ES&H Division
SLAC-R-831

Annual Site Environmental Report: 2005

January 2007

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

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Office of Science (SC)
Stanford Site Office (SSO)
Stanford Linear Accelerator Center (SLAC)
2575 Sand Hill Road, MS-8A
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October 25, 2006

Subject: 2005 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 2005. 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 2005 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,

Nancy N. Sanchez
Manager
Stanford Site Office

Certification of Accuracy

Annual Site Environmental Report
January - December 2005
SLAC-R-831

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.

____________________________________ Date 10/2/2006

Sayed Rokni
Acting 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 (ES&H) Division of the Stanford Linear Accelerator Center (SLAC) prepares an annual report describing its environmental programs and activities.

This *Annual Site Environmental Report: 2005* summarizes SLAC's 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 (SLAC) 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 Program", 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

The Environmental Protection Department edited this report; ES&H Division Publishing formatted and published it; SLAC Technical Publications provided electronic publishing and printing support.

Acronyms

AEC	Atomic Energy Commission
ASER	annual site environmental report
AST	aboveground storage tank
BAAQMD	Bay Area Air Quality Management District
BaBar	SLAC B Factory detector
BMP	best management practice
BTU	British thermal unit
CAA	Clean Air Act
CAFO	Consent Agreement and Final Order
CalARP	California Accidental Release Prevention Program
CEF	Conventional and Experimental Facilities Department
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
DOELAP	Department of Energy’s Laboratory Accreditation Program
DPE	dual-phase extraction
DTSC	California Department of Toxic Substances Control
DWS	drinking water standard
EA	environmental assessment
EIS	environmental impact statement
EMR	environmental management review
EMS	environmental management system
EPCRA	Emergency Planning and Community-Right-to-Know Act

EP	Environmental Protection Department
ES&H	environment, safety, and health
FHWSA	Former Hazardous Waste Storage Area
FMS	flow metering station
FSUST	Former Solvent Underground Storage Tank
FY	fiscal year
GDF	gasoline dispensing facility
GeV	giga-electron volt
GHG	greenhouse gas
gpd	gallons per day
GSA	United States General Services Administration
H-134a	tetrafluoroethane
H_2NO_3	nitric acid
HAPs	hazardous air pollutants
HMBP	hazardous materials business plan
HVAC	heating, ventilation, and air conditioning
IDPE	interim dual-phase extraction
ILC	International Linear Collider
INL	Idaho National Laboratory
IR	interaction region
ISEMS	integrated safety and environmental management system
ISM	integrated safety management
km	kilometer
L	liter
lbs	pounds
linac	linear accelerator
LCLS	Linac Coherent Light Source
LLRW	low-level radioactive waste
LRDP	long-range development plan
LSY	Lower Salvage Yard
m	meter
MAPEP	mixed analyte performance evaluation program
M&O	management and operating
MEI	maximally exposed individual

MFPF	metal finishing pre-treatment facility
mg	milligram
mg/L	milligrams per liter
MGE	Main Gate East Channel
MPMWD	Menlo Park Municipal Water Department
mrem	millirem
mSv	milli Sievert
NAE	North Adit East Channel
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NIH	National Institutes of Health
NOV	notice of violation
NVLAP	National Voluntary Laboratory Accreditation Program
NZE	near-zero emission
OCA	offsite consequence analysis
ODS	ozone-depleting substance
PBR	permit by rule
PBV	parameter benchmark value
PCB	polychlorinated biphenyl
pCi	picoCuries
pCi/L	picoCuries per liter
PEP	Positron-Electron Project
PHA	process hazard assessment
POC	precursor organic compound
ppd	pounds per day
ppm	parts per million
QA	quality assurance
QC	quality control
RACM	regulated asbestos-containing material
RCRA	Resource Conservation and Recovery Act
RMP	risk management plan
RP	radiation protection
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
SLC	SLAC Linear Collider
SMCHSA	San Mateo County Health Services Agency
SMOP	synthetic minor operating permit
SMP	self-monitoring program
SPCC	spill prevention control and countermeasures
SPEAR	Stanford Positron-Electron Asymmetric Ring
SSO	Stanford Site Office
SSRL	Stanford Synchrotron Radiation Laboratory
SVOC	semi-volatile organic compound
SWMP	stormwater monitoring program
SWPPP	stormwater pollution prevention plan
SWRCB	State Water Resources Control Board
TCA	1,1,1-trichloroethane
TDS	total dissolved solids
TPH	total petroleum hydrocarbons
TRI	toxics release inventory
TSCA	Toxic Substances Control Act
TSD	treatment, storage, and disposal facility
TTO	total toxic organics
UFC	*Uniform Fire Code*
Unidocs	Uniform documents
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound
WBSD	West Bay Sanitary District
WM	waste management
WSS	work smart standard
WTS	waste tracking system

Executive Summary

This report provides information about environmental programs during 2005 at the Stanford Linear Accelerator Center (SLAC). Seasonal activities that span calendar years 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.

SLAC effectively applied environmental management in meeting the site's integrated safety and environmental management system (ISEMS) goals. For normal daily activities, all SLAC managers and supervisors are responsible for ensuring that proper procedures are followed so that

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

Throughout 2005, SLAC focused on these activities through the SLAC management systems (described in Chapter 3). These systems were also the way SLAC approached implementing "greening of the government" initiatives such as Executive Order 13148. The management systems at SLAC are effective, supporting compliance with all relevant statutory and regulatory requirements. There were no reportable releases to the environment from SLAC operations during 2005.

In addition, many improvements were continued during 2005, in waste minimization, recycling, stormwater drain system, groundwater restoration, and implementing a chemical management system (CMS) to better manage chemical use. Program-specific details are discussed below.

Air Quality

SLAC operates its air quality management program in compliance with its established permit conditions. During the 2005 annual inspection by the Bay Area Air Quality Management District (BAAQMD), a file review of past operations of an oil-water separator revealed two exceedances of the permit flow rate. A notice of violation (NOV) was issued by the BAAQMD. SLAC instituted measures to correct the situation and applied for an increase in the flow limit from the BAAQMD.

Hazardous Waste

The Environmental Health Division of the San Mateo County Health Services Agency is the California certified unified permitting agency (CUPA) responsible for overseeing hazardous materials and waste management at SLAC. The CUPA inspected SLAC's hazardous waste generation program, tiered permitting, and hazardous materials business plan in 2005. The inspection found everything to be satisfactory. The regulators were particularly impressed with SLAC's CMS mapping system that is under development.

Stormwater and Industrial Wastewater

SLAC operates its industrial and sanitary wastewater management program in compliance with established permit conditions: 2005 was the ninth consecutive year that a review by the program regulators found everything to be satisfactory.

Hazardous Materials Program

Although SLAC has been successful in meeting the regulatory requirements for hazardous materials, it has decided to pursue a more active strategy in managing and reducing its use of such materials. The cornerstone of this effort is the implementation of a CMS.

Environmental Radiological Program

In 2005, 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. As detailed in Chapter 5, SLAC has implemented programs and systems to ensure compliance with all radiological requirements related to the environment.

Groundwater Protection and Environmental Restoration

In general, environmental concerns at SLAC are limited in number, small in scale and are actively being managed or eliminated. The Environmental Restoration Program continued work on site characterization and evaluation of remedial alternatives at four sites with volatile organic compounds (VOCs) in groundwater and several areas with polychlorinated biphenyls (PCBs) and lead in soil. SLAC received a new site cleanup requirements order (*board order*) during 2005 from the California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB) for the investigation and remediation of impacted soil and groundwater. The new board order lists specific tasks and deadlines for the remedial investigation. All 2005 submittals to the board were completed 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 prepared in 2002 (revised June 2003).[1]

1.1 Introduction

SLAC is a national research laboratory operated by Stanford University under contract to the Department of Energy (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 and particle astrophysics. Five 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 (NASA), National Institute of Health (NIH), and other federal and non-federal sources.

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 to 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, synchrotron-based methods and instrumentation to 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

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

includes complex, 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.

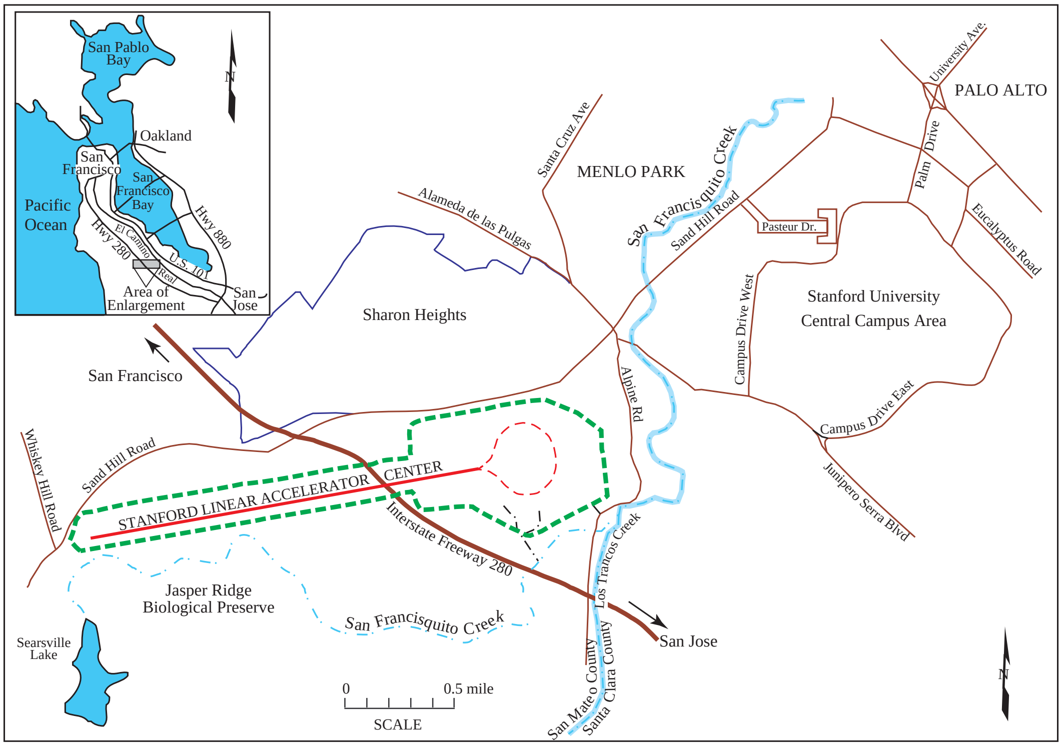

Figure 1-1 SLAC Site Location

A second 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 at 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 three years, a third research drive 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.

The main instrument of research is the 2-mile linear accelerator (linac), which generates high intensity beams of electrons and positrons up to 50 giga-electron volts (GeV). 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 2005.

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.

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.

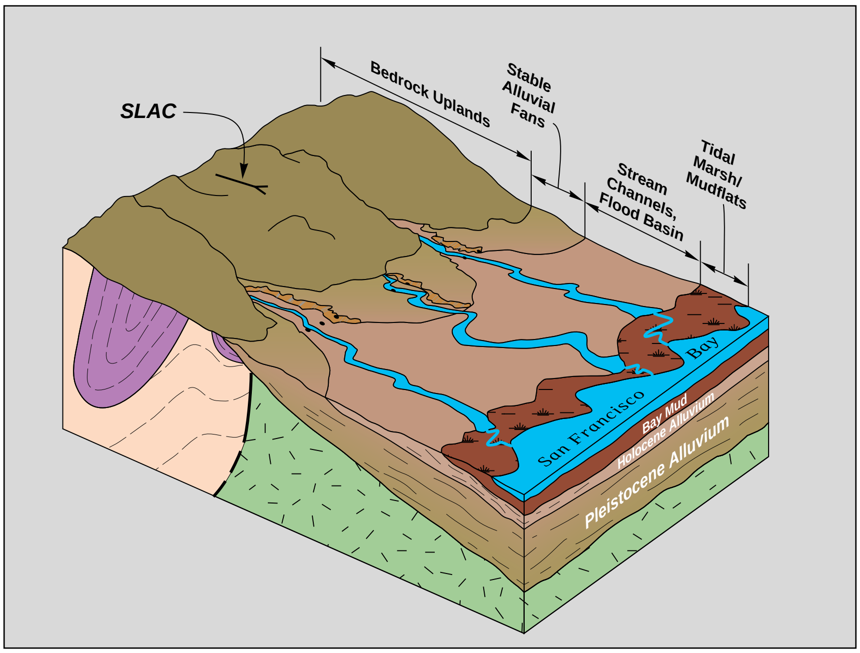

Figure 1-2 Site Area General Geographic and Geologic Setting

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 (AEC). 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 mile at the target (east) end to allow space for buildings and experimental facilities. Much of the western end of the parcel is bordered by Stanford University's Jasper Ridge Biological Preserve, 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.

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 in 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 reserved open space. 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

SLAC domestic water is furnished via the Menlo Park Municipal Water Department (MPMWD), the source of which is the City of San Francisco-operated Hetch Hetchy aqueduct system, fed from reservoirs 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 both transported throughout SLAC 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 about 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 linear accelerator) and domestic uses (such as landscape irrigation and drinking water). The average water consumption by SLAC in 2005 was 35,355 cubic feet per day, or 12,904,600 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 265 are PhD physicists. Approximately 730 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 mainly 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 in western Menlo Park.

Table 1-1provides 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 2005.

2.2 Regulatory Framework

The SLAC Work Smart Standards (WSS) identify environmental protection and safety requirements and standards that are followed throughout the facility.[2]

2.3 Environmental Permits and Notifications

The permits held by SLAC in 2005 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, issued per Title V of the Clean Air Act	1
		34 permitted sources and 21 exempt sources for operation of various types of equipment	55
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 3 – Building 460, conditional authorization permit for batch treatment plant, facility shut down May 2002	0

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

Issuing Agency	Permit Type	Description	Number
		Unit 4 – Building 035, conditional authorization permit for groundwater treatment system	1
		Unit 5 – Former Hazardous Waste Storage Area, PBR for groundwater treatment system	
South Bayside System Authority and West Bay Sanitary District	Wastewater discharge	Flow meter station at Sand Hill Road	1
		Metal finishing pre-treatment facility	1
		Treated groundwater discharge at Building 035 and the Former Hazardous Waste Storage Area	2
Regional Water Quality Control Board	Stormwater	Industrial activities stormwater general permit	1
US Environmental Protection Agency	Hazardous waste	Hazardous waste generator permit	1

2.4 Environmental Incidents

2.4.1 Non-radiological Incidents

A single NOV was issued to SLAC by the BAAQMD for two exceedances of the permitted flow rate of an oil-water separator, no releases were involved however. Other than this, SLAC was in compliance with all non-radiological requirements related to the environment throughout 2005.

2.4.2 Radiological Incidents

In 2005, 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 2005.

2.5 Assessments, Inspections, and Quality Assurance

As described in Chapter 3, "Management Systems", the environmental programs at SLAC are subject to a number of assessments, inspections, and quality assurance measures. Those conducted during 2005 are reported here.

2.5.1 Assessments

2.5.1.1 External

External assessments are periodically conducted on varying basis. There is one monitoring assessment related to the radiological program which occurs regularly, and that is the quarterly monitoring of SLAC perimeter radiation by the California Department of Health Services. Monitoring results from the California Department of Health Services were not shared with SLAC.

A water efficiency survey of SLAC was performed by Maddaus Water Management on November 4, 2005. Recommendations were made to improve the efficiency of water use at SLAC.

2.5.1.2 Independent Assessments

The DOE audited SLAC's ISEMS program on August 18, and October 3 to 11, 2005.

At SLAC's request, the United States Environmental Protection Agency (USEPA) performed a review of SLAC's environmental management system (EMS) in March 2005.

Two other independent Environment, Safety and Health audits occurred in March and April 2005. SLAC's ISEMS and EMS were evaluated by members of DOE's Office of Science Chicago and Oak Ridge Integrated Support Centers in September, October, and November of 2005. The DOE Stanford Site Office (SSO) then sent a self-declaration letter to the director of the Office of Science fulfilling the requirement under DOE Order 450.1, "Environmental Protection Program",[3] and Executive Order 13148 requiring all sites to have an EMS in place by the end of December 2005.

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 2005 by these agencies. A single NOV was issued to SLAC by the BAAQMD for the exceedance of the permitted flow rate.

Table 2-2 Environmental Audits and Inspections

Regulatory Agency	Inspection Title	Date	Violations
South Bayside System Authority	Annual Wastewater Discharge Inspection	March 2	0
Bay Area Air Quality Management District	Various activities with emissions to air	August 24	1
San Mateo County Department of Health Services	Hazardous waste generation program, tiered permitting, and hazardous materials business plan	November 8	0

2.5.3 Quality Assurance

The SLAC site-wide quality assurance (QA) program is consistent with by the requirements of DOE Order 414.1C,[4] and has roles, responsibilities, and authorities for implementing the ten criteria from the DOE order are included in the *SLAC Institutional QA Program Plan*.[5]

3 United States Department of Energy, DOE Order 450.1, "Environmental Protection Program", http://www.directives.doe.gov/pdfs/doe/doetext/neword/450/o4501c2.html

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

5 Stanford Linear Accelerator Center, Environment, Safety, and Health Division, *SLAC Institutional Quality Assurance Program Plan* (SLAC-I-770-0A17M-001), http://www-group.slac.stanford.edu/esh/references/QAplan.pdf

The Office of Assurance (established shortly after the start of 2006) 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 Remedial Investigation and Feasibility Study*[6] for soil and groundwater contamination investigations. This document has most components required of quality assurance project plans according to the USEPA; the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund); and DOE guidance documents. The components include 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. The lab 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.

2.6 Environmental Performance Measures

At the institutional level, a program of performance measures in environmental protection, waste minimization, pollution prevention and EMS have been established.[7] Review of performance to these measures by senior management is part of the overall planned program assessment activities.

Performance measure results are reported in a fiscal year structure; the SLAC fiscal year 2005 (FY05) covered October 1, 2004 through September 30, 2005. The performance measure results for FY05 indicated a rating of *outstanding* on environmental measures,[8] which is the highest attainable rating.

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6 Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection and Restoration Department, *Quality Assurance Project Plan for the Remedial Investigation and Feasibility Study* (SLAC-I-750-2A17M-002, March 2002)

7 Stanford Linear Accelerator Center, Environment, Safety, and Health Division, "ISEMS: Performance Measures" (FY 2004), http://www-group.slac.stanford.edu/esh/general/isems/perfmeas/

8 Stanford Linear Accelerator Center, Environment, Safety, and Health Division, *Final Draft, Annual Environment, Safety, and Health Report* (November 2005)

3 Management Systems

3.1 Introduction

This chapter provides an overview of the Environment, Safety, and Health (ES&H) Division's management systems, including organizational structure, management approach, and EMS implementation. 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 FY08. The previous organization of the SLAC directorates had been in place for many years: Director's Office, Business Services Division, ES&H Division, Research Division, Stanford Synchrotron Research Laboratory (SSRL) Division, and Technical Division. 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.

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 SLAC operates in compliance with federal, state, and local regulations, as well as DOE requirements.

3.3.1 Environmental Protection

The Environmental Protection (EP) Department has three technical groups. The EP and compliance group provided oversight of stormwater and industrial wastewater, toxic substance control, and groundwater protection. The Environmental Restoration Group oversaw work to restore property impacted with chemicals. The Waste Management (WM) Group developed and implemented waste minimization and pollution prevention plans, and coordinated the disposal of regulated waste.

3.3.2 Fire Department

During 2005, the Fire Department, staffed by fire personnel from the Palo Alto Fire Department, continued to report to the ES&H division office. Fire protection services were provided to the site on a 24 hour-a-day, seven days-a-week basis.

3.3.3 Radiation Protection

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

3.3.4 Chemical and General Safety

The Chemical and General Safety (CGS) Department managed the overall safety, and health programs, as well as hazardous materials management, the chemical management system (CMS) and the non-radiological air quality program. .

3.3.5 Medical Department

During 2005, the Medical Department, staffed by contract professional medical personnel, continued to report to the ES&H division office. The Medical Department provided a full range of occupational medicine services.

3.3.6 Knowledge Management

The Knowledge Management Department provided training, publishing, and web services, and managed the division budget.

3.4 Integrated Safety and Environmental Management System

The ES&H program has been designed to ensure SLAC operates in a safe, environmentally responsible manner and complies with applicable laws, regulations, and standards. The program is based on integrating these concerns into the mission and everyday operations of the site, and as such embodied the ISEMS approach even before this was made a DOE requirement and incorporated into the operating contract of the site. In 2005, the elements of ISEMS were extensively revised to further emphasize line management and individual responsibility. The revisions to the ISEMS program at SLAC were guided by an integrated safety management (ISM) steering committee with representatives from all the directorates at SLAC, including the ES&H Division.

3.4.1 Safety and Environmental Management System

The "plan, do, check, and improve" approach of ISEMS[9] has been formally adopted by SLAC, and is the foundation of the site's ISEMS[10] and the ES&H program. The approach consists of the following five core functions:

9 Stanford Linear Accelerator Center, Environment, Safety, and Health Division, "Integrated Safety and Environmental Management Systems", http://www-group.slac.stanford.edu/esh/general/isems/

1. Define the scope of work
2. Analyze the hazards
3. Develop and implement hazard controls
4. Perform work within controls
5. Provide feedback and continuous improvement

3.4.2 Work Smart Standards

To ensure the goals of Guiding Principle 5, "Identification of Safety and Environmental Standards", are met, 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 requirements, known as the SLAC WSS, are reviewed annually, and are based on and respond to potential hazards and environmental impacts identified by those who work at SLAC.[11] As a result of activities related to the serious accident that occurred at SLAC on October 11, 2004, the FY05 WSS review was not finalized by agreement with the DOE Stanford Site Office until late in calendar year (CY) 2005.

3.4.3 Environmental Performance Measures

In addition to adopting work smart standards, 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 measures are adopted and reported in a fiscal-year structure.[12] The performance measure results for FY05 indicated a rating of *outstanding* on environmental measures.

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 instructed in chemical and waste management, waste minimization, pollution prevention, stormwater protection, on-site transportation of hazardous

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10 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

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

12 The measures for fiscal years 1997 through 2005 can be found on line at http://www-group.slac.stanford.edu/esh/general/isems/perfmeas/.

chemicals and waste, and spill and emergency response. Details on the ES&H training program are available on line.[13]

3.5 Environmental Management System

Stanford University provides the land for the SLAC site to the DOE at no cost, charging no rent and exacting no fee. SLAC, as a department of the university, manages the land with future generations in mind, thus ensuring proper stewardship and the eventual return of the land to unrestricted use. This stewardship goal is embodied in the safety management system described above, which already incorporates many of the characteristics and requirements of an EMS as defined in Executive Order 13148, "Greening the Government", including the roles and responsibilities for an EMS.

Requirements for an EMS are contained in the order, DOE O 450.1, "Environmental Protection Program".[14] SLAC continued to follow the path to self declare an EMS. An Environmental Management Review (EMR) was conducted at SLAC by the USEPA (Region 9) in March 2005. Corrective actions were taken in response to the EMR and a DOE review of the SLAC EMS program was conducted in November 2005. The DOE confirmed an EMS was in place at SLAC as of December 31, 2005 as required by the above directives.

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

14 United States Department of Energy, DOE Order 450.1, "Environmental Protection Program", http://www.directives.doe.gov/pdfs/doe/doetext/neword/450/o4501c2.html

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 located in an environmentally sensitive location.

SLAC expends considerable effort to minimize waste and emissions. If possible, SLAC avoids creating waste and emissions in the first place. When unavoidable, SLAC minimizes the amount it does produce, and then carefully manages the impacts that may occur as a result of waste generation.

As noted in Chapter 2, for FY05, the DOE recognized SLAC's environmental performance as *outstanding* (the highest possible rating) for each of the four environmental performance measures included in Stanford University's contract with DOE to manage the facility. Other 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
2001	White House	Closing the Circle Award	Reuse of potential hazardous wastes
2001	Santa Clara County	Letter of recognition	Silicon Valley Chemical Management Services Pilot Project participant
2001	DOE	Pollution Prevention Award	Implementing alternatives to ozone-depleting solvents
2001	DOE	Pollution Prevention Award	Reducing/eliminating hazardous waste generation
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

Additionally, SLAC continually strives to increase its environmental performance, per the objectives of Executive Order 13148, "Greening the Government through Leadership in Environmental Management", and its own EMS (see Chapter 3).

This chapter provides an overview of the non-radiological environmental programs SLAC has implemented to protect air and water quality, to manage hazardous materials safely, and to 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 2005, 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 boilers, solvent degreasers, a paint shop, a plating shop, several machine shops, a magnet shop, and a vehicle fueling station. In addition, high-energy physics experiments can emit volatile organics due to the nature of the gas atmospheres required for use in particle detectors. This section describes the regulatory framework to which SLAC is subject for the purpose of air quality protection, and then presents the status of SLAC's air quality protection programs in 2005.

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 BAAQMD. Included in the BAAQMD roles and responsibilities are implementation of Title V of the Clean Air Act (CAA). As a result of this implementation, SLAC became subject to the Title V permitting program and applied for a synthetic minor operating permit (SMOP). SLAC's Title V SMOP application was submitted on June 1, 2000, and the permit was issued to SLAC by the BAAQMD on July 26, 2002.

The Title V SMOP placed caps on facility-wide emissions of VOCs, total hazardous air pollutants (HAPs), and individual HAPs. SLAC's first annual emissions report under the Title V SMOP was submitted to BAAQMD on time in July 2003.

Other mechanisms by which BAAQMD regulates SLAC's air emissions include

1. Annual enforcement inspections
2. New source permit evaluations
3. Annual information updates for emissions of air toxics as identified by the California Air Resources Board in its toxic substances checklist
4. Annual information updates for adhesives usage as specified in BAAQMD Regulation 8-51-1502.2C
5. Asbestos and demolition project notification requirements

SLAC is also subject to the following two air quality programs:

- The National Emission Standards for Halogenated Solvent Cleaning, under Title 40, *Code of Federal Regulations* (CFR), Part 63.460, administered through the Air Division of Region 9 of USEPA
- The Protection of Stratospheric Ozone, under 40 CFR 82, likewise administered through the Air Division of USEPA Region 9

4.2.2 Program Status

4.2.2.1 Annual Facility Enforcement Inspection

BAAQMD conducted an annual facility-wide inspection on August 24, 2005. A file review of past operations revealed two exceedances of the permitted flow limit at the oil-water separator which receives effluent from a steam-cleaning operations facility. As a result, an NOV was issued to SLAC. In response, SLAC instituted daily recording of the flow and applied for an increase in the flow limit, which was granted early in 2006.

4.2.2.2 New Source Permits

In August 2005, SLAC submitted three individual permit applications to BAAQMD to separate the three subsystems of the BaBar detector that use isobutane. The permits reflect the fact that each subsystem is a unique entity. As such, each subsystem now has its own limit for isobutane emissions, and can be managed independently.

An interim soil vapor extraction system at the former hazardous waste storage area (see Chapter 6) was converted to a full-scale dual-phase extraction system, and permits for both the extraction system and its abatement device were submitted in November 2005. In last year's report, the system was approved for unabated operation, because after initial high concentrations and rapid subsequent decreases, VOC levels were consistently low and within the permitted limits.

The boiler next to the Plating Shop in Building 37 was taken out of service in 2004 and a replacement boiler was installed next to it in April 2005. Since the heating capacity of the new unit is less than 10 million British thermal units (BTUs) per hour and it is fired solely by natural gas, this unit is permit-exempt, in accordance with BAAQMD regulations.

In light of these changes, at the end of 2005 there was a net increase of 1 in the number of permitted and exempt emissions sources. Thus, SLAC had a total of 55 sources of air emissions listed in its facility-wide permit-to-operate, comprising 34 permitted and 21 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, 2004 through June 30, 2005. Following submittal of the former, SLAC received the renewal of its permit-to-operate on June 23, 2005, effective through July 1, 2006. SLAC submitted the Title V annual emissions report on time in July 2005.

Currently, the largest source of air emissions at SLAC is its BaBar detector (BAAQMD Sources S-55 and S-56, representing two separate subsystems). SLAC has operated the detector within permit conditions at all times since its startup in 1999 (Figure 4-1). However, due to steadily increasing flow rates of isobutane through the detector subsystems, a second change-of-condition application was required in 2005, as described above in Section 4.2.2.2. Isobutane is the only precursor organic compound (POC) to be used at SLAC.

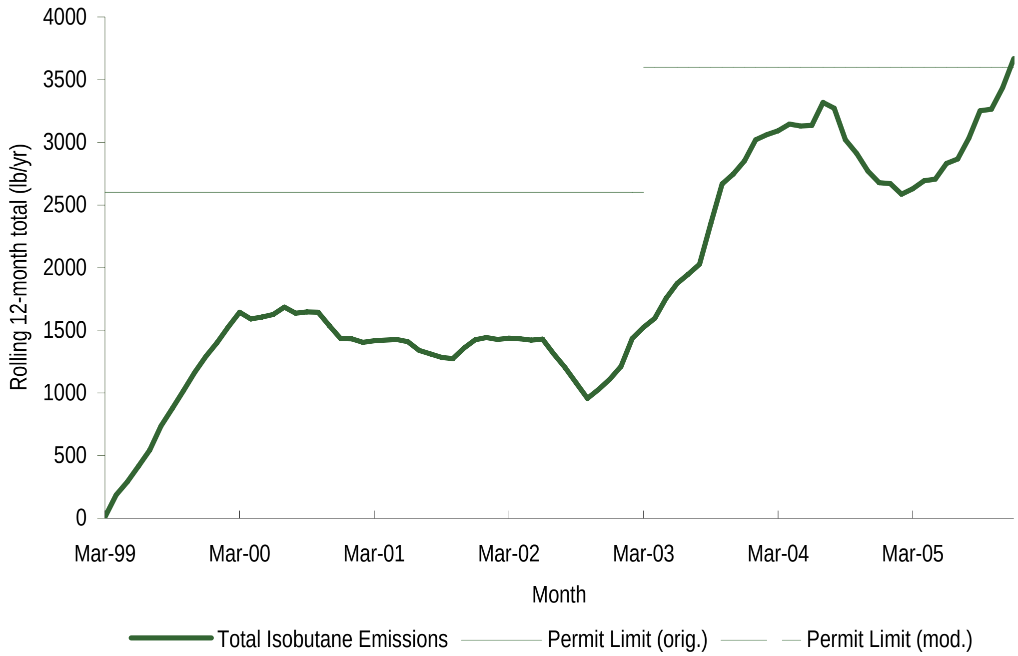


Figure 4-1 POC Emissions from BaBar (DCH-IFR/Sources S-55 and S-56)

4.2.2.4 Annual Air Toxics Report

Concurrent with BAAQMD's annual information request, facilities are also required to review the toxic substances checklist promulgated by BAAQMD to support the California Air Resources Board's Air Toxics program. If facilities emit more of a listed chemical than the *applicable degree of accuracy* threshold, regardless of whether the emissions originate from a permitted source, facilities have an obligation to report air toxics usage at the same time of their annual update.

SLAC submitted its annual air toxics information to BAAQMD on May 31, 2005, covering the 2004 reporting year. Air toxics emitted from permitted sources included the following:

1. H-134a (tetrafluoroethane), a Freon compound used in one of the components of the BaBar Detector: 11,017 pounds (lbs)
2. 3M FC-77 Fluorinert-brand electronic liquid (a mixture of perfluorinated compounds), used in heat exchangers for one of the components of the BaBar detector: 328 gallons (about 4,600 lbs)
3. R-22 and R-404-A, used in SLAC heating, ventilation, and air conditioning (HVAC) equipment: 708 and 78 lbs, respectively
4. 1,1,1-trichloroethane (TCA), a solvent used in the Plating Shop for degreasing parts: 40 lbs

Regarding air toxics emitted from the rest of the facility, a total of 34 air toxics were reported as being used in quantities greater than the corresponding *degree of accuracy*. Usage of these chemicals ranged from a low of 0.017 lbs per year (for chromium) to a high of 20,662 lbs per year for nitric acid (H_2NO_3). The chromium is dissolved in a one percent solution and used as a calibration standard, while H_2NO_3 is used extensively in the Plating Shop, along with other laboratories onsite. These quantities are used to calculate annual permit fees paid to the BAAQMD.

4.2.2.5 Annual Adhesives Usage Report

SLAC submitted its annual adhesives usage report to BAAQMD to satisfy Regulation 8-51-502.2c on April 13, 2006 (covering the 2005 reporting year) and reported using a total of 31 adhesives.

4.2.2.6 Asbestos and Demolition Project Notification Program

For projects that involve the demolition of existing structures or the management of regulated asbestos-containing material (RACM), SLAC is required to provide advance notice to BAAQMD. During 2005, approximately 34 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 notifications were formally submitted to BAAQMD for five of the 34 construction projects.

4.2.2.7 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 National Emission Standards for Hazardous Air Pollutants (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	TCA
S-54	Near-zero emission (NZE) degreaser	Plating Shop	Tetrachloroethylene
S-58	Batch cleaning tank	Electron Gun Testing/Maintenance	TCA
S-61	Batch cleaning tank	Plating Shop	Methylene chloride

In 2004, SLAC participated in a voluntary disclosure program with the USEPA, evaluating all uses of HAPs onsite. To document this process, a consent agreement and final order (CAFO) was later sent to SLAC, signed by the director, Jonathan Dorfan, on June 17, 2005 and submitted to USEPA.

With the successful installation of Source S-54, the Near Zero Emission (NZE) Vapor Degreaser, in 1999, SLAC realized a dramatic decrease in its emissions of chlorinated solvents from its Plating Shop, thus greatly improving its environmental performance and enhancing worker health and safety. The ten-year emissions history of chlorinated solvents from the Plating Shop is shown in Figure 4-2.

4.2.2.8 Protection of Stratospheric Ozone

No releases of stratospheric ozone-depleting substances (ODSs) occurred during 2005 that were subject to the release reporting and corrective action requirements in the ODS regulations (40 CFR 82).

Per Executive Order 13148, "Greening the Government through Leadership in Environmental Management", SLAC is subject to two DOE-mandated ODS-management objectives:

1. By 2005, retrofit or replace 100 percent of chillers that have greater than 150 tons of cooling capacity, were manufactured before 1984, and that use Class 1 ODS
2. 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. Specifically, the final three pre-1984 Class 1 ODS-using chillers at SLAC were replaced in the summer of 2002.

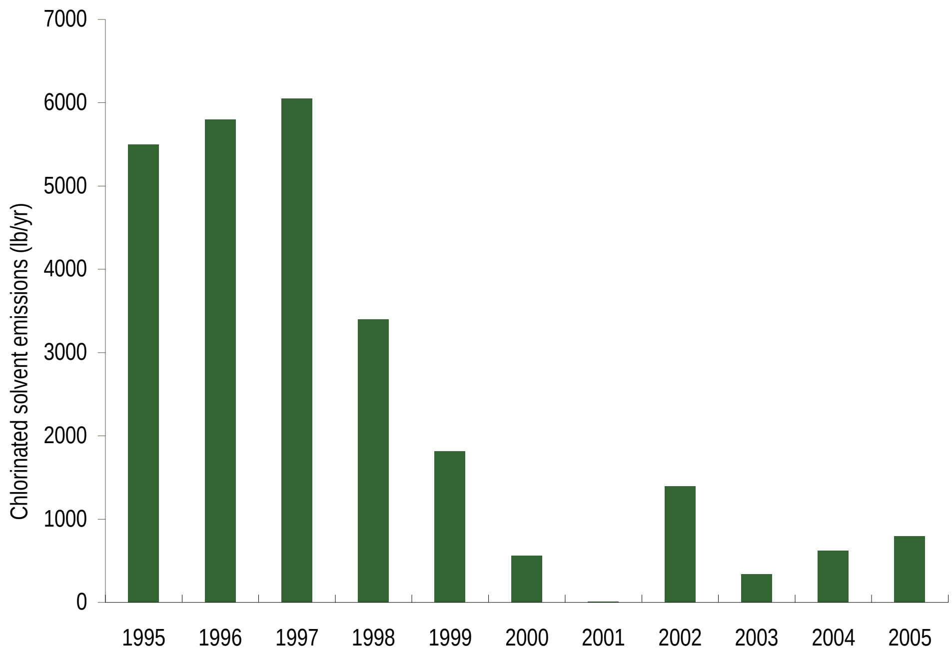


Figure 4-2 Air Emissions from Chlorinated Solvents: SLAC Plating Shop, 1995–2005

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

1. SSRL Building 118 Chiller Replacement
2. Halon Fire Systems Replacement (two systems)
3. Miscellaneous HVAC Equipment Replacement (approximately six small systems)
4. TCA Replacement Project, Conventional Experimental Facilities (CEF)

4.2.2.9 Vehicle Fleet Management

SLAC operates and maintains a fleet of more than 230 cars, trucks, and specialized pieces of heavy equipment to support its daily operations. Vehicles are provided by one of two federal agencies: the DOE or the General Services Administration (GSA). While the latter can be driven off site without restrictions, the aging DOE fleet cannot leave SLAC for insurance purposes, and so must be refueled on site at the gasoline dispensing facility (GDF) that began operating in October 2001.

The GDF is operated and managed by the Transportation Department, which is part of the CEF, and is regulated as a permitted emissions source by the BAAQMD. 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. The source test was performed by a contractor in September 2005 and all results were positive. The results are transmitted automatically to both SLAC and BAAQMD by the contractor.

In addition to SLAC-owned passenger cars and trucks, portable diesel dispensing tanks are filled at the GDF and then transported throughout SLAC to refuel heavy equipment and stationary engines, such as emergency back-up generators.

The GDF provides both gasoline and diesel for SLAC vehicles. Only 1,424 gallons of gasoline were dispensed in 2005, continuing a steady decline for the fourth year in a row. In sharp contrast, however, biodiesel fuel consumption spiked at 6,940 gallons, including 4,822 gallons for May of 2005. This jump in use resulted from a three-day power outage during May. Consequently, generators were pressed into service throughout the site during the outage.

SLAC continued its efforts to replace and upgrade its vehicle fleet. In 2005, four electric vehicles were added to the SLAC GSA fleet, increasing the total number of electric vehicles to 217 (Table 4-3).

Table 4-3 Vehicle Fleet Summary

Indicator	CY05	CY04
Total number of vehicles on site	227	224
Total number of GSA vehicles	217	213
Total number of DOE vehicles	8	11
Average GSA vehicle age in years	3	3
Average DOE vehicle age in years	17	17
Average year vehicle manufactured	2001	2000

At the beginning of the year SLAC operated only 11 DOE-owned vehicles. The average age of these vehicles was 17 years, and they represented the worst-polluting vehicles of SLAC's vehicle fleet. By the end of the year, SLAC had disposed of three of these aging vehicles, leaving only eight DOE trucks onsite.

Further reductions in the average age of SLAC's vehicle fleet are anticipated. As expected, each reduction brings about corresponding decreases in the associated air emissions.

4.2.2.10 Greenhouse Gas Inventory and Baseline

Sulfur hexafluoride (SF_6), the most potent greenhouse gas (GHG) known, is used at SLAC in both electrical equipment and experimental apparatus. Current policy calls for researchers to justify the use of SF_6, evaluate potential alternatives, and commit to responsible management of the gas in all operations. It remains clear that SF_6 is an extremely useful material, by far the most appropriate for some applications, and that research into acceptable substitutes has barely begun. Beginning in 2005 and at the request of

ES&H, research proposals have considered substitutes and incorporated justification for using SF_6, even in minute quantities.

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. Until 2005, the SLAC air quality management program had operated for seven consecutive years without receiving any NOVs from regulators. Nevertheless, 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 caps on facility-wide HAPs emissions
- Installation of new natural gas metering and instrumentation control systems at its main boilers

Future plans include the phasing out of all Class 1 ODSs, 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 younger, 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 Metal Finishing Pre-treatment Facility (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 2005.

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 two mandatory wastewater discharge permits, which are negotiated jointly with the WBSD and SBSA. These permits were renewed on April 1, 2002, and will expire on December 15, 2006, and specify monitoring programs and pollutant discharge limits. SLAC also has two discretionary groundwater discharge permits. One is for the existing groundwater treatment system at the Former Solvent Underground Storage Tank (FSUST), which will expire August 21, 2006. The other permit is for the dual phase extraction and treatment system at the Former Hazardous Waste Storage Area (FHWSA), which became effective October 15, 2004, and expires October 14, 2009. The FHWSA was working in an interim mode and was completed to a full-scale system at the end of CY05. SLAC also has a contractual relationship with the WBSD, which specifies the total industrial and sanitary flow allowed to be discharged. A summary of these requirements is presented in Table 4-4.

Table 4-4 Industrial and Sanitary Wastewater Monitoring Requirements

Sampling Location	WBSD Permit Number	Sampling Frequency	Monitoring Parameters
Sand Hill Road Station	WB 020401-F	Quarterly (by SBSA)	Cd, Cr, Cu, Pb, Ni, Ag, Zn, pH, Flow
Metal Finishing Pre-treatment Facility	WB 020401-P	Semiannually (by SLAC), annually (by SBSA)	Cd, Cr, Cu, Pb, Ni, Ag, Zn, pH, cyanide, Flow
FSUST	GW WB082201	Quarterly (determined by carbon depletion pattern)	Specified organics,* Flow
FHWSA	GW WB041015	Quarterly	As, Cd, Cr, Cu, Pb, Hg, Ni, Ag, Zn, Specified organics, CS2, Flow
Sand Hill Road and three Alpine Road stations (MSub, Alpine, IR08)	Contractual discharge arrangement	Flow data collected on real-time basis	Flow

* Total petroleum hydrocarbon (gasoline), benzene, chloroform, methylene chloride, carbon tetrachloride, perchloroethylene

Per the permit terms, SLAC is required to submit a semi-annual self-monitoring report[15] on the results of its monitoring of the MFPF, a semi-annual certification of a solvent management plan for approximately 100 solvents selected by the SBSA, and quarterly reports for discharges of treated groundwater[16] and radioactivity in industrial wastewater (see Section 5.5.1).

15 Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection Department, *Semiannual Self-Monitoring Report, Mandatory Wastewater Discharge Permit WB 020401-P* (EP 0507-01, 31 July 2005, submitted to Norman Domingo, Technical Services Supervisor, SBSA)

———, *Semiannual Self-Monitoring Report, Mandatory Wastewater Discharge Permit WB 020401-P* (EP 0601-01, 31 January 2006, submitted to Norman Domingo, Technical Services Supervisor, SBSA)

16 Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection Department, *Groundwater Discharge Self Monitoring Report, 1st Quarter 2005, Discretionary Groundwater Discharge Permit No. GW WB041015* (April 9, 2005, submitted to SBSA)

———, *Groundwater Discharge Self Monitoring Report, 2nd Quarter 2005, Discretionary Groundwater Discharge Permit No. GW WB041015* (July 13, 2005, submitted to SBSA)

———, *Groundwater Discharge Self Monitoring Report, 3rd Quarter 2005, Discretionary Groundwater Discharge Permit No. GW WB041015* (October 13, 2005, submitted to SBSA)

———, *Groundwater Discharge Self Monitoring Report, 4th Quarter 2005, Discretionary Groundwater Discharge Permit No. GW WB041015* (January 12, 2006, submitted to SBSA)

SLAC's industrial and sanitary monitoring locations are shown in Figure 4-3. SLAC's Sand Hill Road flow metering station (Sandhill 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 three flow monitoring stations (MSub, Alpine, and IR08) on the south side of the facility, which collectively monitor the flow SLAC discharges to the WBSD's Alpine Road trunk line.

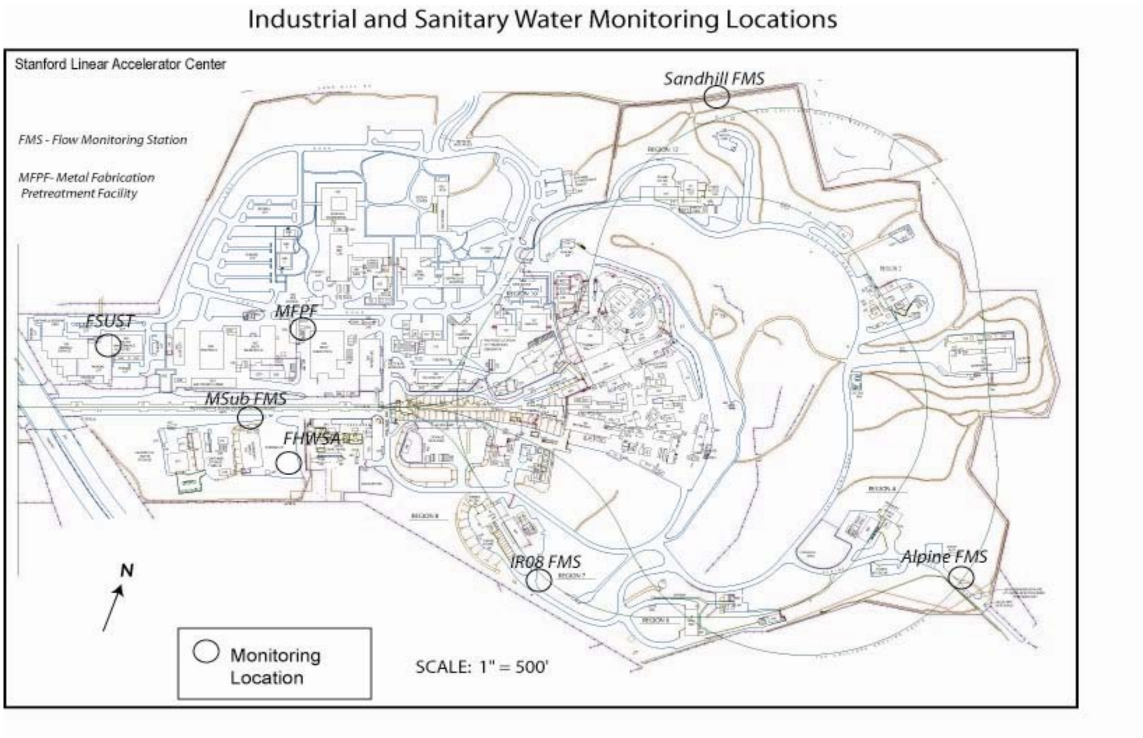


Figure 4-3 Industrial and Sanitary Wastewater Monitoring Locations

4.3.2 Program Status

4.3.2.1 Annual Facility Enforcement Inspection

The SBSA conducted an annual inspection of SLAC on July 29, 2005, with a follow-up meeting on August 19, 2005. Discussion topics during the inspection focused on the proposed modifications to the sanitary

Erler & Kalinowski, Inc, *Groundwater Discharge Self Monitoring Report, 1st Quarter 2005, Discretionary Groundwater Discharge Permit No. GW WB 082201* (April 14, 2005, submitted to SBSA)

———, *Groundwater Discharge Self Monitoring Report, 2nd Quarter 2005, Discretionary Groundwater Discharge Permit No. GW WB 082201* (July 13, 2005, submitted to SBSA)

———, *Groundwater Discharge Self Monitoring Report, 3rd Quarter 2005, Discretionary Groundwater Discharge Permit No. GW WB 082201* (October 13, 2005, submitted to SBSA)

———, *Groundwater Discharge Self Monitoring Report, 4th Quarter 2005, Discretionary Groundwater Discharge Permit No. GW WB 082201* (January 13, 2006, submitted to SBSA)

sewer discharge location as a result of the Safety and Operational Reliability Improvements Project and the implementation of an accidental spill prevention plan, which is part of the industrial waste permit. No NOVs were issued.

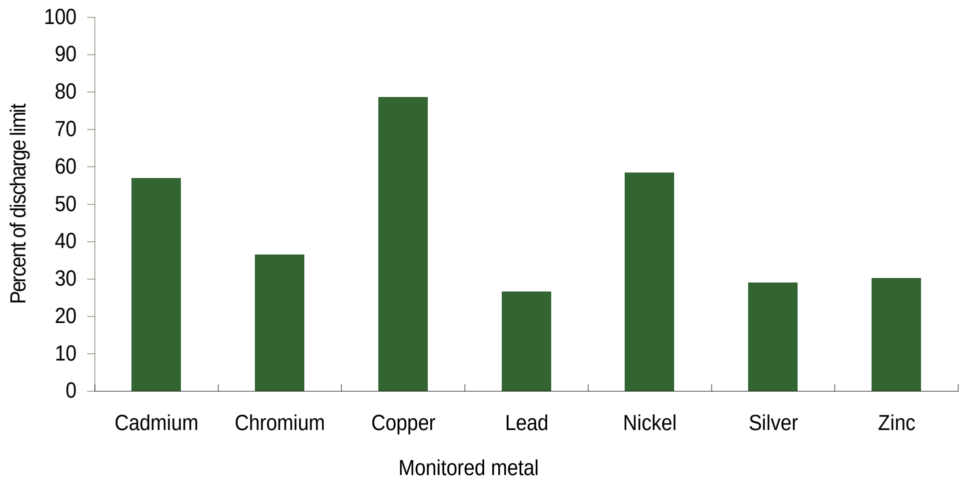
4.3.2.2 Flow Monitoring Results

Total industrial and sanitary wastewater discharge to the WBSD's regional collection system was approximately 23.7 million gallons, which equates to an average of approximately 64,900 gallons per day (gpd). The flow discharge entitlement limit for SLAC is approximately 23.5 million gallons, or 64,400 gpd. Thus, SLAC was approximately 0.8 percent over its facility-wide flow discharge limit in 2005. This was remedied with an increase in entitlement.

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 4-5, along with the discharge limits set forth in SLAC's permits.

SLAC was in compliance with all seven heavy metal limits during 2005. On an annual basis, SLAC discharged from 27 percent (for lead) to 79 percent (for copper) of its permitted discharge limits, as shown in Figure 4-4.



Annual average = calculated average percent of discharge limit from quarterly sampling events

Figure 4-4 Water Quality at the Sand Hill Road Station

Table 4-5 Water Quality at the Sand Hill Road Station

Parameter	January 25, 2005		April 25, 2005		Wastewater Discharge Limits* (ppd)
	SBSA Monitoring Results (mg/L)	SBSA Calculated Results (ppd)	SBSA Monitoring Results (mg/L)	SBSA Calculated Results (ppd)	
Flow (gpd)	94,254	NA	124,565	NA	
Cadmium	<0.0500	<0.039304	<0.0500	<0.051944	0.036
Chromium	<0.1000	<0.078608	<0.1000	<0.103887	0.18
Copper	0.1700	0.133633	0.2000	0.207774	0.13
Lead	<0.1900	<0.149355	<0.1900	<0.197386	0.33
Nickel	<0.1500	<0.117912	<0.0300	<0.031166	0.042
Silver	<0.0150	<0.011971	<0.0150	<0.015583	0.036
Zinc	0.1790	0.140708	0.3050	0.316856	0.45
pH*	8.30	NA	8.30	NA	6.0–12.5
Parameter	August 10, 2005		October 10, 2005		
Flow (gpd)	57,763	NA	57,568	NA	
Cadmium	<0.0100	<0.0048	<0.0100	<0.0048	0.036
Chromium	<0.0200	<0.0096	0.0200	0.0096	0.18
Copper	0.1100	0.0530	0.1300	0.0624	0.13
Lead	<0.0400	<0.0193	<0.0400	<0.0192	0.33
Nickel	<0.0300	<0.0145	0.0700	0.0336	0.042
Silver	0.0070	0.0034	0.0100	0.0048	0.036
Zinc	0.1710	0.0824	0.1610	0.0773	0.45
pH*	8.10	NA	8.20	NA	6.0–12.5

NA = not appllicable

ppd = pounds per day

gpd = gallons per day

1 Calculated Results in lb/day = (gal/day)(mg/l pollutant)(8.34 lb/gal)(10E-6 l/mg)

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

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

The analytical results for water quality samples collected at the MFPF are presented in Table 4-6, along with the discharge limits set forth in SLAC's permits. SLAC was in compliance with all seven heavy metal limits and the cyanide limit on all three sampling dates.

Table 4-6 Water Quality at the Metal Finishing Pre-treatment Facility

			SBSA-Initiated Annual Sampling	SLAC-Initiated Semi-Annual Sampling	
	Discharge Limits		August 10	March 28	October 11
Analytical Parameter	Federal Daily Maximum (mg/L)	Federal Monthly Average (mg/L)	SBSA Monitoring Results (mg/L)	SLAC Monitoring Results (mg/L)	SLAC Monitoring Results (mg/L)
Metals					
Cadmium	0.69	0.26	<0.01	<0.0010	<0.010
Chromium	2.77	1.71	0.080	<0.040	<0.040
Copper	3.38	2.07	1.600	0.1390	0.2500
Lead	0.69	0.43	<0.04	<0.040	<0.040
Nickel	3.98	2.38	0.960	0.0790	0.1300
Silver	0.43	0.24	0.037	<0.0010	<0.010
Zinc	2.61	1.48	0.102	<0.030	<0.030
Non-metals					
Cyanide	1.20	0.65	0.0033	<0.0050	0.040
pH (unitless)	6.0–12.5	NA	8.90	9.22	9.02

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

2 Former Total Toxic Organics (TTO) monitoring requirement was superseded by implementation of SLAC's Solvent Management Plan, which was originally submitted to SBSA on July 31, 2001

3 NA = not applicable

4.3.2.4 Best Management Practices Implementation Results

The Industrial Wastewater Program started initiating best management practices (BMPs) in 2004 to reduce discharge of constituents of concern to the sanitary sewer. The following were accomplished in 2005 as part of this effort:

- A quarterly sampling program for the basin water at Cooling Tower 1701 is used to evaluate the effectiveness of the containment water treatment system. This unit primarily treats rainwater that accumulates in electrical vaults and transformer containments. The treated water is then used as make-up water in Cooling Tower 1701. The sampling confirmed the unit's effectiveness. PCBs have not been detected. A summary of the results are summarized below in Table 4-7.
- The PEP II tunnel continues to be cleaned in a manner to minimize water use, thus allowing for the bagging of solids for disposal instead of solids flowing into the tunnel gutter and discharging to the sanitary sewer. Approximately 800 lbs of solids have been diverted from the sanitary sewer annually.
- As a result of analyzing mop water from the High Bay in Building 44 for metals and PCBs approximately 50 gallons of mop/spill water have been diverted from the sanitary sewer annually.

- Two new guidelines have been posted on the web describing BMPs that are protective to the sanitary sewer for Machine and Craft shops and Wet laboratories.[17]
- The flushing of copper piping as part of new building construction is now being staggered to reduce daily copper loading to the sanitary sewer.

Table 4-7 Cooling Tower 1701 Basin Results

Sample ID	IW-CT05-1	IW-CT05-2	IW-CT05-3
Date	3/28/2005	6/17/2005	9/19/2005
PCB (mg/L)	<0.00020	<0.00020	<0.00020
Diesel (mg/L)	< 0.050	< 0.050	< 0.050
Motor Oil (mg/L)	< 0.050	< 0.050	< 0.050
Mineral Oil (mg/L)	< 0.050	< 0.050	< 0.050
Total Dissolved Solids (mg/L)	1400	1700	1500

4.3.3 Summary and Future Plans

SLAC discharges industrial and sanitary wastewater to the WBSD regional sewer collection system. These discharges originate from manufacturing locations such as SLAC's Plating Shop, heat exchange systems such as SLAC's six major cooling tower installations, and employee toilets and sinks throughout the facility.

SLAC operates its industrial and sanitary wastewater management program in compliance with established permit conditions. In 2005, SLAC operated the program for the ninth consecutive year without receiving any NOVs from program regulators. SLAC is in the process of combining the multiple permits into one site-wide permit that will include flows to both the Sand Hill and Alpine trunk lines and incorporate the groundwater treatment systems and MFPF as sub-discharges. This permit consolidation will allow SLAC to manage its industrial wastewater in a consistent manner and will better represent discharges to the sanitary sewer. In addition, SLAC plans to install additional flow meters to track flow from the Interaction Region 6 (IR-6) area before discharging to the Alpine trunk line.

4.4 Surface Water Management Program

There are 24 stormwater channels that leave the 426-acre SLAC site. In certain portions of the site, stormwater has the potential to come into contact with industrial activities or facilities before discharge. Such activities or facilities include metal working, outdoor storage, cooling towers, electrical equipment operation, and secondary containments.

Many of the 24 channels drain land still in its natural state, where there is no potential for stormwater to contact industrial activities occurring at the site. Some locations drain developed land or areas where

17 Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection Department, "Industrial Water", http://www-group.slac.stanford.edu/esh/groups/ep/water/industrial/

stormwater can potentially come into contact with industrial activities, but the characteristics of the drainage is similar to monitored locations. Therefore, the focus of SLAC's surface water management program is on the remaining seven locations, listed below and shown in Figure 4-5.

1. IR-8 Channel (IR-8)
2. IR-6 Channel (IR-6)
3. North Adit East Channel (NAE)
4. Main Gate East Channel (MGE)
5. IR-2 North Channel (IR-2)
6. Building 81 North Channel (B81)
7. 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, and specifies how it adheres to requirements through its stormwater pollution prevention plan (SWPPP).[18] The SWPPP has two main components: a stormwater monitoring program (SWMP) and a BMPs program.[19] The SWMP presents the rationale for sampling, lists the sampling locations, and specifies the analyses to be performed. The BMPs present a list of 13 generic and site-specific practices that serve to minimize the impact on stormwater from SLAC's industrial activities (see Section 4.4.2.3).

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

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

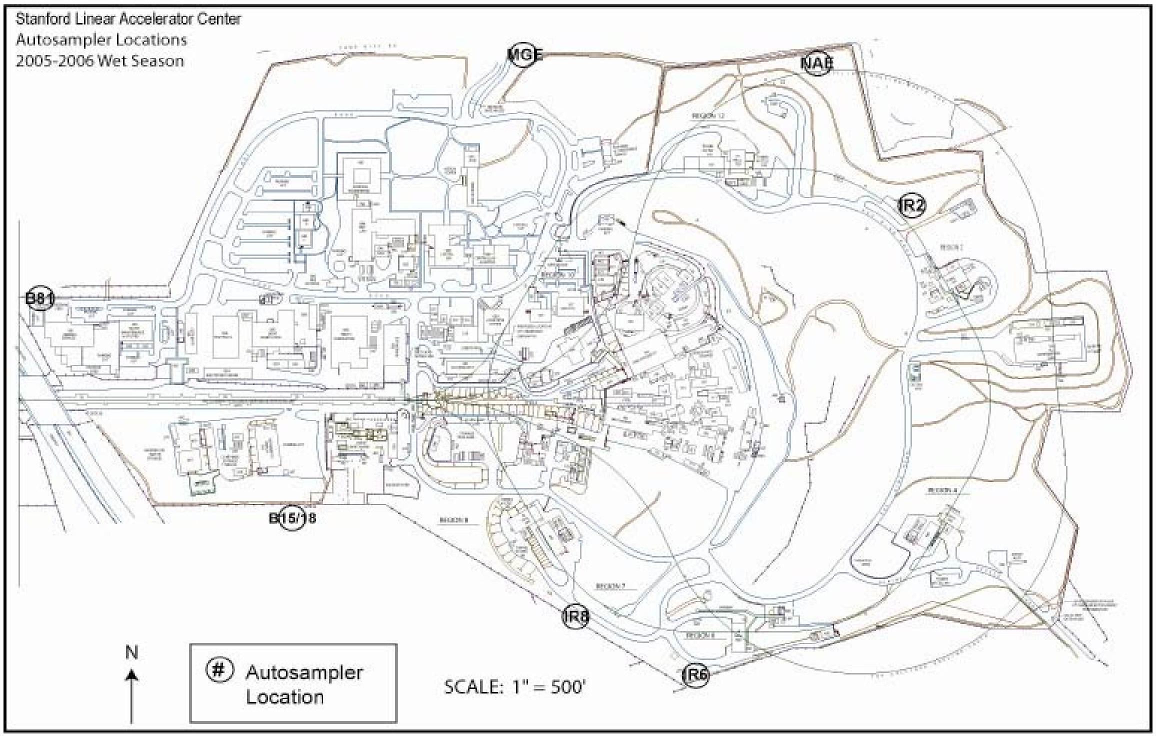

Figure 4-5 Surface Water Monitoring Locations

4.4.2 Program Status

4.4.2.1 Annual Facility Enforcement Inspection

Neither the Environmental Health Division of the San Mateo County Health Services Agency (SMCHSA), nor the RWQCB conducted an inspection of SLAC's surface water protection program this year.

4.4.2.2 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 12 metal and nine non-metal analytes), and methodologies.

The general permit's definition of wet season runs from October 1 through May 30. 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 2005 water quality monitoring results published in the ASER are for the 2005–2006 wet season (that is, the last three months of 2005 and the first five months of 2006).

The general permit requires submission of an annual report on stormwater activities by July 1, following the May 30 close of the wet season.[20] SLAC met all sampling and analysis requirements in its SWMP and delivered its annual report, which includes all water quality monitoring results, to the RWQCB.

Automated samplers are located at each of the stormwater monitoring sites. The samplers are triggered by rain gauges and level sensors. Though this allows for monitoring of storm events that occur during off-hours, the sensors are not always reliable, thus, three storm events that occurred during off-hours activated only some of the samplers. The remaining sample locations had to be sampled during storm events that occurred during facility operating hours.

Stormwater samples were collected at seven locations and analyzed for as many as 14 parameters. Many of the parameters that SLAC monitors have parameter benchmark values (PBVs) established by the SWRCB.[21] Note that PBVs represent a threshold at which BMPs should be re-evaluated for effectiveness, not numerical discharge limits.

If a facility's stormwater monitoring results are entirely below the PBVs, by law the facility operator is entitled to a reduction in stormwater monitoring frequency. Thus, a comparison of SLAC's observed stormwater monitoring results against the PBVs is used to assess the overall effectiveness of SLAC's stormwater management program.

Table 4-8 summarizes the results and compares them to the PBVs. The majority of the analytical results (77 percent) were below the PBVs. Analytes that exceeded the PBVs were primarily specific conductance, aluminum, iron, zinc and total suspended solids (TSS). In an effort to reduce the metals and TSS levels, SLAC increased the preventative maintenance, including annual site-wide street cleaning, as discussed in the next section.

4.4.2.3 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 2005 included the following:

- Improvements to the SWMP continue through programmatic changes and increased documentation
- Outreach activities which include presentations to various groups at SLAC and articles for SLAC's newsletter
- New BMP training for specific areas
- Increased preventive maintenance schedule for stormwater protection activities including annual site-wide street cleaning
- Infrastructure improvement projects: End Station A/End Station B and salvage yards – to be completed in 2007

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20 Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection Department, *2005–2006 Annual Stormwater Report* (EP 0606-05, 30 June 2006, submitted to Rico Duazo, San Francisco Bay RWQCB)

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

Table 4-8 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	Percent of Results >PBV
Metals							
Aluminum	mg/L	14	14	1.9	0.75	7	50
Chromium	mg/L	1	1	0.0047	NA	NA	NA
Copper	mg/L	14	14	0.056	0.0636(H)	0	0
Iron	mg/L	14	14	3.9	1	7	50
Lead	mg/L	14	14	0.033	0.0816(H)	0	0
Manganese	mg/L	1	1	0.13	1	0	0
Zinc	mg/L	13	13	0.66	0.117(H)	9	69
Non-Metals							
TSS	mg/L	14	14	470	100	7	50
TOC	mg/L	14	14	74	110	0	0
pH	SU	14	14	7.9	6-9	0	0
Turbidity	NTU	14	14	260	NA	NA	NA
SC	µs	14	14	3200	200	12	86
PCBs	mg/L	14	1	0.00043	0.000477	0	0
Radioactivity	pCi/L	14	0	ND(2)	NA	NA	NA
Total		169	142			42	33(3)

Notes:

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 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.

2 The analyte was not detected in any of the samples for which it was analyzed.

3 Determined by the total number of results greater than PBVs for those analytes for which PBVs are available.

NA = Not available

ND = Not detected

4.4.3 Summary and Future Plans

SLAC discharges stormwater with the potential to come into contact with industrial activities. An extensive monitoring program is in place at the seven discharge locations where past sampling results indicate the greatest potential exists for industrial contact. During the 2005–2006 wet season, SLAC met all requirements of its monitoring plan.

In 2005, SLAC operated its surface water program for the thirteenth consecutive year without receiving any NOVs from program regulators. When analytical results from the 2005–2006 wet season were compared with the PBVs, over 77 percent of all the parameter results were below the benchmarks. SLAC continued to actively pursue several BMP-related performance improvements during the year.

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 H-134a 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

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 the Resource Conservation and Recovery Act (RCRA), the CERCLA, also commonly referred to as Superfund, its successor, the Superfund Amendments and Reauthorization Act (SARA), and the Toxic Substances Control Act (TSCA).

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

In general, the implementing agency for hazardous materials regulation in California is the CUPA. The CUPA is tasked with overseeing SLAC's hazardous materials management programs is the SMCHSA, Environmental Health Division. A CUPA has broad enforcement responsibilities in the following six hazardous material subject areas:

1. Aboveground storage tanks/spill prevention control and countermeasures (AST/SPCC programs)
2. Hazardous materials business plan
3. California Accidental Release Prevention
4. *Uniform Fire Code* (UFC) hazardous materials issues
5. Underground storage tanks (USTs)
6. 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 AST program and its PCBs management program under the TSCA.

4.5.2.1 Annual Facility Enforcement Inspection

The CUPA performed facility-enforcement inspections October 25-26, with a close-out meeting November 8, 2005. The HMBP review resulted in comments on minor changes within the HMBP and noted that the next submittal will utilize uniform documents (Unidocs) and the CMS system. CUPA was particularly impressed with the CMS mapping system being developed, but stressed that this tool must be kept updated to be useful.

4.5.3 Hazardous Materials Business Plan Program

The Emergency Planning and Community-Right-to-Know Act (EPCRA) was passed in 1986 as Title III of the SARA. SARA 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 2005 reporting year, SLAC updated its HMBP and submitted it to the CUPA on April 4, 2006. 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 lbs for solids, and 200 cubic feet for compressed gases) on a building-by-building basis. The plan also includes the SLAC *Consolidated Chemical Contingency Plan*.[22] 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 first year that the HMBP was submitted electronically through the Unidocs system utilizing the maps and chemical information developed as part of the CMS. The plans for the future include utilizing more of the Unidocs functionality and developing additional program elements to ensure the accuracy of the chemical inventory and maps.

4.5.4 Toxics Release Inventory Program

Under Executive Order 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 toxics release inventory (TRI) program. SLAC annually provides the appropriate information to meet these program requirements to the DOE. Submittals go to the DOE SSO, which provides the 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, 2005, in advance of the July 1, 2005, deadline.

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22 SLAC *Consolidated Chemical Contingency Plan* (SLAC-I-730-3A86H-008)

4.5.5 California Accidental Release Prevention Program

SLAC submitted its CalARP registration information to the CUPA on March 3, 1998. The original registration information was amended on May 15, 1998. The net result was that SLAC registered under the CalARP program for the “CalARP Table 3” substances nitric acid and potassium cyanide.

CalARP program regulations for Table 3 substances state that the county is required to make a determination whether a risk management plan (RMP) is required of SLAC for the CalARP-regulated substances SLAC is managing. In August 2004, SLAC received a letter from the CUPA instructing SLAC to update its chemical inventory information to determine whether SLAC had any regulated chemicals in excess of the CalARP thresholds. Only one chemical was found: potassium cyanide, which is used only in the Plating Shop complex.

Accordingly, the CUPA determined that an RMP would be necessary. By law, the CUPA is required to give SLAC a minimum of 12 months, and a maximum of 36, to submit the RMP. SLAC procured a contractor to prepare an RMP. A draft RMP was submitted to SLAC in September 2005. Based on extensive review of this document and evaluation of the scenarios created, SLAC directed its contractor to expand the scope of the document and perform a detailed process hazard assessment (PHA), as well as offsite consequence analysis (OCA), in order to complete the RMP in mid-2006.

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 2005 is presented in Table 4-9. All 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 4-9 Aboveground Petroleum Tanks

Petroleum Product	Property Control Number	Location	Capacity (gallons)
Diesel	20501	B023 Central Utility	10,000
Diesel	20502	B037 Old Boiler Building	3,700
Diesel	19683	B112 Master Substation	2,000
Gas/Diesel	21443	B035 Vehicle Refueling Station	1,500/500
*Mineral Oil	19659	Mobile Transformer Oil Tank	1,000
*Castrol 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
*Mineral Oil	NA	B062 NLC “8-pack”	440
*Mineral Oil	19595	B021 South Damping Ring	260
*Mineral Oil	18902	B044 Klystron Test Lab	250
Diesel	Unmarked	B756 SLD Generator Fueling	250

* These tanks are used only for short-term storage

A spill prevention, control, and countermeasures (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.[23]

SLAC did not have any USTs in operation during 2005. All USTs previously in operation have been removed.

4.5.7 Toxic Substances Control Act Program

The objective of the 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 2005.

At the end of 2005, 101 transformers were in service at SLAC. Transformers with concentrations greater than 50 parts per million (ppm) but less than 500 ppm are defined by TSCA as PCB-contaminated transformers. Of the 101 transformers in service at SLAC, only 12 are PCB-contaminated. SLAC has no PCB transformers (transformers with concentrations of PCB greater than 500 ppm).

The total quantity of PCBs contained in the 101 transformers currently in service is approximately 24 lbs. Two new, non-PCB transformers were acquired during 2005.

4.5.8 Chemical Management System

In 2004, SLAC officially selected Haas tcm as its CMS contractor. Haas has also supported the safe decommissioning of bulk tanks and gas cylinders. This is done by providing electronic cataloguing, ordering, order tracking, data tracking, material safety data sheets management, electronic invoicing, cost reporting, and ES&H reporting to SLAC. Haas provides all sourcing, purchasing, expediting, and Tier 2 vendor management support for all non-radioactive chemicals and gases used by SLAC.

As part of the start-up process, over 90 SLAC users were formally trained in the system in 2005 and the entire SLAC stores chemical inventory was transferred to the Haas hub. Through the streamlining and centralization of the chemical supply chain, SLAC has removed the need to stockpile or order excess chemicals. Users are comfortable ordering only what they need. As a result there are few unused chemicals at SLAC.

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, and municipal solid waste, and scrap metal.

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23 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

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:[24]

- SLAC will reduce its generation of hazardous waste from routine operations by 65 percent by the year 2005, on a graded scale, using 1993 as the baseline year
- SLAC will recycle 50 percent of its municipal solid waste by the year 2005 on a graded scale

4.6.1 Waste Minimization Accomplishments

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

SLAC continues to make progress in reducing hazardous waste generated from routine operations, as shown in Figure 4-6. For 2005, SLAC reduced generation of hazardous waste from routine operations by 69 percent from the 1993 baseline. The goal for FY05 was to achieve a 65 percent reduction in routine hazardous waste relative to the 1993 baseline. SLAC did not generate significant hazardous waste during one quarter of FY05 due to a temporary halting of operations that resulted from a Type A accident. The 69 percent reduction is based on the three quarters of the year corrected for a full year of operation. Without this correction, the hazardous waste reduction would have been 77 percent but would not have reflected a full year of operation.

24 Stanford Linear Accelerator Center, Environment, Safety, and Health Division, “ISEMS: Performance Measures”, http://www-group.slac.stanford.edu/esh/general/isems/perfmeas/

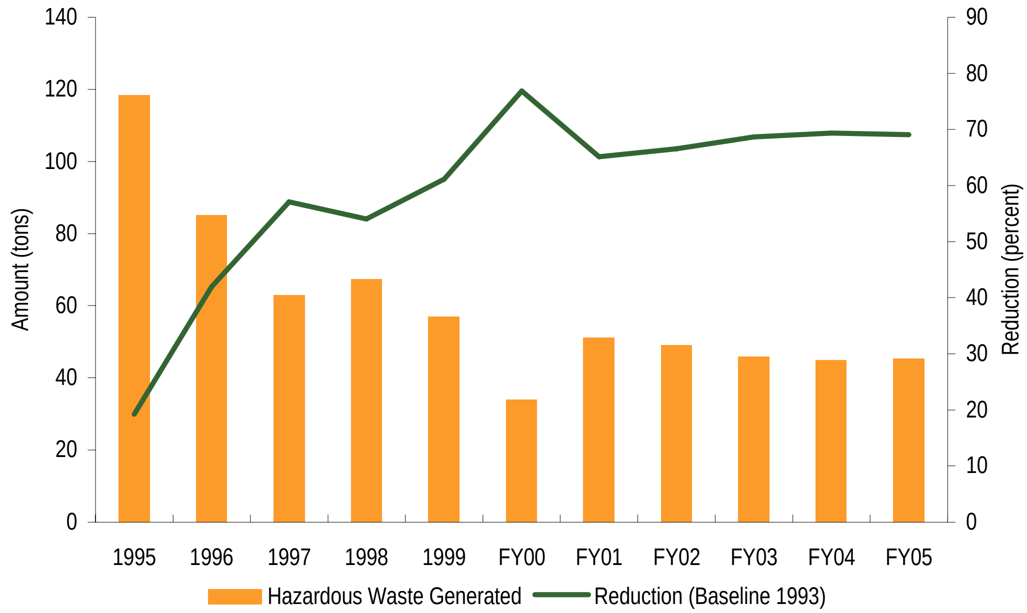

Figure 4-6 Hazardous Waste Generation, 1995–2005

SLAC's progress in recycling its municipal solid waste is shown in Figure 4-7. For 2005, SLAC recycled 52 percent of its municipal solid waste. The goal for FY05 was to achieve 50 percent recycling. The waste generated and percent recycling reflect a full year of operation; these activities were not affected by the Type A accident.

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)
- Trash not otherwise sorted at the source and placed into dumpsters

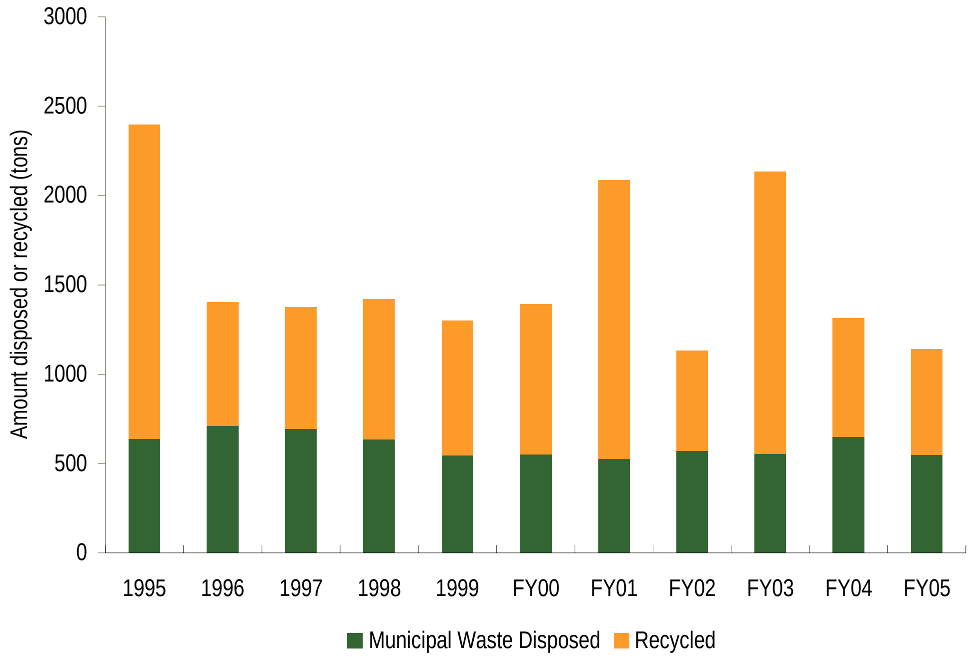

Figure 4-7 Municipal Solid Waste Recycling, 1995–2005

Waste minimization and pollution prevention projects initiated during the last ten years and continuing during 2005 are listed in Table 4-10.

In addition to the projects below, SLAC has been continuing to perform process waste assessments 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:

- Investigated the feasibility of taking waste concrete blocks and creating rubble for reuse in road bed construction projects. When concrete is not associated with radiological control areas, on-site or off-site reuse of concrete rubble for road bed is an attractive option to off-site disposal because of the potential to reduce off-site transportation costs.
- Reviewed SLAC's inventory and generation of electronic waste and investigated options for improved reuse and recycling of waste materials as a measure to ensure there is no misuse of hazardous materials in overseas markets.

4.6.2 Hazardous Waste Management

The RCRA provided cradle-to-grave authority to regulate hazardous wastes, from their generation to their ultimate disposal. Regulation is through a system of record keeping, permitting, monitoring, and reporting.

Table 4-10 Waste Minimization and Pollution Prevention Projects

Name/Description	Year Initiated	Waste Reduction/Pollution Prevention Result
Reduction of plating bath filter usage by more closely monitoring filter pressure drop and performance	1995	Reduced waste by a volume by 16 55-gallon drums per year
Reducing hazardous waste through better waste management – using reuse and on- and off-site recycling measures	1995	Approximately 205 tons of waste disposal avoided from 1997 to 2004
Reducing wastes from spent alkali and acid baths in metal finishing operations by reuse and treatment	1996	1,000 to 5,000 gallons annually
Scrap copper reused in metal finishing operations as plating bath anodes	1996	Reuse varies with production needs
Increased reuse of stock metal through electric discharge machining operations	1996	Improved fabrication technique reduces scrap metal – no quantitative results tracked due to variations in production
PEP II waste reduction promoted through reuse of materials and equipment at SLAC or at off-site facilities	1998	Approximately 1,000 tons of concrete blocks reused at an off-site location
Processing unit to reduce stormwater waste handling by removing PCBs contamination	1999	Approximately 60,000 gallons of stormwater reused in cooling towers annually
Implementation of a site-wide recycling program for paper, cardboard, and beverage cans/bottles	1999	Improved paper and cardboard recycling by over 30 tons per year
Reduction of ferric chloride and filter cake in the treatment of rinse waters from metal finishing operations	2002	As of 2004, SLAC reduced generation of hazardous waste (filter cake) by an average of 49 percent over a three year period relative to 1998 and per gallon of rinse water treated
Off-site recycling program for laser printer and ink jet cartridges	2002	Program for off-site recycling of spent laser printer and ink jet cartridges – recycled 342 cartridges in FY05 and vendor contributed $1 per recycled cartridge to charity
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.

Table 4-10 Waste Minimization and Pollution Prevention Projects (Continued)

Name/Description	Year Initiated	Waste Reduction/Pollution Prevention Result
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.
Chemical Management Service (CMS)	2003	The CMS program is fully implemented. Through streamlining the chemical supply chain has removed the need to order excess chemicals.
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
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

The primary objective of RCRA was to protect human health and the environment. A secondary objective was 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 RCRA program. In turn, the state has delegated its authority for certain aspects of hazardous waste program oversight to CUPAs; the SMCHSA, Environmental Health Division serves as the CUPA tasked with overseeing SLAC's hazardous waste management.

4.6.2.1 Program Status/Annual Facility Enforcement Inspection

SLAC is a hazardous waste generator. SLAC does not have a 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 [TSD] 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 (refer to Section 4.6.2.3 regarding the state-level tiered permit program).

In November 2005, an inspection of SLAC's hazardous waste generation program was conducted by the CUPA. No violations of hazardous waste control regulations were found. The Waste Management Group was cited for a BMP for its implementation of procedures to inspect the trucks and the driver's licensing of the transportation contractor as a measure to ensure safe transport of waste loads.

4.6.2.2 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 and TSCA PCB 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 4-8. Specifically, during FY05, SLAC achieved a 99 percent reduction in its TSCA waste generation compared with a 1990 baseline.

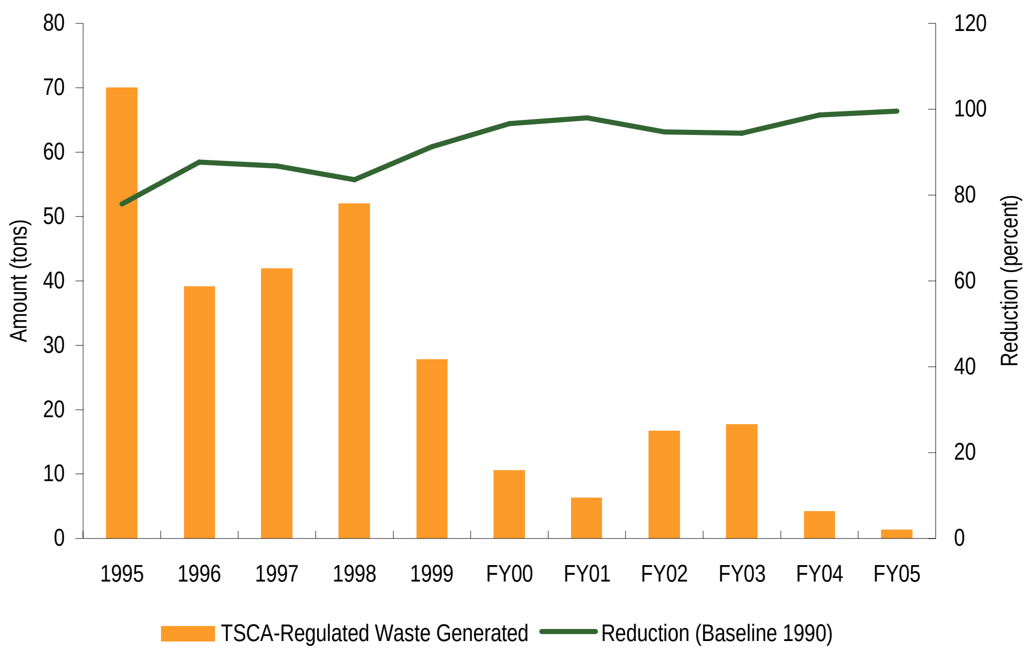

Figure 4-8 TSCA-Regulated Hazardous Waste, 1995–2005

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. 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.

4.6.2.3 Hazardous Waste Treatment: Tiered Permitting Program

The five tiers of California hazardous waste permits, presented in order of decreasing regulation, are called 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 were authorized to treat listed or characteristic hazardous wastes. The various units and tiered permit level are summarized in Table 4-11.

Table 4-11 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

The CUPA last inspected the tiered permitting program at SLAC in November 2005. The program was found to be in compliance, with no violations noted.

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 more clearly demark the treatment operations of the MFPF. SLAC is awaiting 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 called here non-hazardous industrial or regulated waste. SLAC's WM Group manages industrial waste resulting from SLAC's laboratory 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 sent to what are known as 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 CEF 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.

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 dozen green containers. Dumpsters for cardboard collection are strategically place around the site and a specific location is provided for waste wood. Scrap metal 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 4-9.

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 generated by 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.

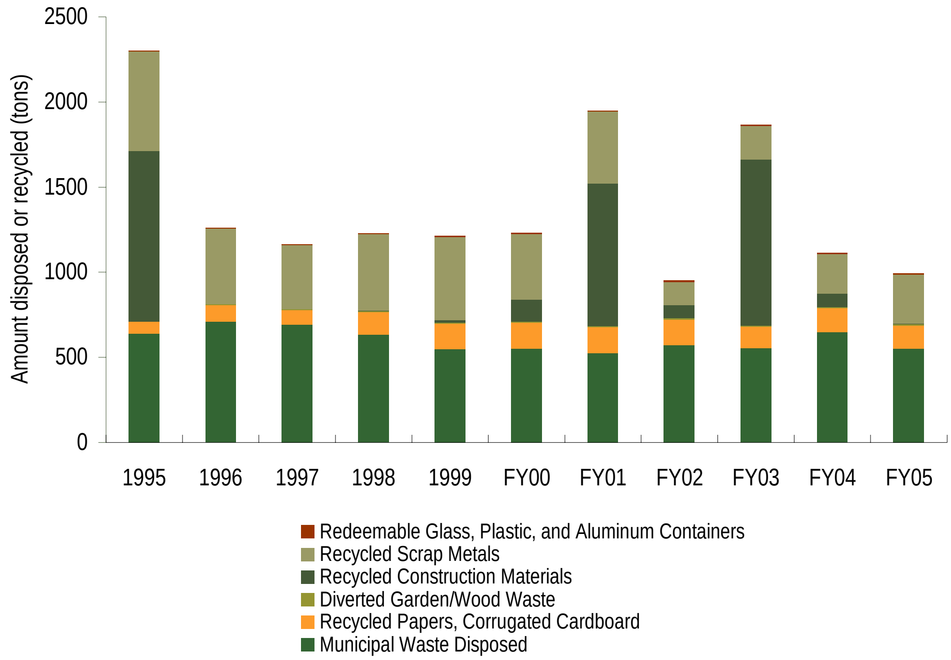

Figure 4-9 Municipal Solid Waste Recycling and Disposal, 1995–2005

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 nearly 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 long-range development plan (LRDP).[25]

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.

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25 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

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
- The visual character of SLAC

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 actions are reviewed to evaluate environmental effects of the federal undertaking including alternatives. If so, 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)

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

SLAC prepared NEPA documentation for five construction projects during 2005, listed in Table 4-12. Since all the projects were relatively minor in scope and environmental impact, all required only the CX documentation. A total of five CXs were prepared to cover all the projects. Completed NEPA documents are forwarded to DOE/SSO for review and approval.

Table 4-12 NEPA Documentation Prepared during 2005

Project Name	Project ID	Project Year	Document ID	Document Type	Date
Storm Drain Improvement & Const. of Covered Parking-Upper Salvage Yard	030114	2006	SS-SC-0503	CX	6/23/2005
Remodeling of Building 751 Mezzanine	5545	2005	SS-SC-0502	CX	6/23/2005
Region 6 Drainage Alpine Road	030115	2006	SS-SC-0504	CX	6/23/2005
Glast Operations Facility-Building 084	5650	2006	SS-SC-0601	CX	10/28/2005
Expansion of the Director's Office	5565	2006	SS-SC-0603	CX	1/5/2006*

* The NEPA was submitted in December 2005 and approved in January 2006.

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 Environmental Radiological 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.

The dose that members of the public receive due to SLAC operations is a small fraction of the dose received from natural background radiation. As in past years, in 2005, 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 linear accelerator at SLAC is encased in a concrete tunnel 25 feet beneath the surface of the ground. Through this underground tunnel, particles are accelerated to nearly the speed of light.

Some 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 radiation that is present whenever particles are accelerated, but that ceases as soon as power to the accelerator is terminated. Direct radiation is mainly due to the secondary photon and neutron radiation emitted when high-energy particles are decelerated.

Both the particles being accelerated and 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 the direct radiation is stopped by the combined shielding on the accelerator structure and the earth that surrounds the accelerator tunnel. SLAC monitors the small fraction of photons and neutrons that pass through the accelerator components, through the surrounding earth, to reach areas outside of the accelerator. This 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 standards (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.[26] In 2005, the maximum dose that could have been received by a member of the public due to direct radiation from SLAC was approximately less than 0.2 mrem (2.0 x 10^{-3} milli Sievert (mSV)), or 0.2 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 2005, SLAC measured direct radiation at 39 locations 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 (DOELAP) and National Voluntary Laboratory Accreditation Program (NVLAP) as a dosimeter supplier, provided and processed the dosimeters. Results from these dosimeters were also used to calculate the collective dose to the population that lives within 80 kilometers (km) (50 miles) of SLAC.

Section 5.8 and Table 5-6 summarize annual doses from both direct radiation and airborne radioactivity 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 2005, the maximum dose that could have been received by a member of the public (business offices in the Portola Valley Training Center on the south east side of SLAC) due to airborne radioactivity from SLAC was 0.04 mrem (4.0 x 10^{-4} mSv), or less than one percent of the 10 mrem regulatory limit.

26 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 that describes the possible sources, types, and quantities of airborne radioactivity released into the atmosphere. [27] As detailed in that report, the released airborne radioactivity was calculated, based on conservative information about accelerator operations in 2005. 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 2005

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)	0.8
Short-lived activation products ($T_{1/2}$ < 3 hr)	Oxygen (^{15}O)	19.6
	Nitrogen (^{13}N)	36.7
	Carbon (^{11}C)	3.9
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		61

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 2005 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 2005, SLAC releases totaled less than 0.03 percent of the applicable limits.

27 Stanford Linear Accelerator Center, Environment, Safety, and Health Division. Radiation Protection Department, *Radionuclide Air Emissions Annual Report – CY2005* (May 2006)

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 drain accelerator cooling systems from time to time. Cooling water, as well as ground- and stormwater that enters the accelerator housing, is disposed of as part of SLAC's industrial wastewater. Thus a small fraction of SLAC's wastewater volume contains radioactivity.

Throughout the year, SLAC sampled and analyzed wastewater at about 30 discharge points. Total activity released during CY05 is summarized in Table 5-3.

Table 5-3 Radioactivity in Wastewater Released in 2005

Category	Radioactive Element	Activity (Ci)	Annual Release Limit (Ci)
Tritium	Hydrogen (^{3}H)	1.4×10^{-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 3H (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 CY1995 through 2005. 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.

Throughout 2005, SLAC reported the results of wastewater monitoring to the SBSA at the end of each calendar quarter.[28]

28 Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Radiation Protection Department, *Radioactivity in Industrial Wastewater for the Period 1 January 2005 to 31 March 2005, ,for the Period 2 April 2005 to 30 June 2005, for the Period 3 July 2005 to 30 September 2005, and for the Period 4 October to 31 December 2005*

Table 5-4 Summary of Radioactivity in SLAC Wastewater, 1995–2005

Year	Radioactive Element	Activity (Ci)	Percentage of Annual Limit
1995	Hydrogen (^{3}H)	1.1 X 10^{-2}	0.2
1996	Hydrogen (^{3}H)	3.4 X 10^{-1}	6.8
1997	Hydrogen (^{3}H)	2.2 X 10^{-2}	0.5
1998	Hydrogen (^{3}H)	7.2 X 10^{-2}	1.4
1999	Hydrogen (^{3}H)	7.1 X 10^{-3}	0.1
2000	Hydrogen (^{3}H)	2.4 X 10^{-3}	0.05
2001	Hydrogen (^{3}H)	2.1 X 10^{-3}	0.04
2002	Hydrogen (^{3}H)	2.4 X 10^{-2}	0.5
	Sodium (^{22}Na)	5.1 X 10^{-5}	1.4*
	Beryllium (^{7}Be)	1.4 X 10^{-2}	
2003	Hydrogen (^{3}H)	4.1 X 10^{-4}	0.008
2004	Hydrogen (^{3}H)	2.0 X 10^{-2}	0.4
2005	Hydrogen (^{3}H)	1.4 X 10^{-3}	0.03

* 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 2005 (and in all previous years), no radioactivity above background was found in any stormwater sample.

SLAC reported the results of the 2005-2006 stormwater monitoring (including checks for radioactivity) to the RWQCB.[29]

5.5.3 Groundwater

Throughout 2005, SLAC analyzed 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. With the exception of the four monitoring wells listed in Table 5-5 below, no radioactivity above natural background was detected in any of the groundwater samples.

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 (20,000 picoCuire/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.

29 Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection Department, *2005–2006 Annual Report for Stormwater Discharges Associated with Industrial Activities* (June 30, 2006, submitted to Rico Duazo, San Francisco Bay RWQCB)

Table 5-5 Summary of Tritium Concentrations Measured in Monitoring Wells in 2005

Period (Month)	Jan to March	April to June	July to Sep	Oct to Dec
Well				
Variable				
EXW-4				
Avg ^3H (pCi/L)	n/a	n/a	4658	3650
% of DWS[1]	n/a	n/a	23	18
No. of Samples	0	0	1	3
MW-30				
^3H (pCi/L)	527	< 500[2]	650	889
% of DWS[1]	3	n/a	3	4
No. of Samples	1	1	1	1
MW-81				
^3H (pCi/L)	1496	1178	1360	1195
% of DWS[1]	7	6	7	6
No. of Samples	1	1	1	1
MW-94				
Avg ^3H (pCi/L)	1942	1229	3250	2804
% of DWS[1]	10	6	16	14
No. of Samples	3	2	2	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 2005

n/a – not available

5.6 Assessment of Radioactivity in Soil

Throughout 2005, SLAC sampled and analyzed soil for projects involving soil excavation on the SLAC site. No soil samples were found to contain radioactivity in excess of natural background near accelerator operations.

5.7 Release of Property Containing Residual Radioactive Material

Throughout 2005, all property, real and personal, exposed to any process that could cause it to become radioactive was 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 also 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 2005: direct radiation and airborne radioactivity. 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 scenario. The reported maximum dose for the MEI, dominated by direct radiation, is based on a person being present 24 hours per day in 2005 at the location near Sand Hill Road, approximately 650 m (2,133 feet) northeast of the intersection of Sand Hill and Whiskey Hill Road.

Table 5-6 compares the 2005 dose results with regulatory limits and natural background. Like previous calculations, the 2005 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.

Table 5-6 Summary of Potential Annual Doses due to SLAC Operations in 2005

	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 2005	0.2 mrem	0.04 mrem	0.25 mrem	0.7 (direct) + 0.2 (air) = 0.9 person-rem
DOE Radiation Protection Standard	100 mrem	10 mrem	100 mrem	n/a
SLAC 2005 Max. Dose as Percentage of DOE Standard	0.2%	0.4%	0.25%	n/a
Dose from Natural Background	100 mrem	200 mrem	300 mrem	1,667,000 person-rem
SLAC 2005 Max. Dose as Percentage of Natural Background	0.2%	0.03%	0.1%	0.0001%

n/a – not applicable

Table 5-7 presents the maximum dose potentially received by a member of the public from direct radiation and airborne radioactivity due to SLAC operations in 1995 through 2005 and compares it with the average dose due to natural background radiation and radioactivity.

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 doses’ 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

Table 5-7 Potential Dose (mrem) to Maximally Exposed Individual, 1996–2005

Year	SLAC Direct and Airborne Radiation	Average, Total Natural Background Radiation	Percentage of Background
1996	4.6	300	1.53
1997	4.2	300	1.40
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

* Starting with the 2003 calculations, the effects of air attenuation (a factor of 40) were taken into account.

5.9.1 Dose to Biota from Direct Radiation

In 2005, 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. Given this monitoring program and the fact that we know animal populations could not have been present except in locations with average dose rates of less than 0.002 rad/day, doses to plant and animal populations at SLAC were well within the limits of the DOE standard throughout 2005.

5.9.2 Dose to Biota from Activation Products

In 2005, 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 2005, but plant and animal populations have no opportunity for access to industrial wastewater at SLAC. Since the radioactive activation concentrations in these monitoring wells 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 2005, no groundwater was found with tritium concentrations in excess of the drinking water standards set by state and federal regulations. Section 5.5.3 summarizes the 2005 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 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 have 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 calendar year 2005, SLAC shipped 1285 cubic feet of LLRW to appropriate treatment and disposal facilities.

6 Groundwater Protection and Environmental Restoration

6.1 Introduction

This chapter describes the groundwater protection and environmental restoration programs at SLAC, in particular the processes for soil and groundwater evaluation used to achieve the Stanford University goal of unrestricted future use of the site.

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.[30] 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. In other words, the groundwater at SLAC is not suitable as a drinking water source because of low flow (as well as high total dissolved solids). In 2001, a report was submitted to the RWQCB requesting exemption for groundwater at SLAC as a potential municipal or domestic supply source, based on criteria specified in state and RWQCB resolutions 88-63 and 89-39, respectively.[31] The request was denied, stating that a basin plan amendment would be required to exempt groundwater from some potential uses.

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

31 Stanford Linear Accelerator Center, *Demonstration that Natural Groundwater Conditions at SLAC Meet Exemption Criteria for Potential Sources of Drinking Water* (SLAC-I-750-A32H-004, October 2001)

6.3 Areas with Potential Impact from Chemicals

A SLAC 1994 report entitled *Summary and Identification of Potentially Contaminated Sites*[32] provides a summary of areas that may have been impacted by chemicals of interest. 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. As other potentially impacted areas were identified, they were incorporated into a master list. These sites were evaluated and ranked based on the need for further investigation.

Based on further investigation, six groundwater sites, sediment in two drainage channels, and a storage area known as the bone yard are being monitored and remediated as necessary. Each of these sites is discussed below.

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 the rest of this chapter, and procedures and requirements to avoid practices that could adversely affect soil and groundwater as discussed in chapters 4 and 5. These procedures include the site's SWPP[33] and SPCC,[34] which discuss BMPs for preventing adverse impacts from spills and operations at SLAC.

6.5 Restoration Activities

SLAC first began to develop a comprehensive environmental restoration program in 1991. 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 2005, SLAC had generally reached the third and fourth steps. Investigative and remediation work proceeded for the impacted sites discussed in this chapter. EP personnel continued investigations for site characterization and evaluation of remedial alternatives during 2005.

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

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

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

SLAC follows 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.

The RWQCB provides oversight and approval of restoration activities that impact surface or groundwater at SLAC. The SMCHSA oversees final confirmation sampling of environmental restoration activities involving remediation of chemically impacted soil.

In May 2005, the RWQCB issued a new board order (No. R2-2005-0022) to 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 numerous 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 site, which is now incorporated into the new board order.

6.6 Groundwater Characterization Monitoring Network

Under the new board order, SLAC has developed a self-monitoring program (SMP) that contains a monitoring schedule for sediment from two drainage channels, surface water, and groundwater. As part of the new SMP, SLAC transitioned from a quarter to a semester monitoring schedule during 2005. The SMP outlines the frequency at which monitoring samples are to be collected and the chemicals of interest they are analyzed for. Work continued in 2005 on installing additional monitoring and extraction wells. Figure 6-1 shows the monitoring network.

SLAC has 126 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 126 wells, 85 wells are used to monitor chemicals of potential concern in six plumes and 28 wells are used as extraction wells for two of the six plumes. The other 13 groundwater monitoring wells are monitored for general site-wide surveillance. The six locations where plume monitoring occurs include the following:

1. Former Hazardous Waste Storage Area (FHWSA)
2. Former Solvent Underground Storage Tank (FSUST) site
3. Test Lab and Central Lab areas
4. Plating Shop area
5. Lower Salvage Yard
6. Beam Dump East

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

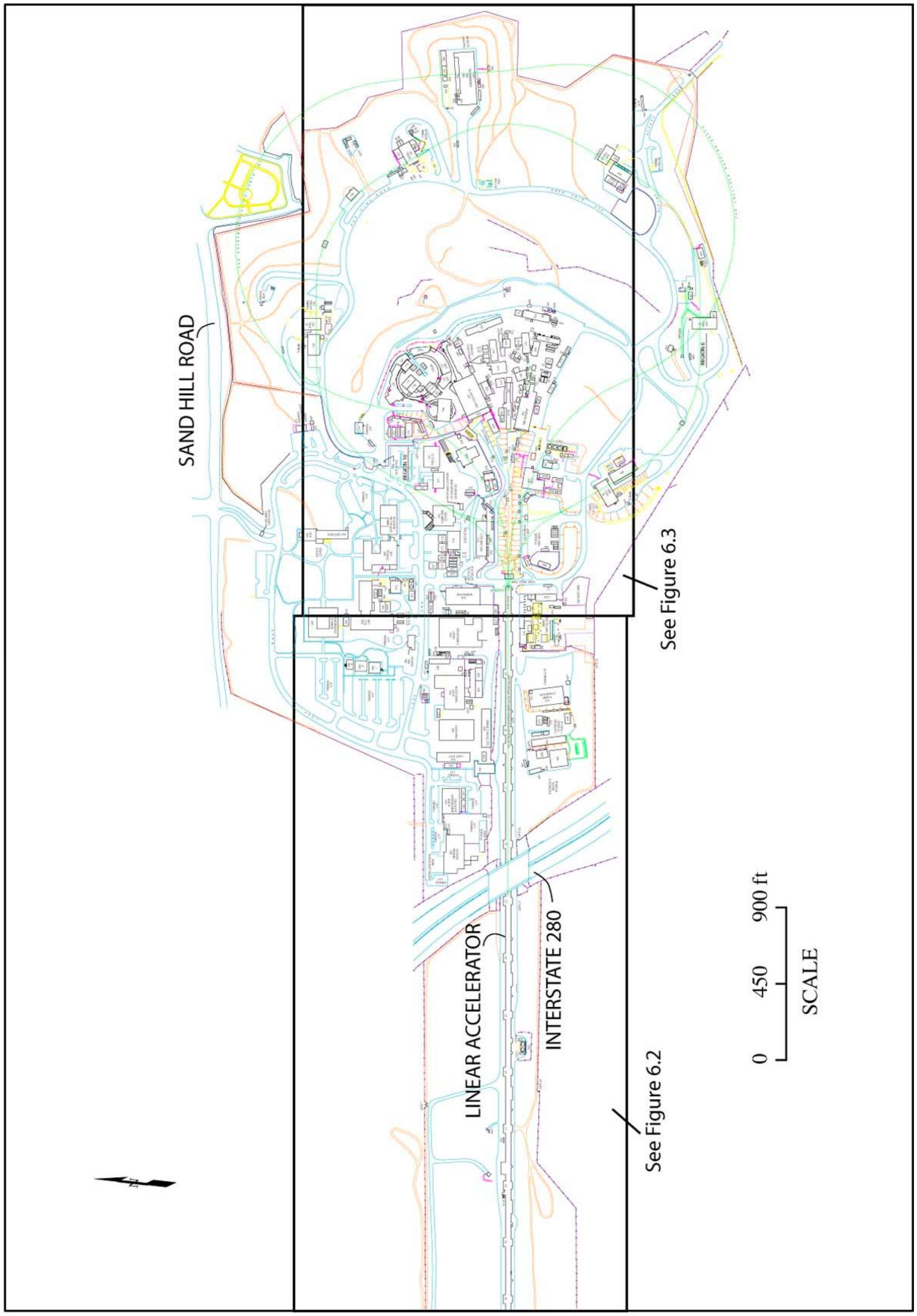

Figure 6-1 Groundwater Characterization Monitoring Network

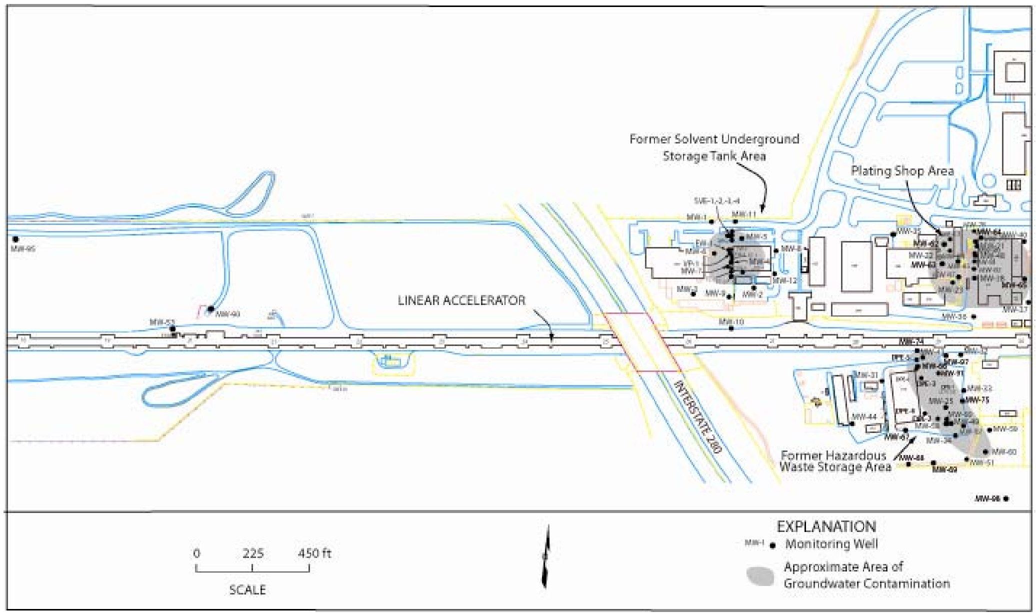

Figure 6-2 Westside Groundwater Network and Impacted Areas

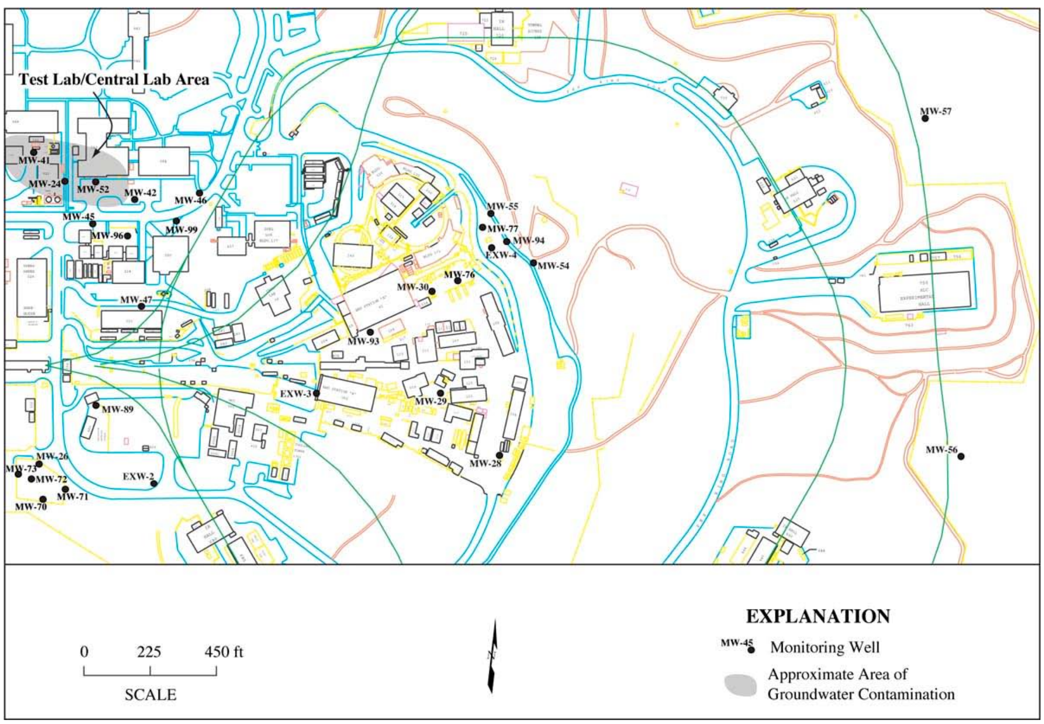

Figure 6-3 Eastside Groundwater Network and Impacted Areas

Table 6-1 Monitoring Locations and Number of Wells

Location	Number
Plume Monitoring	
Beam Dump East	6
Former Hazardous Waste Storage Area	22*
Former Solvent Underground Storage Tank	22
Lower Salvage Yard	5
Plating Shop	21
Test Lab and Central Lab	9
Subtotal	85
Extraction	
Former Solvent Underground Storage Tank	5
Former Hazardous Waste Storage Area	23*
Subtotal	28
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	126

* Four monitoring wells are now listed as extraction wells because they were converted in 2005

Groundwater samples were collected at least once from 113 wells in 2005 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 2005[35] and the summer of 2005.[36] The groundwater analytical results were generally within each well's historic range of concentrations. Samples were analyzed for one or more of the following:

- Total petroleum hydrocarbons (TPH)
- Metals
- Polychlorinated biphenyls

35 Stanford Linear Accelerator Center, *Semi-annual Self-Monitoring Report, Winter 2005* (EP 0503-01, March 2005)

36 ———, *Semi-annual Self-Monitoring Report, Summer 2005* (SLAC-I-750-2A15H-015, December 2005)

- Total dissolved solids (TDS)
- General minerals
- Tritium
- VOCs and semi-volatile organic compounds (SVOCs)

6.7 Groundwater 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. All samples are submitted to an analytical laboratory certified by the California Department of Health Services.

6.7.1 Former Solvent Underground Storage Tank

A groundwater monitoring network is located in proximity to the SLAC Plant Maintenance building in the northwestern portion of the main SLAC campus (see Figure 6-2). This network consists of 22 wells used to monitor the migration of chemical constituents associated with the FSUST site. 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 five extraction wells were subsequently installed, and groundwater has been monitored for VOCs and SVOCs.

The 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. [37] The selected 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. The system was constructed for testing the effectiveness of a five-well extraction system for achieving hydraulic control of the small area of chemically-impacted groundwater. Chemicals of interest in groundwater in the FSUST area include VOCs and SVOCs. SLAC has submitted to the RWQCB the Interim Groundwater Extraction and Treatment Implementation Report and Monitoring Plan for the FSUST Area.[38]

Since the start up of the groundwater extraction system in August 2001, 367,000 gallons of water have been extracted and treated, resulting in the removal of 263 lbs of VOCs and SVOCs. 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.

6.7.2 Former Hazardous Waste Storage Area

The FHWSA was in use from approximately 1973 to 1982. During closure of the FHWSA, PCBs were found in shallow soils. As a result, several inches of topsoil were removed. A monitoring well was installed

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

38 Stanford Linear Accelerator Center, *Interim Groundwater Extraction and Treatment Implementation Report and Monitoring Plan for the Former Solvent Underground Storage Tank Area* (SLAC-I-750-3A33H-016, October 2004)

in this area in 1990, and VOCs were detected in the groundwater. Since then, two soil gas surveys have been performed; and, 22 monitoring wells, 23 extraction wells, and more than 50 soil borings have been installed at this site. Figure 6-2 shows the limited extent of VOCs in the groundwater.

In 2002, a dual-phase groundwater/soil vapor extraction (DPE) pilot test proved promising to treat impacted soil, soil vapor, 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 has been in continuous operation since January 20, 2004. Since that date, a total of 50,100 gallons of water have been extracted and treatment of soil vapor has resulted in the removal of approximately 20 lbs of VOCs. The design of a full scale DPE system for the FHWSA was finalized in 2004.[39] Construction of the full scale system, which will utilize 23 extraction wells, began in June 2005 and is anticipated to be completed in early 2006.

6.7.3 Plating Shop

In 1990, three monitoring wells were installed down-gradient of the Plating Shop. Constituents 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 21 groundwater monitoring wells are currently located at the Plating Shop Area. Groundwater sampling results indicate that chemicals are present in groundwater within three co-mingled plumes. In support of further investigation efforts, a total of 13 soil vapor probes were installed at the Plating Shop Area in December 2004, and the probes were sampled in January and February 2005. The draft site characterization report for the Plating Shop Area was submitted to the RWQCB in December 2003. No comments have been received from the RWQCB regarding the draft site characterization report.[40] A draft remedial alternatives evaluation report[41] has been prepared which recommended soil vapor and groundwater extraction followed by treatment.

6.7.4 Test Lab and Central Lab

A monitoring well was installed between the Test Lab and Central Lab in 1990 at the site of a former, leaking, diesel pump spigot. Chemically impacted soil was removed and the 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.

Data from a soil gas survey, soil borings and additional monitoring wells installed in the Test Lab and Central Lab area helped delineate the sources of contamination. Results of the investigation indicated three possible source areas for VOCs, including one adjacent to the Test Laboratory, and two adjacent to the Central Laboratory. A new perimeter well was installed in August 2005 to monitor the groundwater quality down-gradient of a well which reported the presence of VOCs for the first time in 2001.

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

40 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)

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

Results of the investigative work at the Test Lab and Central Lab area were detailed in the site characterization report for the Test Lab and Central Lab area, which the RWQCB approved in 2002.[42] An evaluation of remedial alternatives report was also prepared for the Test Lab and Central Lab Area and submitted to the RWQCB in 2002.[43] In April 2003, the RWQCB provided comments to the remedial alternatives evaluation report. SLAC responded to the comments in July 2003. The RWQCB approved proceeding with the finalization of the report in September 2004.

6.7.5 Beam Dump East

Beam Dump East is an area in which the high-power electron beam is terminated during experiments in End Station A. Groundwater in the immediate vicinity of Beam Dump East contains tritium at levels within those acceptable for drinking water. The groundwater is monitored in six wells at least two times per year. In 2005, as in previous years, the monitoring indicates that the tritium is localized to two wells in the area of the beam dump.

6.7.6 Lower Salvage Yard

As discussed below in Section 6.8.1 historically, there have been minor detected petroleum hydrocarbons and VOCs have been detected in wells at the Lower Salvage Yard. This site is discussed further below.

6.8 Soil Site Description and Results

In addition to the groundwater sites discussed above, SLAC is also investigating soil sites which have been impacted by chemicals of interest, primarily PCBs, lead and TPH. These sites are discussed below. In one area, the Interaction Region (IR)-6 and IR-8 drainage channels, sediment in drainage channels have been impacted with chemicals of interest and work continues to investigate these areas. At the LSY, the groundwater continues to be monitored and additional soil removal is planned.

6.8.1 Lower Salvage Yard

The LSY has been used for storage of salvaged equipment, including those that are oil-filled, as well as materials such as scrap metal. Prior to its use as a salvage yard, the first SLAC substation occupied part of the area.

Site characterization data indicated several chemicals of interest including PCBs and petroleum hydrocarbons were present above cleanup levels. Thus a removal action was initiated in 1999. A total of 3,114 tons of material were excavated from the yard to achieve the clean-up goal of 1 ppm PCBs, but PCBs above the clean-up goal remained in the side walls of the excavation. Accordingly, additional excavation is planned for the future.

The five monitoring wells at the LSY were sampled in 2005. No chemicals were reported in any of the samples collected.

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42 Stanford Linear Accelerator Center, Environment, Safety, and Health Division, *Test Laboratory and Central Laboratory Site Characterization Report* (SLAC-I-750-3A-33H-009, July 2002)

43 Erler & Kalinowski, Inc, *Draft Evaluation of Remedial Alternatives for the Test Laboratory and Central Laboratory Area* (July 2002)

6.8.2 IR-6 and IR-8 Drainage Channels

Much of SLAC's stormwater runoff is conveyed by the IR-6 and IR-8 drainage channels, which ultimately discharge into San Francisquito Creek. Surface water runoff from the Research Yard drains into the man-made IR-6 drainage channel partially located off site. IR-8, also primarily located off site, is a natural ephemeral drainage that was engineered during SLAC construction to accept groundwater from the accelerator and PEP sub-drainage systems and surface water runoff from the campus area at SLAC.

PCBs and lead were first found in the off-site portions of the IR-6 and IR-8 drainages in 1990. An investigation to further characterize the extent of PCBs and lead was performed and included a 2.5-mile segment of San Francisquito Creek. No PCBs were detected in the creek samples. In 1995, the removal and off-site disposal of PCB and lead impacted sediments from the IR-6 drainage channel and its upstream stormwater catch basins were performed.

In 1996, it was found that sediments with PCBs were still entering the IR-6 drainage channel. Since 1996, additional investigations and remedial work have been completed to identify and remove additional potential upstream sources of PCBs and lead.

Sediments in the IR-6 and IR-8 drainage channels and off-site downstream reaches have been monitored annually since 1998. The annual collection of sediment samples shows that despite remediation efforts, PCBs persist in sediments entering the IR-6 and IR-8 channels' drainages, although at levels significantly lower than historic concentrations.

A number of projects have been completed since 2004 as a follow up to detections of low levels of PCBs and lead found in a drainage channel located downstream of the IR-6 and IR-8 drainage channels, off of the SLAC leasehold boundary. As a result, SLAC completed an extensive field investigation study. The results of the field investigation showed that PCBs and metals associated with a plastic, recycled wire groundcover used by the adjacent leasehold, contributed to the detections found in the drainage. SLAC's contribution to the PCB detections in the channel, if any, could not be established.

6.8.3 Bone Yard and Related Projects

The Bone Yard is an undeveloped outdoor storage area located between the linac and the north access perimeter road, at Sectors 12 and 13 of the linac. It has been in use since 1964, and used for the storage of concrete blocks of all sizes, large iron ingots, steel sheeting and other pieces of iron/steel scrap metal originally used in radiation shielding applications as part of high-energy experiments at SLAC since 1966. Lead, in the form of lead wool, wire and shot, was historically placed between the concrete blocks to provide additional radiation shielding. Bundles of steel rods known as *bullet stock* was another type of shielding historically used to reduce beam energy during experiments and had also been stored for many years at the Bone Yard. The steel rods are approximately 0.35 inches in diameter and 12 feet long, and typically held together by wire in bundles of 15 or more. Interspersed within these bundled steel rods were lead wire and lead shot.

Approximately 3,100 bundles of these steel rods had been placed in the Bone Yard in the early 1970's, stored in about 50 steel racks covering an area of about 4,800 square feet. In September 2005, each bundle of the lead-impacted steel rods was opened, and individually cleaned to remove the lead, then shipped off-site to be recycled as scrap metal. A small number of the steel rods (about 1,000) were found to be slightly radioactive. The radioactive rods were disposed of as radioactive waste. To remove lead fragments that had fallen from the bundles of rods, the underlying soil and asphalt were vacuumed and the top 1 to 2 inches of soil was excavated following removal of the lead-impacted rods. Approximately 20 cubic yards of surface soil was removed and shipped off-site as Non-RCRA Hazardous Waste. The lead fragments and other debris associated with the work were disposed of as hazardous waste.

In October 2005, a small number of bullet stock bundles located at two other locations at SLAC were handled in the same manner. Six racks and two wooden crates containing bundles of bullet stock were cleaned at SLAC's Radioactive Material Storage Yard, and two racks plus a wooden pallet of bullet stock were cleaned at IR-4. In addition, the pavement at two locations in the Research Yard where bullet stock was known to have previously been located was also cleaned with a HEPA vacuum to remove pencil lead and lead shot.

6.8.4 Excavation Clearance Program

During 2005, the excavation clearance program continued to support SLAC-wide projects to ensure proper disposal of excavated soil. An excavation clearance permit must be completed for activities that involve excavation or relocation of soil at SLAC. The form is intended to reduce worker exposure to hazards associated with excavation work at SLAC, including underground utility lines, chemical contamination, and radiological hazards and ensure proper management and disposal of excavated materials. More than 44 projects were supported by this program during 2005.

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