SLAC-R-507

1996 Site Environmental Report
January—December 1996

ENVIRONMENT, SAFETY,
AND
HEALTH DIVISION

SLAC-Report-507
September 1997

Prepared for the Department of Energy
under contract number DE-AC03-76SF00515

STANFORD LINEAR ACCELERATOR CENTER
Stanford University Stanford, California

Contributors

Authors

Rich Cellamare
Georgina Dannatt
Mark Dubrow
Jack Hahn
Rod Hiemstra
Michael Hug
Ken Kase
Maureen McNear
Kyle Millage
Helen Nuckolls
Keith Reynolds
Michael Scharfenstein
Roger Sit

Contributing Authors

Michelle De Camara
Susan Witebsky

Coordinators

Mike Grissom
Ray Jensen

Editor

Gene Holden

Table of Contents

Figures

Appendices

Tables

1 Executive Summary

This report provides information about environmental programs and compliance with environmental regulations in calendar year 1996 (CY96) at the Stanford Linear Accelerator Center (SLAC). SLAC is a national laboratory operated by Stanford University under contract with the US Department of Energy (DOE) and is devoted to experimental and theoretical research in elementary particle physics, in basic sciences using synchrotron radiation, and in accelerator physics and technology. The most significant information in this report is summarized briefly in the following sections.

1.1 Releases

In CY96, as in CY95, there were no known releases of radioactive material by SLAC to the environment in excess of DOE or regulatory limits. There was one reportable release by SLAC to the sanitary sewer when the daily mass limit for chromium was exceeded in a quarterly 24-hour composite sample.

1.2 Environmental Restoration

As a part of SLAC's Environmental Restoration Program (ERP), the EPR Department began work on Remedial Investigation/Feasibility Studies (RI/FS) at four sites with detected volatile organic constituents (VOCs) in groundwater and continued active participation in various public activities.

Work plans for each of the four sites were completed and approved by the regulating agency, the San Francisco Bay Regional Water Quality Control Board (RWQCB) in CY96, and the first phase of investigation and characterization of the sites began.

1.3 Hazardous and Radioactive Waste

The Radioactive Waste Management Group of the WM Department manages the low-level activated metals that are the primary source of radioactive waste at SLAC. The metal comes in the form of beam line components that are managed as radioactive material. In the early 1990's, SLAC changed the designation of some of the accumulated radioactive material that had been stored for potential re-use into radioactive waste. This radioactive waste will be disposed of as time and budget allow.

SLAC complied with all waste management requirements for the disposal of hazardous waste in CY96 as required under federal, state and local regulations. During CY96, all hazardous waste for off-site disposal was successfully shipped from SLAC within 90 days of generation.

1.4 Air Quality

SLAC did not exceed permit limits in CY96 for the 26 air pollution sources that are listed with the Bay Area Air Quality Management District (BAAQMD). During CY96, the BAAQMD did not inspect SLAC.

1.5 Storm Water and Industrial Wastewater

SLAC revised the Storm Water Pollution Prevention Plan (SWPPP). For industrial wastewater, SLAC exceeded it's permit limits for chromium in May CY96.

1.6 Polychlorinated Biphenyls (PCBs)

The Toxic Substances Control Act (TSCA) regulates equipment that is filled with oil or other dielectric fluids containing PCBs. SLAC has some equipment that falls into this category. In CY96 SLAC continued to reduce its inventory of PCBs by disposing of a significant portion of the remaining large and small PCB capacitors as well as other PCB-containing equipment. One transformer remains on inventory as a PCB transformer with greater than 500 parts per million (ppm) of PCB. This transformer is pending reclassification to non-PCB status. SLAC is planning to remove or retrofill and reclassify the remaining 14 PCB-contaminated transformers (50 to 500 ppm of PCBs) over the next few years.

1.7 Assessments

In CY96, SLAC's set of "Necessary and Sufficient ES&H Standards" name changed to "Work Smart Standards" (WSS). The WSS set was incorporated in SLAC's Management and Operating (M&O) contract. The WSS set includes all applicable statutory and regulatory requirements for public and worker safety and environmental protection. It also includes a number of industry standards that were found to be necessary to control specific hazards present at SLAC. One impact of this modification of SLAC's contract is that most DOE Orders that previously had been the basis for SLAC's ES&H program are no longer applicable.

Progress continued in CY96 toward completing the corrective actions developed in response to the 1991 Tiger Team assessment. Forty-three of the 51 environmental findings have been completed, and 53 of the 57 related tasks have also been completed. Seventeen of the 43 environmental findings have been validated, and 33 of the 53 related tasks have also been validated.

Other external appraisals resulted in the identification of 27 corrective action tasks, of which 24 have been completed. None of these corrective action tasks have been validated. Most of these tasks were primarily concerned with the adequacy of SLAC's documented plans and procedures. No significant threats to the environment were noted.

SLAC's Quality Assurance and Compliance organization completed seven environmental assessments. The assessments in 1996 focused on water quality and hazardous waste management practices. No significant problems were identified in these areas. Of the 75 environmental findings made, 68 have been completed.

1.8 Environmental Radiological Program

SLAC monitors potential radiological releases to the environment through wastewater, air emissions, and direct radiation from accelerator operations. SLAC did not exceed regulatory limits for radioactivity released to the environment in CY96. In addition, there were no known instances of noncompliance for radionuclide air emissions in CY96.

1.9 Groundwater

The Groundwater Protection Management Program (GPMP) describes the comprehensive program in place for groundwater protection at SLAC. The GPMP is managed through EPR. Groundwater monitoring data was collected from groundwater monitoring wells. These wells provide surveillance of SLAC's groundwater.

In addition, groundwater was collected from monitoring wells installed to investigate the extent of VOCs in groundwater. This work supports the Remedial Investigation/Feasibility Study (RI/FS) as described in Section 4.5.1 of this report, Environmental Restoration.

1.10 Additional Information

A reader's survey has been provided at the end of this document. Additional information about SLAC is available at:

http://www.slac.stanford.edu/

2 Introduction

2.1 General

The Stanford Linear Accelerator Center (SLAC) is a national facility operated by Stanford University under contract with the Department of Energy (DOE). SLAC is located on the San Francisco Peninsula, about halfway between San Francisco and San Jose, California (see Figure 2-1). The site area is in a belt of low rolling foothills, lying between the alluvial plain bordering San Francisco Bay on the east and the Santa Cruz Mountains on the west. The accelerator site varies in elevation from 53 to 114 meters (m) above sea level, whereas the alluvial plain to the east around the Bay lies less than 46 m above sea level; the mountains to the west rise abruptly to over 610 m (see Figure 2-2).

The SLAC site occupies 170 hectares of land owned by Stanford University and leased in 1962 to the DOE (then the AEC) for fifty years for purposes of research in the basic properties of matter. The land is part of Stanford's "academic reserve," and is located west of the University and the City of Palo Alto, in an unincorporated portion of San Mateo County. The site is bordered on the north by Sand Hill Road and on the south by San Francisquito Creek. The laboratory is located on a roughly 300 m-wide parcel, 3.2 kilometers (km) long, running in an east-west direction. The parcel widens to about 910 m at the target (east) end to allow space for buildings and experimental facilities (see Figure 2-3).

The SLAC population currently numbers about 1,350 people, 150 of which are Ph.D. physicists. At any given time there are between 900 and 1,000 users, or visiting scientists. Approximately 800 staff members are professional, composed of physicists, engineers, programmers, administrative associates, and other scientific-related personnel. The balance of the staff is composed of support personnel including technicians, crafts personnel, laboratory assistants, and clerical and administrative employees.

2.2 Description of Program

The SLAC program centers around experimental and theoretical research in elementary particle physics using accelerated electron beams and a broad program of research in atomic and solid state physics, chemistry, and biology using synchrotron radiation from accelerated electron beams. There is also an active program in the development of accelerators, detectors, and new sources and instrumentation for synchrotron radiation research.

The main instrument of research is the 3.2 km linear accelerator (linac) that generates high intensity beams of electrons and positrons up to 50 GeV, which are amongst the highest energy electron and positron beams available in the world. The linac is also used for injecting electrons and positrons into colliding beam storage rings for particle physics research.

The Positron-Electron Project (PEP) storage ring is about 800 meters in diameter. The PEP program was completed several years ago. PEP is now being upgraded to serve as an Asymmetric B Factory (or PEP-II) that will study the b meson. PEP-II will make use of much of PEP's existing equipment and infrastructure, and is scheduled for completion in 1998.

A smaller storage ring, the Stanford Positron Electron Asymmetric Ring (SPEAR) has its own smaller linac and a booster ring for injecting accelerated beams of electrons. SPEAR is fully dedicated to synchrotron radiation research. The synchrotron light generated by the SPEAR storage ring is used by the Stanford Synchrotron Radiation Laboratory (SSRL) to perform experiments.

Scientists from all parts of the United States and from throughout the world participate in the experimental programs at SLAC.

2.3 Local Climate

The climate in the SLAC area is Mediterranean. Winters are cool and moist, and summers are mostly warm and dry. Long-term weather data describing conditions in the area have been assembled from official and unofficial weather records at Palo Alto Fire Station Number 3 which is 4.8 km east of SLAC. The SLAC site is 60 to 120 m higher than the Palo Alto Station and is free of the moderating influence of the city; temperatures therefore average about two degrees lower than those in Palo Alto. Daily mean temperatures are seldom below zero degrees Centigrade or above 30 degrees Centigrade.

Rainfall averages about 560 millimeters (mm) per year. The distribution of precipitation is highly seasonal. About 75% of the precipitation including most of the major storms occurs during the four-month period from December through March. Most winter storm periods are from two days to as much as a week in duration. The storm centers are usually characterized by relatively heavy rainfall and high winds. The combination of topography and air movement produces short fluctuations in intensity, which can best be characterized as a series of storm cells following one another so as to produce heavy precipitation for periods of five to fifteen minutes with lulls in between.

2.4 Site Geology

The SLAC site is underlain by sandstone with some basalt at the far eastern end of the site boundary. In general, the bedrock on which the western half of the SLAC linac rests is the Whiskey Hill Formation (Eocene age), and the bedrock under the eastern half is the Ladera Formation (Miocene age). On top of this bedrock at various places along the accelerator alignment is the Santa Clara Formation (Pleistocene age), where alluvial deposits of sand and gravel are found. At the surface is a soil overburden of non-consolidated earth material averaging from 0.1 to 1.5 m in depth. A more detailed description of the SLAC geology can be found in the *SLAC Hydrogeologic Review Report* (SLAC-I750-2A15H-002).

2.5 Site Water Usage

Use of water by SLAC is about equally divided between accelerator and equipment cooling, and domestic uses (such as landscape irrigation, sanitary sewer and drinking water). The average water consumption by SLAC for CY96 was 243,000 (2.43 x 10^5) gallons per day. Since half of the water is necessary for machine cooling, the daily consumption of this component of water usage varies directly with the accelerator running schedule, and hence also varies directly with electric power demand (the domestic water usage is relatively constant and is insensitive to the accelerator schedule).

The relationship between power and water consumption can be appreciated if one considers that 85% of the power used in linac operation is finally dissipated by water evaporation, in the ratio of about 630 kilowatt-hours (kWh) per cubic meter of water. SLAC now employs six cooling-water towers comprising a total cooling capacity of 79 mega watts (MW) to dissipate the heat generated by the linac and other experimental apparatuses.

Power-consuming devices are directly cooled by a recycling closed-loop system of low conductivity water (LCW). The LCW is piped from the accelerator (or other devices to be cooled) to the cooling towers, where the heat is exchanged from the closed system to the domestic water in the towers. Prior to discharge, the LCW from the closed system is sampled and analyzed for radioactivity. A portion of the tower water is ultimately evaporated into the atmosphere. Because of this constant evaporation during operation, the mineral content of the remaining water gradually increases and eventually must be discarded as "blowdown" water. SLAC discharged a total of 17,183,731 gallons of wastewater to the sanitary sewer system in 1995, an average of 46,950 (4.7×10^4) gallons per day.

The SLAC domestic water is furnished via the Menlo Park Municipal Water Department (MPMWD) whose source is the City of San Francisco-operated Hetch Hetchy aqueduct system from reservoirs in the Sierra Nevada. SLAC and the neighboring Sharon Heights development, including the shopping center, receive water service from a separate independent system (called Zone 3) within the MPMWD. This separate system taps the Hetch Hetchy aqueduct and pumps water up to a 7,600 cubic meter reservoir west of Sand Hill Road. The Zone 3 system was constructed in 1962 under special agreements between the City of Menlo Park, the developer of Sharon Heights, Stanford University, and the DOE. Since the cost of construction, including reservoir, pump station, and transmission lines, was shared among the various parties; each party has a vested interest in, and is entitled to, certain capacity rights in accordance with these agreements.

2.6 Land Use

San Mateo County has the ultimate planning responsibility with respect to University lands that are within the county, but not within an incorporated city. The San Mateo County General Plan is the primary land use regulatory tool with respect to such lands. Adherence will be made to all applicable federal, state, and local regulations, including chemical and sanitary discharges that might (directly or indirectly) adversely affect environmental quality.

The Board of Trustees of Stanford University is responsible for preserving and protecting Stanford's land endowment for the use of present and future generations of students and faculty. While financial and political influences on land-use policy are taken into account, the dominant and prevailing consideration is the appropriateness of those policies in the furtherance of the University's academic mission. Board policies are designed to encourage land uses consistent with the institutional characteristics and purposes of Stanford, and to discourage those uses or claims which do not relate to or support the mainstream activities of the University. SLAC falls into the former category.

The purpose of the Stanford land endowment is to provide adequate land for facilities and space for the instructional and research activities of the University. The use of lands is planned in a manner consistent with the characteristics of Stanford as a residential teaching and research university, and provides flexibility for unanticipated changes in academic needs. Cooperation with adjoining communities is important and the concerns of neighboring jurisdictions are considered in the planning process.

2.7 Demography

The populated area around SLAC is a mix of office, school, university, condominiums, apartments, single family housing, and pasture. SLAC is mainly surrounded by 5 communities: Atherton town, West Menlo Park, Woodside town, Portola Valley town, and Stanford. Population and housing unit data from the most recent census (1990) of these five communities are shown in Table 2-1.

Table 2-1 Demographic Data

Geographic Area	Population (persons)	Pop. Density (per sq mile)	Housing (units)	Land Area (sq mile)
Atherton town	7,163	1,463.32	2,518	4.895
West Menlo Park	3,959	7,086.19	1,701	0.559
Portola Valley town	4,194	458.02	1,675	9.157
Woodside town	5,035	428.88	1,892	11.740
Stanford	18,097	6,569.14	4,770	2.755
Total	38,448	NA	12,556	29.105

A population estimate within 80 km of SLAC was determined as part of the required input to the CAP88-PC computer code used to demonstrate compliance with the Clean Air Act (CAA). Population data from the 1990 census of San Mateo County and Santa Clara County were used in this study. The area was divided into 13 concentric circles and 16 compass sectors. The population distribution is summarized in Table 2-2.

Table 2-2 Radial Population Data for CAP88-PC

0.1 km	0.3 km	0.5 km	1.0 km	2.0 km	4.0 km	6.0 km	8.0 km	10.0 km	30.0 km	40.0 km	60.0 km	80.0 km	Total
0	0	1,214	2,825	14,106	31,679	42,832	131, 629	114,377	665,574	1,232,353	1,716,571	964,283	4,917,443

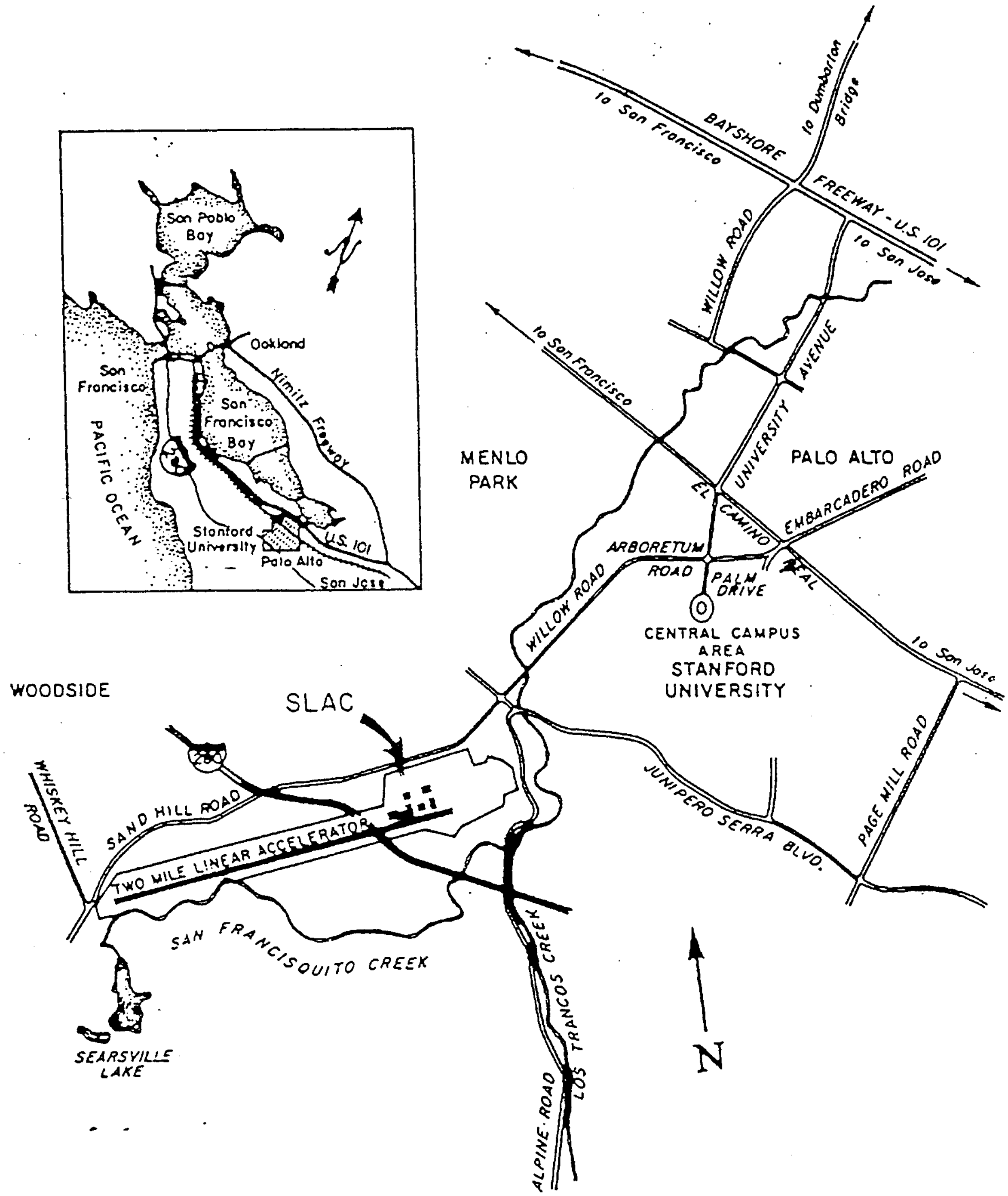


Figure 2-1 SLAC Site Location

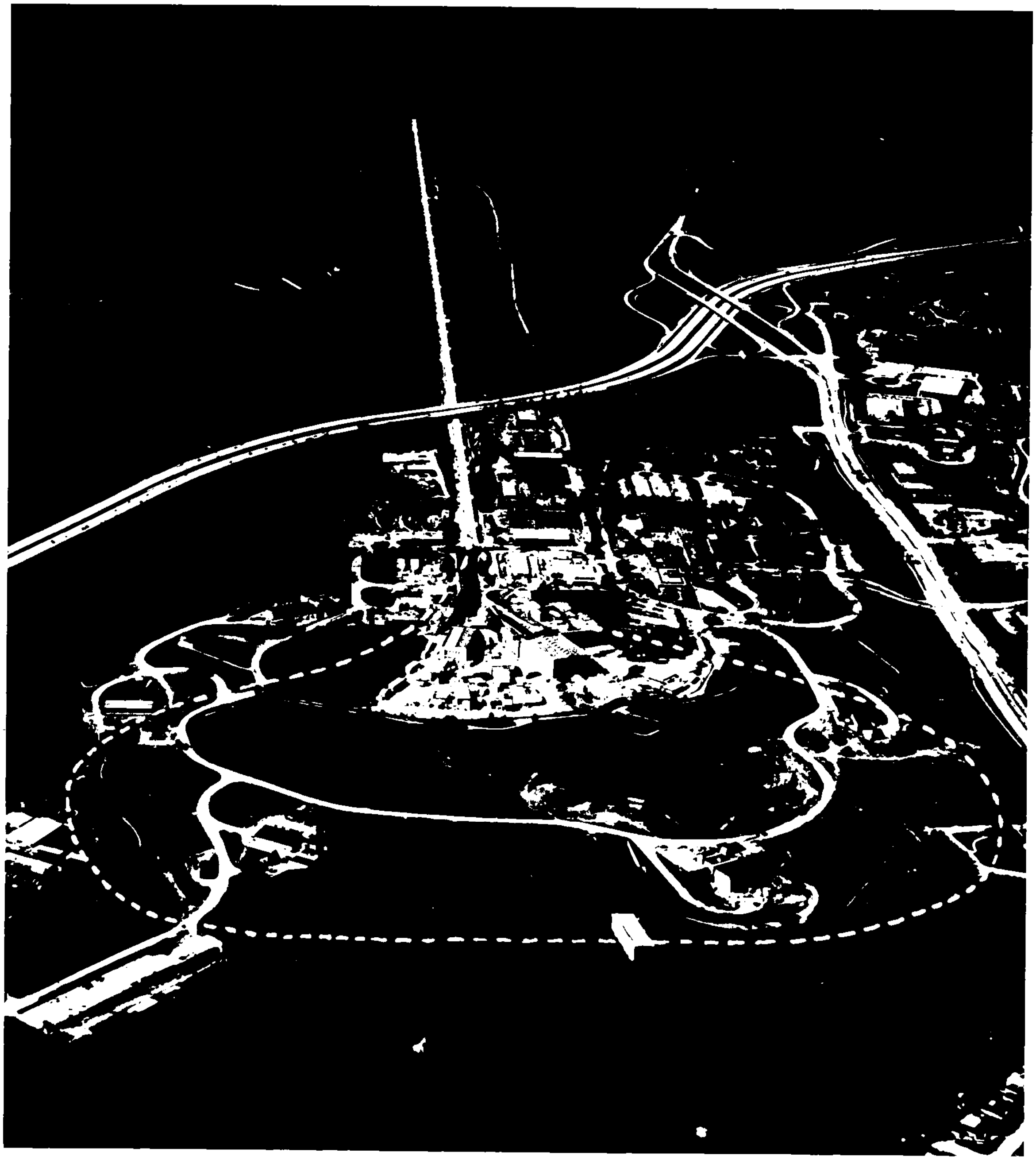


Figure 2-2 Aerial View of SLAC Site

Figure 2-3 SLAC Research Yard and the Surrounding Community

3 Compliance Summary

This section of the *1996 Site Environmental Report* provides a summary of the Stanford Linear Accelerator Center's (SLAC's) compliance with environmental laws and regulations. Specific instances of noncompliance are discussed and descriptions of corrective actions are included. More detailed descriptions of environmental programs are presented in the environmental program information sections (see chapters 4, 5, and 6).

3.1 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

3.1.1 Environmental Restoration

SLAC follows general CERCLA technical guidance in investigating and remediating soil and groundwater contamination. SLAC is not, however, listed in the National Priorities List (NPL) as a Superfund site. Therefore, SLAC is not required to follow formal CERCLA procedures.

In calendar year 1996 (CY96), SLAC's Environmental Restoration Program (ERP), following the general CERCLA guidance, began remedial investigation/feasibility study (RI/FS) work at the four sites of groundwater contamination. Section 6.0 describes this work.

All of these groundwater sites are monitored. One of these groundwater sites is monitored on a semester basis under state Regional Water Quality Control Board (RWQCB) Waste Discharge Order No. 85-88. RI/FS work and clean-up of groundwater sites are done under RWQCB lead. As long as work continues at the presently acceptable pace, SLAC will not be subject to written compliance and/or clean-up agreements.

In CY91, the first phase of an RI was performed in two unlined drainage ditches located between the IR-6 off-site drainage and IR-8. PCB contamination was found in portions of the eastern ditch originating on SLAC property and extending approximately 350 feet off-site onto adjacent undeveloped property owned by Stanford but once leased to a private party. SLAC constructed a fence to prevent uncontrolled access to this contaminated area.

Sampling and analysis of sediments in San Francisquito Creek, located downstream of the drainage ditches, indicated that the contamination had not migrated to that area. However, examination of the upstream (on-site) drainage system revealed PCB and lead contamination.

In CY94, SLAC performed two additional studies to determine whether contamination existed upstream. Soil and sediment samples were taken along a 2.5-mile length of San Francisquito Creek and analyzed for a variety of constituents. The results showed no detectable PCBs in the creek between Searsville Lake and the confluence with Los Trancos Creek. Lead analysis indicated only background levels. Sample analysis of the storm drain catch-basin sediments upstream of the contaminated areas indicated both PCB and lead contamination.

Additional study of the drain system and removal and off-site disposal of contaminated sediments from the catch basins and the IR-6 off-site drainage channel occurred in CY95. The *IR-6 Drainage Channel: Engineering Evaluation and Cost Analysis* (EECA) was written in CY95 to establish clean-up standards based on risk analysis, and to guide the removal action. As the lead regulatory agency, the RWQCB reviewed the EECA. This clean-up is described in Section 4.5.1.3 under IRAs.

In CY96 it was found that sediments with PCBs were still entering the IR-6 drainage channel. Video of the storm drain lines indicated sediment was trapped in the lines. This sediment in the storm drainlines is the source of residual PCB and the lines will be cleaned out in CY97. In addition, the IR-6 drainage channel will be monitored for PCBs in CY97. Further work will depend on results of the storm drain line cleanout and monitoring of the IR-6 drainage channel.

A community relations plan was completed and distributed to the surrounding community in CY93. Extensive community relations activities continued in CY96.

3.1.2 Superfund Amendments and Reauthorization Act (SARA)

The Emergency Planning and Community Right-to-Know Act (EPCRA), otherwise known as the Superfund Amendments Reauthorization Act (SARA) Title III report, and the State equivalent, known as the Hazardous Materials Business Plan (HMBP) report were submitted to the San Mateo County Department of Health Services for CY96. See Table 3-1 for report information.

Table 3-1 EPCRA Compliance Information

Article	Title	REPORT
		Required and Submitted
302-303	Planning Notification	YES
304	EHS Release Notification	YES
311-312	MSDS/Chemical Inventory	YES
313	TRI Reporting	XXXXX[a]

[a]In CY96, SLAC did not exceed the 10,000 pounds use threshold for these chemicals, therefore, no report was required.

3.2 Resource Conservation and Recovery Act (RCRA)

SLAC is a generator of hazardous waste, and as such is not permitted to treat hazardous waste or store it for longer than 90 days. The San Mateo County Department of Health Services is the local agency responsible for inspecting generators of hazardous waste for compliance with federal, state, and local hazardous waste laws and regulations.

The U.S. DOE Oakland Operations Office (DOE) coordinates with the State of California Environmental Protection Agency, Department of Toxic Substances Control (DTSC) on issues pertaining to radioactive and hazardous waste.

During the Fall of 1995 SLAC self reported through the DOE to the DTSC. The self report was to inform the DTSC that SLAC was storing activated lead that had been declared waste beyond the 90 day storage limit. The DTSC inspected SLAC in January 1996 and negotiated a stipulation order for corrective actions. The order allowed for the activated lead to be declared reusable material and packaged for use as shielding.

The County performed a Hazardous Waste Generator Inspection of SLAC in December of 1996. A report was produced from the inspection and stated that, overall, routine generation of waste is performed well. Non-routine activities, however, need improvement in the consistency of the application of standard operating procedures. A County certificate of compliance with violations noted was delivered to SLAC. SLAC developed and implemented a corrective action plan and returned the plan and certificate to the County.

SLAC successfully shipped all routinely generated hazardous waste for off-site disposal within 90 days of generation in CY96. DOE/OAK performed semi-annual and monthly surveillance of the Waste Management (WM) Department for various regulations (OSHA, RCRA, DOE Orders). There were no significant observations or findings for CY96.

In CY96, 44 employees completed training covering general hazardous chemical and waste management, including waste minimization and pollution prevention. An annual "refresher" course was provided, as required, to Hazardous Waste Management Group (HWMG) personnel, Hazardous Waste and Material Coordinators (HWMCs) and assistant HWMCs. As required under RCRA, all hazardous waste minimization certifications for disposal of hazardous waste were properly made.

3.3 National Environmental Policy Act (NEPA)

SLAC formalized a NEPA program in CY92. Under this program, proposed project and action descriptions are reviewed to determine if NEPA Documentation is required. If NEPA Documentation is required, the proper paperwork is prepared and submitted. The project or action is entered in a database and tracked. In CY96, SLAC submitted 10 Categorical Exclusions (CXs) for General Plant Projects (GPPs), Accelerator Improvement Projects, and Capital Equipment Projects.

3.4 Clean Air Act (CAA)

The Bay Area Air Quality Management District (BAAQMD) implements the CAA through a set of rules and regulations for operations or equipment that may cause air pollution. SLAC had a total of 26 air pollution sources listed with the BAAQMD in CY96 (10 permitted, 16 exempt). No permit limitations were exceeded in CY96. SLAC was not inspected by the BAAQMD in CY96.

The National Emission Standards for Hazardous Air Pollutants (NESHAPs) program requires that facilities that release radionuclides into the air report those releases to the appropriate regional office of the Environmental Protection Agency (EPA). In accordance with this requirement, SLAC completed the Radionuclide Air Emissions Annual Report for CY96, which was provided to SLAC's DOE Operations Office in Oakland, CA(DOE/OAK) in June 1997. There were no instances of non-compliance reported.

3.5 Clean Water Act (CWA)

3.5.1 Groundwater Monitoring Program

The Groundwater Protection Management Program (GPMP) summarizes the groundwater program including planning, integration, and coordination of all supporting activities. Completed documents include:

- *Remedial Investigation/Feasibility Study (RI/FS) Workplans and Progress Reports.*
- *Sampling and Analysis Plan* and associated *Standard Operating Procedures*, and *Quality Assurance Project Plan.*
- *Field Sampling Plan.*

3.5.1.1 Site-Wide Monitoring Network

SLAC has a groundwater monitoring network comprised of 21 wells constructed in areas of the facility that historically and/or currently store, handle, or use chemicals that may pose a threat to groundwater quality. In CY96, samples were collected from the wells on a semester basis and analyzed for a wide range of chemical constituents. As reported in previous Site Environmental Reports (SERs), results of the analyses indicated that water in several of the wells contained levels of chlorinated solvents at or above the State of California Maximum Contaminant Levels (MCL) for drinking water.

The four sites identified are described in Section 6.0. The general water quality naturally occurring at SLAC, as measured by total dissolved solids (TDS) values, indicates that the groundwater is not suitable for drinking water. Further definition of the extent of contamination is being performed during the site-wide RI/FS that began in CY96.

3.5.1.2 Radiological Monitoring of Groundwater

Tritium has historically been detected in one well, EXW-4. This well is located next to Beam Dump East (BDE). The tritium levels steadily decreased over the last several years. In fact, the tritium levels have steadily decreased from about one half to one fourth of the Maximum Concentration Level (MCL) of 20,000 pCi/l for drinking water, as discussed in Section 6.5.

In CY96, tritium was also detected in groundwater from MW-30, located next to End Station A (ESA) at the beginning of the beam dump, about 60 meters southwest of EXW-4. Detected levels were less than one tenth the MCL as discussed in Section 6.5.

3.5.2 Surface Water

The Storm Water Pollution Prevention Plan (SWPPP), which include the Best Management Practices (BMPs) and the Monitoring Plan were approved for SLAC in May of 1996. The annual storm water report was submitted to the RWQCB on July 1, 1996.

Other progress noted during CY96 includes:

- Incorporated BMPs into training.
- Obtained funding for elimination of illicit connections and erosion study.
- Met periodically with the RWQCB.
- Conducted walkabouts with each division to assist in the implementation of BMPs.
- Conducted internal Audits tracking corrective action.
- Improved protection to catch basins with strawbales, and cleanouts.
- Successfully utilized autosamplers.
- Began incorporating BMPs into contracts with vendors.
- Published a SWPPP Bulletin.
- Clean-up of the Recreational Vehicle (RV) Storage Area.

The areas that have been identified as needing further improvement include housekeeping and erosion control.

3.5.3 Industrial Wastewater

In CY96, there was a chromium exceedance of SLAC's wastewater discharge permit. After extensive sampling, the source of chromium was not found. Additional self-monitoring will be implemented for CY97.

Data from CY96 indicated that SLAC's average discharge of wastewater to the sanitary sewer was 46,950 (4.7×10^4) gallons per day.

As in previous years, SLAC discharged many batches of low conductivity water (LCW) to the sanitary sewer. All batches, as well as the cumulative total for the year, had contaminant levels that were within applicable radiological regulatory limits. The total number of gallons of LCW discharged to the sanitary sewer during CY96 was 307,887. The total amount of tritium discharged was 338.8 millicuries.

3.6 Safe Drinking Water Act (SDWA)

Drinking water and process water are supplied to SLAC by the City of Menlo Park from the Hetch Hetchy water system. Drinking water and process water are transported throughout the facility by a distribution system partially protected by backflow prevention devices. There are no drinking-water wells at SLAC.

3.7 Toxic Substances Control Act (TSCA)

SLAC has some equipment filled with oil or other dielectric fluids which contain PCBs. In CY96 SLAC continued to reduce its inventory of PCBs by disposing of a significant portion of the remaining large and small PCB capacitors as well as other PCB-containing equipment. One transformer remains on inventory as a PCB transformer pending reclassification to non-PCB status. SLAC is planning to remove or retrofill and reclassify the remaining 14 PCB-contaminated transformers over the next few years.

3.8 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

FIFRA regulates pesticide use in the United States. The term "pesticide" refers to insecticides, rodenticides, and herbicides. SLAC uses licensed subcontractors to apply "registered use" pesticides. SLAC personnel apply "general use" pesticides only. In CY96, SLAC used pesticide and herbicide handling and storage procedures that were developed in CY94. These procedures were incorporated into the subcontracts for landscape maintenance and pest control, and have been implemented by the subcontractors.

3.9 Endangered Species Act (ESA)

Six threatened or endangered species (plants and animals) have been recorded for the general area around SLAC, but not on SLAC property. Sensitive species and their presence at SLAC are evaluated when preparing environmental assessments for proposed projects, as required under NEPA.

3.10 National Historic Preservation Act (NHPA)

There are no eligible NHPA sites at SLAC.

3.11 Executive Order 11988, "Floodplain Management"

According to the Federal Emergency Management Agency (FEMA) floodplain maps for the area, a 100-year flood would not reach the SLAC facility, but would be confined to the San Francisquito Creek channel south of the facility.

3.12 Executive Order 11990, "Protection of Wetlands"

As part of an environmental assessment conducted in CY91, SLAC had a subcontractor perform a survey to determine whether any area(s) within or next to the SLAC facility should be formally designated as wetlands, which are specifically protected under Section 404 of the CWA. The field survey and evaluation were performed using established federal guidance. According to the survey, the IR-8 drainage ditch showed characteristics of wetlands, but a definitive evaluation was not possible because of continuing drought conditions and because the study was performed in the fall, when reproductive structures on vegetation were generally absent.

The report concluded that the natural hydrology of the area would probably not be capable of supporting the wetlands community due to seasonal drought, even under normal conditions. The portion of the IR-8 drainage channel that represents the great majority of the potential wetlands at and around SLAC is approximately 4,000 square feet, less than one-tenth of an acre. By comparison, the Army Corps of Engineers in practice uses ten acres as their functional cutoff for "significant" wetlands.

3.13 Releases to the Environment

3.13.1 Radiological

There were no reportable quantity (RQ) releases of radioactive material to the environment in CY96.

3.13.2 Non-Radiological

A Notice of Violation (NOV) was issued by the South Bayside System Authority (SBSA) on May 7,1996. The NOV was issued for exceedance of the chromium mass loading limit under the Total Facility Discharge Permit.

This appears to be a one time occurrence. After extensive efforts, the source of the chromium was never uncovered. SBSA's three follow-up sampling events confirmed compliance with SLAC's permit limit for chromium

3.14 Assessments

- Monthly conduct of operations audits of the restoration program were performed by the DOE.
- The California Department of Health Services, Radiation Health Branch conducts a site boundary radiation monitoring program. There were four TLD exchanges in 1996.

3.15 Summary of Permits

SLAC has a total of 29 permits:

- 1 California General Industrial Storm Water Permit
- 2 Wastewater discharge permits
- 26 Air pollution permits/listed sources

The specific permits held by SLAC in CY96 were:

- West Bay Sanitary District and South Bayside System Authority
  Wastewater Discharge Permit No. WB920415-P
  Wastewater Discharge Permit No. WB920415-F
  Expiration date: April 14, 1997
- Bay Area Air Quality Management District (BAAQMD)
  Plant No. 556, 26 listed sources (found in Table 5-1).
- Environmental Protection Agency
  Hazardous Waste Generator EPA ID No. CA8890016126

SLAC has filed an NOI to comply with the following permit:

- California Regional Water Quality Control Board
  San Francisco Bay Region
  SLAC Permit Identification Number: 2 41 S 002417
  California General Industrial Storm Water Permit
  Storm Water Permit No. WDR No. 97-03-DWQ
  NPDES Permit CAS000001
  Expiration date: April, 1997

3.16 Other Major Environmental Issues

During CY96, SLAC's set of "Necessary and Sufficient ES&H Standards" name changed to "Work Smart Standards". This set of standards was incorporated into SLAC's Management and Operating (M&O) contract. The set includes all applicable statutory and regulatory requirements for public and worker safety and environmental protection. It also includes a number of industry standards that were found to be necessary to control specific hazards present at SLAC. One impact of this modification of SLAC's contract is that most DOE Orders that had previously been the basis for SLAC's ES&H program are no longer applicable.

Progress continued in CY96 toward completing the corrective actions developed in response to the 1991 Tiger Team assessment. Forty-three of the 51 environmental findings have been completed, and 53 of the 57 related tasks have also been completed. Seventeen of the 43 environmental findings have been validated, and 33 of the 53 related tasks have also been validated.

Other external appraisals resulted in the identification of 27 corrective action tasks, of which 24 have been completed. None of these corrective action tasks have been validated. Most of these tasks were primarily concerned with the adequacy of SLAC's documented plans and procedures. No significant threats to the environment were noted.

SLAC's Quality Assurance and Compliance organization completed seven environmental self-assessments. The assessments in 1996 focused on water quality and hazardous waste management practices. No significant problems were identified in these areas. Of the 75 environmental findings made 68 have been completed.

4 ES&H Organizational Program Information

This section of the *1996 Site Environmental Report* provides an overview of the Stanford Linear Accelerator Center's (SLAC's) Environment, Safety, and Health (ES&H) Division's responsibilities, performance measures, training, pollution prevention, and waste minimization information. Further information about the ES&H Division is available on the world wide web (www) at:

http://www.slac.stanford.edu/esh/esh.html

4.1 ES&H Responsibilities

SLAC's Environment, Safety, and Health (ES&H) Division consists of five departments and a Program Planning Office (PPO). Their shared goal is to help ensure that SLAC operates in compliance with federal, state, and local regulations, as well as DOE Orders related to environment, safety, and health. The five departments are:

- Environmental Protection and Restoration (EPR)
- Operational Health Physics (OHP)
- Radiation Physics (RP)
- Safety, Health, and Assurance (SHA)
- Waste Management (WM)

The EPR Department oversees the majority of SLAC's environmental programs, including programs for environmental restoration; waste minimization; air quality; storm water and industrial wastewater; polychlorinated biphenyls (PCBs); groundwater, and the National Environmental Policy Act (NEPA) review. The WM Department coordinates disposal of hazardous, radioactive, and mixed waste. The OHP Department oversees radiological monitoring and dosimetry at SLAC. The SHA Department oversees quality assurance for SLAC's environmental activities. The RP Department conducts beam checkouts of new experiments to ensure shielding adequacy for the protection of the workers and members of the general public.

4.2 Waste Minimization

4.2.1 Site-Wide Program Planning and Development

SLAC has been implementing its waste minimization program on schedule in accordance with its waste minimization plans. SLAC has two waste minimization plans, a waste reduction plan and a DOE plan. The waste reduction plan was prepared in October of 1995 to comply with California's Hazardous Waste Source Reduction and Management Review Act (Senate Bill-14) and is known as the SB-14 plan.

The SB-14 plan addresses the reduction of specific hazardous waste streams and was revised as of September 1995 in accordance with California regulations. The DOE plan is a site-wide plan to increase employee awareness on waste reduction measures for non-hazardous and low level radioactive wastes as well as hazardous wastes. Both plans will be merged in 1997 to reduce reporting requirements.

Implementation of waste minimization and pollution prevention is a SLAC line responsibility. Some of the highlights of SLAC implementation of waste minimization and pollution prevention measures are discussed below.

SLAC's incentives and awards for waste reduction activities has been implemented through DOE's Pollution Prevention Awards Program. Two measures were submitted by SLAC in the last two years. Each received certificates of recognition that were forwarded to the key employees responsible for implementing the waste reduction measures.

4.2.2 Employee Awareness/Training Measures

On-site training programs were developed and presented to employees to instruct them on how to minimize waste and to increase their awareness of the importance of waste minimization and pollution prevention.

The following training has been accomplished during CY96:

1. For personnel who handled hazardous material and hazardous waste as part of their job:
   - Provided a 3-1/2 hour class, "Introduction to Hazardous Waste and Materials Management".
   - Distributed the SLAC *Hazardous Materials Management Handbook.*
   - Developed a program and schedule to provide this training to new employees. To date, over 500 employees have received this introductory training class.
2. For personnel who were scheduled for refresher training:
   - Developed a course for hazardous waste and materials management, as required by RCRA.
   - Developed and provided advanced training for HWMC.
   - Established a quarterly seminar/workshop for HWMCs to discuss common problems and concerns and to provide training on specific topics selected by the Coordinators.
3. For SLAC Building Managers:
   - Provided a presentation on a pilot program for nonhazardous waste recycling that is planned for CY97.

Other activity to increase employee awareness, mainly for the nonhazardous waste category included updating the five information centers around the site to provide information to employees on recycling and pollution prevention for home use.

4.2.3 Waste Minimization and Pollution Prevention Activities/Implementation

A number of projects were in progress to promote waste minimization and pollution prevention usually to focus on actual or potential generation of major waste streams.

4.2.3.1 Alternatives to Ozone Depleting Substances

To address the replacement of Ozone Depleting Substances (ODSs), SLAC had set up an inter-departmental committee to address the replacement of ODSs in vapor degreasing operations used for special cleaning needs in SLAC's high-energy physics equipment. Of particular concern is equipment used in ultrahigh vacuum service and in high-voltage, high-power applications. Three alternatives to ODSs were identified and are currently implemented or in the implementation stage.

One alternative is the replacement of an existing vapor-degreaser system that uses 1,1,1-trichloroethane with an advanced vapor degreaser system. This replacement system is a closed-system (a near-zero emissions vapor-degreaser system) that will significantly reduce the use of 1,1,1-trichloroethane. The closed system vapor-degreaser may use an alternative solvent (non-ozone depleting) such as perchloroethlyene. The near-zero emissions vapor-degreaser system has been procured and is expected to be fully operational in the next few years after installation and parallel testing with the existing vapor degreasing system.

While perchloroethylene has an increased health hazard over trichloroethane, the use of perchloroethylene in the advanced vapor degreaser is expected to be safe and not increase the threat of worker exposure. Because of the stringent and diverse cleaning needs for ultrahigh vacuum applications and the need for the high degree of reliability in the cleaning operations, the closed-system vapor degreaser was selected as an alternative over other cleaning options, such as aqueous-phase cleaning.

A second alternative that has been implemented is a petroleum-based combustible (low-vapor pressure) solvent. This solvent is used to meet high level cleaning requirements of vacuum system cold traps used by the Stanford Synchrotron Radiation Laboratory (SSRL) and for cleaning applications associated with machining operations in the Mechanical Fabrication Department.

The third alternative has been implemented by the Klystron Microwave/Test Laboratory for critical cleaning applications associated with klystron tubes. This alternative employees a spray-on, citrus-based solvent, followed by a steam-detergent cleaning and a deionized water rinse.

4.2.3.2 Waste Reductions in Metal Finishing Operations

The SLAC Mechanical Fabrication Department (MFD) performs metal finishing operations to fabricate parts and equipment used in high energy physicals experiments. MFD has made headway in implementing three DOE-funded waste reduction projects. One project involves the recovery of acids used in etching operations. Equipment for this project has been installed and is being put into operation. This project is expected to significantly reduce spent acids from these operations. A second project involves reuse of deionized water used in metal finishing operations. This project reduces chemical usage and hazardous wastes generated from the rinsewater treatment facility. This project is planned for operation in 1997. The third project involves reduction of spent plating bath filters. This project has been implemented and will show waste reductions in 1997.

Expected waste reductions are not reported here due to unpredictably of operations.

4.2.3.3 Storm Water Pollution Prevention

The SLAC Plant Engineering Department has made progress in reducing pollution associated with collection and disposal of storm water around the site. This DOE-funded project involved identifying potential sources of storm water pollution and developing a mobile processing unit to treat the storm water in secondary containments and vaults for recycling or discharge to the sanitary sewer. The unit reduces the cost of off-site water treatment and disposal.

4.2.3.4 Reuse of Concrete Blocks

The PEP II Division reused a number of nonradioactive concrete blocks (magnet support blocks that were used in the old PEP facility). The blocks were diverted from landfill disposal by identifying potential reuses for both in-house and outside-user projects. Of the approximate 200 blocks weighing 3 to 7 tons each (1000 tons in total weight), 77 blocks were used for in-house for bridges in the Interaction Region Halls and 110 blocks were sent off site for reuse by the Menlo Park Fire Protection District (MPFPD), which is one of the twenty-six National Urban Search and Rescue Forces in the U.S.

4.2.4 Waste Minimization Reporting

SLAC's Waste Minimization Coordinator continues to attend bimonthly meetings on waste minimization and pollution prevention along with Waste Minimization Coordinators from other DOE facilities and DOE/OAK.

The Waste Minimization Coordinators have been working with representatives of DOE Headquarters (Office of Energy Research) and the DOE/OAK (Office of Environmental Restoration and Waste Management), to promote the implementation of waste minimization and pollution prevention in accordance with DOE Order 5400.1 and the Secretary of Energy Notice SEN 37-92.

Also in accordance with DOE requirements, SLAC prepared two Annual Waste Reduction Reports during 1996, one for the CY95 reporting period and one for the CY96 reporting period.

4.2.5 Trends in Nonhazardous Waste Reduction

The quantities of nonhazardous waste and the materials recycled or diverted from landfill from 1990 to 1996 are summarized in Figures 4-1 and 4-2. Material recycled or diverted is shown with and without scrap metal recycling to show the contribution of scrap metals. In 1990, SLAC achieved 10 percent diversion of nonhazardous waste without scrap metal and 25 percent diversion with scrap metal. In 1996, SLAC increased to 26 percent diversion without scrap metal and 49 percent diversion with scrap metal.

In general, SLAC sends an average of 650 tons per year of nonhazardous waste to landfill. The higher disposal quantity in 1991 was the result of facility-wide cleanup. Of the 650 tons of nonhazardous waste typically generated, most of the waste consists of: bathroom paper towels, food wastes, and paper and cardboard products.

Nonhazardous waste diversion in 1995 was different from most other years because of a one-time event in which 1000 tons of concrete were diverted from landfill so that 65 and 73 percent diversion was achieved with and without scrap metal.

Although SLAC's recycling activity has been effective over the years, it is not without cost. Additional efforts are planned in CY97 to test recycling measures that will reduce collection costs and capture some of the recyclable materials not captured in the existing program.

4.2.6 Trends in Hazardous Waste Reduction

Figure 4-3 shows the trends in the generation of hazardous waste for three major categories: operational, Toxic Substances Control Act (TSCA), and remediation hazardous waste. Operational hazardous wastes from SLAC operations and maintenance activities that are directly applicable to the site's mission.

TSCA wastes result from removal of old electrical equipment (polychlorinated biphenyls [PCB]-containing equipment) and construction practices (asbestos containing materials). These wastes result from the phasing out of these materials from use in SLAC operations. Remedial wastes are the result of past practices or accidental spills. TSCA and remediation wastes are expected to reduce over time by elimination of the sources of PCB and asbestos wastes and by cleanup activities of wastes from past practices and spills.

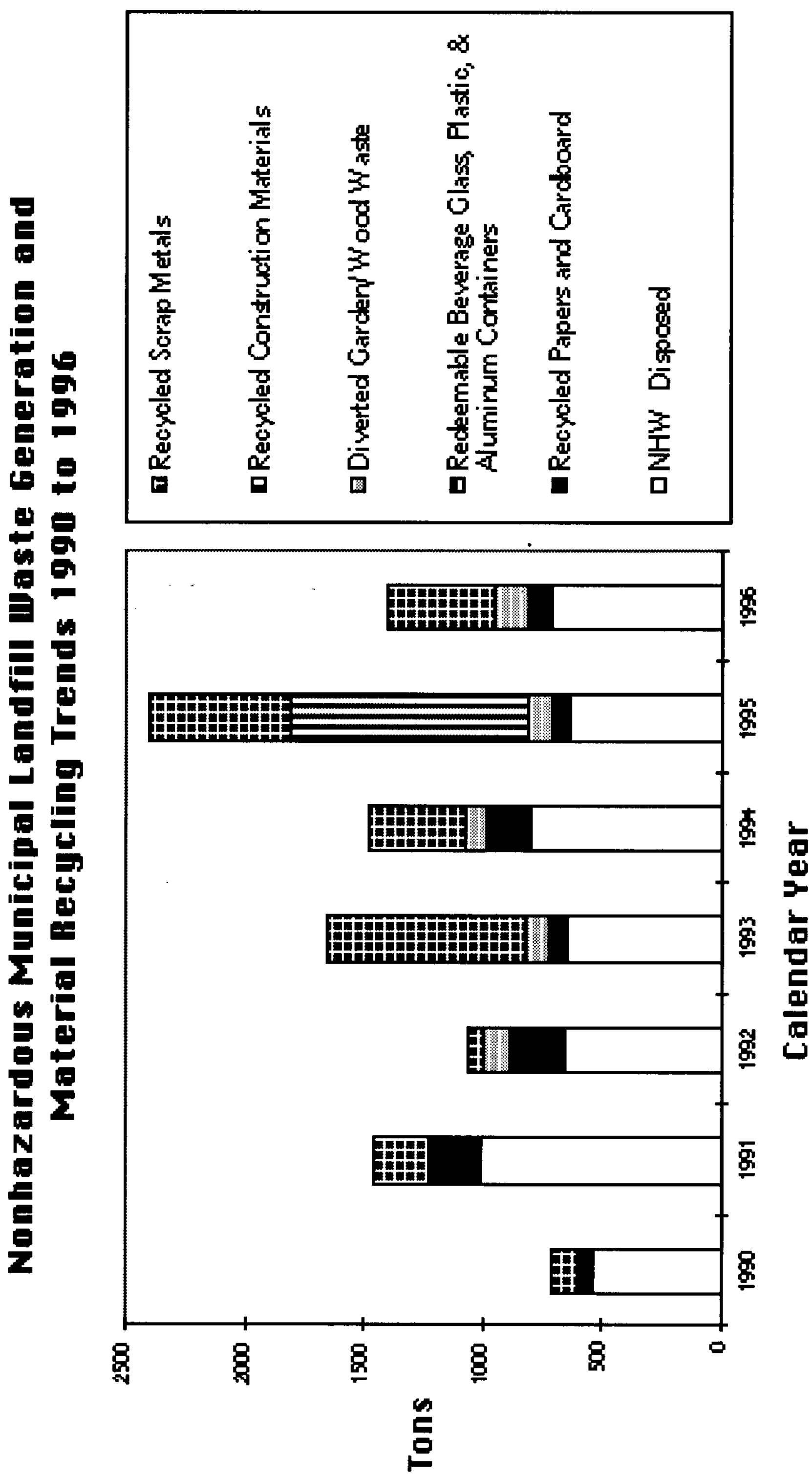
SLAC shows a reduction in operational hazardous waste since 1990, through a combination of programmatic measures, increased employee awareness and reduced equipment fabrication and construction activity. As of CY96, SLAC has reduced its hazardous waste by 42 percent relative to 1993 and by 75 percent relative to 1990.

SLAC will continue to strive in operational hazardous waste reductions based on trends in operation and maintenance activities of earlier years. Some increases in hazardous waste generation may be expected from new project activities and new maintenance projects. However, with SLAC's increased awareness and past experience in waste reduction, SLAC is expecting to continue its success in reducing hazardous waste generation.

4.2.7 Low Level Radioactive Waste Reduction

The quantities of low level radioactive wastes are the accumulation of waste generated over years of SLAC's operation. SLAC's current inventory of low level radioactive wastes are provided in Figure 4-4. A significant portion of SLAC's low level radioactive waste is in the form of scrap metals.

Depending on their condition and the radiological characteristics, some of the metals may be returned to the environment for reuse because radioactive levels are very low and are candidates for regulatory exemption. This waste reduction approach is being further investigated.



NOTES:
1. NHW = Nonhazardous Waste.
2. Cardboard recycling is estimated for 1991 and 1992.
3. Diversion of garden waste started in 1992. The quantity diverted in 1992 is assumed to be the same as the quantity reported in 1993.
4. In 1995, a one-time project to reuse concrete construction materials was conducted.

Figure 4-1 Nonhazardous Municipal Landfill Waste Generation and Material Recycling Trends, 1990-1996

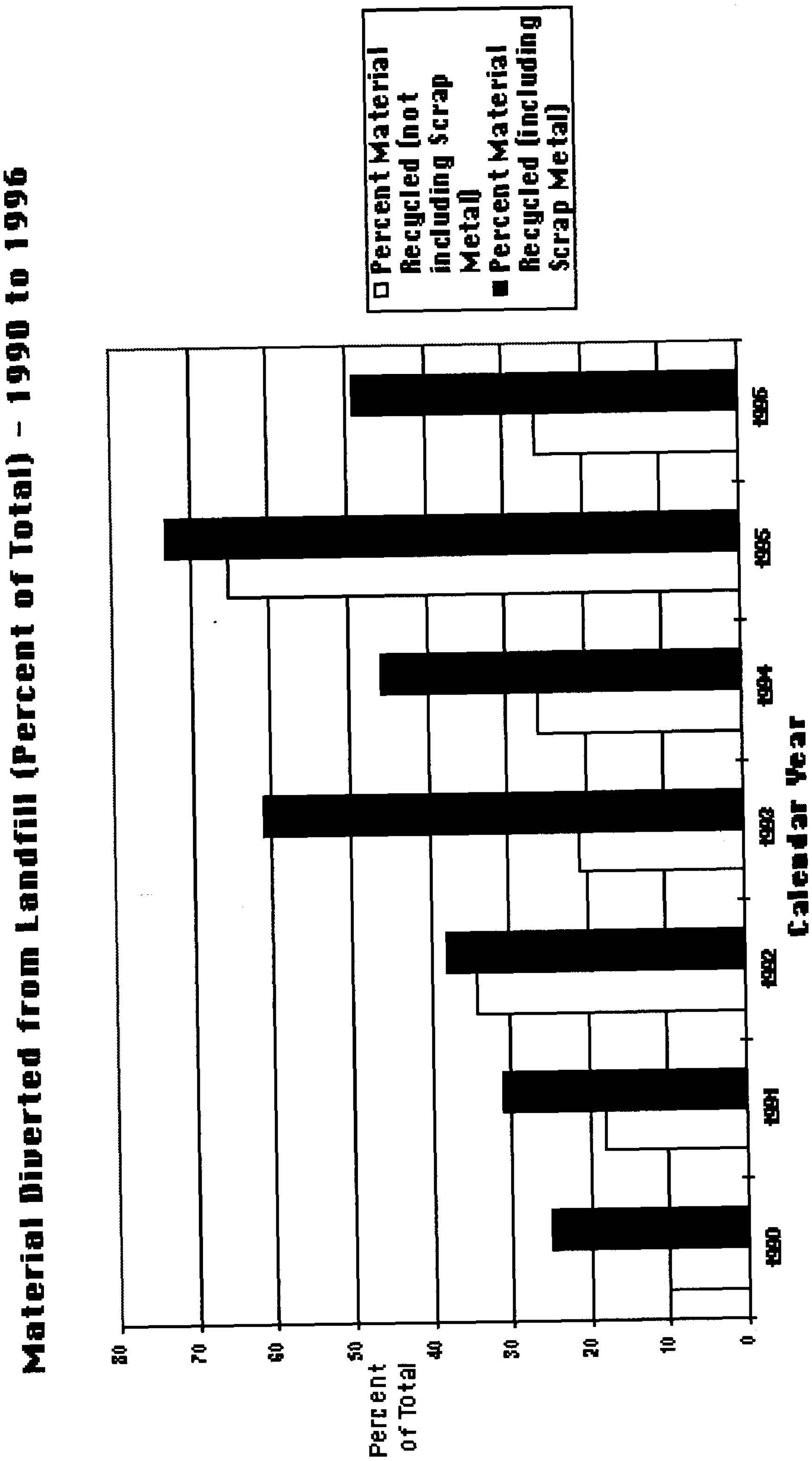
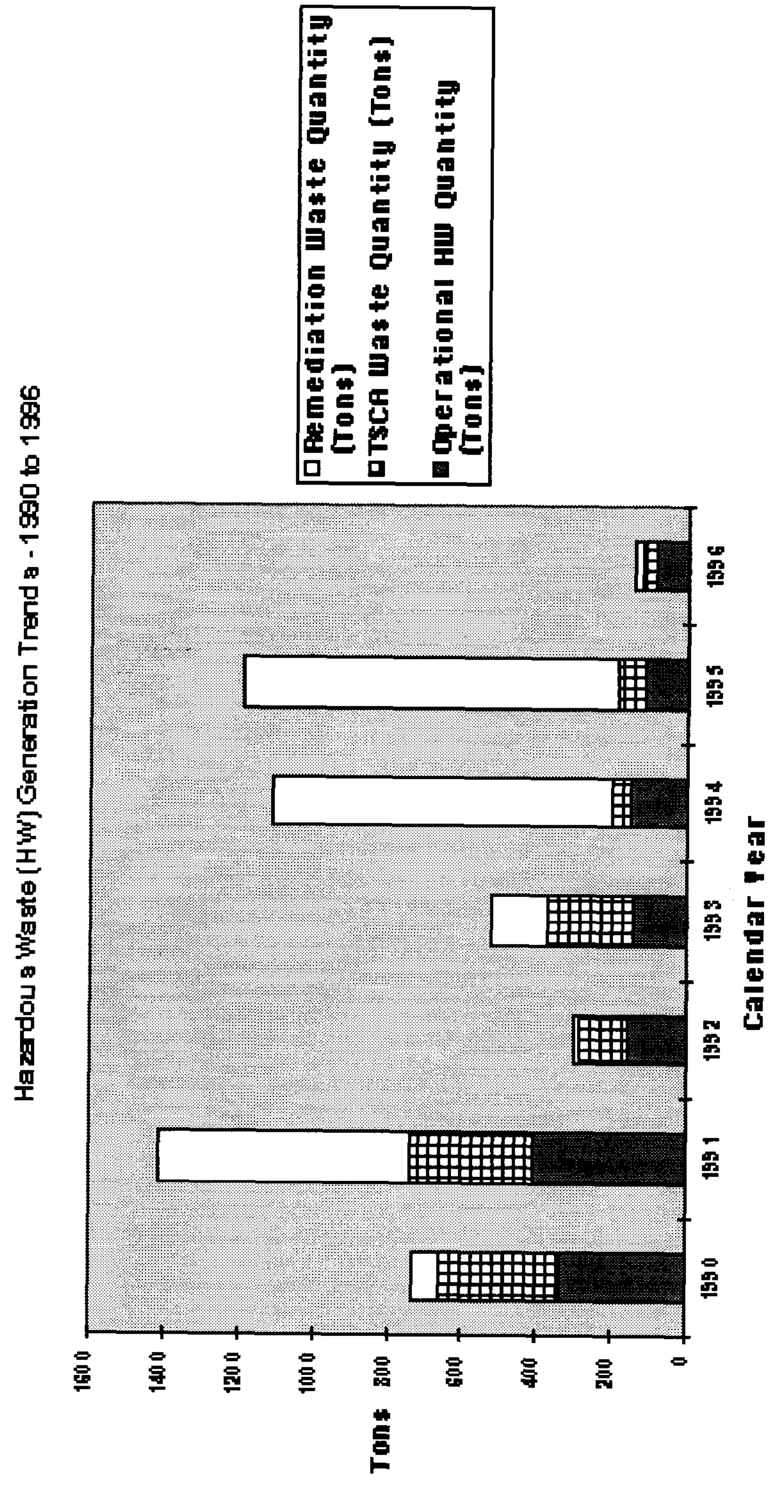


Figure 4-2 Material Diverted from Landfill, 1990 to 1996



Notes:

Operational HW	=	Routine or nonroutine HW generated from site research, supporting operation and maintenance activities.
TSCA	=	Toxic Substance Control Act.
TSCA Waste	=	Removed PCB electric equipment and asbestos HW from site renovations.
Remediation Waste	=	Removal of contaminated soils from site restoration activities.

Figure 4-3 Hazardous Waste Generation Trends, 1990 to 1996

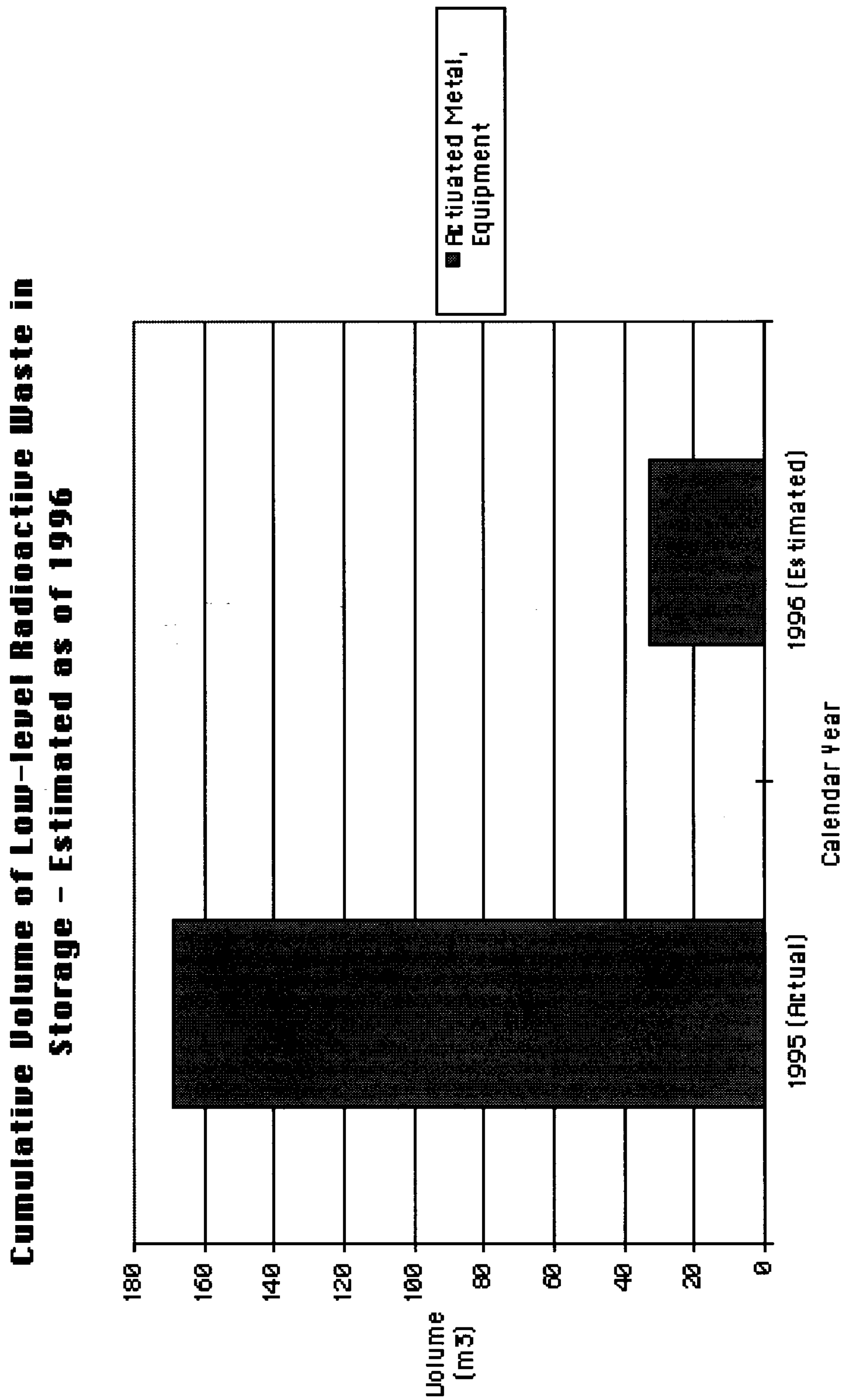


Figure 4-4 Low Level Radioactive Waste in Storage

5 Environmental Non-Radiological Program Information

This section of the *1996 Site Environmental Report* provides an overview of the Stanford Linear Accelerator Center's (SLAC's) environmental activities performed in order to comply with laws and regulations, to enhance environmental quality, and to improve understanding of the effects of environmental pollutants from site operations.

5.1 Clean Air Act (CAA)

Federal air pollution regulations require states to conduct certain activities and to institute specific controls in support of the CAA. The states, in turn, delegate portions of their power and authority to local or regional agencies. Each of these agencies must adopt and enforce rules and regulations necessary to achieve and maintain both the Federal National Ambient Air Quality Standards and the State Ambient Air Quality Standards. The local agency regulating non-radiological stationary air pollution sources at SLAC is the Bay Area Air Quality Management District (BAAQMD).

Non-radiological air emissions at SLAC are primarily Volatile Organic Compounds (VOCs) from solvent cleaning operations; nitrogen oxides (NO_X) from industrial boilers; and particulates (PM10[1]) from metal and wood-working activities in the various shops. SLAC currently has 26 air pollution sources (ten permitted sources and sixteen exempt) listed with the BAAQMD. These sources and their calendar year 1996 (CY96) emissions are identified in Table 4-1.

As required by the BAAQMD, SLAC maintains records for solvent usage for permitted solvent sources. Permit conditions may limit the amount of solvent which can be used at an individual source on an annual basis. Records for individual sources are compared to permit limits, to assure that the limits have not been exceeded. There was one NOV issued in CY96 for one wastewater permit limit exceedance of chromium.

[1] PM10 = Particulate matter less than 10 microns

Table 5-1 BAAQMD Permits and Emissions Annual Average (lbs/day)

S#	Source Description	Particulates	Organics	NO_X[a]	SO_2[b]	CO[c]
4	Degreaser	—	15	—	—	—
5	Spray-booth	—	2	—	—	—
6	Boiler	—	—	6	—	—
10	Woodworking operations (exempt)	—	—	—	—	—
11	Metal cutting operations (exempt)	—	—	—	—	—
13	Metal grinding operations (exempt)	—	—	—	—	—
14	Sandblast booth (exempt)	—	—	—	—	—
16	Sandblast booth (exempt)	—	—	—	—	—
17	Metal and epoxy glass grinding (exempt)	—	—	—	—	—
21	Anodizing, pickling and bright dip operations	—	—	—	—	—
26	Cold cleaner	—	—	—	—	—
30	Sludge dryer	—	—	—	—	—
32	Cold cleaner	—	—	—	—	—
34	Cold cleaner	—	—	—	—	—
36	Wipe cleaning	—	8	—	—	—
37	Cold cleaner	—	7	—	—	—
40	Diesel Storage Tank P-1 (exempt)	—	—	—	—	—
41	Diesel Storage Tank P-2 (exempt)	—	—	—	—	—
42	Diesel Storage Tank P-3 (exempt)	—	—	—	—	—
43	Diesel Storage Tank P-4 (exempt)	—	—	—	—	—
44	Diesel Storage Tank P-5 (exempt)	—	—	—	—	—
45	Diesel Storage Tank P-6 (exempt)	—	—	—	—	—
46	Aerosol Paint Booth (exempt)	—	—	—	—	—
49	Cyanide Room Scrubber (exempt)	—	—	—	—	—
50	Sandblasting booth (exempt)	—	—	—	—	—
51	Small parts blasting booth (exempt)	—	—	—	—	—

[a] Nitrogen Oxide
[b] Sulfur Dioxide
[c] Carbon Monoxide

SLAC is required to comply with the reporting requirements of the Toxic Release Inventory (TRI). This report summarizes the uses and releases during the CY of certain chemicals such as sulfuric acid and 1,1,1-trichloroethane (TCA). Information sources such as purchases of certain chemicals, usage records, and the annual chemical inventory were used to determine which chemicals exceeded the reporting thresholds.

If the usage of these specific chemicals exceeds the reporting thresholds, a Form R report must be submitted for each chemical that exceeds the threshold. In CY96, SLAC did not exceed the 10,000 pounds use threshold for these chemicals, therefore, no report was required.

5.2 Clean Water Act (CWA)

The Federal Water Pollution Control Act, also referred to as the Clean Water Act (CWA), was enacted nearly thirty years ago in order to halt the degradation of our nation's waters. Amendments to the CWA in 1972 established the National Pollutant Discharge Elimination System (NPDES), which regulates discharges of wastewater from point sources such as Publicly Owned Treatment Works (POTWs) and categorically regulated industrial facilities such as electroplating shops. In 1987, the CWA was amended again to include non-point source discharges such as storm water runoff from industrial, municipal, and construction activities. The CWA is the primary driver behind SLAC's water compliance programs.

5.2.1 Surface Water

Federal regulations allow authorized states to issue general permits to regulate industrial storm water, or "non-point source", discharges. California is an authorized state, and on November 19, 1991, the State Water Board adopted the California General Industrial Activities Storm Water Permit (General Permit). SLAC filed a Notice of Intent (NOI) to comply with the General Permit on March 27, 1992. The General Permit was amended on September 17, 1992 to include simplified monitoring and reporting requirements.

The goal of the General Permit was to reduce pollution in the waters of the state. This was achieved by regulating the amounts of pollutants in industrial storm waters which were discharged to waters of the state.

SLAC progressed in the completion of the following items:

- Training:
  - Incorporated BMPs into training.
  - Added a two hour segment to existing Hazardous Materials training.
- Funding:
  - Received funding for the elimination of illicit connections to the storm drains.
  - Began erosion study.
- Meet with RWQCB on a regular basis.
- Walkabouts with each division. This consisted of a review and inspection of each division's areas with representatives from each division and EPR.
- Internal Surveillance and tracking of corrective actions. Several site inspections were performed with corrective actions logged into the

Quality Assurance (QA) database. Improvement was noted at the Recreational Vehicle (RV) storage area.

- Improved protection to catch basins using straw bales and cleanouts.
- Installed stormwater autosamplers at IR 6, IR 8, Main Gate, and North Adit.
- Included BMPs into contracts which utilized subcontractors. These contracts incorporated environmental protection clauses for both water and air.
- Published a SWPPP Bulletin. This site wide ES&H Bulletin (# 41) drew attention to the prevention of storm water pollution.

SLAC's progress on the outstanding compliance items was discussed in bi-monthly meetings with the RWQCB. SLAC volunteered to host the meetings so that the RWQCB could be kept apprised of progress and contribute guidance to SLAC in a timely manner.

5.2.2 Storm Water Monitoring Program

SLAC's storm water monitoring program consists of:

1. Two storm water sampling events per wet season.
2. Monthly visual observations during the wet season.
3. Two visual observations during the dry season.
4. An annual site inspection.

During the 1995/1996 wet season (October-April), SLAC analyzed storm water run-off samples for pH, electrical conductivity, total petroleum hydrocarbons (TPH) as diesel and motor oil, polychlorinated biphenyls (PCBs), pesticides, general minerals, heavy metals, and radioactivity.

There are no enforceable limits, but rather numerical objectives which apply to the data collected for this program based on the RWQCB Basin Plan. The data is used as a general reference for determining whether SLAC appears to be generating storm water pollutants and whether implementation of BMPs have been effective.

5.2.2.1 Metals

Several heavy metals continued to be slightly elevated, although in general, there has been a reduction in metals loading as the BMPs have been implemented.

Although several metals were found in the analysis, they are not used in any significant quantity in SLAC's processes and are naturally occurring. These metals include:

- Arsenic.
- Barium.
- Cadmium.
- Selenium.
- Vanadium.

Other metals may be both naturally occurring and present due to human activities or industrial processes. The metals may include:

- Zinc
- Copper
- Molybdenum
- Lead

Some metals may be due to vehicle emissions such as:

- Motor oil.
- Coolant drippings.
- Brake linings.
- Tire fines.

A level of 0.120 milligrams per liter (mg/l) of copper was found at the Main Gate location in February 1996 which appears to be directly attributable to deposition of brake pad particulates from vehicles traveling either on SLAC property or on the adjoining Sand Hill Road.

5.2.2.2 Total Suspended Solids

Significant levels of suspended silt are generated when it rains. Levels of Total Suspended Solids (TSS) continued to vary greatly with each storm event. Increased levels of metals also appear to correlate with higher levels of TSS.

The samples collected by autosamplers for the first event in the 1996/1997 season generally contained lower levels of TSS and metals, possibly due to use of autosamplers which may eliminate future sampling technique inconsistencies.

5.2.2.3 TPH as Diesel

All of SLAC's regular sampling stations receive run off from paved areas such as roads and parking lots. The values found are similar to past TPH findings.

TPH as diesel was detected at the IR-6 and IR-8 sampling locations at levels of 0.23 and 0.21 mg/l for the February 1996 storm event. This event was probably a heavy storm which mobilized unusually large amounts of silt and particulates and motor oil which is detected by the TPH Diesel scan.

No TPH as diesel was detected for the April 1996 storm event.

5.2.2.4 PCBs

PCBs were found at IR-6 at levels of 0.0016 and 0.011 mg/l for the February and April 1996 sampling events, respectively. The source of these PCBs may be residuals contained in silt materials in the storm drain system. No PCBs were detected in November 1996. The storm drain lines will be cleaned out in 1997.

One sample was collected from a floating location at the Collider Injector Development (CID) drainage channel. A fire occurred at the North

Damping Ring area in February 1996. Removal of fire debris from the building appears to have resulted in the introduction of storm water pollutants, since cadmium, copper, and zinc were higher than those observed in past storm water samples collected along the linac.

5.2.3 Industrial and Sanitary Wastewater

SLAC's industrial and sanitary wastewaters are treated by South Bayside System Authority (SBSA) in Redwood City, California before being discharged to San Francisco Bay. SLAC has two wastewater discharge permits: (1) WB 920415-P, which regulates industrial wastewater, and (2) WB 920514-F, which regulates SLAC as a whole, including industrial and sanitary wastewaters.

SLAC discharged a total of 17,183,731 gallons of wastewater to the sanitary sewer system in 1996, an average of 46,950 gallons per day. There was one violation of discharge limits under Permit WB 9205H-F, which is discussed below. Both permits were automatically renewed on June 15, 1996. Permit requirements included:

1. Quarterly sampling for heavy metals and pH at the Rinse Water Treatment Plant (RWTP).
2. Quarterly sampling for cyanide at the Plating Shop cyanide treatment tank.
3. Biennial sampling for Total Toxic Organics (TTOs) at the RWTP clarifier.
4. Signs posted throughout the site advising personnel not to discharge non-permitted material to the sanitary sewer and providing emergency response numbers should there be an accidental release.

In CY96, SLAC's Sanitary Wastewater Monitoring Program consisted of:

1. Quarterly sampling for heavy metals and pH at the Sand Hill Road Flow Meter Station (FMS) and the RWTP.
2. 24-hour monitoring of flow at the FMS during each quarterly sampling event. SBSA used this flow and the heavy metal results to calculate the mass loading of pollutants in SLAC's wastewater. SBSA submitted quarterly compliance reports to SLAC.

   A Notice of Violation (NOV) was issued by the South Bayside System Authority (SBSA) on May 7, 1996. The NOV was issued for exceedance of the chromium mass loading limit under Permit 2WB920514-F.

   This appears to be a one time occurrence. After extensive efforts, the source of the chromium was never uncovered. SBSA followed up with three sampling events. These sampling events confirmed SLAC's compliance with it's permit limit for chromium.

5.2.3.1 Rinse Water Treatment Plant (Permit: No. WB 920415-P)

SLAC conducted metal finishing operations in an on-site electro-plating shop during CY96. Non-hazardous rinsewaters from the plating shop were processed through the RWTP prior to being discharged to the sanitary sewer. Effluent from the RWTP was required to meet federal metal finishing pre-treatment standards which are specified in the permit.

As required by the federal standards, the SBSA periodically monitored the metal finishing discharges, as well as the effluent from a cyanide treatment tank in the Plating Shop. SLAC and SBSA collected "split" samples from the RWTP and cyanide tank for quality assurance purposes. The sampling locations are shown in Figure 5-1. SBSA and SLAC's analytical results for CY96 are presented in Table 5-2.

5.2.3.2 Total Facility Discharge (Permit: No. WB 920415-F)

This wastewater discharge perm0it covers SLAC's total[2] contribution to the sanitary sewer, including the combined flow from the RWTP and all other wastewater discharges on site. The sampling location is shown in Figure 5-1.

SBSA monitors the discharge quarterly to assure compliance with the permit. SLAC collects "split" samples during these monitoring events and analyzes them to compare results with SBSA for quality assurance purposes.

The discharge limits and the monitoring frequency for this location are provided in Table 5-3. SBSA's analytical results from samples collected in CY96 are presented in Table 5-4. SLAC's analytical results from samples collected in CY96 are presented in Table 5-5.

5.3 Resource Conservation and Recovery Act (RCRA)

RCRA, enacted in 1976, provides "cradle-to-grave" authority to control hazardous wastes from their generation to their ultimate disposal. This is accomplished through a system of transportation manifests, record keeping, permitting, monitoring, and reporting.

Management of hazardous waste at SLAC is performed by the Waste Management (WM) Department. SLAC is a generator of hazardous waste, and is not permitted to treat hazardous waste or store it for longer than 90 days. The San Mateo County Department of Health Services is the agency responsible for inspecting SLAC as a generator of hazardous waste for compliance with Federal, state, and local hazardous waste laws and regulations. SLAC was last inspected by the County in December 1996.

SLAC utilizes a self-developed, site-specific computerized hazardous waste tracking system (WTS). Hazardous waste containers are tracked from the time they are issued to the generator to eventual disposal off-site. The WTS includes electronic information fields which generate information for the Biennial, Superfund Amendments and Reauthorization Act (SARA) Title III, and Toxic Substances Control Act (TSCA) PCB annual reports.

Hazardous waste generated from operations throughout the site are accumulated in Waste Accumulation Areas (WAAs). Each WAA is managed by a Hazardous Waste and Material Coordinator (HWMC), who is provided training and written guidelines on the proper management of WAAs. Training includes spill response preparedness, waste minimization, SLAC's WTS, and required "refresher" generator training.

The Radioactive Waste Management Group of the Waste Management Department manages the low level activated metals that are the primary source of radioactive waste at SLAC. The metal comes in the form of beam line components that are managed as radioactive materials. The program for the management of the radioactive waste is being revised by WM to meet new criteria regulated by the DOE. San Mateo County does not inspect this program.

[2] A small portion of SLAC's domestic wastewater is carried off-site via the sanitary sewer on the south side of the facility. The amount of wastewater is considered by the POTW to be trivial, and is not routinely monitored.

5.4 Toxic Substances Control Act (TSCA)

SLAC has some equipment filled with oil or other dielectric fluids which contain PCBs. PCBs, their use, and their disposal are regulated by TSCA. TSCA regulations include provisions for phasing out PCBs and other chemicals that pose a risk to health or the environment. The EPA is responsible for assuring that facilities are in compliance with TSCA. The State of California further regulates PCBs as a non-RCRA Hazardous Waste. No EPA inspections regarding TSCA were conducted at SLAC during CY96.

SLAC continued to reduce its inventory of PCBs in CY96. This was achieved through the disposal of numerous PCB capacitors (large and small), as well as other PCB-containing equipment.

There are 33 PCB-containing transformers inventoried at SLAC. One remains classified as a PCB transformer (>500 ppm) pending reclassification test runs. Of the remaining 32, 18 are classified as non-PCB (5-50 ppm), and 14 are classified as PCB contaminated (50-500 ppm). SLAC is planning to remove, or retrofill and reclassify the PCB-contaminated transformers over the next few years.

Other activities and actions completed or initiated at SLAC in CY96 included:

- Prepared 1995 PCB Annual Report.
- Completed PCB Transformer Quarterly Inspection Reports, per TSCA.
- Updated and validated the PCB/TSCA transformer and capacitor inventories.

5.5 The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) "Superfund"

5.5.1 Environmental Restoration

In CY91, SLAC began to develop a comprehensive Environmental Restoration Program (ERP). Although not a "superfund" site, SLAC follows general technical CERCLA guidance. The program delineates how SLAC will address environmental contamination problems from discovery and characterization through remediation and long-term monitoring or maintenance, if required. SLAC's restoration approach is as follows:

1. Identify sites with actual or potential contamination (involving soil, groundwater, surface water, and/or air).
2. Prioritize contaminated sites based on site complexity, nature of contamination, associated risks, remaining data needs, and projected remedy.
3. Perform Remedial Investigation/Feasibility Studies (RI/FS) beginning with the highest-priority sites.

SLAC is currently at step 3 above. RI/FS work this past year has proceeded for contaminated groundwater sites which are discussed in Section 7, Groundwater Protection.

SLAC personnel continued to be actively involved in various public participation activities throughout CY96. In particular, the Comprehensive Resource Management and Planning (CRMP) process was used to establish a watershed management group for San Francisquito Creek.

Stanford University hosted the kickoff meeting in late CY93 and has continued to support the objectives of the CRMP throughout CY96. SLAC personnel attended the monthly meetings of the Steering Committee and the Natural Resources Task Force and participated in various developing programs.

5.5.2 The Superfund Amendments and Reauthorization Act (SARA)

SARA Title III, also known as the Emergency Planning and Community Right-to-Know Act (EPCRA) is primarily directed toward developing an inventory of the information needed to compile the various reports required by EPCRA. These reports also address the implementation requirements for statutes in the State of California (the La Follette and Waters Bills).

In CY96, SLAC submitted a Hazardous Materials Business Plan (HMBP) which details the response in the event of a release of hazardous material. This plan designated an emergency coordinator, described the first response and several levels of escalation, delineated the means by which all mandated notification will be made to the local authority (LA) and local fire department, and described the facilities evaluation, containment, and clean up capability. The site maps have not changed significantly since the last submittal in 1993.

Under section 312 of EPCRA, SLAC must provide to the LA and the local fire department, on an annual basis, an annual inventory of hazardous substances that are present in quantities greater than 55 gallons, 500 pounds, or 200 cu. ft. The LA requires a report to be filed for each individual hazardous substance.

Compliance for CY96 was achieved by sending out chemical inventories to the Chemical Inventory Coordinators (CIC). This information was then checked against the chemical inventory database and any discrepancies were checked for verification with the appropriate CIC.

The chemical inventory from 1993 - 1995 dropped because of the replacement of Chlorofluorocarbon (CFC) chemicals with less toxic chemicals, and ammonia gas was taken away and replaced by a new laser plotting system.

Executive Order #12843 has committed SLAC to comply with the TRI reporting requirements under Section 313 of the EPCRA. SLAC, in accordance with DOE guidance, complied with EPCRA Section 313 in CY96.

5.6 National Environmental Policy Act (NEPA)

NEPA provides a three-level mechanism to ensure that all environmental impacts and alternatives to performing a proposed project are considered before it is carried out. The aspects that must be considered when scoping and preparing documentation for a proposed project include archaeological sites, wetlands, floodplains, sensitive species, and critical habitats. If any extraordinary circumstances are identified during project scoping, a range of options for the project must be developed and the impacts of those options evaluated.

SLAC formalized its NEPA program in CY92. All project or action proposals are reviewed to determine if NEPA documentation is required. If NEPA documentation is required, the project or action is entered into a database and tracked. The resulting draft NEPA document is reviewed by specified SLAC staff for concurrence, and is forwarded to the DOE Site Office for review and approval.

The three types of NEPA documentation, in order of increasing complexity, are Categorical Exclusions (CXs), Environmental Assessments (EAs), and Environmental Impact Statements (EISs). In CY96, SLAC submitted 9 CXs for General Plant Projects (GPPs), Accelerator Improvement Projects, and Capital Equipment Projects.

5.7 Assessments

SLAC's assessments during CY96 are described in Section 3.14.

Table 5-2 CY96 Analytical Results of Metal Finishing Effluent After the RWTP

	SAMPLE DATES												PERMIT DISCHARGE LIMIT
	2/1/96		5/7/96		7/31/96		10/28/96		4/2/96		10/1/96		
	SLAC	SBSA	SLAC	SBSA	SLAC	SBSA	SLAC	SBSA	SLAC	SBSA	SLAC	SBSA	
pH	na[a]	7.4	na[a]	7.1	na[a]	8.4	na[a]	8.2	na[a]	na[a]	na[a]	na[a]	6.0-12.5
Cyanide (mg/l)	nd[b]	<0.01	nd[b]	0.01	na[a]	<0.01	na[a]	0.022	na[a]	na[a]	na[a]	na[a]	1.2
Cadmium (mg/l)	<0.001	<0.007	0.028	<0.007	nd[b]	<0.007	nd[b]	<0.007	na[a]	na[a]	na[a]	na[a]	0.69
Chromium(mg/l)	0.053	0.028	0.079	0.08	0.06	0.07	0.077	0.228	na[a]	na[a]	na[a]	na[a]	2.77
Copper(mg/l)	0.029	0.040	0.022	0.04	0.08	0.09	0.17	0.180	na[a]	na[a]	na[a]	na[a]	3.38
Lead(mg/l)	<0.002	<0.05	0.0023	0.06	nd[b]	<0.05	0.0021	<0.05	na[a]	na[a]	na[a]	na[a]	0.69
Nickel(mg/l)	0.10	0.07	0.036	0.03	<0.061	<0.03	0.0016	0.04	na[a]	na[a]	na[a]	na[a]	3.98
Silver(mg/l)	0.023	0.37	0.001	0.004	0.0083	<0.009	0.018	0.049	na[a]	na[a]	na[a]	na[a]	0.43
Zinc(mg/l)	<0.02	0.031	nd[b]	0.01	nd[b]	0.024	nd[b]	0.016	na[a]	na[a]	na[a]	na[a]	2.61
Toxic Organics (mg/l)	na[a]	na[a]	0.011	0.0118	na[a]	na[a]	na[a]	na[a]	0.038	0.0142	0.072	0.0622	2.13
Flow (gal/day)	na[a]	5,560	na[a]	7,320	na[a]	12,670	na[a]	9,250	na[a]	na[a]	na[a]	na[a]	None

[a] Not analyzed for that parameter.
[b] Not detectable for that parameter.

Table 5-3 Sanitary Sewer Standards
Wastewater Discharge Permit No. WB 920415-F
Monitoring Location: Flow Meter Station adjacent to Sand Hill Road

Constituent	Limitation	Units	Monitoring Frequency	Sample Type
Oil and grease[a]	100	mg/l	Quarterly	Grab
pH (Minimum-Maximum)	6.0-12.5	pH	Quarterly	Grab
Arsenic	0.058	lbs/day	None	NA[b]
Cadmium	0.020	lbs/day	Quarterly	Composite
Chromium (total)	0.10	lbs/day	Quarterly[c]	Composite
Copper	0.79	lbs/day	Quarterly[c]	Composite
Lead	0.12	lbs/day	Quarterly[c]	Composite
Mercury	0.001	lbs/day	None	NA[b]
Nickel	0.37	lbs/day	Quarterly[c]	Composite
Silver	0.070	lbs/day	Quarterly[c]	Composite
Zinc	0.68	lbs/day	Quarterly[c]	Composite
Cyanide (total)	0.035	lbs/day	None	NA[b]
Polycyclic Aromatic Hydrocarbons	0.12	lbs/day	None	NA[b]
Methylene Chloride	0.041	lbs/day	None	NA[b]
Chloroform	0.017	lbs/day	None	NA[b]
Perchloroethylene	0.017	lbs/day	None	NA[b]
Benzene	0.0012	lbs/day	None	NA[b]
Carbon Tetrachloride	0.00058	lbs/day	None	NA[b]
Carbon Disulfide	0.0046	lbs/day	None	NA[b]
Phenols	1.5	mg/l	None	NA[b]

[a] Oil and grease of mineral or petroleum origin.
[b] Not Applicable
[c] Split samples were collected by both SLAC and SBSA.

Table 5-4 SBSA Split Sample Results of Sanitary Sewer Discharges from Sand Hill Road Flow Meter Station

	Sample Dates								
	2/1/96		5/7/96		7/31/96		10/28/96		Permit Discharge Limits
Flow (gpd)	59,772		58,348		49,332		43,531		69,577
pH	8.0		7.5		7.9		8.2		6.0-12.5
	Result (mg/l)	(lb/d)	Result (mg/l)	(lb/d)	Result (mg/l)	(lb/d)	Result (mg/l)	(lb/d)	lb/d
Cadmium	<0.007	0.0035	<0.0007	0.0034	<0.007	0.0029	<0.007	0.0025	0.02
Chromium	0.02	0.010	**0.340**	**0.1655**	0.10	0.0411	0.09	0.0327	0.1
Copper	0.13	0.0648	0.30	0.146	0.18	0.0741	0.35	0.1271	0.79
Lead	<0.05	0.0249	0.130	0.0633	<0.05	0.0206	<0.05	0.0182	0.12
Nickel	<0.03	0.0150	<0.03	0.0146	<0.04	0.0165	0.06	0.0218	0.37
Silver	0.024	0.0120	<0.014	0.0068	0.004	0.0016	0.0140	0.0051	0.07
Zinc	0.178	0.0887	0.128	0.0623	0.156	0.0642	0.281	0.102	0.68

Table 5-5 SLAC Split Sample Results of Sanitary Sewer Discharges from Sand Hill Road Flow Meter Station

	Sample Dates								
	2/1/96		5/7/96		7/31/96		10/28/96		Permit Discharge Limits
Flow (gpd)	46,173		56,380		47,374		37,570		69,577
pH	na[a]		na[a]		na[a]		na[a]		6.0-12.5
	Result (mg/l)	(lb/d)	Result (mg/l)	(lb/d)	Result (mg/l)	(lb/d)	Result (mg/l)	(lb/d)	lb/d
Cadmium	<0.01	0.0038	nd[b]	na[a]	0.001	0.0004	nd[b]	na[a]	0.02
Chromium	0.026	0.010	**0.33**	**0.155**	0.013	0.005	0.033	0.010	0.1
Copper	0.10	0.0387	0.30	0.141	0.097	0.038	0.31	0.0971	0.79
Lead	0.0093	0.0036	0.010	0.0047	0.0052	0.0021	0.013	0.004	0.12
Nickel	0.025	0.0097	0.022	0.0103	0.012	0.0047	0.025	0.0078	0.37
Silver	<0.01	0.0039	0.0065	0.0030	0.0017	0.0006	0.0031	0.0009	0.07
Zinc	0.13	0.0503	0.14	0.065	0.13	0.0513	0.26	0.0814	0.68

[a] Not analyzed for that parameter.
[b] Not detectable for that parameter.

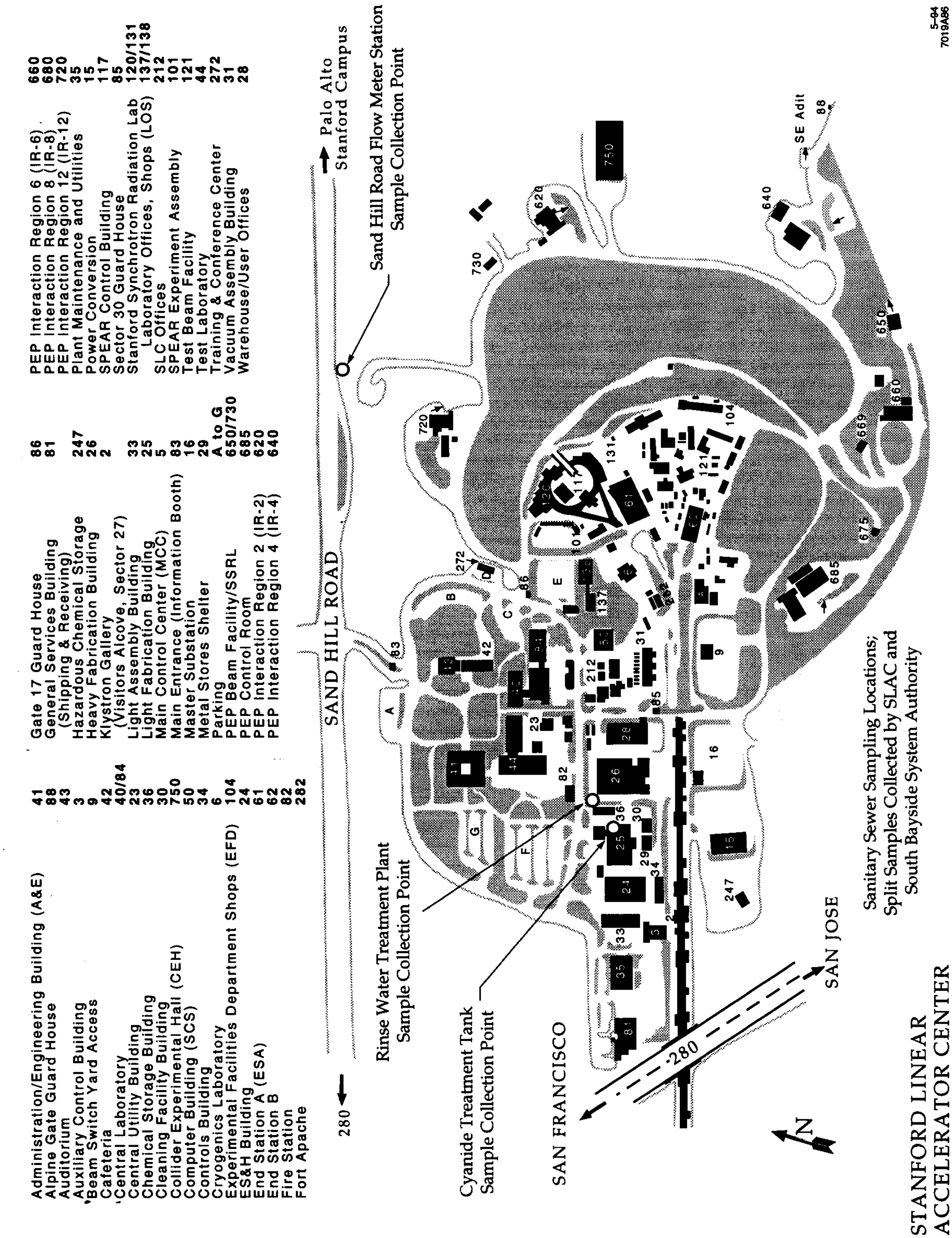


Figure 5-1 Sanitary Sewer Sampling Locations

6 Environmental Radiological Program Information

6.1 Airborne Monitoring

Airborne radionuclides are produced in the air volume surrounding major electron beam absorbers such as beam dumps, collimators, and targets. The degree of activation is dependent upon the beam power absorbed and the composition of the parent elements. The composition of air is well known, consisting of nitrogen, oxygen, and trace quantities of carbon dioxide and argon. Induced radioactivity produced at high energies is composed of short-lived radionuclides, such as oxygen-15 and carbon-11, with half-lives of 2 minutes and 20 minutes, respectively. Nitrogen-13, with a half-life of 10 minutes, is also produced, but in much lower concentrations. As a consequence of water cooling and concrete shielding, both containing large quantities of hydrogen, the thermal neutron reaction with stable argon produces argon-41, which has a half-life of 1.8 hours.

There was no uncontrolled venting of the accelerator housing while the accelerator was operating in calendar year 1996 (CY96). This was accelerator operations policy due to the desire to maintain thermal stability. There is one beam loss area at the Stanford Linear Accelerator Center (SLAC) that is not enclosed, so emissions due to diffusion can occur. This facility was not used in CY96.

The accelerator, the Positron-Electron Project (PEP), Stanford Positron Electron Asymmetric Ring (SPEAR), and experimental areas were designed to transport (not absorb) high energy electrons and positrons. Radioactive gas concentrations were therefore not produced in measurable quantities. The Beam Switchyard (BSY), Positron Source (PS), Beam Dump East (BDE), and electron/positron (e-/e+) beam dumps in the Final Focus System (FFS) represent the only portions of SLAC designed to absorb high energy particles and are the only sources of detectable gaseous radioactive emissions. These areas are not vented continuously. They can be vented in emergencies and at the end of each experimental cycle.

The Derived Concentration Guides (DCGs) for airborne radioactivity appear in Department of Energy (DOE) Order 5400.5, *"Requirements for Radiation Protection for the Public"*. They were derived from dose standards which require that no individual in the general population be exposed to greater than 100 mrem (1.0 mSv) in one year. For this report, the term dose equivalent, in units of rem or Sievert (Sv), will simply be called dose.

Airborne radioactivity produced as the result of SLAC operations in CY96 was short-lived, that is, the half-lives ranged from 2.1 minutes to 1.8 hours and was in gaseous (not particulate) form. The chief radionuclides in SLAC produced airborne radioactivity are listed in Table 6-1.

Table 6-1 Radioactive Gases Released to Atmosphere

Radionuclide	Half-Life	DCG [μCi/cm^3][a,b]
^{15}O	2.1 minutes	1.7×10^{-9}
^{13}N	9.9 minutes	1.7×10^{-9}
^{11}C	20.5 minutes	1.7×10^{-9}
^{41}Ar	1.8 hours	1.7×10^{-9}

[a] μCi = 3.7×10^4 Bq.
[b] Calculated from DOE Order 5400.5, assuming total submersion by dividing the averaged DCG by 10. See Appendix A.

Since SLAC did not routinely release airborne radioactivity while the beam was on and required a waiting period before turning on the fans (if at all); typically there is significant decay time for the short-lived radionuclide before the gases are reduced by the opening of the housing. This would not be the case for a facility such as BDE which has a direct pathway to the atmosphere. By far the greater proportion of exposure an individual may receive under any circumstances from the radionuclides listed in Table 6-1 is from whole-body immersion.

The Environmental Protection Agency (EPA) requires compliance with National Emission Standards for Hazardous Air Pollutants (NESHAPs) (40CFR61) as documented in an annual radionuclide air emissions report. SLAC's report, see Appendix B, for CY96 provided calculations and modeling of air emissions. Emissions were derived by calculating the saturation activity for oxygen-15, carbon-11, nitrogen-13, and argon-41, and then releasing the radionuclides while applying an appropriate decay period.

It was conservatively assumed that these releases occurred at the end of each experimental cycle, that is, whenever the machine was shut down for repair or maintenance, whether or not any venting was performed. For the single facility that was not totally enclosed, a diffusion mechanism was conservatively estimated to determine releases that occurred continuously during beam operations.

The compliance report was generated using the required computer program, EPA, CAP88-PC, Version 1.0. The results (6.37×10^{-4} mrem or 6.37×10^{-6} mSv) show that the annual effective dose equivalent (EDE) was less than 1% of the NESHAPs standard, that is, 1.0 mrem (0.01 mSv) in CY96. Note that the NESHAPs standard, 10.0 mrem (0.1 mSv), is 10% of the DOE DCG's effective dose equivalent to a member of the public, which is 100 mrem (1.0 mSv). Because all the sources at SLAC are defined as minor sources, continuous air monitoring is not required. SLAC is presently evaluating a confirmatory monitoring scheme.

6.2 Wastewater Monitoring

Wastewater containing small quantities of radioactivity within regulatory limits was periodically discharged to the sanitary sewers from the site. The only possible sources of liquid radioactive effluents were from low conductivity water (LCW) cooling systems in the BSY and certain other areas of the accelerator housing. In the event of leaks from these systems, water was collected in stainless steel lined sumps sized to contain the entire water volume. Along the Klystron Gallery there are a series of poly tanks which are used to collect LCW from the alcoves of the gallery.

The greatest source of induced radioactivity was where the electron/positron beam was absorbed. The only significant radionuclides produced in water were the short-lived oxygen-15 and carbon-11, beryllium-7 (half-life of 54 d), and longer-lived tritium (half-life of 12.3 y). Other radionuclides which could potentially be in the water systems would come from activated corrosion products.

The corrosion products were typically gamma emitters. Oxygen-15 and carbon-11 are too short-lived to present an environmental problem in water. Beryllium-7 and the corrosion products were removed from the LCW by the resin beds required to maintain the electrical conductivity of the water at a low level. Therefore, tritium was the only radioactive element present in the water that was of environmental significance in CY96. Tritium emits a soft beta and is detected primarily through liquid scintillation analysis.

All water potentially containing radioactivity was collected into several holding tanks at various points along the accelerator in order to control and keep track of tritium quantities prior to release to the sanitary sewer. Water in these holding tanks was discharged into the sanitary sewer only after radioanalysis had been completed. Radioanalysis records of the wastewater discharged for each quarter of CY96 are given in Table 6-2.

Table 6-2 Radioanalysis Results for Wastewater Discharged During CY96

Period Released	Quantity [gal[a]]	Radioactivity [mCi[b]]
First Quarter	93,085	3.01
Second Quarter	86,040	298[c]
Third Quarter	58,362	0.146
Fourth Quarter	75,940	37.61
Total:	313,427	338.8[d]

[a] 1 gal = 3.8 liter.
[b] 1 mCi = 3.7×10^7 Bq.
[c] This total is due to the non-routine maintenance of one particular LCW cooling system.
[d] This total is 6.8% of the yearly limit of 5 curies for tritium.

The concentration of radioactivity released was less than the DCG specified by DOE Order 5400.5, *"Requirements for Radiation Protection for the Public"*. In addition to the above monitoring, quarterly samples are also taken at the RWTP and the FMS for tritium analysis. The results are shown in Table 6-3.

Table 6-3 1995 Tritium Results of FMS and RWTP

SAMPLING STATION	SAMPLE DATES			
	1/18/95	5/16/95	8/10/95	10/26/95
FMS (pCi/l)	<500	<500	<500	<500
RWTP (pCi/l)	<500	<500	<500	<500

SLAC is also bound by the provisions in a contract for service with the West Bay Sanitary District (WBSD) (Permit No. WB860915-FNS) and State regulations (California Code of Regulations, Title 17, Section 30287) which limited SLAC to a maximum of 5,000 mCi (that is, 5 Ci, or 1.85×10^{11} Bq) of tritium and 1,000 mCi (1 Ci or 3.7×10^{10} Bq) of all other radionuclides to be discharged to the sanitary sewer each calendar year.

Table 6-4 Summary of Annual Effective Dose Equivalents Due to 1996 Laboratory Operations

	Maximum Dose to General Public[a, b] (direct radiation only)	Maximum Dose to General Public[a, b] (airborne radiation)	Maximum Dose to General Public[a, b] (airborne + direct radiation)	Collective Dose to Population within 80 km of SLAC[b]
Dose	4.55 mrem	0.0006 mrem	4.55 mrem	5.02 person-rem
DOE Radiation Protection Standard	100 mrem	10 mrem	100 mrem	—
Percentage of Radiation Protection Standard	4.6%	<1%	4.6%	—
Background	100 mrem	200 mrem	300 mrem	1.47×10^6 person-rem
Percentage of Background	4.6%	<1%	1.5%	Negligible

[a] This is the dose to the maximally exposed member of the general public. It assumes that the hypothetical individual is at the closest location to the facility continuously, 24 hours/day, 365 days/year.
[b] 100 mrem = 1μSv and 1 person-rem = 0.01 person-Sv.

6.3 Stormwater Monitoring

Samples of stormwater as described in Section 5.2.2 were analyzed for radioactivity. The results of these samples showed no detectable levels of tritium or other radioactivity.

6.4 Industrial and Sanitary Wastewater

SLAC surveys batches of potentially radioactive wastewater prior to discharge to the sanitary sewer. Once the result has been logged, the water is discharged to the sanitary sewer in accordance with SLAC's mandatory wastewater discharge permit (WB 920415-F).

SLAC's permit allows the discharge of low concentrations of radioactive contaminants in wastewater in compliance with federal and state discharge limitations. The permit calls for a certified quarterly wastewater discharge report which compares radioactivity discharged to regulatory limitations. No discharge limitations were exceeded in CY96.

6.5 Groundwater

Tritium analyses were conducted on groundwater from EXW-4, MW-30 (see Figure 7-1), and one well installed in CY96 near the accelerator to define the extent of chlorinated solvent constituents of concern in groundwater. Tritium was detected only in EXW-4 and MW-30.

Results for tritium analyses for CY96 groundwater monitoring in Well EXW-4 were 4960 pCi/l, which is less than the California state drinking water maximum concentration level (MCL) of 20,000 pCi/l. This water is not usable as drinking water due to a very high TDS content, and is not used for any purpose at SLAC. Concentration amounts in well EXW-4 have varied (generally between 5,000 and 13,000 pCi/l) since the 1960s. Tritium levels have steadily decreased from about one half to one fourth of the MCL since 1992.

Well EXW-4 is located in the area of Beam Dump East ('BDE). The most probable source of tritium in the groundwater is low-level activation due to beam particle penetration in the area.

Results for tritium analyses for CY96 groundwater monitoring in MW-30 were 682 pCi/l. Concentrations of tritium in MW-30, measured since the well was installed in CY91, have consistently been below 1,000 pCi/l, and is usually less than the detection limit of 500 pCi/l. Well MW-30 is located next to End Station A (ESA) at the beginning of the Beam Dump East (BDE).

These and other wells will continue to be monitored on a 12 to 18 month schedule in order to define any long-term trends in tritium concentration. If a trend of increasing tritium concentration is noted, then an investigation will ensue.

6.6 Passive Thermoluminescent Dosimeter (TLD) Monitoring Program

SLAC has a site boundary environmental TLD monitoring program. Landauer, a National Voluntary Laboratory Accreditation Program (NVLAP) certified dosimetry service, was contracted to provide SLAC with quarterly TLDs. The LDR-X9 aluminum oxide TLD was designed to measure low-level photon radiation with a minimum detection level of 0.1 mrem (0.001 mSv). The LDR-I9 TLD is used for monitoring neutron radiation with a minimum detection level of 10 mrem (0.1 mSv). Both of these TLD systems were in use throughout CY96.

The environmental measurements using TLDs are summarized in Appendix D. TLD results indicated that one site boundary location with the highest accumulated dose-equivalent in CY96 reported 27 mrem (0.27 mSv).

The TLD data for CY96 were used to evaluate the radiation dose from direct radiation to the maximally exposed member of the general public and the collective dose to the general public within 80 km of SLAC. See Appendix D for data.

6.7 Radiological Media Sampling Program

Media sampling was limited to industrial wastewater (the major pathway for radionuclide release to the environment) and stormwater. The low source terms proportionate to DOE's DCGs have identified only this route as a likely pathway for any potential off-site population exposure. Limited soil sampling in past years has not revealed detectable levels of human-made radionuclides. In future years, a planned characterization of the site through media analysis will be done to establish the naturally occurring radionuclides on site and the background levels seen at different areas to serve as baseline values for future reference. Verification of no significant levels of human-made radionuclides by laboratory radioanalytical methods will be done at the same time. Future monitoring will be part of the radiological Environmental Surveillance Program which is being developed under SLAC's Radiological Environmental Monitoring Plan.

6.8 Waste Minimization

6.8.1 Low Level Radioactive Waste Reduction

The quantities of low level radioactive wastes are the accumulation of waste generated over years of SLAC's operation. SLAC's current inventory of low level radioactive wastes are provided in Table 3. A significant portion of SLAC's low level radioactive waste is in the form of scrap metals.

Depending on their condition and the radiological characteristics, some of the metals may be returned to the environment for reuse because radioactive levels are very low and are candidates for regulatory exemption. This waste reduction approach is being further investigated.

7 Groundwater Protection

The Stanford Linear Accelerator Center's (SLAC's) Groundwater Protection Management Program (GPMP) was developed in accordance with Department of Energy (DOE) Order 5400.1. The GPMP provides comprehensive guidance to the groundwater program including planning, integration, and coordination of all supporting activities. Documents such as *Remedial Investigation/ Feasibility Study (RI/FS) Workplans*, a *Sampling and Analysis Plan* and associated *Standard Operating Procedures*, and a *Quality Assurance Project Plan* support monitoring and investigation activities.

The *Annual Well Inspection and Maintenance Manual* guides inspection of wells to protect the integrity of the monitoring wells. In calendar year 1996 (CY96), groundwater monitoring data was collected on a semi-annual schedule from existing wells and from new wells as they were installed for RI/FS work. All reports and documents referred to in this section are available at the SLAC library, or can be obtained from the Environmental Protection and Restoration (EPR) Department at SLAC.

7.1 Groundwater Characterization Monitoring Network

7.1.1 CY96 Summary of Results and Issues

Work began in CY96 on putting in more wells around the four areas of known contamination to define the lateral and vertical extent of potential contamination. A larger than expected area with high concentrations of constituents of concern was encountered at the Former Solvent Underground Storage Tank (FSUST) area, which is described below. Investigations began in CY96 to characterize this source area and to define possible cleanup options.

In addition, the wells in areas with no detected constituents of concern were sampled on a 12 to 18 month basis. Figure 7.1 shows the location of Monitoring Well 30 (MW-30) which had 1.1 ppb of PCB detected in groundwater in February 1996. However, when the well was resampled in August 1996, no PCBs were detected (with a detection limit of 0.5 ppb). MW-30 will be sampled again twice in CY97. If PCBs are consistently detected, the well will continue to be sampled and an investigation will ensue.

7.1.2 Background

SLAC characterizes groundwater at the site in order to determine and document the effects that the facilities have had on groundwater quality. The groundwater monitoring network includes 8 wells which provide environmental surveillance of groundwater conditions. They are used to monitor general groundwater quality in the major areas of the facility that historically or presently store, handle, or use chemicals which may pose a threat to groundwater quality. In addition, SLAC's groundwater monitoring network includes wells that check groundwater at four distinct sites with known groundwater contamination.

The surveillance wells are on the sampling schedule described in the *Quarterly Sampling and Analysis Plan*. During ongoing remedial investigations, the wells are sampled and analyzed on a semi-annual, rather than quarterly, basis. Samples may be analyzed for one or more of the following:

- Volatile organics
- Total Petroleum Hydrocarbons (TPHs)
- Metals
- Polychlorinated Biphenyls (PCBs)
- Total Dissolved Solids (TDS)
- General minerals

Volatile organics have been detected at levels of concern at SLAC. The results of semi-annual sampling and analysis of wells is reported to the RWQCB in Semi-Annual Monitoring reports.

Table 6-1 summarizes the wells at SLAC by the number of wells, area of the facility, and the purpose of the well. The purpose of the well may be either contaminant plume monitoring or environmental surveillance including general background monitoring. Nineteen wells were installed at SLAC in CY96. As noted in Table 6-1, the four areas with groundwater contamination are:

- The Former Hazardous Waste Storage Yard (FHWSY).
- FSUST.
- The area of MW-24 (Test Lab or Central Lab).
- The Plating Shop.

In addition to the 18 wells installed in the areas of groundwater contamination, one well was installed for environmental surveillance at the Vacuum Assembly Building, and a well at the FHWSY was abandoned.

The locations with groundwater contamination are shown in Figure 7-1. The main organic contaminant in all of these areas is trichloroethene (TCE) and its breakdown products. TCE was historically used at SLAC as a cleaning solvent. TCE is no longer in general use at SLAC. It is used in very small quantities in a few research laboratories. The four contaminated groundwater sites are discussed in detail in the next section.

7.2 Groundwater Site Descriptions and Results

Table 7-1 Purpose and Location of Monitoring Wells

	Number of Active Wells	
Area of Site	Groundwater Contaminated Plume Monitoring	Environmental Surveillance
FSUST[a]	11 wells	
FHWSY[b]	7 well	
MW-24	5 wells	
Plating Shop	8 wells	
Research Yard		3 wells
End Station A		1 well
Master Substation 8; Salvage Yard		1 well
HWSY[c]		1 well
End Station B		1 well
Vacuum Assembly Building		1 well
Other (remote area)		1 well

[a] Former Solvent Underground Storage Tank
[b] Former Hazardous Waste Storage Yard
[c] Hazardous Waste Storage Yard

7.2.1 Former Solvent Underground Storage Tank (FSUST)

7.2.1.1 Background

A groundwater monitoring network is located in proximity to SLAC's Plant Maintenance building in the northwestern portion of the facility (see Figure 7-1). This network consists of eleven wells, including three wells that were installed in CY96. The wells are being used to monitor the migration of chemical constituents associated with a FSUST, which contained organic solvents during the period of 1967 to 1978. A pressure test performed on the FSUST in 1983 indicated a leak and the tank and accessible contaminated soil were removed in December 1983.

The California RWQCB requires that SLAC monitor selected wells at the FSUST site on a semi-annual basis (RWQCB Waste Discharge Order 85-88). Since 1987, the samples have been analyzed for volatile organics (EPA Methods 8010/8020) by an analytical laboratory certified by the California Department of Health Services.

7.2.1.2 CY96 Results and Issues

A larger than expected area with high concentrations of constituents of concern was encountered at the FSUST. Potential remedial alternatives will be tested in CY97 and discussed in the RI/FS report.

Results of RI/FS work at the FSUST will be detailed in the RI/FS Report for the FSUST area. This report will be submitted to the RWQCB in CY97 or early CY98.

7.2.2 Former Hazardous Waste Storage Yard (FHWSY)

7.2.2.1 Background

The FHWSY was in use from approximately 1965 to 1982. During closure of the yard, PCBs were found in shallow soils. As a result, several inches of topsoil were removed. Monitoring well MW-25 was installed in this area in 1990, and VOCs were detected in the groundwater. Six more wells were installed in CY96 (see Figure 6-1).

A soil-gas survey was conducted in 1992 at the site to delineate the source-area and extent of groundwater contamination. However, the survey was terminated early because the substrate had low permeability, which severely restricted air-flow through the probe.

7.2.2.2 CY96 Results and Issues

Results of RI studies conducted in CY96 are presented in the April, 1977 *"Progress Report for the Remedial Investigation of the Former Hazardous Waste Storage Area"*, (SLAC-I-750-3A33H-002). A summary of the results follows.

Results of the 1996 RI/FS drilling and testing program at the FHWSY indicate that the bedrock beneath the site comprises gravels, sands, and silts of the Santa Clara Formation along with silts of the underlying Ladera Sandstone. These units are locally covered with fill. Estimates of vertical hydraulic conductivity for the silty sands and sandy silts in the Santa Clara Formation are on the order of 10^{-6} to 10^{-7} cm/sec. In comparison, data from a 1992 slug test in monitoring well MW-25, which is screened across both bedrock units, yield an estimated hydraulic conductivity of 2.7×10^{-6} cm/sec.

The available data indicate the presence of an east-west trending groundwater divide beneath the FHWSY. While groundwater gradients in the southern portion of the area appear to be consistent with the regional southeastern gradient, those in the northern portion appear to dip to the north and northeast, reflecting the influence of the linac subdrain system.

To date, VOCs associated with the FHWSY have been detected in soils primarily in two areas. However, additional chemical data will be necessary for adequate characterization of potential source areas. In addition, VOCs have been detected in groundwater in monitoring well MW-25 located next to the FHWSY, and in two newly installed wells: MW-34 to the south and MW-43 to the north. Based on comparisons of chemical concentrations in shallow soil versus groundwater and taking groundwater gradients into account, groundwater flow in the vicinity of MW-34 appears to be to the southeast, consistent with the regional gradient, while flow in the vicinity of MW-43 appears to be to the north, consistent with the effect of the linac subdrain. In contrast, the groundwater data from newly installed wells MW-32 and MW-33 indicate that the lateral extent of VOCs in groundwater appears to be delineated to the east. Further RI/FS work is planned for CY97 to define the extent of VOCs in soil and groundwater at the FHWSY.

7.2.3 Plating Shop

7.2.3.1 Background

In 1990, three monitoring wells, MW-21, MW-22, and MW-23, were installed downgradient of the Plating Shop. Constituents of concern were detected in all of the three wells and an investigation began as described below.

7.2.3.2 CY95 Results and Issues

Results of RI studies conducted in CY96 are presented in the March, 1977 *"Remedial Investigation Progress Report for the Plating Shop Area"* (SLAC-I-750-3A33H-001). A summary of the results follows.

Five more wells were installed for the RI in CY96 (see Figure 6-1). The results of the RI/FS 1996 drilling and testing program indicate that bedrock at the Plating Shop Area consists of silty sand to sandy silt. Data from a 12.5 hour pumping test indicate that monitoring wells MW-23 and MW-38 are hydraulically connected. The sustainable pumping rate of well MW-38, one of the best producing wells at the Plating Shop Area, is less than 0.5 gallons per minute. Hydraulic conductivities estimated from pumping and slug tests and laboratory measurements range from 1.8×10^{-4} cm/sec to 4.9×10^{-7} cm/sec. The groundwater gradient is to the southeast and is influenced by the subdrainage system of the linear accelerator. Groundwater appears to flow primarily along fractures and/or bedding planes, as well as in the matrix of the subsurface sediments.

On the basis of available data, the lateral extent of chlorinated VOCs in groundwater at the Plating Shop Area has been delineated as extending to MW-40 to the east, but not as far as wells MW-36 and MW-37 to the southeast or MW-35 to the west. Based on the results of groundwater analyses and soil gas surveys, there may be sources of chlorinated VOCs located between the Plating Shop/Light Fabrication Building and the Heavy Fabrication Building. However, the exact location of these sources and their concentrations of VOCs in the soil remain unknown. Consequently, finding these sources is the primary objective of the next phase of field activity planned for CY97. In addition, several wells will be installed in CY97 to define the vertical and lateral extent of VOCs in groundwater.

7.2.4 Test Lab and Central Lab

7.2.4.1 Background

The Test Lab and Central Lab area well, formerly known as Monitoring Well (MW-24), was installed in 1990 at the site of a former leaking diesel pump. Contaminated soil was removed and the well was installed to monitor for the possible presence of diesel fuel. However, diesel fuel has never been detected in this well. Chlorinated solvents have been detected, and a RI is ongoing as described below.

7.2.4.2 CY96 Results and Issues

Results of RI studies conducted in CY96 are presented in the April, 1997 *"Remedial Investigation Progress Report for the Test Lab and Central Lab Area"*, (SLAC-I-750-3A33H-004). A summary of the results follows.

Four more wells were installed for the RI in CY96 (see Figure 6-1). Results of the CY96 remedial investigation at the TL/CL Area indicate that bedrock consists predominantly of silty sands and sandy silts of the Miocene Ladera Sandstone. The groundwater gradient direction is to the southeast and appears to be controlled in part by the occurrence of the PEP tunnel. A sample of silty to clayey sand collected from 20 to 20.5 feel bgs at monitoring well MW-41 has a vertical hydraulic conductivity of approximately 5×10^{-6} cm/sec.

As of the most recent sampling event (August 1996), concentrations of TCE and 1,2 DCE in groundwater from well MW-24 were 46 mg/l and 90 mg/l, respectively. On the basis of the available data, the lateral extent of VOCs in groundwater at the TL/CL area has been defined as not extending as far as wells MW-42 and MW-46 to the southeast, well MW-45 to the south, or well MW-41 to the northwest. To date, a source for the chemicals detected in groundwater in well MW-24 has not been identified. Therefore, the next phase of field activities planned for CY97 will focus on locating the source area. The strategy will be to further narrow down the probable location of the source by further delineating the plume boundaries and the lateral distribution of VOCs in the groundwater.

7.3 Quality Assurance

As described in the *Quality Assurance Project Plan* and the *Standard Operating Procedures*, SLAC conducts a quality data validation review for all data collected for RI/FS activities.

7.4 Groundwater Protection Management Program

Major documents to support the RI/FS work are described in the Groundwater Protection Management Program (GPMP) and include:

1. *Remedial Investigation/Feasibility Study (RI/FS) Workplans.*
2. *Sampling and Analysis Plan.*
3. *Standard Operating Procedures.*
4. *Quality Assurance Project Plan.*
5. *Field Sampling Plan.*
6. *Annual Well Inspection and Maintenance Manual.*

The components of the GPMP include the following:

7.4.1 Documentation of the Groundwater Regime with Respect to Quantity and Quality

The groundwater regime at the SLAC site and nearby off-site areas has been comprehensively documented in the *SLAC Hydrogeologic Review* completed in CY94. This report compiled data and summarized results of the numerous geologic, hydrogeologic, and hydrogeochemical investigations that have taken place at or near SLAC for various reasons:

- Water resources studies.
- Research.
- Geotechnical studies used to site the structures being built at SLAC.
- Environmental and monitoring purposes.

The report developed a conceptual model of the groundwater regime at SLAC. Of particular interest to studies of contaminant transport was the fact that the major bedrock unit underlying SLAC conveyed groundwater primarily by fracture flow. Based on numerous tests in exploratory borings and wells, the hydraulic conductivity of this bedrock was much less than the range of hydraulic conductivity generally accepted as representing natural aquifer material.

7.4.2 Design and Implementation of a Groundwater Monitoring Program to Support Resource Management and Regulatory Compliance

This part of the GPMP identifies all DOE requirements and regulations applicable to groundwater protection and provides the framework for the groundwater monitoring program to:

- Demonstrate compliance.
- Provide data and reporting requirements for the early detection of groundwater contamination.
- Provide data for decisions concerning groundwater resource management.

Two documents, the *Quality Assurance Project Plan* and *Standard Operating Procedures*, provide guidance for the semi-annual groundwater monitoring program and ensure that data collected is of acceptable and comparable quality. These plans follow the applicable Environmental Protection Agency (EPA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and DOE guidance documents referenced in the specific plans.

7.4.3 Management Program for Groundwater Protection and Remediation, as Related to SDWA, RCRA, and CERCLA Requirements

The components of the management program for groundwater protection and remediation include:

1. SLAC personnel-management responsibilities.
2. Prioritization of site groundwater investigation studies.
3. Management of known groundwater contamination sites.
4. Guidelines for management of investigation of potential or known sources of groundwater contamination.

Several documents were prepared in 1993 under the guidance of this section of the GPMP and are discussed further in Section 6.4.6. *A Beneficial Use Assessment*, which included a well survey of the area around SLAC, provided information on possible beneficial uses of groundwater at SLAC, as outlined in the *California Regional Water Quality Control Board Basin Plan*. This report concluded that groundwater at SLAC has a very high TDS content and a very low rate of flow, and is not suitable for most potential beneficial uses.

Figure 6-8 shows the SLAC facility with respect to the location of the nearest downgradient drinking water wells which are shown as wells 46 and 26. Each of these wells supports one residence. Wells 11 and 12 provide drinking water to Stanford University. The groundwater at SLAC has a distinctly different signature than the groundwater in these wells. SLAC's groundwater generally exceeds TDS concentrations of 3,000 milligrams per liter and has been measured as high as 10,000 milligrams per liter.

7.4.4 Summary and Identification of Potentially Contaminated Areas

SLAC's 1992 report entitled *Identification and Summary of Potentially Contaminated Sites* provides a summary of areas that may be contaminated by hazardous substances. Information for the report was collected from a variety of sources including spill reports, aerial photographs, operations records, reports on previous investigations, and interviews with SLAC personnel throughout the facility.

7.4.5 Strategies for Controlling Sources of Contaminants

Strategies for contaminant source control involve measures to control known soil or groundwater contamination, and procedures to address practices that may contribute to groundwater contamination. In addition, the Storm Water Pollution Prevention Plan (SWPPP) and the Spill Prevention, Control, and Countermeasure Plan (SPCCP) discuss best management practices (BMPs) for preventing contamination at the SLAC facility. Environment, Safety, and Health (ES&H) Manual chapters on Secondary Containment and Oil-filled Equipment Management Programs address practices for preventing contamination from reaching soil or groundwater.

To reduce the threat of groundwater contamination further, SLAC has established a Waste Minimization Program and a Pollution Prevention Awareness Program as required under DOE Orders 5400.1 and 5820.2A. These programs have promoted source control through the reduction of hazardous material usage and hazardous waste generation. This was accomplished by encouraging environmentally-conscious engineering and by increasing employee awareness.

7.4.6 CERCLA and DOE Required Remedial Action Program

An RI/FS Workplan written following CERCLA guidance addresses soil and groundwater contamination at SLAC. Associated documents include a *Sampling and Analysis Plan* and associated *Standard Operating Procedures, Quality Assurance Project Plan,* and *Field Sampling Plan.* These documents provide overall guidance for the remedial action program.

DOE 5400.4 required SLAC to follow CERCLA RI/FS guidance. Although no longer required, SLAC still follows applicable parts of CERCLA guidance in developing strategies and preparing documentation. Actual National Priority List (CERCLA sites) are under the oversight of the EPA or designated alternative agencies. The California Regional Quality Control Board provides oversight of SLAC.

8 Quality Assurance

The Stanford Linear Accelerator Center's (SLAC's) site-wide Quality Assurance (QA) Program has been influenced by the requirements of Department of Energy (DOE) Order 5700.6C. The QA Program is described in the *SLAC Institutional Quality Assurance Program Plan* (SLAC-I-770-0A17M-001). This document was approved by the DOE in May 1993. The plan defines the roles, responsibilities, and authorities for implementation of the ten criteria from DOE Order 5700.6C.

The Safety, Health, and Assurance (SHA) Department is involved in the qualification process for environmentally sensitive services, including off-site analytical laboratories. SHA is responsible for auditing the line QA and environment, safety, and health (ES&H) programs; maintaining the *SLAC Institutional Quality Assurance Program Plan;* and providing direction for implementation of the ten criteria from 5700.6C.

The QA Program includes qualification of laboratories that provide analytical services, verification of certification to perform analytical work, and review of Environmental Protection Agency (EPA) performance test results. Also included in this review is adequacy of the internal quality control (QC) practices, record keeping, chain of custody, and the analytical laboratory QA program as a whole.

8.1 Laboratory Testing

Laboratory performance testing is performed as outlined in the latest revision of the *Environmental Laboratory Performance Program* (SLAC-I-770-2A17C-008).

8.2 Radioanalysis Laboratory

SLAC's radioanalysis laboratory participates in DOE's QA Laboratory Intercomparison Program through the Environmental Measurements Laboratory (EML). This program provides environmental samples to participating labs for analysis and evaluates the results. Laboratories are then rated. The categories are:

- Acceptable
- Acceptable with Warning
- Unacceptable.

SLAC's radioanalysis laboratory has been evaluated and rated as "Acceptable".

8.3 Environmental Monitoring

The following procedures and policies that support the QA Program for environmental monitoring activities are used with:

Document #	Title
QC-030-004-00-R0	*Radioactive Water Sampling/Analysis Audit Procedure*
SLAC-I-770-0A19C-001	*Oversight Procedure*
SLAC-I-770-2A19C-004	*Non-Radiological Sampling Audit Procedure*
SLAC-I-770-0A16Z-001	*Establishing Data Quality Objectives*

8.4 Environmental Restoration Program

The Environmental Restoration Program (ERP) uses the *Quality Assurance Project Plan* for the *Remedial Investigation and Feasibility Study* for soil and groundwater contamination investigations. The *Quality Assurance Project Plan* for the groundwater monitoring program and the associated *Data Management Plan* are used for the quarterly groundwater monitoring program. These documents have all the components required of *Quality Assurance Project Plans* according to EPA, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and DOE guidance documents. This includes defining required laboratory and field QA/QC procedures and corrective actions, as well as data validation and reporting.

A Model for Potential Dose Assessment

According to Department of Energy (DOE) Orders, an assessment of whole-body dose equivalent (in person-rem) to the general population near SLAC is required where appropriate. For this report, the term dose equivalent simply will be called dose. SLAC's dose to the maximally exposed member of the general public due to accelerator operations was conservatively estimated to be 4.6 mrem (0.046 mSv) in CY96 from penetrating radiation. The 4.6 mrem (0.046 mSv) value is approximately 1.5% of the total natural background dose and is 4.6% of the dose limit for members of the general population, that is, 100 mrem (1 mSv) per year (DOE Order 5400.5).

There are three major pathways leading to human exposure from human-made ionizing radiation:

- Airborne Radioactivity.
- Food Chain Radioactivity.
- Direct Exposure to Penetrating Radiation.

Of these three major pathways, only direct exposure to penetrating radiation is of any measurable significance from SLAC operations. The sources of this exposure are from neutrons resulting from the absorption of high-energy electrons, from photons from klystron operations, and/or from the experimental areas where energetic particles are created, some of which may escape from the heavily shielded enclosures.

In order to make an accurate and realistic assessment of radiation exposure to the public at low doses, it is necessary that exposure from the natural radiological environment be known, that is, background radiation. This is true because the instruments used respond to natural radiation sources as well as human-made sources, and the portion due to natural radiation must be subtracted from the total measurement. The population exposure assessments appearing in this report are in all cases overstatements, due to the conservative modeling assumptions used compared to the likely actual impact; hence, the resulting values are representative of an upper limit of the possible range.

While the annual radiation dose from accelerator operations at the site boundary has generally been measurable, it has always amounted to less than 10% of the total annual individual dose from natural background radiation. According to an Environmental Protection Agency (EPA) report, the average dose from cosmic, terrestrial, and internal radiation (not including radon) in California is 125 mrem (1.25 mSv). For purposes of comparison, we have rounded this number down to 100 mrem (1 mSv).

Another quantity of interest is the population dose in units of person-rem (person-cSv). This is simply the product of average individual dose and the total population exposed. For example, if

1,000 people are exposed to an average annual background dose of 0.1 rem (1 mSv), then the population dose is 0.1 x 1,000 or 100 person-rem (1 person-Sievert) from natural background radiation. The annual variation of exposure to natural background radiation may be $\pm$ 20%, largely caused by differences in naturally occurring uranium, thorium, and potassium present in the ground and in building material where people live and work.

Most of the high energy accelerator laboratories have made measurements to determine the characteristic attenuation of radiation fields from their facilities. These measurements are unique to each facility because of design differences, types of machines, and surrounding topography. We have chosen a conservative formula for calculating the dose at distances other than the point of measurement. Lindenbaum gave a method for evaluating skyshine which was later verified by Ladu using Monte Carlo techniques. Lindenbaum approximated the falloff by $(e^{-R/\lambda})/R$ where R is distance in meters from the source and $\lambda = 250$ m. This equation fits the SLAC data fairly well, and is the one used to predict doses beyond our measuring stations (see Figure A-1). It is likely that the methods used and reported in this document could overestimate the true population dose by at least an additional factor of two.

In CY95, the doses to the public were dominated by photon radiation from either the klystrons or the accelerator with neutron doses being insignificant. The model used for evaluating the dose to the general public was as follows:

A. Maximally Exposed Member of the General Public:

1. Determined the closest locations of the general public to the facility.
2. Evaluated the Thermoluminescent Dosimeter (TLD) data closest to these locations.
3. Determined the source of the radiation as seen by the TLD station.
4. Extrapolated the photon dose from the source to the general public using a conservative line source geometry (1/R relationship), if the source was klystron radiation. In locations where the line source geometry may not have been accurate, it was conservative.
5. Extrapolated the neutron dose or photon dose from accelerator radiation using the Lindenbaum approximation.
6. Evaluated TLD data to determine the highest dose locations.
7. Determined the location of the general public closest to these TLD locations.
8. Extrapolated the photon dose from the source to the general public using a conservative line source geometry (1/R relationship), if the source was klystron radiation. In locations where the line source geometry may not have been accurate, it was conservative.
9. Extrapolated the neutron dose or photon dose from accelerator radiation using the Lindenbaum approximation.
10. Reported the highest dose to any member of the general public as the maximally exposed individual.

B. Collective Dose to the General Public:

1. Established a population grid out to 80 km from the facility.
2. Determined the highest site boundary TLD dose.
3. Applied this dose conservatively to the whole facility.

4. Applied this dose to the population grid using a line source geometry (1/R relationship) out to 500 meters of the facility and a point source geometry ($1/R^2$ relationship) from 501 meters to 80,000 meters.

5. Extrapolated the neutron dose using the Lindenbaum approximation.
6. Summed all the population doses from the grid.

The population demographics in the vicinity of SLAC, that is, within an 80 km radius, include a mixture of commercial and residential dwellings. Based on the data from the 1990 census, the population estimate in this area is about 4,917,443 residents. Based on the TLD results, the maximum dose at the SLAC site boundary was about 27 mrem in CY96. Using this maximum dose value, it was estimated that the collective dose to the population within 80 km of SLAC was about 5.02 person-rem (0.0502 person-Sv).

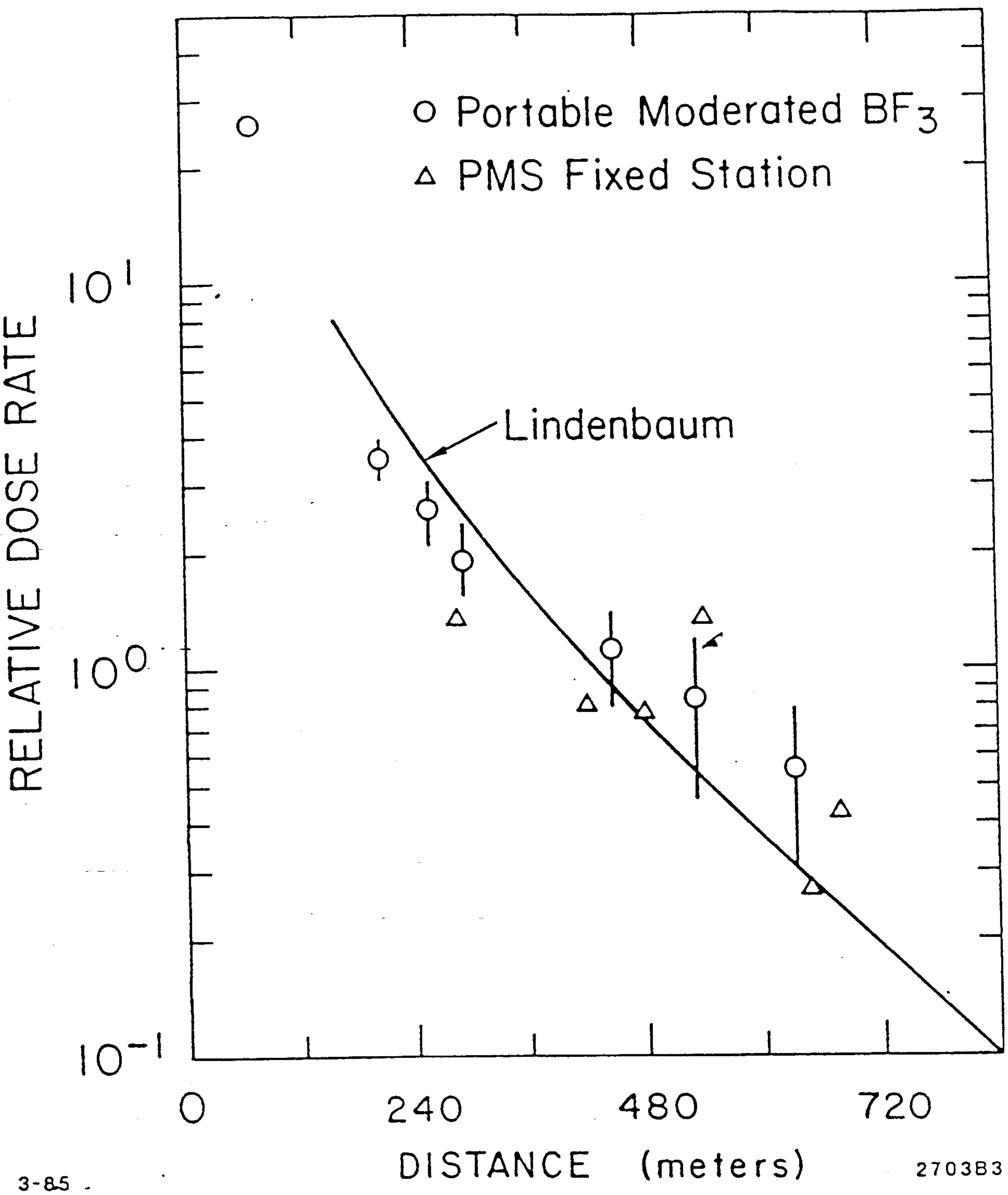


Figure A-1 Measurements made along a line between End Station A and the site boundary.

B

NESHAPs Report

Original report published in June, 1997
Table and section formats reflect those of the original.

1 Facility Information

Stanford Linear Accelerator Center (SLAC) was in full compliance in calendar year 1996 (CY96) with the requirements set forth in 40 CFR Part 61 Subpart H.

1.1 Site Description

SLAC is a national facility operated by Stanford University under contract with the U.S. Department of Energy (DOE). It is located on the San Francisco peninsula, about halfway between San Francisco and San Jose, California. The site area is a belt of low, rolling foothills, lying between the alluvial plain bordering the San Francisco Bay on the east and the Santa Cruz Mountains on the west.

The whole accelerator site varies in elevation from 53 to 114 meters (175 to 375 feet) above sea level, whereas the alluvial plain to the east around the Bay lies less than 46 meters (150 feet) above sea level. The mountains to the west rise abruptly to 610 meters (2,000 feet). The SLAC site occupies 170 hectares (420 acres) of land. The site is located in an unincorporated portion of San Mateo County. It is bordered on the north by Sand Hill Road and on the south by San Francisquito Creek.

The SLAC staff is roughly 1,400 employees, temporary staff, and visiting scientists. The climate in the SLAC area is Mediterranean. Winters are cool (sometimes it rains) and summers are mostly warm and dry.

The populated area around SLAC is a mix of office, school, university, condominiums, apartments, single family housing, and pasture. SLAC is mainly surrounded by 5 communities: Atherton town, West Menlo Park, Woodside town, Portola Valley town, and Stanford. Population distribution and housing data from the 1990 census for these five communities are shown in Table 1 below:

Table 1:Demographic Data

Geographic Area	Population [persons]	Pop. Density [persons/sq.mile]	Housing [units]	Land Area [sq. mile]
Atherton town	7,163	1,463.32	2,518	4.895
West Menlo Park	3,959	7,086.19	1,701	0.559
Portola-Valley town	4,194	458.02	1,675	9.157
Woodside town	5,035	428.88	1,892	11.740
Stanford	18,097	6,569.14	4,770	2.755
Total:	38,448	NA	12,556	29.106

SLAC is a component of the U.S. high energy physics program. The laboratory uses a 3.2 km (2 mile) long electron accelerator to produce and accelerate both electrons and positrons for basic particle physics research.

SLAC also operates the Stanford Synchrotron Radiation Laboratory (SSRL),a synchrotron research facility. This laboratory uses 3 GeV stored electrons to generate synchrotron radiation for basic energy research.

The facilities at SLAC are used to maintain the accelerator, to design and construct new detector systems, and to support research in accelerator technology. There are a variety of facilities at SLAC that may be used at any given time. Facility use is dictated by experimental needs and schedules. Therefore, not every facility is significantly utilized each year. Facilities that are utilized are included in Section 1.2.

1.2 Source Description

Radioactive material is inevitably produced by the operation of the accelerator. During the acceleration process some electrons strike accelerator components and induce radioactivity in the material. In addition, some high-energy particles interact with air molecules producing relatively short-lived radionuclides such as 15O, 13N, 11C, and 41Ar. These radioactive gases are normally produced in areas where the beam strikes beam line components (beam loss). There were eight potential beam loss areas identified at SLAC for CY96 where the saturation air radioactivity is produced:

- Accelerator Housing (LINAC).
- Positron Source.
- Stanford Linear Collider (SLC) Beam Dumps.
- Beam Switchyard (BSY).
- SLC Damping Rings.
- Stanford Synchrotron Radiation Laboratory (SSRL) Booster Injector.
- Final Focus Test Beam (FFTB).

The saturation radioactivity is defined to be the equilibrium air radioactivity level inside these areas when the accelerator is running. Calculations of saturation activity in each of these eight beam loss areas are conservatively based on the specific beam power loss and the area geometry (that is, air path length, air volume, and other factors).

Potential release points from these areas are either from the access openings (that is, entrance doors, manways) or from the forced air ventilation ducts. All the access openings are closed and administratively secured during beam operation; therefore, potential releases occur only after turning off the beam. Ventilation is not used during beam operations.

To maintain personnel doses As Low As Reasonably Achievable (ALARA) considerations, SLAC 's radiological control policies recommend that the time between turning the beam off and venting (or making entry) should be at least one hour during normal operations. This one hour venting/entry delay is long enough for the dominant radionuclide (15O) to decay through several half-lives.

The calculated source terms in each area include the assumptions that the total value of air in the area is at saturation levels, and is instantaneously released whenever that area was shut down for repair or maintenance. These calculated source terms are presented in Tables 2 through 9. In addition, the "number of releases/year" was conservatively estimated for many systems.

The decay time for the produced radioactive gases prior to release varied for the different beam loss areas. Detailed descriptions of the beam loss areas and their associated radionuclide concentrations are discussed below.

1.2.1 Accelerator Housing

The accelerator, or LINear ACcelerator (LINAC), is enclosed in a 3.2 km (2 mile) long housing. The housing is located 7.6 meters (25 feet) below ground. Access to the housing is through 76.2 cm (30 inch) diameter shafts every 100.5 meters (330 feet). These shafts (release points) are also used as intake and exhaust shafts for the accelerator housing.

Before machine operation, the housing is searched and locked. There is a solid cover across each manway shaft which is interlocked with the accelerator. The cover must be in place for machine operation; consequently, the housing is not vented when the accelerator is in operation. There are no releases from these points when the machine is on. After the machine is turned off, that is, no beams are being produced, the housing can be vented.

The radioactive gas concentration is very low in the accelerator housing because there is very little beam loss, as determined by the level of activation in the accelerator structure. It is conservatively assumed that the saturation activities in this area are similar to those in one of the SLC Beam Dump areas.

Table 2: Accelerator Housing Activity

Radionuclide	Saturation Activity (Ci)	Number of Releases per Year	Typical Decay Time (min)	Activity Released (Ci/y)	Percent of Contribution
O-15	1.0E-011	12	60	1.53E-09	0.00%
N-13	2.0E-02	12	60	3.69E-03	5.91%
C-11	3.0E-02	12	60	4.64E-02	74.35%
Ar-41	1.5E-03	12	60	1.23E-02	19.74%
Total:	1.5E-01			6.24E-02	100.00%

* 1 Ci = 3.7 x 1010 Bq

After the electron beam leaves the accelerator, it is guided to an area where it may interact with a stationary target or be directed to collide with a beam of positrons. The distance from this facility to the nearest receptor (receptor defined as a member of the general public) is about 305 meters (1,000 feet).

1.2.2 Positron Source

The positron source is located in an area separated from the accelerator housing by a thick concrete shield. The beam is deflected out of the accelerator into the positron target. The electron beam produces electron/positron pairs in the target. The positrons are separated and transported back to the beginning of the accelerator. The air activation associated with the operation of the positron target has been evaluated with respect to the saturation activities. The saturation activities of potential radioactive gases in this area are listed in Table 3.

Table 3: Positron Source Activity

Isotope	Saturation Activity (Ci)	Number of Releases per Year	Typical Decay Time (min)	Activity Released (Ci/y)	Percent of Contribution
O-15	1.4E+00	4	60	7.12E-09	0.00%
N-13	3.0E-01	4	60	1.85E-02	8.10%
C-11	3.0E-01	4	60	1.55E-01	67.88%
Ar-41	2.0E-02	4	60	5.48E-02	24.03%
Total:	2.0E+00			2.28E-01	100.00%

* 1 Ci = 3.7×10^{10}Bq

The positron source has a separate exhaust fan (release point). The positron source is not vented during machine operation. The distance to the nearest receptor is about 640 meters (2,100 feet).

1.2.3 Beam Dumps

SLAC is operating a machine called the SLAC Linear Collider (SLC). The SLC is the upgraded linear accelerator which produces 50 GeV positrons and electrons. These beams are deflected into transport systems which guide them to an interaction point. After the interaction collision point, any electrons and positrons remaining in the beams are deflected into beam dumps. There are two beam dumps located in shielded rooms in the SLC arcs. The saturation activities for both of these beam dumps are listed in Table 4.

Table 4: SLC Beam Dumps Activity

Isotope	Saturation Activity (Ci)	Number of Releases per Year	Typical Decay Time (min)	Activity Released (Ci/y)	Percent of Contribution
O-15	2.0E-01	10	60	2.54E-09	0.00%
N-13	4.0E-02	10	60	6.15E-03	5.91%
C-11	6.0E-02	10	60	7.74E-02	74.35%
Ar-41	3.0E-03	10	60	2.05E-02	19.74%
Total:	3.0E-031			1.04E-01	100.00%

* 1 Ci = 3.7×10^{10} Bq

The SLC arc and dump areas are not vented (release points) during beam operation. The distance from the north arc SLC vent to the nearest receptor is 274 m (900 feet).

1.2.4 Beam Switchyard

There are four vents (release points) at BSY. The vents at BSY and Beam Dump East (BDE) have covers. The covers are closed during beam operation. Use of the saturation activity produced in the accelerator housing as the release from these four vents will give a conservative estimate of the effective dose equivalent. The distance from this facility to the nearest receptor is about 457 meters (1,500 feet).

Table 5: Beam Switchyard Activity

Isotope	Saturation Activity (Ci)	Number of Releases per Year	Typical Decay Time (min)	Activity Released (Ci/y)	Percent of Contribution
O-15	1.0E-01	6	60	7.63E-10	0.00%
N-13	2.0E-02	6	60	1.85E-03	5.91%
C-11	3.0E-02	6	60	2.32E-02	74.35%
Ar-41	1.5E-03	6	60	6.16E-03	19.74%
Total:	1.5E-01			3.12E-02	100.00%

* 1 Ci = 3.7×10^{10} Bq

1.2.5 Damping Rings

There are two damping rings associated with the SLC. The rings are located on the north and south sides of the accelerator at the end of Sector 1. The distance from these two rings to the nearest receptor is about 274 meters (900 feet). Each ring has a forced air ventilation system (release point). No ventilation is carried out during beam operation. The saturation activity produced in each ring has been calculated. The radionuclides produced and their saturation activities are listed in Table 6.

Table 6: Damping Rings Activity

Isotope	Saturation Activity (Ci)	Number of Releases per Year	Typical Decay Time (min)	Activity Released (Ci/y)	Percent of Contribution
O-15	1.8E-02	10	60	2.29E-10	0.00%
N-13	3.2E-03	10	60	4.92E-04	17.84%
C-11	6.0E-04	10	60	7.74E-04	28.05%
Ar-41	2.2E-04	10	60	1.49E-03	54.11%
Total:	2.2E-02	10	60	2.76E-03	100.00%

* 1 Ci = 3.7×10^{10} Bq

1.2.6 SSRL Booster Injector

SSRL has a 3 GeV booster ring and linac (injector) that produce very low concentrations of radioactive gases. The radionuclides and their saturation activities are listed in Table 7.

Table 7: SSRL Booster/Injector Activity

Isotope	Saturation Activity (Ci)	Number of Releases per Year	Typical Decay Time (min)	Activity Released (Ci/y)	Percent of Contribution
O-15	3.7E-04	36	60	1.69E-11	0.00%
N-13	7.0E-04	36	60	3.88E-04	37.18%
C-11	8.0E-05	36	60	3.71E-04	35.63%
Ar-41	1.2E-05	36	60	2.83E-04	27.19%
Total:	1.2E-03	36	60	1.04E-03	100.00%

*1 Ci = 3.7×10^{10} Bq

The booster ring does not have forced air ventilation, thus the entrance door is the only potential release point. The distance from this facility to the nearest receptor is about 427 meters (1,400 feet).

1.2.7 Final Focus Test Beam

The FFTB is an extension of the old C-line from the BSY and extends out into the research yard. This facility tests technology that is used to reduce electron beam pulse sizes and increase collision probabilities for the next generation linear accelerators. The radionuclides produced and their saturation activities are listed in Table 8.

Table 8: Final Focus Test Beam Activity

Isotope	Saturation Activity (Ci)	Number of Releases per Year	Typical Decay Time (min)	Activity Released (Ci/y)	Percent of Contribution
O-15	1.7E-04	2	60	4.32E-13	0.00%
N-13	3.1E-04	2	60	9.54E-06	46.80%
C-11	3.3E-05	2	60	8.51E-06	41.77%
Ar-41	1.7E-06	2	60	2.33E-06	11.43%
Total:	5.1E-04	2	60	2.04E-05	100.00%

The FFTB does not have forced air ventilation, thus the entrance door is the only potential release point. The distance from this facility to the nearest receptor is about 487 meters (1,550 feet).

1.2.8 End Station A

The End Station A (ESA) facility is used for fixed target experiments utilizing up to 50 GeV electrons from the A-line of the BSY. The majority of the beam loss occurs at BDE, which is a 400 gallon water dump at the end of the line from ESA. The radionuclides produced and their saturation activities are listed in Table 9. ESA did not operate in CY96.

Table 9: End Station A Activity

Isotope	Saturation Activity (Ci)	Number of Releases per Year	Typical Decay Time (min)	Activity Released (Ci/y)	Percent of Contribution
O-15	2.0E-03	0	0	0	0
N-13	3.7E-03	0	0	0	0
C-11	4.0E-04	0	0	0	0
Ar-41	3.0E-03	0	0	0	0
Total:	9.1E-03			0	0

The ESA beam loss area is located at BDE. The distance from this facility to the nearest receptor is about 457 meters (1,500 feet). BDE does not have forced air ventilation, thus the entrance door to BDE is the only potential release point. This entrance door is a gate and does not constitute an area isolated from the environs. Continuous air diffusion to the environs is assumed at a rate of one tunnel volume per week. For this reason, the typical decay time of 0 minutes is used.

The radionuclide activities used for assessing compliance are listed in Table 10. These activities were calculated using internal reports and memoranda to file.

Table 10: Summary Activity by Location for CY96

Isotope	Accelerator Housing [Ci*]	Positron Source [Ci*]	SLC Beam Dump [Ci*]	Beam Switchyard [Ci*])	SLC Damping Rings [Ci*]	SSRL Booster/ Injector [Ci*]	FFTB [Ci*]	END Station A [Ci*]	All Site Total (Ci)	Percent of Contribution
O-15	1.5E-09	7.1E-09	2.5E-09	7.6E-10	2.3E-10	1.7E-11	4.3E-13	0.0E+00	1.2E-08	0.00%
N-13	3.7E-03	1.8E-02	6.2E-03	1.8E-03	4.9E-04	3.9E-04	9.5E-06	0.0E+00	3.1E-02	7.22%
C-11	4.6E-02	1.5E-01	7.7E-02	2.3E-02	7.7E-04	3.7E-04	8.5E-06	0.0E+00	3.0E-01	70.52%
Ar-41	1.2E-02	5.5E-02	2.1E-02	6.2E-03	1.5E-03	2.8E-04	2.3E-06	0.0E+00	9.6E-02	22.25%
Total:	6.2E-02	2.3E-01	1.0E-01	3.1E-02	2.8E-03	1.0E-03	2.0E-05	0.0E+00	4.3E-01	
Percent of Contribution	14.54%	53.08%	24.23%	7.27%	0.64%	0.24%	0.00%	0.00%		100.00%

* 1 Ci = 3.7×10^{10} Bq

2 Air Emissions Data

Nearest Point Source	Type Control*	Efficiency*	Distance to Receptor
Positron Source	Not vented during beam operation	100%	640 m (NNE)
Damping Ring	Not vented during beam operation	100%	274 m (WNW)
SLC Beam Dump	Not vented during beam operation	100%	274 m (NE)
Accelerator Housing	Not vented during beam operation	100%	305 m (N)
Beam Switchyard	Not vented during beam operation	100%	457 m (NNW)
SSRL Booster/Injector	Not vented during beam operation	100%	427 m (N)
FFTB	Not vented during beam operation	100%	487 m (N)
End Station A	Not vented during beam operation; however since this is not a closed facility, emission occurs by diffusion.	100%	457 m (N)

* There are no controls during venting, so efficiency is not applicable.

Non-Point Source	Annual Quantity (Ci)
None Identified	0.0

Table 11: Total Radioactive Gases Potentially Released in CY96 (Decay/Venting Delay Corrected)

Isotope	All Site Total (Ci)	Percent of Contribution
O-15	1.2E-08	0.00%
N-13	3.1E-02	7.22%
C-11	3.0E-01	70.52%
Ar-41	9.6E-02	22.25%
Total (Ci):	4.3E-01	100.00%

* 1 Ci = 3.7×10^{10}Bq

3 Dose Assessments

3.1 Description of the Dose Model

The EPA atmospheric dispersion/radiation dose calculation computer code, CAP88-PC Version 1.0, was used to calculate the average radiation dose to individuals at specified distances and directions from the facility and to individuals within each population segment around the facility. Collective population dose is calculated as the average radiation dose to an individual in a specified area, multiplied by the number of individuals in that area.

The CY96 radioactivity air emissions were conservatively derived and are shown in Table 11 in Section 2. The "number of releases/year" was estimated for each release point. This parameter was purely based on the number of times that the machine was shut down for repair or maintenance in CY96, and was independent of whether or not venting was carried out. The typical period of time after the accelerator was shut down till the opening of the housing for entries in CY96 was about one hour for each of the beam loss areas. These beam loss area-specific decay times were used to calculate the remaining inventory of radioactive gases prior to release.

Each release point was conservatively modeled as a single point source with a stack height of 0.0 meter and a diameter of 0.0 meter. The distances in meters (feet) from each single release point to the respective nearest receptors were specifically noted. The dose assessment model consisted of two parts:

1. Individual source term releases, which took into account the closest receptor and contributions from all other sources to that receptor in order to find the appropriate or "real" Maximally Exposed Individual (MEI).
2. A collective source term release, which was used to determine a collective Effective Dose Equivalent (EDE) to the surrounding population, out to 80 km.

Part 1 of the assessment model included determining where the closest and highest exposed individual resides for each source term and adding the dose contributions from all the other source terms to that individual. This calculation was carried out for each of the eight source terms separately since a point source model of release from the collective sources at SLAC was inappropriate for the nearest receptors. The MEI from each source term (with the appropriate contributions from the other source terms) was compared and the highest of these was considered the MEI for SLAC.

Included as attachments are the Synopsis Report and the Dose and Risk Equivalent Summaries generated by CAP88-PC for each of the source terms: Accelerator Housing (Linac96), Positron Source (PV96), SLC Beam Dumps (SLC96), Beam Switchyard (BSY96), SLC Damping Rings (DR96), SSRL (SSRL96), and FFTB (FFTB96).

Determination of the MEI resulted in locating that individual at the Addison Wesley Publishers Building on the north side of the SLAC facility. Details of this evaluation can be found in Table 12.

Part 2 of the assessment model utilized the radial population grid (shown in Table 13) to calculate the collective dose in person-rem to the surrounding population out to 80 km. In this case, the source term was modeled as the eight sources taken as a point source to the population. The point source model was appropriate for the collective EDE calculations at distances out to 80 km.

An estimate of the population residing within 80 km of SLAC was made using 1990 census data. An area defined by a circle of 80 km radius around the center of SLAC (Sector 30) was further divided into 16 equal sectors, with segments formed by the intersection of the sectors and a total of 13 radial distances of 0.1, 0.3, 0.5, 1.0, 2.0, 4.0, 6.0, 8.0, 10.0, 30.0, 40.0, 60.0, and 80.0 km. The population within each segment was derived by multiplying the segment area by the population density of the appropriate city/cities. Unpopulated areas, that is, mountains and pastures were also taken into account in this population study.

Since SLAC does not have a qualified weather station, meteorological input data for CY96 were based on the averaged data provided for San Francisco Airport (SFO) which most closely represented the local conditions at SLAC. In addition, previous parametric studies have shown that meteorological data did not significantly affect the final results and the use of SFO meteorological data in CAP88-PC yielded a reasonably conservative results for both the MEI and the collective EDE.

Included in this report are the following attachments for this population assessment case (SLAC 96): General Data, Dose and Risk Equivalent Summaries, Weather Data, and the Dose and Risk Conversion Factors.

Table 12 Determination of Maximally Exposed Individual

Source		Contributors	Location	EDE (mrem/yr)	Total (mrem/yr)
1	Beam Dumps		274m NE	4.2E-04	
		SSRL	792m ENE	5.8E-07	
		BSY	1097m NE	6.4E-06	
		LINAC	1372m ENE	1.1E-05	
		Positron Vault	2195m E	3.3E-05	
		Damping Rings	3962m E	1.8E-07	
		FFTB	852m ENE	7.7E-09	
		ESA	822m ENE	0.0E-00	
					4.71E-04
2	SSRL		427m N	3.9E-06	
		Dumps	731m NW	5.6E-05	
		BSY	640m NNE	2.1E-05	
		LINAC	792m NE	2.6E-05	
		Positron Vault	1554m NE	2.4E-05	
		Damping Rings	3353m ENE	1.2E-07	
		FFTB	487m N	4.9E-08	
		ESA	457m N	0.0E-00	
					1.31E-04
3	BSY		457m NNW	5.0E-05	
		SSRL	640m NW	7.4E-07	
		Dumps	1280m WNW	1.1E-05	
		LINAC	366m NNW	1.6E-04	
		Positron Vault	640m NE	1.6E-04	
		Damping Rings	2743m ENE	1.8E-07	
		FFTB	700m NW	9.9E-09	
		ESA	670m NW	0.0E-00	
					3.82E-04
4	Linac		305m N	4.8E-04	
		BSY	457m NW	4.6E-05	
		SSRL	640m WNW	4.5E-07	
		Dumps	1280m WNW	1.1E-05	
		Positron Vault	792m NE	9.9E-05	
		Damping Rings	2438m ENE	2.3E-07	
		FFTB	700m WNW	6.2E-09	
		ESA	670m WNW	0.0E-00	
					6.37E-04

* Location is defined as the distance and direction from the source to the closest and highest dose individual.

Table 12 (continued) Determination of Maximally Exposed Individual

	Source	Contributors	Location	EDE (mrem/yr)	Total (mrem/yr)
5	Positron Vault		640m NNE	1.6E-04	
		LINAC	731m NNW	3.6E-05	
		BSY	914m NW	1.0E-05	
		SSRL	1097m NW	2.3E-07	
		Dumps	1676m NW	9.4E-06	
		Damping Rings	2195m NE	2.1E-07	
		FFTB	1157m NW	3.1E-09	
		ESA	1127m NW	0.0E-00	
					2.16E-04
6	Damping Rings		274m WNW	8.0E-06	
		Positron Vault	2195m W	5.6E-06	
		LINAC	2743m W	8.9E-07	
		BSY	3048m W	3.5E-07	
		SSRL	3353m W	1.0E-08	
		Dumps	3962m W	6.7E-07	
		FFTB	3353m W	1.3E-10	
		ESA	3353m W	0.0E-00	
					1.55E-05
7	FFTB		487m N	4.9E-08	
		Damping Rings	3353m ENE	1.2E-07	
		Positron Vault	1554m NE	2.4E-05	
		LINAC	792m NE	2.6E-05	
		BSY	640m NNE	2.1E-05	
		SSRL	427m N	3.9E-06	
		Dumps	731m NW	5.6E-05	
		ESA	457m N	0.0E-00	
					1.31E-04
8	ESA		457m N	0.0E-00	
		Damping Rings	3353m ENE	1.2E-07	
		Positron Vault	1554m NE	2.4E-05	
		LINAC	792m NE	2.6E-05	
		BSY	640m NNE	2.1E-05	
		SSRL	427m N	3.9E-06	
		Dumps	731m NW	5.6E-05	
		FFTB	487m N	4.9E-08	
					1.31E-04

* Location is defined as the distance and direction from the source to the closest and highest dose individual.

3.2 POPULATION DATA

Table 13 Radial Population Data for CAP88-PC

Direction	0.1 km	0.3 km	0.5 km	1.0 km	2.0 km	4.0 km	6.0 km	8.0 km	10.0 km	30.0 km	40.0 km	60.0 km	80.0 km	Total
N	0	0	125	403	1100	1331	4103	23994	18447	28176	0	330284	321492	729455
NNW	0	0	126	403	1292	1696	4956	21485	19690	127166	96225	816270	184076	1273385
NW	0	0	127	403	1292	1231	1803	2671	2617	25645	18835	0	0	54624
WNW	0	0	127	403	1289	910	650	503	503	13312	3002	0	0	20699
W	0	0	125	379	149	793	650	0	0	100	0	0	0	2196
WSW	0	0	12	0	0	715	520	503	0	120	0	0	0	1870
SW	0	0	12	0	0	242	668	210	0	420	0	0	0	1552
SSW	0	0	12	0	0	417	690	0	420	0	0	0	0	1539
S	0	0	12	0	1195	1529	913	1118	5590	0	6725	37754	24520	79356
SSE	0	0	12	0	1195	1529	3579	1878	3006	28061	27357	24520	58692	149829
SE	0	0	12	0	896	1195	2020	1878	10521	100380	270722	10171	25641	423436
ESE	0	0	12	0	896	598	4855	17926	25498	130550	391124	234674	0	806133
E	0	0	125	0	1195	5976	4855	22360	11180	50686	156449	0	0	252826
ENE	0	0	125	40	1322	5976	5174	15870	4690	107196	69336	78923	28370	317022
NE	0	0	125	391	869	4944	3773	8669	5608	53762	22300	23229	0	123670
NNE	0	0	125	403	1416	2597	3623	12564	6607	0	170278	160746	321492	679851
TOTAL:	0	0	1214	2825	14106	31679	42832	131629	114377	665574	1232353	1716571	964283	4917443

- SEE ATTACHMENTS FOR OTHER INPUT PARAMETERS

3.2 Compliance Assessment

This assessment of the potential radioactivity released is based on calculations of the activity produced and other conservative assumptions as stated in Section 3.1, Description of the Dose Model. This compliance assessment used the computer code CAP88-PC Version 1.0 to calculate the dose for CY96.

Maximally Exposed Individual Effective Dose Equivalent:	6.37E-04 mrem/year (6.37E-06 mSv/year)
Location of Maximally Exposed Individual:	305 meters North (Addison Wesley)

3.3 Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein, and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. (See 18 U.S.C. 1001.)

Kenneth R. Kase
SLAC Facility Manager

SIGNATURE ON ORIGINAL DOCUMENT — 6/15/97
Signature — **Date**

John S. Muhlestein
DOE Stanford Site Office Director

SIGNATURE ON ORIGINAL DOCUMENT — 6/16/97
Signature — **Date**

4 Additional Information

- SLAC did not have any new/completed construction projects nor modifications during CY96. SLAC is currently upgrading the existing Positron Electron Project (PEP) collider to an Asymmetric B Factory (PEP-II) for high energy physics research. The purpose of the proposed PEP-II project is to collide beams of electrons and positrons of different energy to produce abundant pairs of subatomic particles known as B mesons. The production of radioactive gases during the operation of the proposed PEP-II have been estimated and found to be insignificant. Prior EPA approval for facility construction and/or modification associated with the PEP-II project will not be necessary since all radioactive gas source terms at SLAC still contribute less than 1.0% of the 10 mrem/year (0.1 mSv/year) NESHAP's limit.
- There were no unplanned releases of radionuclides to the atmosphere during CY96.
- There were no known diffuse emissions at SLAC .

4.1 Supplemental Information:

- During CY96, the collective effective dose equivalent for the population within 80 km from SLAC 's site boundary (4,917,443 persons) was estimated to be 4.85 x 10-3 person-rem (4.85 x 10-5 person-Sv).
- The reported source terms in the NESHAP's report for CY96 included all unmonitored sources that were identified at SLAC.
- Compliance with Subparts Q and T of 40 CFR Part 61 was not applicable at SLAC.
- Information on Rn-220 emissions from sources containing U-232 and Th-232 where emissions potentially could exceed 0.1 mrem in one year to the public or 10% of the non-radon dose to the public was not applicable at SLAC .
- Information on non-disposal/non-storage sources of Rn-222 emissions where emissions potentially could exceed 0.1 mrem in one year to the public or 10% of the non-radon dose to the public was not applicable at SLAC .
- SLAC did not have any emission points that contributed to more than 1% of the 10 mrem in one year (0.1 mSv in one year) NESHAP's limit. Thus, continuous monitoring of these emission points was not required.

C Calibration and Quality Assurance Procedures

The recording of natural background radiation provides continuous verification that SLAC's monitoring equipment is connected and functioning properly. Also, backgrounds collected during accelerator downtimes and any interrupted operations provide additional information for establishing the calibration baseline.

C.1 Direct Radiation Monitoring Equipment

A regular calibration procedure was performed on the PMSs in CY96. Radiation sources were placed at a measured distance from the detector to produce a known dose equivalent rate, for example, 1 mrem/h (0.01 mSv/h).

The equipment is kept in normal operation during these checks. The data printout is marked so that the calibration data is not confused with actual measurements of machine-produced radiation. This procedure will be carried out at least once each year, and following any equipment repair or maintenance actions.

An appropriate response to natural background radiation provides evidence that the instruments are operating properly. The calibration procedure was not performed in CY96. An improved calibration program is under development.

C.2 Liquid Radiological Effluents

Water samples are analyzed in-house with a liquid scintillation counter (LSC) and a hyper-pure germanium (HPGe) detector as necessary. Both pieces of equipment are calibrated with appropriate National Institute of Standards and Technology (NIST) traceable sources.

D Environmental TLD Measurements for CY96

The following appendix contains data on environmental TLD measurements for CY96. It includes:

- Summary of net photon and neutron doses for CY96.
- Environmental TLD Monitoring Stations (Table D-1).

Notes:

TLD Type	Nominal Minimum Detectable Levels	Type of Radiation Detected
Al_2O_3:C (LDR-X9 Landauer Company)	0.1 mrem	Gamma
NeutrakER (LDR-I9 Landauer Company)	10 mrem	Neutron

D-1 Net Annual Doses for CY96

TLD Location	TLD #	Net Photon Dose (mrem)	Net Neutron Dose (mrem)
Transport Control	—	NA	M[a]
Deployment Control	—	NA	M[a]
SB at Region 6	1	2.2 +/- 6.8	M[a]
SB at Injector	2	2.7 +/- 6.1	M[a]
Computer Center SE Corner	3	1.6 +/- 6.1	M[a]
SB at Region 4	4	5.3 +/- 6.0	M[a]
SB at North Damping Ring	5	21.2 +/- 6.1	M[a]
I-280 Overpass South	6	9.1 +/- 6.2	M[a]
SB at Sector 10 south	7	5.3 +/- 7.4	M[a]
SB across from B of A	8	10.6 +/- 6.5	M[a]
Alpine Gatehouse	9	1.5 +/- 6.2	M[a]
Meteorological Tower	10	1.9 +/- 6.4	M[a]
SB at SLD	11	4.9 +/- 6.0	M[a]
SB at Region 12	12	8.7 +/- 5.9	M[a]
SB at Region 2	13	-2.9 +/- 7.4	M[a]
SLAC Entrance Gatehouse	14	5.1 +/- 7.0	M[a]
SLAC Cafeteria	15	4.1 +/- 5.8	M[a]
SB at Region 8	16	-2.0 +/- 6.2	M[a]
SB at Addison Wesley Building	17	5.5 +/- 6.1	M[a]
SB at Positron Vault	18	7.3 +/- 5.8	M[a]
Control	19	9.5 +/- 6.0	M[a]
SB at Sector 20 south	20	11.5 +/- 6.5	M[a]
SB at South Damping Ring	21	4.3 +/- 6.8	M[a]
I-280 Overpass North	22	20.3 +/- 6.4	M[a]
SB at Sector 21 south	23	11.4 +/- 5.9	M[a]
OHP Department Head Office	24	12.2 +/- 6.4	M[a]
PMS 1	26	11.1 +/- 6.2	M[a]
PMS 2	27	1.2 +/- 5.9	M[a]
PMS 3	28	5.8 +/- 5.9	M[a]
PMS 4	29	1.9 +/- 6.1	M[a]
PMS 5	30	3.1 +/- 6.0	M[a]
PMS 6	31	15.1 +/- 6.3	M[a]
PMS 7	32	8.1 +/- 5.8	M[a]
SB at Sector 24 north	33	27.0 +/- 5.9	M[a]
SB at Sector 17 north	34	9.3 +/- 5.9	M[a]
SB at Sector 5 north	35	17.2 +/- 6.0	M[a]

[a] Below the minimum detection limit.

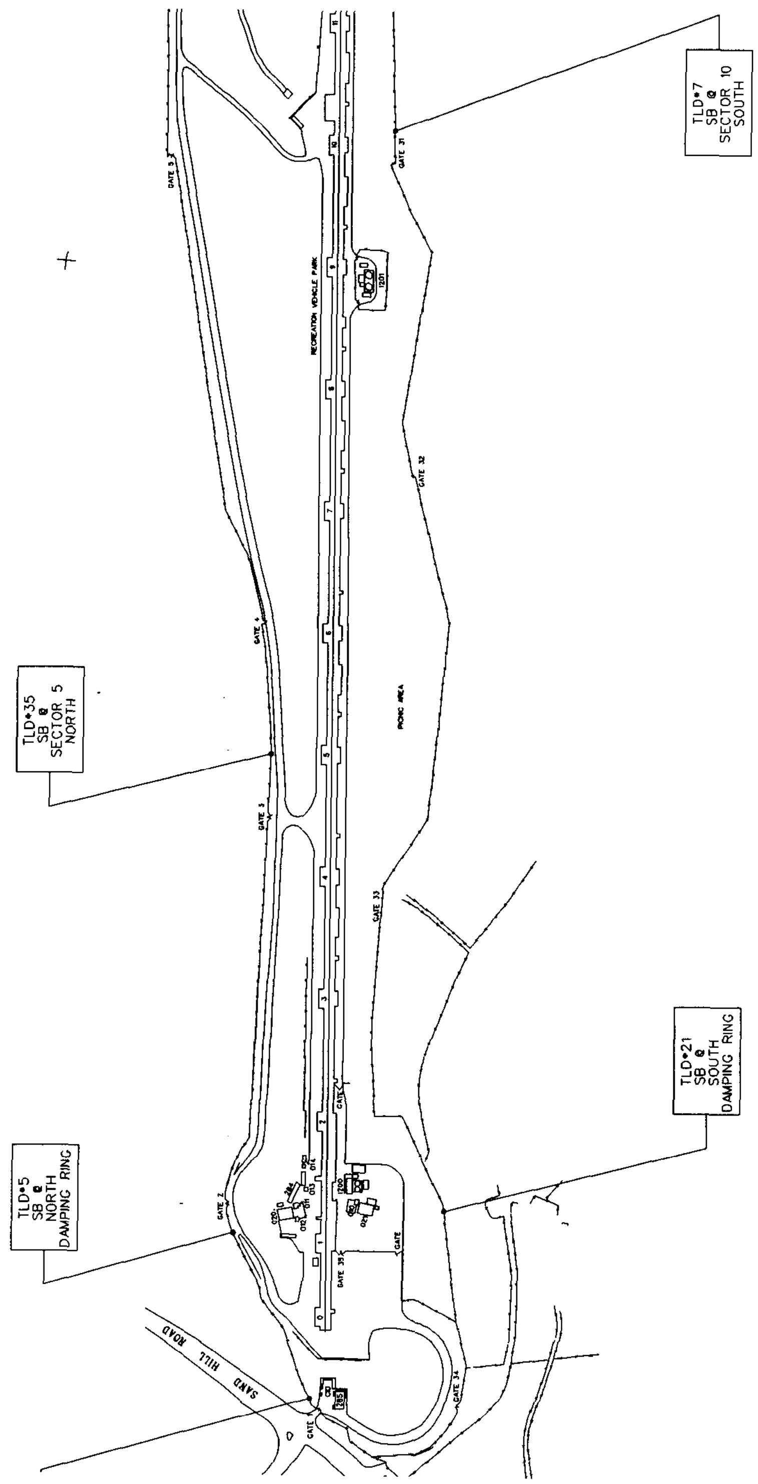


Figure D-1 Environmental TLD Monitoring Stations, Sectors 0 through 12

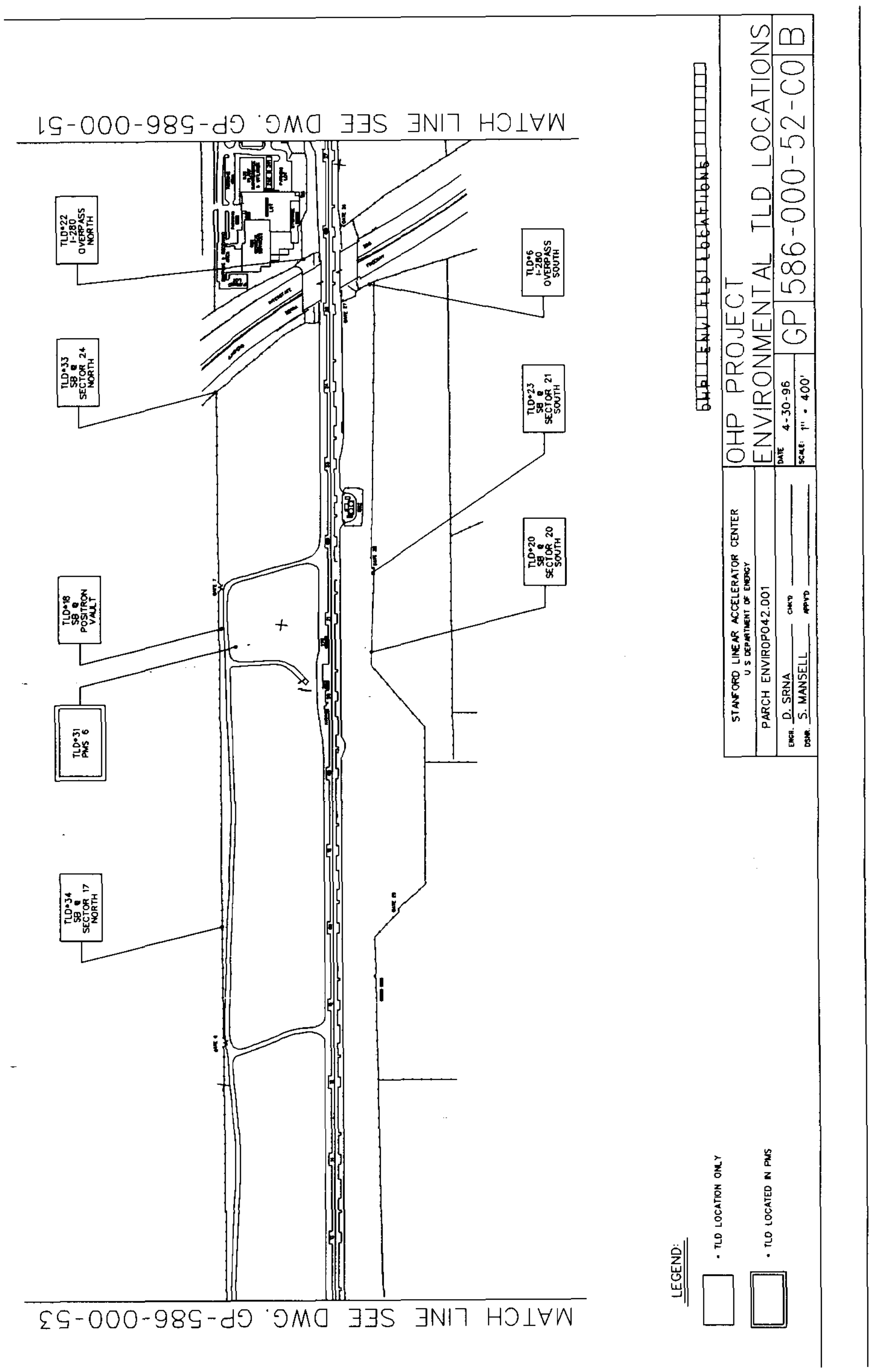


Figure D-2 Environmental TLD Monitoring Stations, Sectors 12 through 27

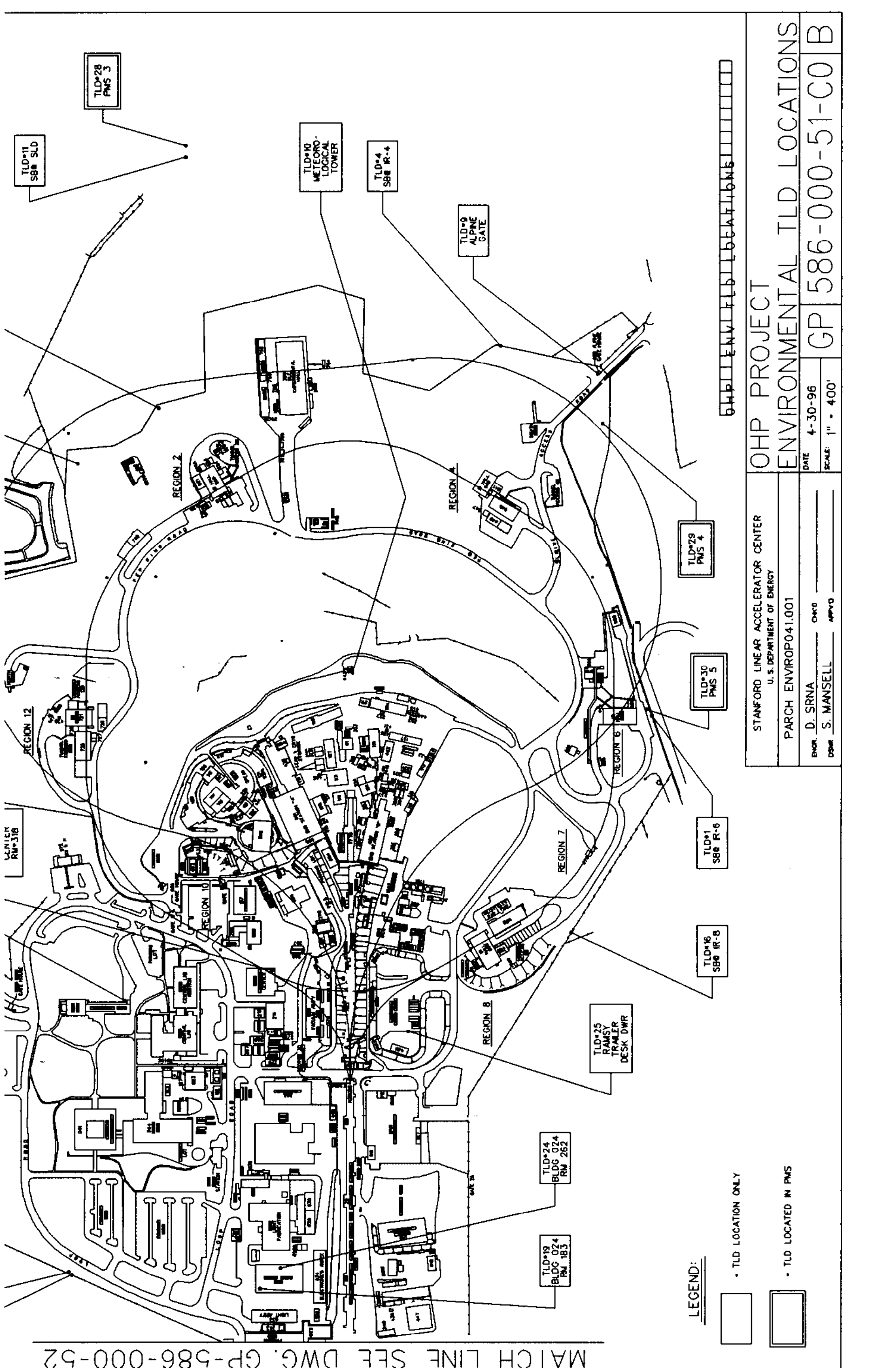


Figure D-3 Environmental TLD Monitoring Stations, Sector 27 through SLC

E Acronym List

A

AIP	Agreement In Principle
ALARA	As Low As Reasonably Achievable

B

BAAQMD	Bay Area Air Quality Management District
BDE	Beam Dump East
BMP	Best Management Practice
BPO	Basin Plan Objective
BSY	Beam Switchyard

C

CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CPM	Counts Per Minute
CRMP	Comprehensive Resource Management and Planning
CWA	Clean Water Act
CX	Categorical Exclusion
CY	Calendar Year

D

DCA	Dichloroethane
DCE	Dichloroethene
DCG	Derived Concentration Guide
DOE	Department of Energy
DOE/OAK	DOE Operations Office, Oakland, CA

E

EA	Environmental Assessment
EC	Electrical Conductivity
EDE	Effective Dose Equivalent

E

EECA	Engineering Evaluation and Cost Analysis
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPR	Environmental Protection and Restoration
ERP	Environmental Restoration Program
ES&H	Environment, Safety, and Health
ESA	End Station A
ESA	Endangered Species Act
ESHCC	Environment, Safety, and Health Coordinating Council

F

FEMA	Federal Emergency Management Agency
FFS	Final Focus System
FFTB	Final Focus Test Beam
FHWSY	Former Hazardous Waste Storage Yard
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FMS	Flow Meter Station
FUST	Former Underground Storage Tank

G

GPMP	Groundwater Protection Management Program
GPP	General Plant Project

H

HMBP	Hazardous Materials Business Plan
HPGe	Hyper-pure Germanium
HWMC	Hazardous Waste and Material Coordinator
HWMG	Hazardous Waste Management Group

I

IR	Interaction Region
IRA	Interim Removal Action

K

kWh	kilowatt-hour

L

LA	Local Authority
LCW	Low Conductivity Water
linac	Linear Accelerator
LSC	Liquid Scintillation Counter

M

MCC	Main Control Center
MCL	Maximum Concentration Level
MCL	Maximum Contaminant Level
MEI	Maximally Exposed Individual
MFD	Mechanical Fabrication Department
MPMWD	Menlo Park Municipal Water Department
MW	mega-watt

N

NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
NOI	Notice of Intent
NO_X	Nitrogen Oxides
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NVLAP	National Voluntary Laboratory Accreditation Program

O

ODS	Ozone-Depleting Substance
OHP	Operational Health Physics

P

PCB	Polychlorinated Biphenyl
pCi/l	Pico-curies per Liter
PED	Plant Engineering Department
PEL	Physical Electronics Laboratory
PEP	Positron-Electron Project
PEP-II	Asymmetric B Factory
PMS	Peripheral Monitoring Station
POTW	Publicly Owned Treatment Work

P

PPO	Program Planning Office
PS	Positron Source

Q

QA	Quality Assurance
QC	Quality Control

R

RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RP	Radiation Physics
RQ	Reportable Quantity
RWQCB	Regional Water Quality Control Board
RWTP	Rinse Water Treatment Plant

S

SARA	Superfund Amendments and Reauthorization Act
SBSA	South Bayside System Authority
SDWA	Safe Drinking Water Act
SER	Site Environmental Report
SHA	Safety, Health, and Assurance
SLAC	Stanford Linear Accelerator Center
SLC	Stanford Linear Collider
SPCCP	Spill Prevention, Control, and Countermeasure Plan
SPEAR	Stanford Positron Electron Asymmetric Ring
SSRL	Stanford Synchrotron Radiation Laboratory
Sv	Sievert
SWPPP	Storm Water Pollution Prevention Plan

T

TCA	Trichloroethane
TCE	Trichloroethene
TDS	Total Dissolved Solid
TLD	Thermoluminescent Dosimeter
TPH	Total Petroleum Hydrocarbons
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act
TSDF	Treatment, Storage, and Disposal Facility

T

TSS	Total Suspended Solids
TTO	Total Toxic Organics

V

VOC	Volatile Organic Compound

W

WAA	Waste Accumulation Area
WBSD	West Bay Sanitary District
WM	Waste Management
WTS	Waste Tracking System

F SER Distribution List

Bill Griffing
Head,
Environment, Safety, and Health Section
Fermi National Accelerator Laboratory MS 119
P.O. Box 500
Batavia, IL 60510

District Manager
West Bay Sanitary District
500 Laurel Street
Menlo Park, CA 94025

Rebecca Failor
Environmental Monitoring Program Leader
L-629
P.O. Box 808
Lawrence Livermore National Laboratory
Livermore, CA 94550

Paul Frame
PTP/TMSD
ORISE
PO Box 117
Oak Ridge, TN 37830

Steve Hsu
State of California
Department of Health Services
Radiological Health Branch
P.O. Box 942732
Sacramento, CA 95634-7320

Ted Hull
Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA 94109

Bill Klokke
South Bayside System Authority
1400 Radio Road
Redwood City, CA 94065

Leslie Laudon
State Water Resources Control Board
Division of Clean Water Programs
P.O. Box 94412
Sacramento, CA 95834-2120

W. Lent
San Mateo Department of Health Services
Office of Environmental Health
County Office Building
590 Hamilton Street
Redwood City, CA 94063

Librarian
Oakridge National Laboratory
Technical Information Center
Oakridge, TN 37830

Felicia Marcus
U.S. Environmental Protection Agency
Region IX
75 Hawthorne
San Francisco, CA 94105

Bob May
TJNAL/SURA Radiation Control Group
Mail Stop 12 A 1
12000 Jefferson Avenue
Newport News, VA 23606

John Muhlestein
U.S. Department of Energy
Oakland Operations Office
Stanford Site Office
Stanford Linear Accelerator Center
P.O. Box 4349 M/S 8A
Stanford, CA 94309

John B. Murphy
Oak Ridge National Laboratory
Building 4500N, MS 6198
Oak Ridge, TN 37831

Charles NeSmith
State Water Resources Control Board
Division of Clean Water Programs
Solid Waste Assessment Test Unit
P.O. Box 944212
Sacramento, CA 94244-2120

James Nusrala
California Regional Water Quality Control Board
San Francisco Bay Region
2101 Webster Street, Suite 500
Oakland, CA 94612

OSTI
U.S. Department of Energy Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, Tennessee 37831

Steve Richie
California Regional Water Quality Control Board
San Francisco Bay Region
1111 Jackson Street
Oakland, CA 94612

Steve Richie
California Regional Water Quality Control Board
San Francisco Bay Region
2101 Webster Street, Suite 500
Oakland, CA 94612

Phil Rutherford, Manager
Radiation Protection & Health Physics Services
Rocketdyne Division
Rockwell International Corporation
6633 Canoga Ave.
P. O. Box 7922 (MS T100)
Canoga Park, CA 91309-7922