ES&H Division
SLAC-R-894

Annual Site Environmental Report: 2007

September 2008

Prepared for the Department of Energy under contract number DE-AC02-76-SF00515
Stanford Linear Accelerator Center, Stanford University, Stanford, CA 94309

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U.S. Department of Energy
Office of Science
Stanford Site Office
2575 Sand Hill Road, MS-8A
Menlo Park, CA 94025

September 19, 2008

Subject: 2007 Annual Site Environmental Report (ASER) for the Stanford Linear Accelerator Center (SLAC)

This report, prepared by SLAC for the U.S. Department of Energy, Stanford Site Office (SSO), provides a comprehensive summary of the environmental program activities at SLAC for calendar year 2007. Annual Site Environmental Reports (ASERs) are prepared for all DOE sites with significant environmental activities, and distributed to relevant external regulatory agencies and other interested organizations or individuals.

To the best of my knowledge, this report accurately summarizes the results of the 2007 environmental monitoring, compliance, and restoration programs at SLAC. This assurance can be made based on SSO and SLAC review of the ASER, and quality assurance protocols applied to monitoring and data analyses at SLAC.

Any questions or comments regarding this report may be directed to Dave Osugi of the SSO at (650) 926-3305, or by mail to the address above.

Sincerely,

SIGNATURE ON FILE

Paul Golan
Site Manager
Stanford Site Office

Certification of Accuracy

Annual Site Environmental Report
January - December 2007
SLAC-R-894

Stanford Linear Accelerator Center

I certify that the information submitted herein is current for the reporting period, accurate, and complete, based on my familiarity with the information and my inquiry of those individuals immediately responsible for obtaining the information.

SIGNATURE ON FILE

Date

Craig Ferguson
Associate Director
Environment, Safety, and Health Division

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Preface

To satisfy the requirements of the United States Department of Energy Order 231.1, “Environment, Safety and Health Reporting”, the Environment, Safety, and Health Division of the Stanford Linear Accelerator Center prepares an annual report describing its environmental programs and activities.

This *Annual Site Environmental Report: 2007* summarizes the Stanford Linear Accelerator compliance with standards and requirements, describes the management and monitoring systems in place, and highlights significant accomplishments for the year.

Organization

The report is published in a single volume, organized into the following chapters:

- Chapter 1, “Site Overview”, describes the environmental setting of the Stanford Linear Accelerator Center and the activities conducted at the site
- Chapter 2, “Environmental Compliance”, gives an account of the regulatory framework and results concerning the site’s environmental programs
- Chapter 3, “Management Systems”, outlines the organizational structure, methods, and responsibilities relevant to environmental programs
- Chapters 4, 5, and 6, respectively “Environmental Non-radiological Programs”, “Environmental Radiological Programs”, and “Groundwater Protection and Environmental Restoration”, give more detailed accounts of the programs and their results for the year

An executive summary provides an overview of the report.

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Editing and Publishing

ES&H Division Publishing edited and published this report; SLAC Technical Publications provided electronic publishing and printing support.

Acronyms

^{3}H	tritium
ASER	annual site environmental report
AST	aboveground storage tank
BAAQMD	Bay Area Air Quality Management District
BaBar	SLAC B Factory detector
BDE	beam dump east
BMP	best management practice
CalARP	California Accidental Release Prevention Program
CARB	California Air Resources Board
CCRA	California climate action registry
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CGS	Chemical and General Safety Department
Ci	curie
CMS	chemical management system
CUPA	certified unified program agency
CWA	Clean Water Act
CX	categorical exclusion
CY	calendar year
DOE	United States Department of Energy
DPE	dual phase extraction
DTSC	California Department of Toxic Substances Control
DWS	drinking water standard
EA	environmental assessment
EBR	Environmental Baseline Report
EIS	environmental impact statement
EMP	environmental management program
EM	environmental management
EMS	environmental management system
EO	Executive Order

EP	Environmental Protection Department
EPCRA	Emergency Planning and Community-Right-to-Know Act
ESC	environmental safety committee
ES&H	environment, safety, and health
ESHAC	ES&H Advisory Committee
FAA	Federal Aviation Administration
FAC	Facilities Department
FHWSA	Former Hazardous Waste Storage Area
FMS	flow metering station
FSUST	Former Solvent Underground Storage Tank Area
FY	fiscal year
GDF	gasoline dispensing facility
GHG	greenhouse gas
GLAST	Gamma Ray Large Area Space Telescope
gpd	gallons per day
GSA	United States General Services Administration
HAPs	hazardous air pollutants
Haas	Haas *tcm*
HMBP	hazardous materials business plan
HMIS	hazardous materials inventory statement
HVAC	heating, ventilation, and air conditioning
IATA	International Air Transport Association
IDPE	interim dual phase extraction
IR	interaction region
ILC	International Linear Collider
INL	Idaho National Laboratory
ISEMS	integrated safety and environmental management system
ISM	integrated safety management
ISO	International Organization of Standardization
JRBP	Jasper Ridge Biological Preserve
km	kilometer
L	liter
lbs	pounds
linac	linear accelerator

LCLS	Linac Coherent Light Source
LLRW	low-level radioactive waste
LRDP	long-range development plan
LSTs	limited streamer tubes
LSY	lower salvage yard
m	meter
M&O	management and operating
MAPEP	mixed analyte performance evaluation program
MEI	maximally exposed individual
MFPF	metal finishing pre-treatment facility
mg/L	milligrams per liter
MGE	Main Gate East Channel
MPMWD	Menlo Park Municipal Water Department
mrem	millirem
mSv	milli Sievert
NA	not applicable
NAE	North Adit East Channel
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NOV	notice of violation
ODS	ozone-depleting substance
P2	pollution prevention
PAHs	polycyclic aromatic hydrocarbons
PBR	permit by rule
PBV	parameter benchmark value
PCB	polychlorinated biphenyl
pCi	picoCuries
pCi/L	picoCuries per liter
PEP	Positron-Electron Project
PERP	portable equipment registration program
ppd	pounds per day
ppm	parts per million
PPOA	pollution prevention opportunity assessments
QA	quality assurance

QC	quality control
rad	unit used to quantify radiation dose
RCRA	Resource Conservation and Recovery Act
REP	Radiological Environmental Program
RI	remedial investigation
RMP	risk management plan
RP	Radiation Protection Department
RPRWM	Radiation Protection Radiological Waste Management
RWQCB	regional water quality control board
SARA	Superfund Amendments and Reauthorization Act
SBSA	South Bayside System Authority
SF_6	sulfur hexafluoride
SLAC	Stanford Linear Accelerator Center
SMOP	synthetic minor operating permit
SMP	self-monitoring program
SPCC	spill prevention control and countermeasures
SPEAR	Stanford Positron-Electron Asymmetric Ring
SSO	DOE Stanford Site Office
SSRL	Stanford Synchrotron Radiation Laboratory
SVOCs	semi-volatile organic compounds
SWMP	stormwater monitoring program
SWPPP	stormwater pollution prevention plan
SWRCB	State Water Resources Control Board
TCA	1,1,1-trichloroethane
TDS	total dissolved solids
TL/CL	Test Lab and Central Lab Area
TPH	total petroleum hydrocarbons
TRI	toxics release inventory
TSCA	Toxic Substances Control Act
TSS	total suspended solids
Unidocs	Uniform documents
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds
WBSD	West Bay Sanitary District

WM	Waste Management Group
WSS	Work Smart Standard
WTS	waste tracking system

Executive Summary

This report provides information about environmental programs during the calendar year (CY) of 2007 at the Stanford Linear Accelerator Center (SLAC), Menlo Park, California. Activities that span the calendar year, i.e., stormwater monitoring covering the winter season of 2007/2008 (October 2007 through May 2008), are also included.

Production of an annual site environmental report (ASER) is a requirement established by the United States Department of Energy (DOE) for all management and operating (M&O) contractors throughout the DOE complex. SLAC is a federally-funded research and development center with Stanford University as the M&O contractor.

Under Executive Order (EO) 13423 and DOE Order 450.1, “Environmental Protection Program,” SLAC effectively implemented and integrated the key elements of an Environmental Management System (EMS) to achieve the site’s integrated safety and environmental management system goals. For normal daily activities, SLAC managers and supervisors are responsible for ensuring that policies and procedures are understood and followed so that

- Worker safety and health are protected
- The environment is protected
- Compliance is ensured

Throughout 2007, SLAC focused on development and implementation of SLAC management systems to ensure continual improvement. These systems provided a structured framework for SLAC to implement “greening of the government” initiatives such as EO 13148. Overall, management systems at SLAC are effective, supporting compliance with all relevant statutory and regulatory requirements.

SLAC continues to demonstrate significant progress in implementing and integrating EMS into day-to-day operations at SLAC. The annual management review and ranking of environmental aspects were completed this year by SLAC’s EMS Steering Committee, the Environmental Safety Committee (ESC) and thirteen objectives and targets were established for 2007. For each objective and target, a work plan, or Environmental Management Program (EMP) was completed and progress reports were routinely provided to SLAC senior management. .

During 2007, there were no reportable releases to the environment from SLAC operations. In addition, many improvements in waste minimization, recycling, stormwater management, groundwater restoration, and SLAC’s chemical management system (CMS) were continued during 2007.

SLAC replaced two process tanks at the Plating Shop which previously contained chromium solutions with non-chromium containing solutions, reducing the overall use of hazardous chemicals. In addition, 346 polychlorinated biphenyl (PCB)-contaminated capacitors were replaced with non-PCB capacitors, reducing the potential of a release of oil with PCBs during an event such as a fire or an earthquake.

SLAC operates its industrial and sanitary wastewater management program in compliance with established permit conditions. During 2007, SLAC obtained a new facility-wide wastewater discharge permit which replaced four separate permits that were previously issued to SLAC.

In 2007, no radiological incidents occurred that increased radiation levels or released radioactivity to the environment. In addition to managing its radioactive wastes safely and responsibly, SLAC worked to reduce the amount of waste generated. SLAC has implemented programs and systems to ensure compliance with all radiological requirements related to the environment. Specifically, the Radiation Protection Radiological Waste Management (RPRWM) Group developed a training course to certify Radioactive Waste Generators, conducted a training pilot, and developed a list of potential radioactive waste generators to train.

In 2007, the SLAC Environmental Restoration Program continued work on site characterization and evaluation of remedial alternatives at four sites with volatile organic compounds in groundwater and several areas with polychlorinated biphenyls and low concentrations of lead in soil. SLAC is regulated under a site cleanup requirements order (*board order*) issued by the California Regional Water Quality Control Board (RWQCB), San Francisco Bay Region in May 2005 for the investigation and remediation of impacted soil and groundwater at SLAC. The board order lists specific tasks and deadlines for completion of groundwater and soil characterization and other remediation activities. All 2007 submittals to the RWQCB were completed and submitted on time.

1 Site Overview

This chapter describes the environmental setting of SLAC and the activities conducted at the site.

For an overview of site environmental planning, including descriptions of environmental resources, see the long-range development plan (LRDP) prepared in 2002 (revised June 2003).[1]

1.1 Introduction

SLAC is a national research laboratory operated by Stanford University under contract to the DOE. SLAC is located on the San Francisco Peninsula, about halfway between San Francisco and San Jose, California (see Figure 1-1). Current research and scientific user facilities are in areas of photon science, particle physics, and particle astrophysics. Six scientists have been awarded the Nobel Prize for work carried out at SLAC and there are 10 members of its faculty in the National Academies.

The majority of SLAC funding comes from DOE Office of Science, with smaller contributions from National Aeronautics and Space Administration, National Institute of Health, and other federal and non-federal sources. SLAC also receives funding from the DOE Office of Environmental Management (EM) for soil and groundwater investigation and remediation activities at the site managed by SLAC for EM.

1.1.1 SLAC Mission

Photon Science Discoveries

- To make discoveries in photon science at the frontiers of the ultrasmall and ultrafast in a wide spectrum of physical and life sciences

Particle and Particle Astrophysics Discoveries

- To make discoveries in particle and astroparticle physics that redefine humanity's understanding of what the universe is made of and the forces that control it

Operate Safely; Train the Best

- To operate a safe laboratory that employs and trains the best and brightest, helping to ensure the future economic strength and security of the nation

1.1.2 Research Program

SLAC has three major research areas. The first, in photon science, is to develop and support innovative research instrumentation for x-ray based studies of matter on length scales down to the nano- to atomic-level and on time scales from milli- down to femto-seconds. Photon science research includes complex,

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[1] Stanford University Architect/Planning Office, *Stanford Linear Accelerator Center Long Range Development Plan* (December 2002, revised June 2003), http://www-group.slac.stanford.edu/bsd/SLAC_LRDP_final.pdf

correlated and magnetic materials science, molecular environmental science, and structural biology; there is a rapidly developing new area of excellence in ultrafast x-ray science.

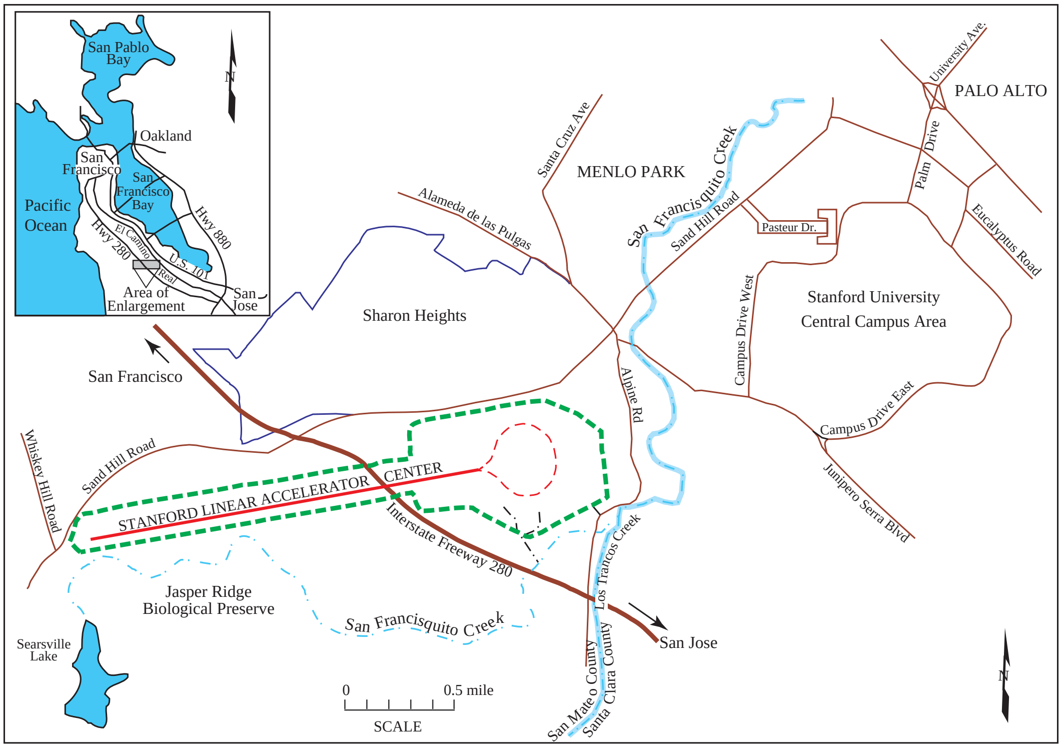

Figure 1-1 SLAC Site Location

Another research area is the use of particle accelerators and observatories in space and on the ground to understand what our universe is made of at its most basic and fundamental level. The principal areas of particle physics are the electron energy frontier using a linear collider, theoretical investigations of the quantum universe and, at the Kavli Institute for Particle Astrophysics and Cosmology, non-accelerator tests of the Standard Cosmology Model through investigations of dark matter and dark energy.

Continuing over the next year, a third research area at SLAC is the construction of the Linac Coherent Light Source (LCLS), the world's first x-ray-free electron laser. SLAC is committed to the on-time and on-budget construction and rapid commissioning of this major new facility that will open revolutionary frontiers for photon science in the coming decades. Construction activities at LCLS continued through much of CY 2007.

The 2-mile linear accelerator (linac) at SLAC, constructed in the early 1960s, generates high intensity beams of electrons and positrons up to 50 giga-electron volts. The linac is also used for injecting electrons and positrons into colliding-beam storage rings for particle physics research.

The Positron-Electron Project (PEP) storage ring is about 875 yards in diameter. While the original PEP program was completed in 1990, the storage ring has since been upgraded to serve as an asymmetric B factory (known as PEP-II) to study the B meson. PEP-II continued its program with the SLAC B Factory (BaBar) detector throughout 2007.

A smaller storage ring, the Stanford Positron-Electron Asymmetric Ring (SPEAR), contains a separate, shorter linac and a booster ring for injecting accelerated beams of electrons. SPEAR is fully dedicated to synchrotron radiation research. The synchrotron light generated by the SPEAR storage ring is used by the Stanford Synchrotron Radiation Laboratory (SSRL), a division of SLAC, to perform experiments. At the SSRL, researchers view the nanoworld, leading to discoveries in solid-state physics, material science, environmental science, structural biology, and chemistry. In the past, researchers at SSRL have looked at remnants of soft tissues in hundred-million-year-old dinosaur fossils; mapped the distribution of elements in diseased brains, seeking a deeper understanding of Alzheimer’s and Parkinson’s diseases; worked out the structures of scores of proteins; and characterized the quantum electronic workings of new materials, leading the way toward the superconductors of the future.

SLAC is committed to continuing its leadership in advocating and working on the design of the International Linear Collider (ILC) machine and the detector. The laboratory has the strongest electron accelerator group in the United States, if not the world, and in collaboration with our international partners will contribute to both the design and testing of major ILC subsystems as well as to the overall design.

1.2 Location

SLAC is located in a belt of low, rolling foothills between the alluvial plain bordering San Francisco Bay to the east and the Santa Cruz Mountains to the west. The site varies in elevation from 175 to 380 feet above sea level. The alluvial plain to the east around the bay lies less than 151 feet above sea level; the mountains to the west rise abruptly to over 2000 feet.

The site occupies 426 acres of land owned by Stanford University. The property was leased in 1962 for purposes of research into the basic properties of matter. The DOE now owns the original 50-year lease to the Atomic Energy Commission. The land is part of Stanford’s academic reserve and is located west of the university and the city of Palo Alto in an unincorporated portion of San Mateo County.

The site lies between Sand Hill Road and Alpine Road, bisected by Highway 280, on an elongated parcel roughly 2.75 miles long, running in an east-west direction. The parcel widens to about 0.65 miles at the target (east) end to allow space for buildings and experimental facilities. The south side of much of the western end of the parcel is bordered by Stanford University’s Jasper Ridge Biological Preserve (JRBP), which includes part of the San Francisquito Creek riparian channel, the last channel of its kind between San Jose and San Francisco still in its natural state.

1.3 Geology

The SLAC site is underlain by sandstone, with some basalt at the far eastern end. In general, the bedrock on which the western half of the SLAC linac rests is the Whiskey Hill Formation (Eocene age), and the bedrock under the eastern half is the Ladera Sandstone (Miocene age). On top of this bedrock at various places along the accelerator alignment is the Santa Clara Formation (Pleistocene age), where alluvial deposits of sand and gravel are found. At the surface is a soil overburden of non-consolidated earth material averaging from 0.3 to 3 feet in depth. Figure 1-2 shows the general geographic and geologic setting of the area.

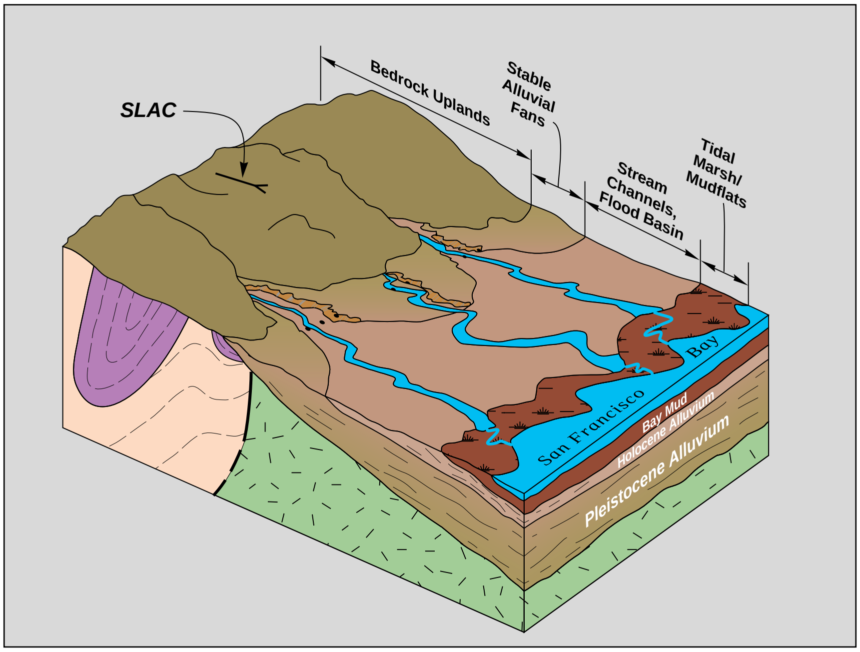

Figure 1-2 Site Area General Geographic and Geologic Setting

1.4 Climate

The climate in the SLAC area is Mediterranean. Winters are cool and moist, and summers are mostly warm and dry. Daily mean temperatures are seldom below 32 degrees Fahrenheit or above 86 degrees Fahrenheit.

Rainfall averages about 22 inches per year. The distribution of precipitation is highly seasonal. About 75 percent of the precipitation, including most of the major storms, occurs during the four-month period from December through March. Most winter storm periods are from two days to a week in duration. The storm centers are usually characterized by relatively heavy rainfall and high winds. The combination of topography and air movement produces substantial fluctuations in intensity, which can best be characterized as a series of storm cells following one another that produce heavy precipitation for periods of five to 15 minutes with lulls in between bursts.

1.5 Land Use

The SLAC site is located on an unincorporated portion of San Mateo County and is zoned in the San Mateo County General Plan as a residential estate. Approximately 34 percent of the property is developed with buildings and pavement, mostly in the core campus area.

Land use to the immediate west is commercial, and farther west is agricultural and the JRBP. Land use to the north is mostly commercial, residential, and recreational (a golf course), with a school and convalescent hospital north of the central campus. Land use to the east is residential, recreational (another golf course), and educational (the Stanford campus). Land use to the south is agricultural (including a horse boarding and training facility), reserved open space, and residential.

1.6 Water Supply

Domestic water for SLAC is supplied by the Menlo Park Municipal Water Department (MPMWD). The source is the City of San Francisco-operated Hetch Hetchy aqueduct system that is fed from reservoirs located in the Sierra Nevada. SLAC and the neighboring Sharon Heights development (to the north), including the Stanford shopping center, receive water service from an independent system (called *Zone 3*) within the MPMWD. This separate system taps the Hetch Hetchy aqueduct and pumps water up to a 268,391-cubic-feet reservoir in Atherton north of Sand Hill Road, approximately 1.5 miles from central SLAC.

The Zone 3 system was constructed in 1962 under special agreements between the City of Menlo Park, the Sharon Heights developer, Stanford University, and the DOE. The cost of construction, including reservoir, pump station, and transmission lines, was shared among the various parties, so each party has a vested interest in the system, and is entitled to certain capacity rights in accordance with these agreements.

Drinking and process water are transported throughout the SLAC site by a distribution system protected by backflow prevention devices. SLAC has no drinking-water supply wells. The drinking-water supply well nearest to SLAC is located approximately 1,500 feet from the SLAC boundary

Use of water at SLAC is about equally divided between water used to cool equipment (such as the linac) and domestic uses (such as landscape irrigation and drinking water). The average water consumption by SLAC in 2007 was 42,070 cubic feet per day, or 15,355,800 cubic feet total.

1.7 Demographics

SLAC’s primary customers are the approximately 3,000 students, postdoctoral students, and scientists from around the world who make use of its accelerator-based instrumentation and techniques for their research. SLAC has a working population of about 1,500, of which about 279 are PhD physicists. Approximately 681 staff members are professional, including physicists, engineers, programmers, and other scientific-related personnel. The balance of the staff comprises support personnel, including technicians, crafts personnel, laboratory assistants, and administrative assistants. In addition to the regular population, at any given time SLAC hosts between 900 and 1,000 visiting scientists.

The populated area around SLAC is a mix of offices, schools, single-family housing, apartments, condominiums, and Stanford University. Approximately 3,500 people live within a one-mile radius of central SLAC. SLAC is surrounded by five communities: the city of Menlo Park; the towns of Atherton, Portola Valley, and Woodside; and the unincorporated community of Stanford University, which is in Santa Clara County. Nearby unincorporated communities in San Mateo County include Ladera and two neighborhoods located in western Menlo Park.

Table 1-1 provides a summary of populations in the communities around SLAC. Within one mile of SLAC’s perimeter are two public and two private schools with elementary and/or middle school students.

Table 1-1 Populations of Communities near SLAC

Type	Community	County	Population
Incorporated town or city	Atherton	San Mateo	7,194
	Menlo Park	San Mateo	30,785
	Palo Alto	Santa Clara	58,598
	Portola Valley	San Mateo	4,462
	Woodside	San Mateo	5,352
Unincorporated community	Ladera	San Mateo	1,492
	Stanford	Santa Clara	13,200
	West Menlo Park	San Mateo	3,629
	Weekend Acres	San Mateo	268
Total			124,980

Sources:

1 Census 2000 data from the San Mateo County web site and from US Census Bureau site

2 Stanford population from Stanford University Planning Department estimates

Note: Population in unincorporated areas outside the defined communities is not included

2 Environmental Compliance

2.1 Introduction

This chapter provides a summary of the regulatory framework within which the environmental programs of SLAC operate, and compliance with those regulations for 2007.

2.2 Regulatory Framework

The SLAC Work Smart Standards (WSS) identify environmental protection and safety requirements and standards that are applicable to facilities and facility operations.[2]

2.3 Environmental Permits and Notifications

The permits held by SLAC in 2007 are shown in Table 2-1.

Table 2-1 General Permits Held by SLAC

Issuing Agency	Permit Type	Description	Number
Bay Area Air Quality Management District	Air quality	Synthetic minor operating permit (SMOP), issued per Title V of the Clean Air Act	1
		36 permitted sources and 22 exempt sources for operation of various types of equipment (after initial permitting, consolidated into SMOP)	58
California Department of Toxic Substance Control	Hazardous waste treatment	Unit 1A – Building 025, permit by rule (PBR) for cyanide treatment tanks	1
		Unit 1B – Building 038, PBR for metal finishing pretreatment facility	1
		Unit 1C – Building 038, PBR for batch hazardous waste treatment tank	1
		Unit 2 – Building 038, PBR for sludge dryer	1
		Unit 4 – Building 035, conditional authorization permit for Former Solvent Underground Storage Tank (FSUST) groundwater treatment system	1

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[2] Stanford Linear Accelerator Center, “Work Smart Standards”, http://www-group.slac.stanford.edu/esh/general/isems/wss/

Issuing Agency	Permit Type	Description	Number
		Unit 5 – Former Hazardous Waste Storage Area (FHWSA), PBR for groundwater treatment system	1
South Bayside System Authority and West Bay Sanitary District	Wastewater discharge	Mandatory Wastewater Discharge Permit	1
Regional Water Quality Control Board	Stormwater	Industrial activities stormwater general permit	1
US Environmental Protection Agency	Hazardous waste	Hazardous waste generator	1

2.4 Environmental Incidents

2.4.1 Non-radiological Incidents

SLAC was in compliance with all non-radiological requirements related to the environment throughout 2007. There were no reportable releases to the environment during 2007.

2.4.2 Radiological Incidents

In 2007, no radiological incidents occurred that increased radiation levels or released radioactivity to the environment. As detailed in Chapter 5, "Environmental Radiological Program", SLAC was in compliance with all radiological requirements related to the environment throughout 2007.

2.5 Assessments, Inspections, and Quality Assurance

As described in Chapter 3, "Management Systems" of the SLAC Environmental Safety and Health (ES&H) Manual, the environmental programs at SLAC are subject to assessments, inspections, and quality assurance measures. Those conducted during 2007 are reported here.

2.5.1 Assessments

2.5.1.1 Internal

On July 2 and 3, 2007, Radiation Protection (RP) Department performed a review of their Radiological Environmental Program (REP). Results of the review indicated the program was well conceived and implemented. The program was found to be compliant concerning air effluents, aqueous effluents, direct radiation, and the Radioanalysis Laboratory. The review concluded that the program would acquit itself well in the upcoming DOE audit. In addition, recommendations for improvement were identified.[3]

2.5.1.2. External

External assessments conducted by regulators are conducted periodically and include quarterly radiation monitoring of the SLAC perimeter by California Department of Health Services. On July 23 and 24, 2007,

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[3] A full description of the recommendations can be found in *SLAC Assessment Report: Radiological Environmental Program*, July 2-3, 2007.

the DOE performed a review of the Radiation Protection Department's Environmental Radiation Protection Program. The program was found to be well managed; REP program staff was found to be competent and adequately trained for their required duties; and the Radioanalysis Laboratory was found to be well documented and well equipped for the lab analyses performed. No findings were identified, but two observations were listed: (1) Recommendations or weaknesses identified in the 2007 SLAC Internal Assessment should be entered and tracked in the SLAC corrective action tracking system, and (2) radioactive material storage areas should be located in a covered facility to minimize the potential for radioactive contamination of stormwater.[4]

2.5.1.3 Independent Assessments

The Environmental Safety and Health Advisory Committee (ESHAC) is an external committee of Stanford University that works in conjunction with the SLAC Policy Committee which advises the president of Stanford University on all aspects of SLAC operations. The goals of the ESHAC are to review the SLAC ES&H vision, mission, strategy, plans, progress against plans, and performance. The ESHAC met with SLAC in April 2007 to review the environmental management programs. There were no significant findings. They noted that efforts are underway to enhance the system components such as work planning and control and pollution prevention and to ensure that SLAC meets all of the requirements in the new EO 13423, Strengthening Federal Environmental, Energy and Transportation management, and they would like to see more emphasis on and investment in pollution prevention.

2.5.2 Inspections

Periodic inspections of the environmental programs are performed at SLAC by environmental regulatory agencies. Table 2-2 lists the inspections conducted in 2007 by these agencies.

Table 2-2 Environmental Audits and Inspections

Regulatory Agency	Inspection Title	Date	Violations
South Bayside System Authority	Annual Wastewater Discharge Inspection	December 8	0
Bay Area Air Quality Management District	Routine annual inspection	August 9	0
	Non-routine investigative visit (follow-up to liquid chemical release at CT-1701 chemical shed)	February 7	0
San Mateo County Department of Health Services	Hazardous waste generation program, tiered permitting, and hazardous materials business plan	January 16, 18, 19 and 23	1
	Verification of information presented in California Accidental Release Prevention Program (CalARP) Risk Management Plan, submitted September 2007	April 25	0

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[4] U. S. Department of Energy Oak Ridge Office, *Final Report Environmental Radiation Protection Program Review at Stanford Linear Accelerator Center*, July 23-24, 2007.

The California certified unified program agency (CUPA) inspector issued one notice of violation (NOV) in 2007. The NOV noted that that required hazardous waste refresher training for some generators was overdue at the time of inspection. The corrective action for this finding has been completed by SLAC.

In addition, the following non-compliance issues were noted and have been corrected.

Hazardous Waste Program:

- Fire extinguishers were overdue for service and had access blocked
- Three hazardous waste containers at the Motor Pool had funnels which did not meet the regulatory definition of a closed container.

Tiered Permit Treatment Facilities:

- The hazardous waste tanks at Treatment Unit 4 did not have structural integrity assessments.
- The hazardous waste tanks at Treatment Units 1B, 1C, and 2 did not have structural integrity assessments.

Hazardous Materials Business Plan:

- Chemical inventory did not include hazardous waste in storage areas outside of the Hazardous Waste Yard.
- Inadequate securing of gas cylinders located at Building 26

2.5.3 Quality Assurance

The SLAC site-wide quality assurance (QA) program is consistent with the requirements of DOE Order 414.1C,[5] and has roles, responsibilities, and authorities for implementing the ten criteria from the DOE order are included in the *SLAC Institutional QA Program Plan*.

The Office of Assurance is responsible for:

- Auditing quality assurance for line work as well as ES&H programs
- Maintaining the *SLAC Institutional Quality Assurance Program Plan*
- Providing direction for implementation of the ten criteria from DOE Order 414.1C

2.5.3.1 Environmental Non-radiological Program

The Environmental Restoration Program uses the *Quality Assurance Project Plan for the Environmental Restoration Program*[6] for soil and groundwater characterization and remediation activities. This document includes all components required of quality assurance project plans and are consistent with United States Environmental Protection Agency (USEPA); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund); and DOE guidance documents. The components include

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[5] United States Department of Energy, DOE Order 414.1C, "Quality Assurance", http://www.directives.doe.gov/pdfs/doe/doetext/neword/414/o4141c.html

[6] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection and Restoration Department, *Quality Assurance Project Plan for the Environmental Restoration Program* (SLAC-I-750-2A17M-003 R003, May 2007)

defining required laboratory and field QA and quality control (QC) procedures and corrective actions, and data validation and reporting.

2.5.3.2 Environmental Radiological Program

Twice a year SLAC participates in the Mixed Analyte Performance Evaluation Program (MAPEP) held by DOE Idaho National Laboratory (INL). Under this program, the INL provided the SLAC Radioanalysis Laboratory with samples that contained unknown gamma- and beta-emitting radionuclides. SLAC used these samples to test and improve its gamma counting and liquid scintillation counting capabilities. This ensures that the lab’s counting system performs accurate measurements. Except for tritium, MAPEP Session 17 results, submitted May 2007, were all acceptable, which is consistent with previous results. During the tritium activity calculation, the background subtraction was not performed due to operator error. After performing the background subtraction, the results fall within the acceptable range.

3 Management Systems

3.1 Introduction

This chapter provides an overview of the organizational structure, management approach, and EMS implementation used to protect the environment. The results for the various measures and reviews discussed below are contained in Chapter 2, “Environmental Compliance”.

3.2 SLAC Organization

In May of 2005, an extensive reorganization of the SLAC Directorates took place in anticipation of a change in program at SLAC from DOE High Energy Physics funded activities to DOE Basic Energy Sciences funded activities by the end of fiscal year (FY) 2008. After the reorganization, elements of the old directorates were reassigned to Director’s Office, Operations Directorate, Photon Sciences Directorate, Particle and Particle Astrophysics Directorate, and LCLS Construction Directorate. Specifically, the Business Services and ES&H Divisions were reassigned to the Operations Directorate while the SSRL Division was reassigned to the Photon Sciences Directorate. Additionally, the SLAC Office of Assurance was formed in 2006 in response to DOE Order 226.1. The purpose of SLAC’s assurance program is to ensure that products and services meet or exceed customer’s expectations. SLAC’s customers include the DOE, the many users who participate in experiments at SLAC using the laboratory’s unique experimental facilities, and the sponsors of work conducted under work-for-others program.

3.3 ES&H Division Organization

The ES&H Division consists of six departments (see below) and a division office. The division office is tasked with overall strategic planning and management. The shared goal is to ensure that SLAC operates in compliance with federal, state, and local laws and regulations, as well as DOE directives..

3.3.1 Environmental Protection

The Environmental Protection (EP) Department has three technical groups. The EP Group provides oversight of stormwater and industrial wastewater, toxic substances control, and groundwater protection. The Environmental Restoration Group oversees work to restore property impacted with chemicals. The Waste Management (WM) Group develops and implements waste minimization and pollution prevention plans, and coordinates the management and off-site disposal of sanitary, hazardous and low-level radioactive waste.

3.3.2 Chemical and General Safety

The Chemical and General Safety Department (CGS) manages the SLAC’s overall safety and health programs, as well as programs in hazardous materials management, training, fire safety, medical, CMS and non-radiological air quality.

During 2007, the Fire and Emergency Management Group, staffed by personnel from the Palo Alto Fire Department, continued to provide services on a 24 hour-a-day, seven days-a-week basis.

During 2007, the Medical Department, staffed by contracted professional medical personnel, continued to provide a full range of occupational medicine services to the site.

3.3.3 Radiation Protection

The RP Department includes four technical groups. The Radiation Physics Group provides expertise in shielding design for new experiments and facilities, and provides oversight for the safe operation of beam lines to protect workers, members of the general public and the environment. The Field Operations Group oversees radiological monitoring and control. The Dosimetry and Radiological Environmental Protection Group provides dosimetry services and environmental impact monitoring and assessment. The Radioactive Waste Management Group oversees radioactive waste management at SLAC.

3.3.4 Knowledge Management

The Knowledge Management Department provides publishing and web services, and manages the ES&H Division budget.

3.4 Integrated Safety and Environmental Management System

The Integrated Safety and Environmental Management System (ISEMS) is a document that describes how SLAC ensures that the site is operated in a safe, environmentally responsible manner and complies with applicable laws, regulations, standards and other requirements. The ISEMS is based on integrating the key elements of effective integrated safety and environmental management systems into the mission and everyday operations of the site, and as such embodied the ISEMS concepts prior to the DOE requirements that were formally incorporated into the management and operating contract for the site. The revisions to the ISEMS program at SLAC were guided by an integrated safety management (ISM) steering committee and an environmental management (EMS) steering committee with representatives from all the directorates at SLAC, including the ES&H Division. SLAC’s Environmental Safety Committee now serves as the EMS steering committee and an EMS Coordinator ensures conformance with EMS requirements specified in DOE Order 450.1.

3.4.1 Safety and Environmental Management System

The “plan, do, check, and improve” approach of ISEMS[7] has been formally adopted by SLAC, and is the foundation of the site’s ISEMS[8] and the ES&H program. The approach consists of the following five core functions:

1. Define the scope of work
2. Analyze the hazards
3. Develop and implement hazard controls
4. Perform work within controls

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[7] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, “Integrated Safety and Environmental Management Systems”, http://www-group.slac.stanford.edu/esh/general/isems/

[8] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, *SLAC Integrated Safety and Environmental Management System Description* (SLAC-I-720-0A00B-001), http://www-group.slac.stanford.edu/esh/general/isems/sms.pdf

5. Provide feedback and continuous improvement

3.4.2 Work Smart Standards

To ensure that SLAC complies with safety and environmental standards, the laws and regulations that specify the environment, safety, and health requirements of the laboratory have been identified and incorporated into the SLAC management and operating contract. These contract requirements, known as the SLAC WSS, are reviewed at least annually, and are based on identification of potential safety and health hazards, environmental aspects and impacts and regulatory non-compliances identified by those who work at SLAC[9].

3.4.3 Environmental Performance Measures

In addition to adopting WSS, SLAC evaluates its activities against performance measures. The environmentally relevant measures are:

- Environmental violations and releases
- Environmental restoration goals
- Waste minimization/pollution prevention goals
- Hazardous and radioactive waste

Specific performance objectives, measures and targets are developed by DOE and SLAC, approved and formally incorporated into the M&O contract each fiscal year.. DOE uses the contract performance measures to formally evaluate contractor performance in all areas, including ES&H.

3.4.4 Training

To ensure every employee is both aware and capable of fulfilling his or her responsibilities, the ES&H Division operates an extensive program of classroom- and computer-based training. For example, personnel who handle hazardous chemicals and waste are provided training in chemical and waste management, waste minimization, pollution prevention, stormwater protection, on-site transportation of hazardous chemicals and waste, and basic spill and emergency response. Details on the ES&H training program are available on line[10].

3.5 Environmental Management System

An EMS is essentially a systematic approach for environmental improvement – a continual cycle of planning, implementing, reviewing and improving actions taken to achieve protection of the air, water, land, and other natural resources potentially impacted by operational activities. SLAC's EMS program, patterned after the International Organization for Standardization (ISO) 14001, was formally in place on December 21, 2005 following a DOE assessment of the site's EMS and issuance of a self-declaration letter.

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[9] Stanford Linear Accelerator Center, "Work Smart Standards Set", http://www-group.slac.stanford.edu/esh/general/isems/wss/.

[10] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, "Training", http://www-group.slac.stanford.edu/esh/training/

SLAC's EMS program is consistent with the requirements of DOE Order 450.1, and as described in Section 3.4, has been integrated with the ISM in the ISEMS for the site.

The annual review and ranking of environmental aspects was completed this year by SLAC's EMS Steering Committee, the ESC, and thirteen objectives and targets were established for 2007. For each objective and target, a work plan, termed an EMP was completed. The objectives and targets established in 2007 are listed below. Additional work and accomplishments completed by SLAC's core environmental programs are discussed in subsequent sections of this document. The 2007 EMS objective and targets were:

- Reduce green house gas (GHG) emissions by minimizing consumption and release of sulfur hexafluoride (SF_6)
- Reduce risk from hazardous chemicals by using information from the CMS to identify pollution prevention (P2) opportunities
- Meet the requirements of the RWQCB (May 18, 2005) Order for soil and groundwater investigation and remediation
- Reduce facility impacts on sanitary sewer system discharges beyond compliance requirements, specifically, reduce copper discharges
- Reduce E-waste by improving management practices
- Minimize generation of radioactive materials and waste by expanded training of waste generators
- Store radioactive materials in covered facility; determine cost for improvement and request appropriate funding
- Reduce stormwater impacts by investigating sources of problem constituents
- Reduce water use by developing scope of work and cost estimate for water metering
- Reduce energy usage by continuing Site Electrical Power Monitoring Project (sub-metering)
- Control LCLS construction environmental impact by ensuring compliance with best management practices (BMPs) in the stormwater pollution prevention plan
- Establish air monitoring system and formalize National Emission Standards for Hazardous Air Pollutants (NESHAPs) air dose evaluation methodology
- Formalize radiological groundwater protection program by developing a program manual

Of the thirteen EMPs developed for the 2007 objectives and targets, eleven were closed and two remain open with actions carrying over to 2008. Notable accomplishments of the EMPs include the following:

- Reviews of SF_6 inventory and usage helped to identify opportunities for reducing SF_6 emissions from the Master Substation.
- Hexavalent chromium was replaced with a less toxic material at the Plating Shop this year (900 gallons of solution).
- All compliance requirements established under the RWQCB Order were met.

- A best management practice (BMP) was developed for treating water from pipe flushing operations prior to discharge. Water from pipe flushing will be containerized and treated at SLAC's Metal Finishing Pretreatment Facility (MFPF).
- A new training class for radioactive waste generators was developed and piloted. One of the focuses of the class was to educate generators on ways to minimize the generation of radioactive waste. An implementation plan for full roll-out of the course and schedule for training was completed.
- A preliminary study was conducted by an outside vendor to identify appropriate sub metering systems for 17 buildings and one cooling tower at SLAC.
- Stormwater inspections and stormwater protection BMPs were completed to ensure stormwater compliance for the LCLS project.
- A comprehensive program manual was developed that documents the SLAC operations and its potential impacts, program rationales, protection and monitoring measures for radiological environmental protection including direct radiation, radioactive air, wastewater, stormwater, and groundwater.
- Research of e-waste disposal/recycling vendors was conducted to identify improved recycling options for e-waste. To promote proper e-waste recycling and waste disposal, and purchasing of Energy Star electronic equipment, an article was published in SLAC's daily on-line newsletter, *SLAC Today*.

In the coming year, SLAC's EMS will be further enhanced to incorporate the elements of EO 13423–*Strengthening Federal Environment, Energy, and Transportation Management*, signed by the President on January 24, 2007, which requires federal agencies to meet a number of sustainable goals in the areas of fleet operation, energy efficiency, renewable energy, water consumption, electronics stewardship, "green" purchasing, sustainable building and continued reduction of toxic chemicals and waste. EO 13423 revokes and replaces EO 13148, *Greening the Government Through Leadership in Environmental Management*, among other EOs. SLAC's EMS will be used to establish measurable targets and objectives for meeting the sustainable goals of the EO.

4 Environmental Non-radiological Programs

4.1 Introduction

During the course of providing accelerators, detectors, instrumentation, and support for national and international research programs, SLAC manufactures and maintains one-of-a-kind research equipment, which requires the use and management of industrial chemicals, gases, and metals. In addition, SLAC has the potential to impact the environment due to storage and handling of chemicals and the large quantities of electricity and cooling water that are used in the operation of the accelerator. Finally, SLAC has environmental management issues relevant for any employer with more than 1,500 full-time staff, 3,000 scientific users per year, more than 230 vehicles, hundreds of buildings, and 426 acres of land situated in an environmentally sensitive location.

SLAC has focused considerable efforts to identify and eliminate or minimize waste generation and emissions. SLAC first works to avoid generating waste and emissions.. When unavoidable, SLAC attempts to minimize the amount it does produce and then carefully manages the impacts that may occur. Recent recognition of SLAC's environmental performance accomplishments is provided in Table 4-1.

Table 4-1 Recent Environmental Awards

Year	Organization	Award/Recognition Program	Description
2002	USEPA	Champion of Green Government Award	Identifying/developing alternatives to ozone depleting solvents
2003	USEPA	Champion of Green Government Award	Reuse and reclamation of hazardous materials, and reduction of hazardous waste generation
2004	DOE	Pollution Prevention Award	Development of a site-wide chemical management system
2004	USEPA	Champion of Green Government Award	By upgrading lighting in Klystron Gallery will save $236,000 annually
2006	DOE	Pollution Prevention and Environmental Stewardship Accomplishment – Noteworthy Practice	Resource conservation achieved by building experimental facilities with reused materials
2006	DOE	Pollution Prevention and Environmental Stewardship Accomplishment – Best in Class	Instituted the Chemical Management Services which manages chemicals procurement and use

Additionally, SLAC continually strives to increase its environmental performance, per the objectives of EO 13423, "Strengthening Federal Environment, Energy, and Transportation Management" (see Chapter 3).

This chapter provides an overview of the non-radiological environmental programs SLAC implements to protect air and water quality, to manage hazardous materials in a safe and environmentally responsible manner, and to eliminate or minimize the generation of hazardous, non-hazardous, and solid waste. The chapter sections are organized by protection program and describe the regulatory framework, program status for 2007, and relevant performance trends. The radiological environmental program is discussed in

Chapter 5, and programs covering the monitoring and remediation of groundwater, soil, and sediment are discussed in Chapter 6.

4.2 Air Quality Management Programs

SLAC operates various sources of air pollution, including a plating shop, a paint shop, several machine shops, boilers, solvent degreasers, backup generators, and a vehicle fueling station. In addition, high-energy physics experiments have the potential to emit volatile organic compounds (VOCs) due to the nature of the gas atmospheres required for use in particle detectors. Finally, GHGs are being actively managed in response to the passage of Assembly Bill 32 (AB32), the California Global Warming Solutions Act. This section describes the regulatory framework to which SLAC is subject for the purpose of air quality protection, and presents the status of SLAC's air quality protection programs in 2007.

4.2.1 Regulatory Framework

In the San Francisco Bay Area, most federal and state air regulatory programs are implemented through the rules and regulations of the Bay Area Air Quality Management District (BAAQMD). Included in the BAAQMD roles and responsibilities are implementation of Title V of the Clean Air Act. SLAC's Title V SMOP permit was issued by the BAAQMD on July 26, 2002. The Title V SMOP placed limits on facility-wide emissions of VOCs, total hazardous air pollutants (HAPs), and individual HAPs.

Mechanisms by which BAAQMD regulates SLAC's air emissions include:

1. Annual enforcement inspections
2. New source permit applications
3. Annual information updates for emissions of air toxics as identified by the California Air Resources Board (CARB) in its toxic substances checklist
4. Annual information updates for adhesives usage as specified in BAAQMD Regulation 8-51-1502.2C
5. Notification requirements for demolitions, significant renovations, and any activity involving asbestos

In addition, SLAC is subject to the following two federal air quality programs, both of which are administered through the Air Division of USEPA Region 9:

- National Emission Standards for Halogenated Solvent Cleaning, under Title 40, *Code of Federal Regulations* (CFR), Part 63.460
- Protection of Stratospheric Ozone, under 40 CFR 82

4.2.2 Program Status

4.2.2.1 Annual Facility Enforcement Inspection

The annual facility-wide inspection was performed by BAAQMD on August 9, 2007. The inspection consisted of a file review followed by field visits to various emissions sources at SLAC. No violations were issued as a result of the inspections.

In addition, the BAAQMD visited the site on February 7, 2007 in response to a liquid chemical release that occurred at the Cooling Tower 1701 chemical shed. There were no direct air quality issues, since the release was in liquid form and involved no permitted sources of air emissions, and no notices of violation were issued by the BAAQMD related to the event.

4.2.2.2 New Source Permits

Two of the three permit applications submitted by SLAC to BAAQMD in 2006 were still pending at the end of 2007. The first was for the portable generator associated with the Gamma Ray Large Area Space Telescope (GLAST) project. The second pending application was for a trailer-mounted portable generator. Under BAAQMD's Accelerated Permit program, a proposed source can commence operation upon submittal of a complete permit application package. Because both units qualified for this program, they have been placed into service as portable emergency standby generators. The third application was for the SSRL paint shop, which was determined to be exempt from BAAQMD permitting requirements.

Two additional permits were obtained for new emergency standby generators in 2007 under the state Portable Equipment Registration Program (PERP). This program is administered by the CARB.

In 2007, SLAC applied for a permit to operate a soil vapor extraction system on the west side of the Plant Maintenance and Utilities Building (Bldg. 35). This project was the next phase in the remediation of residual chemicals of concern associated with a former underground spent-solvent tank. This project qualified for an Accelerated Permit, and following submittal of an application, the system was tested in September 2007 and began full-scale operations in October 2007.

One of SLAC's portable emergency standby generators was taken out of service in June 2007. This 15-year-old unit had already been replaced by a newer generator permitted in 2006.

During 2007, SLAC maintained a total of 58 sources of air emissions listed in its facility-wide permit-to-operate, comprising 36 permitted and 22 exempt sources.

4.2.2.3 Annual Update for Permit-to-Operate and Annual Title V SMOP Emissions Report

SLAC submits two primary annual reports to the BAAQMD. One is the annual update that is prepared in response to the BAAQMD information update request for selected permitted sources, and covers the previous calendar year. The other is the Title V annual emissions report for all onsite sources for the SMOP and covers the period of July 1, 2005 through June 30, 2006. Following submittal of the former report, SLAC received the renewal of its permit-to-operate on June 23, 2007, effective through July 1, 2008. SLAC submitted the Title V annual emissions report on time in July 2007.

As was the case last year, the largest source of air emissions at SLAC in 2007 was the BaBar detector. SLAC has operated the detector within permit conditions at all times since its initial startup in 1999, using isobutane, which is the only significant Precursor Organic Compound used at SLAC. In 2005, BAAQMD modified and expanded the BaBar subsystem permits to create three individual permits, the drift chamber, the instrumented flux return/resistive plate chamber, and the testing facility for limited streamer tubes (LSTs). Each permit included a specific emissions threshold for isobutane. Throughout 2007, all three subsystems operated smoothly with no emissions limit exceedances. LSTs testing were completed by the end of 2006. The plastic LSTs replaced older metal detector components in three phases; and the final phase was completed in June 2007.

4.2.2.4 Annual Adhesives Usage Report

SLAC submitted its annual adhesives usage report to BAAQMD to satisfy Regulation 8-51-502.2c on April 11, 2007 (covering the 2006 reporting year) and reported using a total of 36 adhesives.

4.2.2.5 Asbestos and Demolition Project Notification Program

For projects that involve the demolition of existing structures or the management of regulated asbestos-containing material, SLAC is required to provide advance notice to BAAQMD. During 2007, approximately 32 construction projects were evaluated for the purpose of air quality protection. Based on the project scopes and the results of pre-work asbestos surveys, asbestos/demolition/renovation notifications were submitted to BAAQMD for four of these projects.

4.2.2.6 National Emission Standards for Hazardous Air Pollutants

SLAC operates four sources that are subject to 40 CFR 63, Subpart T, “National Emission Standards for Halogenated Solvent Cleaning”, part of the NESHAPs regulations, as shown in Table 4-2. Reporting comprises an annual performance report and two semi-annual exceedance reports.

No exceedances occurred during the covered reporting periods. The four NESHAPs units were operated in accordance with their NESHAPs emissions limits during the covered reporting periods.

Table 4-2 Halogenated Solvent Cleaning Sources Subject to NESHAPs

Source	Source Description	Location	Halogenated Solvent Used
S-4	Batch vapor degreaser	Plating Shop	1,1,1-Trichloroethane (TCA)
S-54	Near-zero emission degreaser	Plating Shop	Tetrachloroethylene
S-58	Batch cleaning tank	Electron Gun Testing/Maintenance	TCA
S-61	Batch cleaning tank	Plating Shop	Methylene chloride

4.2.2.7 Protection of Stratospheric Ozone

No releases of stratospheric ozone-depleting substances (ODS) occurred during 2007 that were subject to the release reporting and corrective action requirements in the ODS regulations (40 CFR 82).

Per the requirements of EO 13423, “Greening the Government through Leadership in Environmental Management”, SLAC was subject to two DOE-mandated ODS-management objectives:

- By 2005, retrofit or replace 100 percent of chillers that have greater than 150 tons of cooling capacity, were manufactured prior to 1984, and that use Class 1 ODS (chillers with cooling capacities of 150 tons and less are not included)
- By 2010, eliminate the procurement of all Class 1 ODS

SLAC completed the activities to attain the first objective in 2002, three years ahead of schedule. The only major chiller left onsite that uses a Class I ODS is a 150-ton unit manufactured prior to 1984, which is currently slated for replacement with a Class II or non-ODS chiller in FY09.

SLAC identified the following four continuing projects that will be necessary to achieve the second objective.

- SSRL Building 118 Chiller Replacement – slated for replacement in FY09
- Halon Fire Systems Replacement (two systems) – under review for applicability

- Miscellaneous heating, ventilation, and air conditioning (HVAC) Equipment Replacement (approximately six small systems) – in progress
- TCA Relocation Project, Facilities Department (FAC) – in progress

4.2.2.8 Vehicle Fleet Management

SLAC operates and maintains a diverse fleet of cars, trucks, and specialized pieces of heavy equipment to support its daily operations. Vehicles are provided by one of two federal agencies: the DOE and the General Services Administration (GSA). SLAC continues to replace and upgrade its service fleet as resources allow.

The onsite gasoline dispensing facility (GDF) is regulated as a permitted emissions source by the BAAQMD. The GDF provides both gasoline and diesel for SLAC vehicles. Records of deliveries of both gasoline and diesel are tracked and reported annually to BAAQMD. Under the conditions of SLAC's site-wide air permit, the gasoline dispensing system obtained an annual source test to ensure proper functioning. In accordance with its individual permit, a source test was performed for the GDF in September 2007 and all results were within regulatory limits. The results were transmitted automatically to the BAAQMD.

Secondary fuel distribution is achieved by portable diesel dispensing tanks. These tanks are also filled at the GDF and then transported throughout SLAC to refuel heavy equipment and stationary engines, such as emergency back-up generators.

To reduce the amount of petroleum-based fuel used at SLAC, in accordance with EO 13423, SLAC Fleet Services is considering converting the GDF from gasoline and diesel to E85 ethanol blend and gasoline.

4.2.2.9 Greenhouse Gas Inventory and Baseline

SF_6, the most potent GHG known, is used at SLAC in both electrical equipment and experimental apparatus. In light of recent concerns about GHG and new California legislation (Assembly Bill 32), research proposals now routinely address the use of SF_6, evaluate potential alternatives, and address the responsible management of this gas, even in minute quantities. It remains clear that SF_6 is an extremely useful material, by far the most appropriate for some applications, and that more research into acceptable substitutes is urgently needed. In the meantime, the ES&H Division continued its efforts to raise awareness of the need for rigorous management of SF_6 throughout the facility. AB32 has a five-year implementation schedule that extends through 2012, and SLAC is actively working to address the likely major requirements.

4.2.3 Summary and Future Plans

SLAC emits pollutants to the atmosphere from its operation of one-of-a-kind research and manufacturing equipment, as well as from more conventional sources such as building maintenance and vehicle fleet operation. SLAC operates its air quality management program in compliance with its established permit conditions. SLAC maintains an active program to improve its environmental performance in the air quality arena. Recent years have witnessed the following accomplishments:

- Decrease of more than 90 percent in halogenated solvent emissions from SLAC's Plating Shop
- Replacement of three pre-1984, Class 1 ODS using chillers
- Decrease in the average age of SLAC's vehicle fleet

- Successful negotiations to obtain a Title V SMOP, which implements limits on facility-wide HAPs emissions
- Installation of new natural gas metering and instrumentation control systems at its main boilers
- Enrollment in the California Climate Action Registry (CCAR), which is currently voluntary but affords facilities the opportunity to develop a GHG inventory and establish a baseline against which all future reductions can be measured The data are being compiled for submittal, which is required to complete membership in the program.

Future plans include the phasing out of all Class 1 ODS, continued work on the GHG baseline/inventory survey for the facility, development and implementation of a new air emissions data management system, and further transition to a newer, more alternatively-fueled vehicle transportation fleet.

4.3 Industrial and Sanitary Wastewater Management Program

SLAC discharges industrial pollutants and sanitary sewage to the sewage collection system operated by the West Bay Sanitary District (WBSD). The sewage is then conveyed via the WBSD's collection system to the wastewater treatment plant operated by the South Bayside System Authority (SBSA). Much of SLAC's industrial pollutants are removed prior to discharge at such facilities as the MFPF and the contained water treatment system at Cooling Tower 1701. This section describes the regulatory framework under which SLAC operates for the purpose of water quality protection, and presents the status of SLAC's water quality protection programs in 2007.

4.3.1 Regulatory Framework

The Federal Water Pollution Control Act, also referred to as the Clean Water Act (CWA), was enacted in 1972 to halt the degradation of our nation's waters. The CWA established the National Pollutant Discharge Elimination System, which regulates discharges of wastewater from point sources such as a publicly owned treatment work and categorically regulated industrial facilities such as electroplating shops. In 1987, the CWA was amended to include non-point source discharges such as stormwater run-off from industrial, municipal, and construction activities. The CWA is the primary driver behind the SLAC water quality protection programs.

SLAC operates its industrial and sanitary wastewater programs under a mandatory wastewater discharge permit (WB 061216) which is negotiated jointly with the WBSD and SBSA. The permit, which covers the entire facility, was issued on December 16, 2006, and may be renewed annually until December 15, 2011. SLAC also has a contractual relationship with the WBSD, which specifies the total industrial and sanitary flow allowed to be discharged.

SLAC's industrial and sanitary monitoring locations are shown in Figure 4-1. SLAC's Sand Hill Road flow metering station (Sand Hill flow meter station [FMS]) is located immediately upstream of SLAC's sewer system connection to WBSD's Sand Hill Road trunk line, just to the north of the SLAC main gate.

SLAC also has four flow monitoring stations on the south side of the facility, which collectively monitor the flow SLAC discharges to the WBSD's Alpine Road trunk line. The four locations are the MSub, Alpine, FHWSA Treatment System and Interaction Region 8 (IR08), as shown on Figure 4-1

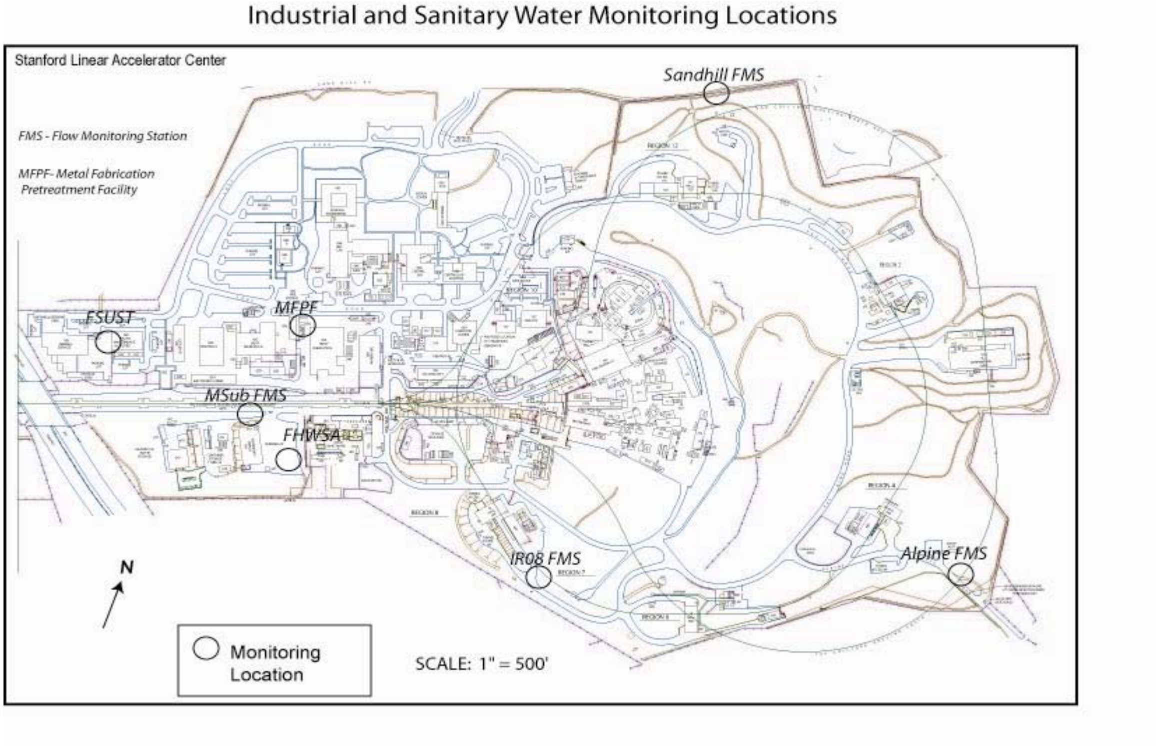

Figure 4-1 Industrial and Sanitary Wastewater Monitoring Locations

SLAC is required to submit a semi-annual self-monitoring report[11] which includes the results of its monitoring of the MFPF and FHWSA Treatment System, certification of a solvent management plan for approximately 100 solvents selected by the SBSA, and reports for discharges of radioactivity in industrial wastewater (see Section 5.5.1).

4.3.2 Program Status

4.3.2.1 Annual Facility Enforcement Inspection

The SBSA conducted an annual inspection of SLAC on December 11, 2007. The inspection focused on the Plating Shop and cooling tower operations. No NOV was issued.

4.3.2.2 Flow Monitoring Results

Total industrial and sanitary wastewater discharged to the WBSD's regional collection system was approximately 17.6 million gallons, which equates to an average of approximately 48,200 gallons per day (gpd). SLAC was within its discharge entitlement of approximately 23.5 million gallons, or 64,400 gpd.

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[11] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection Department, *Semiannual Self-Monitoring Report, Mandatory Wastewater Discharge Permit WB 020401-P* (July 19, 2007, submitted to Norman Domingo, Technical Services Supervisor, SBSA)

———, *Semiannual Self-Monitoring Report, Mandatory Wastewater Discharge Permit WB 061216* (January 28, 2008, submitted to Norman Domingo, Technical Services Supervisor, SBSA)

4.3.2.3 Water Quality Monitoring Results

A summary of the water quality results for the Sand Hill Road station is presented in Table 4-3, along with the discharge limits set forth in SLAC's permits. SLAC was in compliance with all permitted discharge limits at the Sand Hill Road Station.

Table 4-3 Water Quality at the Sand Hill Road Station

Parameter	SBSA Calculated Results (ppd)				Wastewater Discharge Limits* (ppd)
	January 30, 2007	May 1, 2007	July 11, 2007	October 23, 2007	
Cadmium	<0.004	<0.004	<0.009	<0.004	0.036
Chromium	<0.03	<0.03	<0.03	<0.03	0.18
Copper	0.100	0.11	0.07	0.09	0.13
Lead	<0.04	<0.04	<0.04	<0.04	0.33
Nickel	<0.03	<0.03	<0.03	<0.03	0.042
Silver	<0.016	0.004	0.014	<0.006	0.036
Zinc	0.26	0.12	0.17	0.32	0.45
pH**	8.20	8.20	8.30	8.00	6.0–12.5

ppd = pounds per day

* Compliance is determined by comparing the mass discharge limit with the average of the samples taken for the previous 12 months.

** pH is regulated as Daily Maximum rather than an Annual Average Limit

The analytical results and permit limits for water quality samples collected at the MFPF are presented in Table 4-4. SLAC was in compliance with all discharge limits.

Table 4-4 Water Quality at the Metal Finishing Pre-treatment Facility

2007			SBSA Annual Sampling	SLAC Semi-Annual Sampling	
	Discharge Limits		August 2 & 31	April 24	December 6
Analytical Parameter	Federal Daily Maximum (mg/L[2])	Federal Monthly Average (mg/L)	SBSA Monitoring Results (mg/L)	SLAC Monitoring Results (mg/L)	SLAC Monitoring Results (mg/L)
Metals					
Cadmium	0.11	0.07	<0.004	0.000054	0.000036
Chromium	2.77	1.71	<0.03	0.0045	0.012
Copper	3.38	2.07	0.09	0.130	0.15
Lead	0.69	0.43	<0.04	0.00039	0.0043
Nickel	3.98	2.38	<0.03	0.025	0.1
Silver	0.43	0.24	0.007	0.043	0.011
Zinc	2.61	1.48	0.02	0.0073	0.01
Non-metals					
Cyanide	1.20	0.65	0.0053	<0.006	<0.032
pH (unitless)	6.0–12.5	NA[3]	9.50	9.14	8.66

1 All monitoring results, except for pH, are expressed in units of milligrams per liter (mg/L).

2 mg/L = milligram per liter

3 NA = not applicable

4.3.2.4 Best Management Practices Implementation Results

The Industrial Wastewater Program started initiating BMPs in 2004 to reduce discharge of constituents of concern to the sanitary sewer. The following were accomplished in 2007 as part of this effort:

- Two process tanks at the Plating Shop which previously contained chromium solutions were replaced with non-chromium containing solutions. This BMP is expected to reduce the amount of chromium discharged from the MFPF.

4.4 Surface Water Management Program

Stormwater flows from the 426-acre SLAC site through 25 drainage channels. In certain areas of the site, stormwater has the potential to come into contact with industrial activities or facilities. Such activities or facilities include metal working, outdoor storage, cooling towers, electrical equipment operation, and secondary containments. Many of the channels drain areas where the stormwater has little or no potential of exposure to industrial activities. SLAC has identified seven monitoring locations which are representative of stormwater discharges associated with industrial activities. These are listed below and shown in Figure 4-2.

- IR-8 Channel (IR-8)
- IR-6 Channel (IR-6)
- North Adit East Channel (NAE)
- Main Gate East Channel (MGE)
- IR-2 North Channel (IR-2)
- Building 81 North Channel (B81)
- Building 15 and Building 18 combined flow (B015/B018)

4.4.1 Regulatory Framework

Federal regulations allow authorized states to issue general permits to regulate industrial stormwater or non-point source discharges. California is an authorized state; and in 1991, the State Water Resources Control Board (SWRCB) adopted the industrial activities stormwater general permit, with the goal of reducing water pollution by regulating stormwater discharges associated with industrial activities. SLAC filed a notice of intent to comply with the general permit.

California's general permit was re-issued in 1997. SLAC adheres to the requirements of the general permit, through its development and implementation of a stormwater pollution prevention plan (SWPPP).[12] The SWPPP has two main components: a stormwater monitoring program (SWMP) and a BMP program.[13] The SWMP presents the rationale for sampling, lists the sampling locations, and specifies the analyses to be performed. The BMPs include a list of 17 generic and site-specific practices that serve to minimize the impact on stormwater from SLAC's industrial activities (see Section 4.4.2.2).

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[12] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection and Restoration Department, *SLAC Stormwater Pollution Prevention Plan* (SLAC-I-750-0A16M-002)

[13] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection Department, "Stormwater", http://www-group.slac.stanford.edu/esh/groups/ep/water/stormwater/

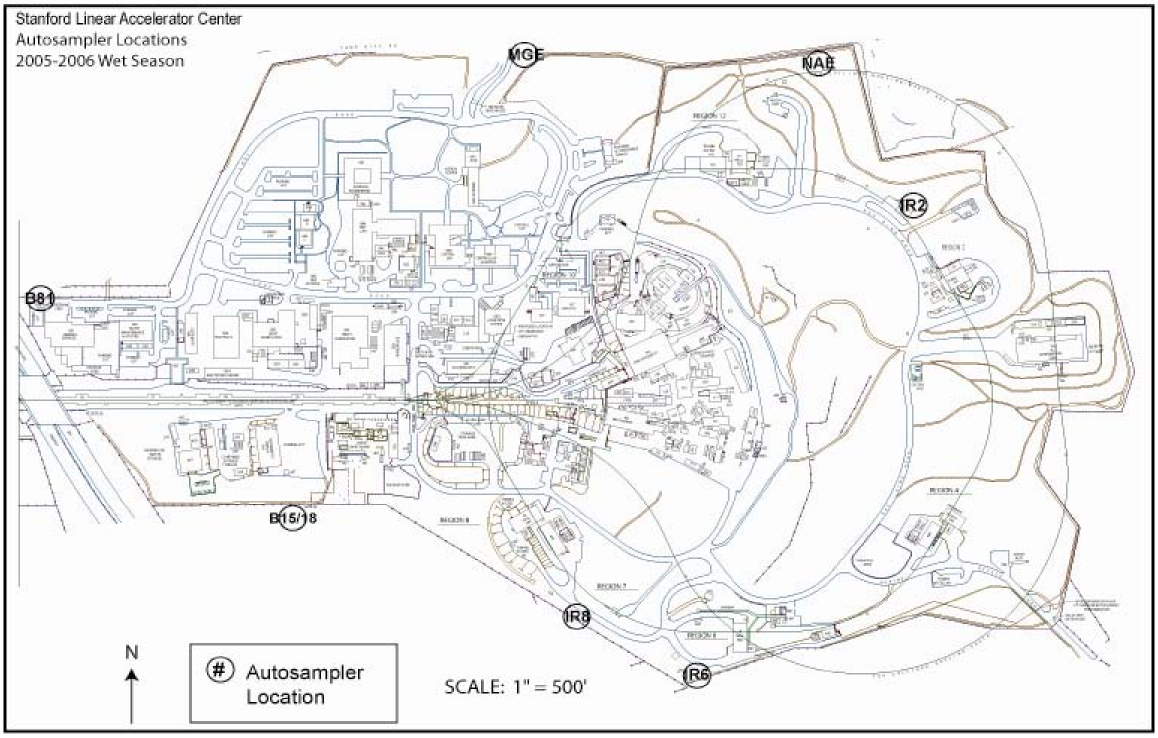

Figure 4-2 Surface Water Monitoring Locations

4.4.2 Program Status

4.4.2.1 Water Quality Monitoring Results

SLAC's SWMP incorporates all general permit sampling and analysis requirements, such as frequency (samples collected from first storm of season and one additional storm), locations (samples collected from locations where stormwater comes into contact with industrial activities), analytes (SLAC analyzes for five metals and nine non-metal analytes), and sampling methodologies.

The general permit's definition of wet season runs from October 1 through May 31. This reflects SLAC's climatological conditions, as rain rarely falls during June through September. Since the general permit's definition of wet season spans two calendar years, the 2007 water quality monitoring results published in the ASER are for the 2007–2008 wet season (October 2007 through May 2008).

The general permit requires submission of an annual report on stormwater activities by July 1, following the May 31 close of the wet season.[14] SLAC met all sampling and analysis requirements in its SWMP and delivered its annual report, which included all water quality monitoring results, to the RWQCB.

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[14] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection Department, *2007–20087 Annual Stormwater Report* (30 June 2008, submitted to Rico Duazo, San Francisco Bay RWQCB)

Automated samplers are located at each of the stormwater monitoring sites. The samplers are triggered by rain gauges and level sensors. Samples are collected during the first storm event at each location and one other event during the rainy season. During the 2007-2008 wet season, 14 samples (two samples per location) were collected during three storm events.

Stormwater samples were analyzed for 14 parameters. Many of the parameters that SLAC monitors have parameter benchmark values (PBVs) established by the SWRCB.[15] PBVs are not regulatory discharge limits, rather, they are meant to be used as guidance for comparison with measured results to determine the effectiveness of BMPs in drainage areas. Exceeding a BPV is not considered a stormwater violation.

Table 4-5 summarizes the results and compares them to the PBVs. The majority of the analytical results were below the PBVs. Analytes that exceeded the PBVs were specific conductance, aluminum, iron, zinc and total suspended solids (TSS). The source of these analytes in the stormwater is believed to be primarily from natural sources in the soil and groundwater. SLAC continues to investigate potential industrial sources for these analytes.

Table 4-5 Water Quality Results and Comparison to Parameter Benchmark Values

Analyte	Units	Number of Results	Number of Detects	Maximum Conc. Detected	SWRCB PBV (1)	Number of Results >PBV
Metals						
Aluminum	mg/L	14	14	6.8	0.75	7
Copper	mg/L	14	14	0.04	0.0636(H)	0
Iron	mg/L	14	14	7.7	1	7
Lead	mg/L	14	14	0.023	0.0816(H)	0
Zinc	mg/L	14	14	0.49	0.117(H)	9
Non-Metals						
Total Suspended Solids	mg/L	14	14	350	100	3
Total Organic Carbon	mg/L	14	14	86	110	0
pH	SU	14	14	8.25	6-9	0
Turbidity	NTU	14	14	140	NA	NA
Specific Conductance	µs	14	14	1420	200	7
Polychlorinated Biphenyls	mg/L	14	0	ND	0.000477	0
Radioactivity	pCi/L	14	0	ND	NA	NA
Total		168	140			30

Notes:

PBV = parameter benchmark value

pCi/L = picoCuries per liter

1 SWRCB parameter benchmark values are available at www.swrcb.ca.gov/stormwtr/docs/smanlrdc.doc. Metal PBVs shown are on a total metal basis. (H) signifies that this is a hardness dependant benchmark. The PBV shown for polychlorinated biphenyls (PCBs) is for Aroclor-1260. SWRCB PBVs have not been set for chromium, molybdenum, radioactivity (tritium, gamma), or turbidity. SLAC may choose to develop benchmarks for site specific conditions.

NA = Not available

ND = Not detected above the reporting limit

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[15] State of California, State Water Resources Control Board, *Sampling and Analysis Reduction Certification* (no date), http://www.swrcb.ca.gov/stormwtr/docs/smanlrdc.doc

4.4.2.2 Stormwater Management Improvements

BMPs are implemented at SLAC to reduce the potential for stormwater to come into contact with industrial activities. The BMPs are one component of an environmental management system that includes planning, implementing, checking, and improving performance.

BMP and surface water program-related accomplishments during 2007 included the following:

- The stormwater awareness training frequency has been increased and will now be required once every three years for affected employees
- Increased preventive maintenance schedule for stormwater protection activities including annual site-wide street cleaning and continuation of catch basin cleanouts
- Infrastructure improvement projects: End Station A/End Station B project to remove potential unauthorized connections to the stormdrain system was completed in 2007.
- EP staff worked closely with LCLS staff to provide guidance on the development of the construction SWPPP and oversight for stormwater protection activities

4.5 Hazardous Materials Management

SLAC uses hazardous materials as part of its experimental programs in high-energy physics and synchrotron radiation. For instance, isobutane and the refrigerant tetrafluoroethane are used to create detector atmospheres with the appropriate physical and chemical properties to aid in detecting subatomic particles. In addition, SLAC uses hazardous materials in the manufacturing and maintenance of accelerator devices. Examples of hazardous materials managed at SLAC include

- Cryogens
- Flammable gases
- Compressed gases
- Acids and bases
- Solvents
- Adhesives
- Paints and epoxies
- Metals
- Hazardous materials management spans numerous programs; but the purpose remains the same: to ensure the safe handling of hazardous materials in order to protect workers, the community, and the environment.

4.5.1 Regulatory Framework

The regulatory framework for hazardous materials regulations, especially in California, has historically been a complex and overlapping web of statutes and regulations. Some of the most important regulatory drivers at the federal level include Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) also referred to as the Emergency Planning and Community Right-to-Know Act (EPCRA) which focuses on community safety, the Occupational Safety and Health Act (1970) addressing worker safety, the Hazardous Materials Transportation Act whose purpose is to ensure the safe transport of hazardous materials in commerce and the Toxic Substances Control Act (TSCA), the federal statute under which PCBs and asbestos are regulated.

Important drivers at the state level generally date back to the mid-1980s and include hazardous materials business plans (HMBP), the CalARP, the underground and aboveground storage tank programs, and the pollution prevention and waste minimization program.

In general, the local implementing agency for hazardous materials regulation in California is the California CUPA. The Environmental Health Division of the San Mateo County Health Services Agency is the CUPA responsible for overseeing hazardous materials and waste management at SLAC. A CUPA has broad enforcement responsibilities in the following six hazardous material subject areas:

- Aboveground storage tanks (AST)/spill prevention control and countermeasures (SPCC) programs
- Hazardous Materials Business Plan
- California Accidental Release Prevention
- *Uniform Fire Code* hazardous materials issues
- Underground storage tanks (USTs)
- Pollution prevention and waste minimization

4.5.2 Program Status

Discussed in the following sections are the status of SLAC's current programs related to hazardous materials management, including its hazardous materials business plan, toxics release inventory (TRI), and CalARP programs. Also discussed are SLAC's above ground storage tanks program and its polychlorinated biphenyls (PCBs) management program under the TSCA.

4.5.2.1 Annual Facility Enforcement Inspections

The annual CUPA inspection was conducted on January 16, 18, 19 and 23, 2007. See Section 2.5.2.

The U.S. Federal Aviation Administration (FAA) conducted a review of SLAC. The review found that SLAC had failed to provide an adequate emergency contact number on the shipping papers, as required by 49 CFR, for refrigerated samples shipped January 8, 2007. In lieu of civil penalty SLAC was issued a Letter of Correction dated February 28, 2007. The following actions were completed as a result:

- SLAC abandoned the use of a cell phone number as the emergency contact number and as of January 31, 2007 is using CHEMTREC to meet emergency contact requirements.

- Only DOT and International Air Transport Association (IATA) trained personnel prepare samples for air shipment.

- Written procedures have been implemented by SSRL for the preparation and use of sample dewars.

4.5.3 Hazardous Materials Business Plan Program

The EPCRA was passed in 1986 as Title III of the SARA, which established requirements for emergency planning, notification, and reporting. In California, the requirements of SARA Title III are incorporated into the state’s Hazardous Materials Release Response Plan and Inventory Law, more commonly referred to as the HMBP program.

For the 2007 reporting year, SLAC updated its HMBP and electronically submitted it through the Uniform documents (Unidocs) web tool to the CUPA on April 1, 2008. The HMBP includes a list of all hazardous materials present at SLAC in amounts exceeding the state’s aggregate threshold quantities (55 gallons for liquids, 500 pounds (lbs) for solids, and 200 cubic feet for compressed gases) on a building-by-building basis. The inventory includes hazardous materials and waste. The hazardous materials inventory is based on procurement data generated through the CMS. The hazardous waste inventory is based on the database maintained by the Waste Management group. Mixed waste data are provided by the RP Department. Inventory of process and bulk tanks are part of the SLAC property and building databases. The CMS maps are used to indicate storage area locations. The plan also includes the SLAC *Consolidated Chemical Contingency Plan*.[16] This plan combines the emergency response requirements for the following programs:

- Hazardous materials business plan
- Hazardous waste contingency plan
- Spill prevention control and countermeasure plan
- Risk management plan

This was the third year that the HMBP was submitted electronically through the Unidocs system utilizing the maps and chemical information developed as part of the CMS. The CUPA requested that disks containing the hazardous materials inventory statement (HMIS) and maps be submitted in addition to the electronic submittal to fulfill the public access requirements. Information generated by chemical storage asset custodians, will be used to help maintain the accuracy of the CMS maps.

4.5.4 Toxics Release Inventory Program

Under EO 13148, “Greening the Government through Leadership in Environmental Management”, the DOE requires its facilities to comply with the Toxic Chemical Release Reporting and Community Right-to-Know requirements (40 CFR 312), more commonly referred to as the TRI program. SLAC annually provides the appropriate information to meet these program requirements to the DOE. Submittals are provided by SLAC to the DOE Stanford Site Office (SSO) which reviews and sends the TRI information to DOE Headquarters. The information from all DOE facilities is then rolled up and reported to the USEPA.

Of the more than 400 listed TRI chemicals, only two, lead and copper, are reported at SLAC in excess of their respective regulatory threshold criteria. As a result, SLAC prepared release inventory forms for lead and copper and submitted them to the DOE SSO on June 27, 2007, in advance of the July 1, 2007, deadline.

4.5.5 California Accidental Release Prevention Program

SLAC has only one regulated chemical in excess of the CalARP threshold, potassium cyanide, which is used only in the Plating Shop complex. Spent plating baths containing cyanide are stored temporarily at the Chemical Hazardous Waste Management Area pending transport for offsite disposal. In light of this situation, the CUPA determined that a risk management plan (RMP) would be required.

After extensive investigation and discussion, it was determined that, because the worst-case scenario for a release of potassium cyanide did not generate offsite consequences, a more detailed process hazard

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[16] SLAC *Consolidated Chemical Contingency Plan* (SLAC-I-730-3A86H-008)

assessment and offsite consequence analysis were not required. The final Program 1 RMP for SLAC was submitted to the CUPA on September 1, 2006, and received 100 percent certification from the CUPA. A follow-up site visit by the CUPA was performed on April 25, 2007, to observe operations in the Plating Shop and verify the information provided in the RMP. The final step in the RMP process is a 45-day public comment period administered by the CUPA. At the end of 2007, the CUPA had not yet scheduled the 45-day public comment period.

4.5.6 Aboveground Storage Tank Program

ASTs are regulated under the authority of the CWA and California's Aboveground Petroleum Storage Act. A listing of ASTs containing petroleum at SLAC during 2007 is presented in Table 4-6. All of the petroleum tanks at SLAC are constructed of steel. Each tank is either double-walled, or has a cinder-block or poured-concrete containment basin surrounding the tank base.

Table 4-6 Aboveground Petroleum Tanks

Petroleum Product	Property Control Number	Location	Capacity (gallons)
Diesel	20501	B023 Central Utility	10,000
Diesel	19683	B112 Master Substation	2,000
Gas/Diesel	21443	B035 Vehicle Refueling Station	1,500/500
*Vacuum Oil	19596	B020 North Damping Ring	516
Diesel	NA	B082 Fire Station	500
Diesel	NA	B505A Generator Fueling	500
Diesel	NA	B007 MCC Generator Fueling	500
*Vacuum Oil	19595	B021 South Damping Ring	260
X-ray Oil	15192	B044 Klystron Test Lab	900
X-ray Oil	15192	B044 Klystron Test Lab	400
Compressor Oil	NA	B127 Cryogenics	200
Compressor Oil	18562	B127 Cryogenics	200
Diesel	NA	B756 SLD Generator Fueling	500

* These tanks are used only for short-term storage

An SPCC plan is required by 40 CFR 112 for all petroleum-containing ASTs greater than 660 gallons in size. The SLAC SPCC plan remains up to date and is available on line.[17]

SLAC did not have any USTs in operation during 2007. All USTs previously in operation have been removed.

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[17] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection Department, *Spill Prevention, Control, and Countermeasures Plan* (SLAC-I-750-0A16M-001), https://www-internal.slac.stanford.edu/esh/documents_internal/SPCC.pdf

4.5.7 Toxic Substances Control Act Program

The objective of TSCA is to minimize the exposure of humans and the environment to chemicals introduced by the manufacturing, processing, and commercial distribution sectors. One portion of TSCA regulates equipment filled with oil or other dielectric fluids that contain PCBs.

TSCA regulations are administered by the USEPA. No USEPA inspections regarding TSCA were conducted at SLAC during 2007.

At the end of 2007, 99 transformers were in service at SLAC. Transformers with PCB concentrations equal to or greater than 50 parts per million (ppm) but less than 500 ppm are defined by TSCA as PCB-contaminated transformers. Of the 99 transformers in service at SLAC, only 12 are PCB-contaminated. During 2007, one of these transformers (VVS-13) was drained and refilled with new non-PCB oil. SLAC has no PCB transformers (transformers with concentrations of PCB equal to or greater than 500 ppm). The total quantity of PCBs contained in the 99 transformers currently in service is approximately 24 lbs.

A project to replace the last known 346 PCB contaminated capacitors with non-PCB capacitors was completed during 2007. This reduces the potential for a release of oil with PCBs during an event such as a fire or earthquake.

4.5.8 Chemical Management System

SLAC has officially been purchasing chemicals solely through Haas *tcm* (Haas) since August 2005 under its CMS. Haas provides all sourcing, purchasing, expediting, and vendor management support for all non-radioactive chemicals and gases used by SLAC.

The key objectives of the CMS program at SLAC are to:

- Reduce SLAC’s chemical and gas cost through vendor leveraged buying power
- Reduce SLAC’s risk and space requirements associated with storing, managing and handling chemicals
- Reduce time spent by SLAC researchers and other personnel on sourcing, ordering and tracking chemicals

By the end of calendar year 2007, the program has achieved the following:

- 2175 active chemicals were set up in the catalogue
- Approximately $41,000 in vendor-owned inventory stocked for just-in-time delivery. This is a decrease from last year. There are 66 items, a reduction from 97 items, currently stocked in the Haas Hub.
- There were 328 users of the CMS system
- Purchase order cycle time continues to be less than 1 business day on average
- The monthly average savings based on an indexed baseline prices for gain sharable items was $66,587. This represents a 5.3 percent commodity cost reduction, well within the 3 percent goal.

SLAC’s Chemical Management Services Program continues to operate at a steady state for the originally defined scope of work. All defined performance goals are being met.

4.6 Waste Minimization and Management

During the course of its research operations, SLAC generates a variety of waste streams, including hazardous waste, non-hazardous industrial waste, municipal solid waste, and scrap metal.

Whenever practicable, SLAC actively practices the pollution prevention hierarchy with respect to each of these waste streams:

- First, reduce waste and prevent pollution at the source through process changes, substitutions, and work practices
- Second, reduce waste and prevent pollution by reusing or recycling materials
- Third, reduce waste and prevent pollution by using appropriate control technologies
- Finally, after exhausting the first three approaches, exercise proper disposal

The following performance measures in the operating contract between the DOE and Stanford University reflect the importance that both parties place on waste minimization:[18]

- SLAC will reduce its generation of hazardous waste from routine operations by 72 percent by the year 2007 using 1993 as the baseline year
- SLAC will recycle 56 percent of its municipal solid waste by the year 2007

4.6.1 Waste Minimization Accomplishments

SLAC has achieved both of its waste minimization performance measures since the year 2000.

SLAC continues to make progress in reducing hazardous waste generated from routine operations, as shown in Figure 4-3. For 2007, SLAC reduced generation of hazardous waste from routine operations by 73 percent from the 1993 baseline. The goal for FY07 was to achieve a 72 percent reduction in routine hazardous waste relative to the 1993 baseline of 340 tons. The percent reduction that has been achieved over the last five years indicates that waste generation and reduction have been relatively stable for routine hazardous waste. Part of the reason for the stability is because larger waste reductions were easier to achieve in the past. Additional measures, that may be more focused and more difficult to implement, are needed to address hazardous wastes from smaller but more numerous hazardous waste generators. Additional measures to reduce hazardous waste may be taken in the future by helping smaller generators increase their awareness of waste reduction opportunities and helping them learn to develop for themselves more focused waste reduction measures for their work areas.

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[18] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, "ISEMS: Performance Measures", http://www-group.slac.stanford.edu/esh/general/isems/perfmeas/

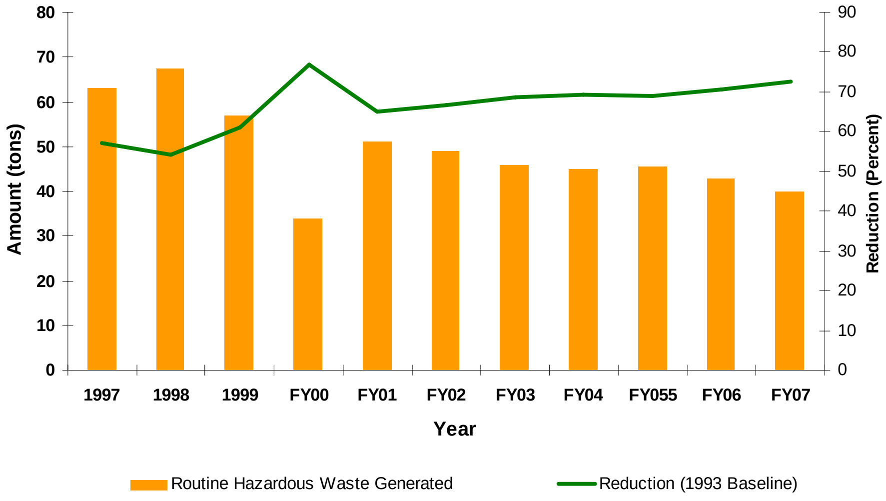

Figure 4-3 Routine Hazardous Waste Generation, 1997–2007

SLAC’s progress in recycling its municipal solid waste is shown in Figure 4-4. For 2007, SLAC recycled 58 percent of its municipal solid waste. The goal for FY07 was to achieve 56 percent recycling.

The term *municipal solid waste* refers to the following waste streams generated at SLAC:

- Beverage containers (glass, aluminum, plastic)
- Paper (white paper, mixed paper)
- Cardboard
- Wood
- Scrap metal
- Garden/landscaping waste
- Construction debris (asphalt, concrete, and soils)
- Universal (fluorescent light bulbs and mercury-containing equipment) and electronic wastes
- Batteries (automotive and common (AA, AAA, C, D, nickel-cadmium, other) batteries)
- Office materials (toner and inkjet cartridges)
- Trash not otherwise sorted at the source and placed into dumpsters

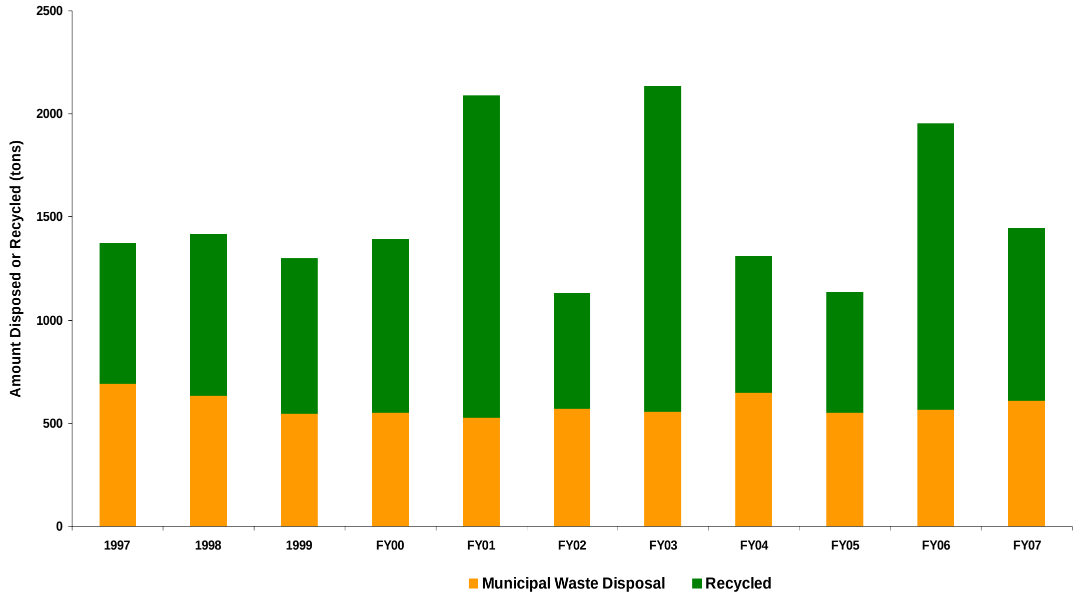

Figure 4-4 Municipal Solid Waste Recycling, 1997–2007

More municipal waste was recycled during 2006, in part due to the recycling of 400 cubic yards of soil, asphalt and concrete generated as part of the construction of a new building.

Waste minimization and pollution prevention projects initiated during the last five years and continuing during 2007 are listed in Table 4-7.

In addition to the projects below, SLAC has been continuing to perform process waste assessments or pollution prevention opportunity assessments (PPOAs) and pollution prevention projects to reduce the use of toxic materials, to conserve resources, and to prevent pollution in a technically and economically feasible manner for the future. Assessments and projects are in the following areas:

- As a pollution prevention opportunity assessment (PPOA) for reduction of PCBs in oil-filled equipment, SLAC investigated the feasibility of replacing over 1,600 gallons of transformer oil containing greater than 28 ppm of PCBs with new non-PCB oil, during maintenance on the transformers load tap changer. The project was safely completed in December 2007.

- As a PPOA in the area of experimental research and development for an international collaboration, SLAC evaluated the feasibility of using nitrogen in the waveguide design of the ILC instead of SF_6, a potent greenhouse gas. The initial analysis indicated that the use of nitrogen as an alternative in the waveguides is promising and is expected to be proven as the ILC design develops.

- As an alternative to bitumen-coated roofing materials which are dark and cause increased radiant heat load in the warmer months of the year, SLAC investigated the use of "cool roof design", which uses white roofing material with high reflectivity to decrease cooling/energy demands. SLAC is planning to implement a pilot project using this design in 2008.

Significant waste minimization and pollution prevention projects completed since 2003 are summarized in Table 4-7.

Table 4-7 Waste Minimization and Pollution Prevention Projects

Name/Description	Year Initiated	Waste Reduction/Pollution Prevention Result
Transportation pollution prevention program	2003	SLAC became the first DOE Office of Science facility to order and dispense only Bio-diesel 20 for all its diesel applications. Also, 25 electric powered vehicles are in use. Three old DOE-owned motor vehicles were replaced with GSA alternative fuel vehicles.
Reduction of equipment using class I ozone-depleting substances (Class I ODS)	2003	Phased out 3 chillers (pre-1984, over 150 ton cooling capacity each) that used Class I ODS
Two-mile klystron gallery lighting upgrade	2003	SLAC completed a two phase project to reduce energy usage and pollution by replacing lower-efficiency lighting system with a high-efficiency one in the 2-mile linear accelerator saving over 4.4 million kilowatt-hours of electricity per year, reducing greenhouse gases generated from electricity generation, and reducing mercury usage.
Water Conservation	2004	A pilot project is in progress to conserve water through the use of waterless urinals.
Development of EMS Objectives and Targets	2005	EMS Objectives and Targets were developed to help further integrate pollution prevention into SLAC day-to-day activities
Chemical Management Service (CMS)	2005	The CMS program is fully implemented. Through streamlining the chemical supply chain has removed the need to order excess chemicals.
Incorporating pollution prevention initiatives into the Linear Coherent Light Source Project	2005	A number of environmental initiatives have been included in the LCLS Project while it is in the design and construction phase – procurement of recycled material content products, soil reuse, radioactive materials reuse, pollution prevention measures to prevent soil and water contamination from lead, construction measures to prevent soil erosion and stormwater pollution
Revision of the Hazardous Waste Chapter and the Waste Minimization and Pollution Prevention Chapter in SLAC ES&H Manual	2006	Developed improved procedures and guidance for management of hazardous waste by employees and for the implementation of waste minimization and pollution prevention (WM/P2). SLAC achievements in WM/P2 are presented site-wide through a SLAC-implemented recognition program for employees.
Phase out of old gas tanks	2006	Using the CMS, SLAC reviewed its use of gasses and associated tanks and phased out numerous gas tanks that were no longer needed or were not acceptable for long-term storage, in turn, reducing SLAC’s on-site chemical inventory.
Eliminating Hexavalent Chromium from SLAC Metal Finishing Operations	2007	The use of hexavalent chromium in plating operations was eliminated. Specifically, 900 gallons of chromic acid solution and approximately 300 gallons of Alodine solution were replaced with a less toxic material.
Klystron Gallery Capacitor Replacement Project	2007	346 PCB capacitors in the Klystron Gallery were replaced with non-PCB capacitors.
PULSE Building Renovation Project	2007	The solicitation for the building renovation project includes sustainable or “green” building requirements based on the *Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings.*

4.6.2 Hazardous Waste Management

SLAC is a 90-day hazardous waste generator. SLAC does not have a Resource Conservation and Recovery Act (RCRA) Part B permit that would allow it to treat hazardous waste, store it on site, and/or dispose of it on site (that is, a treatment, storage, and disposal facility permit) under the federal-level RCRA regulations. SLAC does have permits to treat a few RCRA-exempt and non-RCRA (that is, California-only) hazardous waste streams (see Section 4.6.2.4 regarding the state-level tiered permit program).

4.6.2.1 Regulatory Framework

RCRA provides cradle-to-grave authority to regulate hazardous waste, from generation to disposal. Regulation is through a system of recordkeeping, permitting, monitoring, and reporting.

The primary objective of RCRA is to protect human health and the environment. A secondary objective is to conserve valuable material and energy resources by promoting beneficial solid waste management, resource recovery, and resource conservation systems.

The USEPA has delegated authority to the state of California for implementing the federal RCRA program. In turn, the state has delegated its authority for certain aspects of hazardous waste program oversight to CUPAs; the San Mateo County Health Services Agency, Environmental Health Division, serves as the CUPA with delegated authority to oversee SLAC's hazardous waste management.

4.6.2.2 Annual Facility Enforcement Inspection

The CUPA inspected the hazardous waste management program and tiered permit program treatment facilities on January 16, 18 and 19, 2007. See Section 2.5.2 for details.

4.6.2.3 Hazardous Waste Generation and Tracking

SLAC utilizes a self-developed, site-specific computerized hazardous waste tracking system (WTS). Hazardous waste containers are tracked from the time they are issued to the generator to eventual disposal off-site. The WTS includes fields that generate information for the biennial SARA Title III, TRI, and TSCA PCBs annual reports.

SLAC categorizes the hazardous wastes it generates into the following categories:

- Hazardous wastes from routine laboratory operations
- Hazardous wastes considered to be TSCA-regulated waste
- Hazardous wastes resulting from remediation and/or cleanup/stabilization projects

Hazardous wastes regulated by the TSCA at SLAC result from two sources: removal of old electrical equipment containing PCBs and construction projects containing asbestos. TSCA wastes result from the phasing-out of these chemicals from use at SLAC. SLAC's progress in reducing the quantities of TSCA waste from these sources is shown in Figure 4-5. Specifically, during FY07, SLAC achieved a 97 percent reduction in its TSCA waste generation compared to the TSCA waste generated in 1990.

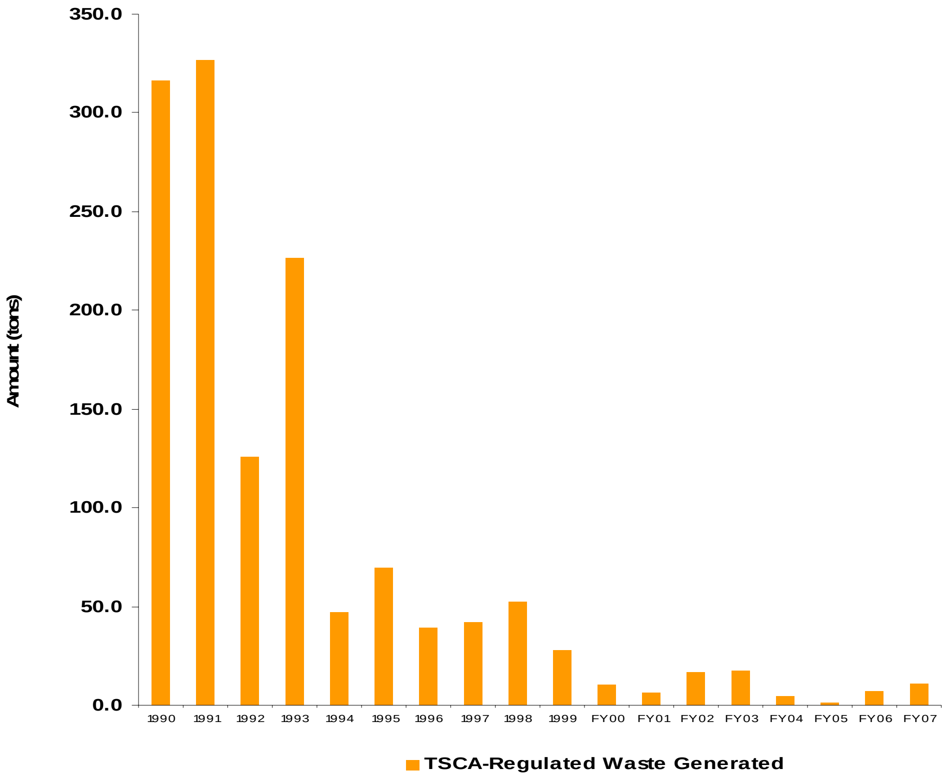

Figure 4-5 TSCA-Regulated Hazardous Waste, 1990–2007

Remediation wastes result from cleanup of soil and groundwater contaminated by historical management practices or accidental spills. Common remediation wastes at SLAC include metal- and PCB-contaminated soils, and volatile and semi-volatile organics in groundwater. Annual quantities of remedial waste generated vary based on projects scheduled for any given year. For a discussion of SLAC's environmental restoration programs that result in the generation of remediation wastes, see Chapter 6.

SLAC's hazardous waste generation rates have been reduced through a combination of waste minimization and pollution prevention techniques, including the following:

- Reducing generation of excess chemicals through CMS
- Converting empty metal containers and drums to scrap metal
- Exchanging chemicals with other users
- Reclassifying waste streams to reduce hazardous waste volumes
- Reusing chemicals
- Returning unused material back to the vendor or manufacturer
- Sending electrical equipment off site for reuse by other organizations

SLAC expects to continue to make progress in reducing the generation of hazardous waste from routine laboratory operations, although in much smaller increments than was previously the case. Additionally, the generation of TSCA and remediation wastes will decrease as SLAC continues to phase out its use of PCBs, removes soils impacted with PCBs, and removes asbestos-containing materials.

4.6.2.4 Hazardous Waste Treatment: Tiered Permitting Program

The five tiers of California hazardous waste permits, presented in order of decreasing regulation, are the full permit, standard permit, *permit by rule*, *conditional authorization*, and *conditional exemption*. SLAC operates a total of six hazardous waste treatment units, five under permit by rule and one under conditional authorization. These units are authorized to treat listed or characteristic hazardous wastes. The various units and tiered permit level are summarized in Table 4-8.

Table 4-8 Hazardous Waste Treatment Units Subject to Tiered Permitting

Tiered Permit Level	Unit Number	Location/Description
Permit by rule	Unit 1A	Cyanide Treatment Tanks
Permit by rule	Unit 1B	Metal Finishing Pre-treatment Facility
Permit by rule	Unit 1C	Batch Hazardous Waste Treatment Tank
Permit by rule	Unit 2	Metal Finishing Pre-treatment Facility – Sludge Dryer
Conditional authorization	Unit 4	Groundwater Treatment System at the FSUST
Permit by rule	Unit 5	Groundwater Treatment System at the FHWSA

Based on correspondence with the California Department of Toxic Substances Control (DTSC), the original MFPF (Unit 1) was not fully authorized because of the cyanide treatment operations, which SLAC had included in the original MFPF permit. As a result, SLAC split out the original MFPF into the above units (1A, 1B, and 1C) to demark more clearly the treatment operations of the MFPF. SLAC continues to await inspection of these units by the DTSC to affirm that Tiered Permit requirements are being met for the cyanide treatment tanks (Unit 1A).

4.6.3 Non-hazardous Waste Management

Non-hazardous waste can be grouped into non-hazardous industrial waste and municipal solid waste.

4.6.3.1 Non-hazardous Industrial Waste Management

In addition to its hazardous waste management program, SLAC also operates various projects that involve disposal of non-hazardous waste classified as either non-hazardous industrial or regulated waste. SLAC’s WM Group manages industrial waste resulting from SLAC’s laboratory operations and remediation operations that, while not classified as hazardous, is not sufficiently “clean” to be disposed of in a municipal or sanitary solid waste landfill. Examples of industrial wastes include soils contaminated with low levels of petroleum hydrocarbons, PCBs or metals such that qualify as non-hazardous but are not acceptable to municipal landfills. In California, industrial wastes are generally termed *Class 2* wastes, since they are specifically required to be disposed of at Class 2 landfills (these provide an intermediate level of protection to the environment between *Class 1*, hazardous waste landfills and *Class 3*, municipal solid waste landfills).

4.6.3.2 Municipal Solid Waste Management

SLAC's FAC Department operates a municipal solid waste program that collects a variety of recyclable materials as well as regular dumpster refuse. SLAC's Property Control Department operates a salvage operation that sells metal and other industrial recyclables (construction materials, for example, concrete, clean soils, asphalt, wood) and equipment for their cash value. SLAC integrates the results of its metal salvage operations when reporting data about its municipal solid waste program. In FY06, SLAC also started including electronic waste collected under salvage operation as a recyclable material.

A site-wide program that recycles white paper, mixed paper, beverage containers (glass, aluminum, and plastic), cardboard, and scrap wood has been fully operational for more than 10 years. Collection stations are strategically distributed around the site with each station incorporating anywhere from one to a dozen green containers. Dumpsters for cardboard collection are strategically place around the site and a specific location is provided for waste wood. Scrap metal and electronic waste is collected and construction materials from building demolition and rehabilitation projects are also recycled. The contributions of the various waste streams being recycled are shown in Figure 4-6.

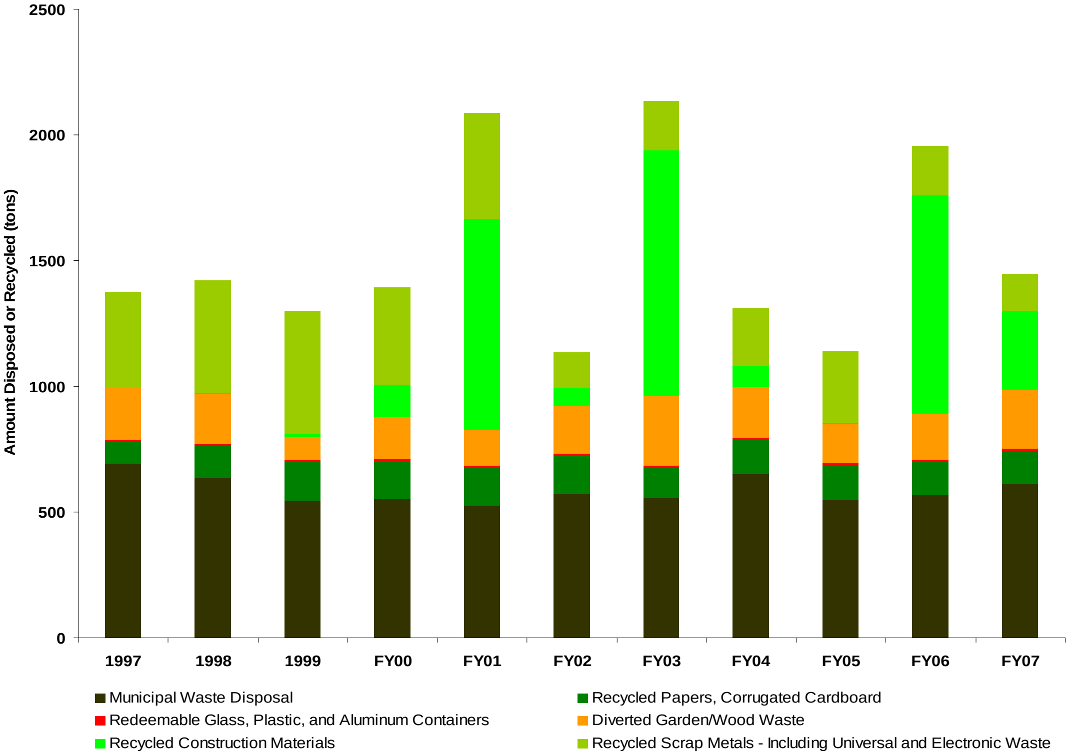

Figure 4-6 Municipal Solid Waste Recycling and Disposal, 1997–2007

Note: Batteries and office materials, although recycled, are not reported because quantities are small in relation to the above.

4.6.4 Other Waste Management Activities

SLAC generates a small quantity of low-level radioactive waste every year; this waste stream is discussed in Chapter 5.

SLAC generates a small quantity of medical waste from the on-site Medical Department. In California, the state Medical Waste Management Act requires proper storage, treatment, and disposal of medical waste. The state program is administered by the California Department of Health Services.

4.7 Environmental Planning

SLAC's scientific and support facilities were constructed under a clearly conceived planning framework established in the site's original general development plan (1961) and master plan (1966). For over four decades, SLAC facilities expanded within this original framework, but over the years, many small support and storage buildings and more parking demands have crowded the core research areas and obscured the original circulation plan. To meet the challenges of constructing major new projects in this constricted and environmentally sensitive location, SLAC employs two primary tools: National Environmental Policy Act (NEPA) analyses on a project-by-project basis, and conformance with SLAC's LRDP.[19]

4.7.1 SLAC Long Range Development Plan

In December 2002, SLAC published its LRDP, the result of both SLAC's LRDP Working Committee and the professional land use, environmental, and campus planners from the Stanford University Architect and Planning Office. The LRDP was revised in June 2003.

The LRDP encourages the gradual replacement of small, outdated structures with more efficient and well-planned development. The plan includes a series of diagrams that overlay planned structures and circulation systems with environmental constraints to intelligently guide the location of future projects. Environmental factors considered in developing the plan include the following:

- Geology and seismicity
- Topography
- Sedimentation and erosion potential
- Hazardous materials
- Considerations of site locations relative to sensitive receptors
- Flooding and wetlands
- Habitat and species protection
- Visual character of SLAC

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[19] Stanford University Architect/Planning Office, *Stanford Linear Accelerator Center Long Range Development Plan* (December 2002, revised June 2003), http://www-group.slac.stanford.edu/bsd/SLAC_LRDP_final.pdf

4.7.2 National Environmental Policy Act

SLAC developed its NEPA program in 1992. It is administered by SLAC's Operations Directorate, with staff from the EP Department providing environmental resources input and document review as requested. Under this program, proposed projects and actions are reviewed to evaluate NEPA documentation requirements, as required. The Operations Directorate works in conjunction with DOE to determine which of the following three categories of NEPA documentation, presented in increasing order of complexity, is required:

- Categorical exclusion (CX)
- Environmental assessment (EA)
- Environmental impact statement (EIS)

Environmental aspects that must be considered when scoping and preparing NEPA documentation commonly include potential increases in air emissions or hazardous materials usage; waste generation; impacts on wetlands, sensitive species, and critical habitats; and increases in water consumption and wastewater discharge.

SLAC prepared and reviewed NEPA documentation for seventeen projects during 2007, listed in Table 4-9. The projects were relatively minor in scope and environmental impact. The projects were assigned a CX reference number. Completed NEPA documents are forwarded to the DOE SSO and the NEPA Compliance Officer located at the Integrated Support Center, Oak Ridge Office, if necessary, for review and approval. Only one CX was prepared and approved by DOE.

Table 4-9 NEPA Documentation Prepared during 2007

Project Name	Project ID	Date	Document ID
Bldg 050 1st Floor Space Rearrangement	140129	2/8/07	SS-SC-06-08
Bldg 050 Sun Microsystem Black Box #1	370401	3/23/07	SS-SC-06-08
ILC Cleanroom at Bldg 006	370601	4/11/07	SS-SC-06-08
Bldg 460 Modification	5745	4/11/07	SS-SC-06-08
Bldg 040 Space Upgrade	5746	5/25/07	SS-SC-06-08
Bldg 018 Elevated Storage Area Installation	5798	6/6/07	SS-SC-06-08
Bldg 050, 2nd Floor Power Management Modules	5733	6/25/07	SS-SC-06-08
Bldg 050 Harmonic Filters	5796	6/25/07	SS-SC-06-08
Bldg 084 Cleanroom	370090T	6/25/07	SS-SC-06-08
Removal and Disposal of Trailers 288, 289, 290 & 293	170019	6/25/07	SS-SC-06-08
Demolition of Trailers 288, 289, 290 & 293	140105	6/25/07	SS-SC-06-08
SPM Sample Preparation and Analysis System	370201	7/6/07	SS-SC-07-01
Main Gate Backup Power	030131	8/7/07	SS-SC-06-08

Project Name	Project ID	Date	Document ID
Replacement of Diesel Storage Tank at Bldg 505A	140136	9/5/07	SS-SC-06-08
Bldg 050 Sun Microsystem Black Box #2	371401	9/26/07	SS-SC-06-08
A Sagnac Magnetometer for Low Temperature	377771	10/29/07	SS-SC-07-01
Renovation of Haller Lab	140147	11/8/07	SS-SC-06-08

5 Environmental Radiological Program

5.1 Introduction

All members of the public receive radiation doses from natural background radiation and from an assortment of human activities. This chapter describes sources of radiation and radioactivity at SLAC and provides an overview of how SLAC's Radiological Environmental Protection (REP) Program assesses direct radiation and radioactivity in water, air, and soil for the purpose of determining the potential radiation dose to the public and impacts to the environment.

As in past years, in 2007, the dose that members of the public receive due to SLAC operations is a small fraction of the dose received from natural background radiation. In addition, the potential radiation dose to the public and the radiation-related impacts to the environment from SLAC operations were significantly below all regulatory limits.

5.2 Sources of Radiation and Radioactivity

The 2-mile-long linac at SLAC is encased in a concrete tunnel 25 feet beneath the surface of the ground. Through this underground tunnel, beam particles are accelerated to nearly the speed of light.

Some beam particles strike accelerator components during the acceleration process. When that happens, the decelerating particles may emit secondary radiation in the form of high-energy photons and neutrons. At SLAC, *direct radiation* is the secondary radiation that is present whenever beam particles are accelerated, but that ceases as soon as power to the accelerator is terminated.

The secondary radiation may also make the substances they strike become radioactive. Table 5-1 lists the predominant radioactive elements produced in water or air and their half-lives.

Facilities at SLAC are designed to meet all applicable safety and environmental requirements. Nearly all direct radiation is stopped by the combined shielding on the accelerator structure and the ground or thick concrete walls that surround the accelerator tunnel. SLAC monitors the small fraction of photons and neutrons that pass through the accelerator components, through the surrounding earth or walls, to reach areas outside of the accelerator housing. This direct-radiation monitoring is described in Section 5.3.

SLAC also assesses, measures, and reports on radioactivity as required by its policies and by state or federal regulations. Sections 5.4 through 5.6 and 5.9 describe SLAC's programs to assess and control radioactivity that can be released into the environment. All known releases of radioactive materials are included in the tables in those sections.

Table 5-1 Activation Products in Water or Air

Radioactive Element	Half-life	Primarily Produced In
Oxygen (^{15}O)	123.0 seconds	Water or air
Nitrogen (^{13}N)	10.0 minutes	Air
Carbon (^{11}C)	20.3 minutes	Water or air
Argon (^{41}Ar)	1.8 hours	Air
Beryllium (^{7}Be)	53.6 days	Water
Hydrogen (^{3}H)	12.3 years	Water

5.3 Monitoring for Direct Radiation

DOE regulations (10 CFR 835) require SLAC to demonstrate that radiation and radioactivity from SLAC did not cause any member of the public to receive a radiation dose greater than 100 millirems (mrem, a unit used to quantify radiation dose to humans) during the year.[20] In 2007, the maximum dose that could have been received by a member of the public due to direct radiation from SLAC was less than 0.006 mrem (6.0 x 10^{-5} milli Sievert (mSv)), or 0.006 percent of the 100 mrem regulatory limit. This maximally exposed individual (MEI) is located near Sand Hill Road, approximately 650 meters (m) (2,133 feet) northeast of the intersection of Sand Hill and Whiskey Hill Road.

During 2007, SLAC measured direct radiation at 43 locations around SLAC site boundary to determine the potential radiation dose to a member of the public. Readings from dosimeters used to measure radiation were recorded each calendar quarter. Landauer Incorporated, accredited by the DOE's Laboratory Accreditation Program and National Voluntary Laboratory Accreditation Program as a dosimeter supplier, provided and processed the dosimeters. Results from these dosimeters were also used to calculate the collective dose to the population (about 5 million) that lives within 80 kilometers (km) (50 miles) of SLAC.

Section 5.8 and Table 5-6 summarize annual doses from both direct radiation (0.006 mrem) and airborne radioactivity (0.12 mrem) and show how those doses compare with those from natural background radiation.

5.4 Assessment of Airborne Radioactivity

USEPA regulations (40 CFR 61) enacted under the Clean Air Act and DOE Order 5400.5 require SLAC to demonstrate that airborne radioactivity released did not cause any member of the public to receive a dose greater than 10 mrem during the year. In 2007, the maximum dose that could have been received by a member of the public due to airborne radioactivity from SLAC was 0.12 mrem (1.2 x 10^{-3} mSv), or about one percent of the 10 mrem regulatory limit. This MEI is located in the business offices in the Portola Valley Training Center on the south east side of SLAC.

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[20] United States Department of Energy, DOE Order 5400.5, "Radiation Protection of the Public and the Environment", http://www.directives.doe.gov/pdfs/doe/doetext/oldord/5400/o54005c2.html

SLAC files an annual report to the USEPA that describes the possible sources, types, and quantities of airborne radioactivity released into the atmosphere.[21] As detailed in that report, the released airborne radioactivity was calculated, based on conservative information about accelerator operations in 2007. Table 5-2 summarizes the released radioactivity, showing the quantities in curies (Ci). Potential doses to members of the public due to the released radioactivity were determined using USEPA- software CAP88. In addition to providing information on maximum individual doses, SLAC also assessed and reported the collective dose to the population that lives within 80 km (50 miles) of SLAC.

Table 5-2 and Table 5-6, as well as Section 5.8, provide a summary of the results and information on how the maximum possible doses compare with natural background radiation.

Table 5-2 Airborne Radioactivity Released in 2007

Category	Radioactive Element	Activity (Ci)
Tritium	Hydrogen (^{3}H)	n/a
Krypton-85	Krypton (^{85}Kr)	n/a
Noble gases ($T_{1/2}$ < 40 days)	Argon (^{41}Ar)	2.7
Short-lived activation products ($T_{1/2}$ < 3 hr)	Oxygen (^{15}O)	56.2
	Nitrogen (^{13}N)	105.0
	Carbon (^{11}C)	11.2
Other activation products ($T_{1/2}$ > 3 hr)	n/a	n/a
Total radioiodine	n/a	n/a
Total radiostrontium	n/a	n/a
Total uranium	n/a	n/a
Plutonium	n/a	n/a
Other actinides	n/a	n/a
Total		169

n/a – not applicable

$T_{1/2}$ – half life

5.5 Assessment of Radioactivity in Water

Three types of water are monitored for radioactivity at SLAC: industrial wastewater, stormwater, and groundwater. This section summarizes the 2007 monitoring and results for each water type.

5.5.1 Industrial Wastewater

Federal and state regulations (10 CFR 20.2003 and 17 CCR 30253) limit the radioactivity in industrial wastewater that SLAC releases to the sanitary sewer system. In 2007, SLAC releases totaled less than 50% of the applicable limits.

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[21] Stanford Linear Accelerator Center, Environment, Safety, and Health Division. Radiation Protection Department, *Radionuclide Air Emissions Annual Report – CY2007* (May 2008)

Although most of the cooling water or other water present in the accelerator does not contain radioactivity other than what is naturally present, some of the water becomes activated by radiation from the accelerator (see Section 5.2). Routine operations require SLAC to completely or partially drain and replenish accelerator cooling systems from time to time, and cooling water is disposed of as part of SLAC's industrial wastewater. Thus a small fraction of SLAC's wastewater volume contains radioactivity. Approximately every 5 to 10 years, depending on operations, an entire system may be discharged and refilled. This was the case in 2007 when the entire system water cooling one of SLAC's beam dumps and all the water in the dump itself was discharged to the sewer, an operation that has not occurred for this system for at least 10 years. The cleaning of the system took several discharges and has spanned 2007 and 2008. Due to this system's large volume and high tritium concentration, the total SLAC release for 2007 is considerably higher than in previous years.

Throughout the year, SLAC sampled and analyzed wastewater discharges. Total activity released during CY07 is summarized in Table 5-3.

As required by regulation, each quarter of 2007, SLAC reported the results of wastewater monitoring to the SBSA at the end of each calendar quarter.[22]

Table 5-3 Radioactivity in Wastewater Released in 2007

Category	Radioactive Element	Activity (Ci)	Annual Release Limit (Ci)
Tritium	Hydrogen (^{3}H)	2.3	5
Activation products ($T_{1/2}$ > 3 hr)	Sodium (^{22}Na)	0	1*
	Beryllium (^{7}Be)	0	
Total radioiodine	n/a	0	
Total radiostrontium	n/a	0	
Total uranium	n/a	0	
Plutonium	n/a	0	
Other actinides	n/a	0	

* Combined. Excluding ^{3}H (for which there is a 5 Ci annual limit), there is a 1 Ci limit for the combined activity of all radioactive elements released during the calendar year

n/a – not applicable

Table 5-4 summarizes the historical results of wastewater monitoring for CY1997 through 2007. The final column of the table compares the radioactivity discharged by SLAC into the sanitary sewer with the annual limit for such discharges set by federal and state regulation. Each year, the quantities and types of radioactivity in wastewater discharged depend on past accelerator operations and on details of wastewater handling.

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[22] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Radiation Protection Department, *Radioactivity in Industrial Wastewater for the Period 1 January 2007 to 31 March 2007, for the Period 2 April 2007 to 30 June 2007, for the Period 3 July 2007 to 30 September 2007, and for the Period 4 October to 31 December 2007*

Table 5-4 Summary of Radioactivity in SLAC Wastewater, 1997–2007

Year	Radioactive Element	Activity (Ci)	Percentage of Annual Limit
1997	Hydrogen (^{3}H)	2.2×10^{-2}	0.5
1998	Hydrogen (^{3}H)	7.2×10^{-2}	1.4
1999	Hydrogen (^{3}H)	7.1×10^{-3}	0.1
2000	Hydrogen (^{3}H)	2.4×10^{-3}	0.05
2001	Hydrogen (^{3}H)	2.1×10^{-3}	0.04
2002	Hydrogen (^{3}H)	2.4×10^{-2}	0.5
	Sodium (^{22}Na)	5.1×10^{-5}	1.4*
	Beryllium (^{7}Be)	1.4×10^{-2}	
2003	Hydrogen (^{3}H)	4.1×10^{-4}	0.008
2004	Hydrogen (^{3}H)	2.0×10^{-2}	0.4
2005	Hydrogen (^{3}H)	1.4×10^{-3}	0.03
2006	Hydrogen (^{3}H)	1.2×10^{-3}	0.02
2007	Hydrogen (^{3}H)	2.3	46

* Sodium-22 and Beryllium-7 combined. Excluding ^{3}H (for which there is a 5 Ci annual limit), there is a 1 Ci limit for the combined activity of all radioactive elements released during the calendar year

5.5.2 Stormwater

The program for monitoring stormwater is described in Section 4.4 of this report. In 2007 (and in all previous years), no radioactivity above natural background was found in any stormwater sample.

SLAC reported the results of the 2007-2008 stormwater monitoring (including checks for radioactivity) to the RWQCB.[23]

5.5.3 Groundwater

Throughout 2007, SLAC performed in-house analysis of water samples from monitoring wells for the presence of radioactivity each time the wells were sampled under the groundwater monitoring plan described in Chapter 6 of this report. As part of the groundwater monitoring program (see Section 6.6), select samples are also sent to an external California-certified laboratory for tritium analysis. The results from the external laboratory are in general agreement with the in-house analysis.

With the exception of the four monitoring wells listed in Table 5-5 below (these are in-house results), no radioactivity above natural background was detected in any of the groundwater samples.

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[23] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection Department, *2007–2008 Annual Report for Stormwater Discharges Associated with Industrial Activities* (June 30, 2008, to be submitted to Rico Duazo, San Francisco Bay RWQCB)

The detected concentrations of tritium in the water samples summarized in Table 5-5 were below federal and state limits set for tritium in drinking water (drinking water standard, DWS = 20,000 picoCurie/liter (pCi/L)) under 22 CCR 64443 and 40 CFR 141.66. In addition, groundwater is not used at SLAC for any purposes because of its very low well yields. Even if there was an adequate supply of groundwater available at SLAC, it could not be used as drinking water due to the high content of total dissolved solids (TDS).

Table 5-5 Summary of Tritium Concentrations Measured in Monitoring Wells in 2007 (in-house analysis)

Period (Month)	Jan to March	April to June	July to Sep	Oct to Dec
Well Variable				
EXW-4				
Avg ^{3}H (pCi/L)	3857	n/a	4177	3594
% of DWS[1]	19	n/a	21	18
No. of Samples	7	0	2	6
MW-30				
Avg ^{3}H (pCi/L)	< 500[2]	686	545	753
% of DWS[1]	n/a	3	3	4
No. of Samples	2	1	1	1
MW-81				
Avg ^{3}H (pCi/L)	4811	7663	4404	2763
% of DWS[1]	24	38	22	14
No. of Samples	2	1	2	1
MW-94				
Avg ^{3}H (pCi/L)	3064	3406	3180	2432
% of DWS[1]	15	17	16	12
No. of Samples	1	1	1	2

[1] DWS – drinking water standard: 20,000 pCi/L for tritium

[2] 500 pCi/L was the minimum tritium concentration that was detectable by SLAC in 2007

n/a – not available

5.6 Assessment of Radioactivity in Soil

Throughout 2007, SLAC sampled and analyzed soil for projects involving soil excavation on the SLAC site (such as the construction of the new LCLS facility). No soil samples were found to contain radioactivity in excess of natural background.

5.7 Release of Property Containing Residual Radioactive Material

Throughout 2007, all property, real and personal, exposed to any process that could cause it to become radioactive were surveyed for radioactivity before it was permitted to be removed from SLAC. Property that had any detectable radioactivity was identified as *radioactive*, and was either retained for appropriate reuse on site or was disposed of as radioactive waste. Therefore, property releases do not add to the potential public dose. Material which did not have detectable radioactivity was not considered radioactive and was released from any further controls. There were additional controls on movement of property between locations on site, but these are not relevant to this report and are documented elsewhere.

5.8 Potential Dose to the Public

The maximum possible dose to members of the public due to SLAC are very small compared with doses from natural background radiation and are well below all regulatory limits.

Table 5-6 summarizes the dose results for the two modes that were the potential contributors to public radiation dose in 2007: direct radiation (0.006 mrem) and airborne radioactivity (0.1 mrem). Releases of radioactivity in water and property were too small to result in a radiation dose to a member of the public under any imaginable, credible scenario. Table 5-6 also compares the 2007 dose results with regulatory limits and natural background.

The reported maximum dose for the MEI, dominated by direct radiation, is based on a person being present 24 hours per day in 2007 at the location Sand Hill Road, approximately 650 m (2,133 feet) northeast of the intersection of Sand Hill and Whiskey Hill Road. Like previous calculations, the 2007 calculation of the MEI dose does not include any dose reduction for hills that may lie between the locations of dose measurements and the MEI. However, since 2003, the effects of air attenuation for direct photon radiation calculations (a factor of 40) are taken into account.

The MEI due to the potential emission of radioactive air is located in the business offices in the Portola Valley Training Center on the south east side of SLAC.

Table 5-6 Summary of Potential Annual Doses due to SLAC Operations in 2007

	Maximum Dose to General Public – Direct Radiation	Maximum Dose to General Public – Airborne Radioactivity	Maximum Dose to General Public – Airborne + Direct	Collective Dose to Population within 80 km of SLAC
Dose from SLAC in 2007	0.006 mrem	0.1 mrem	0.1 mrem	0.03 (direct) + 0.74 (air) = 0.8 person-rem
DOE Radiation Protection Standard	100 mrem	10 mrem	100 mrem	n/a
SLAC 2007 Max. Dose as Percentage of DOE Standard	0.006%	1.0%	0.1%	n/a
Dose from Natural Background	100 mrem	200 mrem	300 mrem	1,667,000 person-rem
SLAC 2007 Max. Dose as Percentage of Natural Background	0.006%	0.05%	0.03%	0.000005%

n/a – not applicable

Table 5-7 presents the maximum dose potentially received by a member of the public from both direct radiation and airborne radioactivity due to SLAC operations in 1998 through 2007 and compares it with the average dose due to natural background radiation and radioactivity.

Table 5-7 Potential Dose (mrem) to Maximally Exposed Individual, 1998–2007

Year	SLAC Direct and Airborne Radiation	Average, Total Natural Background Radiation	Percentage of Background
1998	4.6	300	1.53
1999	4.5	300	1.50
2000	5.7	300	1.90
2001	5.3	300	1.77
2002	2.1	300	0.70
2003*	0.2	300	0.07
2004	0.2	300	0.07
2005	0.3	300	0.1
2006	0.5	300	0.2
2007	0.1	300	0.03

* Starting with the 2003 calculations, the effects of air attenuation were taken into account.

5.9 Biota Dose

The DOE technical standard, “A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota” (DOE-STD-1153-2002), suggests that DOE facilities protect plants and animals by assuring the following dose rates due to “exposure to radiation or radioactive material releases” into the applicable environment are not exceeded:

- Aquatic animals: should not exceed 1 rad/day
- Terrestrial plants: should not exceed 1 rad/day
- Terrestrial animals: should not exceed 0.1 rad/day

The term *rad* is a unit used to quantify radiation dose.

5.9.1 Dose to Biota from Direct Radiation

In 2007, SLAC monitored dose and dose rate at approximately 250 on-site locations (indoors and out) using passive radiation dosimeters posted for three to six month periods. For each period, the average dose rate among these 250 dosimeters was found to be less than 0.002 rad/day, and the maximum dose rate was less than 0.02 rad/day. Based on the results of this monitoring program and the fact that we know animal populations could not have been present except in locations with these low dose rates, doses to plant and animal populations at SLAC were well within the limits of the DOE standard throughout 2007.

5.9.2 Dose to Biota from Activation Products

In 2007, SLAC tested soil and water samples for the presence of radioactivity in excess of natural background, as described in sections 5.5 and 5.6. Tritium was occasionally found in industrial wastewater in 2007, but plant and animal populations have no opportunity for access to industrial wastewater at SLAC. Since the radioactive activation concentrations in these sampled media are much lower than from direct radiation, there is no possibility that plants or animals will receive dose rates that exceed the limits of the standard due to radioactive activation products at SLAC.

In 2007, no groundwater was found with tritium concentrations in excess of the DWS set by state and federal regulations. Section 5.5.3 summarizes the 2007 results of monitoring for radioactivity in groundwater. There is no possibility that plants or animals will receive dose rates that exceed the limits of the standard due to radioactive activation products in groundwater at SLAC.

5.10 Low-level Radioactive Waste Management

Low-level radioactive waste (LLRW) is produced at SLAC sporadically. Prior to 2002, wastes resulting from routine operations had not been tracked as a category separate from other operations such as one-time upgrade, equipment failure replacement, and special projects. A system is now in place to allow tracking of *routine operation wastes*.

LLRW minimization is accomplished through education and training for the waste generator, careful planning of work operations, thorough survey and characterization of materials, segregation, reuse, and volume reduction when applicable.

SLAC continues to manage its LLRW in compliance with all applicable laws and regulations. During CY07, SLAC shipped approximately 2,900 cubic feet of LLRW to appropriate treatment and disposal facilities for low-level radioactive waste.

6 Groundwater Protection and Environmental Restoration

6.1 Introduction

This chapter describes the groundwater protection and environmental restoration programs at SLAC, including the regulatory framework, site cleanup objectives, an overview of potential chemical impacts, summary of most recent restoration activities, and SLAC's groundwater monitoring program

6.2 Background Conditions

The groundwater regime at SLAC and nearby off-site areas has been comprehensively documented in the *SLAC Hydrogeologic Review* completed in 1994.[24] This report compiles data and summarizes results of the numerous geologic, hydrogeologic, and hydrogeochemical investigations that had taken place at or near SLAC for the following reasons:

- Water resources studies
- Research
- Geotechnical studies (used to site structures being built at SLAC)
- Environmental monitoring

The report developed a conceptual model of the groundwater regime at SLAC. Based on many tests in exploratory borings and wells, the hydraulic conductivity of this bedrock is much less than the range of that generally accepted as representing natural aquifer material. The groundwater at SLAC is not used as a drinking water source because of low yield as well as naturally occurring high TDS content.

The document *The Geology of Stanford Linear Accelerator Center* [25] provides a detailed description of the geology of SLAC.

6.3 Areas with Potential Impact from Chemicals

A SLAC 1994 report entitled *Summary and Identification of Potentially Contaminated Sites*[26] provided a summary of areas that may have been impacted by chemicals of concern from past SLAC operations. Information for the report was collected from a variety of sources including incident reports, aerial photographs, operations records, reports on previous investigations, and interviews with personnel throughout the facility. Two additional environmental summary documents were completed in 2006. The

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[24] Stanford Linear Accelerator Center, *Hydrogeologic Review* (SLAC-I-750-2A15H-002, 1994)

[25] _______, *Geologic Field Guidebook of Stanford Linear Accelerator Center* (SLAC-I-750-2A32H-015, November 2006)http://www-group.slac.stanford.edu/esh/groups/ep/geology/geologicreport.pdf

[26] ESA Consultants, *Stanford Linear Accelerator Center, Summary and Identification of Potentially Contaminated Sites* (February 1994)

Environmental Baseline Report[27] (EBR) provides an updated inventory of facilities and areas at SLAC that were considered to have the potential to have chemical impacts, and summarizes the results of the environmental investigations and remediation activities that have occurred to date. The EBR identifies chemicals of potential concern, defines Investigation Areas and Operable Units, and provides a decision process for determining which areas still require additional actions. The *Work Plan for the Remedial Investigation and Feasibility Study*[28] provides additional description and current status of investigation areas and describes the framework for completing the environmental investigations and remedial actions at the facility.

6.4 Strategies for Controlling Potential Sources of Chemicals

Strategies for chemical source control involve measures to control known soil or groundwater impacts as discussed in this chapter, and procedures and requirements to avoid practices that could adversely affect soil and groundwater as discussed in Chapter 4. These procedures include the site's SWPPP[29] and SPCC,[30] which discuss BMPs for preventing adverse impacts from spills and operations at SLAC.

6.5 Restoration Activities

SLAC first began environmental investigation and restoration activities in the mid-1980s and by 1991 had developed a comprehensive environmental restoration program. Program activities range from discovery and characterization to remediation and long-term monitoring or maintenance where required.

The restoration approach at SLAC is to accomplish the following steps:

- Identify sites with actual or potential impacts (involving soil, groundwater, surface water, and/or air)
- Prioritize impacted sites based on site complexity, nature of chemical impact, associated risks, remaining data needs, and projected remedy
- Investigate sites and identify remedies that protect human health and the environment, beginning with the highest-priority sites
- Implement remedies and monitor for effectiveness

As of 2007, SLAC had generally reached the third and fourth steps. Restoration work conducted to date generally consists of two categories, soil excavation to remove localized areas of PCB or other chemically-impacted soils, and extraction and treatment of solvent-impacted soil vapor and groundwater. There are six areas with chemicals of potential concern in groundwater. Each of these is described in Section 6.7 below, along with a description of sites where soil removal has recently been conducted.

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[27] Sapere Consulting, *Stanford Linear Accelerator Center Environmental Baseline Report* (February 2006)

[28] Stanford Linear Accelerator Center, *Work Plan for the Remedial Investigation and Feasibility Study* (SLAC-I-750-A17M-008, May 2006)

[29] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection and Restoration Department, *SLAC Stormwater Pollution Prevention Plan* (SLAC-I-750-0A16M-002)

[30] ———, *Spill Prevention, Control, and Countermeasures Plan* (SLAC-I-750-0A16M-001), https://www-internal.slac.stanford.edu/esh/documents_internal/SPCC.pdf

6.6 Regulatory Framework

In May 2005, the RWQCB issued a new Board Order (No. R2-2005-0022) for SLAC for the investigation and remediation of impacted soil and groundwater resulting from historical spills and leaks that occurred during the course of operations at SLAC. The Board Order addresses release sites at SLAC and consolidates the investigation and cleanup activities at the facility. It also rescinds an earlier Board Order that addressed contamination at only one of the sites, the FSUST, which is now incorporated into the new Board Order. In January 2006, the RWQCB was designated by the State as the Administering Agency (i.e., lead agency) for the environmental cleanup work at SLAC[31]. As the lead agency, the RWQCB has the responsibility to determine the adequacy and extent of cleanup, issue necessary authorizations and permits, and following the determination that an approved remedy has been accomplished, issues a certificate of completion. The RWQCB has specified site cleanup to residential standards for un-restricted land use[32], consistent with how the SLAC property is zoned.

SLAC follows as practicable the general CERCLA technical guidance in investigating and remediating soil and groundwater. SLAC was not listed in the National Priorities List as a Superfund site because USEPA determined that the conditions at the site did not warrant inclusion.

All sampling activities are performed according to the environmental restoration program's Standard Operating Procedures[33]. All samples are submitted to analytical laboratories certified by the California Department of Health Services. Analytical data generated by field activities are reviewed and validated for QA and QC purposes.

6.7 Groundwater Characterization Monitoring Network

As part of the May 2005 Board Order, SLAC has a self-monitoring program (SMP) that contains a monitoring schedule for sediment from two drainage channels, surface water, and groundwater. The SMP outlines the frequency at which monitoring samples are to be collected and the chemicals to be analyzed for. Work continued in 2007 on installing additional monitoring wells. Figures 6-1 through 6-3 show the monitoring network.

SLAC has 134 wells across the site used for groundwater monitoring and extraction. Figure 6-2 and Figure 6-3 identify the specific well locations. The groundwater monitoring wells are used to monitor general groundwater quality in the major areas of the facility that historically or currently store, handle, or use chemicals. Of the 134 wells, 90 wells are used to monitor chemicals of potential concern in six plumes and 31 wells are used as extraction wells for two of the six plumes. The other 13 groundwater monitoring wells are used for general site-wide surveillance. The six locations where plume monitoring occurs include the following:

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[31] California Environmental Protection Agency, *Site Designation Committee Resolution No. 06-01* (January 2006)

[32] Regional Water Quality Control Board, *Approval of Stanford Linear Accelerator Center Long Range Redevelopment Plan* (November 18, 2005)

[33] Stanford Linear Accelerator Center, *Standard Operating Procedures for the Environmental Restoration Program Revision 003* (SLAC-I-750-2A15H-001 R003, May 2006).

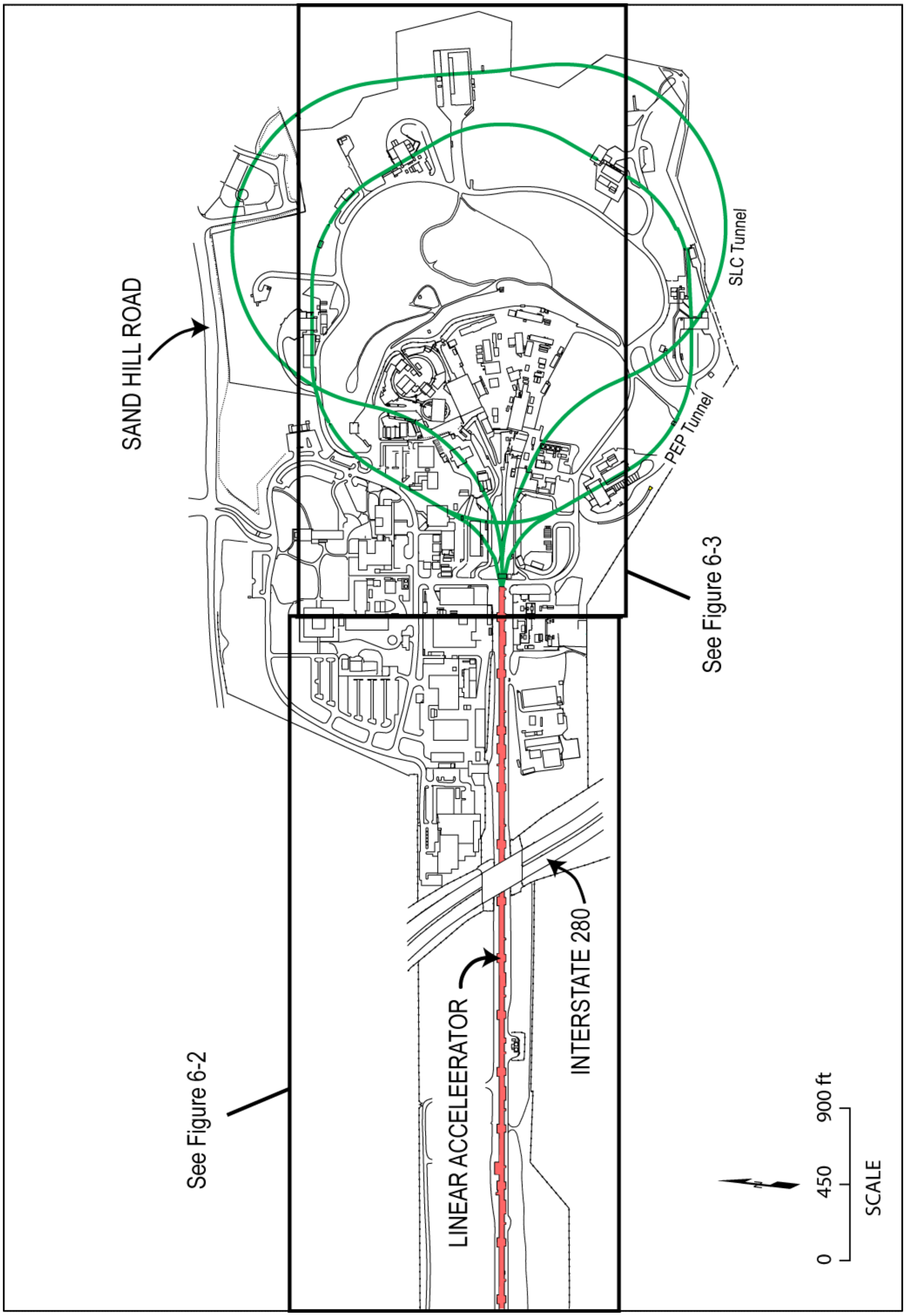

Figure 6-1 Groundwater Characterization Monitoring Network

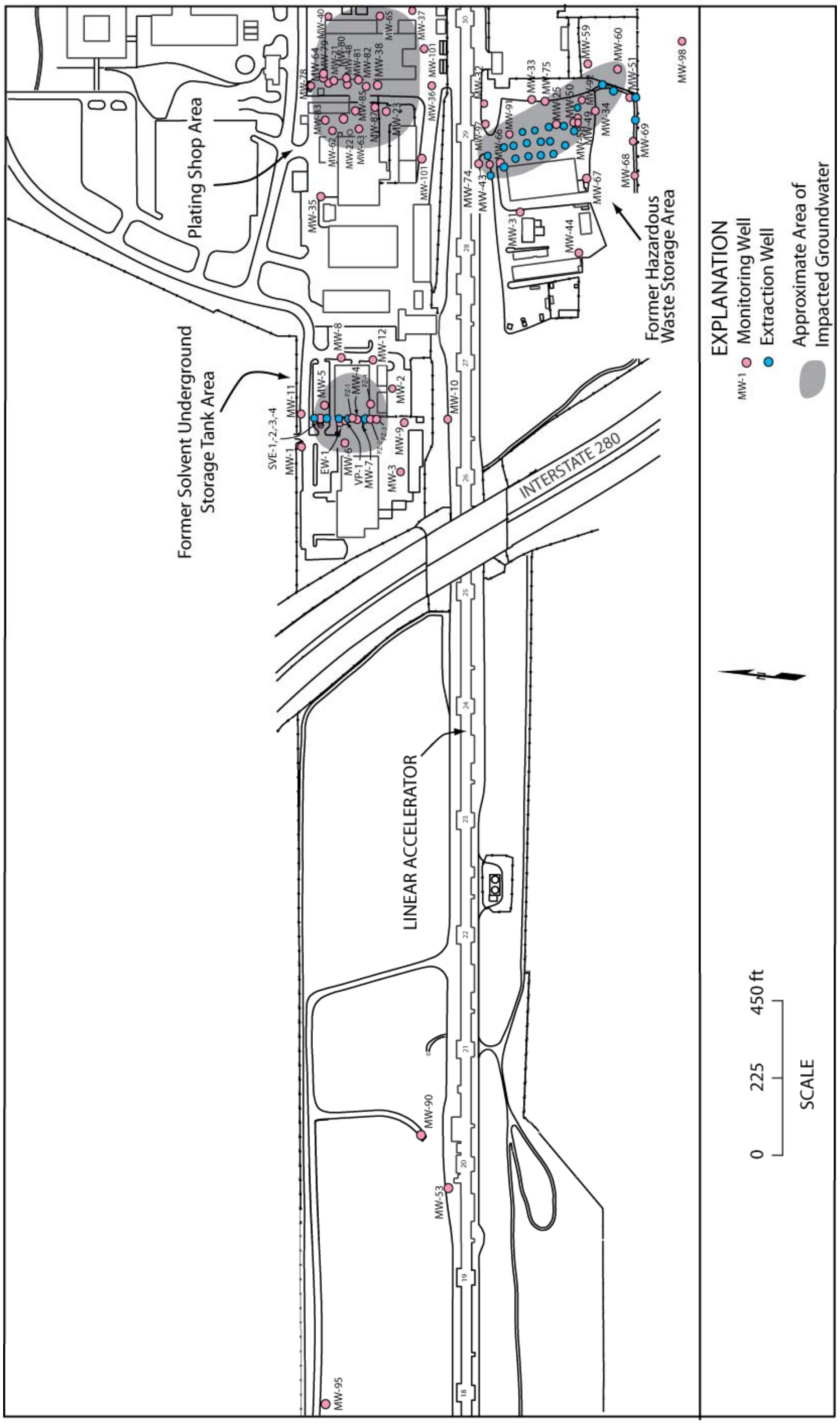

Figure 6-2 Westside Groundwater Network and Impacted Area

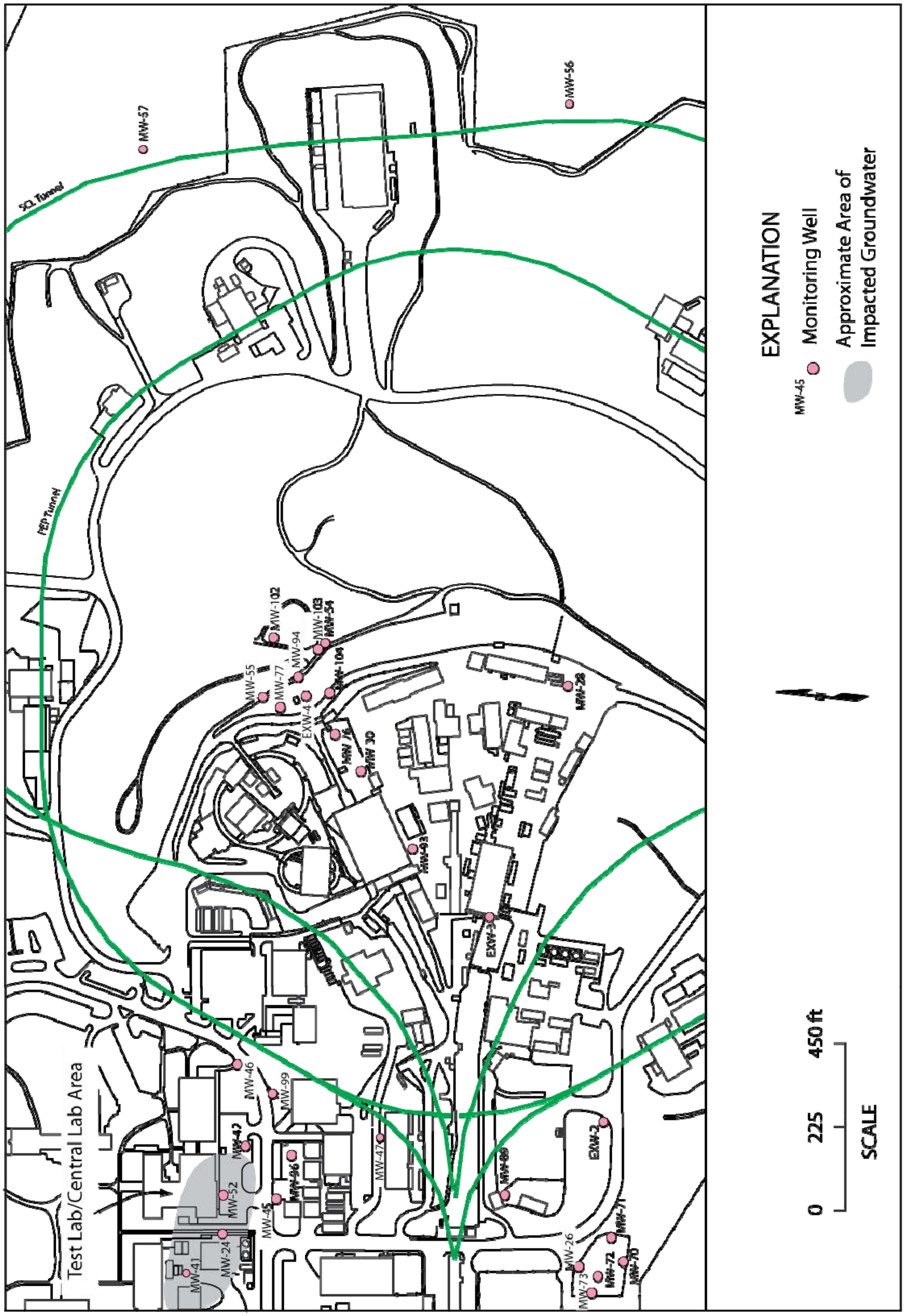

Figure 6-3 Eastside Groundwater Network and Impacted Areas

- Former Hazardous Waste Storage Area (FHWSA)
- Former Solvent Underground Storage Tank (FSUST) Area
- Test Lab and Central Lab Area (TL/CL)
- Plating Shop Area (PSA)
- Lower Salvage Yard (LSY)
- Beam Dump East (BDE)

Table 6-1 summarizes the wells at SLAC by location, number, and purpose of the wells.

Table 6-1 Monitoring Locations and Number of Wells

Location	Number of Wells
Plume Monitoring	
Beam Dump East	9
Former Hazardous Waste Storage Area	22
Former Solvent Underground Storage Tank	22
Lower Salvage Yard	5
Plating Shop	23
Test Lab and Central Lab	9
Subtotal	90
Extraction	
Former Solvent Underground Storage Tank	8
Former Hazardous Waste Storage Area	23
Subtotal	31
Environmental Surveillance	
Centralized Waste Management Area	1
End Station B	1
Magnet Yard	2
Other (remote)	5
Research Yard	3
Vacuum Assembly	1
Subtotal	13
Total	134

Groundwater samples were collected at least once from 113 wells in 2007 and analyzed for a variety of constituents. The results of groundwater monitoring of wells were reported to the RWQCB in the semi-annual self-monitoring report for the winter of 2007[34] and the summer of 2007.[35] The groundwater analytical results were generally within each well's historical range of concentrations. Samples were analyzed for one or more of the following:

- Total petroleum hydrocarbons (TPH)
- Metals
- Polychlorinated biphenyls (PCBs)
- Total dissolved solids (TDS)
- General minerals
- Tritium
- VOCs and semi-volatile organic compounds (SVOCs)

6.8 Site Descriptions and Results

The six groundwater sites are described below. The sites pose no current risk to human health or the environment. Through the work described below, remediation strategies that protect current and future potential uses of the property are being defined.

6.8.1 Former Solvent Underground Storage Tank Area

A chemical plume in groundwater associated with the FSUST is located in proximity to the SLAC Plant Maintenance building in the northwestern portion of the main SLAC campus (see Figure 6-2). The FSUST was used to store organic solvents from 1967 to 1978. A pressure test performed on the FSUST in 1983 indicated a leak. The FSUST and accessible chemically impacted soil were removed in December 1983. A network of 22 monitoring wells and eight extraction wells were subsequently installed, and groundwater has been monitored for VOCs and SVOCs.

The initial evaluation of remedial alternatives report for the FSUST established remedial action objectives and then evaluated 42 alternatives to determine which would meet best the objectives.[36] The recommended interim remedial alternative for the FSUST, a groundwater extraction and treatment system, was constructed at the FSUST area during the summer of 2001 as a pilot system and has been in operation since August 27, 2001.

Construction associated with an upgrade of the FSUST treatment system to dual phase soil vapor/groundwater extraction (DPE) was completed in August 2007. DPE operations, which started on October 18, 2007, increased the mass removal rate of VOCs and SVOCs from an average of 0.14 pounds per day to an average of 2.2 pounds per day for the remainder of 2007.

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[34] Stanford Linear Accelerator Center, *Semi-annual Self-Monitoring Report, Winter 2007* (SLAC-I-750-2A15H-019, May 2007)

[35] ———, *Semi-annual Self-Monitoring Report, Summer 2007* (SLAC-I-750-2A15H-021 November 2007)

[36] Stanford Linear Accelerator Center, *Evaluation of Interim Remedial Alternatives for the Former Solvent Underground Storage Tank Area* (SLAC-I-750-3A-33H-006, 2003)

Since the start up of the remediation system at the FSUST in August 2001 and through December 2007, approximately 562,300 gallons of groundwater have been extracted and treated, resulting in the removal of over 550 lbs of VOCs and SVOCs from extracted groundwater and soil vapor. Monitoring well data collected thus far indicate a capture zone encompassing the entire plume has been established and chemical data indicate that the plume appears to be shrinking in size.

6.8.2 Former Hazardous Waste Storage Area

The FHWSA was in use as a storage area from approximately 1973 to 1982. Following cessation of its use as a storage area, PCBs were found in shallow soils. As a result, several inches of topsoil were removed. A monitoring well was installed in this area in 1990, and VOCs were detected in the groundwater. Since then, two passive soil gas surveys have been performed; 22 monitoring wells, 23 soil vapor and groundwater extraction wells, 15 soil gas probes, and more than 50 soil borings have been installed at this site. Figure 6-2 shows the extent of VOCs in the groundwater. The draft site characterization report for the FHWSA was submitted to the RWQCB in 2004[37] and approved in June 2006.

In 2002, a DPE pilot test proved promising to treat impacted soil, and groundwater, and was recommended as a suitable remediation technology. Two DPE wells were installed at the FHWSA in 2003 as part of an interim dual-phase extraction (IDPE) system. The IDPE system was in operation from December 2003 to March 2006, resulting in the extraction and treatment of a total of 55,000 gallons and the removal of approximately 20 lbs of VOCs.

The design of a full scale DPE system for the FHWSA was finalized in 2004[38] and the construction of the system was completed in March 2006 after six months of construction. The full scale DPE system is designed to reduce the concentration of VOCs in soil and groundwater, at the FHWSA and prevent the migration of impacted groundwater. The full scale system utilizes 19 groundwater/soil vapor extraction wells and four vacuum-enhanced groundwater extraction wells. Groundwater extraction and treatment began on March 6, 2006. Soil vapor extraction began on April 3, 2006.

During 2007, the system extracted and treated an average of approximately 700 gallons of groundwater per day using air stripping technology and extracted approximately 88,000 cubic feet of soil vapor per day. At the end of December 2007, the full scale DPE treatment system at the FHWSA extracted and treated a total of 689,060 gallons of groundwater and removed a combined total (groundwater and vapor) of 34.8 lbs of VOCs.

6.8.3 Plating Shop Area

In 1990, three monitoring wells were installed down-gradient of the PSA. Chemicals of interest were detected in all three wells; and an investigation began and included installation of additional monitoring wells, a soil gas survey, and remediation beneath a steam cleaning pad.

A total of 23 groundwater monitoring wells are currently located at the PSA (see Figure 6-2). Groundwater sampling results indicate that chemicals are present in groundwater within three co-mingled plumes. The

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[37] Stanford Linear Accelerator Center, Draft Site Characterization for the Former Hazardous Waste Storage Area (SLAC-I-750-3A33H-015, September 2004).

[38] Erler & Kalinowski, *Technical Specifications and Drawings for the Dual Phase Extraction and Treatment System at the Former Hazardous Waste Storage Area* (2004)

draft site characterization report for the PSA was submitted to the RWQCB in 2003[39] and approved in 2007 as a Remedial Investigation (RI)-equivalent report required under the Board Order. In support of remedial design efforts, a total of 13 soil vapor probes were installed at the PSA in December 2004, and the probes were most recently sampled in May and December 2007. A draft remedial alternatives evaluation report[40] has been prepared which recommends soil vapor and groundwater extraction followed by treatment. A Preliminary Design was completed in 2007 for the construction of a full-scale DPE system at the PSA. Construction of the DPE system to address identified risk-based areas of concern will be evaluated as part of the Board Order required Feasibility Study under preparation by SLAC.

6.8.4 Test Lab and Central Lab Area

A monitoring well was installed between the TL and the CL in 1990 at the site of a former, leaking, diesel pump spigot. Chemically impacted soil was removed and a monitoring well was installed to monitor for the possible presence of diesel fuel. Diesel has never been detected in this well, but chlorinated solvents have been detected.

Data from a soil gas survey, soil borings and additional monitoring wells installed in the TL/CL helped delineate the sources of contamination (see Figure 6-3). Results of the investigation indicated three possible source areas for VOCs, including one adjacent to the TL, and two adjacent to the CL. As part of further investigation of the possible source areas, six soil vapor probes were sampled in May and November of 2007. The results of the effort identified a risk-based area of concern and that a groundwater remediation system may be required to achieve site cleanup goals. The evaluation on the need of a groundwater remediation system in this area is currently underway as part of the Feasibility Study to be completed as part of the Board Order.

6.8.5 Beam Dump East

BDE is used as a subsurface high-energy beam termination point for the End Station A beamline operations and is located in the hillside along the northeastern edge of the research yard. Groundwater is monitored in nine wells and sampled at least two times per year. Three of the nine wells were installed during 2007 to evaluate the local groundwater for tritium. In 2007, as in previous years, the monitoring indicates that the tritium is localized to two wells in the area of the beam dump and present at levels far below the drinking water standards.

6.8.6 Lower Salvage Yard

There have been minor detections of TPH and VOCs in wells at the LSY. The five monitoring wells at the LSY were sampled in 2007. Low levels of TPH were reported in groundwater samples collected at the LSY.

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[39] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, *Draft Site Characterization Report for the Plating Shop Area* (SLAC-I-750-3A33H-12, December 2003)

[40] Erler & Kalinowski, Inc., *Draft Remedial Alternatives Report for the Plating Shop Area, Stanford Linear Accelerator Center, Menlo Park, California* (December 2003)

6.8.7 Removal Actions

Soil removal actions were completed at six Group I Investigation Areas (Group I IAs) in 2007 to remove debris and soil impacted with PCBs, TPH, polycyclic aromatic hydrocarbons (PAHs) and/or metals at concentrations above Preliminary Remediation Goals (PRGs) or pre-established cleanup goals. Work was completed in accordance with a Removal Action Work Plan prepared and approved by the RWQCB in June 2007. The removal action successfully removed chemically-impacted soils and debris from Former Substation 406, the Building 081 Drainage Swale, the Sector 0 Storage Area and Drainage Swale, the Sector 16 Soil Relocation Area. and the Former Cement Plant Area.

A combined total of approximately 3,180 cubic yards of soil and debris were excavated and disposed of at licensed off site disposal facilities. Final site grading and site restoration work is scheduled in 2008.

6.9 Excavation Clearance Program

During 2007, the excavation clearance program continued to support SLAC-wide projects to ensure proper disposal of excavated soil. An excavation permit form must be completed for activities that involve excavation or relocation of soil at SLAC. The permitting process is intended to identify potential hazards associated with excavation work at SLAC and ways to reduce worker exposure to these hazards. These hazards include underground utility lines, chemical contamination, and radiological hazards and ensure proper management and disposal of excavated materials.

More than 90 projects were supported by this program during 2007. This included the collection of samples for waste characterization for three of these projects.

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