

Annual Site Environmental Report: 2017

September 2018



*Restoring the
Environment*



Photo: D. Sabba

Prepared for the Department of Energy, Office of Science, under contract number DE-AC02-76-SF00515
SLAC National Accelerator Laboratory, Stanford University, Stanford, CA 94309



U.S. DEPARTMENT OF
ENERGY

Office of
Science

SLAC Site Office

SLAC National Accelerator Laboratory
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September 27, 2018

Subject: 2017 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 2017. 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 2017 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 Mitzi Heard of the SSO at (650) 926-5704, or by mail to the address above.

Sincerely,

SIGNATURE ON FILE

Paul Golan
Site Manager
SLAC Site Office

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Preface

To satisfy the requirements of the United States Department of Energy (DOE) SLAC Site Office approved Site Compliance Plan for DOE Order 231.1B, “*Environment, Safety and Health Reporting*,” the Environment, Safety and Health Division (ES&H) of the SLAC National Accelerator Laboratory prepares an annual report describing its environmental programs and activities.

This *Annual Site Environmental Report: 2017* 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.

Acronyms

³ H	tritium
AB	Assembly Bill
AJH	Authority Having Jurisdiction
ASER	Annual Site Environmental Report
ASTs	aboveground storage tanks
ATS	Action Tracking System
BAAQMD	Bay Area Air Quality Management District
BDE	beam dump east
BMP	best management practice
CCR	California Code of Regulations
C&D	construction and demolition
CACM	Contractor Assurance and Contract Management Office
CalARP	California Accidental Release Prevention Program
CAS	Contractor Assurance System
CARB	California Air Resources Board
CB	catch basin
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERS	California Environmental Reporting System
cf	cubic feet
CFR	Code of Federal Regulations
Ci	curie
CIWQS	California Integrated Water Quality System
CMS	chemical management system
COPCs	chemicals of potential concern
CPR	cardiopulmonary resuscitation
CUPA	Certified Unified Program Agency
CWA	Clean Water Act
CY	calendar year
CX	categorical exclusion
DD	Downstream Defender
DOE	United States Department of Energy
DPE	dual-phase extraction
DREP	dosimetry and radiological environmental protection

DWQ	Department of Water Quality
DWS	drinking water standard
EA	Environmental assessment
EBR	Environmental Baseline Report
e.g.	for example
EIS	Environmental impact statement
EMP	Environmental Management Program
EMS	environmental management system
EMT	emergency medical technicians
EO	Executive Order
EP	Environmental Protection Department
EPCRA	Emergency Planning and Community-Right-to-Know Act
ERT	emergency response team
ES&H	Environment, Safety & Health
FACET	Facility for Advanced Accelerator Experimental Tests
FHWSA	Former Hazardous Waste Storage Area
FMS	flow metering station
FS	Feasibility Study
FSUST	Former Solvent Underground Storage Tank
ft ³	cubic feet
FY	fiscal year
gal	gallons
GDF	gasoline dispensing facility
GHG	greenhouse gas
GIS	gas insulated switchgear
GSS	Government Scientific Source
GWP	global warming potential
HAPs	hazardous air pollutants
HPSB	high-performance sustainable building
HMBP	hazardous materials business plan
HSU	hydrodynamic sedimentation unit
i.e.	that is
IAS	Integrated Assessment Schedule
IDPE	interim dual-phase extraction
IGP	industrial general permit
IH	industrial hygiene

IR	interaction region
ISCO	in-situ chemical oxidation
ISEMS	integrated safety and environmental management system
ISM	integrated safety management
IS/MND	Initial Study/Mitigation Negative Declaration
ISO	International Organization for Standardization
KIPAC	Kavli Institute for Particle Astrophysics, and Cosmology
km	kilometer
L	liter
lbs.	pounds
linac	linear accelerator
LCLS	Linac Coherent Light Source
LLRW	low-level radioactive waste
LSY	lower salvage yard
M&O	management and operations
MAPEP	mixed-analyte performance evaluation program
MSub	Master Substation
MEI	maximally exposed individual
mg/L	milligrams per liter
MFPF	metal finishing pre-treatment facility
MPMWD	Menlo Park Municipal Water Department
MPR	monitoring plan report
mrem	milli-rem
mSv	milli-Sievert
MSW	municipal solid waste
na	not available
n/a	not applicable
NAL	Annual Numeric Action Level
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
No.	number
NOI	notice of intent
NOV	Notice of Violation
NPL	National Priorities List
n/r	not required
OU	operable unit

PBR	permit by rule
PCBs	polychlorinated biphenyls
PCGs	Preliminary Cleanup Goals
pCi/L	pico-Curies per liter
PTO	permit to operate
ppm	parts per million
PSA	Plating Shop Area
QA	quality assurance
QC	quality control
RA	risk assessment report
RAP	remedial action plan
REP	Radiological Environmental Protection
RCRA	Resource Conservation and Recovery Act
RD	remedial design report
RI	remedial investigation
RMP	risk management plan
RP	Radiation Protection Department
RWM	radioactive waste management
RWQCB	Regional Water Quality Control Board
RY	research yard
SAP	sampling and analyses plan
SARA	Superfund Amendments and Reauthorization Act
SB	State Bill
SF ₆	sulfur hexafluoride
SIMES	Stanford Institute for Materials and Energy Sciences
SIMS	SLAC Issues and Improvements Management System
SLAC	SLAC National Accelerator Laboratory
SMEs	subject matter experts
SMOP	synthetic minor operating permit
SMP	self-monitoring program
SPCC	spill prevention, control, and countermeasures plan
SPP	Strategic Partnership Program
SSMP	Sanitary Sewer Management Plan
SSO	Department of Energy, SLAC Site Office
SSOF	sanitary sewer overflow
SSPP	Strategic Sustainability Performance Plan

SSRL	Stanford Synchrotron Radiation Lightsource
SVCW	Silicon Valley Clean Water
SVE	soil vapor extraction
SVOCs	semi-volatile organic compounds
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
T&IM	training and information management
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
TSS	total suspended solids
US	United States
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds
WBSD	West Bay Sanitary District
WM	Waste Management Group
WP	Work Plan
XW	extraction well
yr	year
ZWP	Zero Waste Program

Executive Summary

This report provides information about environmental programs during calendar year (CY) 2017 at the SLAC National Accelerator Laboratory (SLAC) in San Mateo County, California. Activities that overlap the calendar year - e.g., stormwater monitoring covering the winter season of 2016/2017 (October 1, 2016 through May 31, 2017) are also included.

Production of an annual site environmental report (ASER) is a requirement established by the United States Department of Energy (DOE) under DOE Order 231.1B for all management and operations (M&O) contractors throughout the DOE complex. SLAC is a federally funded research and development center managed and operated by Stanford University for the DOE.

Under Executive Order (EO) 13693, *Planning for Federal Sustainability in the Next Decade*, and DOE Order 436.1, *Departmental Sustainability*, SLAC effectively implements and integrates the key elements of an Integrated Safety and Environmental Management System (ISEMS) to achieve the site's integrated safety and environmental management system goals. SLAC ensures the site is operated in a safe and environmentally responsible manner, and complies with applicable laws, regulations, standards, and other requirements. 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 2017, SLAC continued to strengthen its management systems. These systems provided a structured framework for SLAC to implement “greening of the government” programs required by EO 13693 and DOE Order 436.1. Overall, management systems at SLAC are effective, supporting compliance with all relevant statutory and regulatory requirements. The following are among SLAC's progress on key environmental goals in the areas of energy, recycling, waste reduction, greenhouse gases, water, sustainable building, and fuel/fleet:

- SLAC recycled 542 tons of metals, including 200 tons removed from the Klystron Gallery, in support of the Linac Coherent Light Source (LCLS) II construction
- SLAC implemented an energy dashboard tool to help monitor each metered building and highlight energy use variations
- SLAC's Zero Waste Program (ZWP) was expanded by one additional building, bringing the total to fifteen buildings in the program. Approximately 75 percent of SLAC's staff now work in buildings that are participating in the program
- SLAC diverted 89 percent of its construction and demolition debris
- SLAC diverted 76 percent of its municipal solid waste

- SLAC recycled 71 metric tons of recycled electronic waste and universal waste combined
- Up to 34 percent of SLAC's total electric energy came from renewable sources such as wind and hydroelectric sources, avoiding generating 15,000 metric tons of greenhouse gases (GHGs)
- SLAC successfully disposed of 185 tons of radioactive and mixed wastes from the Sectors 0 to 10 equipment removal and the Beam Switchyard in support of the LCLS II project construction

In 2017, there were no radiological impacts to the public or the environment from SLAC operations. The potential doses to the public were evaluated based on both calculation and measurements; the impacts are negligible and far below the regulatory and SLAC administrative limits. Potential exposure to the public from SLAC operations represents 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.

SLAC is regulated under a site cleanup requirements order (Board Order) issued by the San Francisco Bay Area Regional Water Quality Control Board (RWQCB; Board Order number R2-2009-0072) 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 remediation efforts are being designed and implemented to meet these established goals. The Board Order also lists specific tasks and deadlines for completion of remediation activities.

All deliverable submittals to the RWQCB in 2017 were completed and submitted on time. In 2017, SLAC Environmental Restoration Program personnel continued remediation efforts in specific areas impacted by chemicals of potential concern (COPCs). The COPCs present in groundwater, sediment, soil and soil vapor are volatile organic compounds and semi-volatile compounds. In December 2012, the Water Board approved the shutdown of the Test Lab/Central Lab (TL/CL) area system for a rebound test. Per recommendations provided in the 5-Year Review Report, the CL system was restarted in January 2017 to evaluate if continued operations would result in meeting the soil vapor cleanup goals. Monitoring data from the end of 2017 indicated that soil vapor remediation goals have been met at the CL with continued operation of the DPE system, to be followed by rebound testing. Operating data indicate that the remediation systems at the other three locations have also resulted in significant decreases in concentrations of COPCs in groundwater and soil vapor and are achieving hydraulic control of the groundwater plumes. In 2017, soil removal actions were completed at two additional areas within SLAC – the entire Interaction Region (IR) 6 primary drainage channel and sections of the IR-8 drainage channel, resulting in the removal of approximately 3,400 tons (2,430 cubic yards) of chemically impacted soil. In addition, a Hydrodynamic Sedimentation Unit was installed at the start of the IR-6 channel to remove suspended sediment from reaching the channel, and, targeted materials containing polychlorinated biphenyls (PCBs) were removed from select areas of the Research Yard.

1 Site Overview

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

1.1 Introduction

SLAC is a multi-program national laboratory operated by Stanford University under contract to the DOE. The lab is located in Silicon Valley, about halfway between San Francisco and San Jose, California (Figure 1-1).

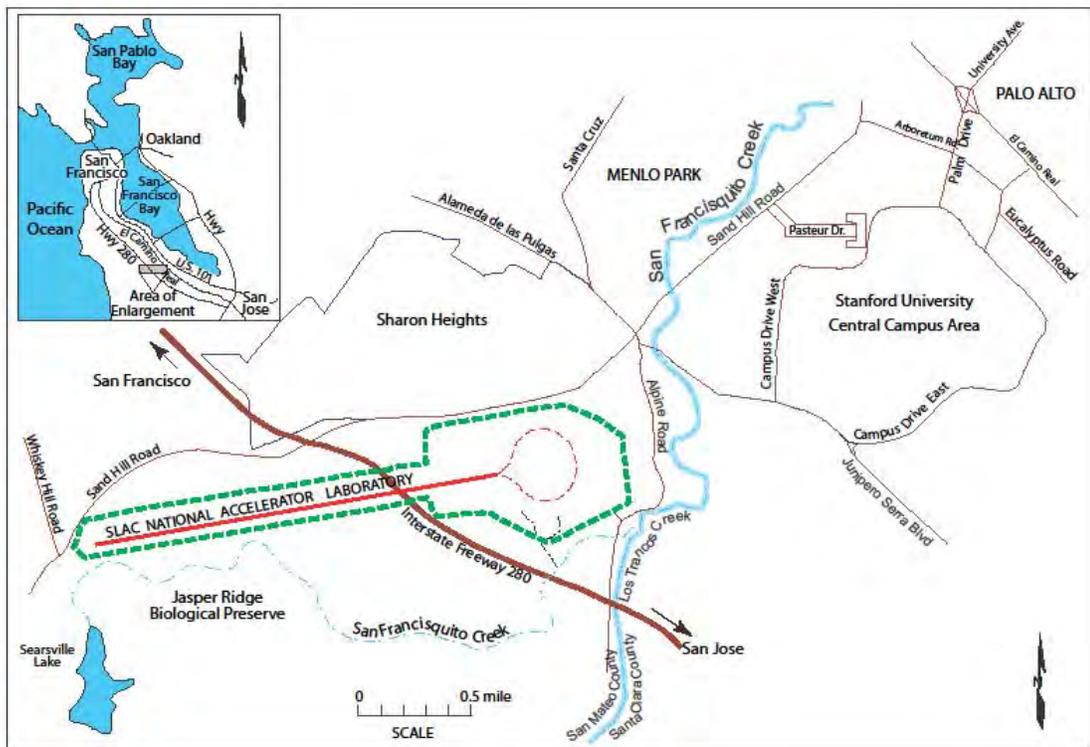


Figure 1-1 SLAC Site Location

1.1.1 SLAC Mission

As the world leader in X-ray and ultrafast science and a hub for cutting-edge research, SLAC's mission is to deliver scientific discoveries and develop research tools that help address the most challenging scientific and technological problems facing society and industry and transform our understanding of the universe. In support of this mission, SLAC has four laboratory goals:

1. Be the world leader in X-ray and ultrafast science and in our selected areas of accelerator science and high energy physics;

2. Expand and increase our impact in Office of Science mission areas by leveraging our world-leading core capabilities and expertise;
3. Broaden and strengthen our impact across critical national needs by using our position within Stanford and Silicon Valley; and
4. Be the “best-in-class” DOE lab for safe, efficient and innovative operations that align with and enable our research mission.

As a multipurpose national laboratory managed by Stanford for the Office of Science, SLAC supports the DOE mission, which is to ensure America’s security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions. Within this mission, our aim is to leverage our intellectual capital, our relationship with Stanford and our location within Silicon Valley to:

- Innovate and operate world-leading accelerators, light sources and other tools for the use of scientists from around the world as well as from SLAC and Stanford;
- Deliver transformative chemical, materials and biological science enabled by our unique facilities;
- Find solutions for the nation’s energy challenges; and
- Define and pursue a frontier program in cosmology.

1.1.2 Research Program

For more than 50 years, SLAC National Accelerator Laboratory has stood at the forefront of scientific discovery. What started as home to the world’s longest particle accelerator, one of the largest scientific endeavors of its time, has over the years, become the scene of transformative scientific research, where building blocks of matter have been discovered and life’s fundamental processes studied and better understood.

For the first 40 years of operation, the linear accelerator hosted pioneering experiments in particle physics including research that led to three Nobel Prizes. These were for the realization that protons in the atomic nucleus are composed of smaller entities called quarks; discovery of the J/psi particle, which implied the existence of the charm quark; and discovery of the tau lepton, the first of a new family of fundamental building blocks. In the more recent years, the BaBar experiment offered important insights into the imbalance of matter and antimatter in the universe, providing experimental evidence that led to the award of the 2008 Nobel Prize in physics to the theorists who first explained the source of this imbalance. These and other particle physics discoveries reshaped our understanding of matter and inspired completely new areas of science.

Today, SLAC is a multipurpose national laboratory, leveraging the lab’s historical strength in particle physics and accelerator research to power discoveries across an even greater range of scientific disciplines. SLAC operates the world’s first hard X-ray free-electron laser, which generates light of unprecedented brilliance that enables the capture of atomic-scale snapshots. SLAC also helps companies use synchrotron radiation to design better pharmaceuticals, stronger materials and more efficient sources of energy, and continues to build on a solid foundation in particle physics to peer into the farthest reaches of the universe, using ever more sophisticated tools and techniques.

SLAC is home to three very large and sophisticated research facilities open to the broader research community of the world. They are the:

- Stanford Synchrotron Radiation Lightsource (SSRL), which produces bright X-ray light for probing matter at the atomic and molecular level, enabling advances in energy production, environmental cleanup, nanotechnology, new materials and medicine
- LCLS X-ray laser, which illuminates objects and processes at unprecedented speed and scale for research in physics, structural biology, energy science, chemistry and other fields
- Facility for Advanced Accelerator Experimental Tests (FACET), which hosts experiments aimed at improving the power and efficiency of particle accelerators used in basic research, medicine, industry and other areas important to society

The past decade has seen a new round of change, as SLAC evolved into a multipurpose laboratory with strong programs in cosmology, chemistry, biology, materials science and energy research, as well as national user facilities that attract thousands of visiting scientists each year. The lab now jointly operates three institutes and a research center with Stanford:

- Kavli Institute for Particle Astrophysics, and Cosmology (KIPAC),
- Stanford Institute for Materials and Energy Sciences (SIMES),
- Stanford PULSE Institute,
- SUNCAT Center for Interface Science and Catalysis

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 and 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 United States (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 signed a new lease in 2010, 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, oriented 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, 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. San Francisquito Creek is seasonal (dashed line, Figure 1-1) with sections of its streambed drying up during warmer months. Los Trancos Creek typically has water flowing year-round (Figure 1-1), but not during the recent drought conditions.

1.3 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 typically averages about 22 inches per year. The distribution of precipitation is highly seasonal. Approximately 75 percent of the precipitation, including most of the major storms, occurs during the four-month period from December through March of each year. Most periods of winter storms last from two days to a week in duration. The storm centers are usually characterized by relatively heavy rainfall and high winds.

1.4 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 30 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 Jasper Ridge Biological Preserve. Land use to the north is mostly commercial, residential, and recreational (a golf course), with a school and office buildings located 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), preserved open space, and residential.

1.5 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 within the MPMWD. This separate system taps the Hetch Hetchy aqueduct and pumps water up to a 268,391 cubic-foot reservoir north of Sand Hill Road, approximately 1.5 miles from 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 primarily utilized (as high as 80 percent usage) to support cooling of high-energy experimental equipment, buildings and associated processes. The remainder of water supply supports SLAC office buildings/grounds and the Stanford facilities on the SLAC campus that include the Guest House, Arrillaga athletic field, Stanford Research Computing Facility, and Kavli building. 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 the SLAC boundary along the stream margin of San Francisquito Creek. This well was formerly used for agricultural supply but is now 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.

1.6 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 linear accelerator (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.

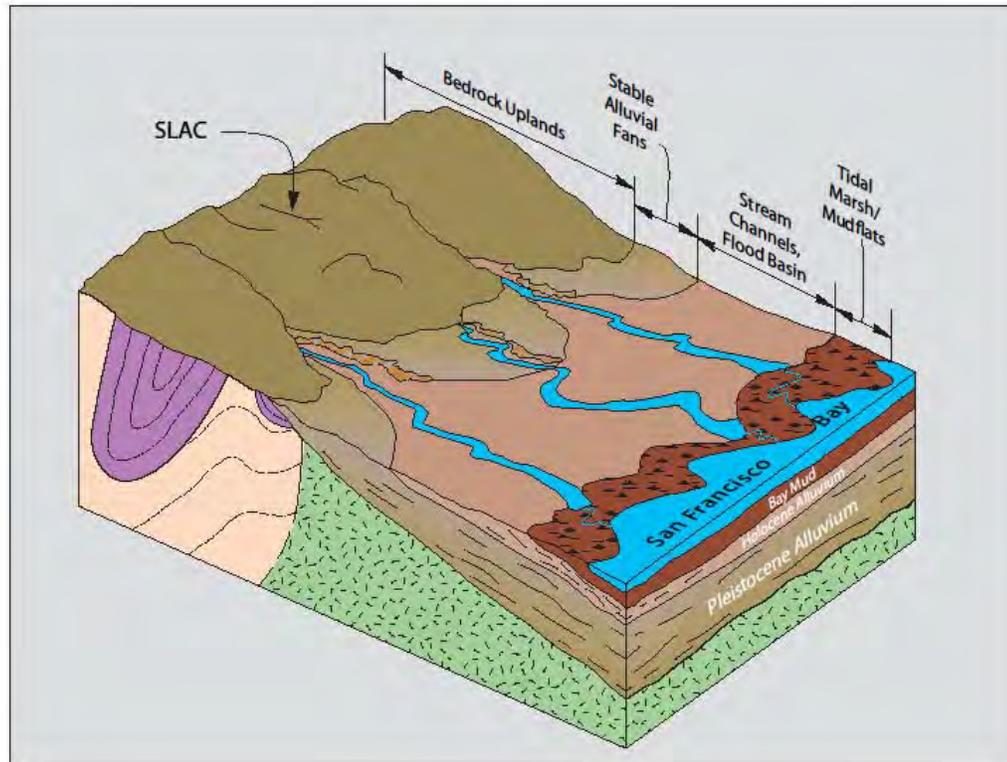


Figure 1-2 Site Area General Geographic and Geologic Setting

1.7 Demographics

SLAC has a daytime population of more than 1,500 full-time employees, including scientists, engineers, technicians and specialists in a wide range of operational support areas, from human resources and business services to facilities, security and maintenance. In addition, about 80 undergraduate students, 220 graduate students and 150 postdoctoral researchers work at SLAC. As stewards of renowned user facilities, SLAC hosts, supports and collaborates with more than 4,000 U.S. and international researchers, including many at SSRL, LCLS and FACET, as well as in laboratory-hosted science programs.

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 located in Santa Clara County. Nearby unincorporated communities in San Mateo County, include Ladera and two neighborhoods located in western Menlo Park. Two public and two

private schools with elementary and/or middle school students are located within one mile of SLAC's perimeter.

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 CY 2017.

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 2017 are shown in Table 2-1 below.

Table 2-1 General Permits Held by SLAC

Issuing Agency	Permit Type	Description	Number
BAAQMD	Air quality	SMOP issued per Title V of the Clean Air Act	1
		Encompasses 48 sources of air emissions - 37 permitted, 2 registered and 9 permit-exempt. After initial permitting, individual sources integrated into SMOP Separately, SLAC has a PTO for an onsite above-ground GDF from the BAAQMD	1
California Department of Toxic Substances Control	Hazardous waste treatment	Unit 1A – Building 025, 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
Silicon Valley Clean Water and West Bay Sanitary District	Wastewater discharge	Mandatory Wastewater Discharge Permit	1
Regional Water Quality Control Board	Stormwater	Industrial activities stormwater general permit	1
San Mateo County/CUPA	CUPA programs	PBR; Above-Ground Tank/SPCC plan; Hazardous	1

Issuing Agency	Permit Type	Description	Number
		Material Storage > 32,000 gal, 224,000 lbs., 11,2000 cf.; Hazardous Waste Generator 51-250 tons; CalARP	
US Environmental Protection Agency	Hazardous waste	90-day hazardous waste generator	1

Notes:

BAAQMD - Bay Area Air Quality Management District
 CalARP – California Accidental Release Prevention Program
 cf – cubic feet
 CUPA – Certified Unified Program Agency
 gal – gallon
 GDF – gasoline-dispensing facility
 lbs. – pounds
 cf. – cubic feet
 PBR – permit by rule
 PTO – permit to operate
 SMOP - synthetic minor operating permit
 SPCC - Spill Prevention, Control and Countermeasures Plan
 > - greater than

2.4 Environmental Incidents

2.4.1 Non-radiological Incidents

No incidents of a non-radiological nature occurred at SLAC during CY 2017.

2.4.2 Radiological Incidents

During CY 2017, no radiological incidents occurred that would have increased radiation levels above natural background to the public, or released radioactivity to the environment; SLAC was compliant with all radiological requirements related to the environment and the public.

2.5 Assessments, Inspections, and Quality Assurance

The environmental programs at SLAC are subject to routine assessments, inspections, and quality assurance measures conducted by SLAC, DOE and external regulators. Those conducted during CY 2017 are reported here.

2.5.1 Assessments

External assessments conducted by regulators occur periodically and include quarterly radiation monitoring of the SLAC perimeter by the California Department of Health Services. Currently, monitoring results are not available to SLAC for CY 2017.

2.5.2 Inspections

Periodic inspections of the environmental programs are performed at SLAC by federal, state and local environmental regulatory agencies. Table 2-2 lists the inspections conducted in CY 2017 by these agencies.

Table 2-2 Environmental Audits and Inspections

Regulatory Agency	Inspection Title	Date	Violations
BAAQMD	GDF Compliance Inspection	January 10, 2017	0
Silicon Valley Clean Water	Annual Compliance Inspection	September 26, 2017	0
San Mateo County Certified Unified Program Agency	Annual Storm Water Compliance Inspection	December 12, 2017	0
San Mateo County Certified Unified Program Agency	CalARP Compliance Inspection	December 12, 2017	0

2.5.3 Quality Assurance

The SLAC Quality Assurance (QA) program is consistent with the DOE SLAC Site Office (SSO) approved Site Compliance Plan for DOE Order 414.1D, Quality Assurance, and includes documented roles, responsibilities, and authorities for implementing the QA criteria in the plan. The SLAC prime contract also includes an H clause that requires SLAC to implement a Contractor Assurance System (CAS) as outlined in the SLAC Contractor Assurance Description approved by the DOE SSO. Both the QA and CAS programs at SLAC require the performance of risk and compliance-based self-assessments and the management of associated issues. Environmental Program Assessments of program elements are conducted by SLAC and DOE based on past performance, management discretion or regulatory drivers and are tracked in the Integrated Assessment Schedule (IAS). Issues from these assessments were managed via the SLAC Action Tracking System (ATS). In 2017, the ATS was upgraded to the SLAC Issues and Improvements Management System (SIMS). The IAS and SIMS are maintained by the SLAC Contractor Assurance and Contract Management (CACM) Office.

The SLAC CACM Office is responsible for:

- Ensuring that risk and compliance-based self-assessments or audits are routinely performed for Environment, Safety and Health (ES&H) programs and documented in the SLAC IAS
- Ensuring that issues from ES&H Program assessments or audits are managed in the SLAC ATS
- Providing direction for implementation of the SLAC CAS and QA criteria from SSO-approved Site Compliance Plan for DOE Order 414.1D as they apply to ES&H program implementation

2.5.3.1 Environmental Non-radiological Program

The Environmental Protection Department uses the *Quality Assurance Project Plan for the Environmental Protection Program*¹ for data quality review of analytical laboratory results of solid and liquid samples. This document includes all components required of quality assurance project plans and is consistent with United States Environmental Protection Agency (USEPA), Comprehensive Environmental Response,

¹ SLAC National Accelerator Laboratory, Environment, Safety, and Health Division, Environmental Protection Department, *Quality Assurance Project Plan for the Environmental Protection Program* (SLAC-I-750-2A17M-003 R007, December 2015)

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, along with data validation and reporting.

2.5.3.2 Environmental Radiological Program

Programmatic QA/QC is governed by the SLAC Radiological Environmental Protection (REP) program manual. Specific radioanalysis laboratory procedures and data validation as well as reporting for environmental samples are governed by the SLAC Radioanalysis Laboratory Quality Assurance Manual. SLAC has resumed its participation in the Mixed Analyte Performance Evaluation Program (MAPEP), which was discontinued in 2014 due to resource constraints. In CY 2017, SLAC passed the MAPEP performance tests with excellent results - less than 10 percent biases for both water and soil mixed analyte samples. Duplicate samples (mainly well water samples) are biannually analyzed by both SLAC and an off-site, California State certified radioanalysis laboratory. The two sets of results are then compared and documented to identify any discrepancies. For CY 2017, the results of these comparisons were consistent with each other, supporting the high level of QA/QC standards of the SLAC data.

3 Management Systems

3.1 Introduction

This chapter provides an overview of the SLAC organizational structure, management approach, and Environmental Management System (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 the following six directorates: Accelerator Directorate, Fundamental Physics Directorate, LCLS Directorate, Energy Sciences Directorate, SSRL Directorate, Technology Innovation Directorate, and Mission Support. 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 the Strategic Partnership Program (SPP).

3.2.1 ES&H Division Organization

The ES&H Division is part of the Mission Support Directorate and consists of seven departments and a Division Office. The Division Office is tasked with overall strategic planning and management. The shared goal is to ensure that SLAC operates in compliance with federal, state, and local laws and regulations, as well as DOE directives.

3.2.1.1 Occupational Health

The Occupational Health Center, which is associated with the Division Office, provides on-site medical services including treatment of minor injuries such as cuts, minor abrasions and burns, sprains/strains, and removing splinters and ticks. The department also provides a medical surveillance program for employees who may be potentially exposed to chemical and physical hazards.

3.2.1.2 Environmental Protection

The Environmental Protection (EP) Department has two primary functional areas, Environmental Compliance and Environmental Restoration. The EMS, which is an overarching management system that SLAC uses for identifying and managing environmental aspects, is managed by the EP Department. SLAC’s EMS is further described in Section 3.5. The EP Department also develops and implements the following programs: pollution prevention, stormwater and industrial wastewater, air quality, toxic substances control, National Environmental Policy Act (NEPA), the National Historic Preservation Act, and spill prevention, as well as groundwater protection and oversees work to restore soil and groundwater impacted with chemicals from historical operations.

3.2.1.3 Chemical and Waste Management

The Chemical and Waste Management Department consists of the Chemical Management Group, and Waste Management (WM) Group. 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 WM Group is responsible for coordinating the management and off-site disposal of regulated and hazardous wastes, and for developing and implementing hazardous waste minimization plans.

3.2.1.4 Health and Safety Services

The Health and Safety Services Department consists of two groups – the Industrial Hygiene (IH) Group and the Safety Specialist Group. The IH Group is responsible for assisting with the management of SLAC's safety and health programs, and keeping SLAC workers safe by anticipation, recognition, evaluation, prevention, and control of environmental factors or stresses. The Safety Specialist Group is responsible for operations, maintenance, and construction safety oversight, safety program ownership, and for providing safety training to SLAC personnel. This includes safety programs such as confined space, hoisting and rigging, fall protection and excavation safety.

3.2.1.5 Security and Emergency Management

The Security and Emergency Management Department provides oversight of two intertwined site safety functions - SLAC Site Security and Emergency Management. The SLAC Site Security is led by the Security Manager and staffed by contract security professionals, who are responsible for providing site-wide security services and emergency assistance 24 hours a day, seven days a week. The SLAC Security team includes Certified Emergency Medical Technicians (EMT). Emergency response oversight is led by the Security Manager and Assistant Fire Marshal, who is also SLAC's Emergency Management Coordinator. The SLAC emergency management organization includes the SLAC Emergency Response Team (ERT) and SLAC Site Security. The ERT team is made up of SLAC employees who have been trained in basic cardiopulmonary resuscitation (CPR), Medical Aid and emergency response. As of May 1, 2012, SLAC has been supported by the County of San Mateo Fire Department through a Memorandum of Agreement with the Menlo Park Fire Protection District.

3.2.1.6 Radiation Protection

The SLAC Radiation Protection (RP) Department is responsible for the radiation safety and radiological programs that protect the workers, the general public, and the environment. The RP Department includes five technical groups: Radiation Physics Group, Dosimetry and Radiological Environmental Protection (DREP) Group, Field Operations Group, Radioactive Waste Management (RWM) Group, and Laser Safety Group. The Radiation Physics Group provides support for safety analysis and control, which includes shielding calculations and radiation safety system design, as well as providing authorization and oversight for the safe operation of the accelerator, the beam line and experiments. The DREP Group provides dosimetry services (external, internal, area, environment and high-dose) assessment and/or monitoring of radiological impacts to the public and environment (see Chapter 5). The DREP group also operates the in-house Radioanalysis Laboratory and operates the instrumentation program. The Field Operations Group oversees radiological workplace monitoring, management of radioactive materials and sources, training, radiological control and work support. The RWM Group is responsible for radioactive waste management at SLAC such as low-level radioactive waste disposal (see Chapter 5). The Laser Safety Group develops and implements SLAC's Laser Safety Program.

3.2.1.7 Code Compliance and Authorities Having Jurisdiction (AHJ) Services

The ES&H Code Compliance and AHJ Services Department includes the Building Inspection Office (BIO) led by the Building Code Official and two Safety Officers/AHJs - the Electrical Safety Officer and the Fire Marshal. BIO provides review, oversight, and authorization for construction, modification, renovations, demolition, use, occupancy, and alteration of all buildings, structures, and areas at SLAC. During construction, the BIO performs on-site inspections to ensure conformance to the authorized design. Upon completion of construction, the BIO issues a certificate of occupancy. In addition to their BIO duties, the Electrical Safety Officer provides assistance to site personnel on electrical safety and control of hazardous energy matters, and the Fire Marshal provides assistance to site personal on fire protection and life safety matters.

3.2.1.8 Training and Information Management

The Training and Information Management (T&IM) Department serves all essential functions in the implementation of SLAC's safety and health programs. The department manages a catalog of approximately 125 ES&H courses and coordinates the provision of classroom and availability of computer-based training that affects all workers at SLAC. It collaborates with the Human Resources office, which manages all SLAC training, to ensure the training system supports the assignment, provision and tracking of all formal training. Additionally, the T&IM Department manages the periodic review coordination, updating and publishing of the approximately 50 chapters in the ES&H Manual and ES&H web and business applications resources.

3.3 Integrated Safety and Environmental Management System

SLAC's commitments to protecting the health and safety of on-site personnel, the public, and the environment are embodied in the SLAC Environment, Safety and Health Policy.² SLAC ensures the site is operated in a safe and environmentally responsible manner, and complies with applicable laws, regulations, standards and other requirements through implementation of an ISEMS. The ISEMS integrates the key elements of effective safety and environmental management systems into the mission and everyday operations of the site.

3.3.1 Integrated Safety and Environmental Management System

The 'plan, do, check, and improve' approach of ISEMS³ has been formally adopted by SLAC, and has been incorporated into the SLAC Worker Safety and Health Program.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):

² SLAC Environment, Safety and Health Policy, http://www-group.slac.stanford.edu/esh/about_esh/eshpolicy.htm

³ SLAC 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-720-0A21B-001-R010), <http://www-group.slac.stanford.edu/esh/general/wshp/>

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

3.3.2 Requirements Management System

The laws and regulations that specify ES&H and other external requirements of the Laboratory are derived from the following:

- The DOE/Stanford University prime contract for SLAC
- DOE approved site compliance plans for contractual DOE Directives
- SLAC program documentation (ES&H Manual)
- SLAC subject matter experts (SMEs)

SLAC's External Requirements dataset contains laws and regulations not specifically cited in the prime contract in DOE Directive site compliance plans. Updates to the dataset are managed by SLAC's Prime Contract Office and occur when SLAC program documentation is updated affecting citations of external regulations (industrial safety standards, local laws), and when external regulations are identified by SMEs as applicable to the work performed at SLAC. SMEs notify the Prime Contract Office of any new or changed regulations so the dataset can be updated, as appropriate.

3.3.3 Environmental Performance Measures

In addition to complying with external requirements, SLAC evaluates its performance against measures and metrics. Specific performance objectives, measures and targets are jointly 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 results of ongoing field observations, surveillances and routine assessments of SLAC operations and construction activities to formally evaluate contractor performance in all areas, including ES&H.

In fiscal year (FY) 2017, SLAC established environmentally relevant performance goals to ensure protection of the environment. Measures were initiated to ensure the effective development, implementation, and maintenance of an efficient Environmental Management System.

SLAC received a grade of A from DOE for its environmental performance. In particular, the following accomplishments were noted for FY 2017:

- SLAC submitted all FY 2017 environmental protection program deliverables and successfully passed on-site regulatory inspections.
- SLAC completed the majority of all major remedial actions required under the Water Board Order for the West SLAC and Research Yard Operable Units (OU).

- SLAC recycled 542 tons of metal, including 200 tons removed from the Klystron Gallery, in support of the LCLS II construction.
- SLAC successfully disposed of 185 tons of radioactive and mixed wastes from the Sectors 0 to 10 equipment removal and the Beam Switchyard reconfiguration projects.

3.3.4 Training

To ensure workers are both aware and capable of fulfilling their responsibilities safely, SLAC maintains an extensive catalog of classroom and computer-based environmental and health and safety 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 SLAC's training program are available online.⁵ Workers are required to have all appropriate environmental, health and safety training prior to performing any work assigned to them. Training is documented in SLAC's Safety Training Assessment database for every worker receiving training, which is formally reviewed and approved by the worker's supervisor annually.

3.4 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*⁶ 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 2017 EMS Report Card, indicating that all elements of the EMS are in place and working. Despite receiving a score of "green", SLAC continually strives to improve its EMS.

SLAC's EMS is consistent with International Organization of Standardization (ISO) 14001:2004. The EMS was formally in place on December 21, 2005, following a DOE assessment and declaration, and has been assessed and revalidated by DOE every three years. SLAC's EMS was last assessed in April 2015 by the DOE who determined the EMS to be fully implemented and in conformance with the ISO 14001:2004 standard for EMS. Based on these results, SLAC's EMS was formally revalidated by the DOE in June 2015.

The annual review and update of environmental aspects and determination of significance was completed during the year by SLAC's EMS Working Group. Five new objectives and targets were established for 2017. For each objective and target, a work plan, also referred to as an Environmental Management Program (EMP), was completed. These EMPs addressed the following environmental aspect categories:

⁵ SLAC National Accelerator Laboratory, *SLAC Training*, <http://www-group.slac.stanford.edu/esh/training/>

⁶ SLAC National Accelerator Laboratory, *EMS Description*, SLAC-750-0A03H-002 R6, September 2015

- Air emissions
- Use, reuse, and recycle
- Conservation of resources

Several of the notable accomplishments achieved during FY 2017 for the EMPs include the following:

- SLAC's Building 048 was upgraded to achieve compliance as a High Performance Sustainable Building.
- SLAC's ZWP was expanded by one additional building, bringing the total to fifteen buildings in the program. Approximately 75 percent of SLAC staff now work in buildings that are participating in the program.
- SLAC implemented an energy dashboard tool to help monitor each metered building and highlight energy use variations.
- SLAC developed a ride-sharing incentive pilot program, utilizing SLAC's BeWell Healthy Work Group program.

Additionally, SLAC's progress on the sustainability goals of EO 13693, including those related to GHGs, energy, water, fuel-reduction and high-performance sustainable buildings is provided in Section 4.7, *Sustainability*. SLAC's GHGs inventory work is discussed in Section 4.2.2.9.

4 Environmental Non-radiological Programs

4.1 Introduction

During the course of providing state of the art research equipment and support for national and international research programs, SLAC manufactures, uses, maintains and runs one-of-a-kind research equipment, which requires the use and management of various industrial chemicals, gases and metals, and utilizes resources such as energy and water. SLAC also has environmental management issues typical of any employer with more than 1,500 full-time staff. In addition to the regular population, SLAC hosts 80 undergraduate students, 220 graduate students and 150 postdoctoral researchers as well as more than 4,000 U.S. and international researchers, as well as in laboratory-hosted science programs.

SLAC has focused considerable efforts to minimize potential environmental impacts including working to eliminate the generation of waste and emissions. Additionally, SLAC continually strives to improve its environmental performance.

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
2011	DOE	Secretarial Honors Achievement Award	Reducing fugitive emissions of sulfur hexafluoride (SF ₆) while raising awareness and sharing case studies
2013	USEPA	Federal Electronics Challenge – Bronze Award	Reducing the environmental impacts of electronics in the End-of-Life phase
2016	Silicon Valley Water Conservation Awards Coalition	Silicon Valley Water Conservation Award for a Government Agency	Reducing potable water usage

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 sections in this chapter are organized by environmental protection programs, which describe the regulatory framework and program status for CY 2017, 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 Program

SLAC operates various sources of regulated air emissions, including a plating shop, a paint shop, several machine shops, boilers, solvent degreasers, emergency generators, and a vehicle fueling station, as well as diesel trucks and several types of off-road equipment. In addition, GHGs, which are generated indirectly through electricity use and used in electrical substations as well as research equipment, are being actively managed per Assembly Bill (AB) 32, the California Global Warming Solutions Act of 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 program during CY 2017.

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 (Operating Permits) of the Clean Air Act. SLAC's Title V synthetic minor operating permit (SMOP) was issued by the BAAQMD on July 26, 2002. The 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 administering AB 32, the implementation of which was completed in 2012. Additionally, CARB has several regulations applicable to SLAC, including those governing diesel-fueled equipment and vehicles, large spark ignition equipment and sources of sulfur hexafluoride, a potent greenhouse gas (GHG).

Finally, SLAC is subject to 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

All air quality deliverables were submitted to regulators on a timely basis during CY 2017.

4.2.2.1 Biennial Facility Inspection

The biennial BAAQMD site inspection, which was performed on February 28, 2017, found no significant issues and no Notice of Violations (NOVs) were issued.

4.2.2.2 New Source Permits

SLAC permitted one new stationary emissions source during CY 2017. This source was a stationary diesel-powered emergency generator for Building 057, the Arrillaga Science Center. Construction is anticipated to be completed, and the building occupied by August 2018. In addition, two obsolete sources were removed from the SMOP. The first was a solvent degreasing source and the second a diesel-powered generator. At the end of CY 2017, under the SMOP SLAC managed 48 sources of air emissions, 37 of which were permitted sources, two were registered sources, and 9 were exempt sources (Chapter 2, Table

2-1). Separately, SLAC manages an onsite aboveground gasoline dispensing facility (GDF) under a separate BAAQMD operating permit.

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

SLAC has two overarching annual deliverables to the BAAQMD, as well as other deliverables described in subsequent sections. The first overarching annual deliverable is an annual information update requested by BAAQMD for selected permitted sources. This report was submitted to the BAAQMD in April 2017. The BAAQMD permit to operate is renewed annually, and spans two years, from July 1 to June 30 of the following year. SLAC's permit-to-operate renewal for 2017 - 2018 went into effect on July 1, 2017, and is valid through June 30, 2018.

The other overarching annual BAAQMD deliverable is the Title V annual emissions report for all onsite sources included in the SMOP, covering the period of July 1, 2016 through June 30, 2017. SLAC submitted the Title V annual emissions report in July 2017.

4.2.2.4 Annual Adhesives Usage Report

In April 2017, SLAC submitted its CY 2016 adhesives usage report to the BAAQMD to satisfy BAAQMD Regulation 8-51-502.2c.

4.2.2.5 Annual Air Toxics Report

SLAC submitted its annual air toxics report covering CY 2016 to BAAQMD in April 2017, in accordance with AB 2588.

4.2.2.6 Asbestos and Demolition Project Notification Program

For projects that involve the demolition or significant renovation of existing structures, or the management of regulated asbestos-containing material, SLAC is required to provide advance notice to the BAAQMD. During CY 2017, demolition projects were evaluated by the SLAC Air Quality Program Manager for the purpose of air quality protection. Based on the projects' scope and the results of pre-work asbestos surveys, zero asbestos demolition/renovation notifications were submitted to BAAQMD for these projects.

4.2.2.7 National Emission Standards for Hazardous Air Pollutants

SLAC owns and operates emissions sources that report under 40 CFR 63, Subpart T "National Emission Standards for Halogenated Solvent Cleaning", which is part of the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations. None of these solvent cleaners and degreasers were in service during CY 2017. The NESHAP deliverables required by the USEPA is comprised of one annual performance report and two semi-annual exceedance reports. For CY 2016, the annual report was consolidated with the second semi-annual report, and was submitted to the USEPA in January 2017. The report included information on four degreasers, one of which is permanently out of service. It was removed from both the SMOP and NESHAP reports. The first semi-annual report for CY 2017, which was submitted to USEPA in July 2017, included information on the three remaining degreasers.

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. SLAC submitted its CY 2016 On-Road Diesel (also known as the Truck and Bus

Regulation) annual report to CARB in January of 2017. The CY 2016 annual off-road diesel equipment report was submitted to the BAAQMD in February 2017.

The permit for SLAC's onsite GDF requires annual source testing of the gasoline dispensing system to ensure proper functioning. A routine annual source test was performed on the GDF on September 20, 2017; all results were within regulatory limits. The GDF has two tanks, each with its own dispensing nozzle: a larger 1,500-gallon tank and a smaller 500-gallon tank. SLAC renewed the GDF permit. The renewal for 2017 - 2018 went into effect on September 1, 2017, and is valid through August 31, 2018. BAAQMD conducted a routine inspection on January 10, 2017. No NOVs were issued.

4.2.2.9 Greenhouse Gas Inventory and Baseline

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 produced by combustion of natural gas in a boiler. Scope 2 emissions are associated with onsite use, but are generated by an offsite entity, such as electrical power. 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 are included in this category.

In accordance with requirements outlined in EO 13693, the DOE established an agency-wide GHG reduction target relative to a 2008 baseline. In FY 2017, SLAC achieved a cumulative reduction in Scope 1 and 2 emissions of 57 percent and in Scope 3 emissions of 7 percent relative to the 2008 baseline.

As part of its GHG management program, CARB established a program that specifically addresses gas-insulated switchgear (GIS), electrical equipment filled with sulfur hexafluoride (SF₆). This compound is the most powerful GHG known, having a Global Warming Potential (GWP) of 23,900 relative to carbon dioxide, which has a GWP of 1. As such, SLAC monitors all purchase and use of SF₆ closely; explores less potent GHG alternatives; and emissions, if any, are tracked and reported to CARB. The annual SF₆ GIS inventory report was submitted to CARB by the June 1, 2017 due date.

4.3 Industrial and Sanitary Wastewater Management Program

SLAC discharges industrial wastewater and sanitary sewage to the wastewater 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 Silicon Valley Clean Water (SVCW).

4.3.1 Regulatory Framework

The Federal Water Pollution Control Act, now referred to as the Clean Water Act (CWA), was enacted into law 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 facilities and categorically regulated industrial facilities, such as electroplating and metal finishing shops.

SLAC operates its industrial and sanitary wastewater programs under mandatory wastewater discharge permits, negotiated jointly with the WBSD and SVCW and covering the entire SLAC facility. The permits are for the duration of one year, with automatic renewal annually for successive one-year terms, up to 5 years. SLAC's Mandatory Wastewater Discharge Permit number WB 161215 will expire on December 15,

2021. SLAC also has a contractual relationship with the WBSD, which specifies the total industrial and sanitary water flow volumes allowed to be discharged into the municipal wastewater collection system.

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

SLAC also has four wastewater flow monitoring stations located 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 Master Substation (MSub), Alpine Gate (Alpine), Interaction Region 8 (IR08) and IR06 Adit, as shown on Figure 4-1.

SLAC is required to submit a semi-annual self-monitoring report, which includes the results of its monitoring of the metal finishing pre-treatment facility (MFPP) and Former Hazardous Waste Storage Area (FHWSA) treatment system. The report also contains certification of a solvent management plan for approximately 100 solvents selected by the SCVW, and reports for discharges of radioactivity in industrial wastewater (see Section 5.5.1).

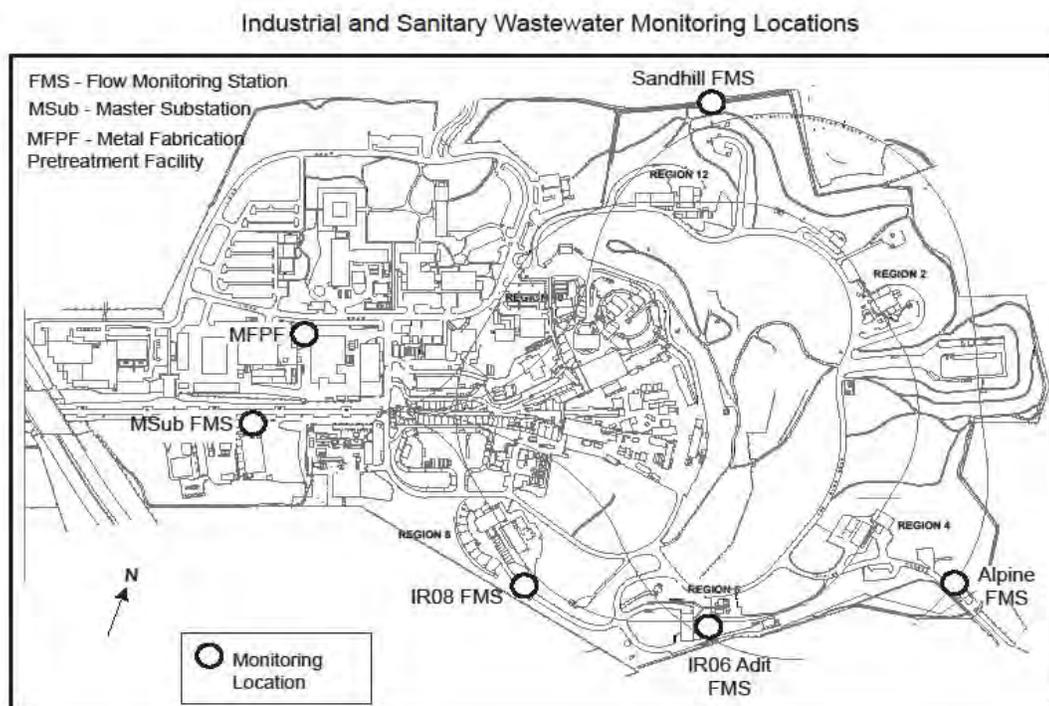


Figure 4-1 Industrial and Sanitary Wastewater Monitoring Locations

4.3.2 Program Status

4.3.2.1 Annual Facility Enforcement Inspection

The SCVW conducted the annual facility enforcement inspection on September 26, 2017. SLAC was found to be in compliance and no issues were noted by the SVCW.

4.3.2.2 Water Quality Monitoring Results

SLAC collects water quality samples semi-annually from the MFPP and FHWSA monitoring locations. In addition, SCVW collects samples quarterly at the Sand Hill Road FMS and annually at both the MFPP and FHWSA. 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 daily maximum mass limit. During 2017, SLAC was within compliance for all permitted discharge limits at all three monitoring locations.

4.3.2.3 Sanitary Sewer Overflow Management

SLAC registered with the State Water Resources Control Board (SWRCB) and the San Francisco Bay RWQCB sanitary sewer overflow reporting systems in October 2008.⁷ All spills from the sanitary sewer system are reported to the SWRCB using the sanitary sewer overflow reporting systems. A Category 1 sanitary sewer overflow (SSOF) is a spill of any volume from the sanitary sewer, which reaches surface water and/or enters a stormdrain channel tributary to surface water. Category 1 spills greater than or equal to 1,000 gallons must be reported within two hours of discovery to the California Office of Emergency Services. A Category 2 SSOF is any spill of 1,000 gallons or greater that does not reach surface water or a drainage channel tributary to surface water. Category 2 spills require that a draft report must be submitted electronically to the California Integrated Water Quality System (CIWQS) within three business days. A Category 3 SSOF is any spill less than 1,000 gallons that does not reach surface water or a drainage channel tributary to surface water. Category 3 spills are reported electronically via CIWQS within 30 calendar days after the end of the month in which the overflow occurred. A no-spill certification must be completed and certified via CIWQS within 30 days of a month in which no spills occur.

In 2017, SLAC had two Category 1 SSOFs, and two Category 3 SSOFs. The two Category 1 SSOFs occurred on January 7 and 8, 2017, when two portable toilets were blown over during a heavy rainstorm with high winds. Approximately 30 and 50 gallons of toilet water, respectively, flowed into nearby stormdrain catch basins. One Category 3 SSOF occurred on March 27, 2017, when an electrical switch failed, resulting in the release of one gallon of sewage onto the asphalt pavement. Another Category 3 SSOF occurred on October 23, 2017, when 10 gallons of sewage flowed onto the asphalt pavement due to a clog in the nearby sewer lift station. All no-spill certifications were submitted on schedule.

In August 2010, the SLAC Sanitary Sewer Management Plan (SSMP) was completed. The Plan includes descriptions of SLAC's sanitary sewer operations and maintenance activities, spill response, and reporting procedures. The SSMP was updated in April 2014 to comply with the new monitoring, recordkeeping, reporting and public notification requirements under Order Number (No.) 2013-0058-EXEC, which came into effect on September 9, 2013.

4.4 Surface Water Management Program

Stormwater flows out of the 426-acre SLAC site through 25 drainage channels. Many of the channels drain areas where the stormwater has little or no potential of exposure to industrial activities. As defined in

⁷ *Statewide General WDRs for Sanitary Sewer Systems, WQO No. WA 2013-0058-EXE*. Available at <https://www.waterboards.ca.gov/>

Attachment A of the SWRCB's Industrial General Permit (IGP) Order 2014-0057- Department of Water Quality (DWQ), stormwater has the potential to come into contact with support activities or facilities. Such activities or facilities include SLAC's Transportation Department at Building 81 (B081), the Lower Salvage Yard, the IR-8 Salvage Yard, and the Research Yard. Based on the permit requirements of the IGP and SLAC's Stormwater Pollution Prevention Plan (SWPPP), revised in December 2017, five locations representative of stormwater discharges associated with support activities are monitored. These locations are listed below and shown in Figure 4-2.

- IR-8 Channel at the E003 outfall;
- IR-6 channel downstream of the Hydrodynamic Sedimentation Unit (HSU);
- Stormdrain catch basin (CB) number CB27E-34, located downstream of the SLAC Transportation Department;
- Stormdrain catch basin number CB31G-7 adjacent to the Lower Salvage Yard; and
- IR-8 Stormdrain sump at the IR-8 Salvage Yard.

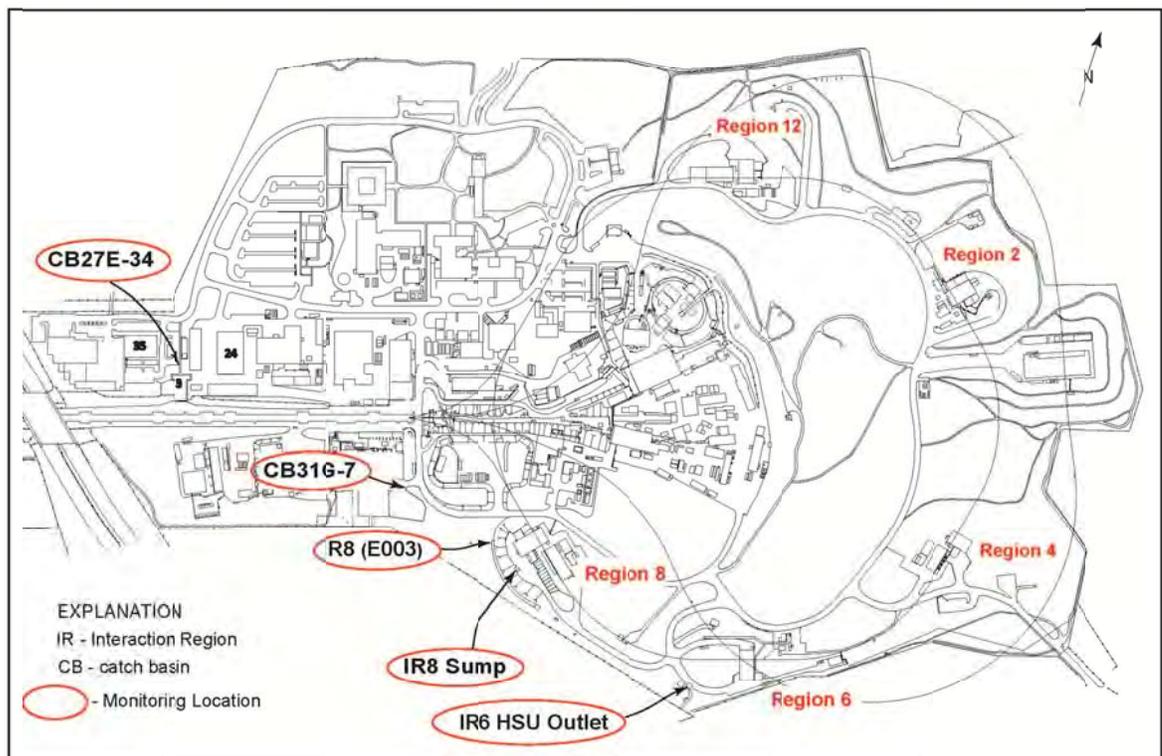


Figure 4-2 Surface Water Monitoring Locations

4.4.1 Regulatory Framework

In 1987, the CWA was amended to include non-point source discharges such as stormwater run-off from industrial, municipal, and construction activities. 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.

From 1997 through June 26, 2015, SLAC's stormwater was regulated under IGP Order 97-03-DWQ. On July 1, 2015, a new State IGP Order, 2014-0057-DWQ, came into effect. SLAC filed a Notice of Intent (NOI) for coverage under the new IGP Order 2014-0057-DWQ, and submitted a revised SWPPP.

The SWPPP has two main components: a Monitoring Plan and Best Management Practice (BMP). The Monitoring Plan describes 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).

4.4.2 Program Status

The reporting period for IGP Order 2014-0057-DWQ runs from July 1 through June 30 of the following year. Since the IGP's period of coverage spans two calendar years the period for monitoring water quality during the wet season of 2016 - 2017 was July 1, 2016 through June 30, 2017.

The IGP requires that stormwater samples be analyzed for three parameters (pH, total suspended solids (TSS), and, for oil/grease), potential pollutants that could result from support activities and operations (identified by Standard Industrial Code in Attachment A of the IGP). The samples are also to be analyzed for any additional parameters related to receiving waters with 303(d) listed impairments or approved total maximum daily load. During the wet season of 2016-2017, stormwater samples were analyzed for the three required parameters as well as seven additional parameters – five metals and two non-metals (Table 4-2). The additional parameters were selected after a review of SLAC's support activities and operations.

Table 4-2 Stormwater Parameters Analyzed

Metals	Non-Metals
Aluminum	Total Suspended Solids *
Copper	pH *
Iron	Oil and Grease *
Lead	Chemical Oxygen Demand
Zinc	Diazinon

* Required parameter under Industrial Stormwater General Industrial Permit Order 2014-0057-DWQ

SLAC compares its stormwater analytical results to the SWRCB-developed Annual Numeric Action Levels (NALs), in particular those for the parameters listed in Table 4-3. A comparison is also made with the Instantaneous NAL values, as applicable. During the 2016-2017 wet season, there were no exceedances of the Instantaneous or Annual NALs for pH, TSS or oil and grease. However, as shown in Table 4-3, the Annual NALs for aluminum, iron and zinc were exceeded.

The exceedances of Annual NAL levels for aluminum, iron and zinc resulted in SLAC changing from a Baseline status to a Level 1 status under the IGP on July 1, 2017. Facilities that enter Level 1 status are required to perform a facility-wide assessment to determine if the implementation of additional best management practices (BMPs) or facility practices can reduce the concentration levels of stormwater sample data to below NALs for the compounds exceeded in the previous year.

Table 4-3 NAL Exceedances in 2016 - 2017 Wet Season

Metals	SWRCB Annual NAL (mg/L)	SLAC Annual Average Concentration (mg/L)
Aluminum	0.75	2.15
Copper	0.0332	0.025
Iron	1.0	3.57
Lead	0.262	0.005
Zinc	0.26	0.29
TSS	100	68
Oil and Grease	15	4.04
Chemical Oxygen Demand	120	55

mg/L – milligrams per liter

Following the Level 1 assessment completed in September 2017, several ways to improve the BMP were identified and implemented. In addition, adjustments to sampling locations were made and the site SWPPP was updated. The updated SWPPP and Level 1 assessment report were uploaded to the SWRCB Storm Water Multiple Application and Report Tracking System in December 2017.

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:

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

Hazardous materials management encompasses numerous programs at SLAC, but the primary goal remains the same: to ensure the safe handling of hazardous materials in order to protect the workers, community, and the environment.

4.5.1 Regulatory Framework

The regulatory framework for hazardous materials regulations, especially in California, has historically been a complex and overlapping web of statutes and regulations. Some of the most important regulatory drivers at the federal level include the following listed acts. The Superfund Amendments and Reauthorization Act of 1986 (SARA - Title III) is also known as the Emergency Planning and Community Right-to-Know Act (EPCRA) and focuses on community safety. The Occupational Safety and Health Act (1970) was enacted for protection of worker health and safety. The Hazardous Materials Transportation Act of 1975 ensures the safe transport of hazardous materials in commerce; and the Toxic Substances Control Act (TSCA) of 1976, is the federal statute under which PCBs and asbestos are regulated.

Important drivers at the state level generally date back to the mid-1980s and include a Hazardous Materials Business Plan (HMBP), the 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 Certified Unified Program Agency (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, which include the SWPPP, the Spill Prevention, Control, and Countermeasures (SPCC) plan, and the Waste Tire Survey and Inspections, as well as the following four hazardous material subject areas:

- Hazardous Materials Business Plan/Emergency Response Plan
- Hazardous Waste/Tiered Permitting/Waste Minimization and Pollution Prevention
- 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 2016 programs related to hazardous materials life-cycle management, including the hazardous materials business plan, the Toxics Release Inventory (TRI), and the CalARP program.

For the period between January 1 and December 31, 2016, 17 chemical storage buildings/areas (or 15 percent of the identified buildings/areas) were field-verified. Usable legacy or unneeded chemicals were removed for redistribution, and products that had expired or had damaged containers or labels were removed for disposal as hazardous waste.

4.5.2.1 Annual Facility Enforcement Inspections

The San Mateo County CUPA began a joint effort with SLAC in December 2017 to improve the maps submitted as part of the HMBP. When completed by March 2018, these new maps will better provide information that the CUPA requires to review - buildings where chemicals are located, the identity of the chemical(s), and the quantity present at that location.

4.5.3 Hazardous Materials Business Plan Program

EPCRA, passed in 1986 as Title III of SARA, establishes requirements for emergency planning, notification, and reporting. In California, the requirements of SARA Title III are incorporated into the state's HMBP program.

For the 2017 reporting year, SLAC's HMBP was updated in November 2017 and will be submitted to the San Mateo County CUPA upon completion of the new maps using the California Environmental Reporting System (CERS).

The HMBP includes the Hazardous Materials Inventory Statement. The inventory consists of all hazardous materials present at SLAC in amounts exceeding the state's aggregate threshold quantities (55 gallons for liquids, 500 lbs. for solids, and 200 cubic feet for compressed gases) on a building-by-building basis. 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 chemical management system (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 new GIS maps are used to indicate storage area locations.

The plan also includes the SLAC Emergency Management Plan. 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 (RMP)

4.5.4 Toxics Release Inventory Program

Under EO 13693, *Planning for Federal Sustainability in the Next Decade*, DOE requires its facilities to comply with Toxic Chemical Release Reporting and Community Right-to-Know requirements (40 CFR 372), 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 and the state of California.

The TRI report is submitted to USEPA by June 30 of each year and reports quantities from the previous calendar year. The TRI report for SLAC submitted online to USEPA and the state of California in June 2017 covered the CY 2016 reporting year. Of the more than 400 chemicals listed in the TRI, only lead is used at SLAC above its regulatory threshold for reporting. As a result, SLAC prepared a TRI Form R for lead and submitted it to the DOE SSO for review and approval in June 2017. TRI data are available to the public via the USEPA website.⁸

⁸

<http://www.epa.gov/tri/tridata/index.html>

4.5.5 California Accidental Release Prevention Program

Under the CalARP program, SLAC has only one regulated chemical that is used in a process above its threshold: potassium cyanide, which is used only in the Plating Shop complex. For this usage, a RMP was originally prepared and submitted to the CUPA in 2006. As part of the RMP, worst-case scenarios were modeled for a catastrophic release of potassium cyanide, but none of the scenarios led to 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 finalized in 2008 following a public comment period. It is required that the RMP be reviewed and updated every 5 years. It was reviewed, updated and submitted to the CUPA in both April of 2012 and April of 2017. The CUPA conducted a routine unannounced CalARP inspection on December 12, 2017. No NOV's were observed.

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. Table 4-3 lists the remaining 11 active and regulated ASTs containing petroleum products at SLAC during CY 2017. All of the petroleum tanks at SLAC are constructed of steel with secondary 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 was updated in 2013, and was under revision during 2017. SLAC does not have any underground storage tanks.

Table 4-3 Aboveground Petroleum Tanks

Petroleum Product	Property Control Number	Location	Number of Tanks	Capacity (gallons)
Diesel	19683	B112 Master Substation	1	2,000
Gasoline	21443	B035 Vehicle Refueling Station	2	1,500/500
Vacuum Oil *	19596	B020 North Damping Ring	1	516
Diesel	21287	B007 MCC Generator Fueling	1	500
Vacuum Oil *	19595	B021 South Damping Ring	1	260
X-ray Oil	15192	B044 Klystron Test Lab	5	1272 ¹

* These tanks are used only for short-term storage

¹ The number is the cumulative capacity of 5 tanks

na - not available

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 CY 2017.

By the end of CY 2017, SLAC had 97 oil-filled transformers. Transformers containing oil 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. Five of SLAC's transformers are PCB-contaminated. Transformers containing PCBs at concentrations of less than 50 ppm are defined by TSCA as non-PCB transformers. Eighty-six of SLAC's transformers are classified as non-PCB transformers.

4.5.8 Chemical Management System

SLAC had been purchasing chemicals solely through *Haas Group International* since August 2005 under its CMS program. In 2017, SLAC began purchasing chemicals through Government Scientific Source (GSS), which provide sourcing, purchasing, expediting, and vendor support for all non-radioactive chemicals and gases purchased by SLAC. The use of GSS is to provide support for SLAC's chemical management system. 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
- Generate chemical usage and compliance reports directly from procurement data

At the end of calendar year 2017, the program had achieved the following:

- Maintained excellent safety performance in the CMS program; no illnesses/injuries or reportable chemical spills in CY 2017
- Ensured contractors have met their training requirements
- Achieved inventory of 5,557 active chemicals in the catalog
- Identified 1,106 users of the CMS program and 107 work areas

4.6 Waste Management and Minimization

During the course of its research operations, SLAC generates a variety of waste streams, including both hazardous wastes and non-hazardous wastes. The latter includes industrial waste, municipal solid waste, and construction and demolition debris.

4.6.1 Hazardous Waste Management and Minimization

4.6.1.1 Regulatory Framework

SLAC is a 90-day hazardous waste generator and as such, is not required to obtain a Resource Conservation and Recovery Act (RCRA) Part B permit that would allow the treatment, storage and/or disposal of hazardous waste onsite (i.e. a treatment, storage, and disposal facility permit) under the federal RCRA regulations. However, SLAC does have permits to treat a few RCRA-exempt and non-RCRA (i.e.

California-only) hazardous waste streams (see Section 4.6.1.2 regarding the state-level tiered permit program).

The USEPA has delegated authority for implementing the federal RCRA program to the state of California. In turn, the state has delegated its authority on 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 activities.

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 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

This section does not include radioactive waste. SLAC utilizes a site-specific computerized hazardous waste tracking system. Hazardous wastes are tracked from the time they are generated to final appropriate disposal off-site. The waste tracking system includes fields that generate information required for the SARA Title III, TRI, State Bill (SB) 14 and TSCA PCB 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, and processes including the following:

- Reducing generation of excess chemicals through CMS
- Converting non-hazardous empty metal containers and drums to scrap metal
- Exchanging chemicals with other users
- Reclassifying waste streams to reduce hazardous waste volumes
- Re-using chemicals
- Returning unused material to the vendor or manufacturer
- Sending electrical equipment offsite for re-use by other organizations

SLAC continues to make progress in reducing hazardous waste generated from routine operations. Routine wastes are those wastes associated with SLAC's routine operations and maintenance processes. For FY

2016 - 2017, SLAC reduced its hazardous waste generated by routine operations from the 1993 baseline of 147 tons to 12 tons, a 92 percent reduction. Measures will continue to be taken to further reduce hazardous waste by helping smaller generators increase their awareness of waste reduction opportunities, helping them procure less hazardous chemicals, and helping them learn to develop for themselves more focused waste reduction measures for their work areas.

4.6.2 Non-Hazardous Waste Management and Minimization

Non-hazardous waste can be grouped into non-hazardous industrial waste, municipal solid waste, and, construction and demolition (C&D) debris.

4.6.2.1 Non-hazardous Industrial Waste Management

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 containing 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

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

- Beverage containers (glass, aluminum, plastic)
- Paper (white paper, mixed paper)
- Cardboard
- Scrap wood
- Scrap metal
- Garden/landscaping waste
- Salvage sales and transfers
- Food wastes
- Tires
- Trash (non-recyclable waste)

SLAC's Facilities & Operations Department operates a MSW management program that collects a variety of recyclable and compostable materials as well as regular dumpster refuse (i.e., trash). SLAC's Property Control Department operates a salvage operation that sells metal, equipment, and other salvageable commodities for their cash value or makes them available to the site and others for reuse. Both of these programs help SLAC minimize disposal of MSW in landfills.

SLAC also has programs in place to manage other wastes including C&D wastes, electronic wastes (e-wastes), and universal wastes, as described in Sections 4.6.2.3 and 4.6.3.

SLAC has made substantial gains in MSW diversion from landfills, as indicated in Table 4-5 and Figure 4-3 below. SLAC's MSW percentage diversion rates since FY 2013 are significantly higher than in past years, due to a large quantity of scrap metal recycled by SLAC starting in FY 2013.

SLAC continues to strive for MSW waste reduction through expansion of zero waste programs in SLAC office buildings. SLAC's zero waste program utilizes a model developed by the City of San Francisco for commercial office buildings, which includes centralized waste, recycling, and compost collection areas, and compost collection of paper towels in the restrooms. The program was first instituted in 2008 at the SLAC cafeteria, and in FY 2012, SLAC began expanding this program to office buildings.

Through FY 2017, the program has been implemented in fifteen buildings (Buildings 024, 028, 035, 040, 041, 051, 052, 053, 55, 120, 137E/W, 750/751, 901, 950, 999), which include a large majority of the higher occupancy buildings at the facility. Approximately 75 percent of SLAC staff work in buildings participating in the program.

Table 4-5 Breakdown of Municipal Solid Waste (MSW) Diversion Quantities FY 2013 - FY 2017
(Excluding C&D, E-Waste, and Universal Waste)

Year (FY)	MSW Disposed (all Offsite) (tons)	MSW Diverted (1) (tons)	MSW Composted (2) (tons)	Waste to Energy (3) (tons)	MSW Diversion Percentage Rate (%)
2013	399.3	1769.5	115.2	-	82.5
2014	306.1	1493.1	105.9	28.8	84.2
2015	269.9	982.8	131.7	34.9	81.0
2016	301.1	505.4	190.3	51.6	71.3
2017	321.9	624.5	326.6	89.5	76.4

(1) "MSW Diverted" includes materials recycled including paper, cardboard, scrap metal, scrap wood, equipment sold or transferred, and tires, and does not include C&D, e-waste, or universal wastes.

(2) "MSW Composted" includes materials composted including green waste such as garden and landscape trimmings and food waste.

(3) Waste to Energy includes those materials diverted from landfill and used for energy, such as scrap wood sent as fuel to boilers. Prior to FY 2014, this category was not tracked separately but included in the MSW Diverted tonnage.

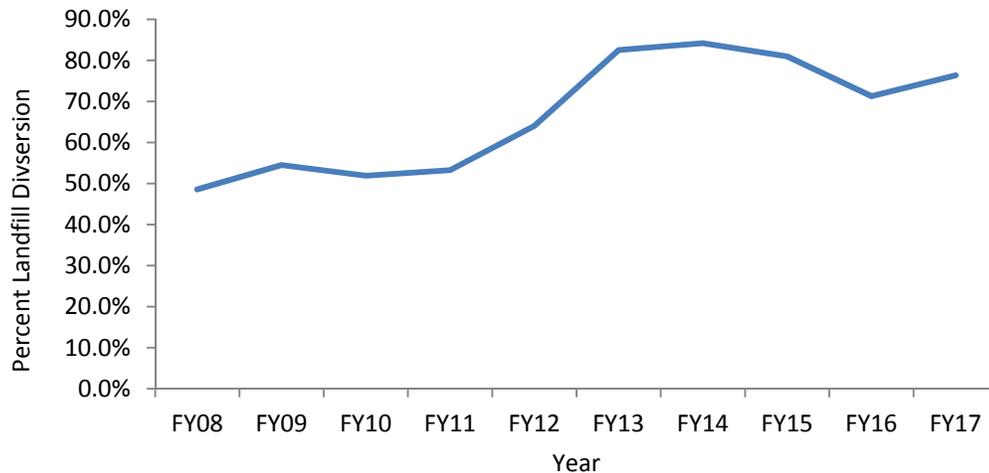


Figure 4-3 Municipal Solid Waste Diversion Rates 2008 – 2017 (Excluding C&D, E-Waste, and Universal Wastes)

Additional information on SLAC's MSW diversion program and data are provided in SLAC's *Site Sustainability Plan*.⁹

4.6.2.3 Construction and Demolition Debris

C&D debris include a variety of non-hazardous materials generated as a result of construction projects, and may include concrete, wood, metal, gypsum board, and other materials. SLAC's major construction and renovation contracts include requirements for recycling of C&D wastes and as a result, SLAC achieves high landfill diversion rates for C&D materials, as illustrated in Table 4-6. Recycling of demolition materials from a number of construction projects, including the LCLS II, accounted for the very high tonnage of C&D diverted in FY 2017.

Table 4-6 Breakdown of Construction and Demolition Diversion Quantities FY 2013 - FY 2017 (Excluding Soil Reuse)

Year (FY)	C&D Disposed (tons)	C&D Diverted (tons)	Diversion (%)
2013	39	509	93
2014	33	2,414	99
2015	71	923	93
2016	107	4,579	98
2017	86	704	89

% - percentage
FY – fiscal year

⁹ SLAC National Accelerator Laboratory, *Site Sustainability Plan FY 2017*, December 2016

4.6.3 Other Waste Management Activities

SLAC has programs in place to recycle electronic waste (e-waste) and universal wastes (e.g., bulbs and batteries). In FY 2017, over 71 metric tons of these wastes were recycled, and all of SLAC's electronic wastes were recycled through electronics recyclers that were certified under either the e-Stewards or Responsible Recycling programs, helping to ensure proper disposition of these materials.

SLAC generates a small quantity of low-level radioactive waste every year; this waste stream is discussed in Chapter 5. In addition, 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 document *Site Sustainability Plan*,¹⁰ summarizes SLAC's planned actions and performance status on the sustainability goals derived from EO 13693, as adopted by DOE in their *Strategic Sustainability Performance Plan (SSPP)*.¹¹

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 across the federal complex.

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

Table 4-7 Progress against Select Sustainability Goals of EO 13693 and the DOE Strategic Sustainability Performance Plan through FY 2017

Category	EO 13693/DOE Goal	Progress
Energy Reduction	25 percent energy intensity (BTU per gross square foot) reduction by FY 2025 from the FY 2015 baseline value (2017 target 5 percent)	SLAC did not meet the 5 percent reduction target. In spite of a 17 percent increase in SLAC's population between FY 2015 and FY 2017, energy intensity increased a modest 3 percent in the specific goal subject buildings. Energy reductions were actively pursued through lighting projects in 9 buildings. A 48 percent reduction was achieved in Building 048, and 88 percent reduction in Building 750.
Renewable Energy	Renewable electric energy shall account for at least 10 percent of total electric consumption	SLAC met the target by offsetting 34 percent of the site's electrical consumption with renewable energy from a combination of wind and hydroelectric sources. This effectively avoided generating 15,000 metric tons of GHG.

¹⁰ SLAC National Accelerator Laboratory, *Site Sustainability Plan FY 2017*, December 2016.

¹¹ U.S. Department of Energy, *2016 Strategic Sustainability Performance Plan*, September 2016.

Category	EO 13693/DOE Goal	Progress
Greenhouse Gas Reduction	50 percent Scope 1 and 2 GHG reduction by FY 2025 from the FY 2008 baseline (2017 target: 25 percent)	SLAC met the interim target of 25 percent reduction for FY 2017, by achieving 57 percent reduction compared to the FY 2008 baseline.
Water Reduction	36 percent potable water intensity (gallons per gross square foot) reduction by FY 2025 from the FY 2007 baseline (2017 target: 20 percent)	SLAC met the water reduction target by achieving a 62 percent reduction. SLAC reduced water consumption each year, for the last four years.
Sustainable Building	17 percent of buildings larger than 5,000 gross square feet to be compliant with the HPSB by FY 2025, with progress to 100 percent thereafter.	SLAC's goal is nine HPSB buildings. In FY 2017, existing Building 048 achieved HPSB Certification. SLAC now has six HPSB compliant buildings, with plans to convert three additional buildings.
Waste Reduction	Divert at least 50 percent non-hazardous solid waste (excluding C&D debris) by FY 2017.	SLAC met the target and has exceeded the MSW diversion goal for the last several years, with a 72 percent diversion rate for FY 2017 (excluding C&D debris). Similarly, the C&D diversion goal was exceeded, with an 89 percent diversion rate for FY 2017.

BTU – British thermal units
C&D – construction and demolition
FY – fiscal year

GHG – greenhouse gases
HPSB – high-performance sustainable building
MSW – municipal soil waste

4.8 National Environmental Policy Act

SLAC's mission has expanded from a single-purpose high-energy physics laboratory to a multi-program laboratory conducting research in the areas of photon science, particle physics, cosmology, structural biology and medicine, material science, and emerging technologies. SLAC continues to upgrade the original linear accelerator and its associated machines and hardware in response to its evolving programs, and ensures that the NEPA requirements are followed on a project-by-project basis for all new construction projects.

NEPA, the goal of which is to protect, restore and enhance the environment, was enacted into law in 1970. SLAC developed its formal NEPA program in 1992, which is jointly administered by the DOE and SLAC's EP Department. Under this program, proposed SLAC projects and actions are reviewed to evaluate NEPA documentation requirements. The three categories of NEPA documentation in increasing order of complexity are:

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

SLAC staff provides information and technical support to DOE to be used in determining whether proposed federal actions will have a significant effect on the environment. The completed NEPA documents are

forwarded to the DOE SSO for review, concurrence, and/or approval by the DOE NEPA Compliance Officer located at the DOE Office of Science Integrated Support Center in Oak Ridge, Tennessee.

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

To be consistent with the DOE NEPA Openness Policy, SLAC's CX determinations are available to the public at the link provided below.¹² All of the projects reviewed for NEPA purposes in 2017 were relatively minor in scope and impacts, and were classified as CXs.

¹² <http://science.energy.gov/SSO/nepa-documents/>

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 the environment (e.g. air, soil and water) to determine the potential radiation dose to the public and any impacts to the environment.

DOE O 458.1, *Radiation Protection of the Public and the Environment (Change 3)*, requires that radiation and radioactivity from SLAC do not cause any member of the public to receive a radiation dose greater than 100 milli-rems (mrem, a unit used to quantify radiation dose to humans) in a year.¹³

As in past years, the potential dose that members of the public received due to SLAC operations in CY 2017 was a very small fraction of the dose received from natural background radiation. In addition, the potential dose to the public and the radiation-related impacts to the environment from SLAC operations were significantly below all DOE and USEPA regulatory limits and SLAC administrative limits.

5.2 Sources of Radiation and Radioactivity

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

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 then lost, but it 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 - the time required to reduce the radioactivity by half.

Facilities at SLAC are designed to meet all applicable safety and environmental requirements. Nearly all of the direct radiation is stopped by the combined shielding on the accelerator structure and the ground, and by the thick concrete walls of the tunnel that surround the accelerator itself. 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 evaluation and monitoring is described in Section 5.3.

¹³ United States Department of Energy, DOE O 458.1, *Radiation Protection of the Public and the Environment*.

SLAC also assesses, measures, and reports on radioactivity potentially released to the environment as required by SLAC's policies and by state or federal regulations. Sections 5.4 through 5.6 and 5.9 describe SLAC's programs designed to assess and control radioactivity that have the potential to be released into the different types of environmental media. All potential releases of radioactive materials are included in tables within those sections.

Section 5.8 provides a summary of how the calculated potential maximum doses compare with natural background radiation. Table 5-6 summarizes annual doses to the maximally exposed individual (MEI) from both direct radiation (0.03 mrem) and airborne radioactivity released (1.35E-03 mrem), and shows that the doses are much smaller the regulatory limits and the natural background radiation.

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 (tritium (³ H))	12.3 years	Water

5.3 Monitoring for Direct Radiation

In CY 2017, the maximum dose that could have been received by a member of the public due to direct radiation from SLAC was 0.03 mrem [3.0E-04 milli-Sievert (mSv) - the International System of units for dose equivalent].¹⁴ This is 0.03 percent of the 100 mrem regulatory limit. The location of the MEI for this direct radiation is located near the Addison Building Area, an office business property adjoining the north side of SLAC.

During CY 2017, 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, both provided and processed the dosimeters.

Results from these dosimeters were also used to calculate the collective dose to the population (about 5.3 million based on year 2000 census data) that lives within 80 kilometers (km) (equivalent to 50 miles) of SLAC. The collective dose was 0.023 person-rem for CY 2017.

¹⁴ Radiation Protection Department Memo. CY 2017 SLAC Site Boundary Environmental Dosimeter Monitoring Results and Public MEI Dose Calculations, RP-DREP-20180509-MEM-01

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.¹⁵ As detailed below, the potential maximum dose to the MEI of the general public (onsite or off site) from CY 2017 releases of airborne radioactivity was calculated to be 1.35E-03 mrem (1.35E-05 mSv). Approximately 5.93E-04 mrem (44 percent of the MEI dose) can be attributed to ¹³N radioisotope. The MEI location that corresponds to the highest calculated effective dose equivalent for releases in CY 2017 is at the onsite recreational facility. This MEI dose is well below the regulatory limit, which requires airborne radionuclide 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.

Approximately 99 percent of the 1.35E-03 mrem MEI dose can be attributed to emissions from LCLS operations in CY 2017. Additionally, there was no individual release point within SLAC exceeding the 0.1 mrem/year (0.001 mSv/yr) value that requires to be continuously monitored. The maximum value from a single effluent point was 1.0E-03 mrem/yr from the LCLS Dump release point.

The collective effective dose equivalent to the population within 80 km of SLAC's site boundary (estimated at 5.3×10^6 persons) due to releases of airborne radioactivity at SLAC in CY 2017 was calculated to be 2.0E-03 person-rem.

As detailed in the annual NESHAPs report, the released airborne radioactivity was calculated based on conservative information from the SLAC accelerator operations during CY 2017. Table 5-2 summarizes the estimated radioactivity released in CY 2017, showing the quantities in curies (Ci). Potential doses to members of the public due to the released radioactivity were determined using the USEPA-approved software code CAP-88 version 2.

¹⁵ SLAC National Accelerator Laboratory, Environment, Safety & Health Division. Radiation Protection Department, *Radionuclide Air Emissions Annual Report – CY 2017* (June 2018)

Table 5-2 Airborne Radioactivity Released in CY 2017

Category	Radioactive Element	Activity (Ci)
Tritium	Hydrogen (³ H)	n/a
Krypton-85	Krypton (⁸⁵ Kr)	n/a
Noble gases (T _{1/2} < 40 days)	Argon (⁴¹ Ar)	0.03
Short-lived activation products (T _{1/2} < 3 hr)	Oxygen (¹⁵ O)	0.11
	Nitrogen (¹³ N)	0.20
	Carbon (¹¹ C)	0.02
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		0.35

n/a – not applicable

T_{1/2} – half life

< - less than

> - greater than

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 2017 monitoring and results for each water type.

5.5.1 Industrial Wastewater

Federal and state regulations (10 CFR 20.2003 and 17 California Code of Regulators 30253) limit the radioactivity in industrial wastewater that SLAC releases to the sanitary sewer system. In CY 2017, SLAC released 0.0023 percent of the applicable limits (only 1.13×10^{-4} Ci for tritium).

Throughout CY 2017, SLAC sampled and analyzed wastewater discharges for tritium. Total activity released during CY 2017 is summarized in Table 5-3.

As required by regulations, at the end of each calendar quarter of CY 2017, SLAC reported the results of wastewater monitoring and discharge to the SVCW.¹⁶

¹⁶ SLAC, ESH Division, Radiation Protection Department, *Radioactivity in Industrial Wastewater for the Period of 1 January 2017 to 31 December 2017*

Table 5-3 Radioactivity in Wastewater Released into Sanitary Sewer in CY 2017

Category	Radioactive Element	Activity (Ci)	Annual Release Limit (Ci)
Tritium	Hydrogen (^3H)	1.13×10^{-4}	5
Activation products ($T_{1/2} > 3$ hr)	Sodium (^{22}Na)	0	1 *
	Beryllium (^7Be)	0	
Total radioiodine	n/a	0	
Total radiostrontium	n/a	0	
Total uranium	n/a	0	
Plutonium	n/a	0	
Other actinides	n/a	0	

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

n/a – not applicable

Table 5-4 summarizes the historical results of wastewater monitoring for CY 2008 through CY 2017. 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.

Table 5-4 Summary of Radioactivity in SLAC Wastewater, CY 2008– 2017

Year	Radioactive Element	Activity (Ci)	Percentage of Annual Limit
2008	Hydrogen (^3H)	1.8	36
2009	Hydrogen (^3H)	9.1×10^{-5}	0.002
2010	Hydrogen (^3H)	1.2×10^{-2}	0.24
2011	Hydrogen (^3H)	2.08×10^{-4}	0.004
2012	Hydrogen (^3H)	1.1×10^{-4}	0.002
2013	Hydrogen (^3H)	4.63×10^{-5}	0.0009
2014	Hydrogen (^3H)	4.86×10^{-4}	0.01
2015	Hydrogen (^3H)	1.36×10^{-5}	0.0003
2016	Hydrogen (^3H)	6.23×10^{-5}	0.0013
2017	Hydrogen (^3H)	1.13×10^{-4}	0.0023

^3H – tritium
Ci - Curie

5.5.2 Stormwater

The stormwater monitoring program is described in Section 4.4 of this report. As in all previous years, in CY 2017, no radioactivity above natural background was found in any stormwater or stormdrain sediment samples.

5.5.3 Groundwater

Throughout CY 2017, 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. The groundwater SMP includes a groundwater Sampling and Analyses Plan (SAP) that outlines the frequency at which the wells are sampled and the constituents for which the samples are analyzed. Groundwater samples collected as part of the SMP and analyzed for tritium are sent to a California-certified analytical laboratory for independent tritium analysis. Splits of these samples are also analyzed by SLAC's RP Department. The results from the in-house laboratory are in agreement with the results of the external laboratory.

SLAC has 183 groundwater wells (see Chapter 6), 19 of which are sampled for tritium and other radionuclides at least once a year, per the groundwater monitoring program's SAP. Tritium has historically been detected above the analytical method's reporting limit (SLAC's RP Department data) in only the five wells listed in Table 5-5 on the next page. No other radionuclides were detected.

Table 5-5 Summary of Tritium Concentrations from Five Monitoring Wells in CY 2017

Period (Month)		Jan. to March	April to June	July to Sept.	Oct. to Dec.
EXW-4	Avg ^3H (pCi/L)	1092	1610	1187	1111
	percent of DWS ¹	5	8	6	6
	No. of Samples	1	1	1	1
MW-30	Avg ^3H (pCi/L)	534	< 500 ²	508	< 500 ²
	percent of DWS	3	na	na	na
	No. of Samples	1	1	1	1
MW-81	Avg ^3H (pCi/L)	1092	< 500 ²	< 500 ²	< 500 ²
	percent of DWS	5	na	na	1
	No. of Samples	1	1	1	0
MW-82	Avg ^3H (pCi/L)	<500 ²	< 500 ²	< 500 ²	< 500 ²
	percent of DWS	na	na	na	4
	No. of Samples	1	1	1	1
MW-94	Avg ^3H (pCi/L)	1799	1747	1745	1672
	percent of DWS	9	9	9	8
	No. of Samples	1	1	1	1

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 2017

na – not available

pCi/L - picocuries per liter

XW – extraction well

Other than groundwater from these five wells, no radioactivity above natural background levels has ever been detected in samples from any of the other wells. 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, which is 20,000 pCi/L under 22 California Code of Regulations (CCR) 64443 and 40 CFR 141.66. In addition, groundwater beneath SLAC is not used for any purpose because of its very low well yields, and because of the water's naturally high content of total dissolved solids (TDS).

5.6 Assessment of Radioactivity in Soil

During CY 2017, SLAC collected 9 soil samples to support the LCLS II construction project, and analyzed them by gamma ray spectroscopy. Results of all the soil samples were below the detection limit.

Throughout CY 2017, SLAC did not perform any sampling and analysis of soil for radioactivity because there were no excavations within areas at SLAC where soil could potentially be activated from SLAC operations.

5.7 Release of Property Potentially Containing Residual Radioactive Material

All property, both real and personal, exposed to any process at SLAC that could cause the property to have the potential for surface or volumetric radiation contamination has to be measured using appropriate instruments with sufficient detection capabilities before release. In addition to radiological surveys, SLAC uses process knowledge to ensure that the material meets the release criteria for recycled metals. The materials are verified to have no detectable radioactivity before they are cleared and permitted to be released from the radiological controlled areas. At SLAC, property that has any detectable radioactivity is identified as radioactive, and either is retained for appropriate reuse on site or is disposed of as radioactive waste. Only material which does not have detectable radioactivity can be released from radiological controlled areas. Therefore, property releases at SLAC do not add to the potential public dose.

The SLAC material release program has been benchmarked with other similar DOE laboratories and peer-reviewed. The protocols and the releases for certain batches of metals have also been validated and verified by the DOE SSO. Following the protocol described above 542 tons of metal were recycled from several locations at SLAC in CY 2017, including materials removed from the linac's Sectors 0 through 10 in support of the LCLS II project. The recycled metal included material from the Klystron Gallery and accelerator housing (linac Sectors 0 through 10), and excess equipment stored in the Beam Dump East Yard. A radiation portal-gate monitor is in operation at SLAC, which is used as a final screening by SLAC of trucks full of metal that has been tentatively released and is ready to be transported to the appropriate recycling center.

5.8 Potential Dose to the Public

The maximum 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 2017, namely direct radiation (0.03 mrem) and airborne radioactivity (1.35E-03

mrem). Releases of radioactivity into 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 2017 dose results with regulatory limits and natural background.

The MEI due to direct radiation is located near the business offices in the Addison Building area (590 meters north from Sector 20 of the linac), which is located immediately north of SLAC. As with previous years' calculations, the CY 2017 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, the effects of air attenuation for direct photon radiation calculations (a factor of 40) were taken into account.

Table 5-6 Summary of Potential Annual Doses due to SLAC Operations in CY 2017

	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	0.03 mrem	1.35E-03 mrem	0.031 mrem	0.023 (direct) + 0.002 (air) = 0.025 person-rem
DOE Radiation Protection Standard	100 mrem	10 mrem	100 mrem	n/a
SLAC Maximum Dose as Percentage of DOE Standard	0.03 %	0.01%	0.03 %	n/a
Dose from Natural Background ¹⁷	100 mrem	200 mrem	300 mrem	1,667,000 person-rem
SLAC Maximum Dose as Percentage of Natural Background	0.03 %	0.0007 %	0.010%	1.5E-06

mrem – millirem
n/a - not applicable
% - percent

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 2008 through CY 2017, and compares it with the average dose due to natural background radiation and radioactivity.

¹⁷ 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*

Table 5-7 Potential Annual Dose * (mrem/yr) to Maximally Exposed Individual, CY 2008 – 2017

Year	SLAC Direct and Airborne Radiation (mrem)	Average, Total Natural Background Radiation (mrem)	Percentage of SLAC Dose to Natural Background %
2008	0.05	300	0.02
2009	0.06	300	0.02
2010	0.13	300	0.04
2011	0.42	300	0.14
2012	0.53	300	0.18
2013	0.04	300	0.013
2014	0.045	300	0.015
2015	0.045	300	0.015
2016	0.052	300	0.017
2017	0.031	300	0.010

* 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), indicates DOE facilities are to protect plants and animals by assuring the following dose rates due to “exposure to radiation or radioactive material releases” into the applicable environment are not exceeded:

- Aquatic animals: should not exceed 1 rad/day
- Terrestrial plants: should not exceed 1 rad/day
- Terrestrial animals: should not exceed 0.1 rad/day
- Rad, instead of rem, is used in this report, 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 2017, SLAC monitored radiation dose and dose rate at approximately 600 on-site locations (most are outside accelerator shielding housing and the rest are inside shielding housing) using passive radiation dosimeters posted for six-month periods. For each period, the average dose rate of these 600 dosimeters was found to be less than 0.0005 rad/day¹⁸ (dominated by those inside shielding housing), and the maximum dose rate was less than 0.03 rad/day (inside shielding housing). Based on these results, and the fact that the animal population could only have had access to areas with low dose rates (outside shielding housing), doses to plant and animal populations at SLAC were well within the above-mentioned limits of the DOE standard throughout CY 2017.

¹⁸ Monitoring Results for Integrated Area Dose around SLAC for the period from January 2017 through June 2017, and Monitoring Results for Integrated Area Dose around SLAC for the period from July 2017 through December 2017.

5.9.2 Dose to Biota from Activation Products

In CY 2017, SLAC tested water samples for the presence of radioactivity above natural background levels, as described in Sections 5.5 and 5.6. Tritium was occasionally found in industrial wastewater, but plants as well as animal populations have no path by which they would come into 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 have received dose rates from radioactive activation products at SLAC that exceed the standard radiation limits.

In CY 2017, all groundwater samples analyzed for tritium were reported as either non-detects (i.e. below the reporting limit 500 pCi/L) or, if tritium was detected, the concentration was well below the human drinking water standard of 20,000 pCi/L. This value is set by the USEPA regulation. Section 5.5.3 summarizes the CY 2017 results of monitoring for radioactivity in groundwater and it shows that the levels of tritium in the groundwater have been decreasing over time. There is no potential that plants or animals will have received dose rates from activation products in groundwater at SLAC that exceed the limits of the standard.

5.10 Low-level Radioactive Waste Management

SLAC generates low-level radioactive waste (LLRW) and mixed waste from its routine operations, repairs, experiments and special projects such as decommissioning. The total waste generated during CY 2017 was 10,497 cubic feet (ft³), including legacy waste that was processed during CY 2017. Routine operations generated 57 ft³ of which 8 ft³ was mixed LLRW. Waste minimization is accomplished through training of the waste generators, 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 and DOE directives. During CY 2017, SLAC shipped 20,372 ft³ of LLRW containing 0.95 Ci of activity and weighing 168,000 kilograms to appropriately permitted and licensed treatment and disposal facilities for low-level radioactive waste.

6 Groundwater Protection and Environmental Restoration

6.1 Introduction

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

6.2 Background Conditions

The document *The Geology of SLAC*¹⁹ 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*²⁰ 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. The *2006 Environmental Baseline Report*²¹ (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*²² (RI/FS WP) provided additional description and updated the status of investigation areas, defined the four OUs at SLAC (Section 6.5), and described the framework for completing the environmental investigations and remedial actions at the facility.

¹⁹ 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>

²⁰ ESA Consultants, *Stanford Linear Accelerator Center, Summary and Identification of Potentially Contaminated Sites* (February 1994)

²¹ Sapere Consulting, *Stanford Linear Accelerator Center Environmental Baseline Report* (February 2006)

²² 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 include measures to control known soil and groundwater impacts (as are discussed in this chapter), and required procedures that are meant to prevent practices that could adversely affect soil and groundwater (as discussed in Chapter 4). These procedures include the site's SWPPP,²³ 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:

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

By the end of 2017, SLAC had generally reached and continued work towards completion of the fourth step. SLAC's Environmental Restoration Program continued remediation efforts in specific areas impacted by COPCs. Remediation 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 main areas impacted with COPCs in groundwater: the FHWSA, Former Solvent Underground Storage Tank Area (FSUST), the TL/CL area, and the Plating Shop Area (PSA). Current operating data of soil vapor and groundwater extraction at these areas indicate that the remediation systems have resulted in a significant decrease in concentrations of COPCs in soil vapor and groundwater and are achieving hydraulic control of the groundwater plumes. 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 (Water Board) 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

²³ Stanford Linear Accelerator Center, Environment, Safety, and Health Division, Environmental Protection and Restoration Department, *SLAC Stormwater Pollution Prevention Plan* (SLAC-I-750-0A16M-002)

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 Water Board was designated by the State of California the Administering Agency (i.e., lead agency) for the environmental cleanup work at SLAC.²⁴ As the lead agency, the Water Board has the responsibility to determine the adequacy and extent of cleanup, issue necessary authorizations and permits, and following the determination that an approved remedy has been accomplished, issues a certificate of closure. The Water Board has specified site cleanup to standards for un-restricted land use,²⁵ 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 is not listed in the National Priorities List (NPL) as a Superfund site because the USEPA determined that the conditions at the site did not warrant inclusion on the NPL.

Many of the RI/FS documents required under the Board Order for each OU have been completed or are under review by the Water Board. 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 (RA) Reports), followed by a thorough review of remedial options (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 the Water Board's 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.

The following Water Board Order deliverables and other documents were submitted to, or approved by the Water Board during the 2017 calendar year:

- *Final Addendum No.5, Development and Use of Site Specific Preliminary Remediation Goals for Human Health Risk Assessment*, approved by the Water Board in a letter dated February 3, 2017.
- *Final Feasibility Study for RY/SSRL/IR-6 Drainage Channel OU*, approved by the Water Board in a letter received on February 3, 2017.
- *Final 5-Year Report* was sent to the Water Board for formal approval on March 16, 2017.
- *Final Work Plan for the Research Yard Outdoor Media Removal and Replacement* was approved by the Water Board in an email dated May 4, 2017.

²⁴ California Environmental Protection Agency, *Site Designation Committee Resolution No. 06-01* (January 2006)

²⁵ Regional Water Quality Control Board, *Approval of Stanford Linear Accelerator Center Long Range Redevelopment Plan* (November 18, 2005)

- *Semi-Annual Self-Monitoring Program Report, Winter 2017* was submitted to the Water Board on June 9, 2017.
- *Research Yard/SSRL/IR-6 Drainage Channel Remedial Action Plan (RY RAP)* was uploaded onto GeoTracker on June 14, 2017 and accepted by the Water Board. Following the public review and comment period and the public meeting conducted on July 13, 2017, the RY RAP was updated and submitted to the Water Board for formal approval on October 13, 2017.
- *Draft Annual Site Designation Report*, prepared by SLAC on behalf of the Water Board. The report was submitted to the Water Board on September 1, 2017.
- *West SLAC/Campus Area/IR-8 Drainage Channel OU Feasibility Study Report* was approved by the Water Board in letter dated September 5, 2017.
- *Group 3 Removal Action Implementation Report* was submitted to the Water Board for formal approval on October 13, 2017. The report documented soil removal actions completed at five sites throughout SLAC in 2016.
- *Semi-Annual Self-Monitoring Program Report, Summer 2017* was submitted to the Water Board on December 7, 2017.

Table 6-1 summarizes the status of the RI/FS deliverables to the Water Board required under the Board Order as of the end of calendar year 2017.

Table 6-1 Regional Water Quality Control Board Order Deliverables Status

Operating Unit	RI Report	RA Report	FS Report	RAP	RD Report
Groundwater VOC	Complete	Complete	Complete	Complete	Complete
West SLAC	Complete	Complete	Complete	n/r	n/r
Research Yard	Complete	Complete	Complete	Submitted	-
Tritium	Complete	Complete	Complete ²⁶	n/a ²⁷	n/a

Notes

n/a – not applicable

n/r - not required per approved West SLAC Feasibility Study Report

Regular Core Team meetings regarding site cleanup status continued through 2017. The Core Team is a decision-making body consisting of representatives from the Water Board, DOE, Stanford University, and SLAC. As needed, members of the technical team are present at these meetings.

6.7 Groundwater Monitoring and Characterization Network

As part of the Board Order, SLAC implements a groundwater SMP that includes a groundwater SAP outlining the frequency at which wells are sampled, the constituents for which the samples are analyzed and a schedule for collecting groundwater samples from extraction and monitoring wells, surface water

²⁶ A Tritium OU Monitoring Plan was prepared in lieu of a FS Report and approved by the Water Board

²⁷ Per the Water Board-approved Tritium RI Report, a RAP and Remedial Design Report are not necessary at this time

samples, and sediment samples from select catch basins and drainage channels. Figures 6-1 through 6-3 show the areas where wells are used for monitoring.

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

- 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)

Of the 183 wells used by the Restoration Program at SLAC, 112 wells are used for monitoring groundwater quality, COPCs, or water level measurements, 66 wells are extraction wells at a total of five groundwater remediation systems, three wells are inactive soil vapor extraction (SVE) wells, and two wells at the FSUST Area are infiltration wells. Thirteen 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.

Groundwater samples were collected at least once from 98 wells in 2017 and analyzed for a variety of constituents. Results of groundwater samples collected from the monitoring wells were reported to the Water Board in the semi-annual self-monitoring report for Winter 2017²⁸ and Summer 2017.²⁹

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)

The COPCs in groundwater at SLAC are primarily VOCs and to a lesser extent SVOCs. Four of the locations listed above, the FHWSA, FSUST, TL/CL and PSA, have remediation systems that extract soil vapor and groundwater. Preliminary Cleanup Goals (PCGs) at SLAC have been established for groundwater and soil vapor. The systems at the FSUST and FHWSA, PSA and TL/CL were designed with the goal of achieving these PCGs. Operating and monitoring data from these locations indicate that the remediation systems have resulted in significant decreases in concentrations of COPCs in both groundwater and soil vapor, and are achieving hydraulic control of the plumes. In December 2012, the Water Board

²⁸ SLAC National Accelerator Laboratory, *Semi-annual Self-Monitoring Program Report, Winter 2017*(SLAC-I-750-2A15H-054, June 2017)

²⁹ SLAC National Accelerator Laboratory, *Semi-annual Self-Monitoring Program Report, Summer 2017* (SLAC-I-750-2A15H-055, December 2017)

approved the shutdown of TL/CL system for a rebound testing. Per recommendations provided in the 5-Year Review Report, the CL extraction system was restarted in January 2017 to evaluate if continued operations would result in meeting the cleanup goals for soil vapor.

Table 6-2 Monitoring Locations and Number of Wells

Location and Well Type	Number of Wells
<i>Plume Monitoring</i>	
Beam Dump East	9
Former Hazardous Waste Storage Area	24
Former Solvent Underground Storage Tank	22
Lower Salvage Yard	4
Plating Shop Area	26
Test Lab and Central Lab	7
<i>Subtotal</i>	<u>92</u>
<i>Extraction</i>	
Former Solvent Underground Storage Tank	10
Former Hazardous Waste Storage Area	23
Plating Shop Area	26
Test Lab and Central Lab	7
<i>Subtotal</i>	<u>66</u>
<i>Infiltration</i>	
Former Solvent Underground Storage Tank	<u>2</u>
<i>Environmental Surveillance</i>	
Centralized Waste Management Area	1
End Station B	1
Magnet Yard	2
Other (remote)	5
Research Yard	3
Vacuum Assembly	1
<i>Subtotal</i>	<u>13</u>
<i>Piezometer</i>	
Plating Shop Area	4
Former Hazardous Waste Storage Area	3
<i>Subtotal</i>	<u>7</u>
<i>Inactive</i>	
Former Solvent Underground Storage Area	3
<i>Subtotal</i>	<u>3</u>
TOTAL	183

Monitoring data from the end of 2017 indicated that remediation goals for soil vapor have been met at the CL, with continued operation of the DPE system, to be followed by rebound testing.

6.8 Site Descriptions and Results

The groundwater Investigation Areas (IAs) are described below, including four VOC-impacted areas (TL and CL are combined) and one low-level tritium-impacted area. Under the Board Order, the formal FS and RAP reports for the four VOC-impacted groundwater IAs were prepared by SLAC and approved by the Water Board in January 2010 and August 2010, respectively. The Remedial Design report for the Groundwater VOC Operable Unit,³⁰ which includes the four VOC-impacted plume areas, was approved by the Water Board in March 2011, and construction of the selected remedy (DPE at the four VOC-impacted areas) was completed by December 2010. Performance Evaluation Reports for all DPE systems are prepared either annually (PSA and TLCL) or biennially (FSUST and FHWSA) as part of the approved RAP. These reports are provided to the Water Board for information.

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 presence of a leak. The FSUST and accessible chemically impacted soil were removed in December 1983. A network of 21 monitoring wells and 8 extraction wells were subsequently installed, and groundwater is monitored for VOCs and SVOCs.

An interim groundwater extraction and treatment system was installed in 2001 and upgraded to include a soil vapor extraction component in 2007. 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. The average mass removal rate has since declined, as anticipated, as the more concentrated sources are removed in the soil vapor. In 2014, two DPE wells (extraction well (XW) 9 and XW-10) were brought online bringing the total number of DPE wells to ten. The two new wells are intended to improve overall mass removal.

³⁰ C/P/E, *Remedial Design Report for the Groundwater VOC Operable Unit*, (C/P/E SL-22GW-RPTS-CD000001 R0, November 2010)

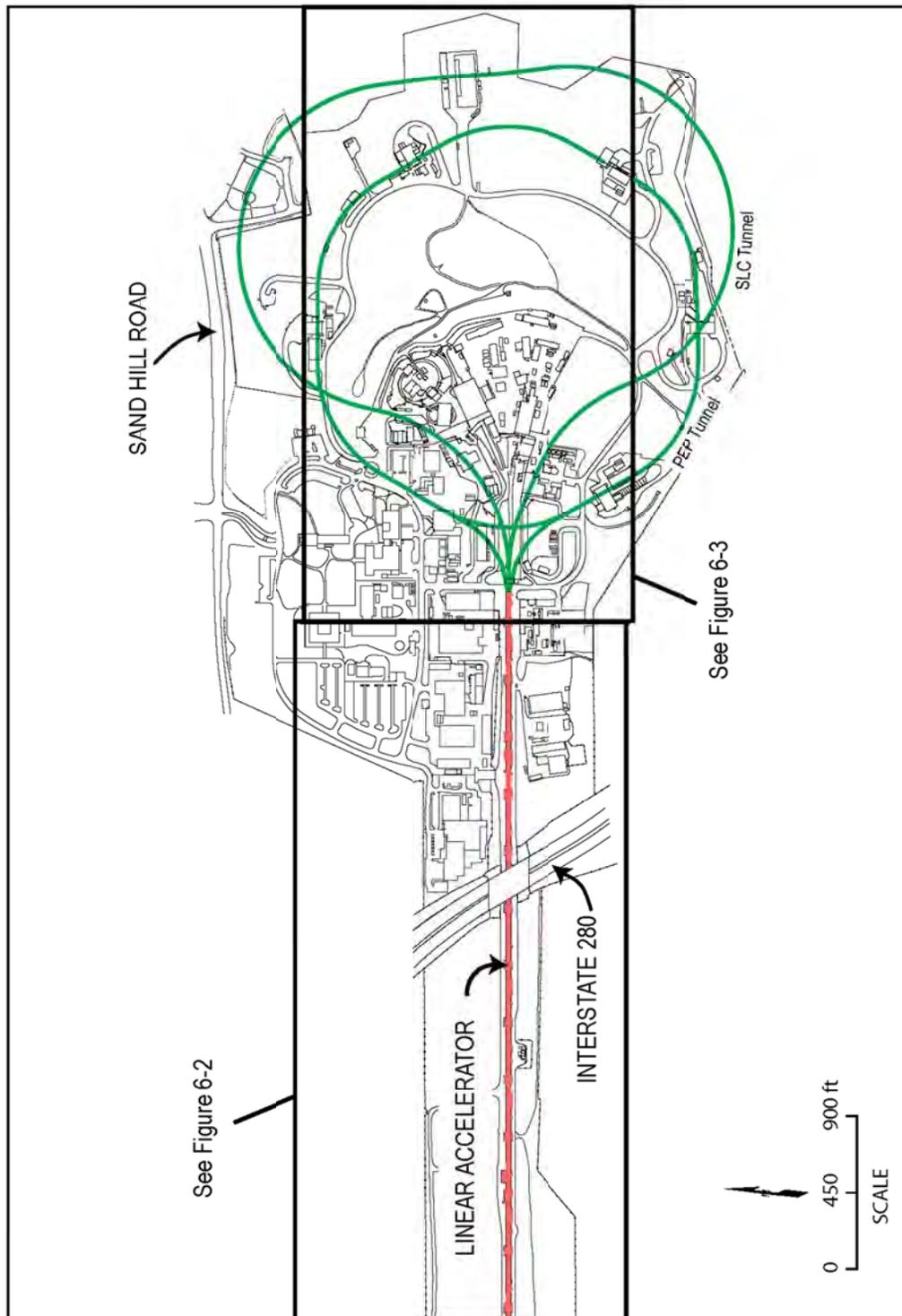


Figure 6-1 Groundwater-Impacted Well Network

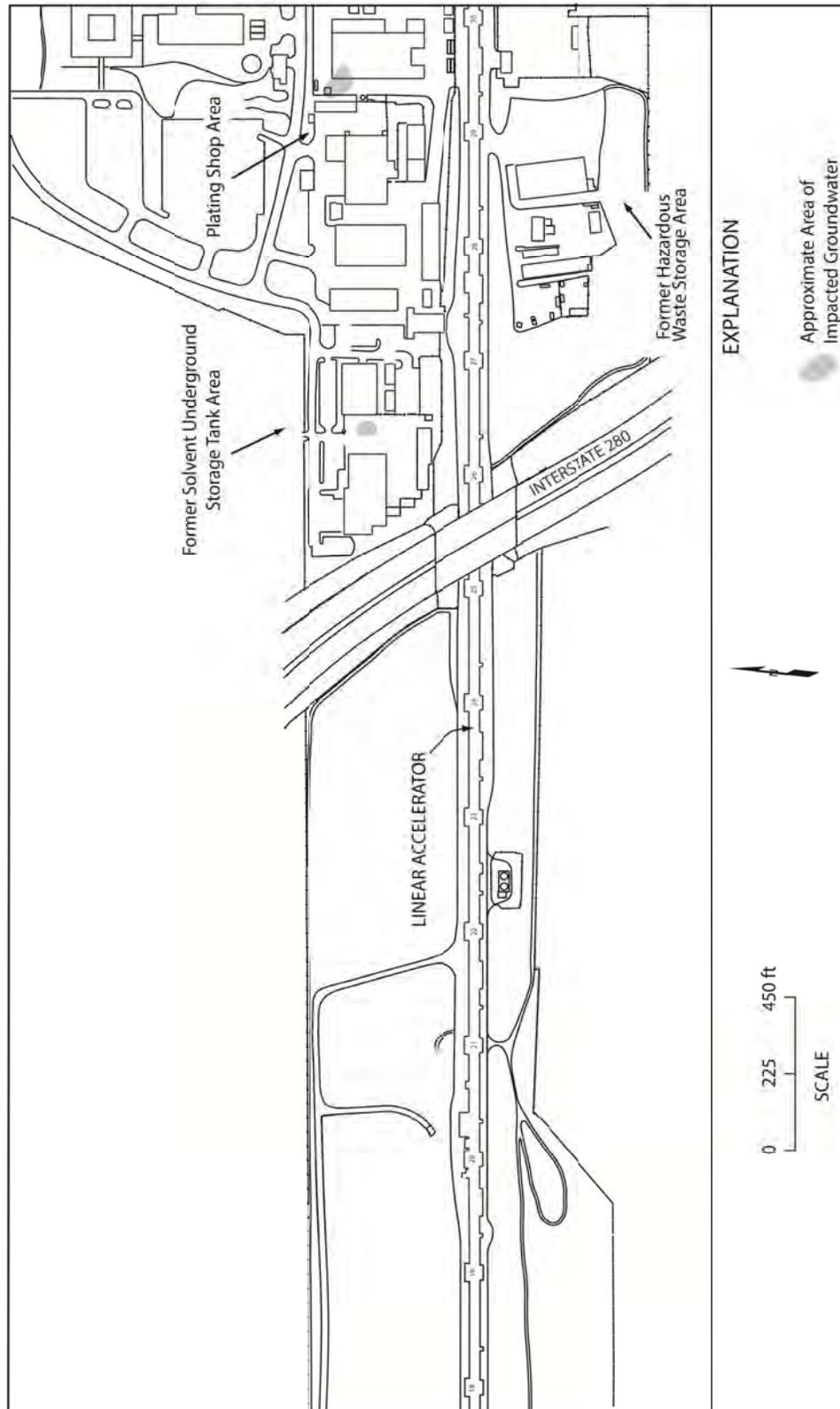


Figure 6-2 Areas in West SLAC where Groundwater is Impacted

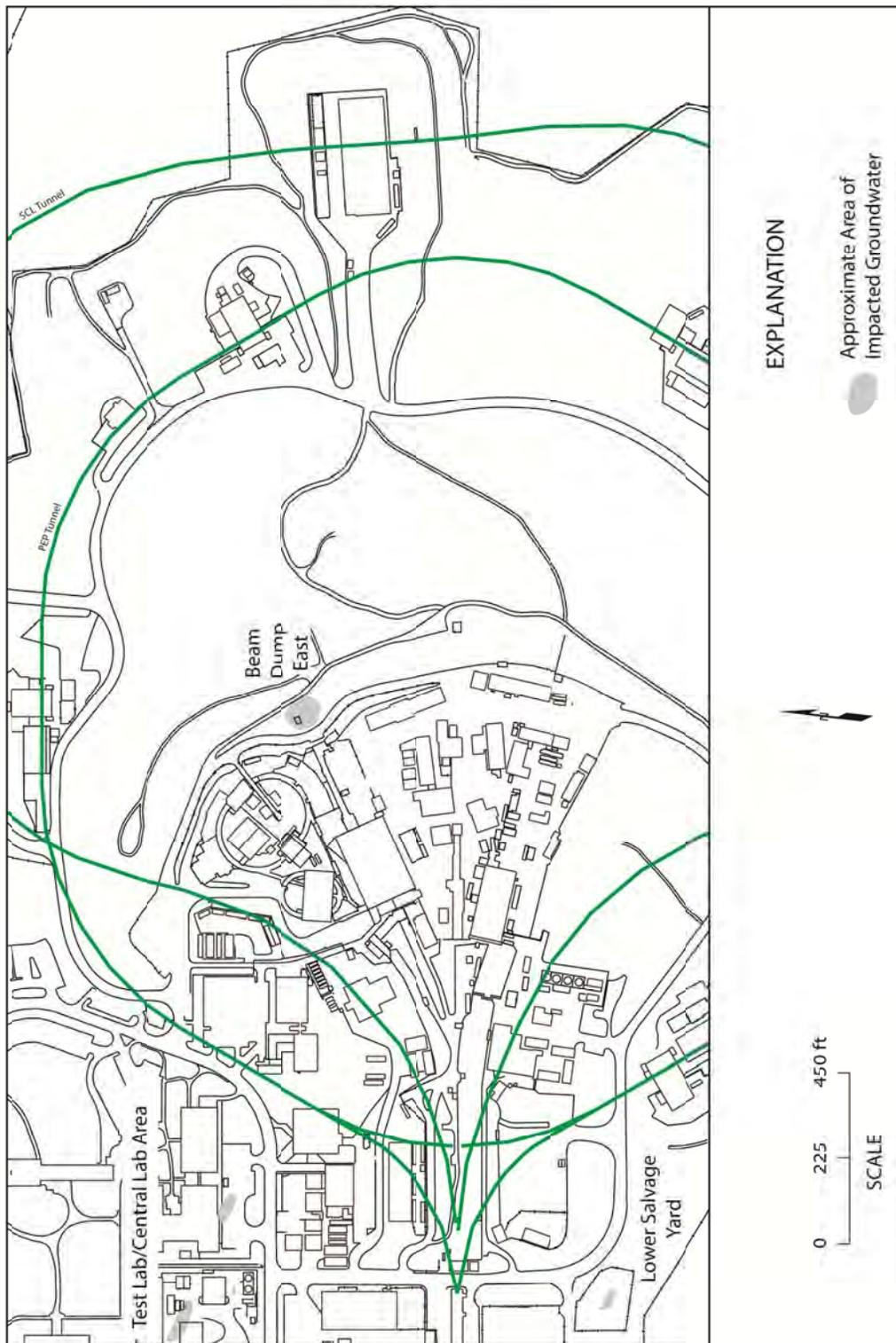


Figure 6-3 Areas in the Main Campus and East end of SLAC where Groundwater is Impacted

In September 29, 2015, the first phase of a two-phase pilot study using in-situ chemical oxidation (ISCO) at the FSUST was conducted. The objective of the pilot study was to determine if infiltration of an oxidant solution into the residual chemically impacted soil source zone could accelerate the VOC and SVOC removal rates from both soil and groundwater. The second phase of the ISCO pilot study was conducted in April 2016. The 2016 and 2017 monitoring results for the pilot study indicated a temporary reduction of VOC concentrations in the monitoring wells installed in the source and nearby areas followed by a gradual rebound of VOC concentrations in the same monitoring wells to near pre-pilot study concentrations.

Since the startup of the remediation system at the FSUST in August 2001 and through December 2017, the DPE system has removed approximately 880.39 lbs. of VOCs and SVOCs from the subsurface (soil vapor and groundwater combined), and treated approximately 1,408,419 gallons of extracted groundwater. Monitoring well data collected thus far indicate a capture zone encompassing the entire plume has been established and chemical data indicate that the plume continues to shrink in size. In addition, the monitoring data show that significant progress has been made to reduce soil vapor VOC concentrations, which is one of the remedial action goals for all the groundwater VOC-impacted areas.

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 performed at the FHWSA proved promising as a treatment method for soil and groundwater that are impacted by COPCs, 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 (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 2004³¹ 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 combined 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.

Between the startup of the system in December 2003 and December 31, 2017, the FHWSA interim and full-scale systems removed approximately 2,390,045 gallons of groundwater and 41.21 lbs. mass of total VOCs and SVOCs. In 2016, the FHWSA DPE operated in a cyclic mode, allowing groundwater to be cyclically extracted (DPE system on) and recharged (DPE system off) in an attempt to increase mass removal through flushing. In 2017, the DPE system largely remained off, with the exception of localized focused DPE well groundwater extraction. Analytical data to date indicate that significant progress has also been made in reducing the concentrations of VOCs in groundwater and in soil vapor. However, there appears to be an area within the FHWSA where DPE has thus far been unable to reduce VOCs concentrations in soil vapor. The recalcitrant area is characterized by very low permeability shallow clayey soils. This area was further evaluated in 2015-2017 and the lateral and vertical extent was established.

⁴⁰ Erler & Kalinowski, *Technical Specifications and Drawings for the Dual Phase Extraction and Treatment System at the Former Hazardous Waste Storage Area* (2004)

Alternative remedial options for this area were evaluated in the Five-Year Technology Review Report, which requires review and reevaluation of a remedial action after a period of five years from the beginning of the RAP implementation. The five-year review report recommendation specified excavation of the low permeability shallow clayey soils as the remedial action. The excavation work is currently being planned for 2018.

6.8.3 Plating Shop Area

In 1990, three downgradient monitoring wells were installed at the PSA. COPCs were detected in all three wells; and an investigation began and included installation of additional monitoring wells, a soil gas survey, and remediation beneath a steam-cleaning pad. Twenty-six 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.

Twenty-six DPE wells make up the treatment system at the PSA, in operation since November 2010. Between the start-up of the system and December 31, 2017, approximately 4,955,688 gallons of groundwater were extracted by the PSA DPE system and 14.31 lbs. mass of total VOCs and SVOCs were removed by the system. Analytical data collected from the monitoring wells thus far indicate that a capture zone encompassing the entire plume has been established and that the plume appears to be shrinking in its vertical and lateral extent. In addition, the data show that significant progress has been made in reducing soil vapor VOC concentrations.

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 and started in November 2010. Between the start-up of the system in November 2010 and the last day of operation in December 2012, when the system was shut down for rebound testing (see below) approximately 200,261 gallons of groundwater was extracted by the TL DPE systems and 682,572 gallons of groundwater was extracted by the CL DPE system. In addition, 0.77 lbs. of total VOCs and SVOCs mass was removed by the TL system, and 3.08 lbs. of total VOCs and SVOCs mass was removed by the CL system. Based on the remediation progress, the Water Board approved turning off the DPE system for rebound testing in December 2012. The fourth year of the rebound test period (initially planned to be a 3-year rebound period) was completed in December 2016. The four-year rebound testing and monitoring results indicate remediation goals have been met, with the exception of one newly identified localized shallow soil vapor zone at the CL. Per recommendations provided in the 5-Year Review Report, the CL DPE system was restarted in January 2017 to evaluate if continued operations would result in succeeding to meet the soil vapor remediation goals in the localized shallow soil vapor zone. Operational data for the CL system indicated that an additional 0.26 lbs. of VOCs and SVOCs were removed in calendar year 2017. The monitoring data at the end of 2017 indicated that SVP remediation goals have been met in the localized area. This successful phase of resumed DPE operation will be followed by rebound testing.

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 2017, as in previous years, the monitoring of groundwater indicates that tritium is localized to two wells in the area of the beam dump at levels far below the drinking water standards (see Section 5.9). 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 Water Board in June 2009. In addition, a Monitoring Plan Report (MPR) was prepared by SLAC under the Board Order and approved by the Water Board 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

Low levels of TPH continue to be detected in groundwater samples collected at the LSY during 2017. Based on the West SLAC OU Baseline Risk Assessment, the detected levels do not represent a human health or ecological risk.

6.8.7 Removal and Remedial Actions

Since CY 2008, soil removal actions have been completed in advance of the formal FS or RAP reports for the West SLAC and RY OUs based on an Engineering Evaluation and Cost Analysis. Soil removal actions since CY 2008 have resulted in the removal of approximately 43,000 cubic yards of impacted soil and debris from 25 areas. The following describes the major removal and remedial actions that were conducted during 2017.

6.8.7.1 Soil and Sediment Removal Action at the IR-6 and IR-8 Drainage Channels

In 2017, soil and sediment were removed from the entire length of the IR-6 primary drainage channel, the southwestern end of the IR-6 secondary channel, a small area on the northeastern end of the IR-6 secondary channel, the northern reach of the IR-8 drainage channel, and the IR-6/8 confluence area. The depth of excavation varied from approximately 1 to 7 feet below ground surface. To support the project, the following permits were granted for the IR-6 and IR-8 removal action project: Regional Water Quality Control 401 Certification Permit; United States Army Corps of Engineers Nation Wide 404 permit California Department of Fish and Wildlife Lake and Streambed Alteration Agreement. In addition, a CEQA Initial Study (IS), Mitigation Negative Declaration (MND), draft Water Board Resolution was prepared. The Water Board posted the IS/MND, draft resolution, and supporting documents on their public website on April 2017. The public comment period ended on 2017. No public comments were received.

The primary elements of the removal action, which took place in August through September 2017 included:

- excavating approximately 3,400 tons (2,430cubic yards) of soil and sediment from the drainage channels and surrounding areas;
- demolishing and removing a concrete oil/water separator that was located adjacent to the IR-8 drainage channel;
- performing confirmation soil sampling to demonstrate that risk-based goals for future unrestricted land use were attained in soil remaining after the excavation;

- backfilling the excavated areas in the drainage channels and restoring drainage channel contours;
- providing erosion control and reseeding with native grasses; and,
- planting willows and cattails in disturbed riparian and wetland areas, respectively.

Biological restoration monitoring and maintenance will be performed in the drainage channels for five years.

6.8.7.2 Targeted Materials Removal from the Research Yard-SSRL (RY-SSRL) Area

This work, which included removal of targeted areas of pavement, expansion joint felt, mastic, and pipe insulation at the RY-SSRL Area, was performed from October to December 2017. The purpose of the targeted material removal was to remove materials that have been identified, through prior environmental investigations, to prevent a potential source of PCB-impacted particulate transport to the IR-6 drainage channel soil. The targeted material removal was a component of the final remedy for the RY-SSRL/IR-6 OU as described in the *Remedial Action Plan for the Research Yard-SSRL/IR-6 Drainage Channel Operable Unit*. The scope of the completed work included pavement removal from three former power station locations in the RY, expansion joint felt material removal from two areas in the RY, deteriorated mastic material removal in two areas of the RY, and pipe insulation removal from an area draining into the RY stormdrain system.

6.8.7.3 Hydrodynamic Sedimentation Unit Installation

During the summer of 2017, a HSU was installed at the head of the IR-6 channel to remove suspended sediments that may have adsorbed PCBs from stormwater flowing upstream of the IR-6 drainage channel. The installation of the HSU was a component of the final remedy for the RY-SSRL/IR-6 OU as described in the *Remedial Action Plan for the Research Yard-SSRL/IR-6 Drainage Channel Operable Unit*. The objective of the HSU is to keep PCBs from accumulating in soil in the IR-6 drainage channel. The IR-6 drainage channel receives stormwater runoff primarily from the RY/SSRL area of SLAC. Prior investigations have determined that low levels of residual PCBs present in the RY-SSRL area have the potential to migrate with suspended sediments in stormwater and accumulate in soil in the IR-6 drainage channel.

The HSU installed was a Downstream Defender® (DD) model DD-12 HSU, a twelve-foot diameter passive treatment unit, manufactured by Hydro International, with a hydraulic capacity of 38 cubic feet per second. The installation included modifications to the existing IR-6 weir structure to convert it into a flow diversion structure capable of diverting up to 20 cubic feet per second of stormwater through the HSU, as well as installation of conveyance piping and tie-ins to the existing stormdrain infrastructure. An estimated 99 percent of the stormwater flowing from the RY will be treated before it enters the IR-6 drainage channel.

6.9 Excavation Clearance Program

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 within SLAC. The excavation clearance program addresses potential worker exposure hazards associated with underground utility lines, chemical contamination, and radiological hazards. The program also ensures proper management and disposal of excavated materials. During 2017, 39 projects were supported by this program.

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