore Water Reclamation Plant; SJCEHD = San Joaquin County Department of Environmental Health; SOV: Summary of violations.

TABLE 4.15.2.1–2.—*Summary of Permits Active in 2001 and 2002 Relevant to Waste Management*

Type of Permit	Livermore Site	Site 300
Hazardous Waste	EPA ID No. CA2890012584.	EPA ID No. CA2890090002.
	Authorization to mix resin in Unit CE231-1 under conditional exemption tiered permitting. Final closure plan submitted to DTSC for the Building 419 interim status unit (February 2001).	Part B Permit—Container Storage Area (Building 883) and Explosives Waste Storage Facility (issued May 23, 1996).
	Authorizations to construct the permitted units of Building 280, Building 695, and additions to Building 693.	Part B Permit—Explosives Waste Treatment Facility (issued October 9, 1997).
	Authorization under hazardous waste permit to operate 18 waste storage units and 14 waste treatment units.	Docket HWCA 92/93-031. Closure and Post-Closure Plans for Landfill Pit 6 and the Building 829 Open Burn Facility.
	Continued authorization to operate seven waste storage units and eight waste treatment units under interim status. Final closure plans submitted to DTSC for the Building 233 and Building 514 interim status units (May 2000).	Post-Closure Permit Application submitted for Building 829 Open Burn Facility (September 2000). Prepared a Notice of Deficiency (NOD) response document to be submitted to DTSC in February 2002.
	Notified DTSC on 3/31/01 that LLNL will not construct and operate Building 280 as a permitted unit as described in our Hazardous Waste Facility permit.	
Medical Waste	One permit for large quantity medical waste generation and treatment covering the Biology and Biotechnology Research Program, Health Services Department, Forensic Science Center, Medical Photonics Lab, and Tissue Culture Lab, and Chemistry and Materials Science Department.	Limited Quantity Hauling Exemption for small quantity medical waste generator.
Sanitary Sewer	Discharge Permit No. 1250 for discharges of wastewater to the sanitary sewer.	
	Permit 1510-G for discharges of sewerable groundwater from CERCLA restoration activities.	
Storage Tanks	Eight operating permits covering 11 underground petroleum product and hazardous waste storage tanks: 111-D1U2 Permit No. 6480; 113-D1U2 Permit No. 6482; 152-D1U2 Permit No. 6496; 271-D2U1 Permit No. 6501; 321-D1U2 Permit No. 6491; 322-R2U2 Permit No. 6504 (exempted); 365-D1U2 Permit No. 6492; and 611-D1U1, 611-G1U1, 611-G2U1, and 611-O1U1 Permit No. 6505.	One operating permit covering five underground petroleum product tanks assigned individual permit numbers: 871-D1U2 Permit No. 008013; 875-D1U2 Permit No. 006549; 879-D1U1 Permit No. 006785; 879-G3U1 Permit No. 007967; and 882-D1U1 Permit No. 006530.

Source: LLNL 2003l.
HWCA = *California Hazardous Waste Control Act*; DTSC = Department of Toxic Substances Control; EPA = U.S. Environmental Protection Agency; LLNL = Lawrence Livermore National Laboratory.

TABLE 5.2.8.1–3.—*Summary of Air Pollutant Emission Rates Associated with Project Operation Under the No Action Alternative under Maximum Conditions*

Pollutant	Vehicular Activity	Natural Gas Usage	Diesel Fuel Use	Total Annual	Significant Emission Level [a]	Average Daily [b]	Significant Emission Level [a]
	Emissions in tons per year			Emissions in tons per year		Emissions in pounds per day	
Precursor organic compounds	0.32	0.025	2.3×10^{-3}	0.35	15	2.7	80
Oxides of nitrogen	1.1	0.32	0.034	1.4	15	11	80
Carbon monoxide	6.0	0.054	7.3×10^{-3}	6.1	-	47	-
Sulfur oxides	0.041	1.8×10^{-3}	3.1×10^{-3}	0.046	-	0.35	-
Particulate matter (PM_{10})	0.60	0.032	2.4×10^{-3}	0.64	15	4.9	80
Formaldehyde		3.0×10^{-4}	3.0×10^{-4}	6.0×10^{-4}		4.6×10^{-3}	
Benzene		2.8×10^{-5}	4.8×10^{-5}	7.6×10^{-5}		5.9×10^{-4}	
Polycyclic organic matter			2.3×10^{-7}	2.3×10^{-7}		1.7×10^{-6}	
Arsenic			4.2×10^{-8}	4.2×10^{-8}		3.2×10^{-7}	
Beryllium			2.4×10^{-8}	2.4×10^{-8}		1.9×10^{-7}	
Cadmium			1.0×10^{-7}	1.0×10^{-7}		8.0×10^{-7}	
Hexavalent chromium			2.2×10^{-9}	2.2×10^{-9}		1.7×10^{-8}	
Lead			8.9×10^{-8}	8.9×10^{-8}		6.8×10^{-7}	
Manganese			1.4×10^{-7}	1.4×10^{-7}		1.1×10^{-6}	
Mercury			3.0×10^{-8}	3.0×10^{-8}		2.3×10^{-7}	
Nickel			1.7×10^{-6}	1.7×10^{-6}		1.3×10^{-5}	

[a] BAAQMD has established significant emission levels in response to local pollutant problems. Projects with emissions in excess of these levels must include stringent mitigation. Emissions related to construction and demolition activities are not specifically quantified in keeping with the BAAQMD's guidance for the analysis of construction impacts (discussed in Section 5.1.8.1) which emphasizes implementation of effective and comprehensive control measures rather than detailed quantification of construction emissions. If all of the control measures, as appropriate, depending on the size of the project area, will be implemented, then air pollutant emissions from construction activities would be considered a less than significant impact. Similarly, any demolition, renovation or removal of asbestos-containing building materials would be considered a less than significant impact if the activity complies with the requirements and limitations of district Regulation 11, Rule 2: Hazardous Materials; Asbestos Demolition, Renovation and Manufacturing (BAAQMD 1999).

[b] Average daily emission rate is based on an operating schedule of 5 days per week, 52 weeks per year.

BAAQMD = Bay Area Air Quality Management District.

TABLE 5.2.10.1–1.—*Summary of Input Parameters for Analysis of Community Noise Issues Under the No Action Alternative*

Parameter	Units	Site	Existing Environment	No Action Alternative
Daily vehicle traffic	1,000 vehicles	Livermore	22.0	22.6
		Site 300	0.5	No change.
Explosives testing [a]	Shot frequency (number per year)	Livermore	Shot frequency is not limited. Hundreds of experiments are conducted each year (e.g., 501 shots within the HEAF during FY2002).	Shot frequency would not be limited, but would not change appreciably.
		Site 300	Shot frequency is not limited. Typical activities include about 200 open air tests per year including gun firings and could include about 12 to 25 tests per year in the Contained Firing Facility.	Shot frequency would not be limited, but would not change appreciably. The activity on open air firing tables would continue to far exceed that in the Contained Firing Facility for the foreseeable future.
	Maximum weight in kilograms	Livermore	Shots range from gram level up to kilogram level. The highest weight shot ever fired in the HEAF was 10 kilograms of C4 (13.4-kilograms TNT equivalent) in the 10-kilogram spherical tank.	No change.
		Site 300	Shots range from gram level up to kilogram level. Based on the type of explosive used and constraints imposed by LLNL management to limit the maximum allowable sound pressure level, not to exceed 126 decibels in nearby populated areas.	No change.

[a] LLNL 2003ar.
FY = fiscal year; HEAF = High Explosives Application Facility; LLNL = Lawrence Livermore National Laboratory; TNT = trinitrotoluene.

TABLE 5.2.13.1–1.—*Types of Hazardous Chemicals in Use at the Livermore Site Under the No Action Alternative*

Chemical	Chemical Abstract Number	Existing Conditions Maximum/Average Quantity	No Action Average Maximum/Average Quantity
Paints/Solvents			
Paint (variety)	NA	700,000/320,296 lb	700,000/330,000 lb
Thinner, lacquer	NA	3,000/500 gal	3,000/515 gal
Methylene chloride	75-09-2	2000/55 gal	2000/58 gal
Methyl alcohol	67-56-1	1800/500 gal	1800/515 gal
Acetone	67-64-1	1200/740 gal	1200/760 gal
Metals			
Lead bricks or ingots	NA	1,000,000 lb	1,000,000 lb
Tantalum	7440-25-7	75,000/20,000 lb	75,000/20,600 lb
Cobalt	7440-48-4	16,500/14,000 lb	16,500 lb
Aluminum	7429-90-5	5000/800 lb	5000/824 lb
Chrome or chromium	7440-47-3	4700/1500 lb	4700/1545 lb
Acids/Bases/Oxidizers			
Oxygen, compressed	7782-44-7	870,000/75,000 ft^3	870,000 ft^3
Hydrogen peroxide<52%	7722-84-1	42,000/18,000 gal	42,000 gal
Ammonium hydroxide	1336-21-6	30,000/1600 lb	30,000/1650 lb
Sodium hydroxide	1310-73-2	25,500/14,000 lb	25,500 lb
Potassium hydroxide	1310-58-3	15,000/400 lb	15,000/410 lb
Sulfuric acid	7664-93-9	11,000/4500 lb	11,000 lb
Nitric acid	7697-37-2	7810/5000 lb	7810/5150 lb
Phosphoric acid	7664-38-2	3600/1000 lb	3600/1030 lb
Cyanuric acid	108-80-5	2500/500 lb	2500/515 lb
Hydrofluoric acid	7664-39-3	1500/850 lb	1500 lb
Industrial Gases			
Argon, compressed	7440-37-1	25,000,000/160,000 ft^3	25,000,000/164,800 ft^3
Helium	7440-59-7	5,000,000/300,000 ft^3	5,000,000/310,000 ft^3
Hydrogen, compressed	1333-74-0	1,500,000/50,000 ft^3	1,500,000/52,000 ft^3
Nitrogen, compressed (Liquified, gaseous)	7727-37-9	500,000/130,000 ft^3	500,000/133,000 ft^3
Carbon dioxide	124-38-9	176,000/124,000 ft^3	176,000/128,000 ft^3
Refrigerants			
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	76-13-1	170,000/16,000 lb	170,000/16,500 lb
Refrigerant, 123 SUVA, (2,2-Dichloro-1,1,1-trifluoroethane)	306-83-2	35,000/1,500 lb	35,000/1,550 lb
Freon 22 (Chlorodifluoromethane)	75-45-6	9000/5000 lb	9000/5150 lb
Freon 11 (Trichlorofluoromethane)	75-69-4	10000/5000 lb	10000/5150 lb
Freon 12 (Dichlorodifluoromethane)	75-71-8	6300/4000 lb	6300/4120 lb
Freon 14 (Tetrafluoromethane)	75-73-0	2,000/500 ft^3	2,000/515 ft^3

Sources: NNSA 2002c, TtNUS 2003.
Note: Additional chemicals are listed in Appendix B. Numbers are rounded.
ft^3 = cubic feet; lb = pounds; gal = gallons; NA = not available.

TABLE 5.2.13.1–2.—*Types of Hazardous Chemicals in Use at Site 300 Under the No Action Alternative*

Chemical	Chemical Abstract Number	Baseline Average Maximum/Average Quantity	No Action Average Maximum/Average Quantity
Paints/Solvents			
Paint (variety)	NA	7200/1200 lb	7200/1230 lb
Thinner, lacquer	NA	310/95 gal	310/125 gal
Methyl alcohol	67-56-1	90/5 gal	90/5 gal
Acetone	67-64-1	400/30 gal	400/35 gal
Metals			
Lead bricks or ingots	NA	25,000 lb	25,000 lb
Acids/Bases/Oxidizers			
Oxygen, compressed	7782-44-7	16,000/5,000 ft^3	16,000/5,150 ft^3
Sulfuric acid	7664-93-9	845/60 lb	845/62 lb
Cyanuric acid	108-80-5	500/50 lb	500/52 lb
Industrial Gases			
Argon, compressed	7440-37-1	30,000/30,000 ft^3	30,000/30,000 ft^3
Helium	7440-59-7	25,000/25,000 ft^3	25,000/25,800 ft^3
Hydrogen, compressed	1333-74-0	700/700 ft^3	700/720 ft^3
Nitrogen, compressed (Liquified, gaseous)	7727-37-9	312,000/280,000 ft^3	312,000/288,000 ft^3
Carbon dioxide	124-38-9	44,000/5,000 ft^3	44,000/5,200 ft^3
Refrigerants			
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	76-13-1	150/10 gal	150/10 gal
Freon 22 (Chlorodifluoromethane)	75-45-6	1,400/870 lb	1,400/910 lb
Freon 12 (Dichlorodifluoromethane)	75-71-8	660/220 lb	660/230 lb
Freon 13 (Chlorotrifluoromethane)	75-72-9	478/478 ft^3	492/492 ft^3
Freon 14 (Tetrafluoromethane)	75-73-0	2,000/500 ft^3	2,000/515 ft^3

Source: LLNL 2002w; TtNUS 2003.
Note: Additional chemicals are listed in Appendix B.
ft^3 = cubic feet; lb = pounds; gal = gallons, NA = not available.

TABLE 5.2.13.1–3.—*Types of Hazardous Materials in Use with New Operations Under the No Action Alternative*

Project Title	Hazardous Materials Expected
BioSafety Level 3 Facility	Small amounts of biotoxins associated with the cultured microorganisms. Typical bench-scale laboratory chemicals (solvents, acids, bases, basic elements, formaldehyde, chloroform, phenol, ethyl alcohol, isopropyl alcohol, sodium hydroxide, potassium hydroxide, and other routine industry-related sterilizing chemicals or cleaning agents). The quantities of chemicals would be well below the reportable quantity thresholds in SARA.
BioSafety Laboratories	Upgrading a series of buildings would include using BSL-1 and BSL-2 materials. Typical bench-scale laboratory chemicals (solvents, acids, bases, basic elements, formaldehyde, chloroform, phenol, ethyl alcohol, isopropyl alcohol, sodium hydroxide, potassium hydroxide, and other routine industry-related sterilizing chemicals or cleaning agents. The quantities of chemicals would be well below the reportable quantity thresholds in SARA.
Tritium Facility Modernization	Operations to support hydrogen isotope research. Tritium and typical bench-scale laboratory chemicals. The small quantities of chemicals would be used in demonstrating simple chemical reactions.
Site 300 Tritium Use	Tritium use.
Advanced Materials Program	Plutonium and other non-radioactive surrogates.
Reclassify B446 as BSL2 and other facilities	Upgrading facilities would include using BSL-1 and BSL-2 materials. Typical bench-scale laboratory chemicals (solvents, acids, bases, basic elements, formaldehyde, chloroform, phenol, ethyl alcohol, isopropyl alcohol, sodium hydroxide, potassium hydroxide, and other routine industry-related sterilizing chemicals or cleaning agents). The quantities of chemicals would be well below the reportable quantity thresholds in SARA.
Terascale Simulation Facility	Computer related materials.
Engineering Technology Complex Upgrade	No changes.
Central cafeteria replacement	Cleaning compounds.
International Security Research Facility	New building, limited to cleaning materials and office supplies.
Container Security Testing Facility	Neutron diagnostics, sealed sources.
Site 300 as a Response Training Facility	
National Ignition Facility	Targets and other materials (see Appendix M).
WIPP Mobile vender	Shipping function being prepared.

Source: TtNUS 2003.
SARA = *Superfund Amendments and Reauthorization Act* of 1986; SNM = special nuclear material; TRU = transuranic; WIPP = Waste Isolation Pilot Plant; BSL = BioSafety Level.

TABLE 5.2.13.2–2.—*Planned Projects Under the No Action Alternative and Associated Waste Projections*

Project Title	Project Description[a]	Expected Waste Streams and Quantities
BioSafety Laboratories (multiple projects)	Modifications to Buildings 132, 151, 153, 154, 190, 235, 241, 281, 432, 435, 446, T1527, T8545, and T4352.	No changes to routine waste generation. Construction debris accounted for in 93-200 tons of debris per year estimate. New operation would be expected to generate (total all waste categories 500-1,000 lb/yr, assumed minimum of 1 metric ton, 0.5-1 m^3/metric ton) Hazardous: 0-1 metric tons/yr (including biohazardous) Municipal solid waste: 0-1 metric tons/yr
Terascale Simulation Facility	Computers required to meet Strategic Computing Initiative.	New operation, not expected to generate hazardous, radioactive, or mixed waste.
D&D U325 Cooling Tower	An old LLW cooling tower to be removed.	No changes to routine waste generation. Several tons of debris would be disposed. Building is part of 700,000 ft^2 of excess properties to be removed. Potential for nonroutine TSCA waste.
D&D Building 222	22,000 ft^2 will be removed.	No changes to routine waste generation. 145 tons of debris would be disposed. Building is part of 225,000 ft^2 of excess properties to be removed. Potential for nonroutine TSCA waste.
D&D	Building 177 AVLIS legacy facility; 13,000 ft^2 will be removed.	No changes to routine waste generation. Up to 6,000 tons of debris. More than 5,000 tons would be recycled. D&D work would include a total of 85 tons of debris for disposal. Hazardous: 0-1 metric tons LLW: 10-20 m^3/yr MLLW: 0-1 m^3/yr TRU: 0 Municipal Solid Waste: 13-60 metric tons/yr. Building is part of 700,000-ft^2 of excess properties to be removed. Potential for nonroutine TSCA waste.
Remove and Replace Offices	Modular offices for 100 to 130 personnel removed per year.	No changes to routine waste generation. Assuming 25,000 to 30,000 ft^2 removed, 200 tons of debris would be disposed. Buildings are part of 255,000 ft^2 of excess properties to be removed. Potential for nonroutine TSCA waste. Construction of 25,000 to 30,000 ft^2 building would result in an estimated 50-60 tons of construction debris.
Site 300 Wetlands Enhancement	Mitigation ponds to replace ATA cooling tower.	None. Excess soil will be used in vicinity.
Tritium Facility Modernization	Renovation and modernization of Building 331.	No net change in routine waste generation as increases in programmatic activities are expected to be balanced by consolidation and other improvements. Construction wastes would be expected, approximately 2 tons/1,000 ft^2.
Site 300 Revitalization Project	Convert S300 to Hetch –Hetchy.	Only construction debris.
Building 292 Cleanup	Clean up T2 contaminated target and machine rooms.	No changes to routine waste generation. Wastes would be considered nonroutine.

TABLE 5.2.13.2–2.—*Planned Projects Under the No Action Alternative and Associated Waste Projections (continued)*

Project Title	Project Description[a]	Expected Waste Streams and Quantities
Reclassify Building446 as BSL-2 Facility	Facility Reclassify entire building to BSL-2 standard.	New operation would be expected to generate: Hazardous: 0-1 metric tons/yr (including biohazardous) LLW: 0-1 m^3/yr MLLW: 0-1 m^3/yr TRU: 0 Municipal Solid Waste: 0-1 metric tons/yr
Engineering Technology Complex Upgrade	Modifications to Building 321 to meet seismic standards, improve space utilization, and add new high precision machine and inspection equipment.	Due to modernization and consolidation, routine waste generation would be expected to decrease. Construction wastes would be expectedApproximately 2 tons per 1,000 ft^2. Upgrade work would be expected to generate: Hazardous 0-2 metric tons/yr (for 3 years) LLW: 12-24 m^3/yr (for 3 years, assumes 0.5 to 1 ton/m^3) MLLW: 1-2 m^3/yr (for 3 years, assumes 0.5 to 1 ton/m^3) TRU: 0 Municipal Solid Waste: 100 metric tons/yr (for 3 years)
Building 298 Roof Replacement	Replace leaking 47,000 ft^2 roof.	No changes to routine waste generation. Assuming 0.5-foot thick roof, 600 tons of debris would be disposed. Potential for nonroutine TSCA waste. Construction of new roof would result in an estimated several tons of construction debris.
Protection of Real Property (roofs)	Reroof Buildings 111, 113, 121, 141, 194, 231, 241, 251, 281, 321, and 332	No changes to routine waste generation. Assuming 840,000 ft^2 of roof, 0.5 foot thick roof, 10,000 tons of debris would be disposed. Potential for nonroutine TSCA waste. Construction of new roofs would result in estimated tens of tons of construction debris.
Central Cafeteria Replacement	Replace existing temporary central cafeteria.	Due to modernization and consolidation, routine waste generation would be expected to decrease. Construction wastes would be expected, approximately 2 tons/1,000 ft^2.
BioSafety Level 3 Facility	1,500 ft^2 building to support biological detection/counter-terrorism.	New operation would be expected to generate: Hazardous: 0-1 metric tons/yr (including biohazardous) Municipal Solid Waste: 0-1 metric tons/yr
International Security Research Facility	64,000 ft^2 building to consolidate national security programs.	Due to modernization and consolidation, routine waste generation would be expected to decrease. Construction wastes would be expected, approximately 120 tons.
Container Security Testing Facility	Two small buildings, location.	No changes to routine waste generation. Construction wastes would be expected, approximately 2 tons/1,000 ft^2.
Site 300 Response Training Facility	Modifying an existing building for assembling and disassembling explosive training devices.	Due to modernization and consolidation, routine waste generation would be expected to decrease. Upgrade construction debris accounted for an estimated 93 to 200 tons of debris per year.

TABLE 5.2.13.2–2.—*Planned Projects Under the No Action Alternative and Associated Waste Projections (continued)*

Project Title	Project Description[a]	Expected Waste Streams and Quantities
National Ignition Facility	Laser system and facility for stockpile stewardship and understanding weapons physics.	Start up of existing capability would be expected to generate the following waste. Hazardous: 15 metric tons per year LLW: 72 m^3/yr MLLW: 6.9 m^3/yr Municipal solid waste: several metric tons/yr
WIPP Mobile Vendor	Ship waste to CCF or WIPP	No changes to routine waste generation.
East Avenue Security Upgrade	Limit access along East Avenue to enhance security of LLNL and SNL/CA.	No changes to routine waste generation.
Superblock Security Upgrade	Add physical barriers.	No changes to routine waste generation. Upgrade construction debris accounted for in 93 to 200 tons of debris per year estimate.
D&D Building 514	Existing EPD waste treatment facility to be replaced by DWTF. D&D after startup of DWTF.	No changes to routine waste generation. Potential for nonroutine TSCA waste, mixed, hazardous, and radioactive waste. Moving permitted capacity to DWTF is considered an administrative action and would not result in changes of routine waste generation.
Extend Fifth Street	Improve traffic circulation with east-west connection.	No changes to routine waste generation. Upgrade construction debris accounted for in 93 to 200 tons of debris per year estimate.
Westgate Drive improvements	Widen Westgate Drive and improve circulation.	No changes to routine waste generation. Upgrade construction debris accounted for in 93 to 200 tons of debris per year estimate.
Deactivation and D&D projects	D&D approximately 255,000 ft^2.	See Table A.2.3–2 waste generation amounts for D&D activities.
Superblock Stockpile Stewardship Program Operations	Several Stockpile Stewardship Programs.	LLW – 460 drums/yr and 10 transportainers/yr TRU – 120 drums/yr and 10 drum overpacks (2/yr) CY 2004 – 20 waste boxes and then 5 waste boxes/yr
Advanced Materials Program	Use of solid state lasers to conduct laser isotope separation experiments.	See Advanced Materials Program CX for estimates (or Appendix N, Integrated Technology Project).
Site Utilities Upgrade	Various upgrades to mechanical utilities, compressed air plant, potable water system, transmission lines.	Only construction debris and noncontaminated solid waste.
Plutonium Facility Ductwork Replacement	Replaces 40-year old glovebox exhaust system.	See glovebox exhaust replacement CX.
SNM Tests with Optical Science Laser	Use of the Optical Science Laser laboratory for an ongoing material study.	Use only encapsulated SNM. No appreciable radioactive waste generations.

Source: LLNL 2002y, TtNUS 2003.

[a] Detailed project descriptions are provided in Appendix A.

Note: SNM tests with Optical Science Laser, Site 300 tritium use, and Advanced Materials Program projects were considered to be modifications of existing processes and not relevant changes impacting waste generation.

ATA = Advanced Test Accelerator; AVLIS = Advanced Vapor Laser Isotope separation; CCF = Central Characterization Facility; CX = categorical exclusion; D&D = Decontamination and Decommissioning; DWTF = Decontamination and Waste Treatment Facility; EPD = Environmental Protection Department; ft^2 = square feet; GBE = lb/yr = pounds per year; LLW = low-level waste; m^3/yr = cubic meters per year; MLLW = mixed low-level waste; SNM = special nuclear material TRU = transuranic waste; TSCA = *Toxic Substances Control Act*; WIPP = Waste Isolation Pilot Plant.

TABLE 5.3.8.1–1.—*Summary of Input Parameters for Air Quality Analysis Under the Proposed Action*

Parameter	Units	Site	No Action Alternative	Proposed Action
Daily vehicle traffic	1,000 vehicles	Livermore	22.6	23.7
		Site 300	0.5	No Change
Air Emission Sources and Facility Status[d]	-	Livermore	The Livermore Site would continue to rank as a mid-sized facility, subject to offset requirements for nonattainment pollutants and employ good controls on POC and NOx sources; remain a minor source for HAPs under NESHAP; and not a significant source of toxic air pollutants.	No change
		Site 300	Site 300 is a small source per definition of the SJVUAPCD, and remains a minor source for HAPs under NESHAP.	No change

HAP = hazardous air pollutant; NESHAP = National Emission Standards for Hazardous Air Pollutants; NO_x = oxides of nitrogen; POC = precursor organic compounds; SJVUAPCD = San Joaquin Valley Air Pollution Control District.

TABLE 5.3.8.1–2.—*Projected Maximum Carbon Monoxide Concentrations Associated with Increased Traffic Conditions in the Environs of the Livermore Site Under the Proposed Action*

	No Action Alternative	Proposed Action
Traffic Assessment [a]		
Peak hourly background traffic through intersection	3,757	3,757
Additional traffic related to alternative	62	166
Total traffic through intersection	3,819	3,923
Maximum 1-Hour Concentrations (ppm)		
Near-roadway CO concentration [b] from:		
Background traffic	0.66	0.66
Increased traffic from alternative	0.012	0.032
Estimated background concentration [c]	3.5	3.5
Total - traffic plus background	4.2	4.2
% of state ambient air quality standard [d]	21	21
Maximum 8-Hour Concentrations (ppm)		
Near-roadway CO concentration from:		
Background traffic (ppm) [c]	0.46	0.46
Increased traffic from alternative [c]	0.008	0.023
Estimated background concentration	1.7	1.7
Total - traffic plus background	2.2	2.2
% of state ambient air quality standard [d]	25	25

[a] Peak hourly traffic is estimated to be 10 percent of the total daily traffic passing through the intersection of Vasco and Patterson Pass Roads. This value (10 percent) is recommended by the air district for use when hourly values are not available. Local traffic patterns are discussed in Section 4.13.2.
[b] Concentrations are assessed for locations 25 feet from roadway. Assessment methodology is discussed in Section 5.1.8.1, and follows BAAQMD CEQA Guidelines (1999). Emission factors and ambient concentrations of carbon monoxide are expected to decline over time through 2010 due to improved emission controls on newer vehicles and reformulated gasoline.
[c] Background carbon monoxide is defined as that part of the ambient CO concentration that is not attributable to traffic sources from a nearby street or intersection. It is calculated according to procedures recommended by BAAQMD (1999).
[d] National 1-hour ambient air quality standard is 35 ppm; more restrictive state standards, 20 ppm, is used. National and state 8-hour ambient air quality standard is 9 ppm.
BAAQMD = Bay Area Air Quality Management District; CEQA = *California Environmental Quality Act*; CO = carbon monoxide; ppm = parts per million.

TABLE 5.3.8.1–3.—*Summary of Air Pollutant Emission Rates Associated with Project Operation Under the Proposed Action Under Maximum Conditions.*

Pollutant	Emissions for Individual Activities under the Proposed Action in tons per year [a]			Total Emissions in tons per year			Average Daily Emissions in pounds per day		
	Vehicular Activity	Natural Gas Usage	Diesel Fuel Use	Proposed Action	No Action Alternative	Significant Emission Level [b]	Proposed Action [c]	No Action Alternative [c]	Significant Emission Level [b]
Precursor organic compounds	0.87	0.22	2.3×10^{-3}	1.1	0.35	15	8.4	2.7	80
Oxides of nitrogen	2.9	2.8	0.034	5.7	1.4	15	44	11	80
Carbon monoxide	16	0.48	7.3×10^{-3}	17	6.1	-	127	47	-
Sulfur oxides	0.11	0.016	3.1×10^{-3}	0.13	0.046	-	0.99	0.35	-
Particulate matter (PM_{10})	1.6	0.28	2.4×10^{-3}	1.9	0.64	15	15	4.9	80
Formaldehyde		2.6×10^{-3}	3.0×10^{-4}	2.9×10^{-3}	6.0×10^{-4}		0.023	4.6×10^{-3}	
Benzene		2.5×10^{-4}	4.8×10^{-5}	3.0×10^{-4}	7.6×10^{-5}		2.3×10^{-3}	5.9×10^{-4}	
Polycyclic organic matter			2.3×10^{-7}	2.3×10^{-7}	2.3×10^{-7}		1.7×10^{-6}	1.7×10^{-6}	
Arsenic			4.2×10^{-8}	4.2×10^{-8}	4.2×10^{-8}		3.2×10^{-7}	3.2×10^{-7}	
Beryllium			2.4×10^{-8}	2.4×10^{-8}	2.4×10^{-8}		1.9×10^{-7}	1.9×10^{-7}	
Cadmium			1.0×10^{-7}	1.0×10^{-7}	1.0×10^{-7}		8.0×10^{-7}	8.0×10^{-7}	
Hexavalent chromium			2.2×10^{-9}	2.2×10^{-9}	2.2×10^{-9}		1.7×10^{-8}	1.7×10^{-8}	
Lead			8.9×10^{-8}	8.9×10^{-8}	8.9×10^{-8}		6.8×10^{-7}	6.8×10^{-7}	
Manganese			1.4×10^{-7}	1.4×10^{-7}	1.4×10^{-7}		1.1×10^{-6}	1.1×10^{-6}	
Mercury			3.0×10^{-8}	3.0×10^{-8}	3.0×10^{-8}		2.3×10^{-7}	2.3×10^{-7}	
Nickel			1.7×10^{-6}	1.7×10^{-6}	1.7×10^{-6}		1.3×10^{-5}	1.3×10^{-5}	

[a] Emissions related to construction and demolition activities are not specifically quantified in keeping with the BAAQMD's guidance for the analysis of construction impacts (discussed in Section 5.1.8.1) which emphasizes implementation of effective and comprehensive control measures rather than detailed quantification of construction emissions. If all of the control measures, as appropriate, depending on the size of the project area, will be implemented, then air pollutant emissions from construction activities would be considered a less than significant impact. Similarly, any demolition, renovation or removal of asbestos-containing building materials would be considered a less than significant impact if the activity complies with the requirements and limitations of district Regulation 11, Rule 2: Hazardous Materials; Asbestos Demolition, Renovation and Manufacturing (BAAQMD 1999).

[b] BAAQMD has established significant emission levels in response to local pollutant problems. Projects with emissions in excess of these levels must include stringent mitigation.

[c] Average daily emission rate is based on an operating schedule of 5 days per week, 52 weeks per year.

BAAQMD = Bay Area Air Quality Management District.

TABLE 5.3.10.1–1.—*Summary of Input Parameters for Analysis of Community Noise Issues Under the Proposed Action*

Parameter	Units	Site	No Action Alternative	Proposed Action
Daily vehicle traffic	1,000 vehicles	Livermore	22.6	23.7
		Site 300	0.5	No change
Explosives testing[a]	Shot frequency (number per year)	Livermore	Hundreds of experiments are conducted each year (e.g., 501 shots within the HEAF during FY2002).	Shot frequency would not change appreciably.
		Site 300	Shot frequency would not be limited, but would not change appreciably from current levels. Typical activities include about 200 open-air tests per year (including gun firings) and could include about 12 to 25 tests per year in the Contained Firing Facility. It is anticipated that the activity on open air firing tables will continue to far exceed that in the Contained Firing Facility for the foreseeable future.	Shot frequency would not change appreciably.
	Maximum weight in kilograms	Livermore	Shot weight would continue to range from gram level up to kilogram level.	No change
		Site 300	Shot weight would continue to range from gram level up to kilogram level. Based on the type of explosive used and constraints imposed by LLNL management to limit the maximum allowable sound pressure level, not to exceed 126 decibels in nearby populated areas.	No change

[a] LLNL 2003ar.
FY = fiscal year; HEAF = High Explosive Application Facility; LLNL = Lawrence Livermore National Laboratory.

TABLE 5.3.13.1–1.—*Types of Hazardous Chemicals for Use at the Livermore Site Under the Proposed Action*

Chemical	Chemical Abstract Number	No Action Average Maximum/Average Quantity	Proposed Action Maximum/Average Quantity
Paints/Solvents			
Paint (variety)	NA	700,000/330,000 lb	700,000/352,000 lb
Thinner, lacquer	NA	3,000/515 gal	3,000/550 gal
Methylene chloride	75-09-2	2,000/58 gal	2,000/60 gal
Methyl alcohol	67-56-1	1,800/515 gal	1,800/550 gal
Acetone	67-64-1	1,200/760 gal	1,200/810 gal
Metals (No changes are expected)			
Lead bricks or ingots	NA	1,000,000 lb	1,000,000 lb
Tantalum	7440-25-7	75,000/20,600 lb	75,000/20,000 lb
Cobalt	7440-48-4	16,500/14,300 lb	16,500/14,000 lb
Aluminum	7429-90-5	5,000/824 lb	5,000/800 lb
Chrome or chromium	7440-47-3	4,700/1,545 lb	4,700/1,500 lb
Acids/Bases/Oxidizers			
Oxygen, compressed	7782-44-7	870,000/78,000 ft^3	870,000/83,000 ft^3
Hydrogen peroxide<52%	7722-84-1	42,000/18,600 gal	42,000/20,000 gal
Ammonium hydroxide	1336-21-6	30,000/1,650 lb	30,000/1,800 lb
Sodium hydroxide	1310-73-2	25,500/14,400 lb	25,500/15,000 lb
Potassium hydroxide	1310-58-3	15,000/410 lb	15,000/440 lb
Sulfuric acid	7664-93-9	11,000/4,640 lb	11,000/5,000 lb
Nitric acid	7697-37-2	7,810/5,150 lb	7,810/5,500 lb
Phosphoric acid	7664-38-2	3,600/1,030 lb	3,600/1,100 lb
Cyanuric acid	108-80-5	2,500/515 lb	2,500/550 lb
Hydrofluoric acid	7664-39-3	1,500/890 lb	1,500/930 lb
Industrial Gases			
Argon, compressed	7440-37-1	25,000,000/165,000 ft^3	25,000,000/180,000 ft^3
Helium	7440-59-7	5,000,000/310,000 ft^3	5,000,000/330,000 ft^3
Hydrogen, compressed	1333-74-0	1,500,000/52,000 ft^3	1,500,000/55,000 ft^3
Nitrogen, compressed (Liquified, gaseous)	7727-37-9	500,000/133,000 ft^3	500,000/150,000 ft^3
Carbon dioxide	124-38-9	176,000/128,000 ft^3	176,000/136,000 ft^3
Refrigerants			
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	76-13-1	170,000/16,500 lb	170,000/18,000 lb
Refrigerant, 123 SUVA, (2,2-Dichloro-1,1,1-trifluoroethane)	306-83-2	35,000/1,550 lb	35,000/1,700 lb
Freon 22 (Chlorodifluoromethane)	75-45-6	9,000/5,150 lb	9,000/5,500 lb
Freon 11 (Trichlorofluoromethane)	75-69-4	10,000/5,150 lb	10,000/5,500 lb
Freon 12 (Dichlorodifluoromethane)	75-71-8	6,300/4,120 lb	6,300/4,400 lb
Freon 14 (Tetrafluoromethane)	75-73-0	2,000/515 ft^3	2,000/550 ft^3

Source: LLNL 2002m.
Note: numbers are rounded. Additional chemicals are listed in Appendix B.
ft^3 = cubic feet; gal = gallons; lbs = pounds; NA = not available.

TABLE 5.3.13.1–2.—*List of Hazardous Chemicals for Use at Site 300 Under the Proposed Action*

Chemical	Chemical Abstract Number	No Action Average Maximum/Average Quantity	Proposed Action Maximum/Average Quantity
Paints/Solvents			
Paint (variety)	NA	7,200/1,230 lb	7,200/1,300 lb
Thinner, lacquer	NA	310/125 gal	310/105 gal
Methyl alcohol	67-56-1	90/5 gal	90/5 gal
Acetone	67-64-1	400/35 gal	400/30 gal
Metals (No changes are expected)			
Lead bricks or ingots	NA	25,000 lb	25,000 lbs
Acids/Bases/Oxidizers			
Oxygen, compressed	7782-44-7	16,000/5,150 ft^3	16,000/5,500 ft^3
Sulfuric acid	7664-93-9	845/62 lb	845/70 lb
Cyanuric acid	108-80-5	500/52 lb	500/55 lb
Industrial Gases			
Argon, compressed	7440-37-1	30,000/30,000 ft^3	30,000/33,000 ft^3
Helium	7440-59-7	25,000/25,800 ft^3	25,000/27,500 ft^3
Hydrogen, compressed	1333-74-0	700/720 ft^3	700/770 ft^3
Nitrogen, compressed (Liquified, gaseous)	7727-37-9	312,000/288,000 ft^3	312,000/310,000 ft^3
Carbon dioxide	124-38-9	44,000/5,200 ft^3	44,000/5,500 ft^3
Refrigerants			
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	76-13-1	150/10 gal	150/10 gal
Freon 22 (Chlorodifluoromethane)	75-45-6	1,400/910 lb	1,400/950 lb
Freon 12 (Dichlorodifluoromethane)	75-71-8	660/230 lb	660/240 lb
Freon 13 (Chlorotrifluoromethane)	75-72-9	478/478 ft^3	478/478 ft^3 (No change)
Freon 14 (Tetrafluoromethane)	75-73-0	2,000/515 ft^3	2,000/550 ft^3

Source: LLNL 2002m, TtNUS 2003.
Note: Numbers are rounded. Additional chemicals are listed in Appendix B.
ft^3 = cubic feet; gal = gallons; lb = pounds; NA = not available.

Projections for specific hazardous chemicals for existing Livermore Site operations and Site 300 operations under the Proposed Action are presented in Tables 5.3.13.1–1 and 5.3.13.1–2, respectively. Additional detail is provided in Appendix B.

Increases in overall radioactive materials and explosive materials based on current administrative limits would be expected. Overall, no additional storage handling capacity, regulatory requirements, or security requirements would be needed. Under the Proposed Action, radioactive material and explosive material requirements used for analysis would not exceed existing material management capacities (TtNUS 2003). No new impacts are expected.

New Operations

LLNL anticipates hazardous material usage rates to increase over the next 10 years. The majority of the increase would be due to the full implementation of the NIF, BSL-3, and Integrated

TABLE 5.3.13.2–2.—*Planned Projects Under the Proposed Action and Associated Waste Projections*

Project Title	Project Description[a]	Expected Waste Streams and Quantities
D&D Building 194 line of flight tube	D&D project	No changes to routine waste generation. Several tons of debris would be disposed. Building is part of 820,000 ft^2 of excess properties to be removed. Potential for nonroutine TSCA waste.
D&D Building 808	D&D project	No changes to routine waste generation. Assuming 1,500 ft^2 removed, 9 tons of debris would be generated. Building is part of 820,000 ft^2 of excess properties to be removed. Potential for nonroutine TSCA waste. It is estimated that only 0.350 metric tons per 1,000 ft^2 would be hazardous. Much of the total debris would be diverted, recycled, or reclaimed (67% would be diverted).
D&D Building 412	D&D project	No changes to routine waste generation. Assuming 29,000 ft^2 removed, 190 tons of debris would be generated. Building is part of 820,000 ft^2 of excess properties to be removed. Potential for nonroutine TSCA waste. It is estimated that only 0.350 metric tons per 1,000 ft^2 would be hazardous. Much of the total debris would be diverted, recycled, or reclaimed (67% would be diverted).
D&D Building 175 North Section	D&D project	No changes to routine waste generation. Assuming 16,000 ft^2 removed, 100 tons of debris would be generated. Building is part of 820,000 ft^2 of excess properties to be removed. Potential for nonroutine TSCA waste. It is estimated that only 0.350 metric tons per 1,000 ft^2 would be LLW, mixed waste, or hazardous. Much of the total debris would be diverted, recycled, or reclaimed (67% would be diverted).
D&D Building 212 ITC Accelerator Building	D&D project	No changes to routine waste generation. Assuming 60,000 ft^2 removed, 360 tons of debris would be generated. Building is part of 820,000 ft^2 of excess properties to be removed. Potential for nonroutine TSCA waste. It is estimated that only 0.350 metric tons per 1,000 ft^2 would be LLW, mixed waste, or hazardous. Much of the total debris would be diverted, recycled, or reclaimed (67% would be diverted).

TABLE 5.3.13.2–2.—*Planned Projects Under the Proposed Action and Associated Waste Projections (continued)*

Project Title	Project Description[a]	Expected Waste Streams and Quantities
D&D Building 251	EPD heavy element handling facility.	No changes to routine waste generation. Assuming 32,000 ft^2 removed, 190 tons of debris would be generated. Building is part of 820,000 ft^2 of excess properties to be removed. Potential for nonroutine TSCA waste. It is estimated that only 0.350 metric tons per 1,000 ft^2 would be LLW, mixed waste, or hazardous. Much of the total debris would be diverted, recycled, or reclaimed (67% would be diverted).
D&D Building 419	EPD materials handling and processing facility.	No changes to routine waste generation. Assuming 8,000 ft^2 removed, 48 tons of debris would be generated. Building is part of 820,000 ft^2 of excess properties to be removed. Potential for nonroutine TSCA waste. It is estimated that only 0.350 metric tons per 1,000 ft^2 would be LLW, mixed waste, or hazardous. Much of the total debris would be diverted, recycled, or reclaimed (67% would be diverted).
D&D Building 171	Storage building.	No changes to routine waste generation. Assuming 9,000 ft^2 removed, 54 tons of debris would be generated. Building is part of 820,000 ft^2 of excess properties to be removed. Potential for nonroutine TSCA waste. It is estimated that only 0.350 metric tons per 1,000 ft^2 would be LLW, mixed waste, or hazardous. Much of the total debris would be diverted, recycled, or reclaimed (67% would be diverted).
Increased administrative limit for plutonium in Super block	Increase to 1,500 kg fuel-grade Pu, 500 kg enriched uranium, and 3,000 kg depleted uranium.	No changes to routine waste generation.
Integrated Technology Project	Plutonium isotope separation project in Building 332	See Appendix N 1. Hazardous: 0.42 m^3/yr 3. TRU: 10.42 m^3/yr 2. LLW: 10.42 m^3/yr 4. Mixed Waste: 0.42 m^3/yr
Energetic Materials Processing Center	Consolidates some existing high explosives operations into modern facility.	Due to modernization and consolidation, routine waste generation would be expected to decrease. Construction wastes would be expected, approximately 2 tons per 1,000 ft^2.
Increased Tritium Facility material limits	Increase MAR to 30 grams tritium and tritium limits to 35 grams.	New operation would be expected to generate: Hazardous: No change LLW: 4 m^3/yr TRU: 0 Municipal Solid Waste: No change D&D work: approximately 2 tons per 1,000 ft^2, 20-40 m^3 LLW

TABLE 5.3.13.2–2.—*Planned Projects Under the Proposed Action and Associated Waste Projections (continued)*

Project Title	Project Description[a]	Expected Waste Streams and Quantities
Increased MAR limit for Plutonium Facility	Increase from 20 kg to 60 kg fuel-grade equivalent plutonium in each of two rooms.	No change to routine waste generation.
Materials Science Modernization Project	Research complex to conduct NNSA program precision fabrication and materials experiments.	Due to modernization and consolidation, routine waste generation would be expected to decrease. Construction wastes would be expected, approximately 2 tons per 1,000 ft^2.
High Explosives Development Center	Replace and modernize chemistry and materials science facilities.	Due to modernization and consolidation, routine waste generation would be expected to decrease. Construction wastes would be expected, approximately 2 tons per 1,000 ft^2.
Berkeley Waste Drums	Transport LBNL TRU and mixed TRU waste drums to LLNL for shipment to WIPP.	No changes to routine waste generation.
Projected Increase in Worker Population	Approximately 10 percent increase in workforce across LLNL.	10 percent increase across all categories.
Building Utilities Upgrade	Upgrades to building utilities systems for technological or maintenance reasons.	Construction wastes would be expected, approximately 2 tons per 1,000 ft^2.
Building Seismic Upgrades	Upgrades for buildings seismic deficiencies.	Construction wastes would be expected, approximately 2 tons per 1,000 ft^2.
CBNP Expansion	New technologies for Chemical and Biological Nonproliferation Program.	Very low volumes of chloroform, formaldehyde and biological waste.
Petawatt Laser Prototype	Develop petawatt capability in Building 381.	New operation would be expected to generate. Hazardous: several metric tons per year LLW: 0 TRU: 0 Municipal Solid Waste: several metric tons per year Construction: approximately 2 tons per 1,000 ft^2

TABLE 5.3.13.2–2.—*Planned Projects Under the Proposed Action and Associated Waste Projections (continued)*

Project Title	Project Description[a]	Expected Waste Streams and Quantities
NIF Materials	NNSA proposed experiments with materials	New operation would be expected to generate: Hazardous: 15 metric tons per year LLW: 190 m^3/yr MLLW: 6.9 m^3 per year TRU: none Municipal Solid Waste: several metric tons per year Construction: approximately 2 tons per 1,000 ft^2
NIF Neutron Spectrometer	Add neutron spectrometer to the NIF	New operation would be expected to generate: Hazardous: none Municipal Solid Waste: (included in site-wide quantities) Construction: approximately 2 tons/1,000 ft^2
Consolidated Security Facility	50K gross square feet facility to house Security Department. support staff; currently collocated	No changes to routine waste generation. Consolidation of existing operations. Construction wastes would be expected, approximately 2 tons per 1,000 ft^2
Building 696R Mixed Waste Permit	Permit modification to authorize managing hazardous and mixed waste in Building 696 (currently manages TRU wastes only). Replaces capability of Building 280.	No changes to routine waste generation. Consolidation of existing operations.

Source: LLNL 2002y, TtNUS 2003.
[a] Detailed project descriptions are provided in Appendix A.
CBNP = : D&D = decontamination and decommissioning; EPD = ; ft^2 = square foot/feet; ITC = ; ITC = ; K = thousand; kg = kilograms; LBNL = Lawrence Berkley National Laboratory; LLW = low-level waste; LLNL = Lawrence Livermore National Laboratory; m^3/yr = cubic meters per year; MAR = material-at-risk ; MLLW = mixed low-level waste; NIF = National Ignition Facility; PSA = project specific analysis; TRU = transuranic; TSCA = *Toxic Control Substance Act*; WIPP = Waste Isolation Pilot Plant.

TABLE 5.4.8.1–1.—*Summary of Input Parameters for Air Quality Analysis Under the Reduced Operation Alternative*

Parameter	Units	Site	Existing Environment	Reduced Operation Alternative
Daily vehicle traffic	1,000 vehicles	Livermore	22.6	21
		Site 300	0.5	No Change
Air emission sources and facility status	-	Livermore	The Livermore Site would continue to rank as a mid-sized facility, subject to offset requirements for nonattainment pollutants, and employ good controls on POC and NO_x emission sources, remain a minor source for HAP under NESHAP; not a significant source of toxic air pollutants.	No change
		Site 300	Site 300 would remain a small source per definition of the SJVUAPCD and a minor source for HAPs under NESHAPs, not a significant source of toxic air pollutants.	No change

BAAQMD = Bay Area Air Quality Management District; SJVUAPCD = San Joaquin Valley Unified Air Pollution Control District; HAP = hazardous air pollutant; NOx = oxides of nitrogen; NESHAP = National Emission Standards for Hazardous Air Pollutants; POC = precursor organic compounds.

TABLE 5.4.8.1–2.—*Projected Maximum Carbon Monoxide Concentrations Associated with Decreased Traffic Conditions in the Environs of the Livermore Site Under the Reduced Operation Alternative*

	No Action Alternative	Reduced Operation Alternative
Traffic Assessment [a]		
Peak hourly background traffic through intersection	3,757	3,757
Additional traffic related to alternative	62	-
Reduced traffic related to alternative	-	-187
Total traffic through intersection	3,819	3,570
Maximum One-Hour Concentrations (ppm)		
Near-roadway CO concentration [b] from:		
Background traffic	0.66	0.66
Increased traffic from alternative	0.012	-
Reduction in CO concentration due to decreased traffic from alternative	-	-0.036
Estimated background concentration [c]	3.5	3.5
Total traffic plus background	4.2	4.1
% of state ambient air quality standard [d]	21	21
Maximum Eight-Hour Concentrations (ppm)		
Near-roadway CO concentration from:		
Background traffic (ppm) [c]	0.46	0.46
Increased traffic from alternative [c]	0.008	-
Decreased traffic from alternative [c]	-	-0.025
Estimated background concentration	1.7	1.7
Total traffic plus background	2.2	2.2
% of state ambient air quality standard [d]	25	24

[a] Peak hourly traffic is estimated to be 10 percent of the total daily traffic passing through the intersection of Vasco and Patterson Pass Roads. This value (10 percent) is recommended by the air district for use when hourly values are not available. Local traffic patterns are discussed in Section 4.13.2.

[b] Concentrations are assessed for locations 25 feet from roadway for the year 2014. Assessment methodology is discussed in Section 5.1.8.1, and follows BAAQMD CEQA Guidelines (1999). Emission factors and ambient concentrations of carbon monoxide are expected to decline over time through 2010 due to improved emission controls on newer vehicles and reformulated gasoline. A negative concentration represent a net air quality benefit due to reduced emissions associated with decreased traffic.

[c] Background carbon monoxide is defined as that part of the ambient CO concentration that is not attributable to traffic sources from a nearby street or intersection. It is calculated according to procedures recommended by BAAQMD (1999).

[d] National one-hour ambient air quality standard is 35 ppm; more restrictive state standards, 20 ppm, is used. National and state eight-hour ambient air quality standard is 9 ppm.

BAAQMD = Bay Area Air Quality Management District; CEQA = *California Environmental Quality Act;* CO = carbon monoxide; ppm = parts per million.

TABLE 5.4.8.1–3.—*Summary of Air Pollutant Emission Reductions Associated with Scaled Back Operations Under the Reduced Operation Alternative*

Pollutant	Emissions for Individual Activities under the Proposed Action in tons per year [a, b]			Total Emissions in tons per year			Average Daily Emissions in pounds per day		
	Vehicular Activity	Natural Gas Usage	Diesel Fuel Use	Reduced Operation Alternative	No Action Alternative	Significant Emission Level [c]	Reduced Operation Alternative [d]	No Action Alternative [d]	Significant Emission Level [c]
Precursor organic compounds	-0.97	-0.031	-2.3×10^{-3}	-1.0	0.35	15	-5.2	2.7	80
Oxides of nitrogen	-3.2	-0.39	-0.034	-3.7	1.4	15	-20	11	80
Carbon monoxide	-18	-0.066	-7.3×10^{-3}	-18	6.1	-	-93	47	-
Sulfur oxides	-0.12	-2.2×10^{-3}	-3.1×10^{-3}	-0.13	0.046	-	-0.67	0.35	-
Particulate matter (PM_{10})	-1.8	-0.039	-2.4×10^{-3}	-1.9	0.64	15	-9.6	4.9	80
Formaldehyde		-3.6×10^{-4}	-3.0×10^{-4}	-6.6×10^{-4}	6.0×10^{-4}		-5.1×10^{-3}	4.6×10^{-3}	
Benzene		-3.4×10^{-5}	-4.8×10^{-5}	-8.2×10^{-5}	7.6×10^{-5}		-6.3×10^{-4}	5.9×10^{-4}	
Polycyclic organic matter			-2.3×10^{-7}	-2.3×10^{-7}	2.3×10^{-7}		-1.7×10^{-6}	1.7×10^{-6}	
Arsenic			-4.2×10^{-8}	-4.2×10^{-8}	4.2×10^{-8}		-3.2×10^{-7}	3.2×10^{-7}	
Beryllium			-2.4×10^{-8}	$--2.4 \times 10^{-8}$	2.4×10^{-8}		-1.9×10^{-7}	1.9×10^{-7}	
Cadmium			-1.0×10^{-7}	-1.0×10^{-7}	1.0×10^{-7}		-8.0×10^{-7}	8.0×10^{-7}	
Hexavalent chromium			-2.2×10^{-9}	-2.2×10^{-9}	2.2×10^{-9}		-1.7×10^{-8}	1.7×10^{-8}	
Lead			-8.9×10^{-8}	-8.9×10^{-8}	8.9×10^{-8}		-6.8×10^{-7}	6.8×10^{-7}	
Manganese			-1.4×10^{-7}	-1.4×10^{-7}	1.4×10^{-7}		-1.1×10^{-6}	1.1×10^{-6}	
Mercury			-3.0×10^{-8}	-3.0×10^{-8}	3.0×10^{-8}		-2.3×10^{-7}	2.3×10^{-7}	
Nickel			-1.7×10^{-6}	-1.7×10^{-6}	1.7×10^{-6}		-1.3×10^{-5}	1.3×10^{-5}	

[a] Emissions related to construction and demolition activities are not specifically quantified in keeping with the BAAQMD's guidance for the analysis of construction impacts (discussed in Section 5.1.8.1) which emphasizes implementation of effective and comprehensive control measures rather than detailed quantification of construction emissions. If all of the control measures, as appropriate, depending on the size of the project area, will be implemented, then air pollutant emissions from construction activities would be considered a less than significant impact. Similarly, any demolition, renovation or removal of asbestos-containing building materials would be considered a less than significant impact if the activity complies with the requirements and limitations of district Regulation 11, Rule 2: Hazardous Materials; Asbestos Demolition, Renovation and Manufacturing (BAAQMD 1999).
[b] A negative value represents a reduction in emissions as compared to existing conditions.
[c] BAAQMD has established significant emission levels in response to local pollutant problems. Projects with emissions in excess of these levels must include stringent mitigation.
[d] Average daily emission rate is based on an operating schedule of 5 days per week, 52 weeks per year.
BAAQMD = Bay Area Air Quality Management District

TABLE 5.4.10.1–1.—*Summary of Input Parameters for Analysis of Community Noise Issues Under the Reduced Operation Alternative*

Parameter	Units	Site	No Action Alternative	Reduced Operation Alternative
Daily vehicle traffic	1,000 vehicles	Livermore	22.6	21
		Site 300	0.5	No change
Explosives testing[a]	Shot frequency (number per year)	Livermore	Shot frequency would not be limited, but would not change appreciably from current levels. Hundreds of experiments are conducted each year (e.g., 501 shots within the HEAF during FY2002)	Shot frequency would not change appreciably.
		Site 300	Shot frequency would not be limited, but would not change appreciably from current levels. Typical activities include about 200 open air tests per year (including gun firings) and could include about 12 to 25 tests per year in the Contained Firing Facility. Activity on open air firing tables will continue to far exceed that in the Contained Firing Facility.	Shot frequency would not change appreciably, although one of the approximately four to six open air hydroshot experiments would likely be eliminated.
	Maximum weight in kilograms	Livermore	Shot weight would continue to range from gram level up to kilogram level.	No change
		Site 300	Shot weight would continue to range from gram level up to kilogram level. Based on the type of explosive used and constraints imposed by LLNL management to limit the maximum allowable sound pressure level, not to exceed 126 dB(A) in nearby populated areas.	No change

[a] LLNL 2003ar.
dB(A) = A-weighted decibels; FY = fiscal year; HEAF = High Explosive Application Facility; LLNL = Lawrence Livermore National Laboratory.

TABLE 5.4.13.1–1.—*Types of Hazardous Chemicals in Use at the Livermore Site Under the Reduced Operation Alternative*

Chemical	Chemical Abstract Number	No Action Average Maximum/Average Quantity	Reduced Operation Maximum/Average Quantity
Paints/Solvents			
Paint (variety)	NA	700,000/330,000 lb	700,000/305,000 lb
Thinner, lacquer	NA	3,000/515 gal	3,000/475 gal
Methylene chloride	75-09-2	2,000/58 gal	2,000/53 gal
Methyl alcohol	67-56-1	1,800/515 gal	1,800/475 gal
Acetone	67-64-1	1,200/760 gal	1,200/700 gal
Metals			
Lead bricks or ingots	NA	1,000,000 lb	1,000,000 lb
Tantalum	7440-25-7	75,000/20,600 lb	75,000/19,000 lb
Cobalt	7440-48-4	16,500/14,300 lb	16,500/13,300 lb
Aluminum	7429-90-5	5,000/824 lb	5,000/760 lb
Chrome or chromium	7440-47-3	4,700/1,545 lb	4,700/1425 lb
Acids/Bases/Oxidizers			
Oxygen, compressed	7782-44-7	870,000/78,000 ft^3	870,000/71,000 ft^3
Hydrogen peroxide<52%	7722-84-1	42,000/18,600 gal	42,000/17,100 gal
Ammonium hydroxide	1336-21-6	30,000/1,650 lb	30,000/1520 lb
Sodium hydroxide	1310-73-2	25,500/14,400 lb	25,500/13,300 lb
Potassium hydroxide	1310-58-3	15,000/410 lb	15,000/380 lb
Sulfuric acid	7664-93-9	11,000/4,640 lb	11,000/4,300 lb
Nitric acid	7697-37-2	7,810/5,150 lb	7,810/4,750 lb
Phosphoric acid	7664-38-2	3,600/1,030 lb	3,600/950 lb
Cyanuric acid	108-80-5	2,500/515 lb	2,500/475 lb
Hydrofluoric acid	7664-39-3	1,500/890 lb	1,500/810 lb
Industrial Gases			
Argon, compressed	7440-37-1	25,000,000/165,000 ft^3	25,000,000/152,000 ft^3
Helium	7440-59-7	5,000,000/310,000 ft^3	5,000,000/285,000 ft^3
Hydrogen, compressed	1333-74-0	1,500,000/52,000 ft^3	1,500,000/47,500 ft^3
Nitrogen, compressed (liquefied, gaseous)	7727-37-9	500,000/133,000 ft^3	500,000/123,500 ft^3
Carbon dioxide	124-38-9	176,000/128,000 ft^3	176,000/118,000 ft^3
Refrigerants			
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	76-13-1	170,000/16,500 lb	170,000/15,200 lb
Refrigerant, 123 SUVA, (2,2-Dichloro-1,1,1-trifluoroethane)	306-83-2	35,000/1,550 lb	35,000/1,430 lb
Freon 22 (Chlorodifluoromethane)	75-45-6	9,000/5,150 lb	9000/4750 lb
Freon 11 (Trichlorofluoromethane)	75-69-4	10,000/5,150 lb	10000/4750 lb
Freon 12 (Dichlorodifluoromethane)	75-71-8	6,300/4,120 lb	6300/3800 lb
Freon 14 (Tetrafluoromethane)	75-73-0	2,000/515 ft^3	2,000/475 ft^3

Sources: NNSA 2002c; TtNUS 2003.
Note: Numbers are rounded. Additional chemicals are listed in Appendix B.
ft^3= cubic feet; gal = gallons; lb = pounds; NA = not available.

TABLE 5.4.13.1–2.—*Types of Hazardous Chemicals in Use at Site 300 Under the Reduced Operation Alternative*

Chemical	Chemical Abstract Number	No Action Average Maximum/Average Quantity	Reduced Operation Maximum/Average Quantity
Paints/Solvents			
Paint (variety)	NA	7,200/1,230 lb	7200/1140 lb
Thinner, lacquer	NA	310/125 gal	310/90 gal
Methyl alcohol	67-56-1	90/5 gal	90/5 gal
Acetone	67-64-1	400/35 gal	400/29 gal
Metals			
Lead bricks or ingots	NA	25,000 lb	25,000 lb
Acids/Bases/Oxidizers			
Oxygen, compressed	7782-44-7	16,000/5,150 ft^3	16,000/4,750 ft^3
Sulfuric acid	7664-93-9	845/62 lb	845/57 lb
Cyanuric acid	108-80-5	500/52 lb	500/48 lb
Industrial Gases			
Argon, compressed	7440-37-1	30,000/30,000 ft^3	25,000,000/252,000 ft^3
Helium	7440-59-7	25,000/25,800 ft^3	5,000,000/285,000 ft^3
Hydrogen, compressed	1333-74-0	700/720 ft^3	1,500,000/48,000 ft^3
Nitrogen, compressed (Liquefied, gaseous)	7727-37-9	312,000/288,000 ft^3	500,000/124,000 ft^3
Carbon dioxide	124-38-9	44,000/5,200 ft^3	176,000/118,000 ft^3
Refrigerants			
Freon 113 (1,1,2-trichloro-1,2,2-trifluoroethane)	76-13-1	150/10 gal	150/10 gal
Freon 22 (chlorodifluoromethane)	75-45-6	1,400/910 lb	1,400/827 lb
Freon 12 (dichlorodifluoromethane)	75-71-8	660/230 lb	660/209 lb
Freon 13 (chlorotrifluoromethane)	75-72-9	478/478 ft^3	478/454 ft^3
Freon 14 (tetrafluoromethane)	75-73-0	2,000/515 ft^3	2,000/475 ft^3

Sources: NNSA 2002c, TtNUS 2003.
Note: Numbers are rounded. Additional chemicals are listed in Appendix B.
ft^3 = cubic feet; gal = gallons; lb = pounds; NA = not available.

Cumulative Impacts

The ROI for materials management involves LLNL and its facilities as presented in Chapter 4 of this LLNL SW/SPEIS.

The ROI for cumulative impacts is larger than that presented in Chapter 4 and considers the contributions of LLNL (Livermore Site and Site 300), SNL/CA, other NNSA activities, local projects and activities, and the State of California. NNSA assessed cumulative impacts by combining the potential effects of the Proposed Action with the effects of other past, present, and reasonably foreseeable activities in the ROI. The Proposed Action was chosen to assess and present a bounding scenario of potential cumulative effects. This approach allowed a conservative analysis or a maximum estimation of cumulative impacts, further discussed in Section 5.3.13.1.

TABLE 5.5.1.2–1.—*Potential Accident Frequency and Consequences (Median Meteorology)*[a]

			MEI		Offsite Population[b]		Individual Noninvolved Worker		Noninvolved Worker Population	
Building	**Accident**	**Frequency (per year)**	**Dose (rem)**	**LCFs[c]**	**Dose (Person-rem)**	**LCFs[d]**	**Dose (rem)**	**LCFs[c]**	**Dose (Person-rem)**	**LCFs[d]**
Building 191	Radioactive material dispersion from a spill and fire - No Action	$<10^{-6}$	3.32×10^{-5}	1.99×10^{-8}	4.70×10^{-3}	2.82×10^{-6}	7.23×10^{-5}	4.34×10^{-8}	9.72×10^{-3}	5.83×10^{-6}
	Radioactive material dispersion from a spill and fire - Proposed Action	$<10^{-6}$	Same	Same	Same	Same	Same	Same	Same	Same
Building 194	Design-basis earthquake and fire - No Action	10^{-6} to 10^{-4}	8.66×10^{-4}	5.20×10^{-7}	2.23×10^{-1}	1.34×10^{-4}	3.43×10^{-3}	2.06×10^{-6}	5.83×10^{-1}	3.50×10^{-4}
	Design-basis earthquake and fire- Proposed Action	10^{-6} to 10^{-4}	Same	Same	Same	Same	Same	Same	Same	Same
Building 239	Uncontrolled oxidation of plutonium at elevated temperature - No Action	$<4.5 \times 10^{-7}$	1.73×10^{-2}	1.04×10^{-5}	6.49	3.89×10^{-3}	2.47×10^{-1}	1.48×10^{-4}	2.59×10^{1}	1.55×10^{-2}
	Uncontrolled oxidation of plutonium at elevated temperature - Proposed Action	$<4.5 \times 10^{-7}$	Same	Same	Same	Same	Same	Same	Same	Same
Building 251	Evaluation basis fire - No Action	10^{-6} to 10^{-4}	6.01×10^{-1}	3.61×10^{-4}	1.88×10^{2}	1.13×10^{-1}	5.70	3.42×10^{-3}	8.26×10^{2}	4.96×10^{-1}
	Evaluation basis fire - Proposed Action	10^{-6} to 10^{-4}	Same	Same	Same	Same	Same	Same	Same	Same
Building 331	Plutonium Metal Fire - No Action	10^{-6} to 10^{-4}	5.02×10^{-2}	3.01×10^{-5}	2.39×10^{1}	1.43×10^{-2}	6.40×10^{-1}	3.84×10^{-4}	8.95×10^{1}	5.37×10^{-2}
	Aircraft crash with subsequent fire - Proposed Action	1.53×10^{-6}	1.63×10^{-1}	9.78×10^{-5}	1.13×10^{2}	6.78×10^{-2}	2.11	1.27×10^{-3}	2.73×10^{2}	1.64×10^{-1}
Building 332	Aircraft Crash - No Action	4.86×10^{-6}	1.48×10^{-1}	8.85×10^{-5}	9.70×10^{1}	5.82×10^{-2}	1.84	1.10×10^{-3}	3.18×10^{2}	1.91×10^{-1}
	Room Fire Unfiltered - Proposed Action	3.90×10^{-7}	4.40×10^{-1}	2.64×10^{-4}	2.80×10^{2}	1.68×10^{-1}	4.94	2.96×10^{-3}	9.30×10^{2}	5.58×10^{-1}

TABLE 5.5.1.2–1.—*Potential Accident Frequency and Consequences (Median Meteorology)*[a] *(continued)*

			MEI		Offsite Population[b]		Individual Noninvolved Worker		Noninvolved Worker Population	
Building	**Accident**	**Frequency (per year)**	**Dose (rem)**	**LCFs[c]**	**Dose (Person-rem)**	**LCFs[d]**	**Dose (rem)**	**LCFs[c]**	**Dose (Person-rem)**	**LCFs[d]**
Building 334	Uncontrolled oxidation of plutonium at elevated temperatures - No Action	$< 1.00 \times 10^{-6}$	1.64×10^{-1}	9.84×10^{-5}	6.80×10^{1}	4.08×10^{-2}	3.25	1.95×10^{-3}	2.31×10^{2}	1.39×10^{-1}
	Uncontrolled oxidation of plutonium at elevated temperatures - Proposed Action	$< 1.00 \times 10^{-6}$	Same	Same	Same	Same	Same	Same	Same	Same
Building 581	Earthquake - No Action	2.00×10^{-8}	4.78×10^{-4}	2.87×10^{-7}	1.96×10^{-1}	1.18×10^{-4}	1.43×10^{-3}	8.60×10^{-7}	2.08×10^{-1}	1.25×10^{-4}
	Earthquake during plutonium experiment without yield - Proposed Action	2.00×10^{-9}	1.65×10^{-3}	9.89×10^{-7}	5.46×10^{-1}	3.28×10^{-4}	4.99×10^{-3}	3.00×10^{-6}	7.41×10^{-1}	4.45×10^{-4}
Building 625	Aircraft Crash - No Action	6.10×10^{-7}	2.39×10^{-1}	1.43×10^{-4}	6.62×10^{2}	3.97×10^{-1}	6.49×10^{-1}	3.89×10^{-4}	3.04×10^{1}	1.82×10^{-2}
	Aircraft Crash - Proposed Action	6.10×10^{-7}	7.27×10^{-1}	4.36×10^{-4}	2.02×10^{3}	1.21	1.97	1.18×10^{-3}	9.24×10^{1}	5.54×10^{-2}
Building 696R	Aircraft Crash - No Action	6.29×10^{-7}	8.61×10^{-1}	5.17×10^{-4}	1.29×10^{3}	7.71×10^{-1}	1.39	8.33×10^{-4}	8.33×10^{1}	5.00×10^{-2}
	Aircraft Crash - Proposed Action	6.29×10^{-7}	Same	Same	Same	Same	Same	Same	Same	Same
Site 300 Materials Management Facilities	Depleted uranium release by fire - No Action	10^{-4} to 10^{-2}	3.93×10^{-4}	2.36×10^{-7}	3.81×10^{-1}	2.29×10^{-4}	3.94×10^{-2}	2.36×10^{-5}	9.42×10^{-2}	5.65×10^{-5}
	Depleted uranium release by fire - Proposed Action	10^{-4} to 10^{-2}	Same	Same	Same	Same	Same	Same	Same	Same
Onsite Transportation	Materials Management Section package explosion - No Action	$< 1.00 \times 10^{-6}$	1.16×10^{-1}	6.96×10^{-5}	4.01×10^{1}	2.41×10^{-2}	2.79	1.67×10^{-3}	1.71×10^{2}	1.03×10^{-1}
	Materials Management Section package explosion - Proposed Action	$< 1.00 \times 10^{-6}$	Same	Same	Same	Same	Same	Same	Same	Same

Source: Original

[a] The consequences for the Reduced Operation Alternative would be the same as for the No Action Alternative.

[b] Based on the population of approximately 6,900,000 persons residing within 50 miles of LLNL.

[c] Increased likelihood of a latent cancer fatality.

[d] Increased number of latent cancer fatalities.

LCFs = latent cancer fatalities; MEI = maximally exposed individual.

TABLE 5.5.1.2–2.—*Potential Accident Frequency and Consequence (Unfavorable Meteorology)*[a]

			MEI		Offsite Population[b]		Individual Noninvolved Worker		Noninvolved Worker Population	
Building	**Accident**	**Frequency (per year)**	**Dose (rem)**	**LCFs[c]**	**Dose (Person-rem)**	**LCFs[d]**	**Dose (rem)**	**LCFs[c]**	**Dose (Person-rem)**	**LCFs[d]**
Building 191	Radioactive material dispersion from a spill and fire - No Action	$<10^{-6}$	4.25×10^{-4}	2.55×10^{-7}	4.20×10^{-2}	2.52×10^{-5}	7.14×10^{-4}	4.28×10^{-7}	6.96×10^{-2}	4.18×10^{-5}
	Radioactive material dispersion from a spill and fire - Proposed Action	$<10^{-6}$	Same	Same	Same	Same	Same	Same	Same	Same
Building 194	Design-basis earthquake and fire - No Action	10^{-6} to 10^{-4}	1.30×10^{-2}	7.80×10^{-6}	1.81	1.09×10^{-3}	3.30×10^{-2}	1.98×10^{-5}	3.47	2.08×10^{-3}
	Design-basis earthquake and fire-Proposed Action	10^{-6} to 10^{-4}	Same	Same	Same	Same	Same	Same	Same	Same
Building 239	Uncontrolled oxidation of plutonium at elevated temperature - No Action	$<4.5 \times 10^{-7}$	3.68×10^{-1}	2.21×10^{-4}	1.02×10^{2}	6.12×10^{-2}	2.97	1.78×10^{-3}	2.02×10^{2}	1.21×10^{-1}
	Uncontrolled oxidation of plutonium at elevated temperature - Proposed Action	$<4.5 \times 10^{-7}$	Same	Same	Same	Same	Same	Same	Same	Same
Building 251	Evaluation basis fire - No Action	10^{-6} to 10^{-4}	1.18×10^{1}	7.10×10^{-3}	1.22×10^{3}	7.34×10^{-1}	6.46×10^{1}	3.88×10^{-2}	4.52×10^{3}	2.71
	Evaluation basis fire - Proposed Action	10^{-6} to 10^{-4}	Same	Same	Same	Same	Same	Same	Same	Same
Building 331	Plutonium Metal Fire - No Action	10^{-6} to 10^{-4}	9.98×10^{-1}	5.99×10^{-4}	3.85×10^{2}	2.31×10^{-1}	7.52	4.51×10^{-3}	6.70×10^{2}	4.02×10^{-1}
	Aircraft crash with subsequent fire - Proposed Action	1.53×10^{-6}	3.26	2.28×10^{-4}	1.56×10^{3}	1.10×10^{-1}	2.55×10^{1}	1.79×10^{-3}	2.05×10^{3}	1.44×10^{-1}
Building 332	Aircraft Crash - No Action	4.86×10^{-6}	2.89	1.73×10^{-3}	1.19×10^{3}	7.14×10^{-1}	2.36×10^{1}	1.42×10^{-2}	2.53×10^{3}	1.52
	Room Fire Unfiltered - Proposed Action	3.90×10^{-7}	8.40	5.04×10^{-3}	3.26×10^{3}	1.95	4.46×10^{1}	2.68×10^{-2}	7.80×10^{3}	4.68

TABLE 5.5.1.2–2.—*Potential Accident Frequency and Consequences (Unfavorable Meteorology)*[a] *(continued)*

			MEI		Offsite Population[b]		Individual Noninvolved Worker		Noninvolved Worker Population	
Building	**Accident**	**Frequency (per year)**	**Dose (rem)**	**LCFs[c]**	**Dose (Person-rem)**	**LCFs[d]**	**Dose (rem)**	**LCFs[c]**	**Dose (Person-rem)**	**LCFs[d]**
Building 334	Uncontrolled oxidation of plutonium at elevated temperatures - No Action	$< 1.00 \times 10^{-6}$	3.68	2.21×10^{-3}	1.03×10^{3}	6.18×10^{-1}	4.39×10^{1}	2.63×10^{-2}	2.08×10^{3}	1.25
	Uncontrolled oxidation of plutonium at elevated temperatures - Proposed Action	$< 1.00 \times 10^{-6}$	Same	Same	Same	Same	Same	Same	Same	Same
Building 581	Earthquake - No Action	2.00×10^{-8}	6.15×10^{-3}	3.69×10^{-6}	3.05	1.83×10^{-3}	1.33×10^{-2}	8.01×10^{-6}	2.22	1.33×10^{-3}
	Earthquake during plutonium Experiment without yield - Proposed Action	2.00×10^{-9}	2.16×10^{-2}	1.30×10^{-5}	8.33	5.00×10^{-3}	4.69×10^{-2}	2.82×10^{-5}	8.23	4.94×10^{-3}
Building 625	Aircraft Crash - No Action	6.10×10^{-7}	7.59	4.55×10^{-3}	5.80×10^{3}	3.48	2.70×10^{1}	1.62×10^{-2}	6.44×10^{2}	3.86×10^{-1}
	Aircraft Crash - Proposed Action	6.10×10^{-7}	2.31×10^{1}	1.39×10^{-2}	1.76×10^{4}	1.06×10^{1}	8.23×10^{1}	4.94×10^{-2}	1.96×10^{3}	1.18
Building 696R	Aircraft Crash - No Action	6.29×10^{-7}	1.66×10^{1}	9.93×10^{-3}	1.06×10^{4}	6.38	2.16×10^{1}	1.30×10^{-2}	1.73×10^{3}	1.04
	Aircraft Crash - Proposed Action	6.29×10^{-7}	Same	Same	Same	Same	Same	Same	Same	Same
Site 300 Materials Management Facilities	Depleted uranium release by fire - No Action	10^{-4} to 10^{-2}	7.89×10^{-3}	4.73×10^{-6}	2.60	1.56×10^{-3}	6.27×10^{-1}	3.76×10^{-4}	5.50×10^{-1}	3.30×10^{-4}
	Depleted uranium release by fire - Proposed Action	10^{-4} to 10^{-2}	Same	Same	Same	Same	Same	Same	Same	Same
Onsite Transportation	Materials Management Section package explosion - No Action	$< 1.00 \times 10^{-6}$	2.76	1.66×10^{-3}	6.50×10^{2}	3.90×10^{-1}	5.32×10^{1}	3.19×10^{-2}	1.02×10^{3}	6.12×10^{-1}
	Materials Management Section package explosion - Proposed Action	$< 1.00 \times 10^{-6}$	Same	Same	Same	Same	Same	Same	Same	Same

Source: Original

[a] The consequences for the Reduced Operation Alternative would be the same as for the No Action Alternative.

[b] Based on the population of approximately 6,900,000 persons residing within 50 miles of LLNL.

[c] Increased likelihood of a latent cancer fatality.

[d] Increased number of latent cancer fatalities.

LCFs = latent cancer fatalities; MEI = maximally exposed individual.

TABLE 5.5.2.2–1.—*Potential Chemical Accident Consequences (Median Meteorology)*

		Noninvolved Worker		Site Boundary		
ERPG-2 Concentration (ppm)	**ERPG-3 Concentration (ppm)**	**Average Predicted Concentration (ppm)**	**Fraction of ERPG-2**	**Average Predicted Concentration (ppm)**	**Fraction of ERPG-2**	**ERPG-2 Distance (meters)**
Building 191, High Explosives Application Facility – Chemical Dispersion (1,2-Dichloroethane)						
200	300	0.108	5.4×10^{-4}	0.0175	8.8×10^{-5}	11
Building 239, Radiography Facility – Toxic gas release (NO_2)						
5	20	27.5	5.5	0.81	016	246
Building 322, Plating Shop – Multiple Container Liquid Spill (Hydrofluoric Acid)						
20	50	371	18.6	4.86	0.24	475
Building 331, Tritium Facility actinide activities – Nitric acid spill						
6	78	24	4	0.24	0.04	205
Building 332, Plutonium Facility – Chlorine release						
3	20	593	198	11.6	3.9	1,700
Building 334, Hardened Engineering Test Building – Toxic gas release (NO_2)						
5	20	110	22	2.02	0.40	529
Building 514/612/625/693, Radioactive and Hazardous Waste Management Complex – Earthquake release of Freon-22						
7,500	7,500	415	0.06	169	0.023	19
Building 581, National Ignition Facility – Material Spill, Release of Nitric acid solution						
6	78	130	21.7	12.3	2.1	536
Site 300 Materials Management Facility – Hazardous materials release by fire (LiOH)						
1	102	1.42	1.42	0	0	119
Site 300 Explosive Waste Treatment Facility – Fire release of hydrogen fluoride						
20	50	28.1	1.41	0.097	0.049	119

[a] These consequences apply to the No Action Alternative, the Proposed Action, and the Reduced Operation Alternative.
ERPG = Emergency Response Planning Guideline.