ES&H Division
SLAC-R-986

Annual Site Environmental Report: 2011

September 2012

Prepared for the Department of Energy under contract number DE-AC02-76-SF00515

SLAC National Accelerator Laboratory, Stanford University, Stanford, CA 94309

NATIONAL ACCELERATOR LABORATORY

U.S. DEPARTMENT OF ENERGY | Office of Science

SLAC Site Office
SLAC National Accelerator Laboratory
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September 20, 2012

Subject: 2011 Annual Site Environmental Report (ASER) for the SLAC National Accelerator Laboratory

This report, prepared by the SLAC National Accelerator Laboratory (SLAC) for the U.S. Department of Energy (DOE), SLAC Site Office (SSO), provides a comprehensive summary of the environmental program activities at SLAC for calendar year 2011. 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 2011 environmental monitoring, compliance, and restoration programs at SLAC. This assurance can be made based on SSO and SLAC review of the ASER, and quality assurance protocols applied to monitoring and data analyses at SLAC.

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

Sincerely,

SIGNATURE ON FILE

Paul Golan
Site Manager
SLAC Site Office

Disclaimer

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Preface

To satisfy the requirements of the United States Department of Energy Order 231.1, "*Environment, Safety and Health Reporting*", the Environment, Safety, and Health Division of the SLAC National Accelerator Laboratory prepares an annual report describing its environmental programs and activities.

This *Annual Site Environmental Report: 2011* summarizes the SLAC National Accelerator Laboratory 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 SLAC National Accelerator Laboratory and the activities conducted at the site

Chapter 2, "Environmental Compliance", gives an account of the regulatory framework and results concerning the site's environmental programs

Chapter 3, "Management Systems", outlines the organizational structure, methods, and responsibilities relevant to environmental programs

Chapters 4, 5, and 6, respectively "Environmental Non-radiological Programs", "Environmental Radiological Programs", and "Groundwater Protection and Environmental Restoration", give more detailed accounts of the programs and their results for the year

An executive summary provides an overview of the report.

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Editing and Publishing

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

Acronyms

^{3}H	tritium
AB	Assembly Bill
ASER	Annual Site Environmental Report
ASTs	aboveground storage tanks
BAAQMD	Bay Area Air Quality Management District
BaBar	SLAC B-Factory detector
BDE	beam dump east
BMP	best management practice
CalARP	California Accidental Release Prevention Program
CARB	California Air Resources Board
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CHWMA	chemical hazardous waste management area
Ci	curie
CMS	chemical management system
C&D	construction and demolition
COPC	chemicals of potential concern
CUPA	certified unified program agency
CWA	Clean Water Act
CY	calendar year
CX	categorical exclusion
DOE	United States Department of Energy
DPE	dual-phase extraction
DWS	drinking water standard
E85	blend of fuel where 85 percent is ethanol and 15 percent is gasoline
EA	environmental assessment
EBR	Environmental Baseline Report
EDE	effective dose equivalent
EIS	environmental impact statement
EM	environmental management

EMP	environmental management program
EMS	environmental management system
EO	Executive Order
EP	Environmental Protection Department
EPCRA	Emergency Planning and Community-Right-to-Know Act
ERT	emergency response team
ES&H	environment, safety, and health
FHWSA	former hazardous waste storage area
FMS	flow metering station
FACET	Facility for Advanced aCcelerator Experimental Tests
FS	Feasibility Study
FSUST	former solvent underground storage tank area
FY	fiscal year
GDF	gasoline dispensing facility
GHG	greenhouse gas
gpd	gallons per day
HAPs	hazardous air pollutants
Haas	Haas Group International
HPSB	high performance and sustainable building
HMBP	hazardous materials business plan
IAS	Integrated Assessment Schedule
IDPE	interim dual-phase extraction
IR	interaction region
INL	Idaho National Laboratory
ISEMS	integrated safety and environmental management system
ISM	integrated safety management
ISO	International Organization for Standardization
JRBP	Jasper Ridge Biological Preserve
km	kilometer
L	liter
lbs	pounds
LEED	Leadership in Energy and Environmental Design
linac	linear accelerator
LCLS	Linac Coherent Light Source

LLRW	low-level radioactive waste
LRDP	long-range development plan
LSY	lower salvage yard
M&O	management and operating
MAPEP	mixed-analyte performance evaluation program
MEI	maximally exposed individual
MFPF	metal finishing pre-treatment facility
MGE	main gate east channel
MPMWD	Menlo Park Municipal Water Department
MPR	monitoring plan report
mrem	millirem
mSv	milli-Sievert
na	not applicable
NAE	north adit east channel
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
OU	operable unit
PAFD	Palo Alto Fire Department
PBR	permit by rule
PBVs	parameter benchmark values
PCB	polychlorinated biphenyl
PCGs	Preliminary Cleanup Goals
pCi/L	picoCuries per liter
PEP	Positron-Electron Project
ppm	parts per million
PRGs	preliminary remediation goals
PSA	plating shop area
QA	quality assurance
QC	quality control
RA	risk assessment report
rad	unit used to quantify radiation exposure
RAP	remedial action plan
REP	Radiological Environmental Protection
RCRA	Resource Conservation and Recovery Act

RD	remedial design report
RI	remedial investigation
RM	requirements management
RMP	risk management plan
RP	Radiation Protection Department
RPFO	Radiological Protection Field Operations Group
RWQCB	Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act
SBSA	South Bayside System Authority
SLAC	SLAC National Accelerator Laboratory
SME	subject matter expert
SMOP	synthetic minor operating permit
SMP	self-monitoring program
SPCC	spill prevention, control, and countermeasures
SPEAR	Stanford Positron-Electron Asymmetric Ring
SSO	DOE SLAC Site Office
SSRL	Stanford Synchrotron Radiation Lightsource
SVOCs	semi-volatile organic compounds
SWMP	stormwater monitoring program
SWPPP	stormwater pollution prevention plan
SWRCB	State Water Resources Control Board
TCR	The Climate Registry
TDS	total dissolved solids
TL/CL	test lab and central lab area
TPH	total petroleum hydrocarbons
TRI	toxic release inventory
TSCA	Toxic Substances Control Act
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds
WBSD	West Bay Sanitary District
WM	Waste Management Group
WTS	waste tracking system
yr	year

Executive Summary

This report provides information about environmental programs during the calendar year of 2011 at the SLAC National Accelerator Laboratory (SLAC), Menlo Park, California. Activities that overlap the calendar year -- i.e., stormwater monitoring covering the winter season of 2010/2011 (October 2010 through May 2011) are also included.

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

Under Executive Order (EO) 13423, *Strengthening Federal Environmental, Energy, and Transportation Management*, EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, and DOE Order 436.1, *Departmental Sustainability*, SLAC effectively implements and integrates the key elements of an Environmental Management System (EMS) to achieve the site's integrated safety and environmental management system goals. For normal daily activities, SLAC managers and supervisors are responsible for ensuring that policies and procedures are understood and followed so that:

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

Throughout 2011, SLAC continued to improve its management systems. These systems provided a structured framework for SLAC to implement "greening of the government" initiatives such as EO 13423, EO 13514, and DOE Orders 450.1A and 430.2B. Overall, management systems at SLAC are effective, supporting compliance with all relevant statutory and regulatory requirements.

During 2011, many improvements in waste minimization, recycling, stormwater management, groundwater restoration, and SLAC's chemical management system (CMS) were continued.

The following are among SLAC's environmental accomplishments for 2011. SLAC's last major Class I ozone depleting substance chiller was decommissioned and the drained refrigerant, over 750 pounds, was transferred to the Department of Defense. A Municipal Waste Reduction Plan, which documents current baseline conditions and establishes a strategy for further landfill diversion of municipal wastes, was completed. A study of bottled water alternatives was completed, identifying significant opportunities for reducing bottled water use. Phase II of a five-phase project was completed for installation of advanced electrical metering. The Phase II project included installation of 34 electrical meters in the Master Substation and 19 electrical meters in other SLAC substations, as well as energy efficient lighting upgrades in three buildings during 2011. In addition, a solvent-cleaning operation using trichloroethylene (TCE) and methanol was permanently discontinued in 2011. SLAC recycled 2,134 tons of municipal solid waste in 2011 and disposed of 547 tons, equating to diversion rate for municipal solid waste of 80 percent, up from 69 percent during 2010. In CY 2011, SLAC completed development of a radiological material release program for metals. Twenty-two tons of metals from the Positron-Electron Project II (PEP-II) accelerators and the SLAC B-Factory detector (BaBar) were recycled. Additionally, 280 concrete blocks were removed from SLAC and disposed of at a Class II landfill. In 2011, SLAC generated 21 tons of hazardous waste from routine operations, equating to an 86 percent reduction from the 1993 baseline of 147 tons. The reduction has been achieved through a successful combination of waste minimization and pollution prevention techniques.

In 2011, there were no radiological impacts to the public or the environment from SLAC operations. The potential doses to the public were negligible and far below the regulatory and SLAC administrative limits. The dose that members of the public received due to SLAC operations is a very small fraction of the dose received from natural background radiation. No radiological incidents occurred that increased radiation levels to the public or released radioactivity to the environment. In addition to managing its radioactive wastes safely and responsibly, SLAC worked to reduce the amount of waste generated. SLAC shipped 2,683 cubic feet of low-level radioactive waste, seventy percent of which was legacy waste, to appropriate treatment and disposal facilities for low-level radioactive waste. SLAC also continued its efforts to reduce the inventory of materials no longer needed for its mission by permanently removing 133 sealed radioactive sources from the inventory.

SLAC is regulated under a site cleanup requirements order (Board Order*)* issued by the California Regional Water Quality Control Board (RWQCB; Board Order number R2-2009-0072)), San Francisco Bay Region on October 19, 2009, for the investigation and remediation of impacted soil and groundwater at SLAC. Risk-based preliminary cleanup goals for impacted soil and groundwater have been established for SLAC, and the remedial efforts are being designed to meet these established goals. The Board Order also lists specific tasks and deadlines for completion of groundwater and soil characterization and other remediation activities. All deliverable submittals to the RWQCB in 2011 were completed and submitted on time. In 2011, the SLAC Environmental Restoration Program personnel continued remediation efforts in specific areas impacted by chemicals of potential concern (COPCs). From 2009 through 2011, interim soil removal actions were completed at 15 additional areas within SLAC. These removal actions resulted in the removal of approximately 35,000 cubic yards of impacted soil and debris. As of 2011, dual phase extraction (DPE) systems, which involve the simultaneous extraction and treatment of chemically-impacted groundwater and soil vapor, are operational at all the four major areas within SLAC that have been impacted by COPCs in groundwater. These remedial systems have been demonstrated to successfully provide hydraulic containment and remediation of COPCs in soil and groundwater.

1 Site Overview

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

The 2010 long-range development plan (LRDP) provides an overview of site environmental planning, including descriptions of environmental resources.

1.1 Introduction

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

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

1.1.1 SLAC Mission

- Photon Science Discoveries

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

- Particle and Particle Astrophysics Discoveries

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

- Operate Safely; Train the Best

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

1.1.2 Research Program

SLAC has three major research areas: photon science, particle physics, and accelerator science and technology. In the photon science program, SLAC develops and supports innovative research instrumentation for x-ray based studies of matter on length scales below the nanometer level and on time scales from milli- down to femto-seconds. Photon science research encompasses such diverse elements as magnetic materials science, molecular environmental science, and structural biology; it is a rapidly developing new field in ultrafast X-ray science.

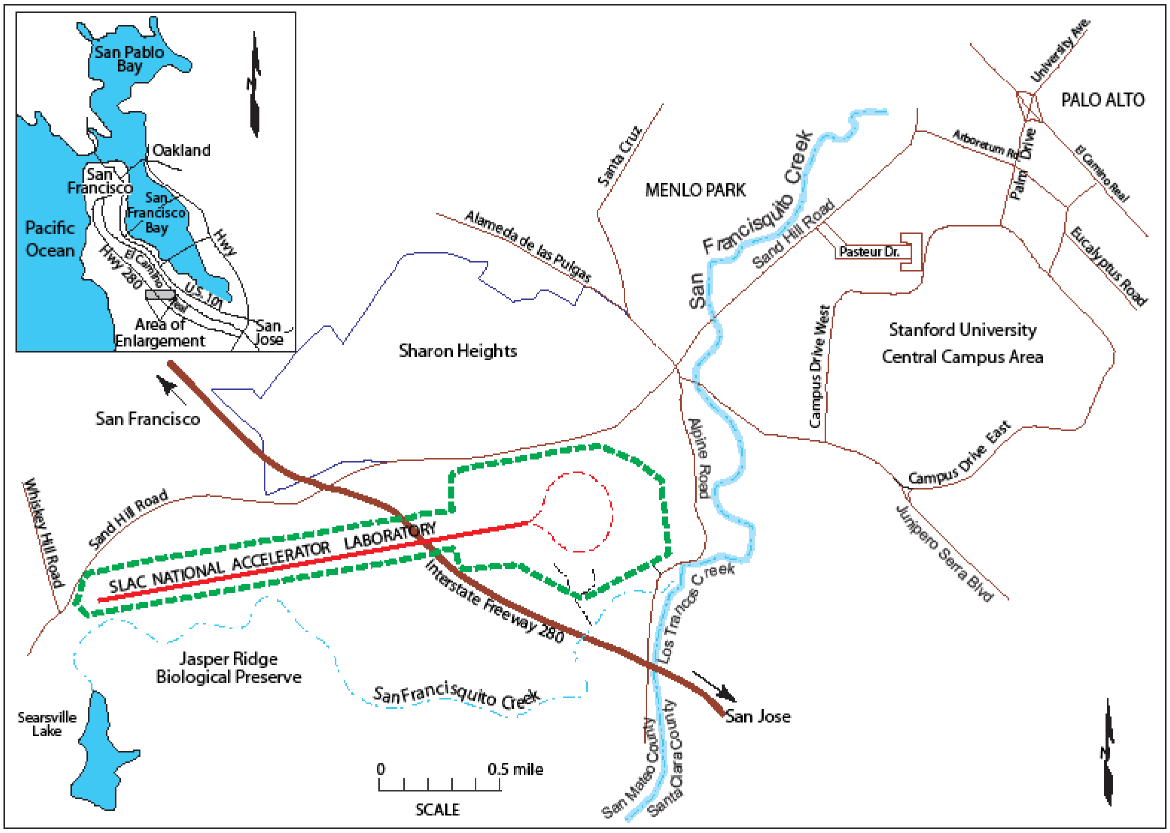

Figure 1-1 SLAC Site Location

The use of particle accelerators and observatories in space and on the ground helps us understand what our universe is made of at its most basic and fundamental level. The principal areas of particle physics studied at SLAC include 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 Model through investigations of dark matter and dark energy.

The Linac Coherent Light Source (LCLS) Directorate continues its experimental operations with the world's first hard X-ray free-electron laser that is exceeding all expectations.

SLAC supports other world-class research in physics, as well. The two-mile linear accelerator (linac) at SLAC, constructed in the early 1960s, generates high-intensity beams of electrons and positrons up to 50 giga-electron volts. The linac is also used to inject electrons and positrons into colliding-beam storage rings for particle physics research. One of these, the Stanford Positron-Electron Asymmetric Ring (SPEAR), contains a separate, shorter linac and a booster ring for injecting accelerated beams of electrons. SPEAR is dedicated to synchrotron radiation research, and the synchrotron light it generates is used by the Stanford Synchrotron Radiation Lightsource (SSRL), a division of SLAC, to perform experiments. At SSRL, researchers work at the nanoscale, making discoveries in solid-state physics, material science, environmental science, structural biology, and chemistry. In the past, researchers at SSRL have: looked at remnants of soft tissues in hundred million-year-old dinosaur fossils; mapped the distribution of elements in diseased brains; sought a deeper understanding of Alzheimer's and Parkinson's diseases; worked out the detailed structures of scores of proteins; and characterized the quantum electronic workings of new materials, leading the way toward the superconductors of the future.

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 lies less than 151 feet above sea level; the mountains to the west rise abruptly to over 2,000 feet.

The site occupies 426 acres of land owned by Stanford University. The property was originally leased by Stanford University in 1962 to the U.S. Atomic Energy Commission, the predecessor to the DOE, for purposes of research into the basic properties of matter. The DOE and Stanford University have signed a new lease which extends through 2043. The land is part of Stanford's academic preserve, 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 0.6 miles at the target (east) end to allow space for buildings and experimental facilities. The south side of much of the western end of the parcel is bordered by Stanford University's Jasper Ridge Biological Preserve (JRBP), which includes part of the San Francisquito Creek riparian channel, the last channel of its kind between San Jose and San Francisco still in its natural state.

1.3 Geology

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

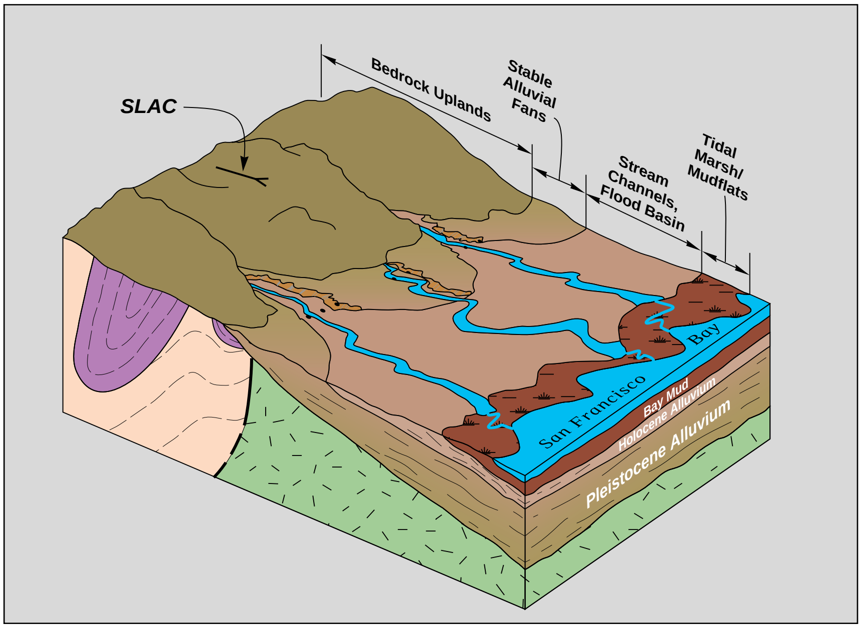

Figure 1-2 Site Area General Geographic and Geologic Setting

1.4 Climate

The climate in the SLAC area is Mediterranean. Winters are cool and moist, and summers are mostly warm and dry. Daily mean temperatures are seldom below 32 degrees Fahrenheit or above 86 degrees Fahrenheit. Rainfall averages about 22 inches per year. The distribution of precipitation is highly seasonal. About 75 percent of the precipitation, including most of the major storms, occurs during the four-month period from December through March. Most winter storm periods are from two days to a week in duration. The storm centers are usually characterized by relatively heavy rainfall and high winds.

1.5 Land Use

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

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

1.6 Water Supply

Domestic water for SLAC is supplied by the Menlo Park Municipal Water Department (MPMWD). The source is the City of San Francisco-operated Hetch Hetchy aqueduct system, which is fed from reservoirs located in the Sierra Nevada. SLAC, the neighboring Sharon Heights development (to the north), and the

Stanford Shopping Center all 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 north of Sand Hill Road, approximately 1.5 miles from central SLAC.

Drinking and process water are transported throughout the SLAC site by a distribution system protected by backflow prevention devices. Use of water at SLAC is about equally divided between equipment cooling (such as the linac) and domestic uses (such as landscape irrigation and drinking water). Groundwater is not used onsite at SLAC; however, five offsite groundwater wells have been identified within a one-mile radius of SLAC, three of which are in use. The closest downgradient groundwater well is located approximately 500 feet south of SLAC along the stream margin of San Francisquito Creek. This well was formerly used for agricultural supply but is capped. Of the other four wells, one is capped, one is used for watering livestock, and the other two are used for residential drinking water.

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 each year. SLAC has an employee population of about 1,600, of which about 20 percent are PhD physicists. Approximately 50 percent 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. SLAC is surrounded by five communities: the city of Menlo Park; the towns of Atherton, Portola Valley, and Woodside; and the unincorporated community of Stanford University, which is in Santa Clara County. Nearby unincorporated communities in San Mateo County include Ladera and two neighborhoods located in western Menlo Park. Within one mile of SLAC's perimeter are two public and two private schools with elementary and/or middle school students.

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 2011.

2.2 Regulatory Framework

The SLAC External Requirements Management Dataset cites the environmental protection and safety requirements and standards that are applicable to the Laboratory.

2.3 Environmental Permits and Notifications

The permits held by SLAC in 2011 are shown in Table 2-1 below.

Table 2-1 General Permits Held by SLAC

Issuing Agency	Permit Type	Description	Number
Bay Area Air Quality Management District	Air quality	Synthetic Minor Operating Permit (SMOP), issued per Title V of the Clean Air Act	1
		Encompasses 36 permitted sources and 21 exempt sources of air emissions (after initial permitting, integrated into SMOP)	57
California Department of Toxic Substances 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
South Bayside System Authority and West Bay Sanitary District	Wastewater discharge	Mandatory Wastewater Discharge Permit	1
Regional Water Quality Control Board	Stormwater	Industrial activities stormwater general permit	1

Issuing Agency	Permit Type	Description	Number
San Mateo County /CUPA	CUPA programs	Permit By Rule; Above Ground Tank/SPCC; HazMat Storage > 32000gal, 224000lb, 112000cf; HazWaste Generator 51-250 tons; CalARP	1
US Environmental Protection Agency	Hazardous waste	90-day hazardous waste generator	1

CUPA – certified unified program agency
SPCC - spill prevention control and countermeasures
CalARP – California Accidental Release Program
PBR – permit by rule

2.4 Environmental Incidents

2.4.1 Non-radiological Incidents

SLAC was in compliance with all non-radiological requirements related to the environment throughout 2011. During 2011, SLAC reported two Category 1 spills and three Category 2 sanitary sewer overflows to the State Water Resources Control Board. The volume of those overflows was approximately 150, 100 and 10 gallons, none of which entered a storm drain channel.

2.4.2 Radiological Incidents

In 2011, no radiological incidents occurred that increased radiation levels above natural background to the public 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 and the public throughout 2011.

2.5 Assessments, Inspections, and Quality Assurance

The environmental programs at SLAC are subject to assessments, inspections, and quality assurance measures. Those conducted during 2011 are reported here.

2.5.1 Assessments

External assessments conducted by regulators occur periodically and include quarterly radiation monitoring of the SLAC perimeter by California Department of Health Services. However, results are not available to SLAC.

The San Mateo County Certified Unified Program Agency (CUPA) inspected SLAC June 21 through June 24, 2011. “Notice to comply” findings reported by the county on the Hazardous Materials Business Plan Inspection report included the need to update the inventory to include all aboveground tanks, generators and portable generator equipment with fuel tank capacities greater than 55 gallons, and the need to improve management and inspection frequency to ensure all emergency equipment (primarily fire extinguishers) is accessible and inspected monthly, and that the inspections are documented. Administrative penalties were assessed by the CUPA on SLAC for these findings. All findings were addressed in a timely manner.

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 2011 by these agencies.

Table 2-2 Environmental Audits and Inspections

Regulatory Agency	Inspection Title	Date	Violations
South Bayside System Authority	Annual Compliance Inspection	April 27, 2011	0
San Mateo County CUPA	Annual Compliance Inspection	June 21-24, 2011	0
Bay Area Air Quality Management District	Soil Vapor Extraction System Inspection	February 24, 2011	0

2.5.3 Quality Assurance

The SLAC site-wide quality assurance (QA) program is consistent with the requirements of the DOE Order 414.1D,[1] and includes documented roles, responsibilities, and authorities for implementing the 10 criteria from the DOE order. Environmental Program Assessments are conducted every three years and are tracked in the Integrated Assessment Schedule (IAS), maintained by the SLAC Office of Planning and Assurance.

The SLAC Office of Assurance is responsible for:

- Auditing quality assurance for line work as well as Environment, Safety and Health (ES&H) programs
- Maintaining the *SLAC Institutional Quality Assurance Program Plan*
- Providing direction for implementation of the ten criteria from the DOE Order 414.1D

2.5.3.1 Environmental Non-radiological Program

The Environmental Restoration Program uses the *Quality Assurance Project Plan for the Environmental Restoration Program*[2] for soil and groundwater characterization and remediation activities. This document includes all components required of quality assurance project plans and is consistent with United States Environmental Protection Agency (USEPA), 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

Programmatic QA/QC is governed by the Radiological Environmental Protection (REP) program manual, and specific radioanalysis laboratory procedures and data validation and reporting are governed by the

[1] United States Department of Energy, DOE Order 414.1D, “Quality Assurance”, http://www.directives.doe.gov/pdfs/doe/doetext/neword/414/o4141c.html

[2] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection Department, *Quality Assurance Project Plan for the Environmental Restoration Program* (SLAC-I-750-2A17M-003 R005, November 2012)

SLAC Radioanalysis Laboratory Quality Assurance manual. In addition, twice per year, SLAC participates in the Mixed Analyte Performance Evaluation Program (MAPEP) administered by the DOE Idaho National Laboratory (INL). Under this program, the INL provided the SLAC Radioanalysis Laboratory with samples that contained unknown gamma- and beta-emitting radionuclides. SLAC used these samples to test and improve the performance of its gamma counting and liquid scintillation counting systems. This ensures that the lab's counting system performs accurate measurements. The technical performances of the MAPEP in 2011 were all acceptable.

3 Management Systems

3.1 Introduction

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

3.2 SLAC Organization

SLAC is organized into six directorates: Accelerator Directorate, Operations Directorate, Photon Science Directorate, Particle Physics and Astrophysics Directorate, Stanford Synchrotron Radiation Lightsource Directorate and Linac Coherent Light Source Directorate. Additionally, the SLAC Office of Assurance, which was renamed the Office of Planning and Assessment, was formed in 2006 in response to DOE Order 226.1A, *Implementation of Department of Energy Oversight Policy.* The purpose of SLAC's assurance program is to ensure that products and services meet or exceed customers' expectations. SLAC's customers include the DOE, the many users who participate in experiments at SLAC using the laboratory's unique experimental facilities, and the sponsors of work conducted under work-for-others program.

3.3 ES&H Division Organization

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

3.3.1 Environmental Protection Department

The Environmental Protection (EP) Department has two technical groups (the Environmental Protection and the Environmental Restoration) that are responsible for developing and managing the requirements under the EMS. The EMS is the overarching system that SLAC uses for identifying and managing environmental aspects and is further described in Section 3.5. The EP Group develops and implements waste minimization and pollution prevention plans, and provides oversight of stormwater and industrial wastewater, air, toxic substances control, spill prevention and groundwater protection. The Environmental Restoration Group oversees work to restore soil and groundwater impacted with chemicals from historical operations.

3.3.2 Field Services Department

The Field Services Department consists of four technical groups – Waste Management Group, Industrial Hygiene Group, Chemical Management Group and Field Safety Group. The Waste Management (WM) Group is responsible for coordinating the management and off-site disposal of regulated and hazardous wastes, and developing and implementing waste minimization and pollution prevention plans. The Industrial Hygiene Group is responsible for assisting with the management of SLAC's safety and health programs, and keeping SLAC healthy and safe by anticipation, recognition, evaluation, prevention, and control of environmental factors or stresses which may cause sickness or impaired health and well being. The Chemical Management Group is multifaceted and addresses chemical safety at every point in the chemical lifecycle from transportation, procurement, use, storage, inventory management, and implements the Toxic and Hazardous Material Reduction Plan. The Field Safety Group is responsible for providing industrial and OSHA construction safety oversight to construction projects, operations and maintenance, as well as providing safety training classes to SLAC personnel.

3.3.3 Security and Emergency Management Department

The SLAC Security and Emergency Department consists of two groups - the Fire and Emergency Management Group which include SLAC Emergency Response Team (ERT) and the Site Security Group. The Fire and Emergency Management Group, which has an Emergency Coordinator and an Emergency Specialist, is staffed by fire protection engineering professionals and in 2011 was supported by personnel under contract from the Palo Alto Fire Department (PAFD). PAFD staffed Station 7 which is located on-site and provided emergency response services 24 hours-a-day, seven days-a-week basis. The Site Security Group, which has a Security Manager, is staffed by contract security professionals and is responsible for providing security services and emergency assistance 24 hours-a-day, seven days-a-week.

3.3.4 Radiation Protection Department

The Radiation Protection (RP) Department includes five technical groups – The Radiation Physics Group, Field Operations Group, Dosimetry and Radiological Environmental Protection Group, Radioactive Waste Management Group, and Laser Safety Group. The Radiation Physics Group is responsible for providing expertise in safety analysis and control (including shielding calculations and safety system design) for new or modified beam lines, experiments and facilities, and providing authorization and oversight for the safe operation of beam lines and experiments to protect the workers, the general public and the environment. The Radiological Protection Field Operations Group (RPFO) is responsible for overseeing radiological monitoring, training, radiological control and work support. The Dosimetry and Radiological Environmental Protection Group is responsible for providing dosimetry services (external, internal and area), assessment and/or monitoring of various types of environmental impact (described in more details in Section 5), operation of the Radioanalysis Laboratory, and operation of instrumentation program. The Radioactive Waste Management Group is responsible for overseeing radioactive waste management at SLAC, such as low level radioactive waste disposal (described in more details in Chapter 5). The Laser Safety Group is responsible for developing and implementing SLAC's Laser Safety Program.

3.3.5 Project Safety Department

The ES&H Project Safety Department consists of three groups – the Building Inspection Office, Project Safety Support Group, and Safety Officer Group. The Building Inspection Office is responsible for providing Building Code oversight of construction projects during the plan review process, and during the construction phase. The Project Safety Support Group is responsible for general construction safety oversight, subcontractor safety (occupational safety and health metrics) evaluation, project support (ES&H liaison) to Project Managers and scientists, and safety oversight of specific programs in areas such as oxygen deficiency hazards, and compressed gas systems. The Safety Officer Group consists of the SLAC Fire Marshall and the Electrical Safety Officer.

3.3.6 Training and Information Management Department

The Training and Information Management Department assists with the implementation of SLAC's safety and health programs including ES&H training, ES&H publishing, and ES&H web and business applications.

3.4 Integrated Safety and Environmental Management System

SLAC ensures that the site is operated in a safe, environmentally responsible manner and complies with applicable laws, regulations, standards and other requirements through implementation of an Integrated

Safety and Environmental Management System (ISEMS). The ISEMS is based on integrating the key elements of effective integrated safety and environmental management systems into the mission and everyday operations of the site.

3.4.1 Integrated Safety and Environmental Management System

The 'plan, do, check, and improve' approach of ISEMS[3] has been formally adopted by SLAC, and has been incorporated into the Worker Safety and Health Plan. [4] Work at SLAC follows the five core functions of Integrated Safety Management (ISM), which is consistent with the EMS process (policy, planning, implementation, checking and corrective action, and management review):

- Define the scope of work
- Analyze the hazards
- Develop and implement hazard controls
- Perform work within controls
- Provide feedback and continuous improvement

3.4.2 Requirements Management System

The laws and regulations that specify the ES&H and other external requirements of the Laboratory are cited in the centralized SLAC External Requirements dataset which is maintained by the SLAC Requirements Management (RM) team. Updates to the RM dataset occur when the DOE/Stanford University Contract for SLAC is modified affecting clauses or DOE Directives, when Management System documentation (i.e. ES&H Manual) is revised;, and when other non-contractual external requirements (e.g. Industrial Standards) are identified based on subject matter expert (SME) input. In addition, SMEs review the dataset at least annually to ensure that regulatory drivers are identified and incorporated.[5]

3.4.3 Environmental Performance Measures

In addition to complying with external requirements, SLAC evaluates its activities against performance measures. Specific performance objectives, measures and targets are developed by DOE and SLAC, and are approved and formally incorporated into the M&O contract each fiscal year. DOE uses the contract performance measures and ongoing field observations of SLAC operations and construction activities to formally evaluate contractor performance in all areas, including ES&H.

In fiscal year (FY) 2011, SLAC established environmentally relevant performance goals to provide the following: a work environment that protects worker safety, health and the environment; efficient and effective implementation of ISEMS; and efficient and effective waste management, waste minimization, and pollution prevention.

SLAC received a grade of A- for its environmental performance. SLAC received the DOE Bronze Award for the Federal Electronics Challenge, completed projects that resulted in tangible risk reduction such as the

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

4 SLAC National Accelerator Laboratory, Environment, Safety, and Health Division, SLAC Worker Safety and Health Program, (SLAC-I-720-)A21B-001-R004), http://www-Worker Safety and Heath Program (WSHP)

5 SLAC National Accelerator Laboratory, Requirements Management, https://slacspace.slac.stanford.edu/sites/ipm/requirementsmanagement/default.aspx

removal of hazardous materials that had been stored on site for many years, diverted over 60 percent of its sanitary waste destined to landfills and recycled over 90 percent of the construction and debris waste from a recently completed major construction project.

3.4.4 Training

To ensure every employee is both aware and capable of fulfilling his or her responsibilities, the ES&H Division operates an extensive program of classroom and computer-based training. For example, personnel who handle hazardous chemicals and waste are provided training in chemical and waste management, waste minimization, pollution prevention, stormwater protection, on-site transportation of hazardous chemicals and waste, and basic spill and emergency response. Details on the ES&H training program are available on line.[6] Workers are required to have all appropriate environmental and safety training prior to performing any work assigned to them. Training received by each worker is documented in his or her Safety Training Assessment, which is reviewed and approved by their supervisor.

3.5 Environmental Management System

The EMS portion of the ISEMS is essentially a systematic approach for ensuring environmental improvement – a continual cycle of planning, implementing, reviewing and improving to ensure protection of the air, water, land, and other natural resources that may be potentially impacted by operational activities. SLAC's EMS program is described in detail in the *EMS Description*[7] document.

The Office of Management and Budget issues an annual Environmental Stewardship scorecard for the federal agencies and an EMS Report Card is one of four elements. SLAC achieved a score of "green" on its 2011 EMS Report Card, indicating that all elements of the EMS are in place and working. Despite receiving a score of "green", SLAC strives to continually improve its EMS.

SLAC's EMS program is consistent with International Organization of Standardization (ISO) 14001:2004. It was first formally in place on December 21, 2005 following a DOE assessment of the site's EMS and issuance of a self-declaration letter of compliance with the requirements of DOE Order 450.1. In June of 2008, DOE Order 450.1 was replaced with DOE Order 450.1A[8] , to implement the requirements and sustainability goals listed in EO 13423 *Strengthening Federal Environmental, Energy, and Transportation Management*. SLAC's EMS was declared in compliance with DOE Order 450.1A on June 1, 2009 and a formal independent audit is conducted at least every 3 years to support self-declaration of conformance of the EMS with the framework and elements of the ISO14001 standard. .

Additional updates to the SLAC EMS will continue as a result of EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*[9], issued October 8, 2009. This EO builds on the sustainability requirements of EO 13423, with greater emphasis on the reduction of greenhouse gases (GHG) emissions by federal agencies. As a result of EO 13514, in May 2011, DOE replaced DOE Orders 450.1A and 430.2B with DOE Order 436.1, a new sustainability directive.

The annual review and update of environmental aspects and determination of significance was completed this year by SLAC's EMS Steering Committee, the Environmental Safety Committee (ESC), and six

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

7 SLAC National Accelerator Laboratory, *EMS Description*, SLAC-750-0A03H-002 R3, February 2012

8 DOE Order 450.1A, http://www.directives.doe.gov/pdfs/doe/doetext/neword/450/o4501a.pdf

9 Executive Order 13514, http://edocket.access.gpo.gov/2009/pdf/E9-24518.pdf

objectives and targets were established for 2011. For each objective and target, a work plan, termed an Environmental Management Program (EMP) was completed. Many of the EMPs developed for 2011 were developed to support progress toward achievement of the sustainability goals of EO 13423 and EO 13514.

Objectives and targets were developed for the following environmental aspects in FY 2011:

- Air emissions
- Industrial and hazardous waste generation
- Soil and groundwater contamination
- Use, reuse, and recycling
- Conservation of resources
- Cultural/historical resource disturbance

Several notable accomplishments for the 2011 EMPs include the following:

- SLAC's last major Class I ozone depleting substance chiller was decommissioned and the drained refrigerant, over 750 pounds, was transferred to the Department of Defense.
- A Municipal Waste Reduction Plan, which documents current baseline conditions and establishes a strategy for further landfill diversion of municipal wastes, was completed.
- A study of bottled water alternatives was completed, identifying significant opportunities for reducing bottled water use.
- A building survey and inventory compilation were completed and a Historic Resource Study Report was submitted to the State Historic Preservation Office.
- Phase II of a five-phase project was completed for installation of advanced metering. Phase II included installation of 34 electrical meters in the Master Substation and 19 electrical meters in other SLAC substations.
- Energy efficient lighting upgrades were completed in buildings 035, 050, and 082.

Additionally, SLAC's progress on the sustainability goals of EO 13423 and EO 13514, including GHG, energy, water, fuel reduction, and high performance sustainable buildings is provided in Section 4.7, *Sustainability*. SLAC's GHG inventory work is also discussed in Section 4.2.2.9.

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 typical of any employer with more than 1,500 full-time staff, 3,000 scientific users per year, hundreds of buildings, and 426 acres of land, some of which are adjacent to a biological preserve.

SLAC has focused considerable efforts to minimize potential environmental impacts. SLAC works to avoid generating waste and emissions. When unavoidable, SLAC attempts to minimize the amount it does produce and then carefully manages the impacts that may occur. Additionally, SLAC continually strives to increase its environmental performance.

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
2006	DOE	Pollution Prevention and Environmental Stewardship Accomplishment – Noteworthy Practice	Resource conservation achieved by building experimental facilities with reused materials
2006	DOE	Pollution Prevention and Environmental Stewardship Accomplishment – Best in Class	Instituted the Chemical Management Services which manages chemicals procurement and use
2008	USEPA	Federal Electronics Challenge – Bronze Award	Reducing the environmental impacts of electronics in the purchasing life-cycle phase
2009	USEPA	Federal Electronics Challenge – Bronze Award	Reducing the environmental impacts of electronics in the purchasing life-cycle phase
2011	DOE	Secretarial Honors Achievement Award	Reducing fugitive emissions of sulfur hexafluoride (SF6) while raising awareness and sharing case studies

This chapter provides an overview of the non-radiological environmental programs SLAC implements to protect air and water quality, to manage hazardous materials in a safe and environmentally responsible manner, and to eliminate or minimize the generation of hazardous, non-hazardous, and solid waste. The chapter sections are organized by protection program and describe the regulatory framework, program status for 2011, and relevant performance trends. The environmental radiological 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 that emit air pollutants, including a plating shop, a paint shop, several machine shops, boilers, solvent degreasers, emergency generators, and a vehicle fueling station. Also, GHGs are used extensively in both electrical substations and research equipment, and are being actively managed in response to the passage of Assembly Bill (AB) 32, the California Global Warming Solutions Act, in 2006. This section describes the regulatory framework to which SLAC is subject for the purpose of air quality protection, and presents the status of SLAC's air quality protection programs during 2011.

4.2.1 Regulatory Framework

In the San Francisco Bay Area, most federal and state air regulatory programs are implemented through the rules and regulations of the Bay Area Air Quality Management District (BAAQMD). Included in the BAAQMD roles and responsibilities is the implementation of Title V of the Clean Air Act. SLAC's Title V synthetic minor operating permit (SMOP) was issued by BAAQMD on July 26, 2002. The Title V SMOP stipulates limits on facility-wide emissions of volatile organic compounds (VOCs), total hazardous air pollutants (HAPs), and individual HAPs, along with various other requirements. At the state level, the California Air Resources Board (CARB) is responsible for the implementation of AB32, and provides notices, workshops, training, lectures, and other means to disseminate information as it is developed, and solicits input.

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

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

4.2.2 Program Status

4.2.2.1 Annual Facility Enforcement Inspection

The BAAQMD inspected SLAC's four soil vapor extraction systems during 2011. No findings resulted from this inspection.

4.2.2.2 New Source Permits

One new emissions source was permitted in 2011. A 150-kilowatt emergency generator was purchased and installed in the SLAC Master Substation. As a result, at the end of 2011, SLAC managed a total of 57 sources of air emissions, comprising 36 permitted sources and 21 exempt sources.

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

SLAC submitted two primary annual deliverables to the BAAQMD. One was the annual information update requested by the BAAQMD for selected permitted sources, and covered calendar year (CY) 2010. This report was submitted on time in April 2011, and SLAC's permit-to-operate was renewed on June 28, 2011, effective through July 1, 2012.

The other BAAQMD deliverable was the Title V annual emissions report for all onsite sources for the SMOP and covered the period of July 1, 2010 through June 30, 2011. SLAC submitted the Title V annual emissions report on time in July 2011.

4.2.2.4 Annual Adhesives Usage Report

SLAC submitted its annual adhesives usage report to BAAQMD to satisfy Regulation 8-51-502.2c on time in April, 2011 (covering the 2010 reporting year).

4.2.2.5 Annual Air Toxics Report

SLAC submitted its annual air toxics report to BAAQMD in accordance with AB2588 on time in April 2011.

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, SLAC is required to provide advance notice to the BAAQMD. During 2011, 28 construction projects were evaluated for the purpose of air quality protection. Based on the project scopes and the results of pre-work asbestos surveys, asbestos/demolition/renovation notifications were submitted to BAAQMD for five of these projects.

4.2.2.7 National Emission Standards for Hazardous Air Pollutants

By the end of 2011, SLAC operated three sources that are subject to 40 CFR 63, Subpart T "National Emission Standards for Halogenated Solvent Cleaning" which is part of the National Emission Standards for Hazardous Air Pollutants (NESHAPs) regulations. A fourth source, a solvent-cleaning operation using trichloroethylene (TCE) and methanol, was permanently discontinued in 2011. This unit was identified as BAAQMD Source S-58.

The NESHAP deliverables required by USEPA are an annual performance report and two semi-annual exceedance reports. For CY 2010, the annual report is consolidated with the second semi-annual report, and was submitted on time in January 2011. The first semi-annual report for CY 2011 was submitted on time in July 2011. The three regulated units (solvent cleaners and degreasers) were operated in accordance with their respective NESHAPs emissions limits during the covered reporting periods, and there were no exceedances of regulatory limits.

4.2.2.8 Vehicle Fleet Management and Source Testing

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

Despite its name, the onsite Gasoline Dispensing Facility (GDF) provides multiple fuels for SLAC vehicles, and, fuel purchasing and dispensing is tracked and reported annually to BAAQMD. The permit for the GDF requires annual source testing of the gasoline dispensing system to ensure proper functioning. A source test was performed on the GDF in September 2011 and all results were within regulatory limits.

To reduce the amount of petroleum-based fuel used at SLAC, in accordance with EO 13423 and EO 13514, SLAC Fleet Services previously converted the GDF diesel pumping system to dispense an ethanol blend (E85). In addition, diesel fuel is now pumped directly into portable trailer-mounted tanks, which are then transported throughout the facility to refuel heavy equipment and stationary engines, such as emergency generators.

4.2.2.9 Greenhouse Gas Inventory and Baseline

SLAC compiled its first GHG inventory in 2004. Beginning with CY 2007 as its baseline year, SLAC reported its GHG emissions voluntarily to The Climate Registry (TCR), an international entity. Between CY 2007 and CY 2008, SLAC GHG emissions decreased more than 40 percent, largely due to the cessation of the BaBar operations, which accounted for the majority of both the GHGs and electricity used onsite. Voluntary reporting was performed until mandatory federal reporting was initiated in 2010.

GHG emissions are divided into 3 categories, or scopes. Scope 1 emissions are generated onsite and are under the direct control of the facility, such as those from natural gas that is combusted in a boiler. Although Scope 2 emissions occur onsite they are not generated by the facility, like electrical power purchased from an offsite entity. Nearly all of SLAC's GHG emissions are Scope 2, due to its high demand for electricity. Scope 3 emissions are business-related but generated offsite; employee commuting and business travel fall into this category.

The DOE, in conformance with EO 13514 requirements, began establishing an agency-wide GHG baseline of its Scope 1 and 2 emissions for FY 2008, using energy and fuel data collected in existing DOE reporting systems. Fugitive emissions data were calculated based on site chemical purchasing data. In December 2011, SLAC submitted its Comprehensive Energy Data Report to DOE, which provided an initial estimate of Scope 3 emissions as well. SLAC is striving to reduce its GHG emissions further in the coming years.

4.3 Industrial and Sanitary Wastewater Management Program

SLAC discharges industrial wastewater 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). 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 2011.

4.3.1 Regulatory Framework

The Federal Water Pollution Control Act, now 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 mandatory wastewater discharge permits which are negotiated jointly with the WBSD and SBSA. The previous permit, which covered the entire facility, was effective from December 16, 2006 to December 15, 2011. A new permit became effective December 16, 2011 and may be renewed annually until December 15, 2016. SLAC also has a contractual relationship with the WBSD, which specifies the total industrial and sanitary flow that is allowed to be discharged.

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

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

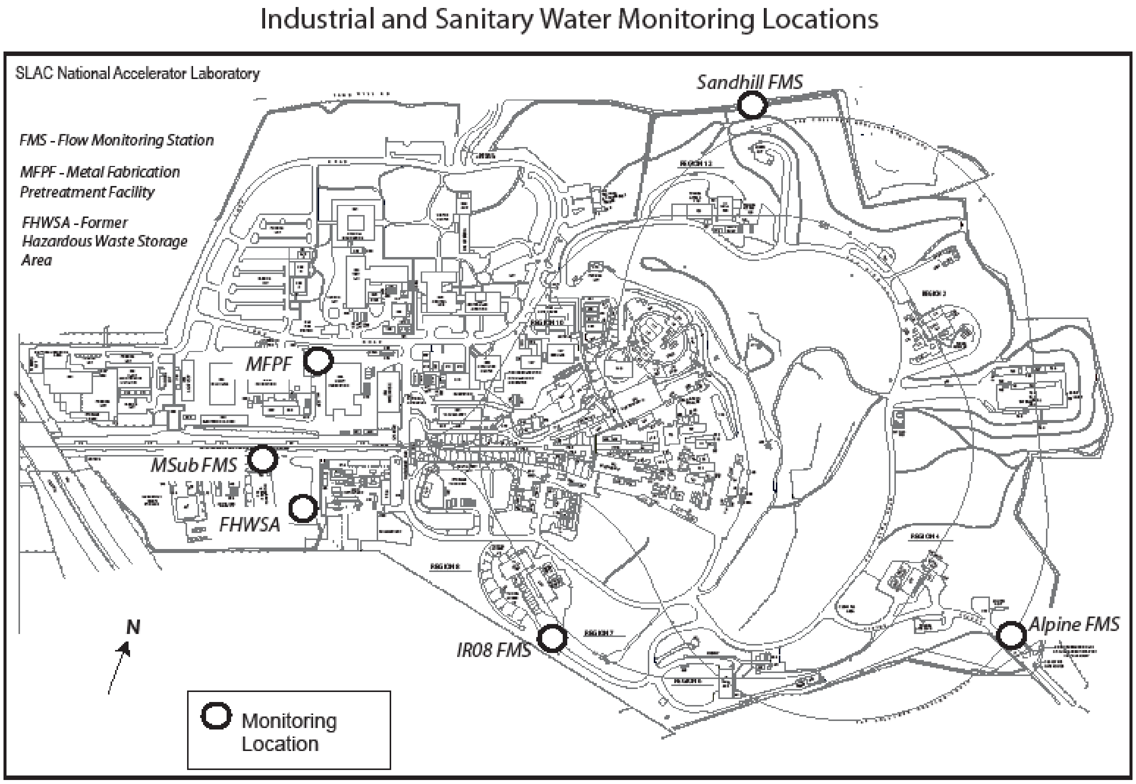

Figure 4-1 Industrial and Sanitary Wastewater Monitoring Locations

SLAC is required to submit a semi-annual self-monitoring report[10] which includes the results of its monitoring of the metal finishing pre-treatment facility (MFPF) and FHWSA Treatment System, certification of a solvent management plan for approximately 100 solvents selected by the SBSA, and reports for discharges of radioactivity in industrial wastewater (see Section 5.5.1).

4.3.2 Program Status

4.3.2.1 Annual Facility Enforcement Inspection

The SBSA conducted the annual facility enforcement inspection on April 27, 2011. No issues were noted.

4.3.2.2 Flow Monitoring Results

Total industrial and sanitary wastewater discharged to the WBSD's regional collection system in 2011 was approximately 22.4 million gallons, which equates to an average of approximately 61,400 gallons per day (gpd). SLAC was within its discharge entitlement of approximately 23.6 million gallons, or 64,600 gpd.

[10] SLAC National Accelerator Laboratory, Environment, Safety, and Health Division, Environmental Protection Department, *Self-Monitoring Report and SMP Certification Required Under Mandatory Wastewater Discharge Permit WB 061216* (July 30, 2011, submitted to Norman Domingo, Technical Services Supervisor, SBSA)

SLAC National Accelerator Laboratory, *Self-Monitoring Report and SMP Certification Required Under Mandatory Wastewater Discharge Permit WB 111216* (January 30, 2012, submitted to Norman Domingo, Technical Services Supervisor, SBSA)

4.3.2.3 Water Quality Monitoring Results

SLAC collects water quality samples semi-annually from the MFPF and FHWSA monitoring locations. In addition, SBSA collects samples quarterly at the Sand Hill Road FMS and annually at the MFPF. Compliance with the water quality parameters contained in the permit is determined at the Sand Hill Road FMS and FHWSA by comparing the mass discharge limit with the average value of the samples taken over the previous 12 months. Results from the MFPF are compared to daily and monthly maximum concentrations. In 2011, SLAC was in compliance with all permitted discharge limits at all three monitoring locations.

4.3.2.4 Sanitary Sewer Overflow

SLAC filed a Notice of Intent with the State Water Resources Control Board (SWRCB) to comply with the terms of the Statewide General Waste Discharge Requirements for Sanitary Sewer Systems.[11] In August of 2010, the SLAC Sanitary Sewer Management Plan was completed and certified. The Plan includes descriptions of SLAC's sanitary sewer operations and maintenance activities, spill response, and reporting procedures.

SLAC registered with the SWRCB and the San Francisco Bay RWQCB sanitary sewer overflow reporting systems in October 2008. All spills from the sanitary sewer system are reported using the sanitary sewer overflow reporting systems. A Category 1 sanitary sewer overflow is any spill from the sanitary sewer which enters a storm drain channel and is not recovered from the storm drain system, or is greater than 1,000 gallons. Category 1 spills must be reported within two hours of discovery if they are not recoverable from the storm drain system or within 3 days if they are greater than 1,000 gallons but do not enter or are recovered from the storm drain system. A Category 2 sanitary sewer overflow is any spill which is not Category 1. Category 2 overflows are reported within 30 days after the end of the month in which the overflow occurred. A no spill certification must be completed within 30 days of a month in which no spills occur.

In 2011, SLAC reported two Category 1 spills: one of approximately 1,300 gallons, which did not enter the storm drain system, and one of approximately 3 gallons that entered a storm drain. SLAC also reported three Category 2 sanitary sewer overflows in 2011. The volume of those overflows was approximately 150, 100 and 10 gallons, none of which entered a storm drain channel.

4.4 Surface Water Management Program

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

- IR-8 Channel (IR-8)
- IR-6 Channel (IR-6)
- North Adit East Channel (NAE)
- Main Gate East Channel (MGE)
- IR-2 North Channel (IR-2)
- Building 81 North Channel (B81)

[11] *Statewide General WDRs for Sanitary Sewer Systems*, WQO No. 2006-0003. Available at State Water Resources Control Board

- Building 15 (B15)
- Building 18 (B18)

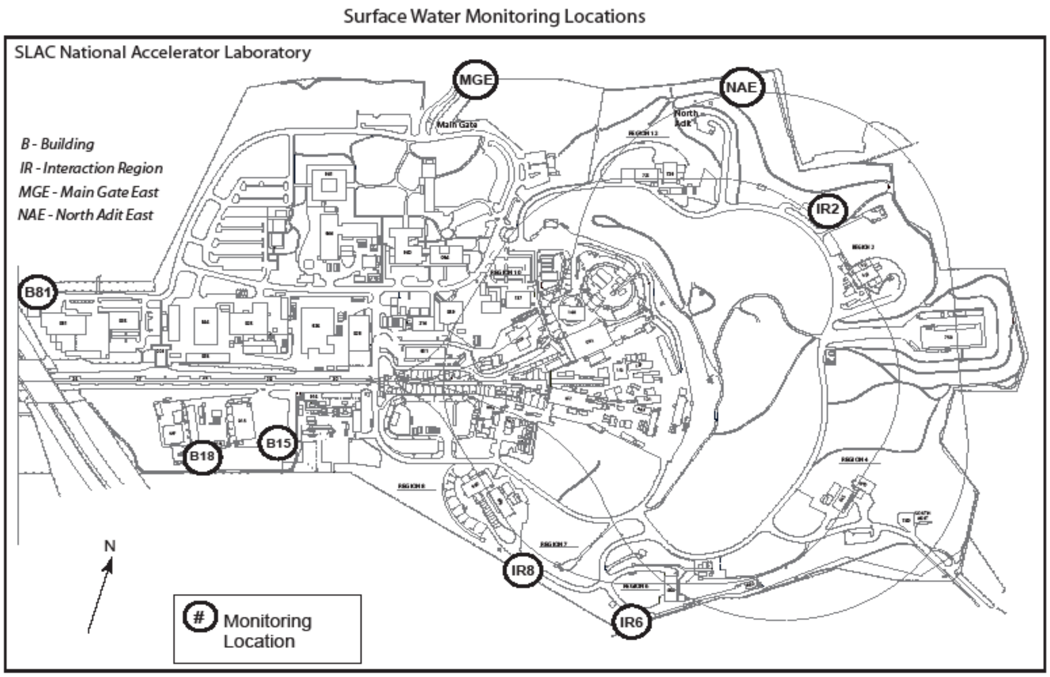

Figure 4-2 Surface Water Monitoring Locations

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 SWRCB adopted the industrial activities stormwater general permit, with the goal of reducing water pollution by regulating stormwater discharges associated with industrial activities. SLAC filed a notice of intent to comply with the general permit.

California's general permit was re-issued in 1997. SLAC adheres to the requirements of the general permit, through its development and implementation of a stormwater pollution prevention plan (SWPPP).[12] The SWPPP has two main components: a stormwater monitoring program (SWMP) and a best management practice (BMP) program.[13] The SWMP presents the rationale for sampling, lists the sampling locations, and specifies the analyses to be performed. The BMPs include a list of 17 generic and site-specific practices that serve to minimize the impact on stormwater from SLAC's industrial activities (see Section 4.4.2).

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12 Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection and Restoration Department, *SLAC Stormwater Pollution Prevention Plan* (November 2007, SLAC-I-750-0A16M-002-R002)

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

4.4.2 Program Status

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

The general permit's definition of wet season runs from October 1 through May 31. This reflects SLAC's climatological conditions, as rain rarely falls during June through September. Since the general permit's definition of wet season spans two calendar years, the 2011 water quality monitoring results discussed below are for the 2011–2012 wet season (October 2011 through May 2012).

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

Automated samplers are located at each of the stormwater monitoring sites. The samplers are triggered by rain gauges and level sensors. Samples are collected during the first eligible storm event at each location and one other event during the rainy season. During the wet season of 2011-2012, a total of 16 samples (two samples per location) were collected during six storm events.

The general permit requires analysis of stormwater samples for four parameters (pH, total suspended solids, specific conductance, and total organic carbon), and any other potential pollutants, identified by the facility, which may be present in the stormwater in significant quantities. During the wet season of 2011-2012, stormwater samples were analyzed for the four required parameters as well as seven additional parameters (Table 4-2). The additional parameters were selected after a review of SLAC's industrial activities and the results of previous sampling events.

SLAC reviews and compares the analytical results with previous sampling data, background levels, and the SWRCB developed parameter benchmark values (PBVs) levels.[15] PBVs are not regulatory discharge limits, rather, they are meant to be used as guidance. The majority of the sample results from the wet season of 2011-2012 were below PBVs. At several of the discharge locations, aluminum, iron, and zinc were present at levels above PBVs. Aluminum and iron concentrations reflect background levels of sediment entrained in the stormwater. The source of zinc is thought to be from contact with galvanized metal in stormwater drain pipes and metal roofs and drainpipes. SLAC will continue to evaluate sources of aluminum, iron and zinc in stormwater, in order to determine how to prevent PBV exceedances during future sampling events.

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[14] SLAC National Accelerator Laboratory, Environment, Safety, and Health Division, Environmental Protection Department, *2011–2012 Annual Report for Stormwater Discharges Associated with Industrial Activities* (June 2012), San Francisco Bay RWQCB

[15] State of California, State Water Resources Control Board, *Sampling and Analysis Reduction Certification* (no date), http://www.waterboards.ca.gov/water_issues/programs/stormwater/docs/smanlrdc.pdf

Table 4-2 Stormwater Parameters Analyzed

Metals	Non-Metals
Aluminum	Total Suspended Solids [1]
Copper	Total Organic Carbon [1]
Iron	pH [1]
Lead	Specific Conductance [1]
Zinc	Polychlorinated Biphenyls
	Radioactivity

1 - Required parameter under Industrial Stormwater General Industrial Permit Order 97-03-DWQ

4.5 Hazardous Materials Management

SLAC uses hazardous materials as part of its experimental programs including the manufacturing and maintenance of experimental devices; as well as in conventional facilities operations, maintenance and construction projects. Examples of hazardous materials managed at SLAC include the following:

- Cryogens
- Compressed gases
- Acids and bases
- Solvents
- Oils and Fuels, including Propane
- Adhesives
- Paints and epoxies
- Metals

Hazardous materials management spans numerous programs but the purpose remains the same: to ensure the safe handling of hazardous materials in order to protect the workers, community, and environment.

4.5.1 Regulatory Framework

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

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

In general, the local implementing agency for hazardous materials regulation in California is the California CUPA. The Environmental Health Division of the San Mateo County Health Services Agency is the CUPA responsible for overseeing hazardous materials and waste management at SLAC. A CUPA has broad enforcement responsibilities. Recently, the scope has expanded to include the SWPPP, the SPCC and Waste Tire Survey and Inspections in addition to the following six hazardous material subject areas:

- Hazardous Materials Business Plan/Emergency Response Plan
- Hazardous Waste/Tiered Permitting/Waste Minimization and Pollution Prevention
- Underground Storage Tanks
- Aboveground Storage Tanks (petroleum tanks only)
- California Accidental Release Program
- California Fire Code Hazardous Materials Management Plan (Section 2701.5.1 and 2701.5.2)

4.5.2 Program Status

Discussed in the following sections are the status of SLAC's 2011 programs related to hazardous materials life-cycle management, including its hazardous materials business plan, toxics release inventory (TRI), and CalARP programs. Also discussed are SLAC's above ground storage tanks program and its PCBs management program under TSCA.

For the period between January 2010 and December 2011, ninety-nine chemical storage buildings/areas, or 75.6 percent of the identified buildings/areas were field verified. There was a reduction in either the number of storage areas and/or inventory in 13 of the buildings visited. Usable legacy or unneeded chemicals were removed for redistribution. Products that had expired or had damaged containers or labels were removed for disposal as hazardous waste. This program has been recognized as an effective tool to identify inventory reduction opportunities and provide avenues for reuse and waste reduction and was given additional resources.

4.5.2.1 Annual Facility Enforcement Inspections

The San Mateo County CUPA inspected SLAC June 21 through 24, 2011. The Notice to comply findings reported by the county on the Hazardous Materials Business Plan Inspection report included:

- The need to update the inventory to include all aboveground tanks, generators and portable generator equipment with fuel tank capacities greater than 55 gallons,

- The need to improve management and inspection frequency to ensure all emergency equipment (primarily fire extinguishers) is accessible and inspected monthly, and that the inspections are documented. Administrative penalties were assessed by the CUPA on SLAC for these findings.

All findings were addressed in a timely manner.

4.5.3 Hazardous Materials Business Plan Program

The EPCRA, passed in 1986 as Title III of the SARA, establishes 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 2011 reporting year, SLAC updated its HMBP and submitted it to the San Mateo County CUPA. The 2012 HMBP will be submitted electronically through the California Environmental Reporting System (CERS) in 2013.

The HMBP includes the Hazardous Materials Inventory Statement (HMIS). The inventory consists of all hazardous materials present at SLAC in amounts exceeding the state's aggregate threshold quantities (55 gallons for liquids, 500 pounds (lbs) for solids, and 200 cubic feet for compressed gases) on a building-by-building basis. It includes hazardous materials in storage as well as hazardous waste, oil-filled equipment, process and bulk tanks, emergency generators containing fuel, and lead/acid batteries. A portion of the hazardous materials inventory is based on procurement data generated through the CMS. The hazardous waste inventory is based on the database maintained by the WM Group. Mixed waste and radioactive materials data are provided by the RP Department. Inventory of process and bulk tanks are part of the SLAC property and building databases. The CMS maps are used to indicate storage area locations. The plan also includes the SLAC *Consolidated Chemical Contingency Plan*.[16] This plan combines the emergency response requirements for the following programs:

- Hazardous Materials Business Plan
- Hazardous Waste Contingency Plan
- Spill Prevention Control & Countermeasure Plan
- Risk Management Plan

4.5.4 Toxics Release Inventory Program

Under EO 13423, "Strengthening Federal Environmental, Energy, and Transportation Management", the DOE requires its facilities to comply with the Toxic Chemical Release Reporting and Community Right-to-Know requirements (40 CFR 312), more commonly referred to as the TRI program. SLAC provides the required information annually to the DOE, which reviews, approves, and sends the TRI information to the USEPA.

The TRI report is submitted to the USEPA in June each year and reports quantities from the previous calendar year. The report submitted in June 2011 covered CY 2010. Of the more than 400 listed TRI chemicals, only one, lead, is used at SLAC in excess of its respective regulatory threshold. As a result, SLAC prepared a TRI Form R for lead and submitted it to the DOE SLAC Site Office (SSO) in June 2011. Roughly one-fourth of the lead removed offsite was recycled. TRI data are available to the public via the USEPA website.[17]

4.5.5 California Accidental Release Prevention Program

SLAC has only one regulated chemical in excess of the CalARP threshold: potassium cyanide, which is used only in the Plating Shop complex. As such, a Risk Management Plan (RMP) was prepared and submitted to the CUPA. Spent plating baths containing cyanide were stored temporarily at the Chemical Hazardous Waste Management Area (CHWMA) pending transport for offsite disposal. However, in 2011 the waste handling procedure was streamlined so that spent plating baths were drummed and picked up by the waste hauler from the area of use, thus eliminating transport to and storage in the CHWMA.

As part of the RMP, worst-case scenarios were developed for the potential release of potassium cyanide, but generated no offsite consequences. Since the impact of such a release was limited to the immediate area of use, SLAC qualified for a Program 1 RMP (the lowest level), whereby a more detailed process hazard assessment and an offsite consequence analysis were not required. The final Program 1 RMP for SLAC was submitted to the CUPA in 2006 and finalized in 2008 after a public comment period.

4.5.6 Aboveground Storage Tank Program

Aboveground storage tanks (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 2011 is presented in Table 4-3. All of the petroleum tanks at SLAC are constructed of steel with secondary

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[16] SLAC National Accelerator Laboratory, 2009 *Consolidated Chemical Contingency Plan* (SLAC-I-730-3A86H-008-R002)

[17] http://www.epa.gov/tri/tridata/index.html

containment. An SPCC plan is required by 40 CFR 112 for all petroleum-containing ASTs greater than 660 gallons in size. The SLAC SPCC plan[18] was revised in 2008 to ensure it was in compliance with 40 CFR 112 Final Rule prior to its enactment.

SLAC does not have any underground storage tanks.

Table 4-3 Aboveground Petroleum Tanks

Petroleum Product	Property Control Number	Location	Capacity (gallons)
Diesel	19683	B112 Master Substation	2,000
Gasoline/E85	21443	B035 Vehicle Refueling Station	1,500/500
Vacuum Oil *	19596	B020 North Damping Ring	500
Diesel	22658	B082 Fire Station	500
Diesel	19781	B505A Generator Fueling	500
Diesel	21287	B007 MCC Generator Fueling	500
Vacuum Oil *	19595	B021 South Damping Ring	300
X-ray Oil	15192	B044 Klystron Test Lab	364/ 227/ 227
Compressor Oil	None	B127 Cryogenics	200
Compressor Oil	18562	B127 Cryogenics	200
Diesel	None	B756 SLD Generator Fueling	500

* These tanks are used only for short-term storage

4.5.7 Toxic Substances Control Act Program

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

TSCA regulations are administered by the USEPA. No USEPA inspections regarding TSCA were conducted at SLAC during 2011.

Transformers with PCB concentrations of 500 parts per million (ppm) and greater are defined by TSCA as PCB transformers. SLAC has no PCB transformers. Transformers with PCB concentrations equal to or greater than 50 ppm but less than 500 ppm are defined by TSCA as PCB-contaminated transformers. During 2011, SLAC had 105 oil-filled transformers, down from 107 the previous year, after two transformers where appropriately disposed of. Only 10 of the 105 oil-filled transformers are PCB-contaminated. The total quantity of PCBs contained in the 105 transformers currently in service is estimated to be approximately 20 lbs.

4.5.8 Chemical Management System

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

[18] Stanford Linear Accelerator Center, Environment, Safety and Health Division, Environmental Protection Department Spill Prevention, Control, and Countermeasures Plan (SLAC-I-750-0A16M-001-R003), September 2008. https://www-internal.slac.stanford.edu/esh/documents_internal/SPCC.pdf

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

- Reduce SLAC's chemical and gas cost through vendor leveraged buying power
- Reduce SLAC's risk and space requirements associated with storing, managing and handling chemicals
- Reduce time spent by SLAC researchers and other personnel on sourcing, ordering and tracking chemicals
- Ability to generate chemical usage and compliance reports directly from procurement data

SLAC entered a new contract with Haas in 2011 that includes the following new services:

- Haas will support SLAC sustainability efforts by identifying safer or preferred products and setting up opportunities with potential SLAC users to meet the suppliers and test products
- Financial approvals will be based on charge codes to support an organization with more of a matrix structure
- Haas will provide scanners that will allow easier inventory tracking
- Haas will provide secondary HazCom labels in conformance with the new OSHA format

By the end of calendar year 2011, the program achieved the following:

- Safety performance continues to be spotless; no illness/injury or spills, and contractors have all met their training requirements
- 3,652 active chemicals were in the catalog
- There were 476 users of the CMS system and 88 work areas
- Purchase order cycle time continues to be less than half a business day on average

SLAC's CMS program continues to meet or exceed performance goals.

4.6 Waste Management and Minimization

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

4.6.1 Hazardous Waste Management and Minimization

4.6.1.1 Regulatory Framework

SLAC is a 90-day hazardous waste generator. SLAC does not have a Resource Conservation and Recovery Act (RCRA) Part B permit that would allow it to treat hazardous waste, store it on site, and/or dispose of it on site (that is, a treatment, storage, and disposal facility permit) under the federal RCRA regulations. SLAC does have permits to treat a few RCRA-exempt and non-RCRA (that is, California-only) hazardous waste streams (see Section 4.6.1.2 regarding the state-level tiered permit program).

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

4.6.1.2 Hazardous Waste Treatment: Tiered Permitting Program

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

Table 4-4 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

4.6.1.3 Hazardous Waste Tracking

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

4.6.1.4 Hazardous Waste Minimization

SLAC 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
- Utilizing the Department of Defense’s Ozone Depleting Substance Reserve Program

SLAC continues to make progress in reducing hazardous waste generated from routine operations, as shown in Figure 4-3. Routine wastes are those wastes associated with SLAC's routine operations and maintenance processes. For 2011, SLAC reduced its hazardous waste generated by routine operations from the 1993 baseline of 147 tons to 21 tons, representing an 86 percent reduction. The increase in waste reduction from FY 2007 is due to accounting for wastes that were able to be recycled, such as waste oils. In FY 2011, routine wastes were up 5 tons from FY 2010 due to several projects including clean out of sanitary sewer lines and chemical inventory reduction projects. Measures will continue to be taken to further reduce hazardous waste by helping smaller generators increase their awareness of waste reduction opportunities, helping them select less hazardous chemicals, and helping them learn to develop for themselves more focused waste reduction measures for their work areas.

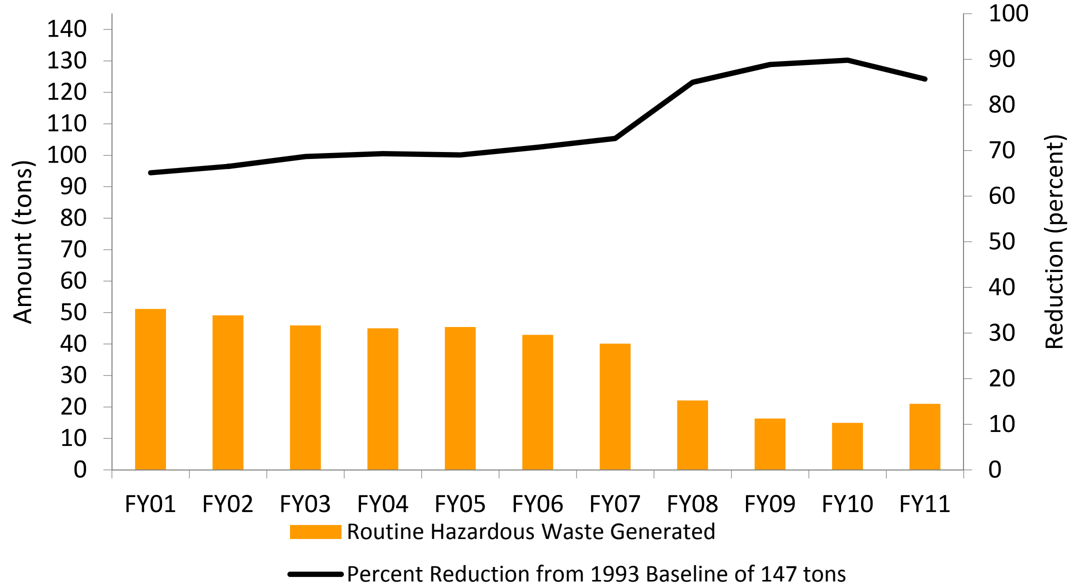

Figure 4-3 Routine Hazardous Waste Generation, 2001-2011

4.6.2 Non-Hazardous Waste Management and Minimization

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

4.6.2.1 Non-hazardous Industrial Waste Management

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

4.6.2.2 Municipal Solid Waste Management

SLAC's Facilities 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 and equipment for their cash value.

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 (soil and miscellaneous non-hazardous construction and demolition debris)
- Universal (fluorescent light bulbs and mercury-containing equipment) and electronic wastes including cathode ray tubes
- Batteries (automotive and common [AA, AAA, C, D, nickel-cadmium, other] batteries)
- Salvage sales and transfers
- Office materials (toner and inkjet cartridges)
- Cafeteria wastes
- Tires
- Trash not otherwise sorted at the source and placed into dumpsters

A site-wide program that recycles mixed paper, beverage containers (glass, aluminum, and plastic), cardboard, and scrap wood has been fully operational for more than 15 years. Collection stations are strategically distributed around the site with each station incorporating anywhere from one to a dozen green containers. Dumpsters for cardboard collection are strategically placed around the site and a specific location is provided for waste wood and non-hazardous construction and demolition debris. Scrap metal and electronic waste is collected and construction materials from building demolition and rehabilitation projects are also recycled. For 2011, SLAC recycled 2,134 tons of municipal solid waste and disposed of 547 tons, equating to a diversion rate for municipal solid waste of 80 percent, up from 69 percent during the previous fiscal year. In part, this is due to the recycling of a high quantity of demolition material generated by the demolition of several old buildings prior to the construction of a new office building (i.e., Building 052). The contributions of the various waste streams being recycled are shown in Figure 4-4.

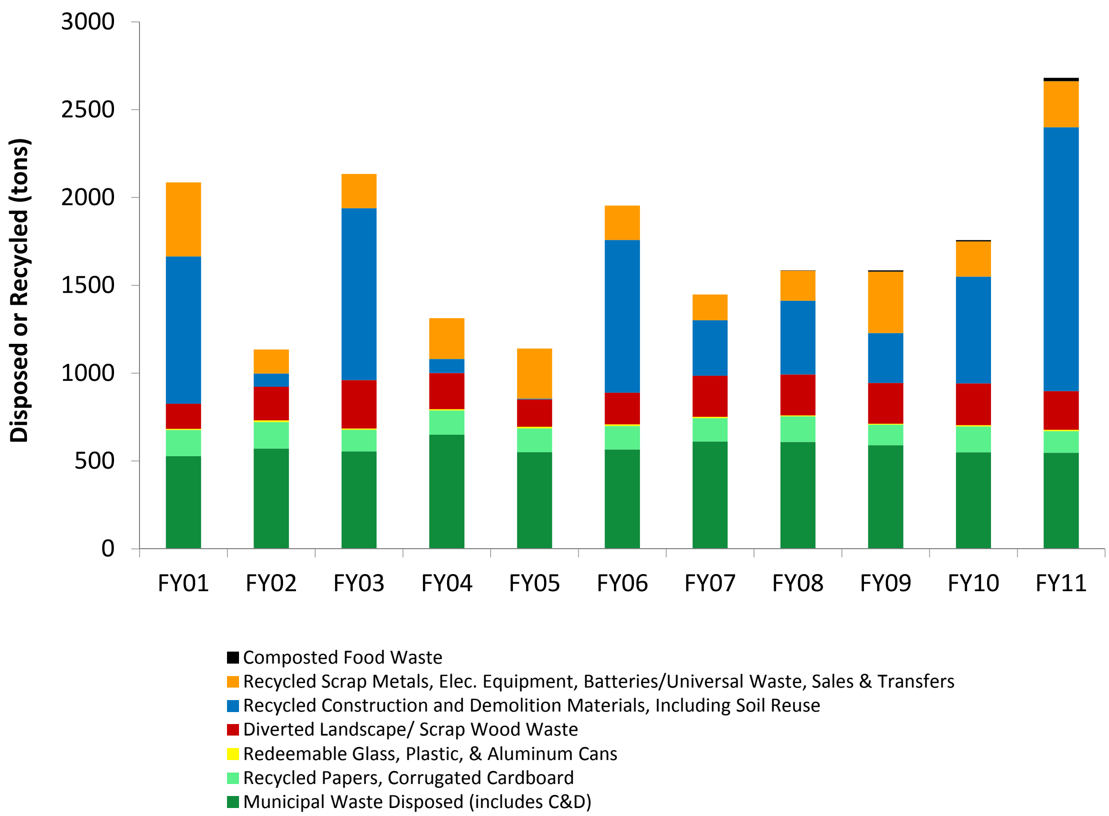

Figure 4-4 Municipal Solid Waste Recycling and Disposal, 2001–2011

4.6.3 Other Waste Management Activities

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

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

4.7 Sustainability

SLAC's *Site Sustainability Plan,*[19] formerly called the *Executable Plan*, summarizes SLAC's planned actions and performance status on the sustainability goals derived from EO 13423 and EO 13514, as adopted by DOE in their *Strategic Sustainability Performance Plan (SSPP).*[20]

A core part of SLAC's Environment, Safety and Health Policy is to "wisely use and conserve natural resources and conduct our activities in a sustainable manner". The EO and DOE SSPP goals complement SLAC's values on sustainability and provide quantifiable objectives and timeframes, consistent over the federal complex.

4.7.1 Progress on Sustainability Goals

Included below is a summary of progress on key sustainability goals, in the key areas of energy, GHG, water, sustainable building, fuel/fleet, and waste, as reported in SLAC's *Site Sustainability Plan*.

Table 4-5 Progress Against Select Sustainability Goals of EO 13423/13514 and the DOE SSPP through FY 2011

Category	EO 13423/13514/DOE Goal	Progress
Energy Reduction	Reduce energy intensity 3 percent/year or 30 percent by FY 2015 relative to FY 2003 baseline.	SLAC has reduced its energy intensity by 49 percent between FY 2011 and FY 2003 baseline. This was due in large part to reduced electrical demand as a result of the completion of the BaBar Experiment in FY 2008. SLAC will continue to incorporate energy savings projects with a good return on investment to reduce energy intensity.
Renewable Energy	Implement at least one on-site renewable energy generating system by FY 2010.	Building 901, completed in FY 2010, was constructed with an 18.8 kilowatt roof-mounted photo-voltaic system.
	Procure 7.5 percent of the site's annual electricity consumption from renewable sources by FY 2013 and thereafter.	Renewable Energy Certificates (RECs) are being purchased equivalent to 7.5 percent of annual energy.

[19] SLAC National Accelerator Laboratory, *Site Sustainability Plan FY 2012*, December 2011.

[20] U.S. Department of Energy, *2011 Strategic Sustainability Performance Plan*.

Category	EO 13423/13514/DOE Goal	Progress
Greenhouse Gas Reduction	Reduce Scope 1 & 2 GHG 28 percent by FY 2020 from an FY 2008 baseline	SLAC has reduced Scope 1 & 2 GHG by 41 percent in FY2011 from the FY 2008 baseline. This was due in large part to reduced electrical demand as a result of the completion of the BaBar Experiment in FY 2008.
Water Reduction	Reduce potable water consumption intensity 2 percent per year through 2020 or 26 percent by 2020 relative to the FY 2007 baseline and reduce industrial, landscaping, and agricultural water consumption by 2 percent a year through FY 2020 or 20 percent by FY 2020 relative to the FY 2010 baseline	The total site water usage has decreased by 47 percent from the FY 2007 baseline through FY 2011. This was due to the BaBar experiment completion and associated reduction in makeup water for cooling towers and leak repairs made. In FY 2010, new controllers and meters were installed on landscaping circuits and meters were installed on all cooling tower make up circuits to enable further water consumption reduction efforts.
Sustainable Building	All new construction, major renovations, and alterations of buildings greater than a 5000 gross square footage must comply with the Guiding Principles of high performance and sustainable building (HPSB) and, where the work exceeds $5 million, achieve Leadership in Energy and Environmental Design (LEED) Gold certification.	Building 901, completed in FY 2010, received LEED Gold certification. The renovation of Building 028 was completed in FY 2011 and was designed to meet LEED Gold certification, which is currently pending. New construction Building 052 and Building 053, and Building 041 renovation are being designed to meet LEED Gold standards or better.
	15 percent of buildings larger than 5,000 gross square feet to be compliant with the five guiding principles of HPSB by FY 2015	SLAC goal is for nine buildings to be compliant with the Guiding Principles by FY 2015, including the five buildings that have or are planned to achieve LEED Gold certification referenced above, and the renovation of four existing buildings.
Petroleum Fuel Reduction	10 percent annual increase in fleet alternative fuel consumption by FY 2015 relative to a FY 2005 baseline.	The SLAC fuel station was converted to dispense E-85 Ethanol alternative fuel in July 2010. SLAC dispensed 282 gallons of E85 in FY 2010 and 3,685 gallons in FY 2011.
	2 percent annual reduction in fleet petroleum consumption by FY2015 relative to a FY 2005 baseline.	SLAC has reduced fuel consumption by 22 percent for FY 2011 relative to a FY2005 baseline. This meets the cumulative reduction target of 12 percent between FY 2005 and FY 2011.

Category	EO 13423/13514/DOE Goal	Progress
Waste Reduction	Divert at least 50 percent non-hazardous solid waste (excluding construction and demolition (C&D) debris). Divert 50 percent of C&D materials by FY 2015.	In FY 2011, SLAC diverted 55 percent of its non-hazardous solid waste (excluding C&D debris). In FY 2011, SLAC diverted 98 percent of the C&D debris generated from building projects.

4.8 Environmental Planning

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

4.8.1 SLAC Long Range Development Plan

In December 2002, SLAC published its LRDP, prepared by both SLAC's LRDP Working Committee and the professional land use, environmental, and campus planners from the Stanford University Architect and Planning Office. The most recent revision of the LRDP was completed in 2010.

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

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

4.8.2 National Environmental Policy Act

SLAC developed its formal NEPA program in 1992, and it is jointly administered by the DOE and the EP Department. Under this program, proposed projects and actions are reviewed to evaluate NEPA documentation requirements, as required. The EP Department works in conjunction with the DOE SSO and the DOE NEPA Compliance Officer to determine which of the following three categories of NEPA documentation, presented in increasing order of complexity, is required:

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

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

SLAC prepared and reviewed NEPA documentation for 61 projects during 2011. To be consistent with the DOE NEPA Openness Policy, SLAC posts its CX determinations for public availability at the link provided below.[21] The projects were relatively minor in scope and environmental impact, and were all classified as CX. Each project was assigned a CX reference number. Completed NEPA documents are forwarded to the DOE SSO and the NEPA Compliance Officer located at the Integrated Support Center, Oak Ridge Office, if necessary, for review and approval.

[21] http://www-group.slac.stanford.edu/esh/groups/ep/epg/nepa.htm

5 Environmental Radiological Program

5.1 Introduction

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

As in past years, the dose that members of the public receive due to SLAC operations is a very small fraction of the dose received from natural background radiation in CY 2011. In addition, the potential radiation dose to the public and the radiation-related impacts to the environment from SLAC operations were significantly below all regulatory limits.

5.2 Sources of Radiation and Radioactivity

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

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

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

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

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

Table 5-1 Activation Products in Water or Air

Radioactive Element	Half-life	Primarily Produced In
Oxygen (^{15}O)	123 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

^{3}H = tritium

5.3 Monitoring for Direct Radiation

DOE regulations (10 CFR 835) require SLAC to demonstrate that radiation and radioactivity from SLAC did not cause any member of the public to receive a radiation dose greater than 100 millirems (mrem, a unit used to quantify radiation dose to humans) during the year.[22] In CY 2011, the maximum dose that could have been received by a member of the public due to direct radiation from SLAC was 0.42 mrem (4.2E-03 milli-Sievert (mSv), which is the International System of units for dose equivalent). This is 0.42 percent of the 100 mrem regulatory limit. This maximally exposed individual (MEI) is located near the Addison Building Area, a property adjoining SLAC to the north.

During CY 2011, SLAC measured direct radiation at 43 locations around the SLAC site boundary to determine the potential radiation dose to a member of the public. Readings from these site-boundary dosimeters used to measure radiation were recorded each calendar quarter. The annual doses from these dosimeters were used to estimate the doses to the MEI based on continuous occupancy of 24 hours a day, 365 days per year. Landauer Incorporated, accredited by the DOE's Laboratory Accreditation Program and National Voluntary Laboratory Accreditation Program as a dosimeter supplier, provided and processed the dosimeters. Results from these dosimeters were also used to calculate the collective dose to the population (about 5 million) that lives within 80 kilometers (km) (50 miles) of SLAC, which was 1.38 person-rem for CY 2011.

Section 5.8 and Table 5-6 summarize annual doses to the MEI from both direct radiation (0.42 mrem) and airborne radioactivity (1.04E-03 mrem) and show how those doses compare with those from natural background radiation.

5.4 Assessment of Airborne Radioactivity

As required by 40 CFR 61 Subpart H, SLAC files an annual report to the USEPA that describes the possible sources, types, and quantities of airborne radioactivity released into the atmosphere.[23] As detailed below, the resulting dose to the MEI of the off-site general public from CY 2011 releases of airborne radioactivity was 1.04E-03 mrem (1.04E-05 mSv). This is well below the regulatory limit which requires releases to be limited so that no member of the public receives a dose in excess of 10 mrem (0.1 mSv) in any one year. In addition, there is no individual release point within SLAC facilities exceeding the 0.1 mrem/year (yr) (0.001 mSv) limit for the continuous monitoring requirement (the maximum value was 1.03E-3 mrem/yr from the Positron Vault release point during the Facility for Advanced aCcelerator

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[22] United States Department of Energy, 10 CFR 835, *Occupational Radiation Protection*, http://www.hss.energy.gov/healthsafety/wshp/radiation/rule.html

[23] SLAC National Accelerator Laboratory, Environment, Safety, and Health Division. Radiation Protection Department, *Radionuclide Air Emissions Annual Report – CY 2011* (June 2012)

Experimental Tests (FACET) operations). The collective effective dose equivalent to the population within 80 km of SLAC's site boundary (estimated 5 x 10^6 persons) due to releases of airborne radioactivity at SLAC in CY 2011was calculated to be 5.4 person-mrem.

The Positron Vault release point (from the FACET operations) contributes about 84 percent of the total airborne radioactivity released to the atmosphere from SLAC operations. Approximately 99 percent of the 1.04E-3 mrem (MEI dose) can be attributed to emissions from the FACET operations. Approximately 8.03E-4 mrem (or 77 percent of the MEI dose) can be attributed to ^{13}N radioisotope. The MEI location that corresponds to the highest calculated effective dose equivalent (EDE) for releases in CY 2011 is at the North end of the Positron Vault, 560 meters from Sector 20 of the linac.

The maximum dose from a single release point (the Positron Vault release point) is 1.03E-3 mrem/yr, which is less than the 0.1 mrem/year limit for continuous monitoring requirement.

As detailed in the annual NESHAPs report, the released airborne radioactivity was calculated, based on conservative information about accelerator operations in CY 2011. 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 the USEPA software CAP88. In addition to providing information on the maximum individual doses, SLAC also assessed and reported the collective dose to the population that lives within 80 km (50 miles) of SLAC, which was 5.4 person-mrem for CY2011.

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 CY 2011

Category	Radioactive Element	Activity (Ci)
Tritium	Hydrogen (^3H)	n/a
Krypton-85	Krypton (^{85}Kr)	n/a
Noble gases ($T_{1/2}$ < 40 days)	Argon (^{41}Ar)	0.016
Short-lived activation products ($T_{1/2}$ < 3 hr)	Oxygen (^{15}O)	0.42
	Nitrogen (^{13}N)	0.785
	Carbon (^{11}C)	0.084
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		1.305

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 CY 2011 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 CY 2011, SLAC released 0.004 percent of the applicable limits (only 2.08×10^{-4} Ci for tritium).

Throughout 2011, SLAC sampled and analyzed wastewater discharges. Total activity released during CY 2011 is summarized in Table 5-3.

As required by regulations, at the end of each calendar quarter of CY 2011, SLAC reported the results of wastewater monitoring and discharge to the SBSA.[24]

Table 5-3 Radioactivity in Wastewater Released into Sanitary Sewer in CY 2011

Category	Radioactive Element	Activity (Ci)	Annual Release Limit (Ci)
Tritium	Hydrogen (^{3}H)	2.08×10^{-4}	5
Activation products ($T_{1/2}$ > 3 hr)	Sodium (^{22}Na)	0	1 *
	Beryllium (^{7}Be)	0	
Total radioiodine	na	0	
Total radiostrontium	na	0	
Total uranium	na	0	
Plutonium	na	0	
Other actinides	na	0	

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

na – not applicable

Table 5-4 summarizes the historical results of wastewater monitoring for CY 2001 through CY 2011. 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.

[24] Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Radiation Protection Department, *Radioactivity in Industrial Wastewater for the Period of 1 January 2011 to 31 March 2011, for the Period of 1 April 2011 to 30 June 2011, for the Period of 1 July 2011 to 30 September 2011, and for the Period of 1 October 2011 to 31 December 2011*

Table 5-4 Summary of Radioactivity in SLAC Wastewater, CY 2001– 2011

Year	Radioactive Element	Activity (Ci)	Percentage of Annual Limit
2001	Hydrogen (^{3}H)	$2.1x10^{-3}$	0.04
2002	Hydrogen (^{3}H)	$2.4x10^{-2}$	0.5
	Sodium (^{22}Na)	$5.1x10^{-5}$	1.4 *
	Beryllium (^{7}Be)	$1.4x10^{-2}$	
2003	Hydrogen (^{3}H)	$4.1x10^{-4}$	0.008
2004	Hydrogen (^{3}H)	$2.0x10^{-2}$	0.4
2005	Hydrogen (^{3}H)	$1.4x10^{-3}$	0.03
2006	Hydrogen (^{3}H)	$1.2x10^{-3}$	0.02
2007	Hydrogen (^{3}H)	2.3	46
2008	Hydrogen (^{3}H)	1.8	36
2009	Hydrogen (^{3}H)	$9.1x10^{-5}$	0.002
2010	Hydrogen (^{3}H)	$1.2x10^{-2}$	0.24
2011	Hydrogen (^{3}H)	$2.08X10^{-4}$	0.004

* ^{22}Na and ^{7}Be 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 CY 2011 (and in all previous years), no radioactivity above natural background was found in any stormwater or storm drain sediment samples.

SLAC reported the results of the CY 2011 stormwater monitoring (including checks for radioactivity) to the RWQCB. [25]

5.5.3 Groundwater

Throughout CY 2011, SLAC performed in-house analysis of water samples from monitoring wells for the presence of radioactivity each time the wells were sampled under SLAC's groundwater Self-Monitoring Program (SMP) as described in Chapter 6 of this report. The SMP includes a Groundwater Sampling Plan which outlines the frequency of sampling the wells. Groundwater samples collected as part of the SMP are also sent to an external California-certified laboratory for independent tritium analysis. The results from the external laboratory are in general agreement with the in-house analysis.

With the exception of two of the four monitoring wells listed in Table 5-5, no radioactivity above natural background was detected in any of the groundwater samples. SLAC has over 100 wells that are sampled for tritium. 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. The drinking water standard for tritium is 20,000 picoCuries per liter (pCi/L) under 22 CCR 64443 and 40 CFR 141.66. In addition, groundwater is not used at SLAC for any purpose because of its very low well yields. Even if there was an adequate supply of

[25] SLAC National Accelerator Laboratory, Environment, Safety, and Health Division, Environmental Protection Department, *2011 -2012 Annual Report for Stormwater Discharges Associated with Industrial Activities* (June 30, 2012, to be submitted to Rico Duazo, San Francisco Bay RWQCB)

groundwater available at SLAC, it could not be used as drinking water due to the naturally high content of total dissolved solids (TDS).

Table 5-5 Summary of Tritium Concentrations Measured in Four Monitoring Wells in CY 2011

Period (Month)	Jan. to March	April to June	July to Sept.	Oct. to Dec.
EXW-4				
Avg ^3H (pCi/L)	2375	2158	2380	1500
percent of DWS[1]	12	11	12	8
No. of Samples	1	1	1	3
MW-30				
Avg ^3H (pCi/L)	< 500[2]	< 500[2]	< 500[2]	< 500[2]
percent of DWS[1]	na	na	na	na
No. of Samples	1	1	1	1
MW-81				
Avg ^3H (pCi/L)	< 500[2]	< 500[2]	< 500[2]	< 500[2]
percent of DWS[1]	na	na	na	na
No. of Samples	1	1	1	1
MW-94				
Avg ^3H (pCi/L)	2190	4623	5042	4226
percent of DWS[1]	11	23	25	21
No. of Samples	1	1	1	3

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 CY 2011

na – not available

5.6 Assessment of Radioactivity in Soil

Throughout CY 2011, SLAC did not need to conduct sampling and analysis of radioactivity in soil because there were no excavations in regions that can potentially be activated from SLAC operations.

5.7 Release of Property Containing Residual Radioactive Material

All property, both real and personal, exposed to any process at SLAC that could cause it to have surface or volumetric contamination have to be measured using appropriate instruments. These instruments have increasing levels of sensitivity. The materials are verified to have no detectable radioactivity before they are permitted to be released from radiological controls. At SLAC, property that had any detectable radioactivity is identified as radioactive, and is either retained for appropriate reuse on site or is disposed of as radioactive waste. Only material which did not have detectable radioactivity can be released from radiological controls. Therefore, property releases at SLAC do not add to the potential public dose.

Following the above protocol, 280 concrete blocks were disposed at a landfill in CY 2011. In addition, 44,226 lbs of metal were recycled from the PEP-II accelerators and BaBar detector.

A radiation portal gate monitor was installed at SLAC in CY 2011, and is also being used to screen full truckloads of metals prior to release to the recycling center.

5.8 Potential Dose to the Public

The maximum possible dose to members of the public due to SLAC operations 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 CY 2011, namely direct radiation (0.42 mrem) and airborne radioactivity (1.04E-03 mrem). Releases of radioactivity in water and property were too small to result in a radiation dose to a member of the public under any credible scenario. Table 5-6 also compares the CY 2011 dose results with regulatory limits and natural background.

Table 5-6 Summary of Potential Annual Doses due to SLAC Operations in CY 2011

	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	0.42 mrem	1.04E-03 mrem	0.42 mrem	1.38 (direct) + 0.005 (air) = 1.385 person-rem
DOE Radiation Protection Standard	100 mrem	10 mrem	100 mrem	na
SLAC Maximum Dose as Percentage of DOE Standard	0.42%	0.0104%	0.42%	na
Dose from Natural Background[26]	100 mrem	200 mrem	300 mrem	1,667,000 person-rem
SLAC Maximum Dose as Percentage of Natural Background	0.42%	0.0005%	0.14%	8.3E-05%

na – not applicable

% - percent

The MEI due to direct radiation is located near the business offices in the Addison Building area. Like previous years' calculations, the CY 2011 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 5-7 presents the maximum dose potentially received by a member of the public from both direct radiation and airborne radioactivity due to SLAC operations in CY 2001 through CY 2011 and compares it with the average dose due to natural background radiation and radioactivity.

[26] National Council on Radiation Protection and Measurement, NCRP Report No. 94, *Exposure of the Population in the United States and Canada from Natural Background Radiation*, http://www.ncrponline.org/Publications/94press.html

Table 5-7 Potential Annual Dose (mrem/yr) to Maximally Exposed Individual, CY 2001–2011

Year	SLAC Direct and Airborne Radiation (mrem)	Average, Total Natural Background Radiation (mrem)	Percentage of SLAC Dose to Natural Background
2001	5.3	300	1.8%
2002	2.1	300	0.7%
2003 *	0.2	300	0.07%
2004	0.2	300	0.07%
2005	0.3	300	0.1%
2006	0.5	300	0.2%
2007	0.1	300	0.03%
2008	0.05	300	0.02%
2009	0.06	300	0.02%
2010	0.13	300	0.04%
2011	0.42	300	0.14%

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

5.9 Biota Dose

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

- Aquatic animals: should not exceed 1 rad (unit used to quantify radiation exposure)/day
- Terrestrial plants: should not exceed 1 rad/day
- Terrestrial animals: should not exceed 0.1 rad/day

Rad, instead of rem, is used here as rad is the unit to quantify radiation dose in a material, in this case animal and plants.

5.9.1 Dose to Biota from Direct Radiation

In CY 2011, SLAC monitored dose and dose rate at approximately 400 on-site locations (most are outside the accelerator shielding and some inside the shielding) using passive radiation dosimeters posted for six month periods. For each period, the average dose rate among these 400 dosimeters was found to be less than 0.0002 rad/day[27] (dominated by those inside the shielding), and the maximum dose rate was less than 0.01 rad/day (inside the shielding). Based on the results of this monitoring program and the fact that we know animal populations could not have been present except in locations with the low dose rates outside the shielding, doses to plant and animal populations at SLAC were well within the limits of the DOE standard throughout CY 2011.

[27] RP Note RP-11-08, *Monitoring Results for Integrated Area Dose around SLAC for Period from January 2011 through June 2011*; RP Note RP-12-07, and, *Monitoring Results for Integrated Area Dose around SLAC for Period from July 2011 through December 2011*.

5.9.2 Dose to Biota from Activation Products

In CY 2011, SLAC tested water and soil 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 CY 2011, but plant and animal populations have no opportunity to come in contact with industrial wastewater at SLAC. Since the radioactivity concentrations in these sampled media are much lower than from direct radiation, there is no possibility that plants or animals will receive dose rates that exceed the limits of the standard due to radioactive activation products at SLAC.

In CY 2011, no groundwater was found with tritium concentrations in excess of the human drinking water standard of 20,000 pCi/L set by state and federal regulations. Section 5.5.3 summarizes the CY 2011 results of monitoring for radioactivity in groundwater. There is no potential that plants or animals will receive dose rates that exceed the limits of the standard due to radioactive activation products in groundwater at SLAC.

5.10 Low-level Radioactive Waste Management

SLAC generates low-level radioactive waste (LLRW) sporadically from routine operations, repairs, and special projects or experiments. Non-routine operations generate the bulk of LLRW at SLAC, amounting to 726 cubic feet for CY 2011. Additionally, SLAC generated a total of 129 cubic feet of routine low level wastes, 123 cubic feet of LLRW and six cubic feet of mixed LLRW. The minimization of LLRW is accomplished through training of 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 CY 2011, SLAC shipped 2,683 cubic feet of LLRW (a total of 1,845 mCi and 14,486 kilograms) to appropriate treatment and disposal facilities for low-level radioactive waste. Legacy waste accounted for 70 percent of the volume shipped for disposal. An effort to reduce the amount of materials no longer needed for SLAC's mission continues. SLAC permanently removed 133 sealed sources from the inventory; these were sent to Energy Solutions for processing prior to burial at the Nevada National Security Site, formerly the Nevada Test Site.

6 Groundwater Protection and Environmental Restoration

6.1 Introduction

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

6.2 Background Conditions

The document *The Geology of SLAC* [28] provides a detailed description of the geology of SLAC. Based on many tests in exploratory borings and wells, the hydraulic conductivity of SLAC's bedrock is overall much less than the range of that generally accepted as representing natural aquifer material. The groundwater at SLAC is not used as a drinking water source because of low yield as well as naturally occurring high TDS content.

6.3 Areas with Potential Impact from Chemicals

A SLAC 1994 report entitled *Summary and Identification of Potentially Contaminated Sites*[29] provides a summary of areas that may have been impacted by chemicals of concern from past SLAC operations. Information for the report was collected from a variety of sources including incident reports, aerial photographs, operations records, reports on previous investigations, and interviews with personnel throughout the facility. Additional environmental summary documents were completed in 2006 through 2011. The *2006 Environmental Baseline Report*[30] (EBR) provided an inventory of facilities and areas at SLAC that were considered to have the potential to have chemical impacts, and summarized the results of the environmental investigations and remediation activities that had occurred. The EBR identified COPCs, defined Investigation Areas, and provided a decision process for determining which areas still required additional actions. At that time, The *Work Plan for the Remedial Investigation and Feasibility Study*[31] (RI/FS WP) provided additional description and updated the status of investigation areas, defined the four Operable Units (OUs) at SLAC, and described the framework for completing the environmental investigations and remedial actions at the facility. As discussed further in Section 6.5, remedial investigations and remedial actions at each OU have been completed at SLAC in accordance with the Board Order and RI/FS WP.

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[28] Stanford Linear Accelerator Center, *The Geology of SLAC* (SLAC-I-750-3A33X-002, November 2006) http://www-group.slac.stanford.edu/esh/groups/ep/geology/geologicreport.pdf

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

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

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

6.4 Strategies for Controlling Potential Sources of Chemicals

Strategies for chemical source control involve measures to control known soil or groundwater impacts as discussed in this chapter, and procedures and requirements to avoid practices that could adversely affect soil and groundwater as discussed in Chapter 4. These procedures include the site's SWPPP [32] which discusses BMPs for preventing adverse impacts from spills and operations at SLAC.

6.5 Restoration Activities

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

The general 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 impacts, 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 2011, SLAC had generally reached and continued work towards completion of the fourth step. Restoration work conducted to date generally consists of two categories, soil excavation to remove localized areas of PCB or other chemically-impacted soils, and extraction and treatment of solvent-impacted soil vapor and groundwater. There are four major areas impacted with COPCs in groundwater: the Former Hazardous Waste Storage Area, Former Solvent Underground Storage Tank Area, the Test Lab/Central Lab area, and the Plating Shop Area. Each of these is described in Section 6.7, along with a description of sites where soil removal has recently been conducted.

6.6 Regulatory Framework

In October 2009, the RWQCB issued an updated Board Order (No. R2-2009-0072) for SLAC for the investigation and remediation of impacted soil and groundwater resulting from historical spills and leaks that occurred during the course of operations at SLAC. The Board Order addresses release sites at SLAC and consolidates the investigation and cleanup activities at the facility. It also rescinds the Board Order issued in May 2005. In January 2006, the RWQCB was designated by the State of California as the Administering Agency (i.e., lead agency) for the environmental cleanup work at SLAC.[33] As the lead agency, the RWQCB has the responsibility to determine the adequacy and extent of cleanup, issue necessary authorizations and permits, and following the determination that an approved remedy has been

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

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

accomplished, issues a certificate of closure. The RWQCB has specified site cleanup to residential standards for un-restricted land use, [34] consistent with how the SLAC property is zoned.

In accordance with the Board Order and the RI/FS WP, the framework for ongoing cleanup activities parallels as practicable the CERCLA RI/FS Process, whereby a sequential series of documents are prepared for accessible areas within each of the four OUs established at SLAC. These OUs include: 1) the Groundwater VOC OU, 2) the Tritium OU, 3) the West SLAC/Campus Area/IR-8 Drainage Channel OU (WSLAC OU), and 4) the Research Yard/SSRL/IR-6 Drainage Channel OU (RY OU). However, it is noted that while SLAC follows the CERCLA RI/FS process, SLAC was not listed in the National Priorities List as a Superfund site because the USEPA determined that the conditions at the site did not warrant inclusion.

Many of the RI/FS documents required under the Board Order for each OU have been completed or are under preparation. These documents include a detailed summary of the nature and extent of the impact (RI reports), baseline human health and ecological risk assessments (Risk Assessment or RA Reports), followed by a thorough review of remedial options (Feasibility Study or FS Reports) to address any remaining soil and groundwater remediation issues at the site. The reports take into consideration the removal actions already implemented and incorporate, in accordance with DOE guidance, an assessment of the NEPA values for the interim actions planned for the OU. Remedial alternatives are evaluated in the FS reports against a number of criteria including effectiveness, ability of implementation, cost, and community acceptance. Upon RWQCB approval of the RI, RA, and FS reports, as applicable, Remedial Action Plans (RAP) and Remedial Design (RD) reports are prepared for each OU. The RAPs outline the steps required to implement the proposed remedial actions required to achieve the cleanup objectives for the site and the RD reports provide the engineering design details for the remedial action. Table 6-1summarizes the status for the RI/FS deliverables required under the Board Order as of the end of FY 2011.

Table 6-1 RWQCB Order Deliverables Status

Operating Unit	RI Report	RA Report	FS Report	RAP	RD Report
Groundwater VOC	Complete	Complete	Complete	Complete	Complete
WSLAC	Under preparation	-	-	-	-
RY	Complete	Draft complete	Under preparation	-	-
Tritium	Complete	Complete	Complete [35]	na [36]	na

na – not applicable

Monthly meetings regarding site cleanup status also continued in 2011, regularly attended by the Core Team, a decision-making body consisting of representatives from the RWQCB, DOE Office of Science, DOE Environmental Management, Stanford University, and SLAC. As needed, members of the technical

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

[35] A Tritium OU Monitoring Plan was prepared in lieu of a FS Report and approved by the RWQCB

[36] Per the RWQCB approved Tritium RI Report, a Remedial Action Plan (RAP) and Remedial Design (RD) Report are not necessary at this time

team are present at these meetings. The monthly Core Team meetings are moderated by an outside facilitator.

6.7 Groundwater Characterization Monitoring Network

As part of the Board Order, SLAC implements a SMP that includes a Groundwater Sampling Plan with a schedule for collecting groundwater samples from extraction and monitoring wells, surface water samples, and sediment samples from select catch basins and drainage channels. The SMP Groundwater Sampling and Analyses Plan[37] outlines the frequency at which monitoring samples are to be collected and the chemicals to be analyzed for. Figures 6-1 through 6-3 show the areas where wells are used for monitoring.

The six locations where plume monitoring occurs are listed below and shown on Figures 6-2 and6-3.

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

[37] Stanford Linear Accelerator Center, *Self-Monitoring Program Sampling and Analysis Plan, Revision 2* (SLAC-I-750-0A32M-005 R002) 2008.

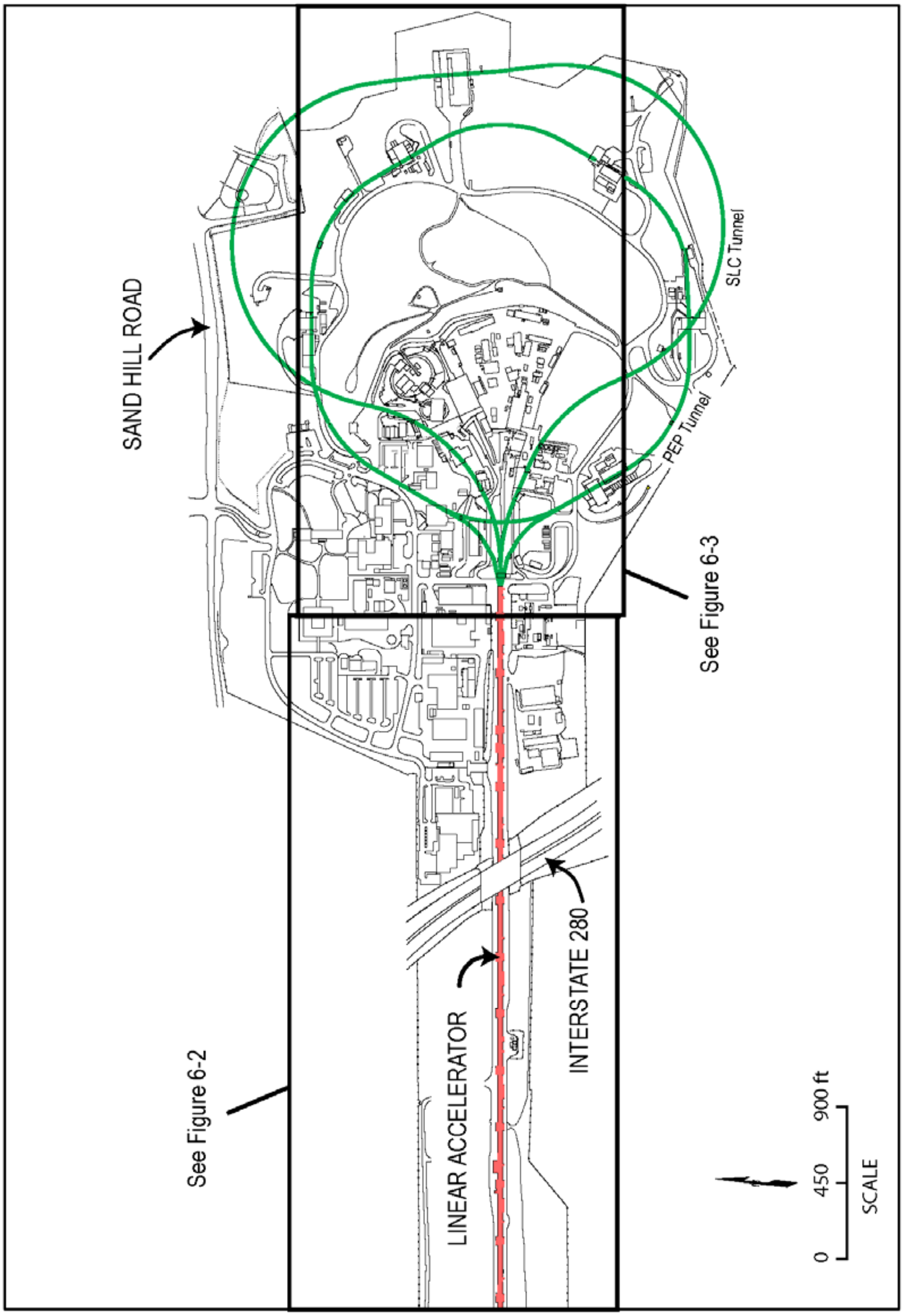

Figure 6-1 Groundwater Characterization Monitoring Network

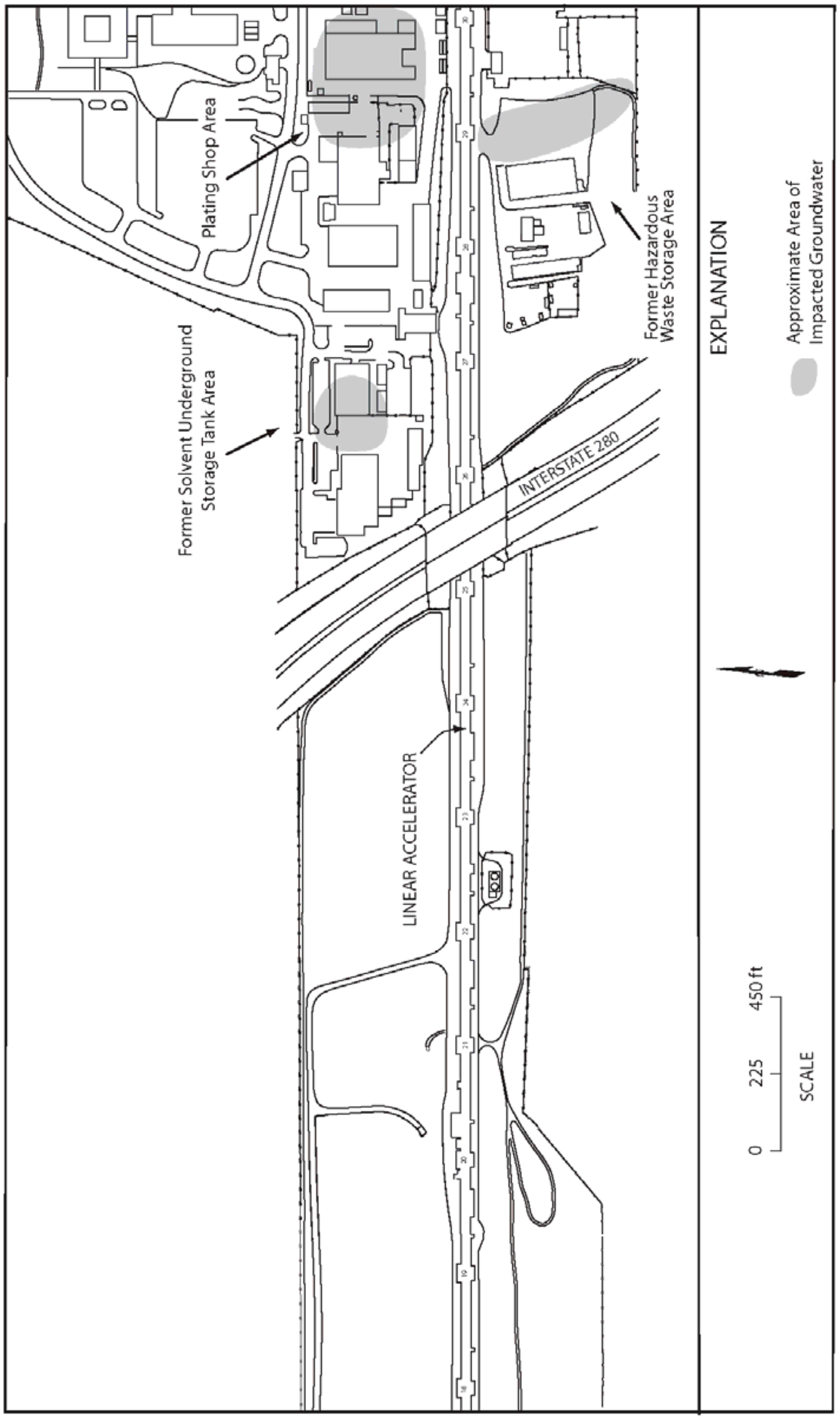

Figure 6-2 Westside Groundwater Network and Impacted Area

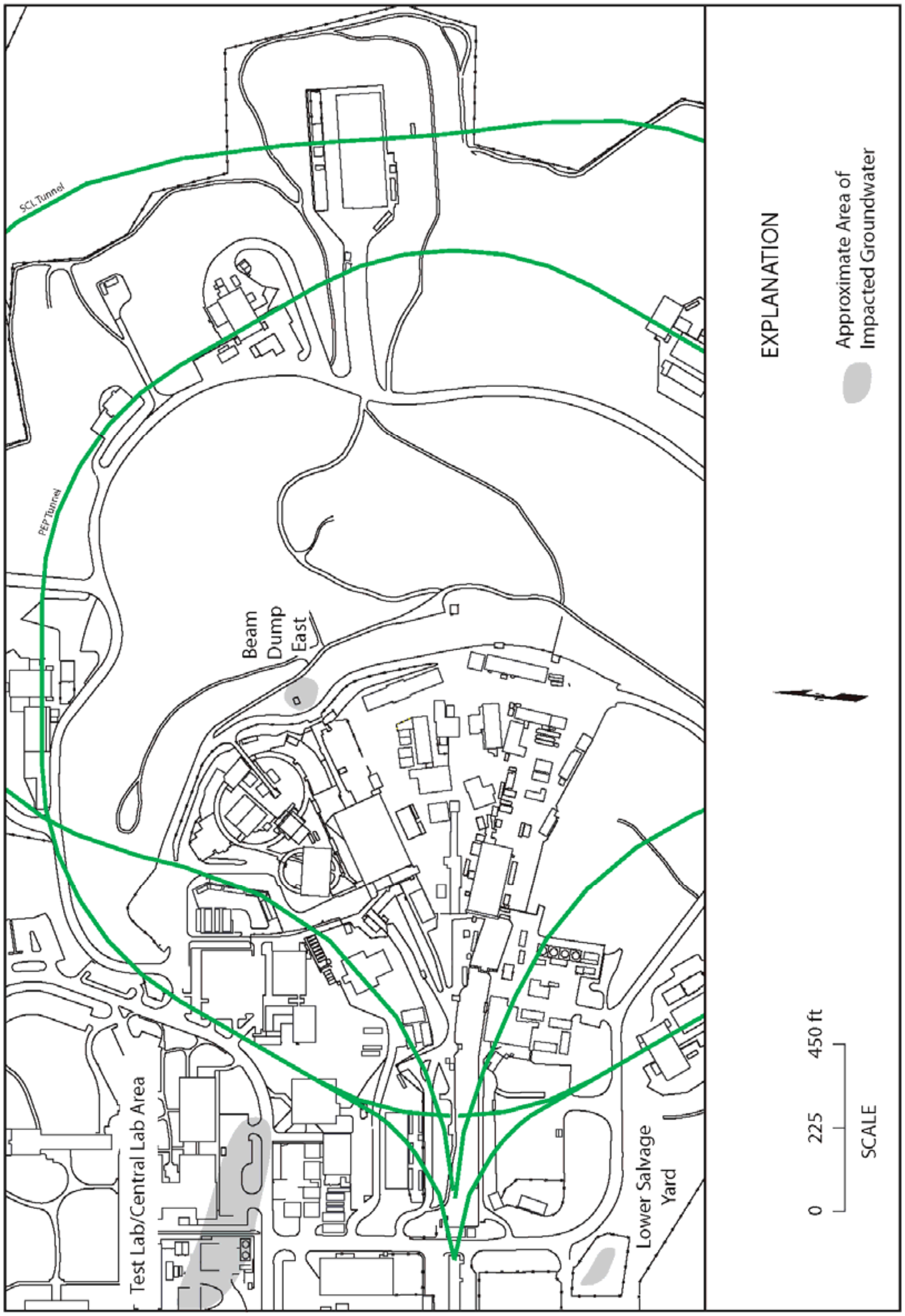

Figure 6-3 Eastside Groundwater Network and Impacted Areas

SLAC has 178 wells across the site, 64 of which are extraction wells, seven wells are used as peizometers (wells only used to measure groundwater elevation), three wells are inactive, and the remaining 104 wells are used as monitoring wells. Of the 104 monitoring wells, 91 wells are used to monitor general groundwater quality and COPCs in the major areas of the facility that historically or currently store, handle, or use chemicals, and 13 wells are used for general site-wide surveillance. Table 6-2 summarizes the wells at SLAC by location, number of wells per location, and purpose of the wells.

Table 6-2 Monitoring Locations and Number of Wells

Location		Number of Wells
Plume Monitoring		
Beam Dump East		9
Former Hazardous Waste Storage Area		24
Former Solvent Underground Storage Tank		21
Lower Salvage Yard		4
Plating Shop Area		26
Test Lab and Central Lab		7
	Subtotal	*91*
Extraction		
Former Solvent Underground Storage Tank		8
Former Hazardous Waste Storage Area		23
Plating Shop Area		26
Test Lab and Central Lab		7
	Subtotal	*64*
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*
Piezometer		
Plating Shop Area		4
Former Hazardous Waste Storage Area		3
	Subtotal	*7*
Inactive		
Former Solvent Underground Storage Area		3
	Subtotal	*3*
TOTAL		*178*

The COPCs in groundwater at SLAC are primarily VOCs and to a lesser extent semi-volatile organic compounds (SVOCs). Four of the six locations, have remediation systems that extract soil vapor and groundwater. Construction of treatment systems for two of the sites, the PSA, and TL/CL, was completed in late 2010 and startup operations completed in early 2011. Operating data indicate that all the remediation systems have helped to decrease concentrations of COPCs in groundwater and soil vapor. Preliminary Cleanup Goals (PCGs) at SLAC have been established for groundwater and soil vapor. The systems at the FSUST and FHWSA, and the recently constructed systems at the PSA and TL/CL have been designed with the goal of achieving these PCGs.

Groundwater samples were collected at least once from 108 wells in 2011 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 2011 [38] and the summer of 2011.[39] The groundwater analytical results were generally within each well's historical range of concentrations. Samples were analyzed for one or more of the following:

- Total petroleum hydrocarbons (TPH)
- Metals
- Polychlorinated biphenyls (PCBs)
- Tritium
- Volatile organic compounds (VOCs)
- Semi-volatile organic compounds (SVOCs)

6.8 Site Descriptions and Results

The groundwater Investigation Areas are described below, including four VOC-impacted areas (TL and CL are combined) and one low-level tritium plume impacted area. Under the Board Order, the formal FS and RAP reports for the four VOC-impacted groundwater Investigation Areas were prepared by SLAC and approved by the RWQCB in January 2010 and August 2010, respectively. The RD report for the Groundwater VOC Operable Unit,[40] which includes the four VOC-impacted plume areas, was approved by the RWQCB in March 2011, and construction of the selected remedy (dual phase extraction - DPE) at the four VOC-impacted areas were completed by December 2010.

6.8.1 Former Solvent Underground Storage Tank Area

A chemical plume in groundwater associated with the FSUST is located in proximity to the SLAC Plant Maintenance building in the northwestern portion of the main SLAC campus (Figure 6-2). The FSUST was used to store organic solvents from 1967 to 1978. A pressure test performed on the FSUST in 1983 indicated a leak. The FSUST and accessible chemically impacted soil were removed in December 1983. A network of 21 monitoring wells and eight extraction wells were subsequently installed, and groundwater is monitored for VOCs and SVOCs.

[38] Stanford Linear Accelerator Center, *Semi-annual Self-Monitoring Report, Winter 2011* (SLAC-I-750-2A15H-035, June 2011)

[39] SLAC National Accelerator Laboratory, *Semi-annual Self-Monitoring Report, Summer 2011* (SLAC-I-750-2A15H-037, December 2011)

[40] C/P/E, *Remedial Design Report for the Groundwater VOC Operable Unit*, (C/P/E SL-22GW-RPTS-CD000001 R0, November 2010)

An interim groundwater extraction and treatment system was installed in 2001 and upgraded in 2007 with a soil vapor extraction component. The DPE operations, which started at the FSUST on October 18, 2007, increased the mass removal rate of VOCs and SVOCs from an average of 0.14 lbs per day to an average of 2.2 lbs per day for the remainder of 2007. In 2008 and 2009, the mass removal rates of VOCs and SVOCs were on average 0.57 and 0.47 lbs per day, respectively. In 2010 and 2011, the average mass removal rate declined to 0.035 and 0.013 lbs per day, respectively, as anticipated as the more concentrated sources are removed in the soil vapor.

Since the start up of the remediation system at the FSUST in August 2001 and through December 2011, approximately 974,552 gallons of groundwater have been extracted and treated. Over 868 lbs of VOCs and SVOCs have been extracted from groundwater and soil vapor. Monitoring well data collected thus far indicate a capture zone encompassing the entire plume has been established and chemical data indicate that the plume appears to be continually shrinking in size.

6.8.2 Former Hazardous Waste Storage Area

The FHWSA was in use as a storage area from approximately 1973 to 1982. Following cessation of its use as a storage area, PCBs were found in shallow soils. As a result, several inches of topsoil were removed. A monitoring well was installed in this area in 1990, and VOCs were detected in the groundwater. Since then, two passive soil gas surveys have been performed, 22 monitoring wells, 23 DPE wells, and 18 soil gas probes have been installed, and more than 50 soil borings have been drilled at this site. Figure 6-2 shows the current extent of VOCs in the groundwater.

In 2002, a DPE pilot test proved promising to treat impacted soil and groundwater and was recommended as a suitable remediation technology. Two DPE wells were installed at the FHWSA in 2003 as part of an interim dual-phase extraction (IDPE) system. The IDPE system was in operation from December 2003 to March 2006. The design of an interim full scale DPE system for the FHWSA was finalized in 2004 [41] and the construction of the system was completed in March 2006 after six months of construction. The full scale system utilizes 19 groundwater/soil vapor extraction wells and four vacuum-enhanced groundwater extraction wells. Groundwater extraction and treatment began on March 6, 2006. Soil vapor extraction began on April 3, 2006.

At the end of December 2011, the IDPE and subsequent full scale DPE treatment systems (selected RAP remedy) at the FHWSA extracted a cumulative combined total of 1,651,398 gallons of groundwater and removed a cumulative combined total of 39.3 lbs of VOCs via groundwater and soil vapor extraction.

6.8.3 Plating Shop Area

In 1990, three monitoring wells were installed down-gradient of the PSA. Chemicals of interest were detected in all three wells; and an investigation began and included installation o f additional monitoring wells, a soil gas survey, and remediation beneath a steam cleaning pad. A total of 26 monitoring wells are currently located at the PSA (Figure 6-2). Groundwater sampling results indicate that chemicals are present in groundwater within three co-mingled plumes.

Construction of a 26 DPE-well system with additional soil vapor probes and monitoring wells was completed and began operation in late 2010. Four wells were constructed to be used as piezometers. At the end of December 2011, the DPE treatment system at the PSA extracted a cumulative combined total of 1,353,616 gallons of groundwater and removed a cumulative combined total of 5.9 lbs of VOCs via

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

groundwater and soil vapor extraction. The operating DPE system at the PSA was constructed in accordance with the RD report for the Groundwater VOC OU which was formally approved by the RWQCB in 2011.

6.8.4 Test Lab and Central Lab Area

Data from previous investigations, including a soil gas survey, soil borings and monitoring wells installed in the TL/CL have helped delineate the sources of groundwater and soil vapor impacts. Results of the investigation indicated three possible source areas for VOCs, including one adjacent to the TL, and two adjacent to the CL. The final remedial design specified two separate DPE systems at the TL/CL.

Construction of separate DPE-well systems at the TL and at the CL with additional soil vapor probes and monitoring wells was completed in late 2010. At the end of December 2011, the DPE treatment system at the TL and CL extracted, respectively, a cumulative combined total of 131,576 and 378,956 gallons of groundwater. At the same time, the systems at the TL and CL removed, respectively a cumulative combined total of 0.62 and 2.23 lbs of VOCs via groundwater and soil vapor extraction. The operating DPE systems at both the TL and CL were constructed in accordance with the RD report for the Groundwater VOC OU which was formally approved by the RWQCB in 2011.

6.8.5 Beam Dump East

The BDE was used as a subsurface high-energy beam termination point for the End Station A beamline operations and is located in the hillside along the northeastern edge of the research yard. Groundwater is monitored in nine wells and sampled at least two times per year. In 2011, as in previous years, the monitoring of groundwater indicates that the tritium is localized to two wells in the area of the beam dump and present at levels far below the drinking water standards. The BDE is part of the Tritium OU, for which a formal RI report has been prepared by SLAC under the Board Order and approved by the RWQCB in June 2009. In addition, a Monitoring Plan Report (MPR) was prepared by SLAC under the Board Order and approved by the RWQCB in December 2009. The MPR specifies continued groundwater monitoring at the BDE with contingent actions in the unlikely event that monitored tritium levels exceed any established threshold concentrations.

6.8.6 Lower Salvage Yard

Two monitoring wells were installed at the LSY during 2011. The two wells, MW-108 and MW-109 were installed to replace wells MW-26 and MW-71, respectively, which were destroyed in 2010 in preparation for the excavation at the LSY in 2011. There have been minor detections of TPH and VOCs in wells at the LSY. Low levels of TPH continue to be detected in groundwater samples collected at the LSY.

6.8.7 Removal Actions

Soil removal actions were completed at five Group I Investigation Areas (Group I IAs) in 2008 to remove debris and soil impacted with PCBs, TPH, polycyclic aromatic hydrocarbons and/or metals at concentrations above Preliminary Remediation Goals (PRGs) or pre-established cleanup goals. Following the removal action work, the *Group 1 Removal Action Implementation Report* was prepared by SLAC and approved by the RWQCB in April 2009. This report documents the excavation and removal of approximately 5,000 tons of chemically impacted soil and debris from the five areas at SLAC. The report includes a residual risk evaluation and forms the basis for proceeding to the closure process for these specific areas. In 2011, SLAC completed preparation of Closure Summary Packages for the five Group 1 IA’s and in August, 2011, the RWQCB provided approval of the Closure Packages. These closure packages provided the requisite documentation to support the cleanup and site closures at SLAC. The

RWQCB approval of these site closures are the first for SLAC and represent the culmination of several years of collaborative work among DOE, Stanford University, SLAC, and the RWQCB.

More recently, the DOE awarded a contract to C/P/E Environmental Services, LLC, of Atlanta, Georgia (CPE), to help perform soil removal cleanup actions at SLAC. The task order has a three-year performance period (2009-2012) with the primary performance objective of restoring the work areas to conditions that are protective of human health and the environment. The soil removal actions were performed as interim remedial actions based on an Engineering Evaluation and Cost Analysis and in advance of the formal FS report for the West SLAC OU. During the three-year performance period, CPE completed interim soil removal actions at 15 areas within SLAC. As of the end of 2011, these areas included the FHWSA—Artificial Ridge, Clean Landfill Area, Bone Yard, Building 24 and Building 34 Area, LSY, Sector 16 Soil Relocation Area Drainage Swale, the Casting Pad & Building 18 Area, select Klystron Gallery Variable Voltage Substation Areas, Sector 16 Storage Area Drainage Channel, IR-6 Secondary Drainage Channel, Building 007 Area, IR-8 Fill Area, IR-8 Landscape Strip Area, and Upper Salvage Yard Area. These removal actions resulted in the removal of approximately 35,000 cubic yards of impacted soil and debris from the 15 areas.

6.9 Excavation Clearance Program

During 2011, the excavation clearance program continued to support SLAC-wide projects to ensure proper disposal of excavated soil. An excavation permit form must be completed for activities that involve excavation or relocation of soil at SLAC. The permitting process is intended to identify potential hazards associated with excavation work at SLAC and ways to reduce worker exposure to these hazards. These hazards include underground utility lines, chemical contamination, and radiological hazards and ensure proper management and disposal of excavated materials. Sixty-seven projects were supported by this program during 2011.

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