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1994 Site Environmental Report

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Lawrence Berkeley Laboratory

1994 Site Environmental Report

May 1995

Prepared for the U.S. Department of Energy Under Contract Number DE-AC03-76SF000

DISCLAIMER

Site Environmental Report
Reader Survey

To Our Readers:

Each annual Site Environmental Report publishes the results of environmental monitoring at the Lawrence Berkeley Laboratory and documents our compliance with federal, state, and local environmental regulations. In providing this information, our goal is to give our readership—whether they be regulators, scientists, or the public—a clear accounting of the range of environmental activities we undertake, the methods we employ, the degree of accuracy of our results, the status of our program, and significant issues affecting programs.

It is important that the information we provide is easily understood, of interest, and communicates LBL's effort to protect human health and minimize our impact on the environment. We would like to know from you whether we are successful in achieving these goals. Your comments are appreciated.

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Acknowledgements

The 1994 Site Environmental Report for Lawrence Berkeley Laboratory (LBL) is prepared for the U.S. Department of Energy (DOE) under the requirements of DOE Order 5400.1. The report is intended to present the status of LBL's compliance programs and environmental surveillance activities, as well as an assessment of the impacts of LBL's operations on the environment for calendar year 1994. The report uses the International System of Units (SI) as the primary means of presenting data.

The report was prepared under the direction of Patrick Thorson of the Environmental Protection Group. The primary authors of the report listed by section of responsibility include:

Iraj Javandel	Groundwater Protection
Ginny Lackner	Introduction, Environmental Nonradiological Program Information
Patrick Thorson	Compliance Summary, Environmental Program Information, Quality Assurance
Henry Tran	Environmental Radiological Program Information

Contributors of information on Environment, Health, and Safety programs include David Balgobin, Blythe Buetzow, Li-Yang Chang, Paul Davis, Thom Davis, Jim Floyd, Robert Fox, Nancy Humphrey, Susan Kelly, Gale Moline, Ron Pauer, Doug Roaldson, Jack Salazar, Brian Smith, Charles Smith, Jackie Thomas, Tim Wan, and Shelley Worsham. Contributors from other LBL programs include Irene Kan and Carol Keilusiak. Production of the report was handled by Steve Wyrick, with assistance from Doug Finley, Sharon Harris, and Una Thornton. Report editing was performed by Rich Albert.

Environmental monitoring and sampling data represent an important element for determining the impact of LBL operations on the environment. David Balgobin, Tom Donovan, Vic Montoya, and Randy Yow were responsible for designing, coordinating, collecting, and maintaining LBL's environmental monitoring and sampling programs. Angela Davi, Tanya Ebermann, and David Yaeger analyzed the samples collected. Finally, Jean Marie Walker and Steve Wyrick managed the variety of data collected by the environmental surveillance program.

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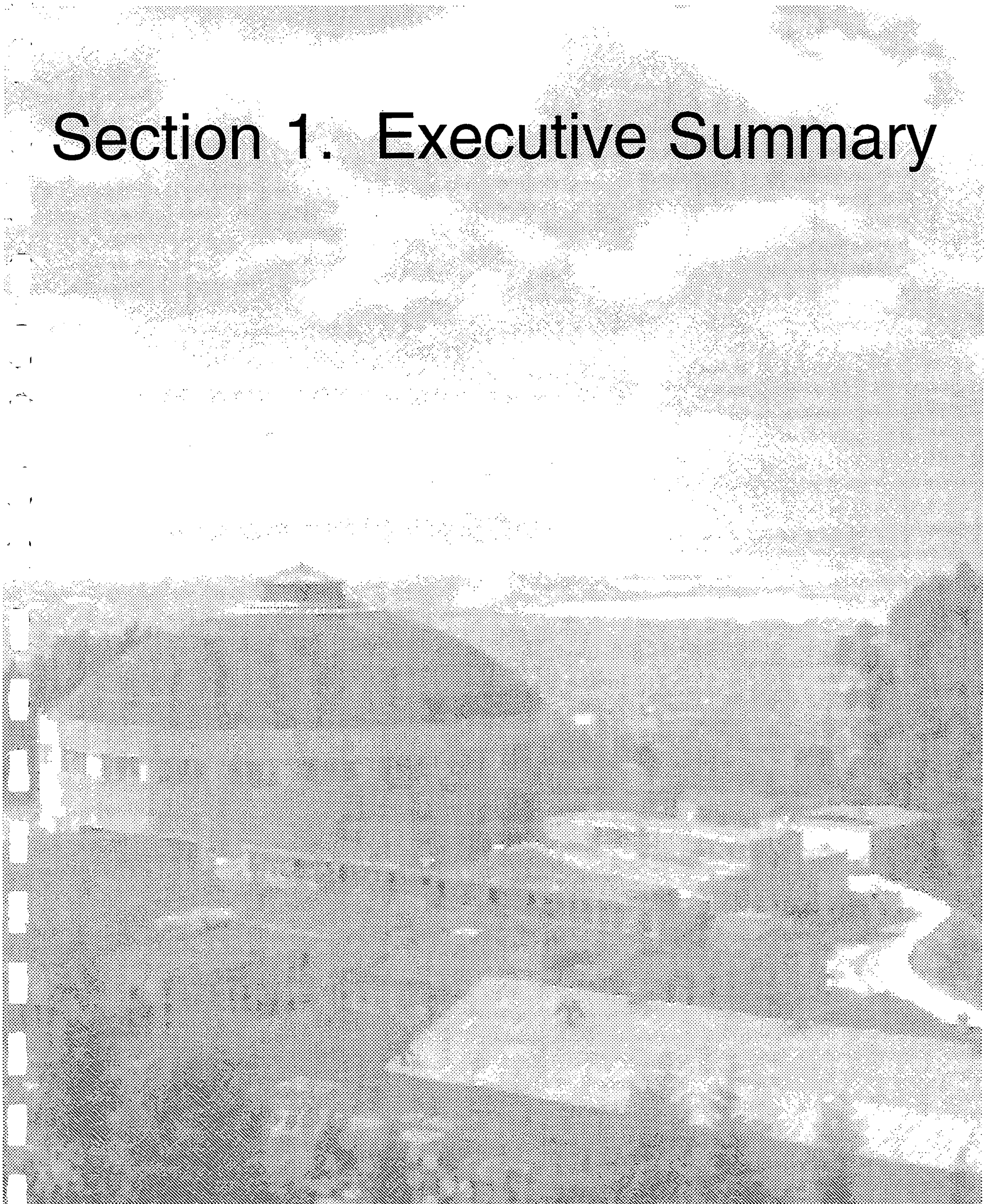
Section 1. Executive Summary



Introduction and Purpose

The 1994 Site Environmental Report summarizes environmental activities at Lawrence Berkeley Laboratory (LBL) for the calendar year (CY) 1994. The report strives to present environmental data in a manner that characterizes the performance and compliance status of the Laboratory's environmental management programs when measured against regulatory standards and DOE requirements. The report also discusses significant highlight and planning efforts of these programs. The format and content of the report are consistent with the requirements of the U.S. Department of Energy (DOE) Order 5400.1, *General Environmental Protection Program.*

For more than 60 years, the Laboratory has maintained a strong tradition of outstanding research. Since its early years as a particle physics accelerator facility, LBL has evolved into a multiprogram institution that pursues research in additional areas such as chemistry, the biosciences, environmental and earth sciences, advanced materials, and energy resources and energy efficiency. LBL has an infrastructure of operational divisions designed to provide the needed assistance in support of the Laboratory's primary livelihood. While conducting research in a highly competitive environment challenged by an ever-changing climate of national scientific priorities, LBL is committed to conducting activities "with full regard for the environment, health, and safety."

Environmental Compliance Programs

The Environment Department of LBL's Environment, Health, and Safety Division is responsible for overseeing environmental compliance activities at the Laboratory. The Environment Department is structured into three groups: Environmental Protection, Environmental Restoration, and Waste Management. Programs within these groups are designed to provide integrated, full service environmental compliance support to the LBL community. Areas of environmental compliance include air quality, water quality, hazardous materials, hazardous waste, waste minimization, pollution prevention, and soil and groundwater characterization and remediation. The group of compliance services offered by the department include regulatory compliance oversight (standards of operation), permitting, audits and inspections, regulatory liaison, training, reporting, corrective action, environmental monitoring and sampling, spills and accidental releases, and program planning. Section 4, *Environmental Program Information*, contains a breakdown of responsibilities by groups.

As the Laboratory's environmental compliance programs have adjusted to the increased demands of environmental regulations in recent years, there are several programmatic accomplishments worth recognizing. The DOE EH-24 audit in November summarized the quality of LBL's environmental programs by the notable lack of any serious findings or observations in their report, and furthermore, by identifying three areas of strength:

- Staff dedication
- External communication
- Air monitoring systems

A few of the individual program highlights not mentioned elsewhere in this Executive Summary are included here. The Laboratory has established an aggressive program for eliminating or reducing its ozone-depleting substance (ODS) usage in solvent cleaning, packaging materials, refrigeration and air conditioning, and fire suppression operations in anticipation of the pending regulatory deadline that prohibits certain ODS production after 1995. The LBL program has been in effect several years and involves cooperation and integration among EH&S, Facilities, and Engineering staff. In November, EH&S expanded the program's scope by issuing an ODS buying policy and guidelines meant to inform buyers of the phase-out requirements and the acceptable alternatives. LBL has already reduced its Class I ODS inventory by almost 37 percent from the 1990 baseline inventory, with additional projects underway that should significantly add to this reduction.

LBL continued to refine its waste minimization and pollution prevention programs in 1994. The Laboratory's sitewide program focuses on issues such as employee awareness, solid waste recycling, and conscientious procurement practices. Waste reduction efforts at the LBL Hazardous Waste Handling Facility continued, including operating the Chemical Exchange Program and providing input into the Laboratory's solid waste contract to require higher levels of recycling. LBL's waste reduction goal for 1994 for acids, coolants, and contaminated solids was 4%. Actual reductions were 76%, 61%, and 28%, respectively.

The Agreement in Principle (AIP) program between DOE and the State of California continued in 1994. This program provided environmental oversight, review of monitoring programs, and other initiatives to ensure compliance with applicable regulations at LBL and five other DOE facilities in California. The State Department of Health Services (DHS) remained the lead agency, with the State Water Resources Control Board (SWRCB) also involved because of stormwater interests. DHS installed thermoluminescent dosimeters (TLDs) at seven sites at or near LBL in 1993. The TLDs are located adjacent to LBL monitoring instrumentation and are changed quarterly. Preliminary data from 1993 were presented by the State at a meeting in October that included DOE and the Laboratory. The State's TLD data, presented in their 1993 annual report, compare well with the data derived from LBL's network of TLD monitors. While the State and LBL used different types of TLD devices, the TLD results indicated that exposure levels were statistically indistinguishable from background. The State AIP program became interested and involved in LBL's stormwater monitoring program in 1994. The SWRCB began a project to install monitoring equipment at four new stations around LBL. Although the locations will be new, the parameters collected by the State will be identical to those gathered by LBL. The SWRCB conducted a site investigation in June to select the monitoring sites. The project is still in the design stage with no date set to begin the installations.

Environmental Permitting

LBL has environmental operating permits issued by regulatory agencies for air emissions, hazardous waste handling and treatment operations, stormwater and wastewater discharges, and underground storage tanks. Section 3, *Compliance Summary*, describes each of these permitted activities in greater detail.

The Bay Area Air Quality Management District (BAAQMD) issues operating permits for stationary sources of air pollutant emissions. These permits are renewed each year. LBL renewed 38 operating permits for various facility-wide activities in 1994. Near the end of the year, one of these sources was removed from operation. There were no new sources permitted in 1994. The Laboratory also has 76 minor sources listed with BAAQMD under registered-exempt status. LBL's operating permits cover a wide range of equipment and operations, such as gasoline dispensing, surface coating (painting, epoxy mixing, and vacuum coating), surface preparation and cleaning (sandblasting and solvent cleaning), and semiconductor research, as well as abatement equipment to control emissions from lead pot melting, material machining, and sulfur hexafluoride discharges.

LBL's Hazardous Waste Handling Facility (HWHF) operates under a full Resource Conservation and Recovery Act (RCRA) permit issued by the California Environmental Protection Agency's (Cal/EPA) Department of Toxic Substances Control (DTSC) for the U.S. Environmental Protection Agency (US/EPA). The permit for both the existing and proposed replacement HWHF was issued in 1993 and is valid until 2003. LBL requested a modification to the permit in March, which was approved by DTSC in July.

LBL has five fixed treatment units (FTUs) located around the facility; these units require less than a full RCRA permit under the State's Tiered Permitting program for hazardous waste treatment and storage units. The Laboratory's FTUs are designed to treat inorganic acids, aqueous waste containing metals and inorganic acids, and oil mixed with water. These units were permitted by DTSC in 1993 during the first year of this program. This permit is renewed annually. LBL began design effort on a new FTU planned for wastewater from an ultra high vacuum cleaning facility. This unit is expected to come on line in 1996.

Water discharges are categorized as either stormwater or wastewater. LBL's stormwater runoff is authorized under a general State permit issued by the State Water Resources Control Board for the entire site, and enforced by the Regional Water Quality Control Board (RWQCB) and the City of Berkeley (COB). As required by the permit, LBL implemented a *Storm Water Pollution Prevention Plan* and a *Storm Water Monitoring Program.* These documents represent LBL's plan and procedures for identifying, monitoring, and preventing contamination in its stormwater discharges.

Discharge limits for wastewater effluent at LBL are established under a permit program administered by the East Bay Municipal Utility District (EBMUD). LBL maintains three separate EBMUD wastewater permits: one general site-wide permit, and two source-specific permits for treatment units at metal finishing operations in Building 25 and Building 77. These permits are renewed annually. LBL's compliance record of no exceedances of the permitted discharge limits in 1993 and 1994 resulted in EBMUD decreasing the site's monitoring and reporting requirements compared to previous years.

Permits for LBL's underground storage tanks (USTs) are issued by COB. At the end of 1994, there were ten permitted USTs containing diesel, gasoline, or transformer oil. The Laboratory removed three permitted tanks during the course of the year. All remaining tanks meet the State's requirements for leak protection and monitoring. Seven of the USTs are double-walled tanks. Three tanks have only single-wall design and will be upgraded to meet new regulatory standards set for December 1998.

Violations and Findings

Notices of Violations (NOV) and findings are most often associated with inspections. Numerous audits and inspections of LBL's environmental programs were conducted during 1994 by regulatory agencies, as well as various organizational units of DOE. Agencies performing inspections this past year included BAAQMD, COB, DHS, DOT, and US/EPA. Table 3-1 contains a detailed list of environmental audits and inspections of the Laboratory for the year, with additional information on each inspection elsewhere in Section 3, *Compliance Summary.*

BAAQMD conducted three inspections of air emissions activities in 1994. The first visit occurred in January with the objective of performing an initial inspection of 15 newly permitted sources. This agency returned in June to inspect an asbestos renovation project for which LBL had submitted the required notification form. BAAQMD then returned in November to confirm that a permitted source had been removed from operation. No violations were issued for any of the three inspections.

EBMUD also did not issue any NOVs to LBL in 1994 for exceeding any of its permitted wastewater discharge limits. However, the Laboratory did have one accidental discharge in September that led to a violation follow-up fee of $300. The fee request was issued by EBMUD for the administrative action of LBL's failure to notify the agency of the discharge immediately. This incident is discussed in the *Environmental Incidents* section below.

In March and April 1995, LBL detected a series of methylene chloride exceedances at its Strawberry sanitary sewer monitoring station. Working cooperatively with the University of California at Berkeley, since both facilities discharge into this system and each facility has an inventory of methylene chloride, an investigation into the cause of this incident began. LBL and UCB have also worked closely with EBMUD while attempting to identify and correct the problem. As of this report, the incident, including issuance of a Notice of Violation, has not yet been resolved. The 1995 Site Environmental Report will include a complete summary of this incident.

In conjunction with DOE/HQ, Westinghouse Hanford Company completed a three-day audit of LBL's waste management program in February. The purpose was to determine conformity with the latest revision of the *Hanford Site Solid Waste Acceptance Criteria.* The audit included only the low-level waste (LLW) and low-level radioactive mixed waste (RMW) programs. The review involved visiting waste sites, observing waste pickups, and reviewing procedures. The Hanford group reported no findings, thus maintaining LBL's "approved" status with the Hanford site.

In February 1995, the Westinghouse Hanford Company raised concerns on long-term storage compatibility in four 208-liter (55-gallon) drums of mixed waste shipped from LBL in May and September of 1994. Hanford and LBL began an immediate investigation into this matter to identify the root cause of this issue and the extent of the problem. Meanwhile, two separate audits of the LBL waste management program were launched in April 1995 after Westinghouse Hanford discovered a discrepancy in the number of inner containers packaged in two of the four aforementioned drums. The first team consisted of Lawrence Livermore National Laboratory (LLNL) and Los Alamos National Laboratory personnel, while the second audit comprised members from LLNL and DOE's Oakland Operations Office (DOE/OAK). The 1995 Site Environmental Report will reflect developments over the course of the coming year on this situation.

US/EPA did not inspect LBL's radionuclide NESHAPs (National Emission Standard for Hazardous Air Pollutants) program in 1994. However, LBL did host a US/EPA training class in June entitled "Conducting Radionuclide NESHAPs Inspections at Department of Energy Facilities." The class was taught by professionals from US/EPA and DOE/HQ, with the primary focus on training regulatory inspectors. Class participants were predominantly from the California Department of Health Services. DOE contractor facilities in the Bay Area also sent staff to the class.

The City of Berkeley inspected activities associated with the UST removal projects performed during the year. Three inspections were held, one each in January, February, and March. No violations were issued during the inspections.

The City also inspected the Laboratory's stormwater compliance program. On two occasions, first in March and again in December, COB looked at LBL's program in relation to the best management practices criteria found in the National Pollutant Discharge Elimination System regulations. COB did not identify any violations during the visit. The City did make several suggestions on general housekeeping and structural enhancements. LBL is implementing the housekeeping suggestion and investigating the feasibility of implementing the City's structural recommendations.

The Hazardous Waste Handling Facility is often the recipient of either regulatory agency or DOE interest because of the nature of the operation. Unlike previous years, DTSC did not conduct any inspections of the HWHF or other waste management compliance activities. However, there were two transportation-related inspections during 1994. Neither inspection revealed any violations. In March, the U.S. Department of Transportation conducted a records review of EH&S and LBL transportation activities. In June, the California Highway Patrol, under authority of the State's Department of Transportation, examined vehicles for hazardous materials packaging and transportation requirements. In September, DOE/HQ performed a Conduct of Operations audit of LBL's waste management program. The audit revealed three concerns: radiation and contamination boundary requirements of the HWHF, operator aids program to control posted information, and a graded-approach matrix for the HWHF. The first of the concerns was resolved by LBL. The Laboratory has proposed to DOE that the other two concerns were invalid since LBL does have program measures in place that resolve this DOE concerns. LBL has not yet received a response from DOE.

The Laboratory's medical waste program received an inspection visit from DHS in June for a two-day visit. Inspectors found no violations during this visit, although the

State did have several observations for program improvement as a result of the audit. DHS reviewed LBL's *Medical Waste Management Plan*, and conducted a field investigation. LBL made several improvements in response to the audit, including updating plans such as the *Medical Waste Management Plan,* and changing the waste pickup schedules to improve efficiency.

In November, DOE/HQ's EH-24 conducted a two-week intensive audit of LBL's environmental management programs, as well as DOE's Berkeley Site Office (DOE/BSO) and DOE/OAK oversight responsibilities. The intent of the audit was to evaluate the Laboratory's environmental programs from the perspective of having management systems in place that ensure effective program development and implementation. A total of nine findings came out of the report. Six of the findings were attributed to LBL programs, while three of the findings targeted DOE/BSO or DOE/OAK. All of the findings were considered minor. The key finding by the audit team was the fragmented and uncoordinated role played by DOE in environmental oversight activities. The key finding was the result of weaknesses in communication, planning, evaluation, and funding that spread throughout the DOE system, beginning at DOE Headquarters. LBL submitted its proposal corrective action plan in January in response to this audit. As of this writing, LBL's plan had not yet been approved by DOE.

Environmental Incidents

Operations at a research facility have a tremendous amount of variation due to the nature of the activity. However, four environmental incidents occurred in 1994 that were considered atypical and of significant reportable value. Two of these incidents occurred in September, while the other two took place in November. Details on each incident are found in the discussion sections of the major environmental statutes in Section 3, *Compliance Summary.*

On September 15, the acid neutralization treatment unit at Building 2 malfunctioned, releasing about 110 liters (30 gallons) of low pH (2.3) liquid to the sanitary sewer. In reporting this release, LBL provided EBMUD with a worst-case estimate of 330 liters (90 gallons). Of this amount, approximately 1 liter (0.3 gallons) was untreated acid. This amount was determined from back-calculating from the pH value and volume of the discharge. LBL responded by inspecting and reinstalling each piece of equipment, installing new mechanical controls, and improving notification procedures giving responsibility to the treatment unit operators to contact EBMUD directly in the event of an accidental discharge.

During the week of September 23 through 30, analytical results and stack flow measurements from the National Tritium Labeling Facility (NTLF) estimate that approximately 1.1 terabecquerels (TBq), or 29 Curies (Ci), of tritium were released. The cause of the incident was a malfunctioning heating tape. The NTLF corrected the problem by installing sensors on critical areas of the affected equipment, with a digital readout installed in the Tritiation Laboratory. This release represents about 25% of the annual release of tritium from the NTLF. While this release was higher than normal, it remained below any regulatory reporting thresholds. The calculated dose to the maximally exposed offsite individual was 0.0006 millisieverts (mSv) (0.06 millirems [mrem]), well below the average daily background radiation dose from natural sources of 0.01 millisieverts (1.0 millirems).

The November incidents both involved soil contamination. On November 9, during removal activities of an underground storage tank near Building 74, the contractor temporarily placed materials en route to disposal bins on the ground. This activity was conducted during a significant rainstorm. The rain washed diesel residue off the materials toward a nearby storm drain. The estimated amount of diesel washed away in the incident was less than 4 liters (1 gallon). LBL's immediate response included covering the three storm drains in the area of the excavation, spreading absorbent over the spill area, placing the materials back in the excavation until the weather improved, and placing the soil spoils into the bins for testing and disposal. Also, LBL notified the City of Berkeley and the State Office of Emergency Services. LBL met with the contractor to review tank removal and safety concerns relevant to adverse weather conditions.

On November 18, laborers trenching between Buildings 51 and 64 unearthed an area of soil contaminated with elemental mercury. LBL notified the City of Berkeley, the State Office of Emergency Services, Cal/EPA's Department of Toxic Substances Control, and the National Response Center of this discovery. LBL's cleanup efforts lasted three days, during which time 21 drums of contaminated soil were removed from the area, until instrumentation could no longer detect the presence of mercury. The apparent point at which the mercury contamination entered the soil was a faulty seal between a concrete slab covering a buried storm drain catch basin and the walls of the catch basin itself. It is suspected that the release into the storm drain system occurred many years ago. The actual source of the mercury has not yet been identified.

A fifth incident with indirect environmental interest occurred at LBL's Building 903 warehouse in August. Approximately 105,000 kilograms (232,000 pounds0 of copper containing extremely low levels of induced radioactivity from previous use at the 184-inch Cyclotron were stored at this warehouse while awaiting approval from DOE for sale or disposal. According to the environmental assessment prepared for DOE approval, both the environmental and workplace impacts from the induced radioactivity in the copper were negligible. For example, the level of radioactivity qualified the copper for handling as a non-radioactive material under California regulations. In July, DOE issued a Finding of No Significant Impact for the environmental consequences from the entire amount of copper. Before LBL could complete plans for the disposition of the copper, approximately 6,800 kilograms (15,000 pounds), or 6% of the copper, were stolen from the fenced-in warehouse in August when thieves broke into three of the 31 sealed crates. From police reports and tips from a scrap dealer, it is believed that the stolen copper was sold to local scrap yards.

Radiological Monitoring

The Laboratory's radiological monitoring program includes elements needed to gather information from several media: air, water, soil, and sediment. Air monitoring consists of two types: direct penetrating radiation (gamma and neutron) and dispersible particulate radionuclides. Water sampling is categorized as rainwater, surface (creek) water, groundwater, and wastewater. Instrumentation measuring penetrating radiation is designed to collect a dose value. All other monitoring and sampling activities collect concentration values. A dose represents the integration of the concentration over a period of time. Section 5, *Environmental Radiological Program Information*, contains a description of the monitoring results from each of these media, along with supporting data. Table 5-17 in that section best summarizes the overall dose impact from LBL's radiological activity in 1994.

The regulatory standards of comparison differ among media. Dose equivalents attributable to LBL radiological operations in 1994 were a small fraction of the relevant US/EPA and DOE radiological standards (Table 5-17), and of the total natural radiation background of approximately 3 mSv/yr (300 mrem/yr). The total dose due to direct penetrating radiation from accelerator operations and airborne radionuclide releases, compared to typical radiation doses received by the general public, is summarized in Figure 1-1. LBL's maximum dose to an individual member of the public for 1994 was 0.0164 mSv (1.64 mrem). The location of this maximum dosage is about 110 meters west of Building 88. The primary contributor (0.015 mSv/yr, or about 91%) to this dosage is the direct penetrating radiation from accelerator activities in Building 88. This value is about 1.6% of the DOE limit of 1 mSv/yr (100 mrem/yr) set forth in DOE Order 5400.5 and about 1% of the background radiation received by each member of the public during the same period. Also of note, this dose value assumes that the maximally exposed individual (MEI) resides at the high dose location 100% of the time during the year. The purpose of this conservative assumption is for the dosage to represent an upper-bound value in compliance reporting.

As previously mentioned, accelerator activities in Building 88 that produce external

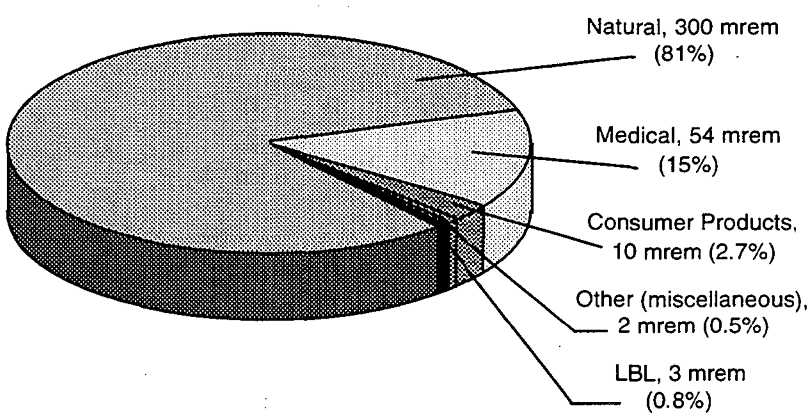


Figure 1-1. Typical Radiation Doses Received by the General Public and the Maximum Contribution from LBL

penetrating radiation are the main source of LBL's highest offsite dose from all radiological pathways. Five real-time radiation monitoring stations spaced around LBL's perimeter record direct gamma and neutron radiation. Information from these monitoring stations is used to calculate the dosage at the MEI from penetrating radiation. Results from these monitoring stations are summarized in Table 5-1.

For dispersible particulate radionuclides, LBL must comply with requirements of 40 CFR 61 Subpart H, the *National Emission Standard for Hazardous Airborne Pollutants Other Than Radon From DOE Facilities* (NESHAPs). The NESHAPs dose standard from all exposure pathways resulting from airborne releases of radionuclides is 0.1 mSv/yr (10 mrem/yr). The maximum effective dose equivalent delivered to a member of the community is defined as the maximum effective dose equivalent (EDE) at an area where non-LBL personnel work or reside.

Dose calculation is based on emissions from a source. Tritium accounts for about 94% of LBL's total airborne radionuclide emissions (Table 5-4). Nearly 20 other radionuclides comprise the remaining 6% of emissions. Radionuclides are used in designated research areas across the Laboratory. During 1994, about 4.3 TBq (115 Ci) of tritium in the form of tritiated water vapor and elemental tritium were released to the atmosphere. Of this total, about 1.1 TBq (29 Ci) were due to one unplanned release from the National Tritium Labeling Facility (see *Environmental Incidents*). The effective dose equivalent from LBL's airborne release of all radionuclides was 0.0014 mSv (0.14 mrem) to a hypothetical maximally exposed individual, who is located offsite about 110 meters northwest of LBL's Building 75. This dose is about 1.4% of the NESHAPs limit and less than 10% of the impact of direct gamma and neutron radiation from accelerator activities. Correlating well with the emissions information, tritium accounted for about 92% of the exposed individual dose at LBL due to airborne radionuclide activity (Table 5-15).

An additional assessment of LBL radiological impact is the population dose. Throughout this report, the phrase population dose means collective effective dose equivalent (CEDE), and dose or dose equivalent means effective dose equivalent. CEDE is defined as the sum of the "doses" delivered to all individuals within an 80-kilometer (50-mile) radius of the Laboratory. The collective effective dose equivalent for LBL's operations in 1994 was estimated to be 0.018 person-Sv (1.8 person-rem).

The radionuclide information used in the dose assessment modeling is gathered by monitoring airborne effluent at building stacks. LBL also monitors atmospheric ambient air at onsite and offsite locations for comparison with modeling results. Environmental air samples were analyzed for tritium, carbon-14, gamma emitters, gross alpha, and gross beta radioactivities. Water and soil samples were analyzed for gross alpha, gross beta, and tritium radioactivities. Results of these analyses are presented in Section 5, *Environmental Radiological Program Information*.

Nonradiological Monitoring

The Laboratory's nonradiological monitoring program consists of wastewater, stormwater, and groundwater sampling. Detailed results from wastewater and stormwater sampling are presented in Section 6, *Environmental Nonradiological Program Information*, while groundwater results are described in Section 7, *Groundwater Protection*.

Under the requirements of the Laboratory's three wastewater discharge permits issued by EBMUD, LBL is required to perform sampling of the sanitary sewer system on specific dates during the year. Fifteen samples were taken during 1994 and analyzed for metals and toxic organics. All wastewater discharge levels were below the limits established in the three permits.

Stormwater discharges are regulated under a general permit issued by SWRCB. The permit program is in its infancy, and stormwater discharges are regulated in a manner different from that for wastewater. Currently there are no specific discharge limits cited in the general permit. References in the permit to the RWQCB *Water Quality Control Plan* (Basin Plan) for the San Francisco Bay Basin are intended as guidelines. Constituent levels presented in the Basin Plan are water quality targets, not measures of compliance for stormwater discharges.

Stormwater samples are analyzed for an extensive suite of possible contaminants, depending upon the location of the sample. In 1994, 125 samples were taken from 10 influent and effluent locations and analyzed for metals and toxic organics. All of the analyses were within the baseline established by the sampling program to date.

None of the toxic organic analyses exceeded the limitations for Human Health 30-day average, even though this water is not used for domestic or agricultural purposes. In 1994 only one sample metal analysis exceeded the Basin Plan guidelines. Of six samples taken from the North Fork of Strawberry Creek, one sample assayed mercury as 4.2 micrograms per liter (0.0042 parts per million). The Basin Plan guideline for mercury is 0.01 microgram per liter. This sample was taken toward the middle of the stormwater sampling period, and samples taken before and after this event assayed as non detectable for mercury. A survey of prevailing site conditions did not indicate a likely candidate for mercury contamination. In accordance with permit requirements, this information is reported as part of the annual report due each year by July 1.

The Laboratory's groundwater monitoring program included quarterly analyses of water samples from its network of monitoring and slope stability wells for a variety of potential contaminants, including organic compounds, metals, and tritium. The total number of monitoring wells now stands at 85, with eleven wells added in 1994. Water samples from approximately half of the new wells showed low levels of contamination with volatile organic compounds. This new information served to better define the distribution of contaminated groundwater on the site, a necessary prerequisite to meaningful evaluation of alternatives to remove contaminants from the groundwater.

Significant Corrective Actions

The combination of being a research-based organization with evolving programs, a facility with an aged infrastructure, and ever-changing regulatory requirements creates a need to constantly upgrade or improve site operations for environmental management reasons. In recent years, this element of the program has shown significantly increased activity and importance in site corrective action projects. Many of these projects require several years to complete. A list of the most significant projects in which environmental compliance plays a key role include:

- aboveground storage tank modifications
- airborne emissions source abatement
- meteorological monitoring upgrade
- radiological NESHAPs stack monitoring upgrades
- sanitary sewer monitoring
- sitewide radiological ambient air monitoring
- storm drain connection repairs
- underground storage tank modifications

Section 4, *Environmental Program Information*, discusses the purpose and status of each project. The radiological NESHAPs stack monitoring upgrades and storm drain connection repairs projects were major facility improvement projects recently completed before regulatory-mandated deadlines.

The NESHAPs project is the result of a Finding of Violation issued by US/EPA in April 1991. US/EPA and DOE signed a Federal Facilities Compliance Agreement (FFCA) in August 1993 that established a schedule for bringing LBL's program into full compliance with the NESHAPs for radionuclides by February 1995. To satisfy the Findings deficiencies and meet the FFCA schedule, LBL began a $1.8 million corrective action project to upgrade its stack emissions monitoring program to NESHAPs standards. LBL completed this project in January 1995.

The storm drain connections project faced a March 30, 1995 regulatory deadline. The statewide General Permit for stormwater discharges associated with industrial activities required the elimination of non-stormwater discharges into storm drain systems. Non-stormwater discharges include flows of process water that should go to sanitary rather than storm sewers. LBL's upgrade project began in 1992 with a sitewide survey that identified 38 improper connections. With completion of the remaining two connections at Building 71 in March 1995, the project met the regulatory deadline.

Environmental Planning

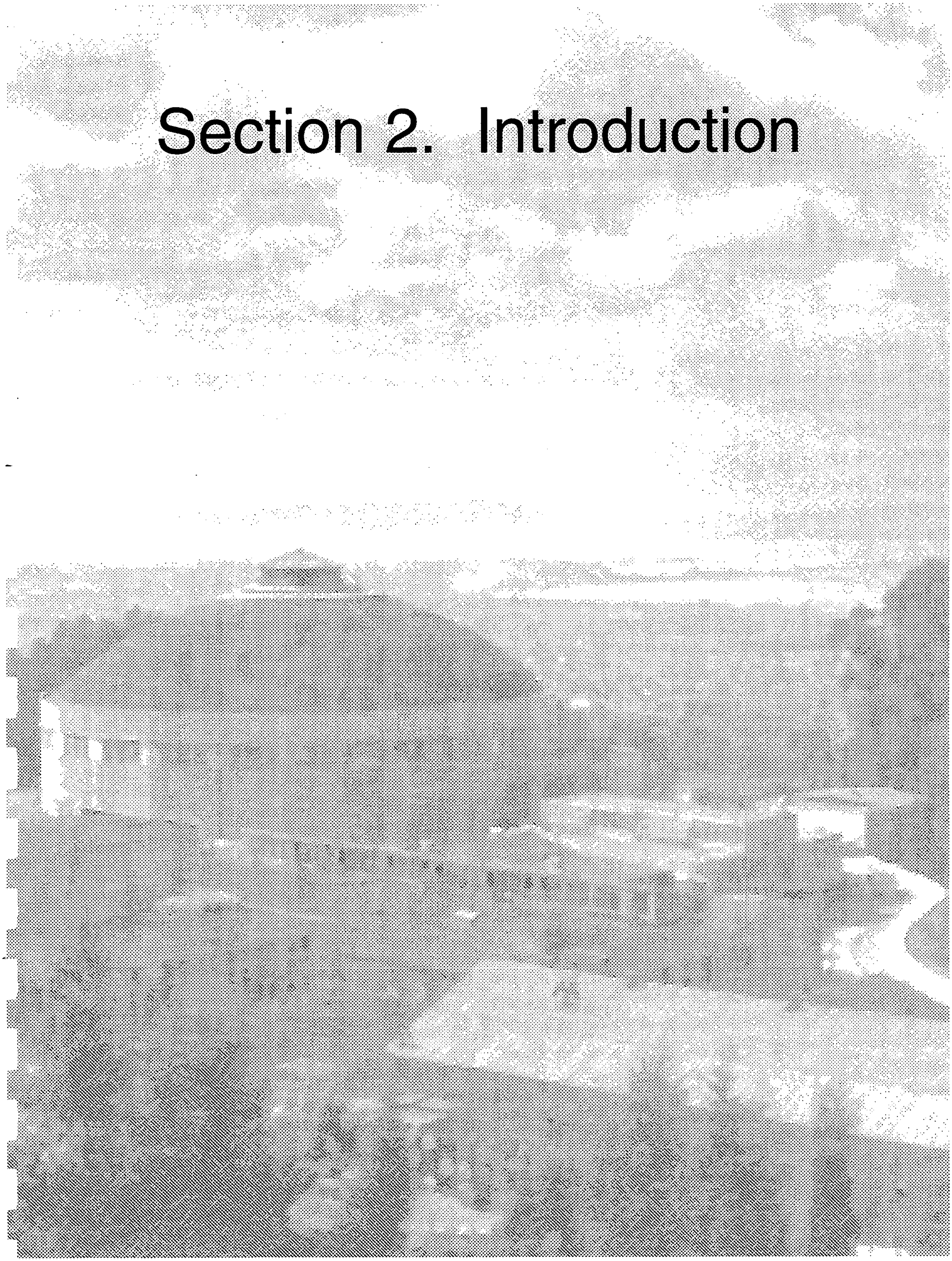
DOE established the *Environment, Safety and Health (ES&H) Management Plan*. The purpose of this Plan is to identify the magnitude of effort, prioritize deficiencies, and determine funding needed to bring DOE into full compliance with all environment, safety, and health laws and regulations. Environmental planning documents request the level of resources necessary to maintain or improve compliance within program areas. The current funding period requested by the Activity Data Sheets (ADSs) is Fiscal Year (FY) 1996 through FY 2000. In 1994 and early 1995, LBL prepared 25 ADSs for environmental protection, environmental restoration, and waste management programs and projects. Refer to Section 3, *Compliance Summary*, for a complete discussion on these requests.

Environmental Performance Measures

Under the Laboratory's operating contract between DOE and the University of California (UC), LBL is required to objectively measure its effectiveness at managing environmental excellence. These measures are called performance measures (PMs). They are prepared quarterly by LBL and submitted to UC annually. Although prepared by LBL, the PMs were jointly developed by LBL, UC, and DOE, and are reviewed annually for possible modifications.

The expectation of the performance measures is to show continual improvement in managing environmental programs. 1994 marked the first full year of using PMs at LBL. A total of 10 PMs have been established for environmental programs covering four general areas: protection and prevention, compliance, integration and accountability, and customer satisfaction. LBL achieved at least a *Meets Expectations* rating in 9 PMs. The Completion of Milestones PM received a needs improvement rating because one DOE-mandated report out of the eight that comprise this performance measure was prepared late. A complete discussion of these results can be found in Section 4, *Environmental Program Information.*

Section 2. Introduction



Origin

LBL began as an accelerator laboratory in 1931, when Ernest O. Lawrence established the Radiation Laboratory with the construction of the 27-Inch Cyclotron on the University of California at Berkeley (UCB) campus. In 1939, the need for higher-energy accelerators resulted in the construction of the 184-Inch Cyclotron on a hill overlooking the campus and the City of Berkeley. The 1940s were a period of rapid growth in response to national defense needs. Further development during the 1950s was more carefully planned, with the construction of permanent concrete and steel-frame structures east and west of the earlier construction.

Over the past decades, LBL has evolved into a multiprogram national research laboratory with a history of distinguished achievement, including the discovery of many elementary particles and all of the named transuranium elements. Nine LBL scientists have won Nobel prizes for their work, and countless others have been honored by awards such as Macarthur Foundation grants, and election to the various national science academies. From an initial emphasis on high-energy and nuclear physics, LBL has diversified to include materials sciences, chemistry, earth sciences, the biosciences, and energy conservation research. It is the oldest of the DOE national laboratories, and the only one located adjacent to a major university.

Mission

LBL is operated under contract by the University of California (UC) for the Department of Energy (DOE).[1] Its fundamental mission is to provide national scientific leadership and technological innovation to support the DOE's objectives. The mission consists of four goals:

- Perform leading multidisciplinary research in the energy sciences, general sciences, and biosciences in a manner that ensures employee and public safety and the protection of the environment.
- Develop and operate unique national experimental facilities for use by qualified investigators from throughout the world, including the Advanced Light Source (ALS), the 88-Inch Cyclotron, the National Center for Electron Microscopy, and the National Tritium Labeling Facility (NTLF).
- Educate and train future generations of scientists and engineers. Hundreds of graduate and undergraduate students pursue research at LBL each year, gaining useful experience for their future careers and contributing greatly to the Lab's achievements. Through the Center for Science and Engineering Education, precollege programs are conducted for students, and various outreach programs are directed at students and science educators.
- Transfer knowledge and technological innovations, and foster productive relationships between LBL research programs, universities, and industry to promote national economic competitiveness. The Technology Transfer Program strives to make technology transfer an integral part of all LBL programs and provides services to the research divisions in support of efforts for licensing or collaboration with industry.

The Site

San Francisco Bay Area

LBL is located 8 kilometers (5 miles) east of San Francisco Bay on the slopes of the Coast Range within 479 hectares (1,183 acres) of land owned by the University of California (Figure 2-1). The Lab's 54-hectare (134-acre) site is under long-term lease to DOE.

LBL lies in Alameda County (population 1,280,000), with the eastern portion of the site in Oakland (population 370,000) and the western portion in Berkeley (population 103,000), largely a university and residential community. Research is also conducted in buildings on the UCB campus (student population 31,500), and at the Richmond Field Station, a University facility within the City of Richmond (population 70,000), about five kilometers (3 miles) north of Berkeley. Some research and other functions are also carried out at various commercial buildings in Berkeley where LBL leases space.

The Laboratory is served by a network of state, county, city, University, and LBL roadways and public, University, and Laboratory transit services. The Laboratory is within commuting distance to the Lawrence Livermore National Laboratory, Sandia National Laboratory, and the Stanford Linear Accelerator Center.

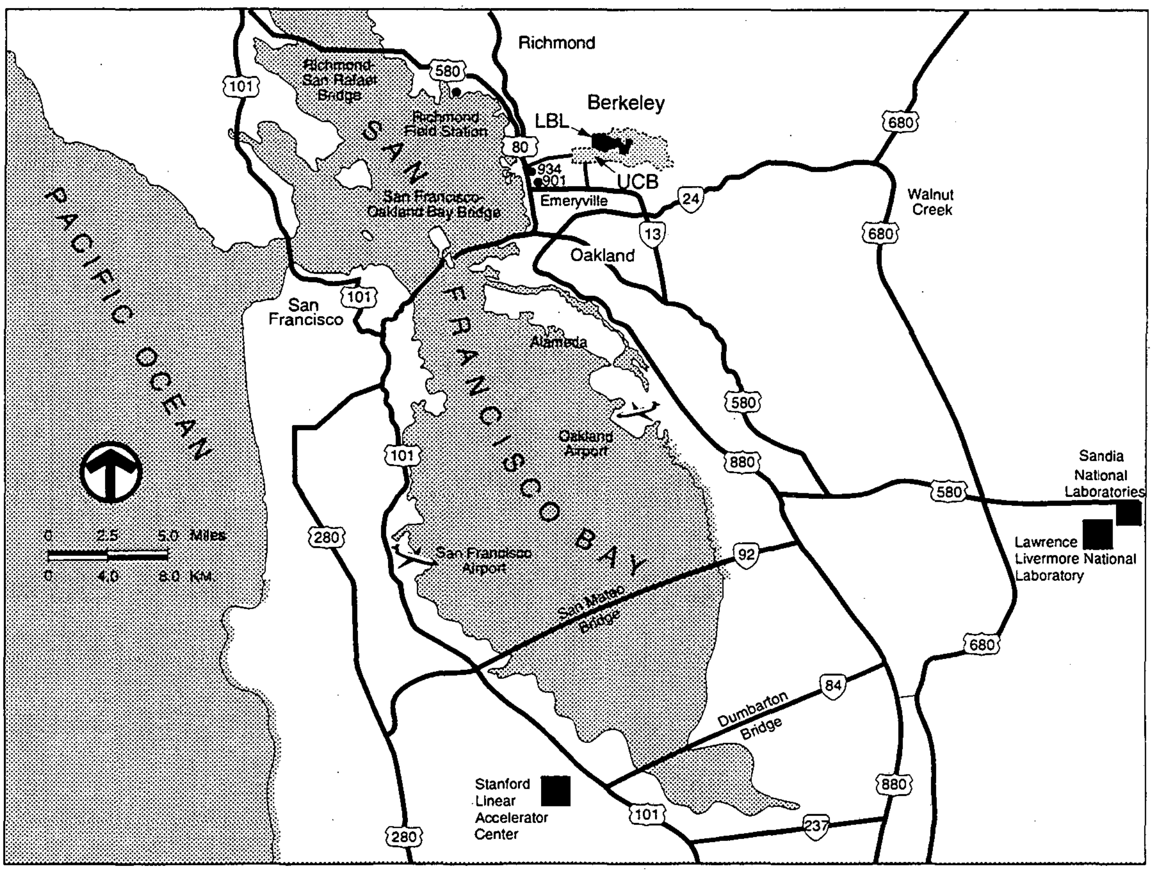


Figure 2-1. San Francisco Bay Area Map

The San Francisco Bay Area is a cosmopolitan region comprised of nine counties with a total land area of 1.9 million hectares (4.6 million acres) and a population of 6.0 million. Although the metropolitan areas are highly developed, only 12% of the total land has been developed as residential, commercial, or industrial area. The highly diversified, technology- and service-oriented labor force of the region totals 3.3 million people. Aerospace, computers, electronics, scientific instruments, and communications equipment comprise more than 50% of all manufacturing jobs.

Alameda County, with an area of 189,950 hectares (469,400 acres), has major educational, research, industrial, and agricultural resources, including six colleges and universities, large private and public research laboratories, heavy and light industry, and extensive nursery and viticulture acreage. Important industries include electronics, automobile assembly, biotechnology, and food processing. The civilian labor force is approximately 600,000.

City of Berkeley

Berkeley is a residential, university, and industrial city encompassing 2,720 hectares (6,720 acres). The City is best known for the presence of the University of California at Berkeley (Figure 2-2). Industries include major biotechnology, electronics, chemical, and pharmaceutical companies; small foundries and fabrication companies; and other high-technology companies and ser-

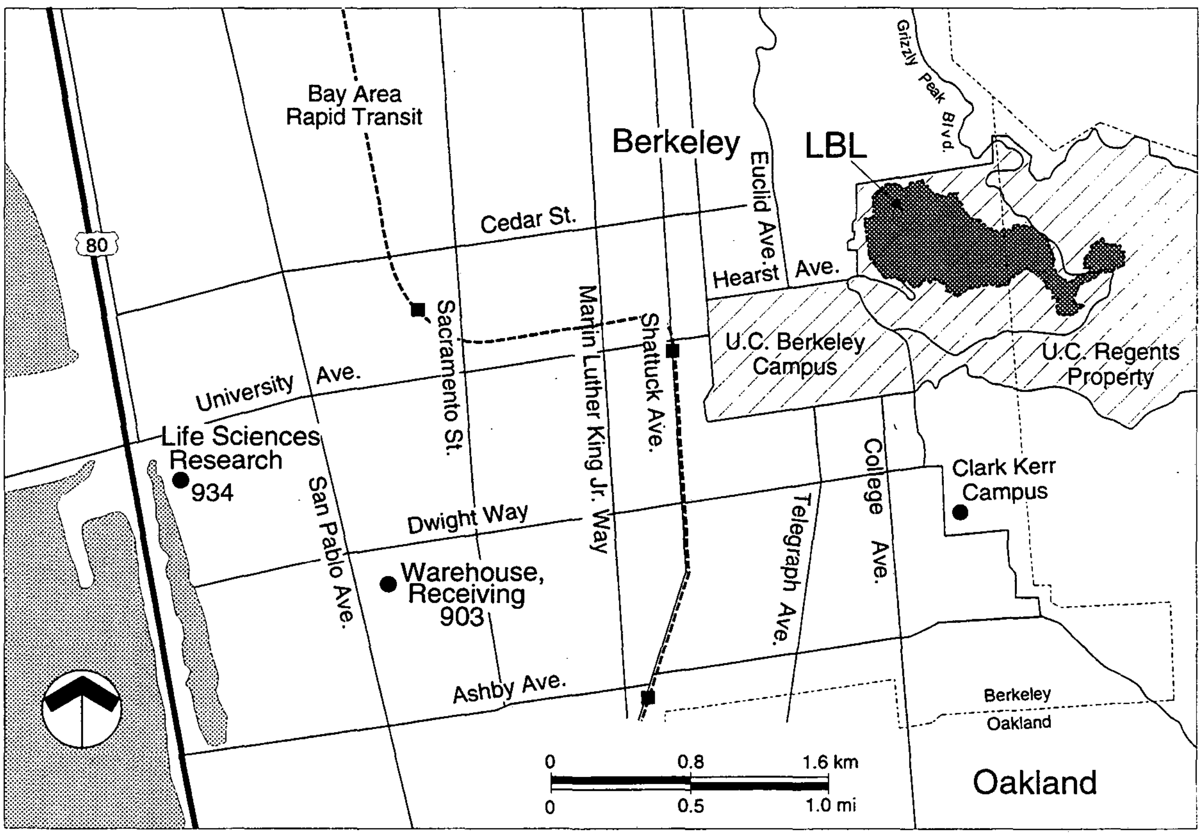


Figure 2-2. Vicinity Map

vice industries. The population of Berkeley has not changed significantly during recent years.

The Laboratory

LBL (Figure 2-3) is sited on the ridges and draws of Blackberry Canyon, which forms the central part of the site, and Strawberry Canyon, which generally forms the southern boundary. The area to the south, which is University land, is maintained largely in a natural state and includes recreational facilities and the University Botanical Garden. Above and to the east of the Laboratory are the University's Lawrence Hall of Science and the Mathematical Sciences Research Institute. LBL is bordered on the north by predominantly single-family homes and on the west by multi-unit dwellings, student residence halls, and private homes. Areas to the west of LBL are highly urbanized.

The eastern section of the main Laboratory site is located in the northeast portion of the City of Oakland. This area is undeveloped and provides LBL with a backdrop of botanical gardens, a regional park, and open space that preserves the rural character of the foothills.

Laboratory Operations

To support the national infrastructure for fundamental science and engineering research, LBL provides a range of unique research facilities and centers to investigators from industry, universities, and government. The major national facilities available to qualified users include:

- The Advanced Light Source, which generates photon beams of unprecedented brightness in the far ultraviolet and soft x-ray regions of the spectrum. This synchrotron radiation source is used for basic and applied research across a broad spectrum of scientific and technological disciplines. The facility began operation in the fall of 1993.
- The 88-inch Cyclotron, which provides light ions, polarized protons and deuterons, and intense and high-charge-state beams of heavy ions (up to krypton) at energies up to about 35 MeV per nucleon. The cyclotron facility has experimental areas for conducting nuclear science experiments, as well as research in other areas such as biomedicine, atomic physics, and radiation damage in semiconductors.
- The National Center for Electron Microscopy, which consists of the High Voltage Electron Microscope, operating at up to 1.5 MeV (the highest energy in the U.S.); the Atomic Resolution Microscope, offering 1.5-Å resolution; and analytical microscopes and support facilities. The Electron Beam Microcharacterization Facility, with resolution down to 1.0 Å, is planned as an upgrade of the facility.
- The National Tritium Labeling Facility, which provides advanced instrumentation to investigators needing high specific activities of tritiated compounds as tracers in chemical and biomedical research.

The Laboratory has established many other programmatic research centers with specific objectives of fostering collaborative research with industrial and educational institutions. These include, among others, the Center for Advanced Materials, the Center for Beam Physics, the Human Genome Center, the Center for X-Ray Optics, the Center for Computational Seismology, the Center for

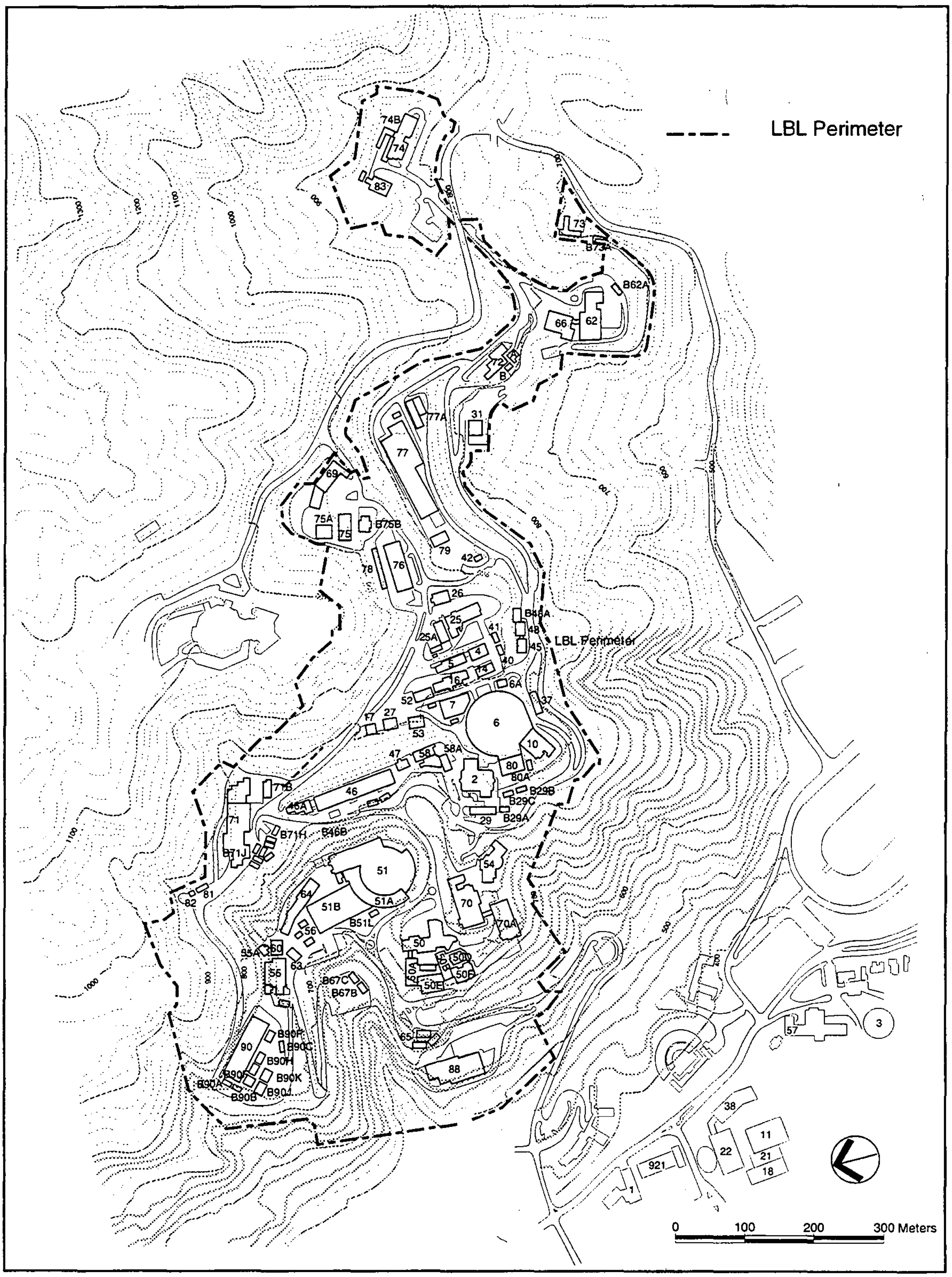


Figure 2-3. Lawrence Berkeley Laboratory Buildings

1	Donner Laboratory
2	Advanced Materials Laboratory (AML) & Center for X-ray Optics (CXRO)
3	Chemical Biodynamics Laboratory
4	Magnetic Fusion Energy (MFE)
5	Magnetic Fusion Energy (MFE)
6	Advanced Light Source (ALS)
7	Central Stores & Electronics Shops
10	Cell & Molecular Biology Research & Photography
14	Accelerator & Fusion Research & Earth Sciences
16	Magnetic Fusion Energy Laboratory
17	EH&S/Applied Sciences Lab
25	Mechanical Technology
25A	Electronics Shops
26	Medical Services
27	High Voltage Test Facility & Cable Shop
29	Electronics Engineering, Research Medicine/Radiation Biophysics Offices
31	Chicken Creek Maintenance Bldg.
36	Grizzly Substation Switchgear Bldg.
37	Utilities Service
40	Electronics Development Lab
41	Magnetic Measurements Lab
42	Salvage
43	Compressor Bldg.
44	Indoor Air Pollution Studies
45	Fire Apparatus
46	RTSS, ALS, Accelerator Development
46A	Real Time Systems Section (RTSS)
47	Advanced Accelerator Study
48	Fire Station
50	Physics, Accelerator & Fusion Research & Nuclear Science
50A	Director's Office, Environment & Laboratory Development, Administration Division, Patents
50B	Physics, Computer Center, IRD & ICSD
50C	PID, Physics
50D	MCSD & Nuclear Science
50E	Earth Sciences
50F	Computing Services, IRD
51	Bevalac/Bevatron
51A	Bevatron Experimental Area
51B	External Particle Beam (EPB) Hall
52	Magnetic Fusion Energy Laboratory
53	SuperHILAC Development
54	Cafeteria
55	Research Medicine/Radiation Biophysics
55A	Nuclear Magnetic Resonance (NMR)
56	Cryogenic Facility
58	Accelerator Research & Development
58A	Accelerator Research & Development Addition
60	High Bay Laboratory
61	Standby Propane Plant
62	Materials & Chemical Sciences
63	Accelerator & Fusion Research
64	Accelerator & Fusion Research
65	Data Processing Services
66	Surface Science & Catalysis Lab
68	Upper Pump House
69	Business Services, Materiel Management, Mail Room & Purchasing
70	Nuclear Science, Applied Science & Earth Sciences
70A	Nuclear Science, Materials & Chemical Sciences & Earth Sciences
71	Heavy Ion Linear Accelerator (HILAC)
71A	HILAC Rectifier
71B	HILAC Annex
72	National Center for Electron Microscopy (NCEM)
72A	High Voltage Electron Microscope (HVEM)
72B	Atomic Resolution Microscope (ARM)
72C	ARM Support Laboratory
73	Atmospheric Aerosol Research
74	Research Medicine/Radiation Biophysics, Cell & Molecular Biology Laboratory
74B	Research Medicine/Radiation Biophysics, Cell & Molecular Biology Laboratory Annex
75	Radioisotope Service & National Tritium Labeling Facility (NTLF)
75A	Compactor, Processing & Storage Facility
76	Construction & Maintenance & Craft Shops
77	Mechanical Shops
77A	Ultra High Vacuum Assembly Facility (UHV)
78	Craft Stores
79	Metal Stores
80	Electronics Engineering
80A	Office Building
81	Liquid Gas Storage
82	Lower Pump House
83	Lab Cell Biology
88	88-Inch Cyclotron
90	Applied Science, Employment, Engineering, Occupational Health, Personnel, Protective Services

SMALL BUILDINGS AND TRAILERS

B-13A	Environmental Monitoring West of 88
B-13B	Environmental Monitoring West of 90
B-13C	Environmental Monitoring South of UC Recreation Area
B-13D	Environmental Monitoring North of 71
B-13E	Sewer Monitoring Station, Hearst Avenue
B-13F	Sewer Monitoring Station, Strawberry Canyon
B-13G	Waste Monitoring Station, West of 70

Figure 2-3. (p.2) Key to Lawrence Berkeley Laboratory Buildings Shown on the Previous Page

Functional Imaging, the Center for Building Science, and the Center for Isotope Geochemistry.

Land Use

LBL's hillside location, with elevations ranging from 200 to 330 meters (650 to 1,000 feet) above sea level, affords dramatic views of nearby San Francisco Bay and its surrounding urban areas. The hillside topography and vistas are both an amenity and a constraint and add an important dimension to site planning at LBL.

Adjacent land use consists of residential, institutional, and recreation areas (Figure 2-4). Development within the Laboratory site is governed by guidelines which state that operations must be compatible with the surrounding community. Visually the Laboratory is associated by the public with the UCB campus, and the Laboratory works with municipal, county, and university planning staffs to maintain and improve relationships and to coordinate development plans.

Facilities

LBL research and support activities are conducted in 77 permanent buildings and 121 trailers and temporary buildings on the main site. The area of the structures totals 178,000 gross square meters (1.95 million gross square feet), including 151,000 gsm (1.66 Mgsf) on the main site, 8,500 gsm (0.09 Mgsf) on the UC Berkeley campus and Richmond Field Station, and 18,000 gsm (0.19 Mgsf) leased off site. In 1994, the average age of the main-site buildings was 30 years. Over 60% of the permanent buildings are over 25 years old, as are the

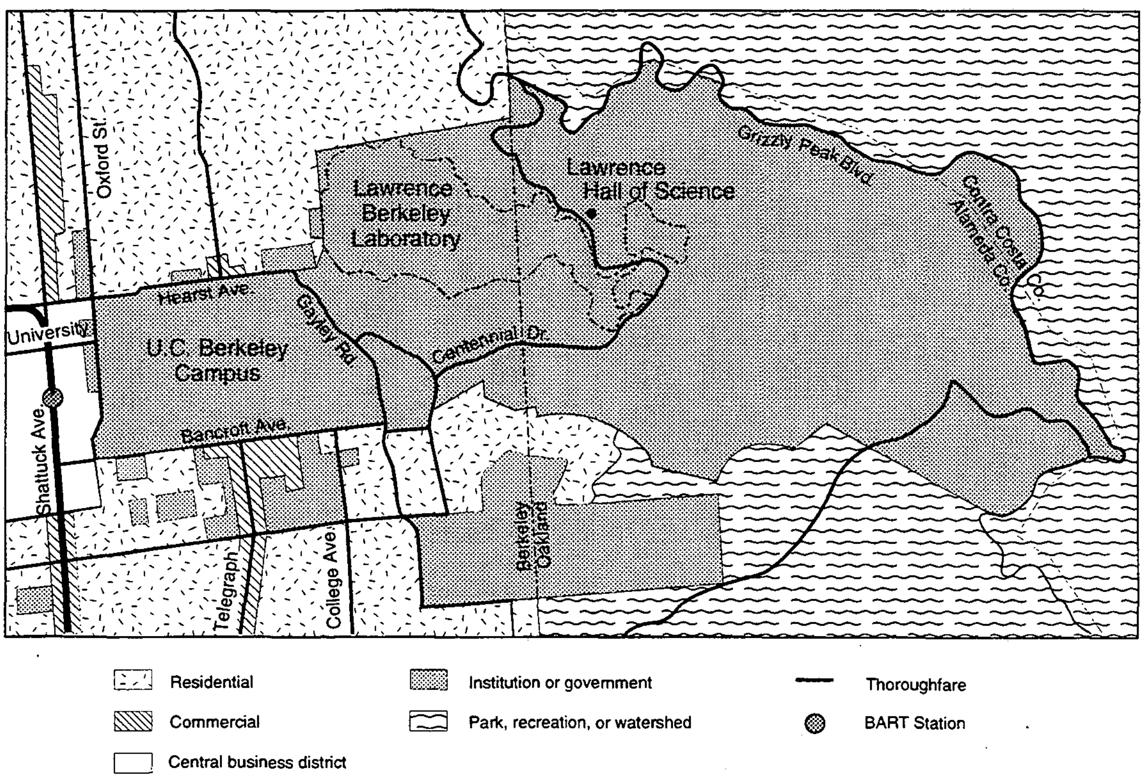


Figure 2-4. Adjacent Land Use

mechanical and electrical systems. The condition of building space, including funded construction, is as follows:

- Adequate: 51,972 gsm (558,839 gsf)
- Substandard, can be made adequate: 82,287 gsm (884,804 gsf)
- Substandard, cannot be made adequate: 19,877 gsm (213,734 gsf).

Figure 2-5 shows the 1994 LBL space distribution. Most of the Laboratory's main site buildings are owned by DOE.

Water Supply

All of the Laboratory's water is supplied continuously by the East Bay Municipal Utility District (EBMUD). There are no drinking water wells on site. The primary water supply is EBMUD's Shasta Reservoir, located in the Berkeley hills to the north of LBL. The Laboratory's high-pressure fire and domestic system is supplied from this reservoir. A secondary source is EBMUD's Berkeley View tank, with a capacity of approximately 11.4 million liters (3.0 million gallons), connected to LBL by EBMUD piping.

Domestic water distributed at LBL is of the highest quality. It originates in 577 square miles of Sierra Nevada watershed lands which are largely untouched by human activity. Water is brought to the Bay Area and ultimately to LBL through a system of lakes, aqueducts, and treatment stations. EBMUD tests for contaminants and meets disinfection standards as required by the Safe Drinking Water Act. All EBMUD-sup-

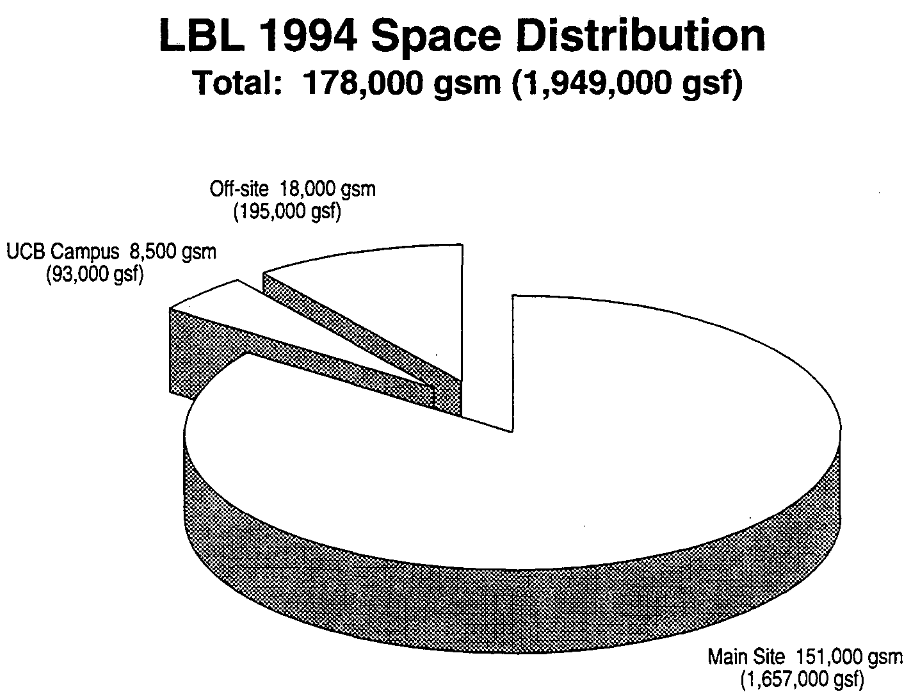


Figure 2-5. 1994 LBL Space Distribution

plied drinking water at LBL meets both primary (health-related) and secondary (aesthetic) standards as defined by federal and state maximum contaminant levels.

The LBL water distribution system contains several backup safety distribution loops and is valved to provide control in case of emergency. The system normally operates by gravity flow, requiring no pumps or energy consumption for operation within the Laboratory. The Laboratory has two 760,000-liter (200,000-gallon) fire-protection storage tanks. One is located behind Building 75 near the Shops and Support Facilities Area, and the other is near Building 71 in the Bevalac Accelerator Complex. Automatically starting diesel-powered pumps will maintain a reliable flow for the fire-protection system during emergencies.

The LBL system that distributes the EBMUD water within the site consists of an extensive piping layout providing domestic water and fire-protection water to all LBL installations. The LBL system also supplies makeup water for cooling towers, irrigation water, and water for other miscellaneous uses. The system includes fire hydrants and Fire Department connections and sprinkler services to almost all buildings. LBL has also completed a project to install backflow preventers at all buildings in accordance with recent building code regulations.

Because of the differences in elevation at the LBL site, there are two main pressure zones, both of which operate at the nominal pressure of about 480,000 pascals (70 pounds per square inch). Most of the existing pipe is either cement-lined and coated steel pipe with welded joints or cast iron and/or ductile iron pressure pipe with mechanical joints.

Much of the pipe has been designed and installed to resist forces caused by earth movement due to slides and/or earthquakes. All of the newer lines have been located to avoid potentially unstable earth areas.

The water system at LBL has a high degree of reliability for both domestic use and emergency purposes. This reliability exists by virtue of the two separate connections to EBMUD sources, the two 760,000 liter (200,000-gallon) storage tanks, and the high quality of both the LBL and EBMUD systems. The system has sufficient capacity to meet the flow-rate and duration requirements for fire protection; in the case where EBMUD service is not available, the capacity is currently limited to 1.5 million liters (400,000 gallons). There is no restriction on the volume of water available from EBMUD. The only limitations are due to the capacity of the existing pipes.

Sanitary Sewer Systems

The western portion of LBL's sanitary sewer system (Table 2-1 and Figure 2-6) connects to the City of Berkeley sewer main at Hearst Avenue. On the south side of the Laboratory, a second connection is made to the City of Berkeley system at Centennial Drive.

The sanitary sewer system at LBL consists of pipe, manholes, and two monitoring stations. Pipe in the system is cast iron or ductile iron. The system is entirely gravity flow and discharges through either a monitoring station at Hearst Avenue or one located adjacent to Centennial Drive in Strawberry Canyon. The Hearst Avenue monitoring system receives discharges from most of the buildings on the hill. Those buildings that lie within the South Strawberry Canyon watershed discharge to the Strawberry mon-

Table 2-1. Site Mechanical Utilities–Sanitary Sewer System

Functional Area	Existing Length, m (ft)	Existing Utilization (%)	Existing Life (yr)	Additions Planned
88-Inch Cyclotron Research Area	268 (880)	50	25+	No
Central Research and Administration Area	1,450 (4,580)	50	15–25+	Yes
Bevalac Accelerator Complex	1,132 (3,715)	50	15–25+	No
Light Source Research and Engineering Area	911 (2,990)	50	15–25+	Yes
Shops and Support Facilities Area	1,320 (4,330)	50	15–25+	No
Material and Chemistry Research Area	335 (1,100)	50	15–25+	No
Life Sciences Research Area	241 (790)	50	15–25+	Yes

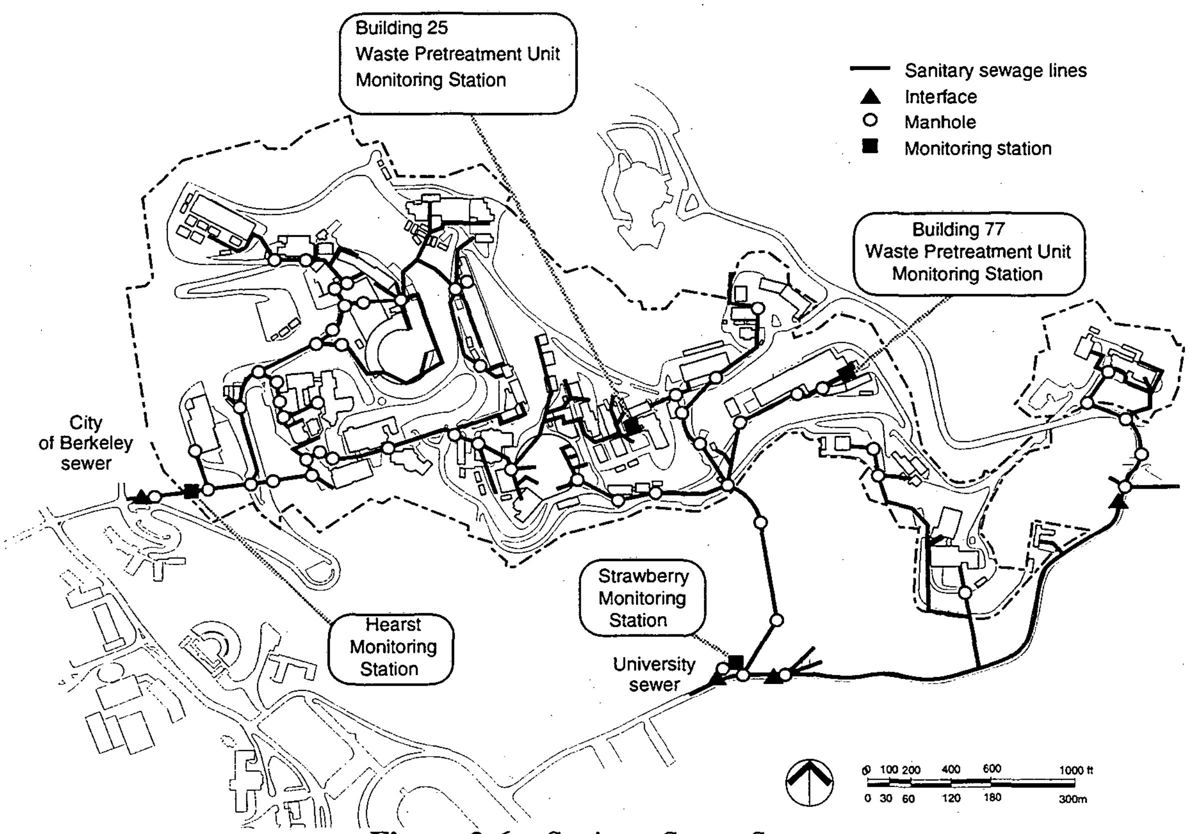


Figure 2-6. Sanitary Sewer System

itoring station, along with effluent from several campus facilities, mainly the Lawrence Hall of Science, the Space Sciences Laboratory, and the Mathematical Sciences Research Institute.

Effluent from the Hearst Avenue monitoring station flows to a manhole located at the intersection of Cyclotron Road and Highland, where it enters the City of Berkeley pipe system and is transported to the EBMUD North Interceptor sewer. The EBMUD North Interceptor carries the effluent to the District's wastewater treatment plant south of the Bay Bridge toll plaza. Here, the wastewater undergoes primary and secondary treatment before it discharges to the San Francisco Bay.

Effluent from the Strawberry Canyon monitoring station flows through a campus sewer that ties in to the City of Berkeley system at a manhole near the intersection of Rimway Road and Canyon Road, just south and east of UCB Memorial Stadium. The City system then delivers the sewage to the EBMUD North Interceptor.

Several of the main sewer lines have been in service since before 1950, and some are as small as 15 centimeters (six inches) in diameter. However, most of the lines are on a steep gradient and have operated satisfactorily.

The monitoring stations continuously measure the volume of the wastewater effluent. The pH and proportional samples of the sewage are also taken at regular intervals and analyzed for various parameters, including heavy metals, chlorinated hydrocarbons, and radioactivity.

The measured total wastewater volume for LBL was approximately 484,000 liters (128,000 gallons) per day. This was approximately 48 percent of water purchased from EBMUD during this period. The remaining 52% was lost to various processes such as landscape irrigation and cooling tower evaporation. Most of the wastewater discharge from the site leaves via the Strawberry Canyon monitoring station.

A regional sewage project recently has been undertaken in the East Bay. The purpose of the project is to decrease the amount of stormwater infiltration into the sanitary sewers and to provide additional transport capacity in sewer lines so that raw sewage will no longer overflow manholes or be discharged into the Bay during the rainy season.

LBL has funded a project that will replace portions of approximately 1,000 meters of underground sanitary sewer lines where a video survey has indicated the potential for imminent failure or leakage. This is the first section of piping to be replaced as a result of this survey. The system is over 50 years old, and portions have deteriorated or failed for a variety of reasons. Survey results revealed sewer breaks, offsets, obstructions, and undulations caused by ground movement and settling. These conditions result in excessive maintenance, sewer line cleaning problems, and possible soil contamination. Further surveys will be conducted as needed.

Storm Drainage System

LBL lies within the Strawberry Creek watershed, which in total contains about 354 hectares (874 acres). There are two main creeks in the watershed, namely the South Fork and the North Fork of Strawberry Creek. This watershed also includes other University of California property, public streets of both the cities of Oakland and Berkeley, and private property.

Because of its hillside location and moderate annual rainfall, surface runoff is a prevalent feature at LBL. An inclusive storm drain system, designed and installed in the 1960s, discharges into the North Fork watershed in Blackberry Canyon on the north side of LBL and the Strawberry Creek watershed on the south side (Figure 2-7). This system provides for runoff intensities expected in a 25-year maximum-intensity storm.

Stormwater runoff from LBL and from the upper parts of the North Fork watershed discharges into a 1.5-meter (60-inch) concrete culvert at the head of LeConte Avenue in Berkeley. The drainage facilities in this watershed have proven to be adequate during the heavy rains of the mid 1980s and the 1994/95 rainy season.

Grounds and buildings in the Strawberry Creek watershed area were heavily damaged during storms in October 1962. Subsequently, extensive improvements were made by LBL and UCB. These improvements included additional pipe and culvert capacity, a retention basin, trash racks, and hardening of stream channels. Current drainage facilities have been able to accommodate all runoff since the improvements have been made.

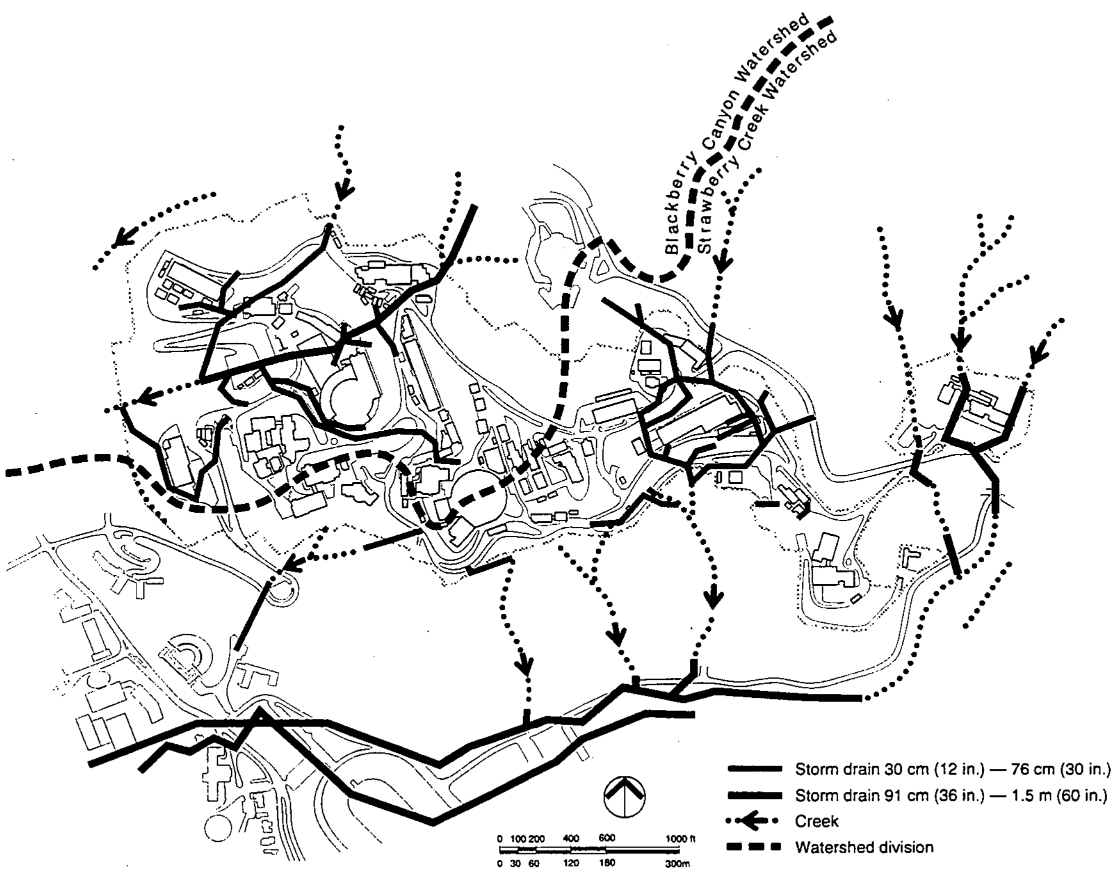


Figure 2-7. Stormwater Drainage

Laboratory Population

The most recent population figures for the Laboratory show over 3,400 full- and part-time employees. This translates to 2,750 full-time equivalent staff. In addition, LBL provided facilities in 1994 for approximately 1,800 guests who worked at the site for varying lengths of time. Over 700 of these guests were on site at any one time, giving an estimated population base at the Laboratory of about 4,200. A breakdown of the population by category is presented in Figure 2-8. Nearly 240 scientists are also faculty members at UC Berkeley or UC San Francisco. They and other LBL researchers provide guidance and opportunities for hundreds of undergraduate, graduate, and post doctoral students who pursue research at the Laboratory each year. Of the total population, including employees and guests, about 4,200 were located at the main site, nearly 800 were located in UCB campus buildings and the Richmond Field Station, and over 300 were located in offsite leased buildings.

Meteorology

LBL has a Mediterranean climate with cool, dry summers and relatively warm, wet winters. The proximity of the Pacific Ocean and the maritime air that flows through the Golden Gate moderate local weather, keeping seasonal temperature variations small. The mean summer (June through September) and winter (November through February) temperatures measured at LBL during 1994 were 15.4°C (60°F) and 9.5°C (49°F), respectively (Figure 2-9). The maximum temperature at the site was 31.2°C (88°F), while the minimum temperature was 2.3°C (36°F). Generally comfortable outdoor conditions prevail throughout the year, although occasional hard freezes in mid-winter and heat waves in summer can occur.

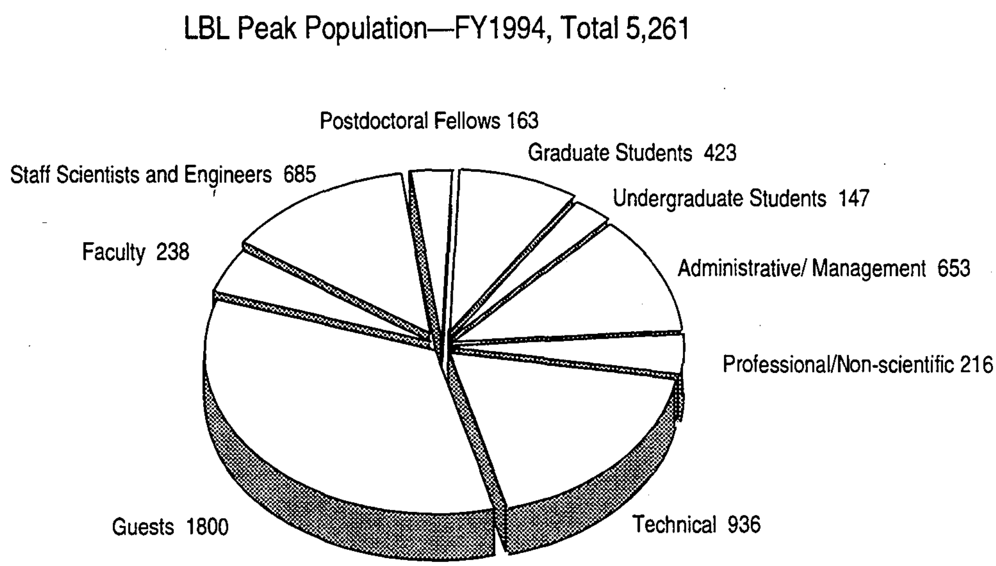


Figure 2-8. LBL Population, 1994

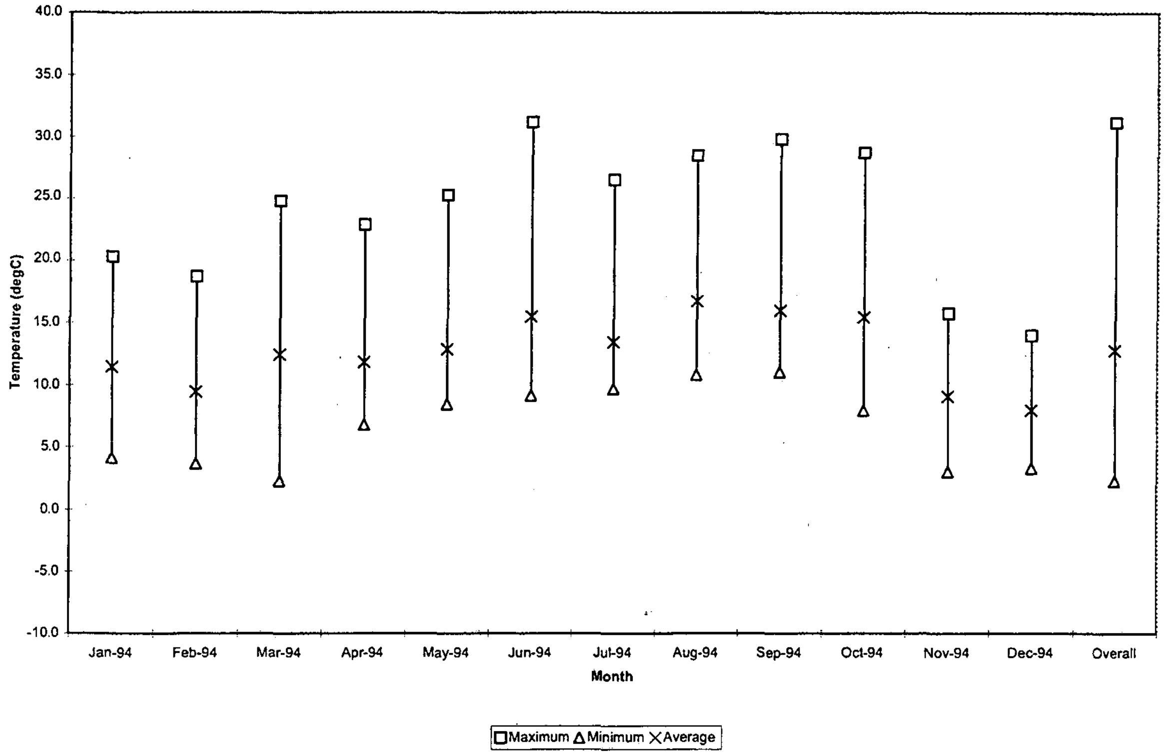


Figure 2-9. 1994 Temperature Summary by Month

Relative humidity ranges from 85–90% in the early morning, when ocean fog often blankets the site, to 65–75% in the afternoon. Annual insolation ranges from 65 to 75% of that which is theoretically available, and the average daytime cloudiness is about the same in summer and winter. Heating degree-days number about 2,600 and cooling degree-days about 150. Winds are generally light and from the southeast or west-northwest direction (Figure 2-10). Over 50% of the time, wind speeds were less that 1.5 meters per second (3.5 miles per hour) in 1994, while about 95% of the time, winds were less than 5 meters per second (11 miles per hour). Predominant wind patterns have winds blowing from the southeast during nighttime hours and from a westerly direction during the daytime. Drought periods of several years' duration are not uncommon, and neither are abnormally wet winters. On average, about 64 centimeters (25 inches) of precipitation falls at LBL annually. About 95% of this total occurs from October through April, the winter rainy season. Calendar year 1994 was an above-normal rainfall year, with about 70 centimeters of precipitation falling. See Figure 2-11 for a monthly breakdown of precipitation totals at LBL in 1994.

Geology

LBL occupies the west- and south-facing slopes of the Berkeley hills immediately east of the main UCB campus. Elevations range from approximately 200 meters (650 feet) to 330 meters (1,000 feet) above sea level. The LBL site is underlain by sedimentary and volcanic rocks whose interbedding, faulting, and folding have created a complex geological structure. In general, the bedrock is relatively weak and has weathered deeply, forming soils several meters thick.

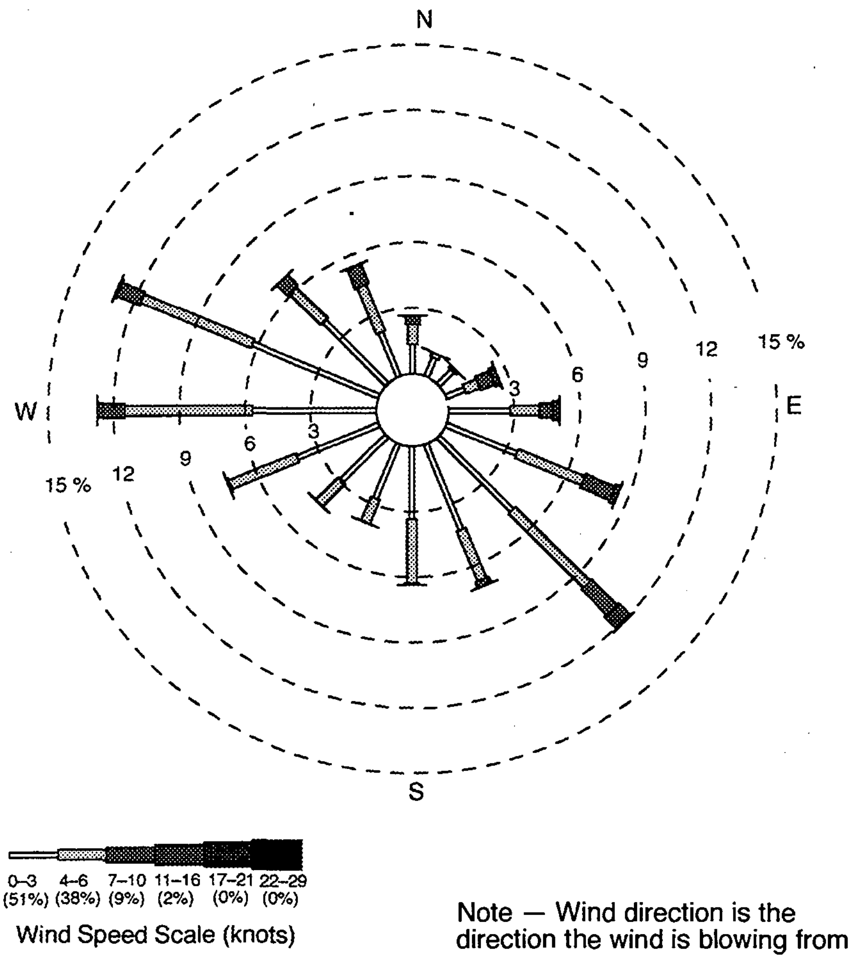


Figure 2-10. 1994 Wind Summary

Three major geologic formations have been identified at the LBL site. The western and southern parts of LBL are underlain by moderately to well-consolidated upper Cretaceous marine sediments. These rocks consist of shales, siltstones, sandstones, and conglomerates. The upper Miocene or lower Pliocene Orinda formation overlies the Cretaceous rocks and underlies most of the Laboratory property. It consists of poorly consolidated claystones, siltstones, sandstones, and conglomerates of relatively low strength and hardness. These rocks are blanketed by clay soils having high shrink-swell characteristics. The volcanic Moraga formation underlies most of the higher elevations of the Laboratory as well as much of the "Old Town" area around the Advanced Light Source. The Moraga formation overlies the Orinda formation. However, in some areas the volcanic rocks of the lower Moraga are interbedded with sedimentary rocks similar to the Orinda. The Moraga formation consists of basalt and andesite flows and pyroclastic tuffs.

Several other formations underlie the easternmost portion of the LBL site. These include siltstones of the Sobrante formation and siltstones and cherts of the Claremont formation. These rocks are separated from

1994 Rainfall

Month	total (cm)	accumulated (cm)
Jan	7.37	7.37
Feb	14.86	22.23
Mar	0.81	23.04
Apr	5.28	28.32
May	4.50	32.82
Jun	0.03	32.84
Jul	0.00	32.84
Aug	0.00	32.84
Sep	0.00	32.84
Oct	0.99	33.83
Nov	24.38	58.22
Dec	11.51	69.72

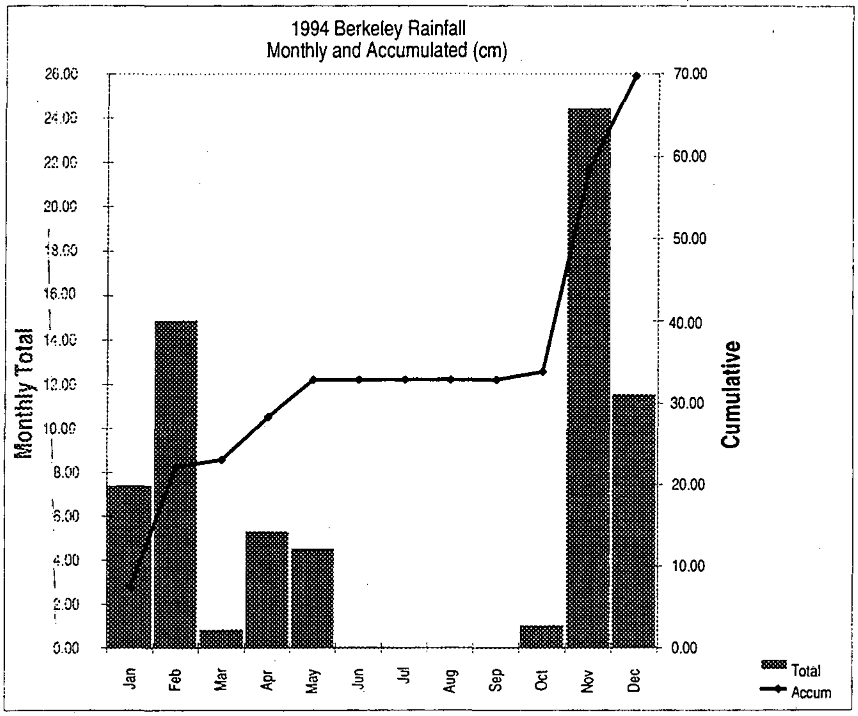


Figure 2-11. 1994 Berkeley Rainfall

the three main formations underlying the LBL site by the Wildcat Fault complex.

Due to the hilly terrain at the LBL site, extensive grading and filling has been necessary to provide suitable building sites. Consequently, cuts up to tens of meters deep have been made in some of the ridges and high ground, and fills up to tens of meters thick are present in some of the original ravines and depressions.

Landslide deposits have been encountered in numerous locations within the LBL site. Many of these slides are related to the contact between the Orinda and the Moraga formations and/or to cutting and filling of the original topography. A soft clay bed up to 0.3 meter (one foot) thick typically exists at the Orinda/Moraga contact. Slide planes develop readily in this material. During the past 20 years the Laboratory has carried out a program of slope stabilization, including shallow dewatering wells, vegetation cover, and soils management, to reduce the risk of property damage due to soil movement. In 1994 Phase I of a project to stabilize slopes behind Building 51 and Building 77 was completed; this involved placing pilings deep into the soil in both areas, installation of drainage systems, and replacement of unstable material.

Hydrogeology

The hydrogeology at LBL is complex. Year-round springs, annual surface seeps, and variable water levels in observation wells indicate discontinuous and localized aquifers. These conditions are due to a number of factors. The different rock units underlying LBL have contrasting permeabilities. Volcanic rocks are typically fractured, while the sedimentary rocks consist of interbedded impervious claystones and siltstones and include moderate-permeability sandstones. Orinda formation sandstones are discontinuous, and probably exist primarily as channel fillings in the claystones and siltstones. The relation between the high-permeability volcanic rocks and the low-permeability sedimentary rocks is complex due to paleotopography, interbedding, faulting, and folding.

Groundwater is a concern for LBL because of its potential effect on slope stability. The fractured bedrock underlying the Laboratory allows percolation that augments groundwater. Faults that cut through bedrock tend to drain groundwater, whereas clay layers impede or direct flow. LBL's complex geology includes both elements. Across the site, water-table depths vary from less than 3 meters (10 feet) to more than 27 meters (90 feet).

During the winter rainy season, groundwater levels and hydrostatic pressures increase, intensifying slide dangers. The Laboratory has installed an extensive system of monitoring wells, hydraugers, and storm drainage lines (Figure 2-7) to maintain slope stability. To control possible groundwater contamination, the Laboratory's Environment, Health and Safety (EH&S) Division has initiated a program that characterizes and remediates groundwater contaminants (see Section 7, Groundwater Protection).

Seismicity

LBL is located in a seismically active region (Figure 2-12). The Hayward Fault, a branch of the San Andreas Fault System, trends northwest–southeast along the base of the hills at the Laboratory's western edge. It has the potential to produce an earthquake of approximately Richter magnitude 7.5. Traces of the Wildcat Fault, also part of the San Andreas system, traverse the Laboratory site on the east, but analysis indicates no evidence that the fault is active in this area. Shorter, apparently inactive, subsidiary faults also transect the Laboratory.

The San Andreas Fault zone, which has potential for a magnitude 8.3 earthquake, lies about 32 kilometers (20 miles) west of LBL, offshore beyond the Golden Gate. The Calaveras Fault, another branch of the San Andreas, lies about 24 kilometers (15 miles) east of LBL. For an earthquake of any given magnitude, the Hayward Fault would produce the most intense ground shaking at LBL because of its proximity. No buildings or building additions are sited across the fault.

To reduce the potential for damage from seismic activity, the Laboratory has carried out a comprehensive earthquake safety program since 1971. All new facilities have been designed and constructed to resist the maximum credible earthquake estimated for the site. All existing LBL buildings have been reviewed, and 34 have been strengthened to meet current risk criteria. Building 90 underwent seismic strengthening in 1993 and 1994.

Biological Resources

Vegetation

Most of the major vegetation remaining within the LBL site is located around the periphery, away from the centrally developed portion. Originally the site was coastal shrubland, but during the last 100 years the area was extensively grazed by cattle and, except near creeks, became primarily grassland. Since cattle-grazing operations ceased in the 1950s, Baccharis brushland has reestablished itself on open slopes, and introduced trees, especially eucalyptus, oak, and

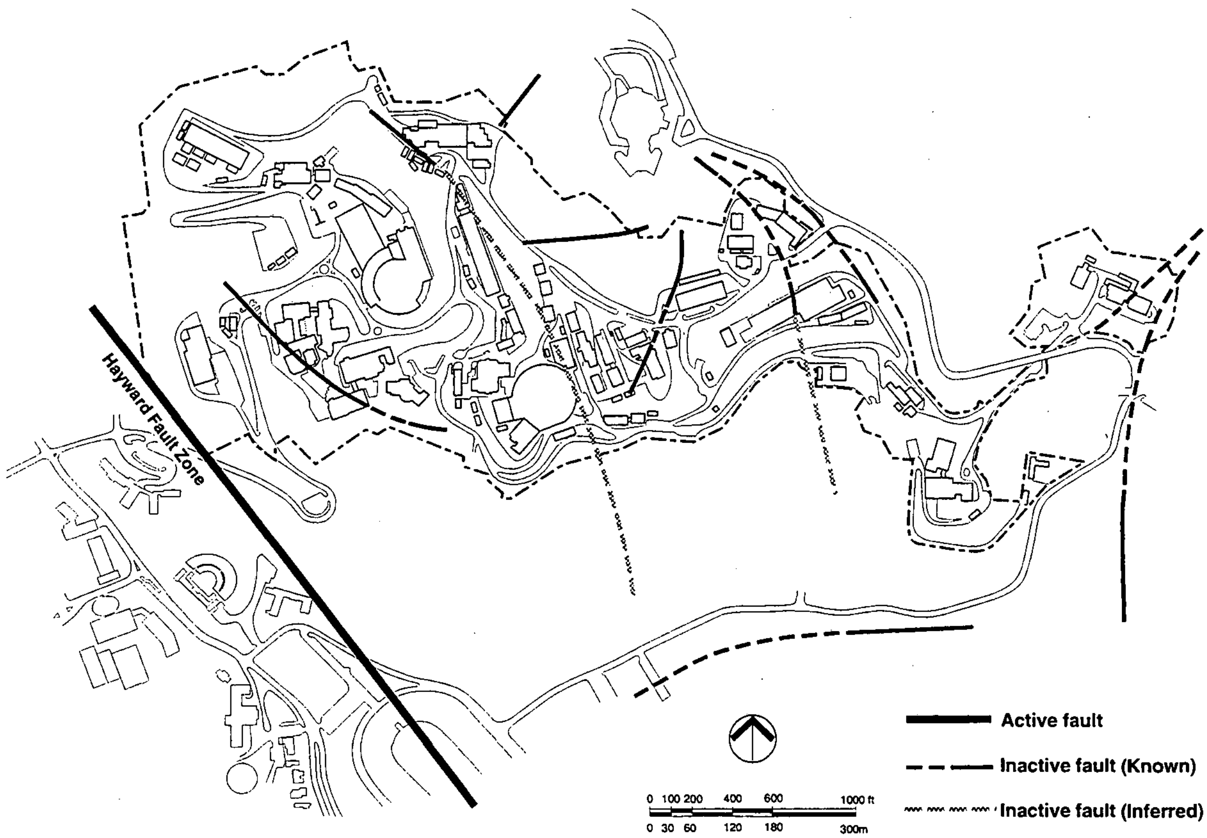


Figure 2-12. Mapped Seismic Faults

evergreens, have formed large stands. Without management intervention or occasional wildfires, open areas of the site will continue the transition to an oak-bay woodland.

Vegetation on the Laboratory site can be broadly categorized into four types: native woodland, eucalyptus plantations, a hillside habitat of grasses and brush, and mixed introduced species (which include ornamental plantings near buildings). Only the remnant stands of oak-bay woodland consist of species native to the site. The most common and widespread vegetation types on the Laboratory site are the hillside habitat and the eucalyptus plantations. The open grassy slopes of the hillside habitat occur primarily in the eastern portion of the Laboratory, while the western portion of the site is more heavily forested (Figure 2-13).

Native Woodland

A mix of Coast Live Oak (*Quercus agrifolia*) and California Bay (*Umbellularia californica*) occurs naturally in ravines and drainages that retain some moisture during the long dry season. The understory can be quite open under the spreading canopies or dense with tangled underbrush. The trees grow relatively slowly, reaching a height of up to 15 meters (50 feet) in about 25 years.

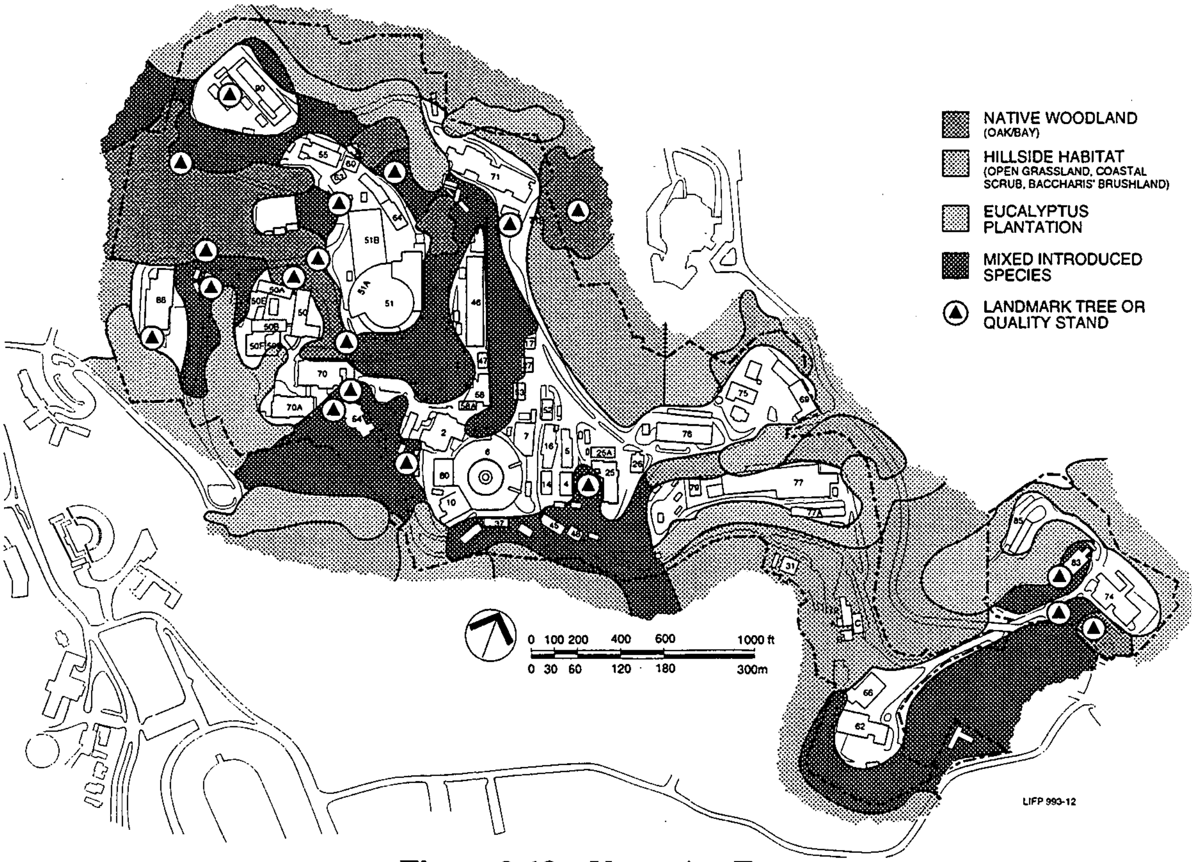


Figure 2-13. Vegetation Types

Eucalyptus Plantations

The Berkeley Hills have been widely planted with introduced eucalyptus, primarily *Eucalyptus globulus*, the Blue Gum eucalyptus. The Laboratory has extensive stands of this tree both on the site and surrounding its borders. Several other eucalyptus species also occur on the Laboratory singly or in small clusters. The Blue Gum eucalyptus grows vigorously and tall, easily reaching a height of 24 to 30 meters (80 to 100 feet). Fruit drop, leaf debris, and large pieces of exfoliated bark from the trees present maintenance and fire management concerns, although eucalyptus stands usually have an open understory.

Hillside Habitat

Several types of grassy, brushy vegetation share the open slopes on and around LBL. Coyote Brush (*Baccharis pilularis*) occurs in sporadic clumps until it spreads sufficiently to form a dense shrub mass about 2 meters (6 feet) tall. Coastal scrub areas on south- and west-facing slopes host sparse, low shrubs up to 1 meter (3 feet) tall dominated by California Sagebrush (*Artemisia californica*). Introduced annual grasses have naturalized in open areas and on most disturbed sites. The major grass species present are Soft Chess (*Bromus mollis*), wild oats (*Avena* spp.), and wild barley (*Hordeum* spp.) Low broad-leaved plants commonly associated with annual grassland include Rabbit-foot Clover (*Trifolium arvense*), Cut-leaved Geranium (*Geranium dissectum*), and

English Plantain (*Plantago lanceolata*). Recent hydroseeding operations to control surficial erosion have used native grass seeds (*Stipa pulchra* and *Stipa sernua*) for their deep rooting and drought-resistant characteristics.

Mixed Introduced Species

Introduced species include trees native to the State, but not naturally occurring on the site, such as Monterey Pine (*Pinus radiata*), Knobcone Pine (*Pinus attenuata*), Canary Island Pine (*Pinus canariensis*), and Coast Redwood (*Sequoia sempervirens*). The conifers are fast-growing trees with a generally sparse understory.

A variety of other introduced ornamental species of trees, shrubs, and perennials has been planted around existing facilities. Many are not Mediterranean-type species and so have not evolved to withstand a long annual dry season. These introduced species require regular supplemental irrigation to maintain health and appearance.

Landscape Buffers

To facilitate appropriate siting of buildings and to protect important open space areas, the Laboratory has established nine landscape buffer zones across the site (Table 2-2 and Figure 2-14). The Laboratory manages these landscape buffers for a variety of functions:

Table 2-2. Landscape Buffer Zones

	Planning and Protection Criteria				
	Views or Exposure	Building Density	Hydrology and Stability	Vegetation	Special Considerations
A. Central Blackberry Canyon			•	•	Forested area with creek
B. West Strawberry Canyon	•			•	Bay view; eucalyptus, dawn redwoods, and cork oaks
C. Light Source Area	•	•		•	Sequoia redwoods, building density
D. East Strawberry Canyon	•	•		•	Dawn redwoods, other evergreens
E Life Sciences Area	•			•	Forested area; evergreen and eucalyptus
F. Grizzly Gate Perimeter	•		•		Slope stability
G. Northeast Perimeter	•		•		Stability, drainage, and exposure
H. Bevalac Perimeter	•	•	•	•	Slope stability; evergreen trees
I Blackberry Canyon	•			•	Exposure, eucalyptus trees

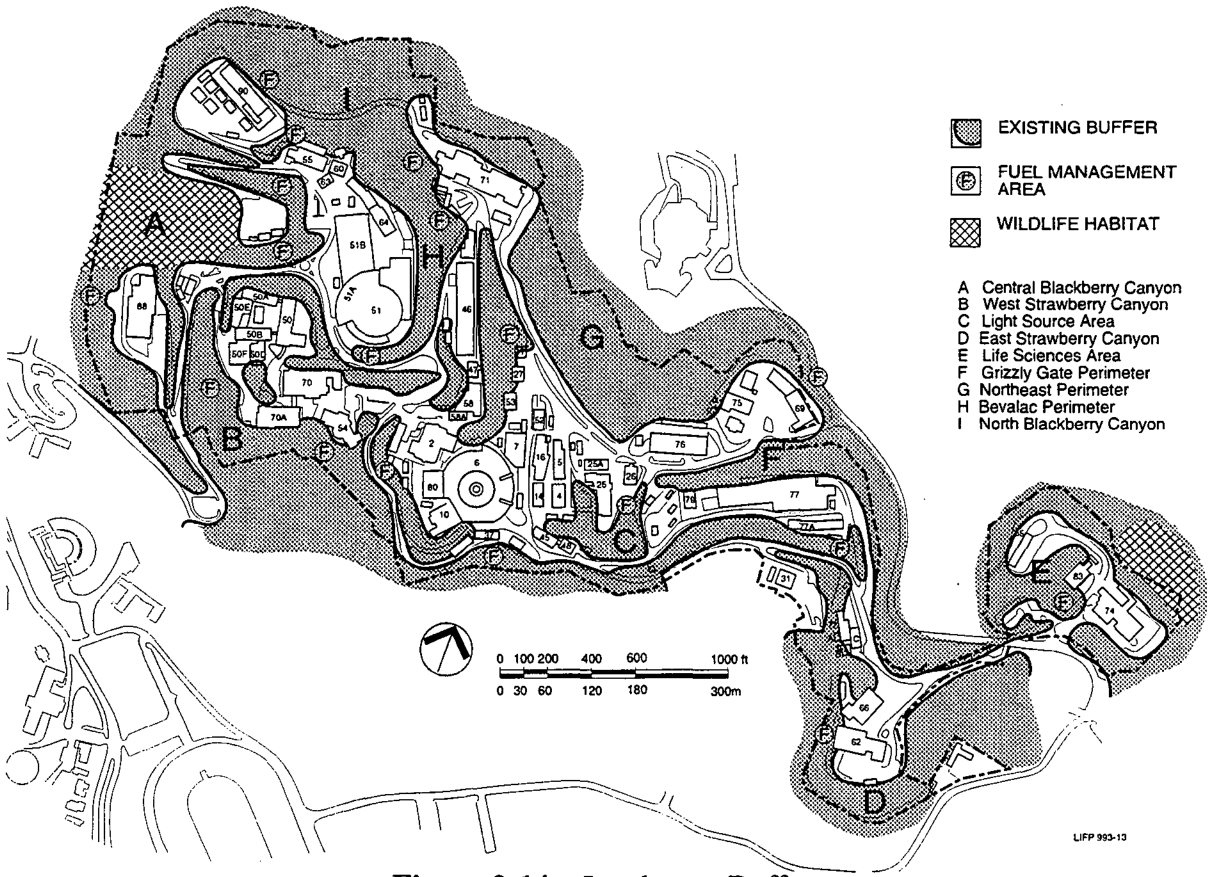


Figure 2-14. Landscape Buffers

- site amenity for employees and visitors
- scale and context for Laboratory development
- separation of adjacent uses, internal and external
- visual and sound screening, internal and external
- microclimate modification
- erosion control
- wildlife corridors and habitat.

An important feature of the landscape buffers is their capacity to blend the developed LBL areas with the surrounding hillside context. Except on the western edge, perimeter landscape buffers merge with adjacent open space beyond the LBL fence line.

Erosion Control

The steepness of the Laboratory site makes protection from wind and water erosion a serious concern. Vegetation provides the best control of surficial erosion by reducing the impact of rain on soil, while plant roots stabilize and hold topsoil.

In 1992, LBL developed a hydroseed project to revegetate bare soil areas on the Laboratory site. The seeding operation depends on winter rains sufficient to produce germination without washing the seed away. Variable weather can require repeated applications for success.

LBL also uses other means to control surficial erosion, including retaining walls, slope terracing, and paving of footpaths.

Fire Management

Within the LBL fence line, most of the Laboratory's north perimeter is managed as a fuel or fire break (Figure 2-14). Control of vegetation is an important element of the *Hillside Fire Management Plan.* Fire protection along the south and east perimeters is complicated by limited buffer space within the fence line and proximity to less-managed University lands.

Since the fire of October 1991, which devastated the adjacent Berkeley/Oakland Hills south of the Laboratory, LBL has updated and intensified its fire management efforts. The primary objective of the renewed effort remains to reduce and control fire hazards in the outdoor areas of the Laboratory. The basic strategy involves reducing fuel loads and fire "laddering" capabilities.

A management and reforestation plan is currently being developed in order to assure long-term continuity in LBL's landscape value. Both inappropriate species and declining trees will require replacement, and the Laboratory will benefit from increased tree cover in several areas.

Wildlife

In general, the Laboratory site supports habitats and associated wildlife that are typical of disturbed portions of the Berkeley-Oakland hills. Approximately 79 species of birds, 20 mammal species, and 19 reptile and amphibian species, none rare or endangered, occur on or near the site.

The most significant wildlife habitats at LBL (Figure 2-14) occur in Blackberry Canyon and to a lesser degree at the northeasterly edge of Functional Planning Area 7, also known as the East Canyon. The lower portion of Blackberry Canyon supports a relatively intact oak-bay woodland, but it is completely surrounded by development, so the habitat is small and limited. The East Canyon area is rated as important because of the high interspersion of habitats and the proximity of adjacent undeveloped lands.

The Baccharis brushland at LBL provides cover, food, and breeding sites for a variety of common birds, reptiles, and small mammals of the region, the dominant mammals of which are brush rabbits and mule deer. The Laboratory's tree stands offer nesting sites for many bird species; during the flowering season, the eucalyptus provide food for nectar-eating birds. In general, the sparse tree understory offers poor wildlife habitat.

Historical and Archaeological Resources

A surface examination of all undeveloped land and proposed building locations within LBL was completed during the preparation of the 1987 Long Range Development Plan Environmental Impact Report.

A check of the data on file with the Archaeological Resource Service indicated that no new archaeological sites have been reported since their last review of this literature, performed in 1982.

Three archaeological sites have been identified that are associated with the Strawberry Creek drainage, the main natural drainage channel through the campus. No prehistoric cultural resources are reported to lie within LBL, as delineated by the chain link fence that borders the Laboratory area.

On July 14, 1986 a surface reconnaissance was conducted of the proposed building locations at LBL and any other open ground accessible within the fenced LBL area. All reasonably accessible parts of the LBL area were examined. Special attention was given to areas of relatively flat land, or rock outcrops. The steep hillsides were not examined intensively, although transects through accessible areas were made.

No indications of historic or prehistoric archaeological resources were encountered in any location within the project area. As previously indicated, the Laboratory is located on steep hillsides with limited amounts of flat land. Those relatively flat areas that do exist are generally covered by buildings or parking areas. Cut and fill operations have been numerous. It appears that all of the LBL areas that might have been suitable for prehistoric occupation and use have been utilized by LBL already. Building 6 (now the ALS and formerly the 184-inch Cyclotron) occupies the most likely area to have contained evidence of prehistoric human occupation or use. Thus far, no evidence of any such use has been uncovered.

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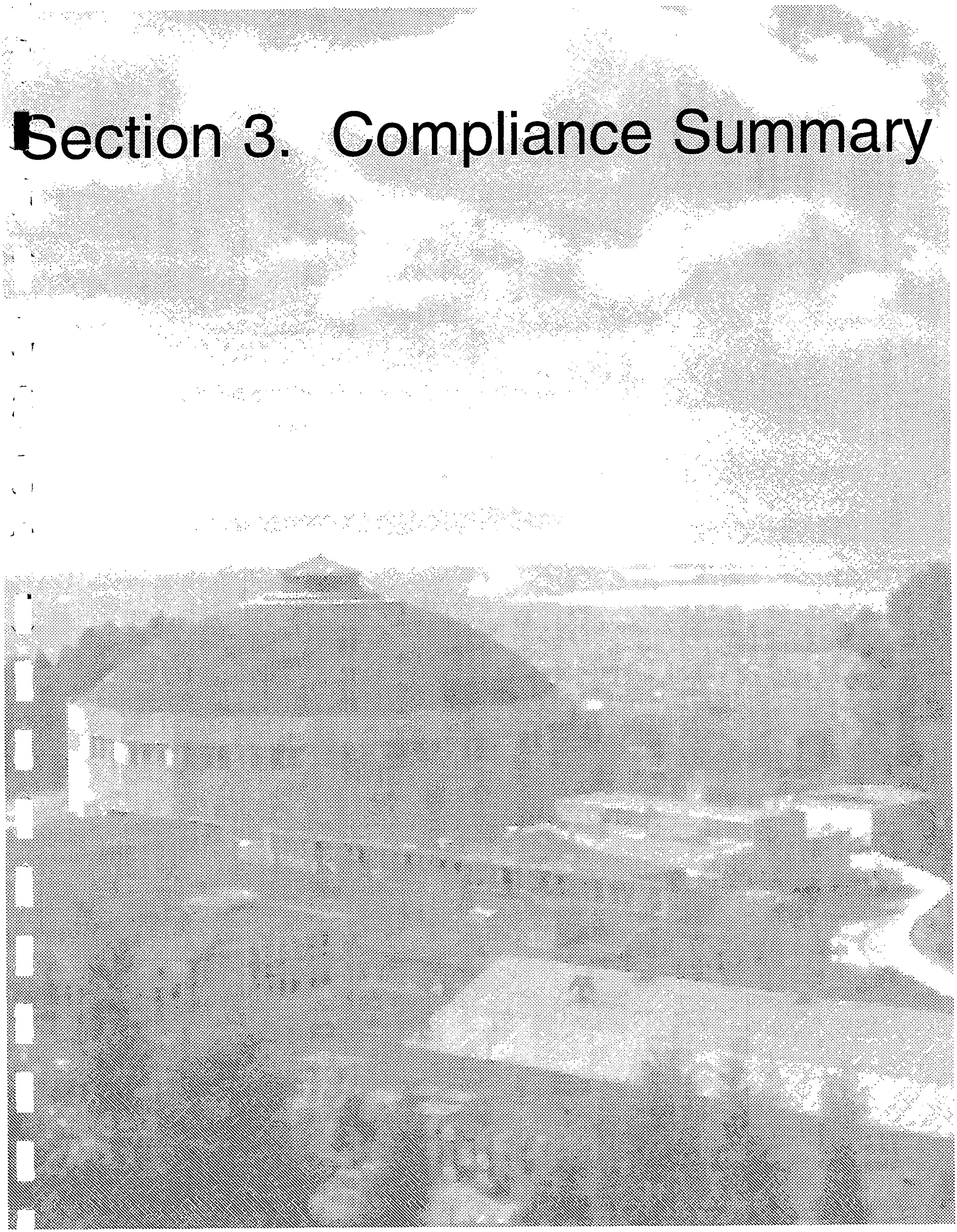
Section 3. Compliance Summary



This section of the report summarizes LBL's compliance status during 1994 with major federal and state environmental statutes and federal executive orders. The status of compliance activities and corrective actions is presented, along with information concerning regulatory inspections, notices of violation issued to the Laboratory, and important regulatory developments affecting LBL. Also included is a discussion of the environmental permits at LBL and noteworthy practices in the Laboratory's environmental programs.

Clean Air Act (CAA)

Enacted initially as the Air Quality Act of 1967, the Clean Air Act[2] was most recently amended in 1990 in a multipurpose effort to:

- protect and enhance the nation's air quality through more stringent standards and control methodologies,
- increase research into prevention and control of air pollution, and
- assist state and local governments in developing their air pollution programs.

The amendments also establish a new goal of promoting pollution prevention. The Clean Air Act is the key statutory reference for federal, state, and local air pollution control programs. It classifies air pollutants into several main classes including:

- air pollutants (e.g., carbon monoxide, nitrogen oxides, particulate matter),
- hazardous air pollutants (e.g., volatile air toxics or radionuclides), and
- ozone-depleting substances (e.g., chlorofluorocarbons or "freons").

The State of California has its own statutory air pollution control program,[3] which was updated significantly in 1988. This Act gives the State additional powers to control sources of air emissions. In complying with the federal and state requirements, air quality protection activities at LBL are divided into two main categories: radiological and nonradiological.

Radiological NESHAPs

In April 1991, US/EPA issued a Finding of Violation to LBL because some of the smaller radiological air emission sources were not evaluated according to the requirements of 40 CFR 61, Subpart H, *National Emissions Standard for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities.*[4] This regulation is a subpart of the National Emission Standards for Hazardous Air Pollutants (NESHAPs).[5] NESHAPs, and DOE Orders 5400.1 and 5400.5, are the compliance standards steering this program at LBL.[6] Since this inspection finding by US/EPA, LBL's radiological air quality program has been undergoing a series of measures to bring the Laboratory into full compliance with this regulation. As a result of US/EPA's Administrative Order and Finding of Violation, US/EPA and DOE signed a Federal Facilities Compliance Agreement (FFCA)[7] in September 1993 aimed at bringing LBL's radiological NESHAPs program into full compliance by February 1995. Prior to the signing of this agreement, LBL embarked upon a $1.8 million corrective action project that would upgrade its stack-emissions monitoring program to NESHAPs standards. The compliance schedule in the FFCA identified 12 milestones for activities related to this corrective action project. Prior to 1994, eight of these milestones had been fulfilled by LBL. The compliance schedule included two more milestones in 1994 and the final two in early

1995. As of this writing, all four of these milestones have been completed, thus achieving completion of the FFCA schedule and drawing to a close this significant corrective action project. The final four milestones were related to the installation and close-out portions of the project, and specifically included:

- bid and award equipment procurement and installation contract
- complete monitoring equipment installation
- complete system startup and test
- project completion and documentation

Further information on this NESHAPs stack-monitoring upgrade project can be found in the Corrective Action Projects portion of Section 4, *Environmental Program Information.*

A follow-up US/EPA inspection in 1993 found no violations in LBL's radionuclide NESHAPs program. There were no US/EPA inspections of the program in 1994. However, there was an anomalous release of tritium from the National Tritium Labeling Facility during the week of September 23 through 30. Analytical results and stack flow measurements estimate that approximately 1.1 terabecquerels (TBq), or 29 Curies (Ci), of tritium was released during this period. This release represents about 30% of the usual annual release of tritium from the NTLF. The calculated dose to the maximally exposed offsite individual was 0.0006 millisieverts (mSv) (0.06 millirem [mrem]), well below the average daily background radiation exposure from natural sources of 0.01 mSv (1.0 mrem). While this release was higher than normal, it was below any regulatory reporting thresholds.

LBL's investigation into this incident identified the root cause as an inadequate man-machine interface in the NTLF's Tritiation and Recovery System (TRS). This deficiency prevents the operator from being aware of a malfunctioning heating tape. LBL corrected the problem by installing thermocouples on all six critical areas of the oxidation loop in the TRS, with a digital readout installed in the Tritiation Laboratory.

LBL collaborated with US/EPA's Headquarters and Region IX to serve as the host site for a 3-day class between June 14–16 entitled *Conducting Radionuclide NESHAP Inspections at Department of Energy Facilities.* Topics covered in the class included a regulatory overview of radiological NESHAPs, computer air dose modeling, representative sampling methods and monitoring systems, inspection techniques, site evaluation, and quality assurance. The class included a field tour of one of LBL's stack-monitoring systems undergoing modification as part of the FFCA. The class was taught jointly by a team of US/EPA and DOE staff. Class participants included personnel from the California Department of Health Services (DHS), as well as the DOE contractor facilities in the Bay Area, including LBL.

Nonradiological

The Bay Area Air Quality Management District (BAAQMD) is the implementing agency for federal and state air quality requirements for nearly all air emission activities. BAAQMD conducted three separate inspections of air emissions activities in 1994. There were no findings or violations from any of the three inspections. See Table 3-1 for a list of all regulatory agency inspections and DOE audits of LBL held in 1994.

Table 3-1. Environmental Inspections of LBL During 1994

Inspection Title	Visiting Organization	Start Date	Duration (days)	Violations, Findings or Concerns
Annual Inspection of Newly Permitted Sources	BAAQMD	1/6/94	1	0
Underground Storage Tanks	City of Berkeley	1/27/94	1	0
FY 1994 Low Level Waste Generators Hanford Management Assessment	DOE/HQ	2/1/94	3	0
Underground Storage Tanks	City of Berkeley	2/25/94	1	0
Storm Water Monitoring Program and Storm Water Pollution Prevention Plan	City of Berkeley	3/22/94	1	0
SAA/WAA Walkaround	DOE-OAK	3/22/94	1	0
Department of Transportation Hazardous Materials Shipper	DOT	3/24/94	1	0
Underground Storage Tanks	City of Berkeley	3/29/94	1	0
SAA/WAA Inspection	DOE	6/1/94	1	0
Asbestos Renovation	BAAQMD	6/2/94	1	0
Medical Waste Inspection	DHS	6/13/94	1	0
Medical Waste Compliance	DHS	6/14/94	1	0
Hazardous Materials Packaging and Transportation	DOT	6/21/94	1	0
US/EPA TSCA Inspection of PCB Operations	US/EPA	6/29/94	1	0
Agreement in Principle Inspection of Storm Water Monitoring Sites	DHS	6/30/94	1	0
DOE/OAK Air Quality Surveillance Appraisal	DOE/OAK	7/26/94	1	0
Conduct of Operations	DOE/HQ	9/19/94	5	3[A]
Preparation of Safety Analysis for Existing HWHF	DOE/OAK	11/3/94	1	0
EH-24 Environmental Programs Audit	DOE/HQ	11/7/94	10	6[B]
Annual Inspection of Permitted Sources	BAAQMD	11/10/94	1	0
Review of RMPP Operations	City of Berkeley	11/14/94	1	4[C]
National Pollutant Discharge Elimination System BMPs	City of Berkeley	12/22/94	1	0

[A] LBL has proposed that 2 of the 3 concems were invalid. DOE has not yet responded to LBL's request.

[B] Nine findings were mentioned by the audit report. However three of the findings were for DOE/OAK and DOE/BSO programs.

[C] All four concems were for lack of restraining or stabilization of equipment.

The first inspection occurred on January 6. This was an initial inspection of 15 newly permitted sources approved by BAAQMD in the latter half of 1993. These sources included 14 building-wide solvent wipe-cleaning activities and one semiconductor fabrication laboratory. Future inspections of these sources will coincide with the routine annual inspection program administered by BAAQMD.

The second BAAQMD visit occurred on June 2 to observe contractors performing asbestos-renovation work on water heater insulation in Building 74. An inspection of this nature is common after the required notice is filed with the regulatory agency indicating the schedule for the asbestos-renovation activity. In addition to the larger asbestos-removal jobs, which require individual notification, LBL submitted a notice to BAAQMD in August indicating that the facility had reached the cumulative limits for small asbestos renovations (i.e., individual projects below 30.5 meters [100 feet], 9.4 square meters [100 square feet], or 1 cubic meter [35 cubic feet]). The last BAAQMD inspection of the year occurred on November 10. The inspection confirmed that permitted printing press activities at off-site Building 934 had been eliminated.

One of LBL's most important permitted sources, a vapor degreasing system (BAAQMD source S-92), was out of service for most of 1994 because of a conversion project in Building 77. A project to convert the Plating Shop to an Ultra-High Vacuum Cleaning Facility (UHVCF) entered the construction phase in May and continued until early 1995. With Source S-92 not available during this period, LBL needed to find an alternative for performing precision parts cleaning functions for the many users on site who rely on this key unit. To compensate for this temporary loss, LBL filed a variance with BAAQMD that requested a solvent usage increase of 475 liters (125 gallons) of 1,1,1-trichloroethane during the period June 6, 1994 through March 5, 1995 using a different, although much smaller, vapor degreasing system (source S-140) on site. There was no projected net emissions increase from this request since the amount used at S-140 was less than the amount saved by S-92's shutdown. The BAAQMD Hearing Board approved LBL's variance request on June 16 for this additional solvent usage at source S-140.

BAAQMD rule-making activity was very brisk in 1994, as the agency continued to implement the requirements of the Clean Air Act Amendments of 1990 and the California Clean Air Act of 1988. The BAAQMD Board of Directors approved changes to 42 existing rules and adopted 7 new rules during the year.[8] Approximately 20 of these rules have a direct impact on LBL activities. Examples of rules that will affect LBL include those for gasoline-dispensing facilities, coating activities, adhesive and sealant use, and solvent-cleaning operations, as well as general permitting and fee requirements.

Boiler Emissions

In one of several notable actions related to changes in BAAQMD regulations, LBL submitted its compliance plan to BAAQMD in December for a regulation intended to reduce oxides of nitrogen and carbon monoxide emissions from boilers.[9] This regulation gave LBL until January 1, 1995 to submit this plan. LBL identified four boilers affected by this rule and elected to comply with the tune-up procedure option in the rule. Other options available included installing emissions-control devices and gaseous monitoring instrumentation. The tune-up option was selected as the most cost effective for LBL. All four boilers are rated as low-fuel-usage types by BAAQMD. The other options would have required significant modifications to each boiler.

Transportation Control

BAAQMD Regulation 13-1,[10] adopted in late 1992 for companies with more than 100 employees, became effective for LBL beginning July 1, 1994. Compliance with the regulation is managed by the Site Access Services organization in the LBL Materiel and Site Logistics Department. The purpose of the regulation is to reduce the number of vehicle trips to large employer sites during commute hours. The regulation has established performance objectives designed to increase the average number of employees per vehicle that arrives on-site during normal commute hours. As the rule presently stands, there are no penalties for not achieving the performance objectives. There are penalties, however, for not satisfying the required milestones of the rule. There were two milestones for LBL in 1994. First, by September 30, LBL registered with BAAQMD as a larger employer (i.e., greater than 100 employees). Registration included designating an Employee Transportation Coordinator and an Employer Program Manager. Both positions were assigned from within LBL's managing department. Second, LBL completed an employee transportation survey during November, prior to the rule's deadline of November 30. LBL chose to use a standardized format adopted by regional planning agencies. The survey was sent to a random sample of employees and requested that they track their commute patterns during the survey week. Failure to respond to the survey is treated conservatively by BAAQMD, and that employee is considered a single occupant commuter. Results of the survey are not yet available. If the survey results do not show LBL achieved desired ridership levels, then more restrictive plans will be needed to meet the performance objectives in the regulation.

Adhesive and Sealant Products

In November, BAAQMD modified Regulation 8-51[11] for implementation on January 1, 1995. This rule is intended to limit the emissions of volatile organic compounds from a wide range of adhesive and sealant products through content limits on products and usage records. Because of the undue burden of maintaining the required monthly facility-wide use records, from small quantity, but widely distributed and numerous, users of these products like LBL, the Laboratory has worked cooperatively with BAAQMD and other DOE facilities in the region on alternative recordkeeping options. In February 1995, LBL submitted an alternative recordkeeping plan to BAAQMD for approval that will be linked with the site's Chemical Inventory Database. This database is a comprehensive site-wide hazardous material tracking system that was initially developed for compliance with the State's Business Plan Act and is being enhanced and used to serve air quality, waste minimization, and other environmental needs as well. BAAQMD approved the LBL plan on April 4, 1995.

Title V Operating Permit

In one other major regulatory development involving BAAQMD, implementation of the Title V operating permit section of the Clean Air Act Amendments of 1990 continued. As the local administering agency of most federal and state air quality laws for stationary sources, BAAQMD has attempted to integrate Title V's new facility-wide permitting requirement with their long-standing permitting system. BAAQMD has worked closely with US/EPA to develop a combined-permit system that meets federal and state requirements. In late 1993, BAAQMD adopted Regulation 2-6, *Major Facility Review*,[12] for those facilities considered major sources by Title V. Major sources in the Bay Area are defined as having the potential to emit more than 9,100 kilograms (10 tons) per year of a single hazardous air pollutant, more than 23,000 kilograms (25 tons) per year of all hazardous air pollutants, or more than 91,000 kilograms (100 tons) per year of any regulated air pollutant. LBL is considered a major source for its potential to emit, although its actual emissions fall well below the above thresholds. Potential to emit is the maximum capacity to emit a pollutant based on physical and operational design. Typically, this assumes around the clock operation for the entire year at full operational capacity. A research facility does not approach these maximum conditions.

There are two categories of permits available under the BAAQMD rule: major facility and synthetic minor. The synthetic minor permit allows facilities to limit actual emissions to below Title V thresholds through federally enforceable permit conditions. With either permit type, a significant effort to apply for and maintain the comprehensive permit will be required. If electing to apply for a synthetic minor permit, LBL will have until November 1997 to prepare and submit this application. Whichever permitting option LBL elects to pursue, the facility will be required, at a minimum, to keep additional site-wide records.

BAAQMD proposed additional changes to its Title V regulation in 1994. The proposed changes include a third permit category that LBL may qualify for, given the Laboratory's actual facility emissions. The new prohibitory permit category will set *de minimus* levels below which a facility is exempt from any Title V requirements. The latest facility-wide inventory of annual air emissions indicates the following approximate quantities:

Regulated Air Pollutants

- 2,000 kilograms (4,400 pounds) of carbon monoxide
- 8,950 kilograms (19,750 pounds) of nitrogen oxides
- 1,050 kilograms (2,300 pounds) of all organic compounds
- 6,350 kilograms (14,000 pounds) of particulate matter
- 1,925 kilograms (4,250 pounds) of Class I ozone-depleting substances

Hazardous Air Pollutants (HAPs)

- 1,225 kilograms (2,700 pounds) of 1,1,1-trichloroethane
- 3,200 kilograms (7,000 pounds) of all HAPs

Ozone-Depleting Substances

The Clean Air Act Amendments of 1990 also require the production phase-out of ozone-depleting substances (ODSs). ODSs are divided into two categories based on a substance's ozone-depletion potential; Class I and Class II. The production phase-out for Class I is the end of 1995. Class II products have staggered phase-out dates beginning in 2005. LBL has established an aggressive program for eliminating or reducing its ODS usage in solvent cleaning, packaging materials, refrigeration and air conditioning, and fire suppression operations in response to requirements of Title VI and other mandated requirements (see Executive Order 12843 later in this section). LBL's ODS reduction program is designed to comply with US/EPA's Significant New Alternatives Policy (SNAP)[13] program for ODSs. In November, EH&S issued an ODS buying policy and guidelines to purchasing staff in an effort to eliminate the introduction of new equipment containing ODS products, especially Class I. The guidelines are meant to inform buyers of the phase-out requirements and the acceptable alternatives. The guidance materials will be updated periodically in response to changes in the SNAP program. Based on a 1990 baseline inventory of ODS sources at LBL, almost 37 percent of the Class I ODS inventory had been eliminated from the site by the end of 1994. Present commitments to eliminate other ODS sources should bring the total to nearly 65 percent by December 31, 1995, the Class I phase-out date. Efforts to date include

- replacement of two of the five onsite vapor degreasing systems with alternative cleaning systems, and funding to replace additional systems in 1995;
- conversion of one centrifugal chiller in Building 2 and funding for conversion of a second chiller in 1995, leaving only 2 centrifugal chillers onsite (Building 50 complex) needing replacement; and
- replacement of approximately a dozen of the highest priority walk-in coolers, ultra-low-temperature freezers, and ice machines around the site.

Funding for additional conversions and equipment replacement are included in future-year budgetary requests. In addition to conversion and replacement activities, LBL has installed ODS leak detection sensors in the 11 machine rooms onsite in which more than 23 kilograms (50 pounds) of ODSs are either used or stored. The sensors are connected to LBL's energy management system, which can notify Facilities Maintenance and Operations (M&O) staff to respond in the event of a system leak. The joint accomplishments to date by EH&S and Facilities in responding to the pending phase-out of ODSs have significantly reduced the Laboratory's actual and potential emissions of Class I ODSs to the environment and lowered the cost to comply with the impact of Title VI.

Clean Water Act (CWA)

The Clean Water Act of 1977[14] amended the Federal Water Pollution Control Act Amendments of 1972, which itself was a consolidation of the original Federal Water Pollution Control Act of 1956, the Water Quality Act of 1965, the Clean Water Restoration Act of 1966, and the Water Quality Improvement Act of 1970. The Act's purpose is to control the effluent discharge of pollutants to navigable waters. To accomplish this goal, separate regulatory programs are in place for point and non-point discharge sources. Point sources are discrete sources, including Publicly Owned Treatment Works (POTWs). As the POTW serving LBL, the East Bay Municipal Utility District (EBMUD) has established sanitary sewer discharge limits[15] to satisfy CWA requirements. Non-point discharges at LBL are generally thought of as stormwater runoff, although activities such as hydrant flushing and vehicle washing fall under this category. The California State Water Resources Control Board (SWRCB) is authorized to administer the non-point source control program in the state.

LBL's sanitary sewer discharge activities in 1994 did not violate any of the limits in the site's wastewater discharge permits. On September 15, however, EBMUD did assess a violation follow-up fee of $300 for failure to notify the District in a timely fashion of a slug discharge. A slug is defined by EBMUD as "any discharge of a non-routine, episodic nature, including but not limited to an accidental spill or a non-customary batch discharge." The incident occurred at the Fixed Treatment Unit (FTU) at Building 2 on August 23, when an electrical or mechanical malfunction in the unit caused a release of about 110 liters (30 gallons) of low-pH liquid to the sanitary sewer, containing approximately 1 liter (0.3 gallons) of untreated acid. When reporting this incident to EBMUD, LBL provided a worst-case estimate of 330 liters (90 gallons). This represents the capacity of the surge tank. LBL undertook an investigation to determine the cause of the late reporting. Corrective action included replacing the defective or failed parts, and meeting with M&O in order to determine what controls could be put on the system to prevent a reoccurrence. Controls added included interlocking systems that disable system pumps and prohibit the discharge of effluent to the sanitary sewer when the pH alarm is triggered. Audible and visible alarms were provided at the building and at the M&O operational headquarters. Additionally, the reporting procedure for nonroutine slug discharges to EBMUD has been changed. It is now the responsibility of the FTU operator to call the EBMUD shift supervisor within thirty minutes of discovering a potential slug discharge. Training sessions were held with M&O personnel to implement the new procedure, and appropriate notices have been posted at the treatment unit. The LBL *Accidental Spill Prevention and Containment Plan* was expanded to cover the units at Buildings 2 and 70A, and relevant procedures were changed accordingly.

Throughout 1994, LBL remained in compliance with all other terms and conditions of its wastewater discharge permits. As a result of LBL's recent compliance record, EBMUD reduced the required annual self-monitoring events at Building 25 from four to two when it issued new permits in October. Additionally, a previous requirement to certify compliance (i.e., non-discharge of any fixer-containing process water) for all the photoprocessing units at LBL was eliminated entirely. However, during March and April 1995, self-monitoring by LBL at its Strawberry outfall revealed a string of sanitary sewer exceedances attributed to methylene chloride. This monitoring point represents the confluence of two main sewer lines that transport wastewater discharge from LBL and University of California at Berkeley facilities in the Strawberry Canyon and eastern LBL region. In addition to notifying EBMUD of these sampling results, LBL began cooperative investigative research into the cause of this incident. Both institutions have also worked closely with EBMUD while attempting to identify and correct the problem. As of this report, the incident, including issuance of a Notice of Violation (NOV), has not been resolved. This incident will be reported in full in the 1995 Site Environmental Report.

LBL's stormwater discharges are governed by the requirements of the State General Permit for Storm Water Discharges Associated with Industrial Activities.[16] In accordance with the sitewide stormwater permit, LBL submitted its second Annual Report on July 1, 1994, to the Regional Water Quality Control Board (RWQCB) and the City of Berkeley. This report addresses stormwater activities undertaken by LBL. See Table 1 in Appendix A, *Data Tables,* for a summary of the results of LBL's stormwater monitoring activities for the 1994–95 rainy season. Results are discussed in Section 6, *Environmental Nonradiological Program Information.* A January 5, 1994 letter from the RWQCB stated that LBL currently complies with the requirements of this permit.

As reflected in LBL's 1992 *Storm Water Pollution Prevention Plan* (SWPPP), the Laboratory identified non-stormwater discharges at the facility that could not be eliminated prior to implementing the SWPPP. LBL submitted a letter to the RWQCB on June 4, 1993, detailing the Laboratory's intent to eliminate these discharges by the regulatory deadline of March 30, 1995. The Laboratory continued to implement this plan during 1994. As a result of the surveys undertaken in 1992, LBL found 38 old connections of industrial or sanitary wastewater discharges to the storm sewer system. Piping modifications were funded and designed, and by the end of 1994 all such connections except one had been eliminated. The corrective actions at the last building, Building 71, were completed during preparation of this report and prior to the regulatory deadline. The *Storm Drain Corrective Repairs* portion of Section 4, *Environmental Program Information*, contains more detail on this project.

The site's stormwater compliance program was inspected twice during 1994 by the City of Berkeley. Neither inspection resulted in a violation. The inspection on March 22, 1994, produced a request for review of a storage area at Building 31 against National Pollutant Discharge Elimination System (NPDES) best management practices (BMP) criteria. The review concluded that the site was being managed in accordance with site BMPs. The inspection on December 22, 1994, suggested general housekeeping and possible structural BMPs for three areas: the Building 69 loading dock area, the Building 76 auto repair/maintenance area, and the Building 31 gardening area. LBL has instituted the housekeeping suggestions and has requested funding to pursue the feasibility of implementing the structural BMPs.

Requirements for the SWRCB's General Construction Activity Storm Water Permit[17] state that such a permit is necessary if more than 20,200 square meters (five acres) of a site are under construction. Since LBL falls below this acreage criteria, it has not needed to file an application for the General Construction Activity Permit. However, LBL does institute best management practices at all construction sites and seeks to avoid impact to the storm drain system from soil erosion or construction material. Examples of LBL's practices include covering excavation piles with weighted plastic, protecting storm drains from soil or other materials by covering or blocking them, practicing general good housekeeping on a site, and storing hazardous materials in containers and away from storm drains.

In 1994, LBL initiated an aggressive program, associated with the *Spill Prevention, Control, and Countermeasures* project, to reduce the risk of environmental releases from aboveground storage tanks (ASTs) containing petroleum products. The entire project improved the protection of the environment in 24 different AST areas.

Secondary containment for ASTs was installed at eight areas, one of which was identified by the DOE Tiger Team as requiring secondary containment. Secondary containment was repaired at seven ASTs. One AST was removed, another AST was drained of oil, and a spill kit was placed at one AST. LBL's Environmental Protection Group audited 90 aboveground storage tank areas during June and July of 1994.

Seven ASTs have small day tanks that are fed by large underground storage tanks (USTs). Time relays were installed at each of these ASTs. These new time relays prevent uncontrolled pumping from the UST if the AST develops a leak. All remaining ASTs requiring secondary containment or other forms of spill protection will be upgraded in 1995.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)

CERCLA[18] was passed in 1980 for the purpose of regulating actual or threatened releases into the environment. Actions under CERCLA include removal and/or remedial action where the release may present an imminent danger as well as remedial investigations and feasibility studies that determine site cleanup options. Based on information provided by LBL in 1991, US/EPA determined that site restoration activities at LBL should not be conducted under CERCLA, but rather under the Corrective Action Program of the Resource Conservation and Recovery Act (RCRA).[19] See Section 7 of this report for a discussion of LBL's site restoration efforts in 1994.

CERCLA also has implications for off site incidences associated with LBL activities. While no new activities of this nature were reported in 1994, two incidents from 1992, detailed in previous Site Environmental Reports, continued to evolve toward settlement.

The first incident involves 13 drums of polychlorinated biphenyl (PCB) waste that had been transported to the North American Environmental, Inc. (NAE) site in Clearfield, Utah in violation of an agreement between NAE and an LBL subcontractor. In accordance with US/EPA protocol, LBL removed all of its reported waste from the site prior to its official designation as a Superfund site in September 1992. LBL also reported to US/EPA that the removed drums showed no evidence of any release while at the site. As of March 1994, LBL was informed that the NAE warehouse owner, Freeport Center, and the Defense Logistics Agency were in the process of conducting an inventory prior to beginning the removal of the remaining waste at the NAE site.

The second incident began in November 1992 and involved the Bay Area Drum (BAD) Company site, a former drum recycling and reconditioning facility in San Francisco. Because of bankruptcy by the site owners and operators, Cal/EPA's Department of Toxic Substances Control (DTSC) has targeted former customers of the site to bear the cleanup costs. A Potentially Responsible Parties (PRP) group, which includes several of the University of California campuses, is negotiating with DTSC over the scope of the cleanup.

Based on oral testimony from a BAD truck driver, DTSC and the PRP group have attributed around 1,400 drums at the site to LBL.

LBL believes that the pickup location described by the driver is actually a campus storehouse. UCB has agreed to take responsibility for those drums. LBL is working with UCOP to obtain a site release since there is no evidence of contamination from any involvement by LBL at the BAD site.

Emergency Planning and Community Right-To-Know Act (EPCRA)

This Act was passed in 1986 as Title III of the Superfund Amendments and Reauthorization Act (SARA).[20] The two general areas of the Act establish requirements for emergency planning and notification, as well as reporting. These sections of SARA Title III are incorporated into requirements of the California Hazardous Materials Release Response Plan and Inventory Law.[21] SARA Title III Section 302 requires notification from facilities handling greater than threshold amounts of extremely hazardous materials. Section 304 requires emergency notifications in the event of certain hazardous-material releases. Section 311 requires that material safety data sheets (MSDSs) be available for all hazardous substances on the site. Section 312 requires that facilities subject to MSDS requirements prepare an annual emergency and hazardous chemical inventory form. Finally, Section 313 requires facilities that use more than specified amounts of certain toxic chemicals to report annual emissions. For LBL, these sections are best summarized by the Toxic Release Inventory report, the *Hazardous Materials Management Plan*, and the *Risk Management and Prevention Program.*

Toxic Release Inventory

A 1992 DOE Memorandum and Executive Order 12856,[22] *Federal Compliance with Right to Know Laws and Pollution Prevention Requirements,* subjected LBL to the Toxic Release Inventory (TRI) reporting requirements of EPCRA. LBL and other DOE facilities must submit their completed TRI report for the previous calendar year to DOE by July 1 of the following year (e.g., the 1993 report was due July 1, 1994). TRI reporting can be separated into two stages: determining usage, and submitting TRI Form R. During the first stage, LBL determined from site visits and record searches that no TRI chemical use during 1993 exceeded the 4,536 kilogram (10,000 pound) criterion under the law. The assessment identified seven chemicals with aggregate sitewide use of more than 454 kilograms (1,000 pounds). As a result of these findings, LBL was not required to prepare the formal Form R's required by the second stage. LBL submitted its 1993 usage determination information to DOE prior to July 1. The usage report identified the seven chemicals and included support information such as source usage records and calculations. The seven chemicals were acetone, CFC-11 (trichlorofluoromethane), CFC-12 (dichlorodifluoromethane), CFC-113 (1,1,2-trichloro-1,2,2-trifluoroethane), nitric acid, sulfuric acid, and 1,1,1-trichloroethane. LBL began programs to reduce sitewide use of these chemicals. Sulfuric acid and 1,1,1-trichloroethane represented the greatest opportunities for reduction.

Hazardous Materials Management Plan

DOE has not waived sovereign immunity rights for compliance with local EPCRA regulations. The City of Berkeley is the local administering agency for such regulations. Nevertheless, the Laboratory voluntarily submitted a *Hazardous Materials Management Plan* to the City of Berkeley on July 1. The Plan included revised business plan documentation (i.e., emergency plans and procedures and training), as well as an updated sitewide chemical inventory report. The documentation must be updated every two years, or sooner if significant changes occur. The inventory must be revised annually. LBL implemented a container tracking system based on a bar-coding technology to collect chemical inventory information across the entire site. Approximately 50,000 individual containers are accounted for in the inventory report. This includes information on about 1,000 individual or aggregate chemicals. Also included in the report was detailed information on physical and regulatory attributes of the chemicals. In late 1994, the City of Berkeley revised its hazardous materials disclosure ordinance.[23] The revisions could potentially increase the number and type of information on hazardous materials that would have to be reported annually.

Risk Management and Prevention Program

Guided by a proposed federal regulation[24] and the existing state hazardous materials management law, the City of Berkeley requested in December 1992 that LBL prepare and implement a *Risk Management and Prevention Program* (RMPP) for onsite facilities using acutely hazardous materials above certain thresholds. At the time the request was made, LBL exceeded the thresholds requiring the preparation of this plan for nitric acid, sulfuric acid, sodium cyanide, and potassium cyanide. However, the Building 77 Plating Shop, which is responsible for triggering the RMPP requirements, underwent a major facility conversion beginning in May 1994. Conversion of this facility from a plating shop to a UHVCF)will eliminate or significantly reduce most of the acutely hazardous materials inventory.

In 1994, LBL verified sitewide operations relative to the state RMPP rule. After this confirmation, LBL drafted an RMPP for the UHVCF and voluntarily submitted this draft to both the City and third-party consultants on October 21. The City of Berkeley and its consultant conducted an inspection of operations covered by the RMPP on November 14. LBL prepared a five-phase action plan in response to the City's comments on LBL's draft and their inspection of the operations. The action plan covered the following items:

- Correct deficiencies identified during the site visit.
- Address COB's comments on the draft RMPP or supporting documentation and procedures.
- Complete a hazard evaluation study for the UHVCF.
- Format and edit the revised RMPP for the target audience.
- Evaluate the new RMPP by third party reviewers.

The revised RMPP is expected to be submitted to the City of Berkeley during May 1995.

Endangered Species Act (ESA)

The Endangered Species Act[25] of 1973 provides a means to protect endangered and threatened species and their ecosystems. Related to this Act, a vegetation and wildlife biologist surveyed the entire perimeter of the LBL site in 1994. The survey resulted in a general inventory of biological resources, with special emphasis on protected species. The survey did not identify any protected species. This survey was conducted to support LBL's vegetation management program.

A biological survey was also conducted in an area adjacent to the southeast corner of Building 74. This survey supplemented previous surveys on the area. It was performed as part of the planning for the Human Genome Laboratory (HGL). The survey was performed in an area proposed for HGL parking. It focused on identifying and mapping vegetation types and surveying for sensitive animal species. The survey observed no protected plant or animal species on or adjacent to the site.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

Passed by Congress in 1972, FIFRA's[26] purpose is to restrict the registration, sale, use, and disposal of pesticides. Restricted-use pesticides are applied by licensed contractors. LBL personnel apply general-use pesticides only. An LBL composting program planned for initiation in 1995 will further reduce the use of pesticides at the Laboratory.

National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA)

National Environmental Policy Act

The main objectives of the National Environmental Policy Act[27] of 1969 are to help officials of the federal government make decisions that are based on an understanding of environmental consequences of those decisions, and to take actions that protect, restore, and enhance the environment. It requires the preparation of specific types of documentation for activities proposed or funded by federal agencies. Under NEPA, a project is classified as either (1) categorically excluded, (2) not categorically excluded but may result in significant adverse environmental effects (prepare an Environmental Assessment), or (3) would result in a significant adverse environmental effects (prepare an Environmental Impact Statement).

In 1994, LBL prepared 178 formal documents in accordance with DOE policies and procedures for NEPA compliance. These included 176 categorical exclusions and 2 environmental assessments (EAs). The EAs include the following:

- In October 1993, an EA for disposition of copper coil windings from the 184-inch Cyclotron was submitted to DOE/EH for issuance of a Finding of No Significant Impact (FONSI). The FONSI was issued by DOE in July 1994. Incidentally, about 6% of the copper was discovered stolen from the Building 903 warehouse in August after LBL received a tip from a scrap dealer that copper was being stolen from LBL and sold to local scrap yards. The EA had shown that the environmental impacts from the extremely low amounts of induced radioactivity in the copper were negligible.
- An EA for the proposed construction and operation of a Human Genome Laboratory at LBL was submitted to DOE in September 1994. During the public comment period on the Draft EA, comments were received from the State's Office of Historic Preservation and the Department of Conservation. LBL responded to the comments and

prepared the Final EA. A FONSI for the project was issued by DOE in April 1995.

LBL's NEPA program was given the DOE NEPA Compliance Officer Quality Award for NEPA planning in 1994. This award goes to individuals and teams who assist the DOE in achieving the environmental stewardship goals of NEPA.

California Environmental Quality Act

At the state level, the California Environmental Quality Act (CEQA)[28] is similar to NEPA. Its objectives are to help agency officials make decisions that are based on an understanding of environmental consequences of those decisions, and take actions that protect, restore, and enhance the environment. Similar to NEPA, it requires the preparation of specific types of documentation for projects proposed, funded, or approved by state agencies or located on state-owned lands.

Under CEQA, a project is classified as either (1) exempt, (2) not exempt; may result in significant adverse environmental effects (prepare an Initial Study), or (3) would result in a significant adverse environmental effects (prepare Environmental Impact Report).

In October 1993, LBL completed an Initial Study *Modification of Permitted Hazardous Waste Handling Facility Operations at LBL and Transportation of Hazardous and Mixed Wastes from an Offsite LBL-leased Building to LBL's HWHF*. The Initial Study was circulated for public comment at that point. LBL received comments on the Initial Study from the Committee to Minimize Toxic Waste. LBL prepared a Revised Initial Study because of a revision to the project, and to address the public comments received from the initial public circulation. The Revised Initial Study was circulated for public comment in March 1994. LBL received comments on the Revised Initial Study from the Committee to Minimize Toxic Waste and from the City of Oakland in April. LBL responded to the Committee's comments in a letter dated May 16, 1994. The comments received from the City of Oakland did not require a response. A Negative Declaration for the project was adopted and the project was approved in May.

In 1994 an Environmental Impact Report (EIR) was prepared for the proposed Human Genome Laboratory at LBL. During the public comment period, comments were received from the City of Berkeley and the East Bay Municipal Utility District. LBL responded to the comments in the Final EIR. The EIR was certified by the University of California Regents in September.

In addition, LBL documented and received University of California Office of the President (UCOP) concurrence that seven proposed projects were categorically exempt from CEQA.

National Historical Preservation Act (NHPA)

During 1994, LBL completed a historic architectural evaluation of the Bevatron and Bevalac at LBL. The resulting report concluded that the Bevatron and Bevalac are eligible for listing in the National Register of Historic Places. The Bevatron was the largest, highest-energy accelerator in the world when it began operation in 1954. During the 1950s and 1960s, four Nobel Prizes were awarded for particle physics research conducted in whole or in part at the Bevatron. Consultation with representatives from the Office of Historic Preservation is underway.

Pollution Prevention Act of 1990 (PPA)

The Pollution Prevention Act[29] of 1990 declares that source reduction is a national policy and directs US/EPA to study and encourage source reduction policies. LBL's levels of pollution remain below the *de minimus* numbers identified in the Act and is therefore not subject to the Act's reporting requirements. However, LBL does have a substantial pollution prevention and waste minimization program in place. Accomplishments in 1994 include the following:

- Finished an acid neutralization project for two laboratories in Building 70A.
- Reduced coolant waste through recycling and reuse in Building 77.
- Reduced cyanide solution waste through process changes at the Building 77 Plating Shop.
- Established a fluorescent light bulb recycling program for mercury reduction at LBL.
- Reduced contaminated solids through reclassification of wastes and on-site recycling and reuse programs.
- Converted the photo shop to digital methods, resulting in acid and chemical waste reduction.

These efforts can be quantified as follows:

- Reduced acidic wastewater by 11,355 liters (3,000 gallons) per year.
- Reduced coolant water by 2,950 liters (780 gallons).
- Reduced cyanide solution by 3,200 liters (850 gallons) and hydrogen sulfide by 2,270 liters (600 gallons).
- Recycled approximately 30,500 linear meters (100,000 linear feet) of fluorescent light bulbs.
- Reduced contaminated solids by approximately 5,000 kilograms (11,000 pounds).
- Reduced chemical and acid wastes by approximately 6,050 liters (1,600 gallons).

The State of California Legislature passed the Hazardous Waste Source Reduction and Management Review Act[30] in 1989 (SB14). Although it is found in the State's Hazardous Waste Control Law, the main emphasis of SB14 is on waste minimization and pollution prevention. In particular, the goals of SB14 are to:

- Reduce hazardous waste at its source.
- Encourage recycling wherever source reduction is not feasible or practicable.
- Where it is not feasible to reduce or recycle, treat hazardous waste in an environmentally safe manner to minimize the present and future threat to health and the environment.
- Document hazardous waste management information, and make that information available to state and local government.

SB14 resulted in LBL's preparing a two-part report in 1991: (1) *Source Reduction Evaluation Review Plan and Plan Summary*, and (2) *Hazardous Waste Management Report Summary*. The report required certification on two levels: technical and financial. The goal of the LBL program is for substantially reduced waste generation, increased recycling, and promoting pollution prevention. This plan established a timetable for performing process waste assessments (PWAs) on those waste streams that are at least 5% of the total waste stream from LBL. Those waste streams include:

- aqueous wastewater treatment effluent.
- spent empty drums larger than 30 gallons capacity.
- waste liquids with pH less than 2.
- waste machining and grinding coolant/water.
- waste mercury (extremely hazardous).
- waste oil (nonautomotive).

The aqueous wastewater treatment effluent from Building 2 was included in LBL's plan because it represented the largest waste stream on site. A wastewater renovation project in 1991 routed only necessary water to LBL's treatment towers. No further assessment of this waste stream is required under SB14 guidance. LBL completed two PWAs in 1993: one for waste oil (nonautomotive), and the other for a portion of the waste liquids with pH less than 2 from the Building 25 Printed Circuit Board process. No PWAs were performed in 1994, although two will be initiated in 1995 and the third in 1996.

The *Hazardous Waste Management Report Summary* is primarily meant to assess changes in waste management activities. SB14 requires updates to both parts of the report by September 1, 1995.

Resource Conservation and Recovery Act (RCRA)

The primary goal of the Resource Conservation and Recovery Act[19] of 1976 is to assure that hazardous waste management practices are conducted in a manner that protects human health and the environment. RCRA established a large and comprehensive structure of regulatory authority for waste disposal activities in several key areas. Those areas most notably affecting LBL include hazardous waste, medical waste, and underground storage tanks. RCRA also created a mechanism for establishing viable partnerships between federal and state agencies for carrying out the requirements of the Act. In California, DTSC has received authority from US/EPA for the RCRA program. California's programs in these three notable areas are also dictated by state statutory requirements.

Hazardous Waste

In addition to administering the requirements for hazardous waste under RCRA, Cal/EPA's DTSC is responsible for overseeing the regulations emanating from the State's Hazardous Waste Control Law.[31] The California law was established in 1973, prior to federal action under RCRA.

Cal/EPA's DTSC did not conduct any inspections of LBL's RCRA compliance program in 1994. This includes both the waste compliance activities associated within the boundaries of the HWHF and the five fixed treatment units across the site that are subject to the State's Tiered Permitting program. The last inspection of either activity took place on separate occasions in November 1993. No violations of hazardous waste laws were found.

Two transportation-related inspections of HWHF activities occurred during 1994. On March 24, the U.S. Department of Transportation conducted an inspection of hazardous materials shipment requirements. This inspection looked at records maintained by EH&S and LBL Transportation. On June 21, the California Highway Patrol, as authorized by the state Department of Transportation, examined vehicles for hazardous materials packaging and transportation requirements. This consisted of inspecting vehicles, vehicle maintenance records, and driver logs. No findings or citations were reporting in either inspection.

LBL prepared the *Biennial Hazardous Waste Report for 1993* in March 1994. The report was submitted to US/EPA, with a copy to Cal/EPA's DTSC. It contains specific generator and transport information for all activities at the Hazardous Waste Handling Facility in 1993. LBL also prepared the Annual Waste Reduction Report for the previous calendar year in March 1994. This report was submitted to DOE. It contains a detailed analysis of waste minimization efforts made by waste generators.

During 1994, the HWHF shipped hazardous waste for offsite disposal in the following amounts:

- nearly 270 metric tons of total hazardous waste
- over 5 metric tons (32 drums) of low-level mixed hazardous and radioactive waste
- more than 26 metric tons (12 boxes, 170 drums) of low-level radioactive waste

RCRA regulations affecting the Universal Treatment Standards for land disposal of hazardous waste[32] became effective on December 19, 1994. These regulations simplify some of the regulatory language affecting required treatment of hazardous waste prior to land disposal by replacing virtually all of the previous numerical treatment standards with new Universal Treatment Standards. It also restricts some methods of land disposal for wastes that exhibit the toxicity characteristic for organic constituents and imposes treatment standards for these wastes. These restrictions affect radioactive mixed wastes at the site. LBL's program has adapted to these new requirements.

In California developments, Senate Bill SB1082, *Certified Unified Program*,[33] is a new law that will delegate enforcement authority to cities and counties under the State's Tiered Permitting program. DTSC will no longer enforce these regulations once the city or county has been certified. The City of Berkeley has applied for this certification authority from the state. SB1082 does not require DTSC to train the cities and counties on Tiered Permitting regulations. This lack of specified training of certified agencies in the law may lead to misinterpretation of Tiered Permitting regulations and confusion at facilities attempting to implement compliance programs.

The environmental restoration program (ERP) at LBL is conducted under the RCRA Corrective Actions Program. Requirements for this program are included in the 1993 RCRA Part B Permit[34] for LBL's Hazardous Waste Handling Facility. The *RCRA Facility Investigation (RFI) Work Plan*,[35] which was submitted to DTSC in November 1992, outlines the planned scope of work for site investigation and specifies (1) areas requiring further site characterization to define the extent of contamination and identify sources, and (2) areas where no further action is needed. In accordance with ERP planning procedures and requests from regulatory agencies, LBL submits *RFI Workplan Addenda*, which provide detailed specifications for planned ERP site investigations, prior to the initiation of specific site activities. LBL submitted five *Workplan Addenda* in 1994.

In compliance with the Part B Permit, LBL began submitting quarterly progress reports[36] to DTSC in August 1993. The quarterly progress reports provide a description of work completed, summaries of findings, summaries of problems encountered, actions taken to correct problems, and projected work for the next reporting period. LBL also submitted a *Phase I Progress Report*[37] in November 1994, which described RFI activities conducted between October 1992 and June 1994. The environmental restoration program also held quarterly meetings with stakeholders, regulatory agencies, and DOE throughout 1994 to discuss the status of the program. Stakeholder agencies include the State Water Resources Control Board, the Regional Water Quality Control Board, the Environmental Management Branch of the California Department of Health Services, the City of Berkeley, and Cal/EPA's Department of Toxic Substances Control. In 1993, DTSC identified the jurisdictional and oversight responsibilities of the various agencies with respect to the RFI corrective action program at LBL. The intent of this was to avoid duplication, delays, and unnecessary hardships to both LBL and the various agencies. See Section 7, *Groundwater Protection*, for more details on environmental restoration monitoring results from 1994.

Trenching activities between Buildings 51 and 64 on November 18 unearthed an area of soil contaminated with elemental mercury. Upon discovery of the material by LBL laborers and confirmation by EH&S' Industrial Hygiene Group (IH) that the substance was mercury, trenching work was immediately halted, the surrounding area cordoned off, and cleanup efforts begun. Also, LBL contacted the City of Berkeley, the State Office of Emergency Services, Cal/EPA's Department of Toxic Substances Control, and the National Response Center of this discovery. During three days of cleanup activity, 21 drums of contaminated soil were removed from the area until instrumentation could no longer detect the presence of mercury. LBL's investigation concluded that mercury apparently entered the soil between a 20-centimeter thick (8-inch thick) concrete slab that covered a buried catch basin and the walls of the catch basin. The area is expected to be designated as a Solid Waste Management Unit under the RCRA Corrective Action Program. Further investigation and cleanup will be performed by the environmental restoration program.

Medical Waste

The Medical Waste Tracking Act[38] of 1988 is one of the 10 subtitles to the Solid Waste Disposal provision under RCRA. Its purpose is to ensure the proper disposal of medical waste generated either in medical research or treatment settings. The definition of medical waste includes biohazardous waste (e.g., blood and blood-contaminated materials), "sharps" waste (e.g., needles), and other waste produced in research relevant to the diagnosis, treatment, or immunization of human beings or animals, or in the production of biological products used in medicine. In addition to the federal requirements, the State's Medical Waste Management Act,[39] first promulgated in

1991, places additional requirements on facilities managing medical waste. Both the federal and state programs are administered by DHS.

Under the State's program, LBL is considered a large-quantity generator, since it generates more than 91 kilograms (200 pounds) of medical waste each month. Registration is renewed annually with the State. LBL completed its annual renewal for Certificate of Registration #00555R3 in November. LBL's medical research programs generated approximately 14,580 kilograms (32,142 pounds) of medical waste in 1994.

LBL generates medical waste at about 100 different locations distributed over 12 buildings, including four offsite buildings. In late 1994, LBL contracted with a new medical waste disposal hauler. Improvements in waste tracking are expected from the new contractor. Both the present and previous contractor made weekly medical waste pickups across the site.

DHS officially implemented an annual inspection program in 1994. DHS held one inspection of the Laboratory's medical waste program. DHS found no violations during this June 13 and 14 inspection. The State inspectors did have several observations for program improvement as a result of the audit. In response, LBL made the following improvements:

- All collection containers were upgraded.
- Medical waste pickup schedules were improved.
- LBL updated its *Medical Waste Management Plan* in August. This plan included sections on training; emergency action; medical waste hauling, treatment, and disposal; hazardous medical waste; radioactive medical waste; document control and recordkeeping; and program certification. Also included in the plan are LBL's *Medical and Biohazardous Waste Generator's Guide* and *Medical and Biohazardous Waste Generator's Training Plan.* The *Medical and Biohazardous Waste Generator's Guide* (PUB 3095) was updated in September to reflect program management improvements.
- Four generator training classes were held.

Underground Storage Tanks

In the early 1980s, the State of California first began addressing the serious threat on groundwater posed by underground storage tanks (USTs) by establishing a rigorous regulatory and remediation program.[40] The state requirements for USTs that contain hazardous materials include permitting, construction design, monitoring, recordkeeping, inspection, accidental releases, financial responsibility, and tank closure. The state program underwent modifications after US/EPA adopted federal regulations on USTs in late 1988 under the provisions of RCRA.[41] These modifications were needed for the state program to obtain federal approval. The City of Berkeley is the local administering agency for the UST regulations affecting LBL.

There were three inspections by the City of Berkeley during 1994: January 27, February 25, and March 29. No violations were found in any inspection. LBL removed three tanks during the course of 1994. Of the remaining ten tanks operating on site, seven are double-walled and meet the pending December 1998 regulatory standards for construction, monitoring, leak containment, and design of operating tanks. Three of the operating tanks have single steel or fiberglass walls and require upgrades to meet the 1998 standards.

Tank removal plans for one double-walled tank (permit registration ID #69-1) and single-walled tank (permit registration ID #4) were submitted to the City of Berkeley in November 1993. The two tanks were removed in April 1994. In June, LBL also submitted a tank removal plan to COB for removal of a single-walled fiberglass tank (permit registration ID #8) located near Building 74. The tank was removed from the site in late November.

In all three removals, sampling and analyses of soils revealed some soil contamination. This has delayed complete site closure. The contamination at the two single-walled tanks could be attributed to previously documented spills or piping leaks. Soils analyses around the double-walled tank produced anomalous results of acetone, which contradicted the historical use of this tank. As required by the City-approved work plans, LBL's Environmental Restoration Group has accepted responsibility for the closure activities of these sites. Removal reports for all three tanks were submitted to the City of Berkeley on July 7 and September 18, 1994, and February 2, 1995, respectively. During removal activities of the tank near Building 74 in November, the contractor temporarily placed ancillary pipes and pipe monitoring probes on the ground with soil spoils. These materials were en route to disposal bins. This activity was conducted during a significant rainstorm. The rain washed diesel residue remaining in or on the pipes and created a sheen of oil from the stockpile to a nearby storm drain. The amount of diesel estimated to have washed away in the incident was less than 4 liters (1 gallon). LBL took immediate corrective action to cover the three storm drains in the area of the excavation, clean up the spill area with absorbent, place the pipes back in the excavation until after the series of storms passed, and place the soil spoils into the bins for testing and disposal. Also, LBL notified the City of Berkeley and the State Office of Emergency Services of this incident. No violations or fines were issued by either agency. LBL representatives met with the contractor to review tank removal and safety concerns relevant to adverse weather conditions.

Safe Drinking Water Act (SDWA)

The Safe Drinking Water Act[42] was originally passed in 1974 and was last updated in 1988. This Act sets primary drinking water standards for public water systems and the protection of underground sources of drinking water. There are no drinking water wells on site. The drinking water supplied to LBL is distributed by EBMUD.

EH&S's Industrial Hygiene Group conducts sampling of drinking fountains, while Facilities' Maintenance & Operations performs any repairs, maintenance, or upgrades on either the fountains or the distribution system. Industrial Hygiene formalized the drinking water program in 1994. The program was approved by IH and M&O in early 1995.

In 1994, IH sampled all drinking water fountains on site for the presence of copper and lead. This sampling of about 135 fountains took place during December. Concentrations at nine fountains were discovered to be over the copper drinking water standard; one of these also exceeded the lead standard. Two of these fountains were deemed unnecessary and were removed from service. Four fountains have been cleaned, reinstalled, and retested. Results are pending on three; the fourth fountain has passed and is back in service. Three drinking fountains remain out of service until cleaning and follow-up testing can be conducted.

The most recent significant work performed by M&O on upgrading the drinking water distribution system was completed in 1993. The project installed over 100 backflow prevention devices where cross-connections in the drinking water distribution system had a potential for contamination with sanitary wastewater.

Toxic Substances Control Act (TSCA)

TSCA[43] became law in 1976. Like many of the key environmental laws, it has been amended several times since first passage. TSCA is designed to minimize the exposure of human beings and the environment to the many chemical substances and mixtures found in manufacturing, processing, commercial distribution, or disposal activities. TSCA establishes a means of evaluating these products before they are introduced into the marketplace and controlling their use once they are approved for manufacturing. The most prominent substance at LBL affected by the TSCA regulations is polychlorinated biphenyls (PCBs).

There was one US/EPA TSCA inspection on June 29 for PCB compliance. The inspection included a visit to several buildings on site and a review of documentation, including LBL's PCB management program and corresponding procedures. There were no findings from the inspection. Under TSCA, regulated PCBs are defined as substances with a concentration greater than 500 parts per million of PCBs. Other lesser categories of PCB concentrations are PCB-containing and PCB-contaminated. LBL has identified, inventoried, and removed all identified PCB transformers.

The number of PCB items and volume of PCBs at LBL has decreased since the US/EPA program began. US/EPA regulations define a concentration of PCBs below 50 parts per million as non-PCB. All 84 utility transformers at LBL are considered non-PCB following an aggressive transformer-oil retrofit program undertaken at the site. The remaining sources of PCBs at LBL are primarily large low- and high-voltage capacitors. Approximately 90 of these capacitors are still in use or stored, containing an estimated 50 to 60 kilograms (130 pounds) of PCBs.

LBL developed a written plan for the management of PCBs on the site. Approval of the document and implementation of its provisions were completed in June. As required by TSCA, LBL prepared an annual PCB activity document, which inventoried and documented PCB-related activities at the site for the previous calendar year, 1993. LBL is not required to submit the report to US/EPA, but it will be made available to the agency if requested.

Executive Order 11988, "Floodplain Management"

Under this Executive Order,[44] which was last amended in 1979, LBL's Facilities Department assesses whether or not a proposed project involving DOE-owned or leased facilities, including those on the

University of California at Berkeley campus, will occur in a designated floodplain. Those floodplain areas nearest LBL include the coastal zone near the San Francisco Bay and a narrow strip of land at the edge of Strawberry Creek, which flows along the LBL southern boundary. The Facilities Department completed a floodplain assessment in April for Building 903, the replacement for the former LBL warehouse, Building 901. The assessment found that Building 903, located in west Berkeley near Carleton and 7th Streets, is not in a floodplain.

Executive Order 11990, "Protection of Wetlands"

Reviewing proposed projects for potential impacts on wetlands is required by this 1977 Executive Order.[45] LBL's main site is not located in a designated wetland area. LBL's Office of Planning and Communication reviews all offsite projects for potential wetlands impacts. No new wetlands assessments were performed in 1994.

Executive Order 12843, "Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances"

This Executive Order[46] was signed in April 1993. It gave federal agencies six months to submit a report to the Office of Management and Budget (OMB) on each agency's plan to reduce and eventually phase out both the procurement and use of substances that cause stratospheric ozone depletion. DOE submitted its report to OMB in November 1993. The DOE report identified efforts in four main usage areas: refrigeration and air conditioning, fire protection, solvent cleaning, and miscellaneous uses. Concurrently, DOE distributed a document entitled *Refrigerant Management Plan for Department of Energy Facilities*[47] to all DOE sites to provide guidance on the implementation of this Executive Order in the largest area affected by this order, refrigeration and air conditioning. LBL's refrigerant management program, first started in early 1993, is consistent with DOE guidance. The LBL program prioritizes operations based on quantity of ODS, age of unit, and unit-specific maintenance history.

Executive Order 12873, "Federal Acquisition, Recycling, and Waste Prevention"

LBL has established an affirmative procurement group in response to this Executive Order[48] from 1993. This group meets every other month to address the key issues involved in this Executive Order. The group consists of staff from the Materiel and Site Logistics Department and the EH&S Division. These issues include the integration of recycled materials into the following products:

- building insulation materials
- cement and concrete containing fly ash
- lubricating oils containing refined oil
- paper and paper products
- retread tires

The group prepared a summary report on their activities, *Affirmative Procurement Report for FY94*, as required under the Executive Order. The group submitted the report to DOE/BSO in early December, who forwarded the report to DOE/HQ. Highlights of important advances in 1994 by LBL in these general areas include the following:

- Construction projects require records on the percentage of recycled materials, as well as other recycling activities.
- LBL's Motor Pool switched motor oil brands to a recycled oil. This new oil is currently used in all LBL vehicles serviced on site.
- An ecology fair was conducted in late April in association with Earth Month. Employees were given lists and shown samples of recycled paper products available from LBL's on site stock, as well as its office products supplier.
- A new contract is being awarded for retread tires. All future tires, except bus tires, will be retreads.

In addition to regular purchases of products of recycled components, the Executive Order mandates that all federal agencies buy printing and writing paper consisting of at least 20% post-consumer material by December 31, 1994, and at least 30% post-consumer material by December 31, 1998. No increase in federal spending on paper products will be allowed under the Order. Instead, agencies must compensate for price increases by reducing paper use and waste.

DOE Order 5400.1, "General Environmental Protection Program"

This DOE Order[5] sets environmental protection program requirements that assure compliance with appropriate federal, state, and local environmental laws and regulations. Codification of this Order and DOE Order 5400.5 into regulation 10 CFR 834, *Radiation Protection for the Public and Environment*,[49] began in 1993. DOE finalized the proposed regulation in December 1994, including incorporation of public comments. Despite a recent moratorium on federal regulations, promulgation of this regulation is now expected in July 1995. When promulgated, this regulation will have some additional impact on environmental radiological protection activities at LBL. The most notable new requirement is the preparation of an *Environmental Radiological Program Plan*. This plan will serve as a key reference resource for all program-related materials, such as specific procedures and planning documents. At present, both locally and nationally, DOE facilities have formed working groups that are determining the most cost-effective ways of implementing this regulation. Key objectives of these groups are to establish consistent interpretation and implementation of the regulation, and to share resources wherever possible. This last item refers to procedures and planning documents that one DOE facility has already prepared.

Under the DOE Order, LBL submitted all reports in 1994 as required. Included in this list are the 1993 Site Environmental Report and the Effluent Release Summary for radiological effluents. The effluent summary was provided to the Waste Systems Information Branch at the Idaho National Environmental Laboratory. The *Environmental Protection Implementation Plan* was updated in December. The *Environmental Monitoring Plan* is in its implementation stage. This plan identifies point source sampling for radiological and nonradiological parameters, and site and off-site ambient air samples for radiological parameters, as well as soil and sediment samples. Some aspects of the environmental surveillance program have not been implemented. This includes sampling and monitoring of locally produced foodstuffs, vegetation, and local surface waters. The DOE

EH-24 audit team cited this omission as a finding in the November audit.

Summary of Permits

Air Emissions

BAAQMD issues operating permits for stationary sources of air pollutant emissions. Sources exempt from permit but for which operating information has been provided to BAAQMD in a permit application are classified as registered-exempt. Operating permits are renewed annually with new permits effective July 1. BAAQMD also requests information on the State's Air Toxics "Hot Spots" Information and Assessment Act of 1987 (AB2588)[50] during the annual permit renewal process. LBL renewed a total of 38 operating permits and 76 registered-exempt sources in 1994. This count differs slightly from 1993, when LBL totals were 40 operating permits and 85 registered-exempt sources. The diversity of research and support activities on site corresponds to a wide range of equipment or activities that are subject to BAAQMD emission source category requirements. Categories affecting LBL include: casting and molding; chemical processing; chemical processing; furnaces, ovens, and kilns; gasoline dispensing; general combustion; liquid storage and loading; material working and handling; miscellaneous equipment (e.g., vacuum devices, welding tools, waste water separators); semiconductor manufacturing; surface coating and printing; and surface preparation and cleaning. See Table 3-2 for a complete listing of permitted sources.

Permitting activities with BAAQMD in 1994 included obtaining an increased usage limit on one of the 14 building-wide solvent wipe cleaning permits and requesting a change in permit conditions affecting 29 sources. The solvent increase in the wipe cleaning permit was requested to account for additional historical cleaning activities in Building 80 that were discovered in early 1994 shortly after the permit was initially approved. The modification application was filed in February and approved in early May. The application to request a change in permit conditions represented a significant effort on the part of LBL environmental staff and BAAQMD Enforcement to clarify potentially conflicting requirements between permit conditions and BAAQMD regulations. This included relaxing the recordkeeping frequency on smaller quantity solvent emission sources from monthly to quarterly, although BAAQMD retained the same rolling 12-month usage-limit condition. This request also served as an opportunity to convert permit conditions to the International System (SI) of units. The request was submitted in early April and approved by BAAQMD in November. No permit applications were filed for new sources during 1994.

Hazardous Waste

The State's Tiered Permitting program for hazardous waste treatment and storage units has been in place since 1993. This program incorporates the provisions of the Resource Conservation and Recovery Act and the State Hazardous Waste Control Law. The five tiers, listed in decreasing order of regulatory complexity, are:

1) Full permit.
2) Standardized permit.
3) Permit-by-rule.
4) Conditional authorization.
5) Conditional exemption.

Table 3-2. BAAQMD Permitted Air Emission Sources Renewed in 1994

BAAQMD Source Category	BAAQMD Source #	Description	Building	Permit Conditions	Abatement Device	Abatement Type
Furnaces, Ovens, and Kilns	104	Paint drying oven	77			
	145	Crystal Growth Furnace	2	X	X	Mist Eliminator
	148	Epoxy Curing Oven	53			
	149	Epoxy Curing Oven	53			
	150	Epoxy Curing Oven	53			
Gasoline Dispensing	76	Gasoline Pumps	76		X	Vapor recovery
Material Working and Handling	64	Sawdust collector	74		X	Cyclone, Simple
	73	Machine shop tools	76		X	Cyclone, Dynamic
	116	Machine shop tools	79		X	Cyclone, Simple
Miscellaneous	124	Sulfur hexafluoride chamber	58A		X	Refrigeration
	159	Vacuum coating chambers	25	X	X	Baghouse, Simple
Semiconductor Manufacturing	168	Instrument Support Laboratory	70A	X		
	186	Semiconductor Fabrication Area	70A	X		
Surface Coating and Printing	74	Paint spray booth	76	X	X	Liquid Separator
	96	Paint spray booth	77		X	Dry Filter
	147	Epoxy Mixing Hood	53	X		
Surface Preparation and Cleaning	38	Ultrasonic cleaner	53	X		
	92	Vapor/spray degreaser	77	X	X	Refrigeration
	97	Sandblast booth	77		X	Baghouse, Shaking
	118	Printing press ink removal	934			
	130	Solvent cleaning, 60 gal/yr. net	77			
	140	Vapor degreaser	52	X		
	141	Ultrasonic degreaser	76	X		
	166	Sandblast booth	71B	X	X	Baghouse, Simple
	172	Wipe Cleaning	52	X		
	173	Wipe Cleaning	58	X		
	174	Wipe Cleaning	62	X		
	175	Wipe Cleaning	77	X		
	176	Wipe Cleaning	80	X		
	177	Wipe Cleaning	88	X		
	178	Wipe Cleaning	16	X		
	179	Wipe Cleaning	25	X		
	180	Wipe Cleaning	46	X		
	181	Wipe Cleaning	53	X		
	182	Wipe Cleaning	2	X		
	183	Wipe Cleaning	66	X		
	184	Wipe Cleaning	70A	X		
	185	Wipe Cleaning	1	X		

LBL's Hazardous Waste Handling Facility operates under the "full permit" tier of the program. The HWHF permit is issued by Cal/EPA's DTSC for US/EPA, under authority granted by the State's Hazardous Waste Control Law. The permit, which allows storage and simple treatment of certain hazardous and mixed (radioactive and hazardous) wastes at the HWHF, was issued on May 4, 1993. The permit is valid for ten years. A request for modification of certain provisions of the permit was submitted to DTSC on March 1, 1994, and approved on July 27. The modifications included the following:

- Added treatment for neutralization of corrosive hazardous wastes and desensitization of potentially shock-sensitive laboratory wastes.
- Changed the closure schedule for two out-of-service hazardous waste treatment units so that they could be closed in 1994.
- Expanded the boundaries of two work areas for sampling and packaging of mixed wastes.
- Allowed the HWHF to receive hazardous and mixed wastes from Building 934, which is the LBL offsite research facility in west Berkeley.
- Updated certain information related to emergency personnel and telephone numbers.
- Corrected typographical errors.

LBL has five additional fixed treatment units (Table 3-3) outside the HWHF that fall under the Tiered Permitting program. Three of these FTUs are authorized for operation under the "conditional authorization" Tier. Two FTUs are authorized to operate under the "permit-by-rule" Tier. Cal/EPA's DTSC granted LBL authorization to operate these FTUs during the program's initial startup phase in 1993. LBL renews this permit with DTSC for these units, called Unit Specific Notifications, annually by March 1. In addition to the five permitted units, LBL began design work on a new FTU to be located at Building 77. Design work is scheduled to be complete in March 1995, with construction scheduled for completion by May 1996.

Table 3-3. LBL's Fixed Treatment Units Subject to Tiered Permitting During 1994

Building	FTU	Description	Permit Tier
77	001	Aqueous waste containing metals and inorganic acid	Permit-by-Rule
25	002	Aqueous waste containing metals and inorganic acid	Permit-by-Rule
76	003	Oil mixed with water	Conditional Authorization
70A/70F	004	Inorganic acid	Conditional Authorization
2	005	Inorganic acid	Conditional Authorization

Stormwater Discharge

LBL's stormwater releases require a permit under the California-wide General Permit for Stormwater Discharges Associated With Industrial Activity (No. 2-01S002421). The California-wide permit is issued by the State Water Resources Control Board and administered and enforced by the Regional Water Quality Control Board as a National Pollutant Discharge Elimination System permit for discharges of stormwater under the Clean Water Act. Under the permit, LBL has implemented a *Stormwater Pollution Prevention Plan* and a *Stormwater Monitoring Program*. Together, these documents represent LBL's plan and procedures for identifying, monitoring, and reducing pollutants in its stormwater discharges. The General Permit was promulgated by the state in 1991 and will be in effect for five years, after which it is subject to renewal or revision by the SWRCB.

Underground Storage Tanks

At the beginning of 1994, there were 13 USTs on site (see Table 3-4), all of which were permitted by the City of Berkeley. The operating permits apply to tanks containing diesel fuel, gasoline, or transformer oil. Three tanks were removed during 1994. Activities associated with these removals, as well as other UST events, were discussed earlier in this section under RCRA compliance.

Wastewater Discharge

In October 1994, EBMUD issued renewed wastewater discharge permits for three LBL activities: one site-wide (Acct. No. 066-00791), and one each for discharge from treatment units at metal finishing operations in Building 25 (Acct. No. 502-38911) and Building 77 (Acct. No. 502-38921). The three permits are renewed annually. The permits incorporate standard terms and conditions, as well as individual discharge limits, provisions, and reporting requirements. Because of LBL's excellent compliance record during the previous permit year, EBMUD decreased LBL's monitoring and reporting requirements compared to last year's permits.

Other Noteworthy Environmental Activities

Tiger Team Activities

Progress continued in 1994 on LBL's corrective action plan for resolving the findings of the 1991 DOE Tiger Team visit.[51] By the end of 1994, 366 of the 375 tasks generated from the Tiger Team assessment were complete Remaining tasks were related to DOE-oversight activities of the site and its programs. These nine remaining tasks were completed in early 1995, marking an end to this mammoth undertaking. Thirty-three tasks were completed in 1994. Laboratory-wide, 1,397 milestones were established to complete the tasks stated in the corrective action plan, including eighty eight completed in 1994 and early 1995.

The corrective action plan specified 107 tasks with 455 corresponding milestones to address environmental issues. Overall, 105 tasks and 453 milestones were completed by the end of 1994 in the environmental class. Five of these tasks and 13 milestones were completed in 1994 alone.

DOE EH-24 Environmental Audit

The DOE EH-24 audit team identified nine findings;[52] seven were in the environmental management systems area, and two were in

Table 3-4. Underground Storage Tank Operating Permits from City of Berkeley for 1994 1994

Registration Tank ID #	LBL Building	Stored Material	Capacity liters (gallons)	Construction	Year Installed
Fiberglass tanks, double-walled					
2-1	2	Diesel	15,200 (4,000)	Fiberglass	1988
2-2	2	Diesel	3,800 (1,000)	Fiberglass	1988
Double-walled steel with fiberglass plastic corrosion protection					
55-1	55	Diesel	3,800 (1,000)	Glasteel	1986
66-1	66	Diesel	15,200 (4,000)	Glasteel	1987
66-2	66	Diesel	7,600 (2,000)	Glasteel	1987
69-1[a]	69	Waste oil	7,600 (2,000)	Glasteel	1987
76-1	76	Unleaded gasoline	38,000 (10,000)	Glasteel	1990
76-2	76	Diesel	38,000 (10,000)	Glasteel	1990
Single-walled tanks					
4[a]	51	Diesel	2,100 (550)	Steel	1968
6	70	Diesel	2,300 (600)	Steel	1953
7	70A	Diesel	3,800 (1,000)	Fiberglass	1975
8[b]	74	Diesel	46,000 (12,000)	Fiberglass	1979
11	58	Transformer oil	7,600 (2,000)	Steel	1978

a Removed from site in April 1994.

b Removed from site in November 1994.

specific technical disciplines. Six of these findings addressed observations made of LBL's environmental management program, while three findings applied directly to either DOE/OAK or DOE/BSO oversight duties. The audit recognized three strengths in LBL programs. Table 3-5 presents the audit's findings, by responsible organization, and strengths.

The key finding of the audit team was DOE's inter-program effectiveness in cross-program communication, oversight, and planning and funding of environmental activities affecting LBL. DOE's organizational structure for managing environmental activities at LBL is complex. The audit team concluded that recent organizational changes and uncertainty of policy decisions at both

Table 3-5. DOE EH-24 Routine Environmental Audit Team Findings

Title of Management Summary Area/ Title of Finding	Strengths of LBL	Findings of LBL	Findings of DOE
Organizational Structure			
DOE Roles and Responsibilities		–	1
Environmental Roles and Responsibilities for LBL Activities on UCB Campus		1	–
Environmental Commitment	X	–	–
Environmental Protection Programs			
Environmental Protection Program Implementation		1	–
Air	X	–	–
Surface Water		–	–
Waste Management		–	–
Inactive Waste Sites and Releases		–	–
Environmental Quality Assurance			
Environmental Procedures and Recordkeeping		1	–
DOE Environmental Quality Assurance Program		–	1
Formality of Environmental Programs			
Environmental Inspection Programs		1	–
Internal and External Communication	X	–	–
Staff Resources, Training, and Development			
Environmental Training Program		1	–
Program Evaluation, Reporting, and Corrective Action			
DOE Environmental Compliance Oversight and Guidance		–	1
Environmental Planning and Risk Management			
Integration of the LBL Planning Process		1	–

DOE/HQ and DOE/OAK creates undefined, poorly coordinated, or misunderstood roles and responsibilities. The ramification from this is a reduction in DOE's effectiveness in carrying out basic environmental management functions impacting activities at LBL.

A summary of the findings from the audit team's review of the 13 environmental management program areas, and the significance of the audit's findings, follows:

- *Organizational Structure (OS)*: Two findings were identified in this area. The first finding concerned DOE roles and responsibilities for environmental management activities at LBL that are not clearly defined, coordinated, or understood. The second finding related to certain roles and responsibilities for LBL activities on the UCB campus that are not fully defined, understood, and implemented.
- *Environmental Commitment (EC)*: There were no findings in this portion of the audit.
- *Environmental Protection Programs (EP)*: The audit team combined weaknesses in several programs into one finding related to implementing environmental protection programs. Overall, LBL has made significant progress in developing and implementing environmental protection programs and has demonstrated strong environmental performance. However, the audit singled out certain elements of the environmental programs that were not fully developed and implemented to ensure continued compliance and environmental excellence. These include elements of the programs for environmental monitoring, drinking water, environmental ALARA, ozone-depleting substance substitutions, waste management, waste minimization/pollution prevention, and groundwater protection.
- *Air (Air)*: There were no findings in this portion of the audit. However, there were weaknesses recognized in coordinating the sitewide phaseout of ozone-depleting substances and tracking of small asbestos-abatement projects. These weaknesses were rolled into the findings under EP, PE, and QA.
- *Surface Water (SW)*: There were no findings in this portion of the audit. However, there were some weaknesses identified in the areas of program implementation and procedures regarding recordkeeping. These weaknesses were rolled into the findings under EP and QA.
- *Waste Management (WM)*: There were no findings identified in this portion of the audit. The audit team noted that slight opportunities for improvement exist in planning, training, program formality, and permit management.
- *Quality Assurance (QA)*: The audit team identified two findings in this segment of the audit. One finding combined relative weaknesses in some programs that were characterized by the following problems:
  - Certain LBL standard operating procedures (SOPs) in use were outdated.
  - No formalized SOPs existed for certain environmental data review activities related to quality verification.
  - Some records and reports were either incomplete or contained incorrect information.

  The second finding pointed out deficiencies in the DOE/OAK quality assurance program, including lack of a program plan, defined roles and responsibilities, training, and appraisals.

- *Inactive Waste Sites and Releases (IWS)*: There were no findings identified in this portion of the audit. The audit team did identify a discrepancy in the number of solid waste management units, and areas of concern were noted between the RCRA RFI and regulatory correspondence. These smaller issues were integrated into the QA finding.
- *Formality of Environmental Programs (FP)*: There was one finding in this portion of the audit related to lack of formality in some of the routine environmental inspection programs. This finding described three deficiencies:
  - the lack of a program to systematically inspect secondary containment of some hazardous waste units, nonhazardous waste receptacles, and the sanitary sewer lines,
  - not properly documenting inspections of the aboveground petroleum storage areas according to written procedures; and
  - the need for written procedures for conducting inspections of stormwater and process wastewater equipment.
- *Internal and External Communication (IC)*: There were no findings in this portion of the audit.
- *Staff Resources, Training, and Development (SR)*: There was one finding identified in this portion of the audit. The environmental training program has not been fully implemented by LBL divisions, does not accurately reflect some of the training requirements, and does not include all LBL personnel (e.g., visitors).
- *Program Evaluation, Reporting, and Corrective Action (PE)*: There was one finding in this portion of the audit. The audit team concluded that oversight of some LBL activities by DOE/OAK and DOE/BSO is fragmented and informal.
- *Environmental Planning and Risk Management (RM)*: There was one finding in this portion of the audit. The finding related to the lack of a formal sitewide comprehensive planning mechanism that integrates strategic and environmental planning, as indicated in the current *LBL Institutional Plan for 1994–1999* and the *Draft Institutional Plan 1995–2000*. The audit team concluded that while some integration occurs, the formality and sustainability of the planning integration progress needed improvement.

The strengths in the Laboratory's environmental programs, recognized by the audit team, include the following:

- *Staff Dedication*: Both staff and management at LBL, especially within the Environment Department, have devoted significant effort since the 1991 Tiger Team assessment developing and implementing many elements of management systems to ensure effective environmental operations.
- *External Communication*: LBL maintains frequent, proactive interaction with regulatory agencies. LBL has implemented a number of mechanisms for routine communication with external parties. Examples include:
  - establishing a community relations plan;

- distributing periodic fact sheets;
- establishing public information repositories at public libraries;
- holding quarterly review meetings with regulatory agencies; and
- holding monthly meetings with City of Berkeley representatives.

- *Air Monitoring Systems*: LBL has made substantial progress since the passage of the Clean Air Act Amendments of 1990 and Executive Order 12843 of 1993 in the control and phase out of ozone-depleting substances. LBL has gone beyond compliance in installation of ODS vapor leak detection systems and certification of Facilities M&O repair technicians. LBL has also instituted an accelerated schedule for ODS substitution projects. Another strength in the air program is the use of sonic detection and ranging (SODAR) stations, which is an innovative method for meeting meteorological monitoring requirements in an urban, complex terrain, while alleviating the aesthetic concerns of meteorological towers.

DOE Functional Appraisal

LBL also neared completion on a corrective action plan developed in response to a DOE/OAK Functional Appraisal of LBL's environmental programs during April 1993. The appraisal reviewed management systems that have been developed or improved since previous appraisals or the 1991 Tiger Team audit. The Functional Appraisal identified six compliance findings and eight best management practice observations. LBL developed 14 tasks with 48 milestones in its corrective action plan to address these findings and observations. By the end of 1994, all but one task had been completed under this plan. This lone task is expected to be completed in the first quarter of 1995 with the final installation of monitoring sites in the Sitewide Radiological Ambient Air Monitoring project. This project is mentioned below under *ERWM Corrective Action Projects* and in detail in Section 4, *Environmental Program Information.*

Agreement in Principle

In September 1990, the State of California and DOE entered into an oversight agreement known as the Agreement in Principle (AIP).[53] The agreement reflects the understanding and commitment between DOE and the State regarding DOE's provision of additional technical and financial support to the State for its activities in environmental oversight, monitoring access, facility emergency preparedness, and initiatives to ensure compliance with applicable federal, state, and local laws at LBL and five other DOE facilities in California. The lead agency for the State under the AIP Program is the Department of Health Services (DHS). The Environmental Management Branch of DHS oversees the program, although the SWRCB provides appropriate assistance. The RWQCB and the Office of Emergency Services are no longer a part of the AIP program. One progress meeting was held onsite in December 1994.

The AIP program began two efforts prior to 1994 that have continued to the present. The efforts focused on monitoring in the areas of environmental radiological dosimetry and stormwater. First, in early 1993 DHS installed thermoluminescent dosimeters (TLDs) at six LBL perimeter monitoring stations and one at the DHS monitoring station on Berkeley Way. These TLDs were located at LBL monitoring stations. The TLD on Berkeley Way has since been relocated to a DHS site in Sacramento. The onsite TLDs were located at five LBL monitoring stations and outside the office building (Building 75) headquartering the Environmental Monitoring Unit. The five environmental stations are identified by the label "ENV-B13x" in Figure 5-1, where x represents A, B, C, D, or H. The AIP network provides a general comparison of radiological measurements around the Laboratory. 1994 represented the second full year of data collection from the DHS TLDs. Dosimeters are changed on a quarterly basis by DHS. TLD exchanges occurred on January 7, April 5, July 1, and October 3. A comparison of the co-located sampling data is not possible in this year's report as LBL is still in the process of obtaining the data from the State. Preliminary data from 1993 were presented at a meeting in October between the State, DOE, and LBL.

Second, the State became active in LBL's stormwater program during late 1993. The initial participation involved commenting on the Laboratory's *Storm Water Monitoring Program.* During 1994, the SWRCB began a project to place stormwater monitoring instrumentation at LBL. The State's monitoring stations will gather the same parameter information as the LBL network. The only distinction between the LBL and AIP monitoring programs will be with the locations. All four proposed AIP monitoring sites will be different from the LBL sites. Several on-site planning meetings were held to select stormwater monitoring locations. An inspection of LBL's present stormwater monitoring sites occurred on June 30. LBL's Facilities Department completed preliminary design and cost estimates on the State's supplemental monitoring plan. As of the end of the year, the State was working out the details of transferring funds to LBL for this project. No date has been set to begin the monitoring installation.

Waste Management Audits

LBL's waste management program underwent a two-day audit by the Westinghouse Hanford Company beginning February 1 to determine conformity with the requirements of the latest revision of the Hanford Site Solid Waste Acceptance Criteria. The scope of the audit addressed only the low-level waste (LLW) and low-level radioactive mixed waste (RMW) programs. The review included visiting waste sites, observing waste pickups, and reviewing procedures. The Hanford group did not report any findings during this audit. LBL's "approved" status with the Hanford site was continued as a result of this audit.

DOE/HQ EM-25 (Office of Operations Assessment) conducted a Conduct of Operations assessment of LBL's Hazardous Waste Handling Facility from September 19 through September 23. The assessment report discussed three concerns:

- There was not a DOE-approved graded-approach matrix or similar document for the HWHF.
- There was no formal operator aids program to control posted information in the facility.
- Radiation and contamination boundary requirements were not being met at the HWHF.

LBL has provided responses to these concerns, indicating that corrective actions have been completed for concern 3 and that concerns 1 and 2 were invalid because LBL has a DOE-approved graded-approach document, the LBL *Operating and Assurance Program Plan,* and operator aids for the HWHF are controlled formally through monthly inspections and weekly meeting discussions, respectively. DOE/OAK has not yet verified the LBL response.

In February 1995, the Westinghouse Hanford Company raised concerns on long-term storage compatibility in four 208-liter (55-gallon) drums of mixed waste shipped from LBL in May and September of 1994. Hanford and LBL began an immediate investigation into this matter to identify the root cause of this issue and the extent of the problem. Meanwhile, two separate audits of the LBL Waste Management program were launched in April after Westinghouse Hanford discovered a discrepancy in the number of inner containers packaged in two of the four aforementioned drums. The first team consisted of Lawrence Livermore National Laboratory (LLNL) and Los Alamos National Laboratory personnel, while the second audit team comprised members from LLNL and DOE/OAK. The 1995 Site Environmental Report will reflect developments over the course of the coming year on this situation.

Environmental Planning

Since late 1992, DOE facilities have developed ES&H Five-Year Plans at the request of the Secretary of Energy. The objectives of this planning activity are to identify the magnitude of effort, prioritize the deficiencies, and determine the funding required to bring DOE programs into full compliance with all environment, safety, and health laws and regulations. There are three categories of activities under the plan; core, compliance, and improvement. Core activities are those deemed essential to maintain current levels of risk and compliance. Compliance activities are those required to move a facility toward full compliance. Improvement activities raise the level of ES&H performance while lowering the ES&H risk. The fiscal year for which the 5-year period funding is requested begins two years from the fiscal year during which the plans are prepared. For example, the Activity Data Sheets (ADSs) prepared in late 1994 and early 1995 are for the funding period FY 1997 through FY 2001. The ADS structure includes a breakdown by costs, resources, and trackable milestones, as well as a narrative justification for the funding request. Environmental planning ADSs are categorized below as Environmental Protection, Environmental Restoration, or Waste Management. Since preparation of the plans crosses over the calendar year, only the most recently submitted ADSs have been included in the lists below.

Environmental Protection

Beginning in January 1993, LBL prepared a series of ADSs for six core and ten compliance activities in the environmental functional areas of air quality, water quality, solid waste generation and control, toxic substances control, and management of environmental activities. Later in 1993, the ES&H Five-Year Plan was renamed the ES&H Management Plan and was broadened to provide complete coverage of all A-106 Environmental Projects and Pollution Prevention activities. The ADSs prepared in early 1995 cover the period from FY 1997 through FY 2001. The requested level of support for the core and compliance activities totals $8.9 million and $7.0 million, respectively. Environmental protection core ADSs are as follows:

- *Protection of Water Quality*
- *Protection of Air Quality*
- *Solid/Hazardous Waste Generation and Control*
- *Environmental Management, Oversight, and Reporting*
- *Control of Toxic Substances*

Environmental compliance ADSs include requests for supplemental resources to work on lower-risk areas of compliance, as well as funding for construction and renovation needed to minimize the impacts of LBL operations on environmental quality. A notable emphasis in the 1995 submission is waste minimization and pollution prevention programs and projects, reflecting the recent focus on these areas by the US/EPA, DOE, and many other agencies and interested parties. The complete list of compliance ADSs prepared for the ES&H Management Plan in early 1995 are as follows:

- *Strawberry Sanitary Sewer Sampling Upgrade*
- *Radiation Protection of the Public and Environment*
- *Wastewater Zero-Discharge Process at Building 77*
- *Groundwater Protection Management Plan Implementation*
- *Environmental Monitoring Database Development*
- *Hearst Sewer Monitoring Equipment Installation*
- *Waste Minimization and Pollution Prevention*
- *Waste Minimization and Pollution Prevention Implementation*
- *Environmental Monitoring Plan Implementation*
- *Underground Storage Tank Removals/Replacements*
- *Ozone-Depleting Substances Reduction Program*
- *Ion-Exchange Resin Reduction and Regeneration Process*
- *NPDES/Best Available Technologies Upgrades*
- *Waste Coolant Reduction at the Building 77 Machine Shop*

Environmental Restoration

LBL's environmental restoration program has prepared and maintained ADSs since the beginning of 1992 for ERWM Five-Year Plan activities. ERWM programs have required this planning activity for an additional year, compared to the environmental ADS described above. The structure of the ADSs in either program is similar. The three environmental restoration ADSs completed in early 1995 are listed below:

- *Closure of the existing Hazardous Waste Handling Facility*
- *Environmental Restoration Program Management*
- *Soil and Groundwater Environmental Assessment and Remediation*

With the exception of *Environmental Restoration Program Management*, these activities share two common tasks: an initial assessment or characterization of the situation, followed by surveillance and/or remediation efforts.

Waste Management

Three ADSs were prepared by LBL for ERWM Five-Year Plan activities in waste management in early 1995, covering the fiscal year period 1997 through 2001. These ADSs include:

- *Facility Operations and Maintenance*
- *New Hazardous Waste Handling Facility*
- *EM Waste Minimization and Pollution Prevention*

The facility operations and waste minimization ADSs are similar to the programmatic ADSs prepared for environmental programs in that they describe the elements required to maintain or improve compliance programs. This waste minimization ADS is principally directed at end-of-stream activities within the HWHF, but includes support for the Laboratory's site-wide pollution prevention program as well. The new HWHF ADS requests support for construction of the new HWHF, which is presently underway.

In addition to the ADSs for facility operations and waste minimization, Waste Management completed a FY95 Work Plan in September 1994 that detailed FY95 work scope and cost estimates in these activity areas.

LBL's Environment Department also spent considerable effort either writing or significantly revising a number of plans and procedures for environmental programs in 1994, including the following:

- *Accidental Spill Prevention and Containment Plan*
- Alternative Solvent Test Results
- *Annual Report on Waste Generation and Waste Minimization Report*
- Environmental ALARA Program
- *Environmental Protection Function Notebook*
- Environmental Protection Group Procedures
- *Environmental Protection Implementation Plan*
- *Environmental Restoration and Waste Management 5-Year Plan*
- ES&H Management Plan Activity Data Sheets
- *Guidelines for Generators of Hazardous Waste at LBL and Guidelines for Generators of Radioactive and Mixed Waste at LBL*
- *Guidelines for Waste Accumulation Areas at LBL*
- *Hazardous Waste Treatment and Storage Permit Application for the Lawrence Berkeley Laboratory Hazardous Waste Handling Facility*
- *Laboratory Analysis Unit Quality Control Manual*
- *Low-Level Waste Certification Plan for the Lawrence Berkeley Laboratory Hazardous Waste Handling Facility*
- *Medical and Biohazardous Waste Generator's Guide*
- *Medical Waste Management Plan*
- *Mixed Waste Certification Plan for the Lawrence Berkeley Laboratory Hazardous Waste Handling Facility*
- *Radioactive and Mixed Waste Management Plan for the Lawrence Berkeley Laboratory Hazardous Waste Handling Facility*
- *RCRA Facility Investigation Workplan*

- *Spill Prevention, Control, and Countermeasure Plan*
- *Stormwater Monitoring Program*
- Underground Storage Tank Removal Plans
- Waste Management Group Procedures
- *Waste Minimization and Pollution Prevention Awareness Plan*

ERWM Corrective Action Projects

LBL's ERWM-funded corrective action project, entitled Air Toxics Facility Assessment and Rehabilitation, neared completion in 1994. This project was funded in 1991 at nearly $3.2 million to correct site-wide deficiencies in environmental monitoring and emissions controls. The project was divided into five subprojects:

- airborne emissions source abatement
- meteorological monitoring upgrade
- radiological NESHAPs stack monitoring upgrades (two separate projects)
- sitewide radiological ambient air monitoring

The airborne emissions source abatement and meteorological monitoring upgrade portions were completed in 1994. The remaining radiological monitoring projects closed 1994 on the verge of completion. Each is expected to be finished in the first quarter of 1995. Each of these projects is discussed in detail in Section 4, *Environmental Program Information.*

Training

The EH&S Training Unit offers approximately 40 courses for LBL permanent, temporary, and visiting staff. These are courses that are required or recommended by regulation and/or LBL policy. The largest of these courses are the *Hazardous Waste Generators* and *Radioactive/Mixed Waste Generators training*. Over 1,350 Laboratory employees have been trained in one or both of these classes since their inception; the number of current LBL staff trained in these areas is 906. Due to improvements in compliance and understanding, the requirement for annual retraining for waste generators has been suspended. Other classes of significant size include Chemical Hygiene and Safety and Medical/Biohazardous Waste. Training courses are offered to employees over a wide range of frequencies, from every other week to once a year. On-demand training, designed to meet the needs of a particular division or group, is also available and is becoming increasingly common.

To improve the efficiency of identifying the training requirements of employees, the Training Unit developed a Job Hazards Questionnaire (JHQ) with input from all divisions this past year. Each division is responsible for distributing the JHQ to staff. The Training Unit is presently working on two approaches to aid in distribution of the JHQ: completing the questionnaire at the time of hiring and linking the questionnaire to the annual performance evaluation.

Completed JHQs are available on line for widespread access by LBL employees. To date, over 2,700 active employees and guests have filled them out. The on-line JHQ readily identifies the necessary EH&S-sponsored courses for an employee. Currently, the on-line system does not discern job-, equipment-, or division-specific training, although the JHQ is capable of capturing that information. This need has been identified, and efforts to modify the system have been initiated.

Self-Assessment

The LBL self-assessment program provides a formal process for assuring quality and regulatory compliance in all facets of Laboratory operations. It satisfies the requirements of DOE Order 5700.6C,[54] Quality Assurance, for worker, management, and independent assessments. The Office of Assessment and Assurance prepared the FY 94 LBL Self-Assessment Report, which describes LBL's self-assessment activities and summarizes the results of the divisions' self-appraisals in the areas of environmental protection and occupational safety and health. It also describes opportunities for improving environmental protection and occupational safety and health at LBL, discusses root causes, and presents the status of FY93 corrective action strategies. This report fulfills the requirement in the *Mitigation Monitoring Plan for the Proposed Renewal of the Contract Between DOE and the Regents of the University of California for Operation and Management of the Lawrence Berkeley Laboratory* (September 1992) for LBL to implement Mitigation Measure IV-K-1 relating to Hazardous Materials.

The Office of Assessment and Assurance analyzed FY94 self-assessment information to identify opportunities for improvement in Laboratory operations. Multidisciplinary teams of senior management and staff were convened to formally investigate the root causes of each of the opportunities for improvement. The results were a series of cause-and-effect relationships leading from the root causes to the problems. Corrective actions that focus on the root causes will be developed and implemented in FY95.

UC/DOE Contract

Effective October 1, 1992, DOE and the University of California[1] entered into a new contract agreement for the five-year period ending in 1997. The contract requires the use of a objective measures of management performance in the area of environmental excellence, called performance measures (PMs). LBL is required to report the results of a self-assessment on the PMs to the University of California annually. Additionally, the performance measures are revised annually, in cooperation with DOE, to continually improve performance related to environmental programs. For 1994, environmental performance measures have been established in the following areas.

- *Radiation Protection of the Public*: The current self-assessment is *Far Exceeds Expectations*. This PM is a direct measure of the effectiveness of LBL policies related to maintaining public exposures as low as reasonably achievable (ALARA). The PM established a *de minimus* annual dose of 0.03 mSv (3 mrem). LBL reduced its offsite dose below this number to 0.015 mSv (1.5 mrem) for 1994.
- *Process Waste Minimization*: The current self-assessment is *Far Exceeds Expectations*. This PM is a direct measure of the effectiveness of LBL policies related to minimizing the generation of toxic and hazardous wastes. The goal under this PM was a reduction of 5% for acids, coolant, and contaminated solids waste. LBL greatly exceeded these expectations in 1994, with reductions of 76%, 51%, and 28% respectively.

- *Solid Waste Minimization*: The current self-assessment is *Exceeds Expectations*. This PM is a direct measure of the effectiveness of Laboratory policies that minimize the generation of landfill waste. This is a measure of surrounding community satisfaction. LBL exceeded its goal of a 10% reduction for 1994 in the total weight of waste shipped off site for disposal.
- *Source Reduction and Pollution Prevention*: The current self-assessment is *Meets Expectations*. This is a continuous improvement measure that requires review to determine additional improvement opportunities in the areas of waste minimization beyond those identified above. The first measurable criterion for this PM was not due until January 1995 when a list of candidate waste streams for review was due. LBL has prepared this list and will continue to evaluate this PM in 1995.
- *Tracking and Trending of Findings*: The current self-assessment is *Far Exceeds Expectations*. This measure is a direct reading of DOE and external regulatory bodies satisfaction that the number of findings or violations per audit or inspection is decreasing from previous years. By implementing a proactive management strategy that includes early planning, supervisor responsibilities, and employee training, LBL was able to measure a reduction from a base (1993) of 25 inspections totalling 98 findings, to 1994 results tallying 43 inspections and only 24 findings. This translates to a downward trend from 3.9 findings per inspection to 0.56 findings per inspection.
- *Tracking and Trending of Environmental Releases*: The current self-assessment is *Far Exceeds Expectations*. This PM is a direct measure of the effectiveness of Laboratory policies concerning the inadvertent release to the environment of hazardous substances. LBL has reduced the mean time between environmental releases from 6.5 weeks in 1995, to 26 weeks in 1993, to no reportable releases in 1994.
- *Regulatory Commitments*: The current self-assessment is *Meets Expectations*. This PM measures how effectively LBL implements federal compliance requirements. LBL met, on time or ahead of schedule, all three identified regulatory commitments for environmental and waste management programs.
- *Integration*: The current self-assessment is *Meets Expectations*. This PM indirectly measures how well EH&S Division policies have been integrated into every aspect of LBL operations by internal customers. This PM was first implemented in October 1994. LBL has completed initial evaluation of the PM, providing evidence that integration has been successfully attained.
- *Completion of Milestones*: The current self-assessment is *Needs Improvement*. This PM directly measures EH&S Division performance against DOE specific compliance needs. It measures how well the EH&S Division performs in providing certain correspondence to DOE, compared to when the correspondence is due. There were eight milestones identified under this PM. LBL completed seven of these milestones on schedule. Completion of the eighth milestone was delayed due to preparation activities for the DOE EH-24 Routine Environmental Audit.

- *Regulator Customer Satisfaction*: The current self-assessment is *Meets Expectations*. This PM requires performing a regulator satisfaction survey. Participants from DOE, UC, LLNL, and Los Alamos National Laboratory have joined with LBL to develop a survey for key regulatory agencies to complete each year. For the time being, LBL has referenced excerpts from the DOE EH-24 Routine Environmental Audit to benchmark progress in this area.

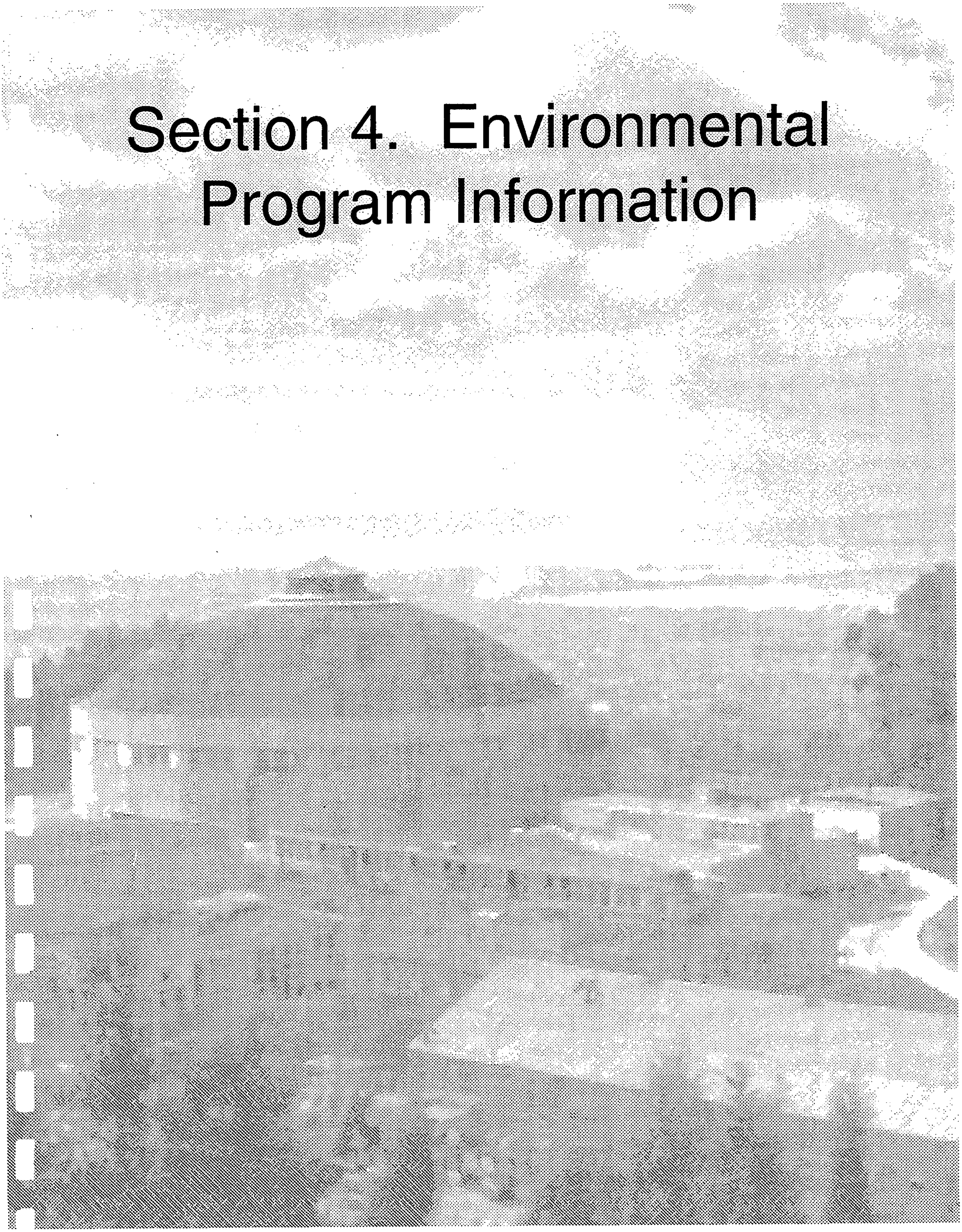
Overall, the EH&S Performance Measure rating is estimated as *Exceeds Expectations*. The environmental performance measures described above show five areas of excellence and only one area of weakness. See Section 4, *Environmental Program Information*, for more information.

LBL Programs

The future of LBL will be shaped significantly by several new or upgraded research and support programs:

- The Advanced Light Source has been operational since 1993. The ALS has two insertion devices and two bend magnets which became operational in 1993. The first scientific results were obtained with the high brightness ultraviolet/soft x-ray light.
- The Biomedical Isotope Facility (Building 56) project entered the construction phase in 1994. This building is presently scheduled for completion in June 1995.
- The Human Genome Laboratory (HGL) neared completion of the design phase. This project is divided into two phases. Phase I addresses demolition of Building 74B, presently located at the new HGL site. Phase II represents construction of the new HGL. Demolition under Phase I is scheduled to begin in April 1995. LBL anticipates awarding the construction contract under Phase II in September 1995. Construction of the Building is expected to be completed in December 1997.
- The new HWHF (Building 85) is now into the construction phase. Site work was completed in January 1994. Construction of the HWHF began in October. Construction on the building is expected to be completed in May 1996.

Section 4. Environmental Program Information



Environmental Program Overview

This section of the report provides an overview of LBL's major environmental programs. Many of these regulatory programs are administered at either the state, regional, or local level in California. The administering agencies implement regulatory programs designed to meet applicable federal, state, and local requirements. Authority to administer a regulatory program must have been delegated downward from a federal, and in some cases, state agency, provided the administering agency's program is at least as stringent as that of the agency granting the delegation.

Most of LBL's regulatory compliance programs dictated by the major federal environmental statutes discussed in Section 2, *Compliance Summary*, are administered by the Environment Department of the Laboratory's Environment, Health, and Safety Division. The Environment Department is organized into three functional groups: Environmental Protection, Environmental Restoration, and Waste Management. Figure 4-1 displays the Department's organization. The summaries that follow identify the managing group and provide a brief description of the primary environmental responsibilities of that group. Detailed information on program-specific

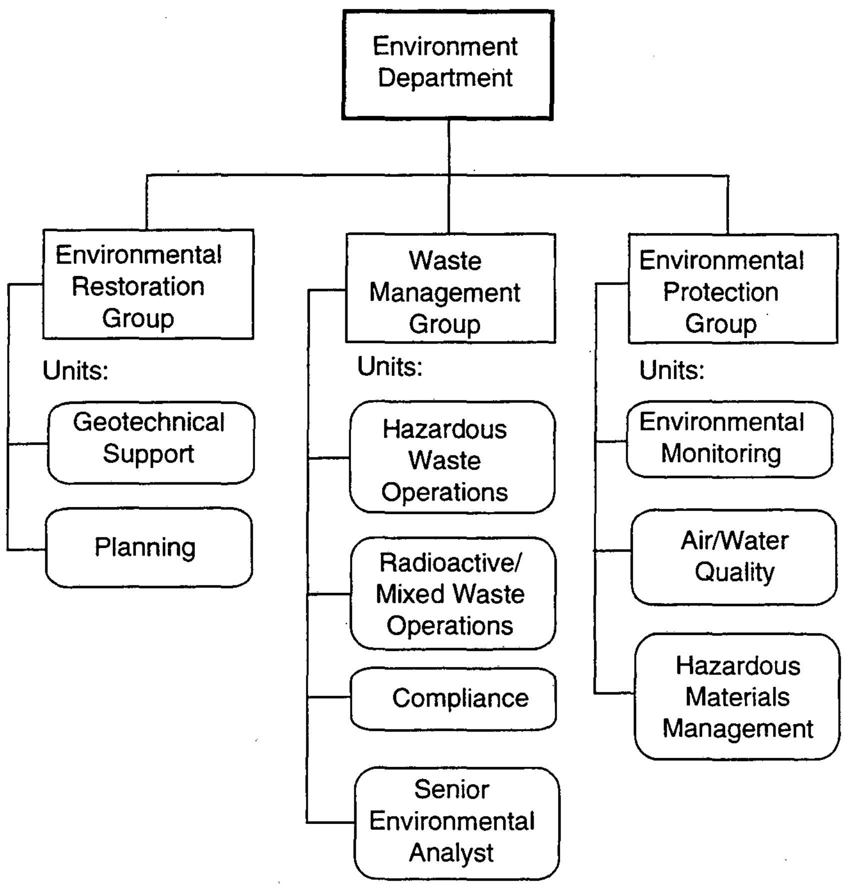


Figure 4-1. Environment Department

corrective action projects is presented later in this section. Descriptions of environmental monitoring activities associated with these programs follow in subsequent sections.

DOE Orders require that DOE facilities and DOE contractor-managed facilities like LBL comply with applicable federal, state, and local environmental laws, regulations, ordinances, and the DOE Orders. The recently extended operating contract between DOE and the University of California reiterates these compliance objectives. The University of California has established a series of performance measures to track activities at LBL. Environmentally related performance measures will be discussed later in this section.

Environmental Protection Group

The Environmental Protection Group (EPG) is responsible for overseeing compliance with environmental regulations at LBL. The regulations that frame the oversight responsibilities of the Environmental Protection Group are considerably more diverse that those of the other two groups. Environmental protection encompasses various media and corresponding regulations and monitoring requirements: air, water, and soil. EPG is separated into three operating units to address environmental issues: Air/Water Quality, Hazardous Materials Management, and Environmental Monitoring. In addition to providing sitewide oversight for routine compliance activities, each unit prepares necessary operating procedures, reports, and plans. The discussion below provides background on the key responsibilities of this group.

Air/Water Quality Unit

The Air/Water Quality Unit oversees Laboratory-wide compliance with air and water quality regulations. Air and water quality includes radiological and nonradiological forms of emissions. Air quality regulations are developed and governed by US/EPA and BAAQMD, respectively. Water quality covers both sanitary sewer and stormwater discharges. Sanitary sewer regulations are administered by EBMUD. Stormwater regulations are administered by both the RWQCB and the City of Berkeley.

The key areas of responsibility for the unit include:

- Ensuring that Laboratory-wide activities comply with regulatory standards of operation.
- Providing onsite compliance oversight information and training.
- Obtaining necessary environmental operating permits.
- Coordinating inspections of facilities by regulatory agencies and LBL personnel.
- Maintaining current inventories of emissions and discharges.
- Preparing plans and reports required by regulation, such as the annual US/EPA NESHAPs report, the State's *Air Toxics Hot Spots Information Act* report, the *Storm Water Pollution Prevention Plan* for the RWQCB and the EBMUD *Accidental Spill Prevention and Containment Plan*.
- Managing LBL's Environmental *As Low as Reasonably Achievable* (ALARA) radiological program.

- Assessing environmental risk through multi-media dose and toxics risk assessments.
- Reporting and investigating accidental releases and spills to appropriate agencies.
- Interacting with agencies during the rule-development phase for regulations potentially impacting LBL.

Hazardous Materials Management Unit

The Hazardous Materials Management Unit (HMMU) oversees a number of individual compliance program activities. The list of distinct programs includes underground storage tanks, aboveground storage tanks, hazardous waste treatment units, waste minimization, pollution prevention, waste generator support, and PCB-containing equipment. Each program includes compliance, monitoring, and reporting requirements driven by federal, state, and local regulations, as well as DOE Orders. Specific responsibilities of the HMMU include the following:

- Developing procedures and plans for managing PCB-containing materials and equipment.
- Overseeing compliance for TSCA-regulated substances such as PCBs and asbestos.
- Overseeing compliance activities of the underground storage tank program at LBL.
- Interfacing with personnel in other LBL organizations addressing environmental compliance issues.
- Providing training and technical guidance to promote awareness of spill prevention and control of hazardous materials.
- Managing permits for fixed treatment units and provide compliance oversight to treatment unit operators at LBL.
- Maintaining the *Groundwater Protection Management Program* plan.
- Providing sitewide generator assistance on waste issues under the functions of the waste minimization and pollution prevention programs.
- Preparing and implementing the *Waste Minimization and Pollution Prevention Awareness Plan.*

As more attention has been placed on waste minimization and pollution prevention by DOE and regulatory agencies, LBL has established several resourceful means of reducing waste. In 1993, under oversight from this unit, LBL developed a Laboratory-wide Chemical Exchange Database (CED). This program is accessible to anyone at LBL via the Laboratory's computer network. The CED was developed to promote the use of surplus chemicals that might have been shipped for disposal as hazardous waste in previous years. The unit was also instrumental in revising the Laboratory's solid waste contract to require an increase in solid waste recycling. Under the new language, all subcontractors must recycle at least 25% of the waste they collect. LBL assists in this effort by segregating wood scraps, organic compost, and cardboard. This program is required by the California Integrated Waste Management Act[55] of 1989 and applies only to recyclable material in 20-yard bins of regular wastes.

Environmental Monitoring Unit

LBL's environmental monitoring program consists of two major activities: (1) measurement and monitoring of effluents from

Laboratory operations, and (2) surveillance (i.e., the measurement, monitoring, and calculation) of the effects of those operations on the environment and public health. Key responsibilities of the Environmental Monitoring Unit for completing this objective include:

- Providing routine surveillance of radiological and nonradiological air emissions, penetrating radiation, meteorology, surface wastewater and stormwater discharges, and groundwater related to environmental permits and compliance requirements.
- Providing periodic surveillance of soil/sediment and vegetation.
- Ensuring that activities are performed in a timely manner in accordance with environmental regulations and permits, and DOE Orders.
- Providomg systems for data management and implement quality assurance activities that comply with the *EPG Function Notebook*.
- Preparing and submit environmental monitoring reports to regulatory agencies and DOE.
- Interfacing with other EH&S and LBL organizations in conducting sampling and monitoring efforts.
- Serving as coordinator of LBL involvement in the Agreement-in-Principle collaborative effort between DOE and the State of California.
- Initiating investigations and conducting sampling to determine the extent and type of environmental releases.

The *Environmental Monitoring Plan* and *Parameter Review Plan* are the foundation documents for the program. These plans identify the monitoring needs for the facility and detail the existing and planned monitoring activities designed to satisfy these needs and determine the environmental impact of Laboratory operations. Current elements of the environmental monitoring program are presented in Table 4-1. The monitoring plan focuses considerable attention on the importance of quality assurance in all aspects of environmental monitoring. More discussion on quality assurance is found in Section 8, *Quality Assurance*.

Environmental Restoration

The Environmental Restoration Group (ERG) oversees site and groundwater characterization and cleanup activities onsite. The primary goal of the group is to ensure that the risk to human health and the environment from past releases of hazardous and/or radioactive materials is either reduced to allowable levels or eliminated. The group performs functions necessary to characterize the extent of contamination to the soil and groundwater of the site, and to determine appropriate corrective measures.

As mentioned in Section 3, *Compliance Summary*, and with activities detailed in Section 7, *Groundwater Protection*, LBL's site restoration activities are conducted under the RCRA Corrective Action Program. This group is involved with soil and groundwater characterization activities that are of sitewide interest to the RWQCB, and specific activities at the HWHF that are of interest to Cal/EPA's DTSC. The requirements associated with HWHF activities are identified in the RCRA Part B permit for this facility. To accomplish the primary goal of the group, Environmental Restoration is organized into two units: Planning and

Table 4-1. Environmental Monitoring Program Elements

Monitoring Activity	Frequency	Medium	Reference
Monitoring of penetrating radiation at five perimeter stations and in each major accelerator complex. Data are telemetered from the stations to a central location and collected by a computerized data acquisition system.	Continuous: gamma and neutron flux	Air	DOE 5400.5; DOE/EH-0173T[56]
Sampling stack emissions in all areas where significant quantities of radionuclides are handled.	Weekly	Air	DOE/EH-0173T; 40 CFR 61, subpart H
Continuous sampling of ambient air at ten points on site and at five offsite and perimeter locations. Fourteen sites are sampled for particulate matter, eight for tritiated water (HTO), four for radioiodine, and one for $^{14}CO_2$.	Weekly	Air	DOE 5400.1; DOE/EH-0173T
Rainfall and dry deposition are sampled at nine onsite and four perimeter locations. Two additional sites are sampled whenever there is a significant rainfall. Rainwater is analyzed for tritium and gross alpha and beta activity.	Monthly	Air	DOE/EH-0173T
Sediments are sampled annually at creek sampling locations.	Yearly	Sediments	DOE 5400.1, DOE 5400.5
Sampling of the two LBL sewer outfalls. Outfall flow and pH are continuously measured at each site. Composite samples are analyzed for tritium, radioiodines, and gross alpha and beta emitters.	Weekly	Wastewater	DOE/EH-0173T; CCR Title 17,[57] 30287 and 30288
24-hour composite samples from the two sewer outfalls and LBL's two metal finishing shops are analyzed for a series of regulated metals. Grab samples are analyzed for chlorinated hydrocarbons, oil and grease, cyanide, phenols, total suspended solids, and filterable chemical oxygen demand.	Once every 2 or 3 months (from wastewater discharge permit)	Wastewater	40 CFR 433[58]
Sampling of groundwater by collecting grab samples at six LBL hydraugers and five creeks that drain the LBL watershed. The samples are analyzed for tritium and gross alpha and beta emitters.	Monthly: hydraugers; Weekly: creeks	Water	DOE/EH-0173T
30-minute composite sample at the start of a storm event, plus additional "grab" samples from creeks and streams. Samples analyzed for gross alpha, beta, tritium, metals, organics, oil/grease, gasoline, and diesel.	First storm event, plus at least one other	Water	40 CFR 122[59]

organized into two units: Planning and Geotechnical Support.

Planning Unit

The Planning Unit is involved in all four major phases of the site restoration program: site assessment, field investigation, data evaluation, and site remediation. This unit oversees activities such as:

- Planning program objectives and goals.
- Developing workplans consistent with group planning objectives and meeting the concerns of regulatory agencies and DOE.
- Selecting corrective measures after evaluating potential stabilization or cleanup options.
- Reviewing and assessing possible risks to the environment or public.
- Ensuring that efforts are conducted in compliance with federal, state, and local requirements.
- Evaluating data collected from soil and groundwater sampling.
- Coordinating contractor efforts at monitoring wells.
- Communicating program results to regulatory agencies, DOE, and community groups through regularly scheduled status meetings.

Geotechnical Support Unit

The Geotechnical Support Unit is designed primarily to provide support services to the group during field activity phases such as site assessment, field investigation, and site remediation. Areas of responsibility for the unit include:

- Constructing monitoring wells and drilling boreholes.
- Testing aquifers, sample groundwater, monitor the vadose zone, conducting soil gas surveys, and evaluating the analytical results.
- Creating geologic cross-sections using structural mapping methods.
- Characterizing the nature and extent of subsurface contamination.
- Applying appropriate corrective techniques to areas requiring stabilization or cleanup.

Waste Management

The Waste Management Group (WMG) manages hazardous, medical, and radiological waste activities at LBL. The Waste Management Group is divided into four units: Compliance, Senior Environmental Analyst, Hazardous Waste Operations, and Radioactive Waste Operations.

The hazardous waste regulations that LBL must comply with are among the most stringent and complicated in the nation. They consist of both the federal requirements under RCRA and the state requirements from its Hazardous Waste Control Law. Cal/EPA's DTSC has received delegation authority for the federal program. The City of Berkeley Toxics Program, through a Memorandum of Understanding with Cal/EPA, administers the requirements of RCRA and HWCL for hazardous waste generators.

LBL's Hazardous Waste Handling Facility is a RCRA-permitted storage facility designed to manage the large number, although relatively small quantities, of waste chemicals classified as hazardous. The HWHF permit is valid through 2003. LBL has begun construction activities on a new HWHF, presently scheduled for completion in May 1996.

Compliance Unit

Like the other three units to follow, the Compliance Unit assures that all LBL operations involving waste management are performed in a safe, responsible, and fully compliant manner. The key responsibilities of this unit include:

- Coordinating RCRA Part B permitting activities.
- Conducting internal audits of the HWHF.
- Assisting generators in evaluation of waste streams and characterization of hazardous wastes.
- Performing radioactive and mixed waste certification activities as required for Hanford documentation.
- Tracking waste disposal records.
- Auditing offsite treatment, storage, and disposal (TSD) facilities.
- Negotiating contracts with hazardous waste haulers, transporters, and TSD facilities.
- Evaluatomg contractors to ensure cradle-to-grave compliance.
- Providing training of Waste Management staff and maintain training records.
- Preparing, maintaining, and reviewing relevant documents for managing hazardous, radioactive, mixed, and medical wastes.

Senior Environmental Analyst Unit

The Senior Environmental Analyst Unit is accountable for performing the following tasks:

- Managing the medical waste program, including all activities associated with the medical waste hauler.
- Overseeing construction work on the new HWHF as the client of the project.
- Providing assistance to generators on waste acceptance criteria.
- Preparing forecasts for operations activities.

Hazardous Waste Operations and Radioactive Waste Operations Units

These two units share similar responsibilities, differing only in the type of waste that the units handle. The two units co-manage operation of the Hazardous Waste Handling Facility. The primary responsibilities of these units include:

- Overseeing and arranging for pickup, packaging, transport, and disposal of hazardous waste, as well as radioactive and mixed wastes.
- Assisting generators in solving hazardous, radioactive, and mixed waste disposal problems.
- Treating and storing hazardous, radioactive, and mixed wastes in accordance with RCRA Part B permit conditions and DOE Orders.
- Ensuring that all wastes meet transportation requirements for offsite disposal.
- Arranging for sampling and analysis of wastes as required by quality assurance/quality control and DOE Moratorium procedures.

- Managing the HWHF to ensure compliance with regulatory storage requirements.
- Supervising the onsite contractor performing hazardous, radioactive, and mixed waste handler support.

Long Range Planning and Special Projects

In addition to the four above-mentioned units, Waste Management has established a section called Long Range Planning and Special Projects. This section is responsible for developing work plans and planning documents that are required by DOE, including the Group's contribution to the *5-year ES&H Management Plan*. This special section also tracks overall program progress, generates performance measures, and performs budget analysis and review.

UC/DOE Contract Performance Measures

The present five-year operation contract for LBL between the University of California and the Department of Energy requires objective performance measures in many areas of management, including environmental compliance. All PMs are generated and maintained by LBL, and reported to UC annually. 1994 represented the first full year for which these PMs were prepared. The PM criteria are reviewed annually and revised as appropriate as a way of measuring continuous improvement in environmental programs. In addition, the performance measure process has a means of addressing significant changes in actual or anticipated workloads at LBL that may arise. LBL is responsible for notifying UC and DOE of such changes as soon as possible. Significant change is defined as a shift in workload by at least 10% that would affect the performance measure. There are five objective categories for which LBL is reporting:

- *Protection and Prevention*: LBL will conduct operations in a safe manner that protects human health, the environment and the public, and prevents adverse impacts.
- *Compliance*: The Laboratory will comply with applicable federal, state and local EH&S laws, regulations and ordinances, and with applicable and accepted DOE directives.
- *Integration and Accountability*: The Laboratory program and line management is accountable for integration of EH&S programs into all programs and operations.
- *Risk Management and Resource Allocation*: LBL will ensure that EH&S risks are analyzed and risk reduction resources are allocated appropriately for its programs and operations.
- *Customer Satisfaction*: The Laboratory will conduct its business in a manner that meets or exceeds customer expectations and, through continuous communications, will foster customer and stakeholder mutual trust and credibility.

Within these categories, seven PMs have been established to track environmental compliance excellence.

Radiation Protection of the Public

The purpose of this PM is to ensure that LBL operations do not exceed the allowable federal limit of 1 millisievert (100 millirems) for radiation doses to the maximally exposed member of the public.

Furthermore, the PM requires that the public radiation dose decrease from the previous year until the site *de minimus* value is reached. LBL proposed a *de minimus* value of 0.03 millisieverts (3 millirems), which was agreed upon by both UC and DOE in October.

LBL uses a proactive management strategy to reduce the public dose and minimize environmental releases. This strategy is embedded in LBL's environmental ALARA program, a formal program that is incorporated into the routine activities of LBL's existing ALARA Committee. This committee consists of members from both EH&S and the research community. The ALARA committee meets once a month to review past and present environmental and safety concerns.

The Air/Water Quality Unit of EPG calculates the public radiation dose from direct penetrating radiation and airborne dispersible radionuclides on a quarterly basis. Figure 4-2 shows the cumulative public dose for 1994 at the maximally exposed individual (MEI) receptor. For LBL, the MEI represents a hypothetical person because of the receptor's proximity to the facility. The figure also displays both the DOE reporting limit and LBL's *de minimus* value. The MEI value for 1994 operations at LBL was about 0.015 millisieverts (1.5 millirems). This performance achieved a *Far Exceeds*

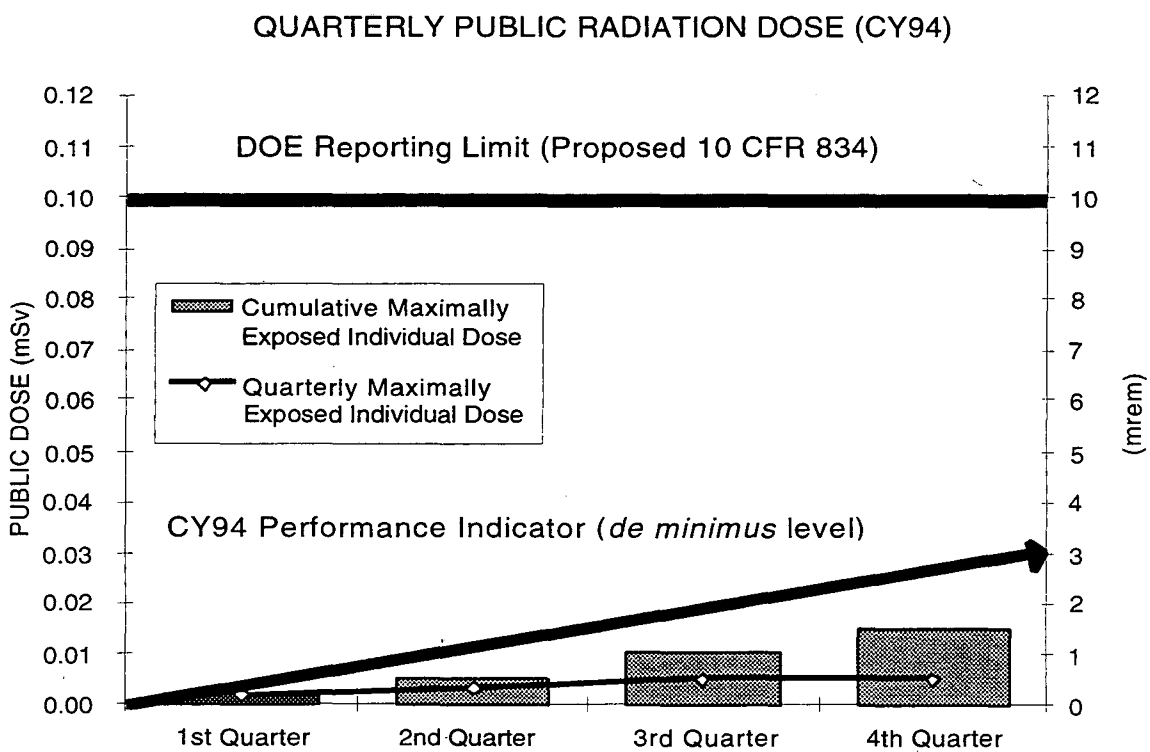


Figure 4-2. Cumulative Public Dose

Expectations rating using the Contract's success criteria.

Process Waste Minimization

DOE and LBL together selected 3 of 5 process waste streams that were the highest generators of waste for 1993. The performance measure requires LBL to reduce the rate of generation of each waste stream by 5% from the previous year. Recycling is considered a method of waste minimization.

Initial efforts by the Hazardous Material Management Unit concentrated on developing the tracking capabilities required to provide accurate evidence supporting LBL's waste minimization and pollution prevention efforts. The three waste streams agreed upon by DOE and LBL for this PM were acids, coolants, and contaminated solids. LBL received a *Far Exceeds Expectations* rating for its waste stream reductions. In 1994, acid wastes were reduced by 76%, coolants by 61%, and contaminated solids by 28% (Figures 4-3 through 4-5). To support continued success in this activity, DOE's EM-334 has approved an LBL request for funding to train waste generators in Pollution Prevention Opportunity Assessment (PPOA) methods. The funding will also allow LBL to reduce acids, coolants, and contaminated solids waste-stream levels to ones that are as low as practicable by using PPOA methods.

LBL's program success can be attributed to an enterprising partnership that cuts across all major sitewide and waste generator functions. Within this integrated program,

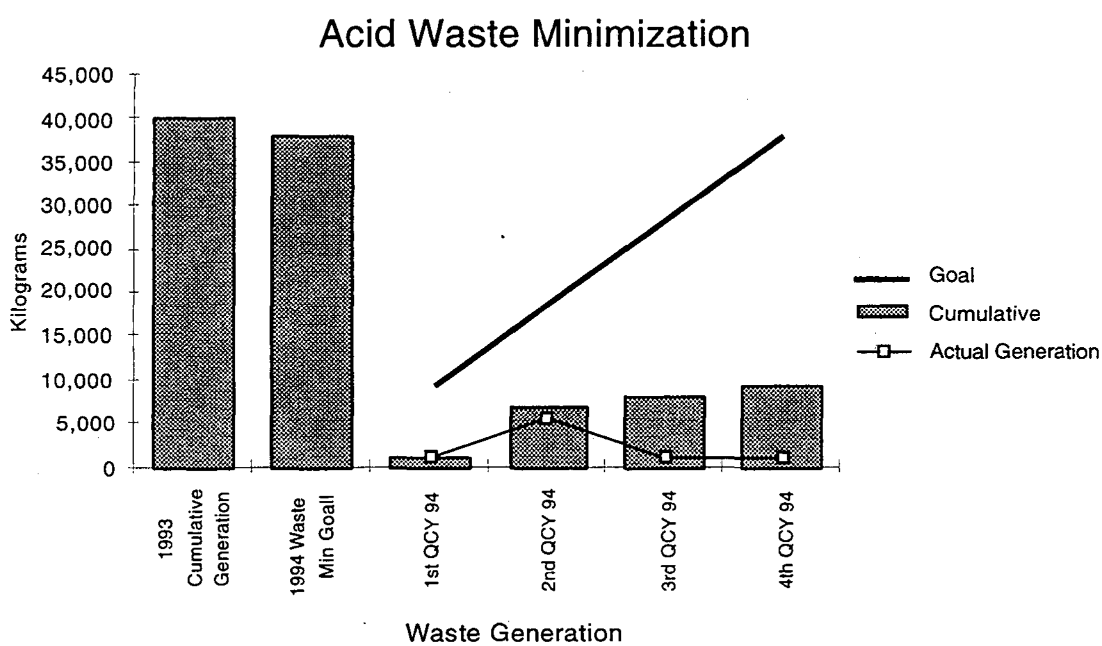


Figure 4-3. Acid Waste Minimization

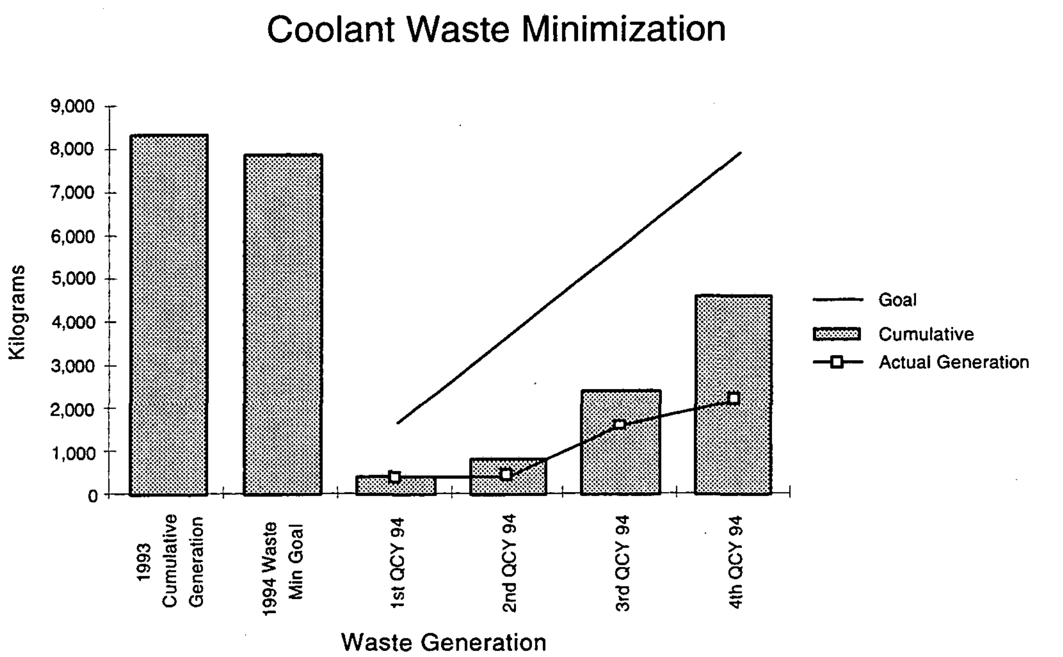


Figure 4-4. Coolant Waste Minimization

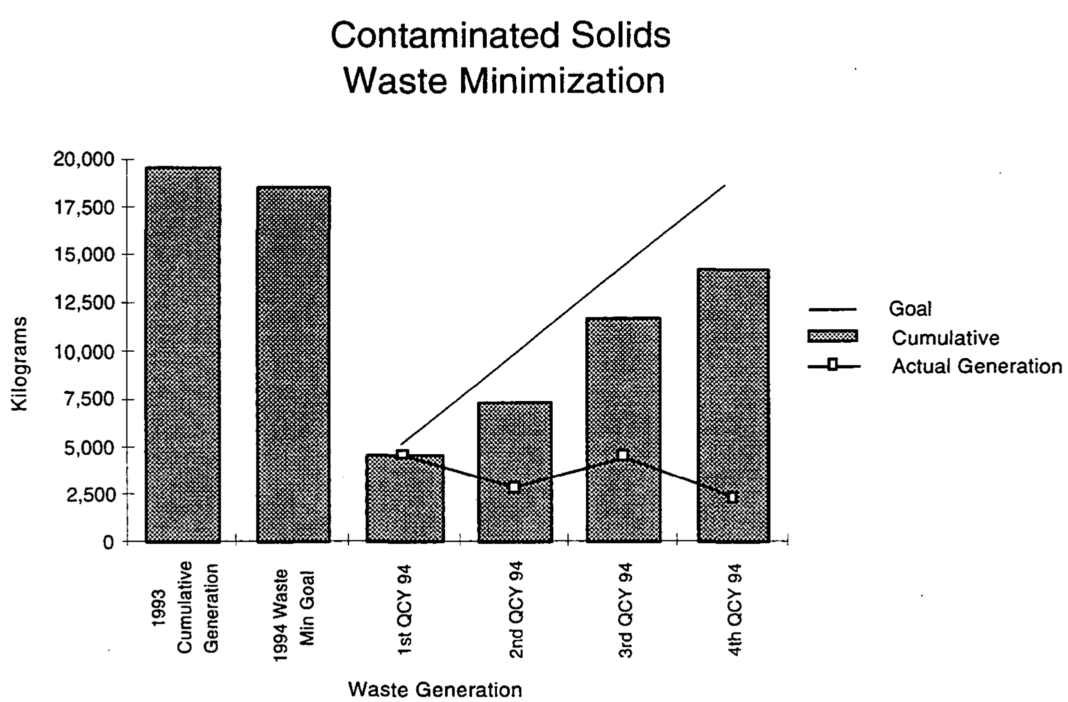


Figure 4-5. Contaminated Solids Waste Minimization

HMMU staff facilitate efforts to determine where waste reduction opportunities exist and to make recommendations on the most effective course of action. Recommendations may include source reduction, process changes, employee awareness, administrative controls, or increased reuse and recycling. HMMU staff work closely with generators in implementing specific waste reduction activities.

Solid Waste Minimization

Under this performance measure, LBL will decrease the aggregate weight of all waste generated sitewide by 10% each calendar year. This reduction may include nonhazardous waste. This value may not include construction debris, air emissions, or sanitary wastewater discharges. Demolition and decommissioning activities are considered changes in workload and will be addressed accordingly. HMMU waste minimization/pollution prevention staff also are monitoring this PM.

1993 was established as the baseline year for this PM. The baseline value was estimated because nonhazardous waste from LBL and UCB were combined during that period. LBL recognized this weakness and renegotiated the contract with the recycling contractor to provide a means for creating an accurate baseline in 1994. LBL exceeded its 10% annual reduction goal for offsite aggregate weight of waste disposal from its baseline (Figure 4-6). This resulted in an

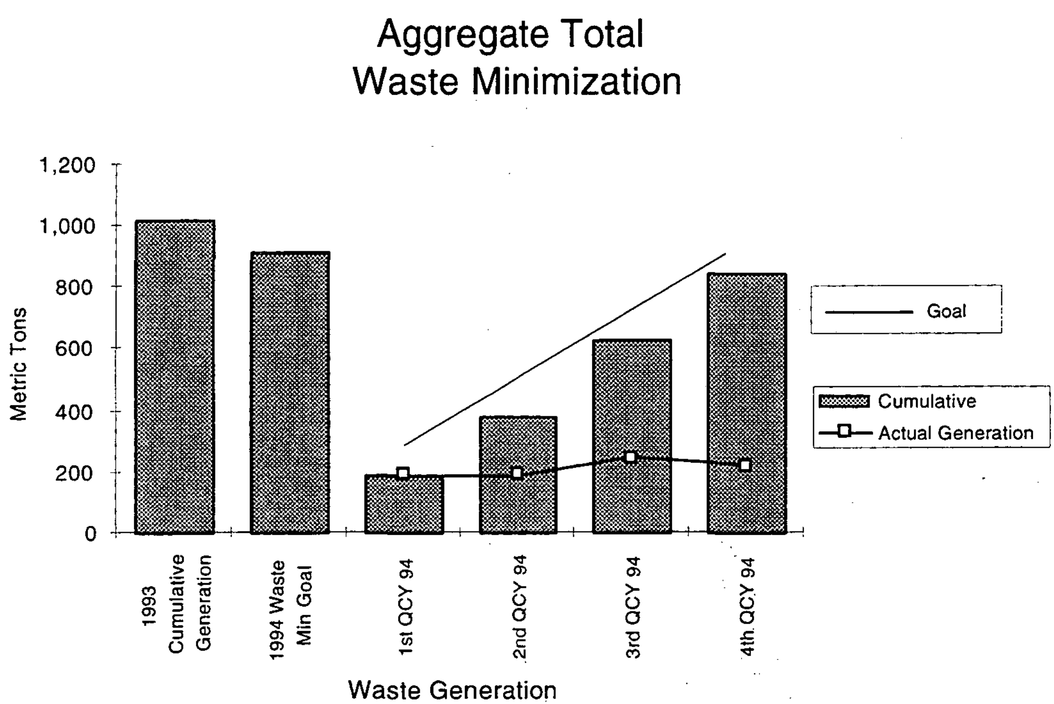


Figure 4-6. Aggregate Total Waste Minimization

Exceeds Expectation rating against this PM's success criteria.

One key area was responsible for LBL achieving this rating in 1994. Since hazardous, radioactive, and biological waste streams make up less than 20% of the total aggregate weight, LBL was able to concentrate its efforts on a paper recycling program. LBL generators are required to separate paper waste into dry and wet containers. The contractor picking up the nonhazardous solid waste performs additional sorting for recycling at its consolidation station. This second step leads to significant reductions in paper waste disposal. Besides these recycling efforts, several operations at LBL have switched to electronic communication and data dissemination systems. In 1995, LBL expects to meet its aggregate weight reduction goal through a sitewide Yard Waste Reduction program. Included in this program are the purchase of a shredder and several mulchers designed to target most of the Laboratory's yard waste. Other reduction activities will rely on the PPOA training discussed earlier and findings from a special generator task force that will look at critical waste streams.

Source Reduction and Pollution Prevention

This performance measure is still in the evaluation stage. The first measures of progress are set for the first quarter of 1995. LBL will survey its operations for candidate source reduction and pollution prevention opportunities by January 31. The survey must not include opportunities identified in the *Process Waste Minimization* performance measure. From this survey, LBL will identify a site-specific number of prioritized opportunities and a set of milestones and metrics for each opportunity by March 1. Candidate reduction opportunities will be evaluated against criteria that include compliance, size of waste stream, cost of waste stream, and site and public safety. Waste stream opportunities will be prioritized before initiating PPOAs or Process Waste Assessments. Progress on this PM will be measured on the site-specific milestones. Responsibility for this performance measure again falls within the HMMU.

Tracking and Trending of Environmental Releases

A downward trend is expected in this tracking of reportable occurrences of environmental releases that exceed regulatory or permitted levels. Releases that are abnormal but do not exceed regulatory requirements will not be included in this PM.

The metric being used with this performance measure is the mean time between environmental releases. The base year for comparison purposes is 1993. However, for a historical perspective, the mean time between environmental releases in 1992 was 6.5 weeks (8 occurrences). The mean time value for base year 1993 was 26 weeks. During 1994, there were no environmental releases that exceeded regulatory or permitted levels. From this performance, the success criteria rated LBL as *Far Exceeds Expectations*. Although this PM reflects all of LBL's environmental activities, EPG manages the tracking responsibilities for EH&S.

In addition to the performance record in 1994, LBL has taken several positive measures to manage the reduction of environmental releases. The *Storm Water Cross-Connection Correction, Spill Prevention Control and Countermeasures*

Implementation, and *Closed-Loop Acidic Wastewater Recycling System Projects* are all multi-year projects underway with reducing environmental releases the main objective. In addition, the *Environmental Protection Implementation Plan* establishes a framework for managing environmental protection activities at LBL, including actual or potential releases.

Regulatory Commitments

This performance measure is the joint responsibility of the Environmental Protection and Waste Management Groups. In short, it states that all funded regulatory consent agreement milestones will be met. Departures from these schedules must be approved by the appropriate regulatory agency prior to passage of the milestone, with UC and DOE properly informed ahead of time.

The Environmental Protection Group is responsible for managing the stack emissions-monitoring upgrade project to ensure compliance with the NESHAPs Federal Facilities Compliance Agreement. This PM tracks LBL's success at meeting the milestones during the performance period of July 1, 1994 through June 30, 1995. The FFCA includes three milestone dates during this period. LBL has met all three. The last milestone marked the completion of the project.

The Waste Management Group is responsible for preparing a plan that identifies the treatment of its mixed waste so that it meets Land Disposal Restrictions. WMG's association with this performance measure is less straightforward than EPG's as there is no formal, signed compliance agreement related to the issue. This element of the performance measure is included because the above-referenced mixed waste treatment plan is a requirement of the Federal Facilities Compliance Act passed by Congress in 1992. This Act will be put into an order by the State at the end of the process. DOE has established two milestones for LBL for this Act. LBL met the first milestone by submitting the draft treatment plan in August 1994. LBL is set to complete the final milestone during the second quarter of 1995.

Because of the commitment by EPG and WMG to accomplishing these reporting milestones on time or ahead of schedule, LBL was given a *Meets Expectations* grade for this PM's success criteria.

Completion of Milestones

This last performance measure is shared by the entire Environment Department. The measure requests that all EH&S budgetary and planning information, and reports required by DOE Orders listed in the UC/DOE contract and guidance will be submitted to DOE according to the schedules stated in the directives. The goal is to complete 100% of the milestones. The list of budgetary and planning information and reports includes the following:

- *Environmental Monitoring Plan*
- *Environmental Protection Implementation Plan*
- *Groundwater Protection Management Plan and sub-plan Groundwater Monitoring Plan*
- *Environment, Safety, and Health Management Plan*
- *Waste Minimization and Pollution Prevention Awareness Plan*

- *Annual Report on Waste Generation and Waste Minimization Progress*
- Annual Site Environmental Report
- Environmental Restoration and Waste Management 5-Year Plan

LBL submitted seven of these eight reports on time. LBL missed the due date for the EPIP because personnel preparing this report were required to redirect effort to preparation activities for the DOE EH-24 Routine Environmental Audit that occurred between November 7 and 18. For missing this one due date, LBL was given a rating of *Needs Improvement* in this performance measure.

Corrective Action Projects

In addition to the routine compliance activities managed by the three groups of the Environment Department, an important element of LBL's environmental management program involves upgrading or improving site operations. This element of the program has increased significantly in recent years in response to dynamics such as the Tiger Team investigation of 1991, changing regulations, and life-cycle replacement of aging infrastructure.

Since 1991, a large Environmental Restoration and Waste Management (ERWM) corrective action project entitled *Air Toxics Facility Assessment and Rehabilitation* has involved a great deal of time and effort while going through the design and construction phases. The project includes nearly $3.2 million in corrective action work, and contains the following subprojects:

- airborne emissions source abatement
- meteorological monitoring upgrade
- radiological NESHAPs stack monitoring upgrades
- sitewide radiological ambient air monitoring

These four subprojects either were completed or entered their final stages in 1994. The meteorological monitoring and airborne emissions source abatement subprojects were completed in January and August, respectively. The schedule for completing the radiological monitoring upgrade projects extended into early 1995. The completion date for the NESHAPs subproject coordinated with the FFCA compliance schedule.

Other significant corrective action projects involving the department included:

- sanitary sewer monitoring
- storm drain connection repairs
- aboveground storage tank modifications
- underground storage tank modifications

Airborne Emissions Source Abatement

Certain activities at LBL emit or have the potential to emit hazardous air pollutants directly to the atmosphere. The *Airborne Emissions Source Abatement* project evolved from the rescoped ERWM corrective action project in early 1992. Its objective was to reduce or eliminate emissions of hazardous air pollutants. The project was further divided into several subprojects:

- lead pot ventilation and filtration
- glass shop ventilation and filtration
- centrifugal chiller replacement
- walk-in refrigeration replacement
- ice machine replacement

The lead pot ventilation and filtration portion was the first subproject completed. LBL finished installing an improved ventilation system that included HEPA-type filtration efficiency (approximately 93%) of harmful lead emissions from the exhaust system in late 1993. The Tiger Team audit determined that the lead pot melting and pouring operation at Building 77 did not have an adequate exhaust ventilation system. Fabricating specially designed lead-based shielding materials for LBL's research programs is one of the critical onsite support capabilities of LBL's Engineering Division.

The glass shop is another support facility located in Building 77. This shop produces specialty glassware used in laboratory research. The raw materials used in making these products have changed over time as the need for stronger containers has evolved. Presently, quartz is one of the products used in the process. The heating process creates a hazardous byproduct called amorphous silica. An improved exhaust ventilation system, with emission filtration, was completed in August 1994. Although the lead pot and glass shop operations are emission sources of hazardous air pollutants, BAAQMD concluded that neither source had emissions above levels that require an operating permit.

The remaining three subprojects reduced LBL's inventory and usage of Class I ozone-depleting substances. As mentioned in the Clean Air Act portion of Section 3, *Compliance Summary*, Class I ODSs will be phased out of production globally after December 31, 1995. LBL's *Refrigerant Management Plan* identified these three subprojects as high-priority relative to other systems that either contain or use ODSs. All three subprojects were completed by August 1994. The replacement refrigerants conformed to the requirements of US/EPA's Significant New Alternatives Policy Program.

The first of the three ODS phase-out projects converted one of the two large centrifugal chillers that provide air conditioning to the Building 2 complex. These two centrifugal chillers were installed only a few years ago during the construction of this building and are considered young in terms of a life-cycle analysis. Retrofitting was determined to be the best option for such systems. Conversion of the first unit from Freon-11 to hydrochlorofluorocarbon-123 (HCFC-123) was completed in the late summer of 1994. Improvements in the ventilation and leak detection systems were included in the project to address certain characteristic properties of HCFC-123. LBL recovered approximately 290 kilograms (640 pounds) of Freon-11 during the conversion process. An equal amount of refrigerant will be recovered during conversion of the second centrifugal chiller in this building. This conversion is funded for FY95 and scheduled to take place during the summer.

The two remaining ODS phase-out projects involved lesser design efforts and smaller amounts of refrigerant than the Building 2 centrifugal chillers. One project converted two walk-in refrigeration units in Building 1 (Donner Lab) from Freon-12 to HCFC-22. The other project replaced seven ice machines containing Freon-12 with systems containing HCFC-22. These ice machines were found in various buildings across the LBL site.

Meteorological Monitoring Stations

Onsite meteorological data of wind speed, wind direction, and temperature have been collected at LBL since the 1960s. Onsite data are needed to properly carry out the NESHAPs requirement for estimating the dose impact of LBL's radiological emissions on the environment. Other uses of meteorological data include estimating the risk from air toxic emissions for either obtaining environmental operating permits from regulatory agencies or preparing health risk assessments of new projects. Additionally, meteorological data can be vital for emergency response activities such as spills, gas releases, or fires.

A 1988 DOE Functional Appraisal of environmental programs and the 1991 DOE Tiger Team found the LBL meteorological monitoring program inadequate. LBL agreed to update its monitoring program in its Tiger Team corrective action plan. The project that LBL embarked upon was divided into two stages: (1) prepare a monitoring plan based on the site's existing monitoring site, physical setting, and regulatory requirements; and (2) implement the plan through design and installation of the recommended equipment.

The monitoring plan that emerged recommended using remote-sensing instrumentation to gather the needed airflow information after it became apparent that using traditionally instrumented tower systems was not feasible at LBL. The number and height of towers needed to accurately characterize and collect meteorological data created insurmountable architectural and aesthetic obstacles. The only cost-effective technical alternative for collecting near-ground-level wind speed, wind direction, and atmospheric turbulence data is with remote-sensing SODAR (SOnic Detection And Ranging) instrumentation. SODAR technology works on the principle that a signal of known frequency is sent skywards in known directions. The unit then listens for a return signal. Three-dimensional wind patterns are derived based on the frequency detected from the different directions. For example, if no change in the signal frequency is detected, then the SODAR concludes that calm wind conditions prevail.

In addition to avoiding the obstacles posed by a network of conventional tower monitoring systems, SODAR technology brought certain advantages such as portability, lower cost, and improved data resolution. This last feature is represented by the SODAR system's ability to collect wind information at many levels, while a tower collects data usually at only one level. This enhanced resolution gives a much more realistic picture of the wind profile near the ground, which may change considerably both in direction and speed in complex settings such as LBL. Since nearly all of LBL's emissions to the atmosphere are at or near room temperature, the exhaust plume has little extra rise due to heat differences with the outside air. As a result, understanding differences in airflow patterns in the zone just above building rooftops is important.

The monitoring plan prepared in late 1992 recommended three mini-SODAR monitoring locations around LBL, with a 20-meter tower located at one of the mini-SODAR sites for quality assurance purposes (Figure 4-7). The majority of the next year was spent by LBL's project team selecting the monitoring locations, designing the sites, and awarding contracts to individual vendors for installing the mini-SODAR stations

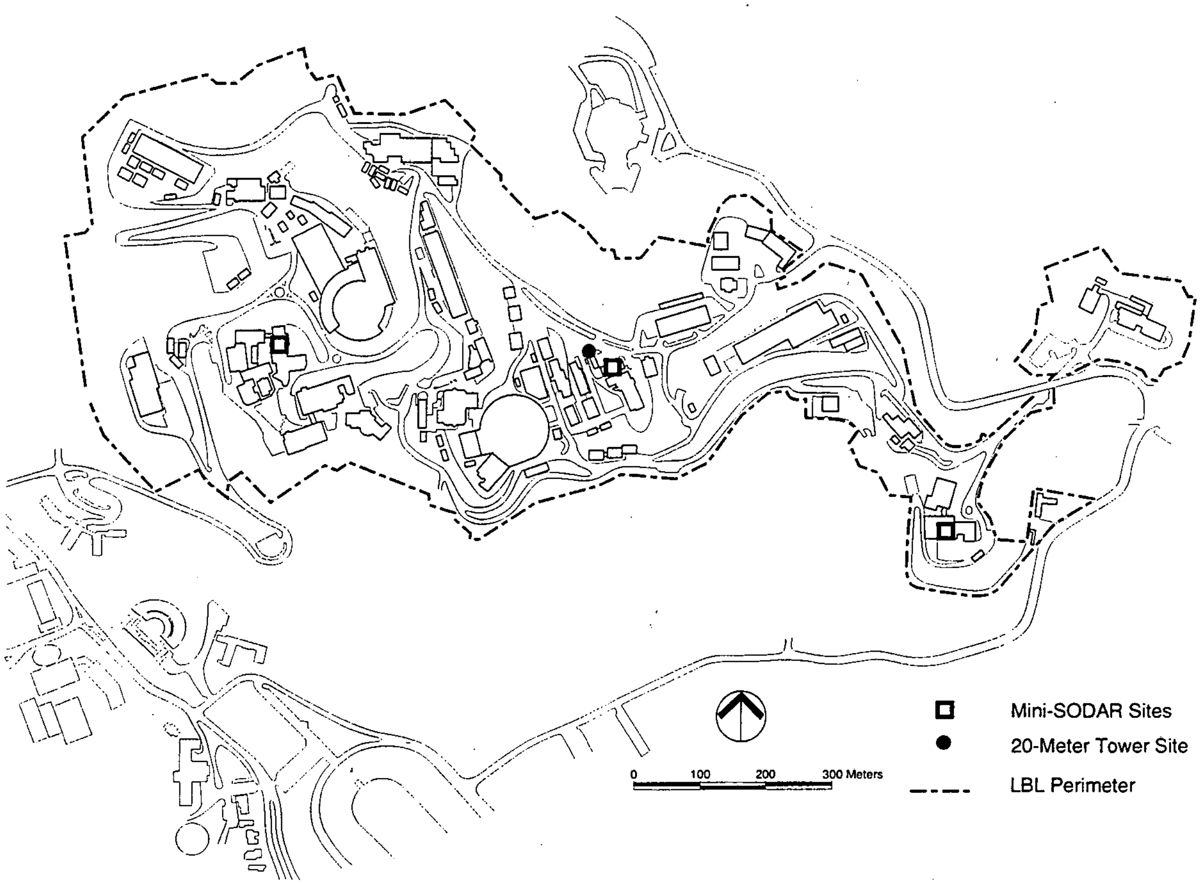


Figure 4-7. Meteorological Monitoring Network

and the monitoring tower. Actual installation of the mini-SODAR systems and the meteorological tower began in January 1994. Two of the three mini-SODAR stations and the tower were declared operational in February 1994. The third mini-SODAR station on the roof of Building 25 is ready for startup, but has experienced operational delays in response to changes in hardware which the vendor is making.

Data from this monitoring network are routinely collected, reviewed in near real-time, and archived on a central computer. The initial audit of the meteorological instrumentation on the tower was conducted in September. A minimum of one year of quality-assured data must be collected before LBL can use these data for NESHAPs dose assessments or other regulatory applications. The wind rose shown in Section 2, *Introduction*, summarizes preliminary wind speed and direction information representative of the site for 1994.

NESHAPs Stack Monitoring

As mentioned in Section 3, *Compliance Summary*, US/EPA issued a Finding of Violation and Order against DOE in April 1991 because LBL was not evaluating its radionuclide sources in compliance with applicable NESHAPs requirements. The resultant Federal Facilities Compliance Agreement between DOE and US/EPA in 1993 was designed to bring LBL's

NESHAPs stack monitoring program into full compliance by February 1, 1995. The total expense of the corrective action project was approximately at $1.8 million.

NESHAPs-regulated radionuclides may be released to the atmosphere from research activities at LBL. These research activities are dynamic. Research projects often have a fixed duration, and new projects may occur at new locations and emit a different set of radionuclides. These changes affect both the sampling strategy and sampling devices. To track compliance and continually assess stack monitoring requirements, LBL reviews all activities that may release radionuclides through the LBL *Radiological Work Authorization* program administered by EH&S's Radiation Assessment Group. This program tracks the use and inventory of all radionuclides on site. An assessment based on the nature of the work being proposed and the state of the radionuclide provides part of the basis for determining the dose to the nearest offsite member of the public. Adhering to US/EPA regulations and DOE EH-1073T, this assessment is performed with the assumption that no portion of the release is collected by emission controls. Using the US/EPA-approved models COMPLY and CAP88-PC, dose estimates are used in conjunction with a compliance strategy approved by US/EPA to determine the degree of sampling/monitoring or adminis-

Table 4-2. Summary of LBL NESHAPs Compliance Strategy Set for Initial Implementation in 1995

Category	Annual Effective Dose Equivalent (AEDE) (millirem/year)	Sampling/Monitoring Strategy	Number of Sources (1994)
Non-compliant	AEDE $\geq$ 10.0	Reduce or relocate source term and reevaluate prior to authorization.	0
I	10.0 > AEDE $\geq$ 0.1	US/EPA Application to Construct or Modify required, along with continuous isokinetic sampling. Analytical differences associated with half-life of radionuclide. Half-life greater than 100 hours: weekly analysis. Half-life less than 100 hours: hourly telemetry to central location.	4
II	0.1 > AEDE $\geq$ 0.05	Continuous isokinetic sampling with weekly analysis.	0
III	0.05 > AEDE $\geq$ 0.01	Continuous isokinetic sampling with monthly analysis.	1
IV	0.01 > AEDE $\geq$ 0.001	Sampled annually during project activity (continuous two-week sampling run). Isokinetic sample probe design, with sample mass flow set for average stack velocity.	6
V	0.001 > AEDE	No monitoring required. Inventory controlled by administrative methods (Radiation Work Permit) and annual reconfirmation.	57

trative controls necessary to achieve compliance. The compliance strategy will be implemented in 1995, and is summarized in Table 4-2. This new strategy differs slightly from that used in 1994. In particular, the Category V sampling strategy still consisted of weekly stack sampling. Upon completion of the *Radiological Work Authorization* database, this new strategy will be implemented. The sampling/monitoring strategy adopted by LBL in order to come into compliance with NESHAPs is summarized in Table 4-3.

The overall upgrade project embarked upon in conjunction with the FFCA is divided into three levels. The first level upgrades stacks so that emission measurements can be taken with either a portable or continuous sampling device. These represent the less significant regulated radionuclide emission sources at the Laboratory. At the end of 1994, this upgrade affected 47 stacks that require periodic monitoring (portable sampler) and 17 stacks that require a fixed, non-isokinetic, continuous sampler.

The second and third levels of the compliance project upgrade the stacks that have the greatest potential to emit radionuclides at LBL. Both levels include real-time monitoring capability. The second level focuses on installing real-time, isokinetic monitoring of radionuclide emissions at Buildings 75 and 75A. This upgrade will include the emissions from the National Tritium Labeling Facility and the existing Hazardous Waste Handling Facility. The third level of the project involves real-time non-isokinetic monitoring of air-activation emissions from accelerator activities in Buildings 56 and 88. Building 56 will be the location of LBL's

Table 4-3. NESHAPs Point Source Compliance Sampling Monitoring Summary

Sampling/Monitoring Method	Sampling Location
Real-time monitoring of HT and HTO	B75 NTLF exhaust
Continuous isokinetic sampling of HT and HTO	B75 NTLF exhaust
Real-time monitoring of ^{11}C, ^{13}N, ^{15}O	B88 accelerator exhaust
Real-time monitoring of ^{11}C, ^{13}N, ^{15}O	B56 Biomedical Isotope Facility accelerator exhaust
Real-time monitoring of particulates and iodine	B75 mixed and radioactive waste handling area
Continuous isokinetic sampling of particulates and iodine	B75A waste compactor
Continuous isokinetic sampling of particulates and iodine	B75 mixed and radioactive waste handling area
Continuous sampling of particulates, iodines, tritium, and sulfur	17 stacks located on 13 onsite and offsite buildings
Periodic sampling of particulates, iodines, tritium, and sulfur	44 stacks located on 13 onsite and offsite buildings
Periodic monitoring of ^{18}F	3 stacks located on B74B

new Biomedical Isotope Facility. Building 88 is the location of the 88-Inch Cyclotron.

In 1994, the project advanced to the construction phase. While there have been some minor changes to the design and scope at all three levels of the project, the Laboratory did complete the project prior to the FFCA deadline of February 1995.

Sitewide Radiation Monitoring and Sampling

A Tiger Team finding in 1991 cited deficiencies in a number of monitoring areas, including an insufficient distribution of monitoring stations and an unsatisfactory ambient air monitoring network. The finding referenced DOE Order 5400.1,[5] Chapter III, which sets forth the requirements for environmental monitoring. Broadly speaking, environmental monitoring consists of effluent monitoring and environmental surveillance.

The *Sitewide Radiation Monitoring and Sampling Project* adds nine new high-volume air samplers strategically located to measure the highest expected concentrations of particulate releases from the Laboratory. Two new gamma and neutron monitoring stations are positioned to detect direct radiation and backscatter from the 88-Inch Accelerator and the Advanced Light Source. Figure 4-8 shows the locations of the existing ambient air samplers and the proposed locations for the new high-volume air samplers. The current network of ambient air samplers and monitoring stations will remain in operation until their value with respect to the new stations is determined.

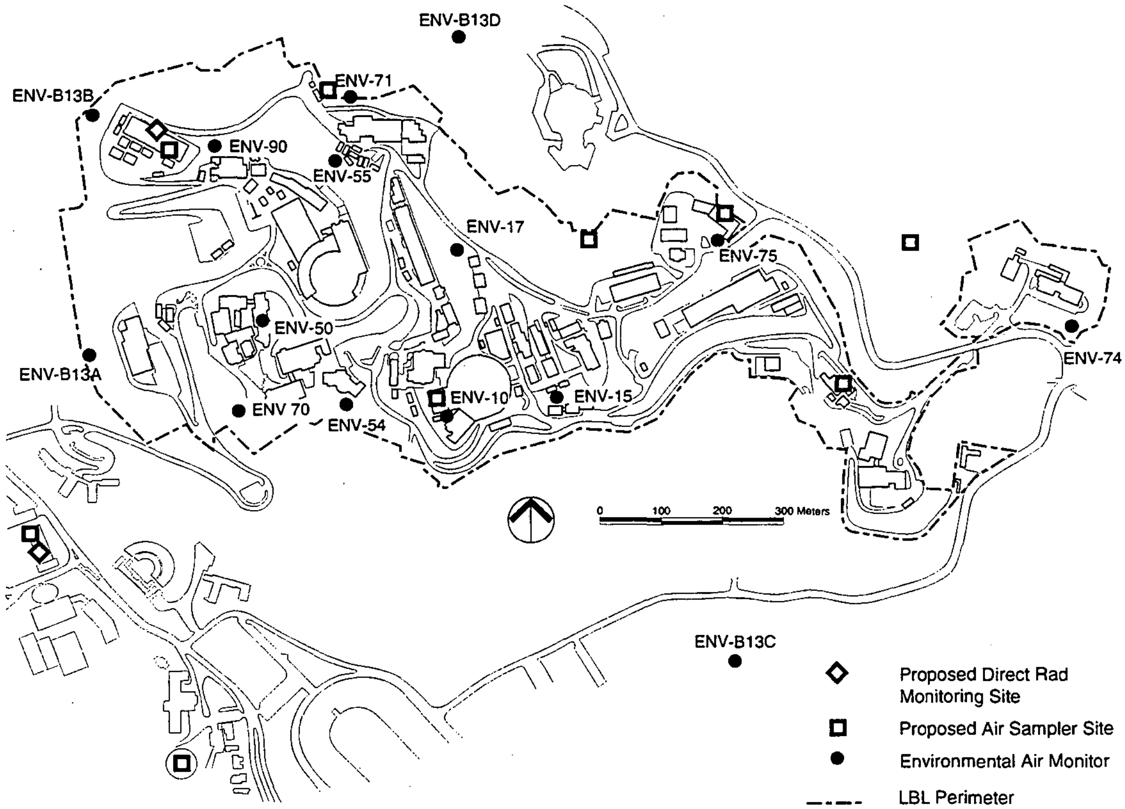


Figure 4-8. Existing and Proposed Ambient Air Samplers

The scheduled completion date for this project is March 1995.

Sanitary Sewer Monitoring Upgrade

All LBL wastewater effluent is discharged through one of two sanitary sewer outfalls. The effluent is monitored from vaults located near the LBL boundary of each drainage area. The Hearst vault is located in Blackberry Canyon east of Hearst Avenue, and the Strawberry vault is located on Centennial Drive, south of the site.

A project to upgrade the Hearst and Strawberry sanitary sewer monitoring stations was completed in December 1993. The Strawberry flume was modified to make flow readings more reliable and to correct a faulty stilling section for the pH probe. Corrections at Hearst included the construction of a new vault and flume and the installation of sampling pumps. The objective of the upgrade was to make reliable measurement of the wastewater flow possible, to reduce maintenance costs, and to provide safer access to the flume vault. The new flume vault is not considered a confined space, unlike the older one.

During 1994, a second phase of the project designed further refinements for the Hearst monitoring station, which included shelf space for various monitoring instruments, provision of conduits for future monitoring by telemetry, and installation of a gate valve in the flume in order to make flow measurements and instrument calibration more precise and efficient. These improvements are expected to be completed in May 1995.

Storm Drain Connection Repairs

The Clean Water Act requires that discharges of stormwater associated with industrial activities be regulated by an NPDES permit. LBL has been covered under the statewide General Permit since 1992. One of the requirements of the permit is the elimination of, or the request of an extension to eliminate, non-stormwater discharges into storm drain systems prior to October 1, 1992, the implementation date for the Permit's *Stormwater Pollution Prevention Plan*. The permit termed these connections "illicit," and defined them to include discharges of process water that should properly go to sanitary rather than storm sewers. In 1992, LBL opted to request an extension from the RWQCB until March 30, 1995 to eliminate all such connections.

LBL began its storm drain connections repair project by performing a sitewide survey in 1992. That survey identified 38 improper connections: 31 within buildings and 7 at exterior locations. A few of the connections were corrected by construction or removal activities that concurrently eliminated the problem. Since fiscal year 1993, the project has been staged to complete engineering efforts first, then begin construction activities as fiscal year funding requests were honored. Through this incremental approach, LBL has been able to steadily eliminate these improper connections with the compliance deadline in mind. At the end of 1994, the project was ahead of schedule, and construction work remained on only two connections at Building 71. Work on these last connections was completed in March 1995.

Aboveground Storage Tank Modifications

The Clean Water Act and the State's Aboveground Petroleum Storage Act outline the regulatory requirements for aboveground storage tanks. In May 1993, LBL conducted a sitewide audit to assess the current conditions of approximately 70 petroleum storage areas on the site, including transformers, engine generators, and petroleum drum storage areas. This audit revealed 33 aboveground petroleum storage areas that potentially required repair or modification.

Of the remaining 33 aboveground petroleum storage areas, four areas were identified as not requiring modification after further investigation, and five areas were scheduled for repair/modification in 1995. During June and July 1994, a sitewide audit of aboveground petroleum storage tanks revealed an additional six areas that would potentially require repair or modification in 1995. Nonpetroleum (i.e., chemical or hazardous) ASTs consist of FTU tanks, drum storage at Waste Accumulation Areas, and drum storage at drum storage areas. FTU tanks are inspected each operating day by operators of the FTU. WAAs are inspected weekly by EH&S's Waste Management Group staff. Drum storage areas contain petroleum and non-petroleum drums. Both types of drums are inspected during routine petroleum drum inspections. Additional discussion on AST corrective action activities are included in the *Clean Water Act* portion of Section 3, *Compliance Summary*.

Underground Storage Tank Modifications

As noted in Section 3, *Compliance Summary*, three underground storage tanks remain at LBL that must be removed prior to December 1998. This is the implementation date for new regulatory standards affecting the construction, monitoring, leak detection, and design of new and existing underground storage tanks. During 1994, LBL completed removal activities for two additional single-walled tanks that were targeted by these new standards. Details on these tank removals are discussed in the *Resource Conservation and Recovery Act* portion of the *Compliance Summary*.

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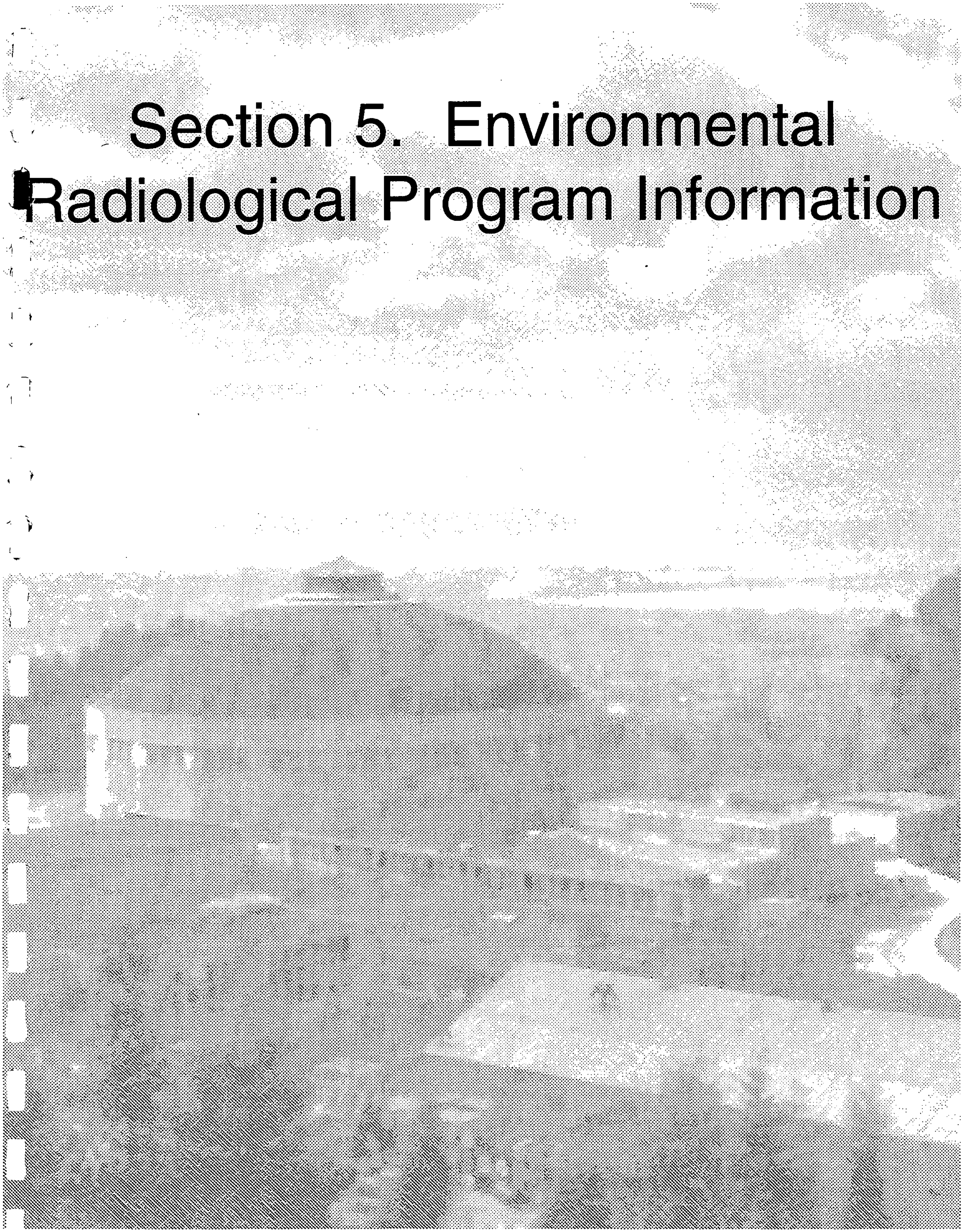
Section 5. Environmental Radiological Program Information



The LBL environmental radiological program consists of assessing site activities in several general environmental protection areas: external penetrating radiation, air, water, and soil/sediment and vegetation. The overall radiological impact from these pathways is less than 1% of the background radiation for 1994. This section discusses in detail the impact LBL research and support programs have on these various environmental media.

External Penetrating Radiation

Radiation-producing machines (accelerators, x-ray machines, and irradiators) and various radionuclides are used at LBL for high energy particle studies and biomedical research. At LBL, external penetrating radiation is associated mainly with accelerator/irradiator operations.

Accelerator-Produced Penetrating Radiation

To determine the environmental radiological impact of LBL accelerator operations, LBL maintains five permanent real-time environmental monitoring stations (EMSs) at various locations around LBL's perimeter. Figure 5-1 displays the location of these stations. this figure also displays the TLD monitoring locations, which are discussed later in this section. The EMSs continuously detect and record direct gamma and neutron radiation. Each station contains sensitive neutron and gamma pulse counters. The neutron detector is mainly a 500-cubic cen-

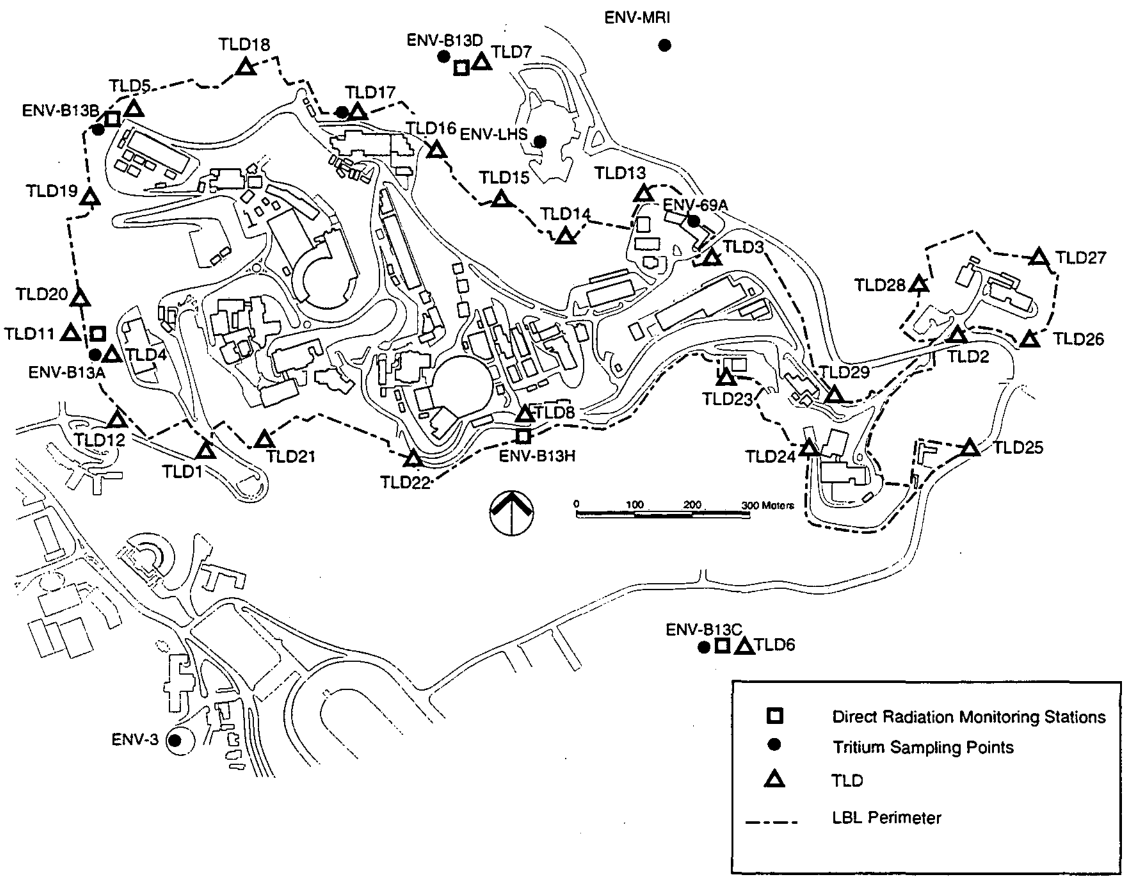


Figure 5-1. Environmental Monitoring Stations

timeter cylindrical boron trifluoride (BF_3) gas-proportional counter housed in a 6-centimeter thick (2.5-inch thick) cylindrical paraffin moderator. The gamma detector is an energy-compensated Geiger-Muller chamber. The calibrated output pulses from these detectors are transferred electronically to a central storage computer in Building 75.

With the closure of the Bevalac in early 1993, Building 88 contains the sole remaining accelerator that generates this type of radiation. This accelerator runs heavy ions during a significant fraction of its operating schedule. Successful work in beam development several years ago followed with an increase in beam currents. This led to a correspondingly slight increased dose equivalent at the Building 88 EMS. However, recently the trend has been gradually downward. The decrease in monitored dose equivalent can be attributed to improvements in accelerator beam optics, local shielding, and cave selection. The shutdown of the Bevalac also resulted in an overall reduction of the maximum offsite exposure and population dose.

Since early 1991, the 88-Inch Cyclotron has administratively controlled its use of light-ion runs, reducing the potential for an offsite dose exceeding 0.005 mSv (0.5 mrem). The former injection source that provided beam currents up to 100 milliamperes is no longer used. The new source will only allow beam currents of less than 10 milliamperes. During 1994, light ion runs (^1H and ^3He) in the 88-Inch Cyclotron averaged less than 10 percent (400 hours) of all running time for the year. The gamma and neutron doses attributable to LBL accelerator operations during 1994 are listed in Table 5-1, as estimated from measurements at the five EMSs.

Irradiator-Produced Penetrating Radiation

Historically, DOE facilities have reported "fence-post doses," which are measured or computed values reflecting the exposures to a hypothetical individual living 100% of the time at the perimeter of the facility. In keeping with the DOE trend toward presenting realistic assessments of exposures to actual individuals, this section will provide both maximum fence-post dose estimates and

Table 5-1. 1994 Annual Penetrating Radiation Dose due to Accelerators (Measured by EMSs at the LBL Perimeters)

Monitoring Station	Net Gamma Dose (mSv*/yr)	Net Neutron Dose (mSv*/yr)	Total Dose** (mSv*/yr)
Station 13 A (Bldg. 88)	0.0122	0.0031	0.0153
Station 13 B (Bldg. 90)	0.0082	0.0012	0.0094
Station 13 C (Panoramic)	0.0054	0.0008	0.0062
Station 13 D (Olympus Gate)	0.0032	0.0005	0.0037
Station 13 H (ALS)	0.0045	0.0010	0.0055

* 1 mSv = 100 mrem
** DOE standard = 1 mSv/yr (100 mrem/yr)

estimates of exposures to workplaces or dwellings of LBL's nearest neighbors.

LBL is currently storing two shielded gamma irradiators in the Building 75 waste yard behind a large earth berm to minimize the potential worker and offsite exposure. One unit contains about 20 trillion (10^{12}) Bq (543 Ci) of ^{137}Cs, and the other unit contains 10 x 10^{12} Bq (270 Ci) of ^{60}Co. The gamma radiation field attributable to these irradiators measured at the perimeter fence nearest to the devices was less than 2 x 10^{-5} mSv/hr (0.002 mrem/hr). This value was determined by a survey meter and extrapolated to give an annual fence-post dose of less than 0.18 mSv/yr (18 mrem/yr). However, the perimeter fence at this location is on UCB land. The nearest offsite workplace (40-hour/week occupancy) is the Lawrence Hall of Science, which is approximately 270 meters from the fence. The nearest residence is approximately 500 meters away. Both of these offsite locations are shielded by a hillside. Even if the hillside shielding is ignored, the predicted doses from these irradiators would be about 5 x 10^{-5} mSv/yr (0.005 mrem/yr) and 7 x 10^{-5} mSv/yr (0.007 mrem/yr) at the Lawrence Hall of Science and at the nearest home, respectively. These retired irradiators are clearly marked, barricaded, and cordoned off. The dose rate at the nearest accessible distance to these units is approximately 0.002 mSv/hr (0.2 mrem/hr). LBL has recently placed TLD meters in the vicinity to better determine the actual dose. These results will be available beginning in 1995.

Several gamma irradiators of multicurie magnitude are being used at LBL to carry out radiobiological and radiochemical research. The largest of these units is a ^{60}Co unit housed in an interlocked, massive, reinforced-concrete-covered labyrinth built as part of Building 74. This unit is also the irradiator closest to the LBL perimeter. Routine surveys taken when the shielding for the irradiator was not in place confirmed that no area exceeded 0.01 mSv/hr (1 mrem/hr) at 1 meter from the outside walls or ceiling. The Building 74 irradiator is about 80 meters from the LBL perimeter fence, 150 meters from the nearest offsite workplace (a UCB Botanical Garden building), and more than 700 meters from the nearest residence. The projected annual dose equivalents to members of the public are about 0.014 mSv/yr (1.4 mrem/yr) at the perimeter fence, 0.001 mSv/yr (0.1 mrem/yr) at the Botanical Garden building, and less than 2 x 10^{-4} mSv/yr (0.02 mrem/yr) at the nearest residence. The remaining smaller, well-shielded gamma irradiators pose considerably lesser environmental impact than the Building 74 irradiator. These irradiators are used in sealed containers, and located and monitored throughout the Laboratory. A summary of the 1994 penetrating radiation doses due to the most significant gamma irradiators is given in Table 5-2.

Environmental TLD Program

LBL expanded its sitewide environmental Thermoluminescent monitoring program in December 1994 to cover a total of 26 locations near the site boundary (Figure 5-1) and six locations around two offsite facilities (Building 903 Warehouse and Building 934). The TLD network's objective is to confirm the estimated exposures from external penetrating radiation, and to ensure that public radiation exposure is kept well below allowable regulatory limits. The expanded TLD monitoring program uses aluminum

Table 5-2. Estimated 1994 Annual Penetrating Radiation Dose due to Gamma Irradiators

	Estimated Gamma Dose* (mSv**/yr)		
Irradiator Location	Fence-Post	Nearest Residence	Nearest Workplace
Building 75	<0.18	<0.00007	<0.00005
Building 74	<0.014	<0.0002	<0.001

* DOE standard = 1 mSv/yr (100 mrem/yr)
** 1 mSv = 100 mrem

oxide TLDs, which are designed to measure low-level gamma and photon radiation with a minimum detection level of 0.0001 mSv (0.1 mrem). Initial measurement results from this network are expected to be included in the 1995 Site Environmental Report.

Air

LBL employs a wide variety of radionuclides in its radiochemical and biomedical research programs. In addition, radioactive materials are a resultant byproduct from the operations of the charged-particle accelerators such as the 88-Inch Cyclotron. Table 5-3 presents physical characteristics of the more predominant airborne radionuclides used and/or monitored at LBL during 1994.

The most commonly and widely used radionuclides in LBL research programs are ^{3}H, ^{14}C, ^{18}F, ^{32}P, ^{35}S, and ^{125}I. Table 5-3 and the glossary contain reference lists with names of the radionuclides used at LBL.

Vapors and gases comprise the principal form in which radionuclides are released from LBL stacks. Particulate materials are normally filtered from effluent streams such that measurable radioactivities of particulate releases are rarely observed. Radionuclides in the above list that were released to the atmosphere from LBL stacks during 1994 are ^{3}H as tritiated water vapor (HTO), ^{14}C as CO_2, ^{35}S as SO_2, and ^{125}I in various gaseous forms.

Both ^{226}Ra and ^{227}Ac produce gaseous radioactive daughters, specifically two isotopes of radon, ^{222}Rn and ^{219}Rn, respectively. ^{226}Ra and ^{227}Ac are being used in LBL research activities. However, they are either in sealed canisters (calibration sources), in natural uranium ores, or in electroplated targets or foils in quantities too small to produce any consequential environmental impact. In addition, both ^{226}Ra and ^{227}Ac are daughters of natural uranium isotopes (^{238}U and ^{235}U, respectively). These naturally occurring isotopes are found, along with their daughters, at concentrations of a few parts per million in most continental rocks and soils.

DOE Order 5400.5[6] makes no provision for evaluating unidentified radionuclides. Throughout this report, unidentified radionuclides are assumed to be ^{232}Th if they are alpha-emitting material or ^{90}Sr if they are beta-emitting material. This is a

Table 5-3. Airborne Radionuclides Used and/or Monitored at LBL During 1994

Nuclide Name (Atomic Number)	Radio-Nuclide Symbol	Principal Radiation Types	Principal Energy (MeV)	Half-Life
Americium (95)	^{241}Am	α	5.40	432 years
		γ	0.06	
Argon (18)	^{41}Ar	β	1.2	1.83 hours
		γ	1.3	
Carbon (6)	^{11}C	β^+/γ	0.511	20.5 minutes
Carbon (6)	^{14}C	β	0.156	5730 years
Curium (96)	^{248}Cm	α	5.08	3.39×10^5 years
Cobalt (27)	^{60}Co	β	0.318	5.27 years
		γ	1.33	
Fluorine (9)	^{18}F	β^+/γ	0.511	109.7 minutes
Hydrogen/ Tritium (1)	^{3}H	β	0.0186	12.28 years
Iodine (53)	^{125}I	γ	0.027	60.14 days
Nitrogen (7)	^{13}N	β^+/γ	0.511	9.97 minutes
Nickel (28)	^{63}Ni	β	0.066	100.1 years
Oxygen (8)	^{15}O	β^+/γ	0.511	122 seconds
Phosphorus (15)	^{32}P	β	1.71	14.3 days
Rubidium (37)	^{86}Rb	β	1.77	18.66 days
		γ	1.08	
Sulfur (16)	^{35}S	β	0.167	87.44 days
Strontium (38)	^{90}Sr	β	0.546	28.6 years
Thorium (90)	^{232}Th	α	4.01	1.4×10^{10} years
		β	0.04	
Uranium (92)	^{238}U	α	4.2	4.47×10^9 years
		β	0.029	
Zinc (30)	^{65}Zn	γ	1.12	244 days
Zirconium (40)	^{95}Zr	β	0.4	64 days
		γ	0.757	

Reference: See reference number 61.

conservative approach because these assigned radionuclides represent the most restrictive alpha and beta emitters listed in DOE Order 5400.5. ^{90}Sr is normally used as a calibration source in radioanalytical environmental laboratories. ^{232}Th is occasionally used in only five of LBL's more than 80 laboratories. Although ^{227}Ac, which is 4,500 times more restrictive a beta emitter than ^{90}Sr, is also used at LBL, its most likely state is in equilibrium with its alpha-emitting daughters (^{227}Th and ^{223}Ra) and it would thus be detected as an alpha emitter.

Radioactive gases produced by the accelerator operations are mainly short-lived radionuclides such as ^{11}C, ^{13}N, ^{15}O, and ^{41}Ar. These induced radioactive gases are normally produced in areas where the beam strikes beam-line components. A number of other activation products, including ^{10}C, ^{16}N, ^{14}O, ^{38}Cl, and ^{39}Cl are also produced. However, these radionuclides represent less than 5% of the total discharged activation products and are shorter-lived than the four major species listed. Therefore, they do not significantly contribute to the offsite dose equivalent. ^{39}Cl is produced from ^{40}Ar, which is approximately 1% of the atmosphere.

At present, discharge points across the site with the most significant potential for routine or accidental release are continuously or periodically sampled. The exception to this procedure is the air-activation-product discharges from accelerators. These discharges were calculated based on accelerator use parameters and were not monitored in 1994. LBL installed air-activation-product monitors on all accelerators by February 1995. The 1994 discharges from LBL accelerators were estimated using a model developed by Patterson and Thomas.[62] The total airborne effluent released during 1994 from all radiological sources is presented in Table 5-4. As seen in this table, the vast majority of the airborne effluent, 94%, is in the form of ^{3}H.

Tritium Monitoring

Atmospheric tritium, as HTO, is measured at eight locations, as seen in Figure 5-1. Three of the stations are on site:

- ENV 69A (northeast of Building 69)
- ENV B13A (west of Building 88)
- ENV B13B (northwest of Building 90).

Five of the stations are off site:

- ENV 3 (on the roof of Building 3)
- ENV LHS (in the public area of the Lawrence Hall of Science)
- ENV MRI (in the public area of the UCB Mathematical Science Research Institute)
- ENV B13C (across Strawberry Canyon, south of LBL)
- ENV B13D (northwest of the Lawrence Hall of Science)

The tritium is captured by passing atmospheric air through a column containing silica gel. The silica gel HTO samples are changed weekly at each station. The analytical process involves first converting the adsorbed water into distilled water. Then, a 5-milliliter aliquot is placed in a vial and counted in a liquid scintillation counter. The detection limit for HTO in this liquid is 7.4 Bq/L (200 pCi/L). This corresponds to an atmospheric detection limit of 1.9 x 10^{-3} Bq/L (0.05 pCi/L).

Table 5-4. Total Air Effluent Radioactivities Released during 1994

Nuclide	LBL 1994 Total Air Effluent (Ci*/yr)	% of Total Effluent
^{3}H	1.2×10^{2}	93.89%
^{18}F**	2.3×10^{0}	1.91%
^{13}N**	2.3×10^{0}	1.89%
^{15}O**	1.4×10^{0}	1.14%
^{11}C**	1.4×10^{0}	1.10%
^{41}Ar**	8.0×10^{-2}	0.07%
^{14}C	8.2×10^{-4}	0.00%
^{35}S	3.4×10^{-4}	0.00%
^{125}I	1.0×10^{-4}	0.00%
^{95}Zr	9.0×10^{-5}	0.00%
^{32}P	4.8×10^{-5}	0.00%
^{90}Sr	4.0×10^{-5}	0.00%
^{232}Th	2.1×10^{-5}	0.00%
^{65}Zn	4.8×10^{-6}	0.00%
^{63}Ni	2.6×10^{-6}	0.00%
^{86}Rb	1.6×10^{-6}	0.00%
^{248}Cm	6.8×10^{-7}	0.00%
^{238}U	2.4×10^{-7}	0.00%
^{241}Am	3.6×10^{-8}	0.00%
^{60}Co	3.4×10^{-14}	0.00%
TOTAL:	1.2×10^{2}	**100%**

* 1 Ci = 3.7×10^{10} Bq
** Estimated/calculated values

The minimum detection limit for tritium and all other radionuclides is based on the sample counting time and the counts of the representative background samples. The gross analytical result from a sample is then subtracted from the background counts to determine the net result. This industry-standard method minimizes statistical biasing in the data but can lead to apparent ambiguous results where the average sampling value for the entire year for a radionuclide is below the minimum detection limit.

Atmospheric tritium concentrations measured at the LBL network of stations for 1994 are presented in Table 5-5. All values are within the allowable DOE standard.

Nearly all of the tritium released from LBL was discharged from the Building 75 (National Tritium Labeling Facility and

Table 5-5. Summary of ^{3}H Concentrations for Airborne Environmental HTO Samples

Sample Location	Number of Samples	Concentration (pCi*/L) Average**	Maximum**
ENV 69A	46	0.66	2.4
ENV 3	46	0.1	0.3
MRI	44	0.14	2.4
LHS	45	0.08	0.5
B-13A (Bldg. 88)	47	0.07	1.3
B-13B (Bldg. 90)	45	0.04	0.5
B-13C (Panoramic)	46	0.03	0.5
B-13D (Olympus)	45	0.09	1.0

* 1 pCi = 3.7 x 10^{-2} Bq
** DOE 5400.5 standard = 100 pCi/L

Hazardous Waste Handling Facility) stacks. These stacks are monitored for tritium as described above. During 1994, approximately 4.3 x 10^{12} Bq (115 Ci) of tritium emission were measured from these stacks. Of this, 3.2 trillion Bq (86 Ci) were associated with LBL normal operations, and the remainder were from an unplanned release that occurred in September. A summary of the trends in annual releases of tritium as HTO from the Building 75 activities for the period 1984 through 1994 is presented in Figure 5-2.

Unplanned Releases

During 1994, there was one unplanned tritium release to the atmosphere from LBL. Continuous monitoring data collected from the NTLF stack revealed that approximately 1.1 x 10^{12} Bq (29 Ci) of HTO were released to the environment during the week of September 23 to 30. The direct cause of this event was determined to be a malfunctioning heating tape on one oxidation loop of the NTLF Tritiation and Recovery System. The malfunctioning heating tape has been repaired. Thermocouples have been placed on all the critical areas of the oxidation loop and digital readouts installed inside the Tritiation Laboratory to prevent similar future occurrences.

The dose impact from this unplanned release is estimated at 4.4 x 10^{-4} mSv (0.044 mrem) EDE to a maximally exposed individual 110 meters northwest of Building 75. This estimate is based on CAP88-PC[63] computer modeling. This level is well within the allowable emission limit of 0.1 mSv (10 mrem) for the year. The reported EDE for 1994 due to airborne radionuclides includes this unplanned release contribution.

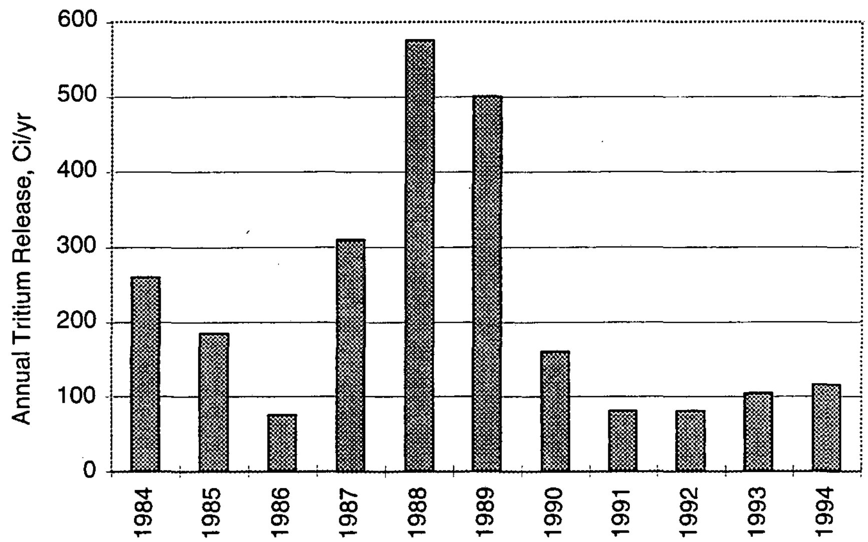


Figure 5-2. Summary of Annual Tritium Releases from Building 75, 1984 through 1994

Radioiodine Monitoring

Filter papers containing 55% activated carbon are used to sample air effluent for radioiodine. Radioiodines in air, specifically ^{125}I, are assayed by analyzing the activated-carbon filters with a thin-window Geiger-Muller detector. The detection limit for ^{125}I in stack effluents is 0.74 Bq/ml (20 pCi/L).

Carbon-14 Monitoring

Atmospheric $^{14}CO_2$ is measured by air sampling with sodium hydroxide. Samplers are changed weekly. Air is bubbled through a jar containing 30 milliliters of 0.2-molar sodium hydroxide (highly diluted) and thymol blue as a pH indicator. A 5-milliliter aliquot of the sodium hydroxide is added to a liquid scintillation "cocktail" and counted in a liquid scintillation counter. The detection limit for $^{14}CO_2$ is 7.4 x 10^{-3} Bq/L (0.2 pCi/L). The average and maximum concentrations of atmospheric ^{14}C for 1994 are given in Table 5-6.

Gross Alpha/Beta Monitoring

Gross atmospheric particulate alpha and beta activities are measured by air sampling at the 14 points shown in Figure 5-1. The gross alpha and beta sampling media are 10 centimeters x 23 centimeters (4 inches x 9 inches). fiberglass-polyester filters through which air is pumped at 113 liters per minute (4 cubic feet per minute) at the onsite locations, and 75 liters per minute (2.7 cubic feet per minute) at the perimeter stations.

Samples are collected weekly for radioanalyses. Before they are counted, they are set aside for five days to allow short-lived radon and thoron daughters (naturally occurring airborne radionuclides) to decay. The filters are loaded into an automatic counter that determines gross alpha activity by means of a large-area 0.25-mil Mylar-window gas-proportional counter. Gross beta activity is counted with Geiger-Muller detectors with 30 milligram per square centimeter windows. The detection limit for alpha emitters is 1.1 x 10^{-4} Bq/L (3 x 10^{-3} pCi/L). The detection limit for beta emitters is 4.4 x 10^{-3} Bq/L (1.2 x 10^{-1} pCi/L). To ensure accuracy of all counting results, each group of samples counted includes at least one NIST-traceable reference standard and a number of background samples. Gross alpha and gross beta concentrations for these particulate air samples are presented in Table 5-7.

Water

Rainwater

During the rainfall season, generally October through May, rainwater is collected monthly or whenever there is significant rainfall. Rainwater in the collectors on the north side of Building 75 and on the roof of Building 4 are analyzed for tritium and gross

Table 5-6. Summary of ^{14}C Concentrations for Airborne Environmental Samples

Sample Location	Number of Samples	Concentration (pCi*/L)	
		Average**	Maximum**
ENV3	51	0.03	1.6

(*) 1 pCi = 3.7 x 10^{-2} Bq
(**) DOE Order 5400.5 standard = 500 pCi/L

Table 5-7. Summary of Gross Alpha and Beta Concentrations for Particulate Air Samples

Sample Location	Number of Samples	Concentration (1.0 x 10^{-6} pCi*/L)			
		Alpha Average**	**Alpha Maximum****	**Beta Average*****	**Beta Maximum*****
B-13A (Bldg. 88)	47	1.0	19	2.0	41
B-13B (Bldg. 90)	45	1.0	10	3.0	50
B-13C (Panoramic)	46	2.0	41	5.0	70
B-13D (Olympus)	46	1.0	17	1.0	30

* 1 pCi = 3.7 x 10^{-2} Bq
** DOE Order 5400.5 standard (^{232}Th) = 7.0 x 10^{-6} pCi/L
*** DOE Order 5400.5 standard (^{90}Sr) = 9,000 x 10^{-6} pCi/L

alpha and beta activities. Tritium analysis of water samples is accomplished by liquid scintillation counting. Water samples are prepared for gross alpha and beta analysis by acidification (HNO_3) and evaporation into 5-centimeter (2-inch) diameter stainless steel planchettes. Organic residues not wet-ashed by the nitric acid treatment are oxidized by flaming the planchettes.

All measurements of gross alpha and beta activity from atmospheric deposition at outlying perimeter and onsite stations lie within the range of historical normal background measurements. However, tritium exceeding the US/EPA drinking water standards was detected in rainfall collected within the Laboratory boundary near the stack from the Building 75 National Tritium Labeling Facility (see Table 5-8). Historically, tritium in rainwater at LBL has exceeded the drinking water standard, although 1992 was an exception to this trend. As mentioned earlier, local drinking water is supplied by EBMUD from sources located more than 150 kilometers east of LBL.

Surface (Creek) Water

Weekly samples are obtained from the six creek sampling points indicated in Figure 6-1. A 1-liter (1-quart) grab sample is taken from each site and analyzed for tritium and gross alpha and beta emitters. Gross alpha, gross beta, and tritium concentrations for these water samples are given in Tables 5-9 and 5-10.

Groundwater

Groundwater flows from the sub-horizontal slope stability wells (hydraugers), whose bores are represented by the heavy dashed lines in Figure 5-3. Sampling and analysis of this medium is fully discussed in Section 7, *Groundwater Protection.*

Wastewater (Sanitary Sewer)

LBL sewer outfalls are sampled continuously. Sample-to-flow ratios are designed to be between 10 and 20 parts per million, and composite samples are taken weekly.

Table 5-8. Summary of ^3H Concentrations for Rainwater Samples

Sample Location	Number of Samples	Concentration (pCi*/L) Average**	Maximum**
Building 4	12	<700***	2,200
Building 75	11	12,000	53,200

* 1 pCi = 3.7×10^{-2} Bq
** 40 CFR 141 Drinking Water Standard = 20,000 pCi/L
*** 700 pCi/L is the minimum detectable amount for the sample aliquot used

Table 5-9. Summary of Gross Alpha and Beta Concentrations for Surface Water Samples

		Concentration (pCi*/L)			
Sample Location	**Number of Samples**	**Alpha Average****	**Alpha Maximum****	**Beta Average*****	**Beta Maximum*****
Blackberry	45	0.94	10.8	1.0	30
Chicken	47	1.07	7.4	2.0	40
Claremont	46	0.68	9.9	2.0	60
Lower Strawberry	46	0.65	10.9	2.0	70
Upper Strawberry	46	0.96	18.3	2.0	30
Wildcat	46	0.68	9.9	2.0	60

* 1 pCi - 3.7×10^{-2} Bq
** DOE Order 5400.5 standard = 50 pCi/L
*** 40 CFR 141 Drinking Water standard = 20,000 pCi/L

Table 5-10. Summary of ^3H Concentrations for Surface Water Samples

		Concentration (pCi*/L)	
Sample Location	**Number of Samples**	**Average****	**Maximum****
Blackberry	43	<700***	1,900
Chicken	43	<700***	11,700
Claremont	43	<700***	<700***
Lower Strawberry	43	<700***	<700***
Upper Strawberry	43	<700***	700
Wildcat	43	<700***	900

* 1 pCi = 3.7×10^{-2} Bq
** 40 CFR 141 Drinking Water Standard = 20,000 pCi/L
*** 700 pCi/L is the minimum detectable amount for the sample aliquot used

Water samples for gross alpha/beta and tritium analyses are preserved with nitric acid (HNO_3). No preservation is made to the sewage water samples for radioiodine analysis, since radioiodine would be driven out of the water samples when they are acidified. The iodine contained in the samples is precipitated with silver using stable KI as a carrier. The iodine aliquots are filtered, and the filtrate is processed in the same manner as the acid (HNO_3) samples described earlier. After the filtrate planchette has been flamed, the filter containing any precipitated radioiodine is placed in the planchette and is counted. The prepared planchettes are weighed (the tare weight of each planchette

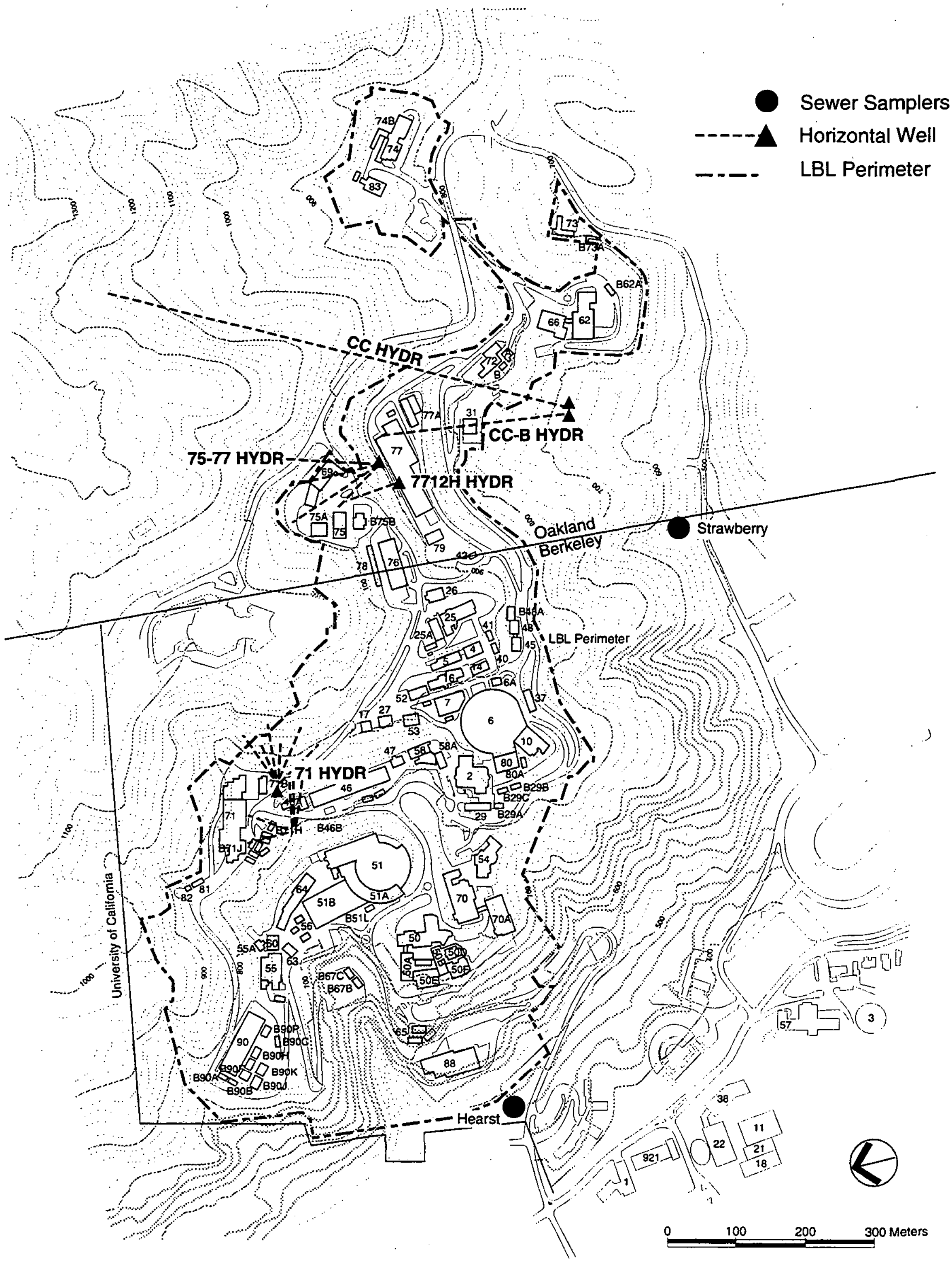


Figure 5-3. Map of LBL Hydrauger and Sewer Sampling Sites

is first determined) and counted in a thin-window, low-background gas-proportional counter for both gross alpha and gross beta activities. Since the samples are thick, self-absorption is computed based on areal sample density, which is the sample weight divided by the area of the planchette (20.26 cm^2), assuming an alpha energy of 5.2 MeV and a beta energy of 1 MeV. Radioanalyses of sewer wastewater for 1994 are summarized in Tables 5-11 and 5-12.

Sediment/Soil and Vegetation

Sediment/Soil

The *Environmental Monitoring Plan* details the soil and sediment sampling that will be performed on an annual basis. This plan was based on a history of site activities and was developed prior to the completion of the *Storm Water Monitoring Program* in October 1992.

Table 5-11. Summary of Gross Alpha and Beta Concentrations for Sewage Water Samples

			Concentration (pCi*/L)		
Sample Location	**Number of Samples**	**Alpha Average****	**Alpha Maximum****	**Beta Average*****	**Beta Maximum*****
Hearst Station	47	1.8	13.8	5.6	24.2
Strawberry Station	46	1.2	5.9	4.9	16.2

* 1 pCi - 3.7 x 10^{-2} Bq
** CCR Title 17 standard (^{232}Th) standard = 400 pCi/L
*** CCR Title 17 standard (^{90}Sr) = 90,000 pCi/L

Table 5-12. Summary of ^3H Concentrations for Sewage Water Samples

		Concentration (pCi*/L)	
Sample Location	Number of Samples	Average**	Maximum**
Hearst Station	43	<700***	9,400
Strawberry Station	43	<700***	4,100

* 1 pCi = 3.7 x 10^{-2} Bq
** CCR Title 17 Standard = 1 x 10^9 pCi/L
*** 700 pCi/L is the minimum detectable amount for the sample aliquot used

During 1994, soil samples were taken from various sampling locations around LBL buildings and at four environmental monitoring stations. These samples were analyzed for gross alpha and beta and tritium (Table 5-13). With respect to radionuclides, no unusually high level of contamination was seen in any of the locations. No sediment samples were taken in 1994.

Vegetation

Currently, there is no routine vegetation monitoring at LBL. Proposals for sampling locations, frequencies, and analyses for the future vegetation monitoring program at LBL are documented in the LBL *Environmental Monitoring Plan.*

Radiological Dose Assessment

Accelerator-Produced Radiation

In 1976, LBL developed a site-specific model to assess the population dose equivalent attributable to penetrating radiation.[64] Population figures from the 1980 US census[65,66] are used in this calculation.

Table 5-13. Soil and Sediment Radioanalysis Results

Sampling Location	Gross Alpha (pCi*/g)	Gross Beta (pCi*/g)	Tritium (pCi*/g)
ENV B13A	16	16	0.2
ENV B13B	13	17	0.2
ENV B13C	12	12	1.3
ENV B13D	10	8	2.0
10A	12	27	1.3
10B	14	13	1.6
15	12	11	1.4
17	10	5	1.5
50	13	21	0.2
54	13	17	0.2
55	12	8	1.2
69A	10	6	2.0
71A	11	11	0.2
71B	10	7	1.3
74	15	13	0.2
75	14	12	0.2
90	11	10	0.2

(*) 1 pCi = 3.7×10^{-2} Bq

Although the population within 80 km (50 mi) of LBL increased by about 20% during the 1970s and 1980s from 5 to 6 million, the populations of Berkeley and Oakland, the two cities immediately adjacent to LBL, declined. Recomputing the population dose model with population statistics from the 1990 census produced no significant difference.

In the LBL model, population dose equivalent is computed from the maximum measured value of perimeter (fence-post) neutron dose. During 1994 the maximum annual fence-post dose, estimated at EMS 13A (near Building 88), was 0.015 mSv (1.5 mrem) (see Table 5-1). The model's expression relating population dose equivalent M (in person-rem) to maximum measured fence-post dose H_0 (in rem—a rem is 1,000 mrem) is:

$$M < 10^3 \times H_0.$$

Since H_0 was 0.015 mSv (1.5 mrem or 1.5×10^{-3} rem), the collective effective dose equivalent (CEDE) to the approximately 5 million people within 80 kilometers (50 miles) of LBL attributable to penetrating radiation from LBL accelerator operation during 1994 was about 0.015 person-Sv (1.5 person-rem).

Airborne Radionuclides

The dose to the maximally exposed individual and the CEDE resulting from airborne releases of radionuclides for 1994 are 1.4×10^{-3} mSv (0.14 mrem) and 0.018 person-Sv (1.8 person-rem), respectively. The NESHAPs regulations in 40 CFR 61 Subpart H require that facilities releasing airborne radionuclides compute the impact of such releases using an approved code. In this report, CAP88-PC was used to compute the effective dose equivalent to a maximally exposed offsite person. CAP88-PC is a microcomputer radionuclide dispersion and dose-assessment code supplied and approved by US/EPA. This dose was calculated for the point of maximum offsite exposure and represents the cumulative exposure from all significant exposure pathways (inhalation, ingestion, air immersion, and surface exposure). The methods and parameters used to calculate the dose are very conservative. For example, the model assumes that a major portion of the food consumed by the hypothetical individual was grown within the assessed area. The individual was assumed to reside at this location continuously throughout the year. In addition, all of the tritium released was assumed to be the most hazardous form, tritium oxide. Consequently, this dose is not a dose actually received by anyone, but an upper-bound estimate.

Fourteen CAP88-PC individual modeling runs were executed to predict the impact of 14 single/grouped release points, as described in Section II of Appendix B, *NESHAPs*. As mentioned previously, the NTLF was identified as the major release point at LBL. Therefore, the maximally exposed individual associated with this facility was also specified, with appropriate distances and directions, in each of these fifteen individual CAP88-PC runs. The reported EDE to a MEI at LBL includes contributions from all of these fifteen CAP88-PC models (see Table 5-14).

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. One "population"

Table 5-14. Summaries of Dose Assessment from All LBL Release Points

		Relative to the MEI of Building 75			
Building Number	Building Name	75 MEI Distance (m)	75 MEI Dir.	75 MEI Dose (mrem*/yr)	% Total EDE
75	National Tritium Labeling Facility	110	NW	1.3×10^{-1}	91.6%
74, 74B & 83	Buildings 74/74B/83 Research Med.	730	WNW	4.2×10^{-3}	2.96%
70 & 70A	Nuclear / Applied Science	510	NE	3.6×10^{-3}	2.54%
88	88-Inch Cyclotron	670	ENE	1.7×10^{-3}	1.2%
75-127 & 75A	Hazardous Waste Handling Facility	150	NW	6.7×10^{-4}	0.47%
55	Research Med & Rad Biol.	490	E	6.3×10^{-4}	0.44%
934	Molecular & Cell Biol. (off-site)	4900	ENE	5.4×10^{-4}	0.38%
75A (D)	Waste Storage Area (Diffuse)	150	NW	3.7×10^{-4}	0.26%
3	Calvin Lab at UCB	1070	NE	7.6×10^{-5}	0.05%
1	Donner Laboratory at UCB	980	ENE	2.1×10^{-5}	0.01%
6	Advanced Light Source (ALS)	370	NNE	1.8×10^{-5}	0.01%
2	Advanced Material Lab.	370	NE	1.3×10^{-13}	0.00%
26	Medical Services & Counting Lab.	240	N	9.6×10^{-7}	0.00%
62	Materials & Chem. Science	650	NW	7.5×10^{-7}	0.00%
TOTAL				**1.26×10^{-1}**	**100.00%**

* 1 mrem = 10×10^{-2} mSv

CAP88-PC run was used to carry out this population dose assessment. This CAP88-PC model is based on the input parameters from the Building 75 computer run, with the source terms replaced by all the radionuclides listed in Table 5-4. A summary of this collective dose assessment attributed to each radionuclide is given in Table 5-15.

Radiological impact from accelerator operations and airborne radionuclides is minimal compared to applicable standards and nominal background radiation. As presented in Table 5-16 and Figure 5-4, the maximum effective dose equivalent due to 1994 LBL operation is about 0.016 mSv (1.6 mrem) per year. This value is about 0.5% of the nominal background and less than 2% of the DOE-permitted annual limits.

Table 5-15. Summary of Collective EDE Assessment, Population Within 80 km of LBL

Nuclide	Collective EDE (Person-rem* /yr)	% Total Collective EDE
^{3}H	1.32×10^{0}	71.70%
^{232}Th	3.24×10^{-1}	17.60%
^{18}F	5.94×10^{-2}	3.23%
^{248}Cm	5.93×10^{-2}	3.22%
^{13}N	1.74×10^{-2}	0.95%
^{11}C	1.64×10^{-2}	0.89%
^{208}Tl	1.57×10^{-2}	0.85
^{228}Ac	1.41×10^{-2}	0.77%
^{15}O	3.07×10^{-3}	0.17%
^{212}Bi	2.59×10^{-3}	0.14%
^{212}Pb	2.36×10^{-3}	0.13%
^{41}Ar	2.32×10^{-3}	0.13%
^{238}U	1.21×10^{-3}	0.07%
^{90}Sr	1.00×10^{-3}	0.05%
^{241}Am	8.35×10^{-4}	0.02%
^{95}Zr	4.10×10^{-4}	0.02%
^{125}I	3.77×10^{-4}	0.01%
^{14}C	1.62×10^{-4}	0.01%
^{65}Zn	6.75×10^{-5}	0.00%
^{228}Th	3.98×10^{-5}	0.00%
^{35}S	2.32×10^{-5}	0.00%
^{32}P	2.10×10^{-5}	0.00%
^{228}Ra	8.87×10^{-6}	0.00%
^{220}Rn	7.81×10^{-6}	0.00%
^{86}Rb	1.12×10^{-6}	0.00%
^{63}Ni	3.39×10^{-7}	0.00%
^{216}Po	2.08×10^{-7}	0.00%
^{60}Co	1.08×10^{-11}	0.00%
TOTAL	$\mathbf{1.84 \times 10^{0}}$	**100.00%**

* 1 Person-rem = 1.0×10^{-2} Person-Sv

Table 5-16. Summary of LBL Radiological Impact

	Maximum Individual (Accelerators)	Maximum Individual (Airborne Nuclides)	Maximum All Sources	Collective Dose within 80 km of LBL (All Sources) [person-rem /yr]
MEI LOCATION	Residence (110m W of Bldg. 88)	Workplace (110 m NW of Bldg. 75)	Residence (110 m W of Bldg. 88)	Within 80 km of LBL
Annual EDE [mrem/yr]	1.5	0.14	1.64	1.8
DOE / EPA Standards (mrem/yr)	100	10	100	na
LBL impact as % of DOE/EPA Standard	1.5%	1.40%	1.64%	na
Annual Background b(mrem/yr)	100	200	300	1.50×10^6
LBL impact as % of background	1.5%	0.07%	0.99%	0.00%

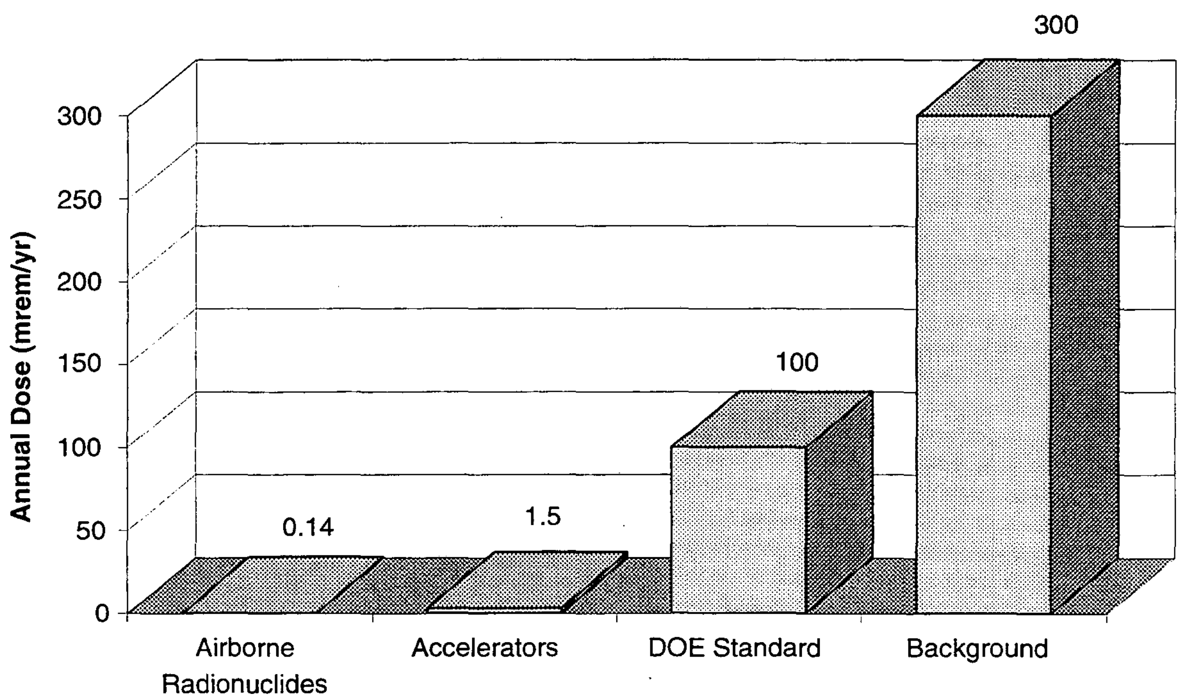


Figure 5-4. LBL Radiological Impact for 1994

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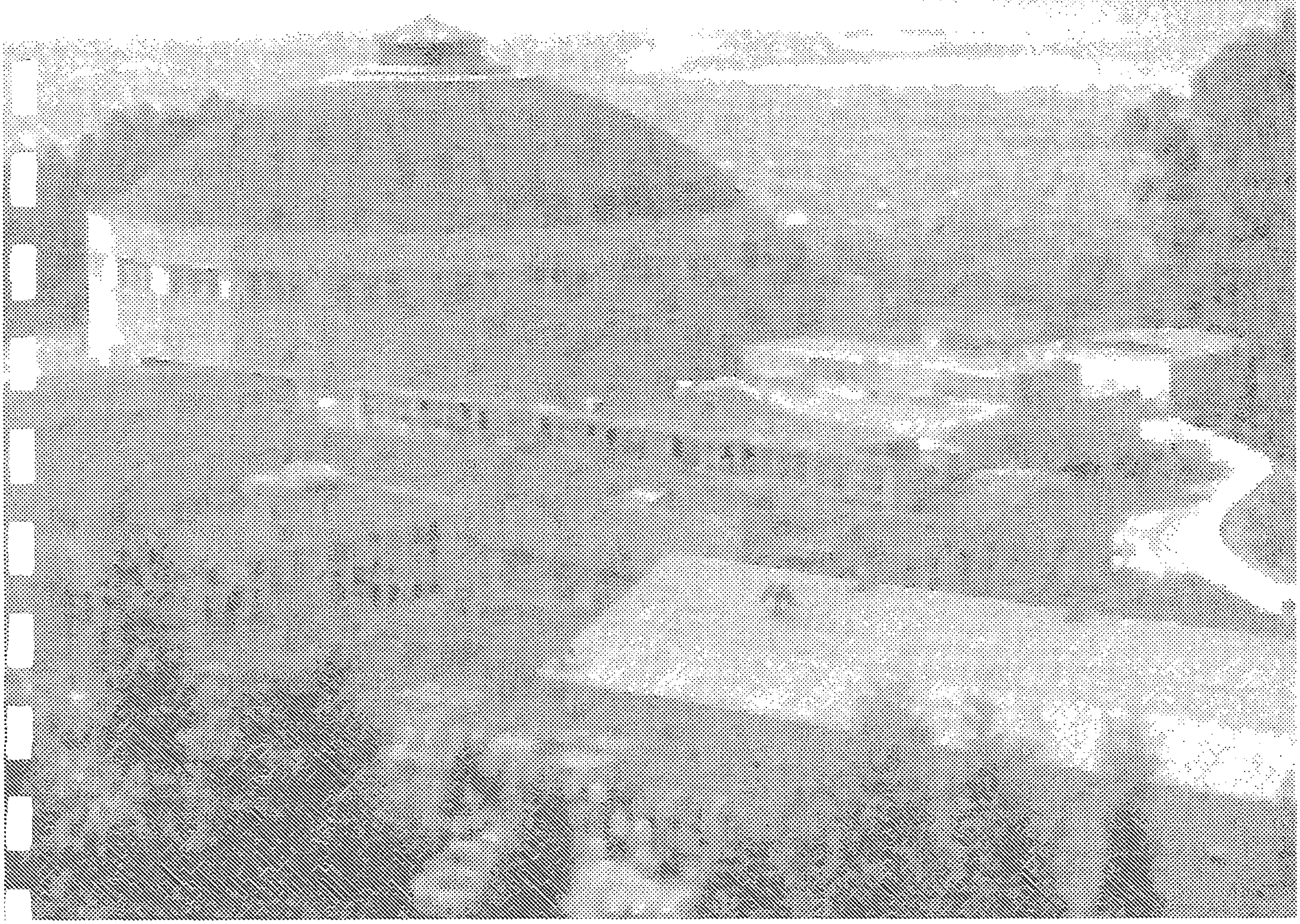
Section 6. Environmental Nonradiological Program Information



General Industrial Stormwater Permit

Applicability to LBL

The Clean Water Act,[14] enacted by Congress in 1972 as an amendment to the Federal Water Pollution Control Act, gave the US/EPA authority to regulate the discharge of any pollutant from a point source to navigable waters by means of a permit system called the National Pollutant Discharge Elimination System (NPDES). The State of California has an authorized NPDES program, which is administered by the State Water Resources Control Board.

The SWRCB administers its NPDES program through the General Industrial Storm Water Permit, general permit number CAS000001. Under this permit, industries identified by their Standard Industrial Code (SIC) number must file a Notice of Intent (NOI) and satisfy a number of other requirements, including development of a *Storm Water Monitoring Program* (SWMP) and *Storm Water Pollution Prevention Plan* (SWPPP). These are the guiding documents for the facility's compliance with stormwater permitting regulations.

Although LBL's general classification is 8733, Noncommercial Research Organization, two of the secondary SIC codes under which LBL is classified, 7539 (Automotive Repair Shops) and 3499 (Fabricated Metal Products), require at least portions of the main facility to acquire a stormwater permit. SIC code 7539 applies to the automotive repair facility in Building 76, and 3499 refers to the Ultra High Vacuum Cleaning Facility in Building 77. Additionally, because it contains a hazardous waste storage facility with a Part B RCRA permit at Building 75, LBL is specifically subject to permitting under the stormwater rules. Accordingly, LBL submitted an NOI in March of 1992, and had the SWPPP and SWMP in place by October 1, 1992.

Offsite locations where LBL activities are conducted (including parts of 21 buildings on the UCB campus and three offsite leased buildings) have not been included in this program, because they are not physically contiguous to the property addressed in this program, and do not contain any industrial activity or have any hazardous materials exposed to stormwater.

Discussion of results

The *Storm Water Monitoring Program* details the rationale for sampling, sampling locations, and the suite of analyses performed. The sampling design is summarized in Table 6-1. The sampling points, labeled StW 1 through StW 10, are indicated in Figure 6-1. Two of the monitoring points, StW1 and StW3, are actually influent points, where stormwater comes onto the LBL site from residential areas, roads, and other campus facilities located above it. These points were chosen as a basis of comparison and to increase the possibility of locating a source should contaminants be found.

Site operations and terrain were reviewed with respect to potential contaminants that could be released to surface runoff. Sampling points were chosen based on their representativeness of the site and runoff. The sampling strategy remains flexible, because not all the creeks flow during a given storm. Decisions are made in the field to modify the strategy if a particular creek is not flowing.

Table 6-1 Sampling Design

Monitoring Location	TASK					
			SAMPLING			
	Test for Non-Stormwater Discharge (Twice/Season)	Visual Observation[1]	First Storm Event[2]		Other Storm Events[2]	
			Grab[3]	Composite	Grab[3]	Composite
North Fork of Strawberry Creek Inlet (StW1)						
North Fork of Strawberry Creek Outlet (StW2)	•	•	•	•	•	•
Strawberry Canyon Inlet (StW3)	•	•	•	•	•	•
Chicken Creek Outlet (StW4)	•	•	•	•	•	•
Cafeteria Creek Outlet (StW5)	•	•			•	
Ravine Creek Outlet (StW6)	•	•			•	
Ten-Inch Creek Outlet (StW7)	•	•			•	
No Name Creek Outlet (StW8)	•	•			•	
Banana Creek Outlet (StW9)	•	•			•	
Pineapple Creek Outlet (StW10)	•	•			•	

[1] One storm per month.
[2] Significant storm water discharge must be preceded by 72 hours of dry weather.
[3] Grab samples must be taken during the first 30 minutes of the discharge. Except for the first storm event, such grab sampling will not be performed during the same storm event at all locations.

All creeks must be sampled and analyzed for the following:

- pH, total suspended solids, specific conductance, and total organic carbon (TOC). Oil and grease may be substituted for TOC.
- Toxic chemicals and other pollutants that are likely to be present in stormwater discharge in significant quantities.

Table 1 in Appendix A, *Data Tables,* summarizes the analytical results for parameters for stormwater samples taken in calendar year 1994. Since the official rainy season

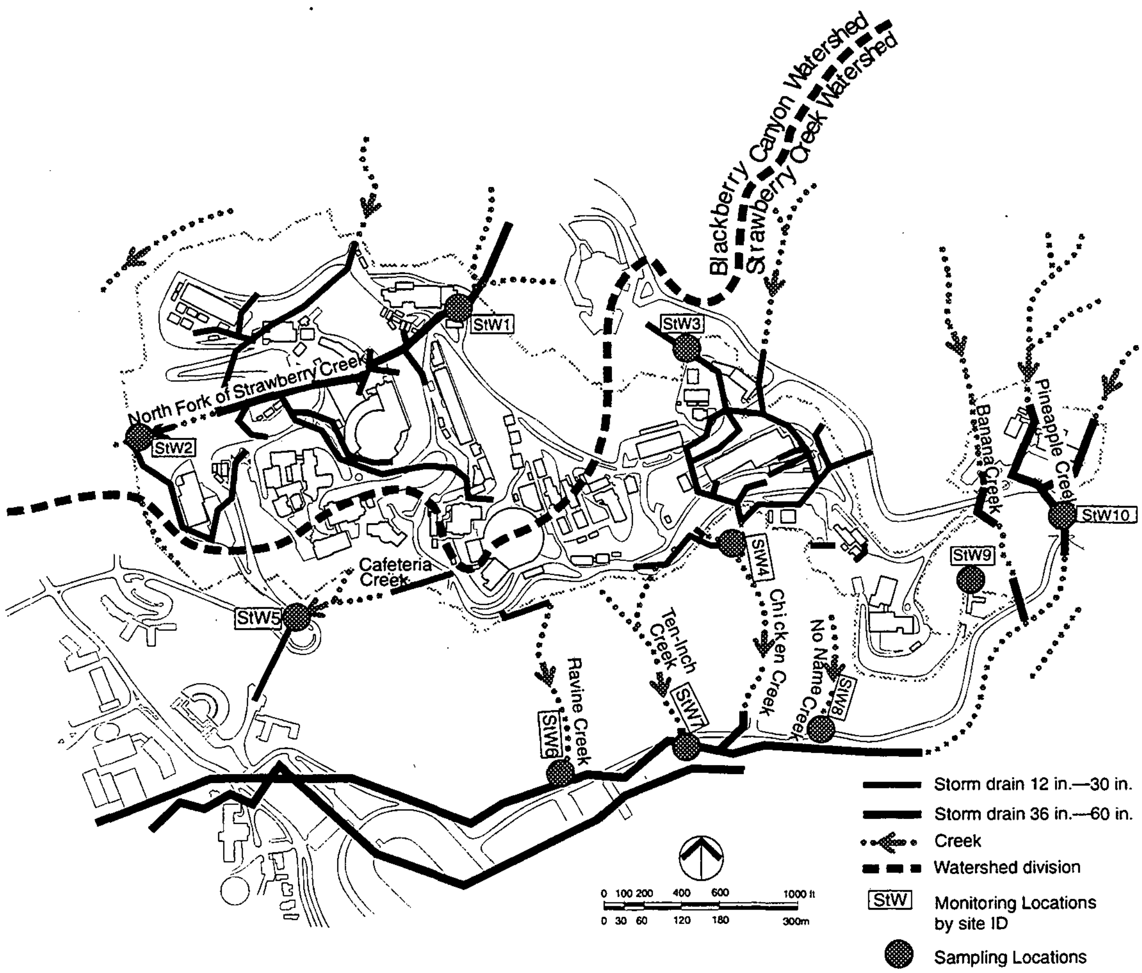


Figure 6-1 Site Storm Drainage and Monitoring Locations

runs from October 1 through April 1, the results in both tables include monitoring done for portions of two rainy seasons (1993–94 and 1994–95). Figures 6-2 and 6-3 show the 1994 results for metals and organic compounds at three of the more prominent stormwater sampling locations.

In general, the following statements can be made as a summary of the results for 1994:

- The pH was always near neutral.
- No volatile organic carbons were found.
- No PCBs were found.
- No cyanide was found.
- Small amounts of oil and grease were found in StW2, StW3, and StW4, and Total Petroleum Hydrocarbons (diesel) were found occasionally in StW2 and StW3. It should be noted that StW3 is an influent monitoring point; that is, it monitors stormwater coming onto the site from roads and facilities above LBL.
- Some metals, primarily chromium, copper, lead, and zinc, were present at levels above those given in RWQCB's Water Quality Control Plan (Basin Plan).[67] It is uncertain exactly how these numbers

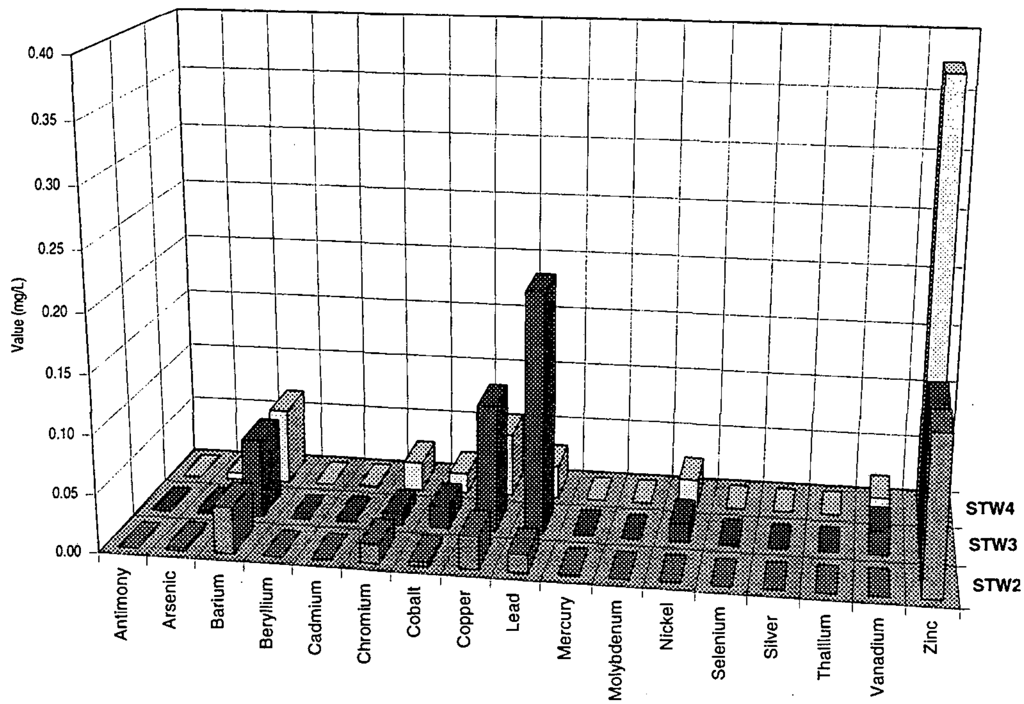


Figure 6-2. 1994 Stormwater Sampling Summary, Metals

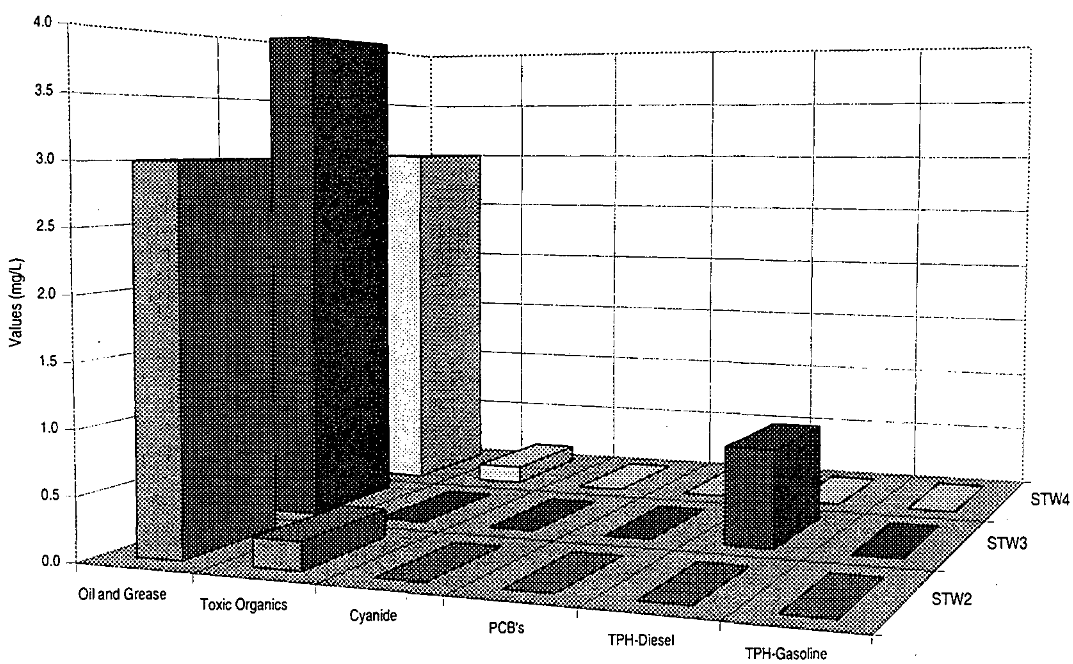


Figure 6-3. 1994 Stormwater Sampling Summary, Organics

are to be interpreted, given that background levels of these metals are unknown and that in at least one case (1/21/94 #1), the numbers leaving the site at StW4 are lower than the incoming numbers at StW3 for the same storm.

The General Permit differs from many other environmental permits in that no specific discharge limits are given against which the RWQCB or City of Berkeley are currently enforcing. The General Permit does reference the Basin Plan for the San Francisco Bay Region. Table IV-1A of the Basin Plan contains Shallow Water Effluent Limitations for some constituents that are used as a guideline to assess surface water runoff quality. Table 6-2 shows both the Human Health and Aquatic Life limits given in Table IV-1A for comparison purposes.

Sediment Sampling

Section 4.2.3 of the *Environmental Monitoring Plan* (EMP) details the soil and sediment sampling that is performed on an annual basis. The plan design was based on a history of site activities and was developed prior to the completion of the SWMP in 1992. Samples are analyzed for metals and a suite of toxic organics, including PCBs, diesel, kerosene and oil, and for gross alpha, beta, and tritium. Table 2 in Appendix A summarizes the nonradiological analytical results for all sampling locations.

In 1994 samples were taken from 17 locations, both on and offsite. There is no significant change from the results of sediment sampling in 1993. This information will be useful in establishing baseline values against which future sampling results can be measured.

Sanitary Sewer Discharge Permit Self-Monitoring

LBL currently has three Wastewater Discharge Permits issued by EBMUD; one for discharges from the site as a whole, and

Table 6-2. Shallow Water Effluent Limitations

	Fresh Water (all values in µg/L)	
Chemical Name	Human Health, 30-day Average	Aquatic Life, Daily Average
Arsenic	5	190
Cadmium	10	1.1
Chromium VI	50	11
Copper	1,000	11.8
Cyanide		5.2
Lead	50	3.2
Mercury	0.01	2.4
Nickel	600	160
Selenium	10	5
Silver	50	4
Zinc	5,000	110

two for so-called categorical discharges from the two metal finishing facilities on site, Building 25 and Building 77. As the local Publicly Owned Treatment Works, EBMUD regulates all industrial discharges to its treatment facilities. As part of the terms and conditions of the permit, EBMUD mandates that LBL perform self-monitoring for certain constituents in its discharges at certain prescribed intervals. In addition, EBMUD often performs monitoring at LBL concurrently with our self-monitoring efforts as a check on our methods and analyses.

EBMUD renewed LBL's three wastewater discharge permits on October 26, 1994. The 1994 self-monitoring dates listed in the August 1993 and September 1994 permits are presented in Table 6-3.

No NOVs for exceedance of discharge limits were issued to LBL by EBMUD in 1994, continuing the site's clean record from 1993. This includes results from self-monitoring, other internal monitoring efforts, and the concurrent sampling done by EBMUD. One NOV for delayed notification of a slug discharge was issued on September 15, 1994. Details of this incident may be found in Section 3.

Trend histograms for various contaminants in LBL's effluent for the last five years are presented in Figures 6-4, 6-5, and 6-6. Changes in LBL operations in metals finishing and implementation of programs designed to reduce pollution discharges may account for any downward trends seen in these figures. The actual self-monitoring results for the site, Building 77, and Building 25 are given in Table 3 in Appendix A, *Data Tables*.

In addition to self-monitoring, LBL performs several other tasks and submits reports as mandated by the wastewater discharge permits. Semiannual effluent-meter calibration reports were submitted on May 25 and November 29, 1994. For these reports, each of the flowmeters at the Hearst and Strawberry outfalls was calibrated at several different levels. All parameters passed calibration, and no adjustments to the flowmeters were made. An annual sewage meter reading report was submitted on June

Table 6-3. LBL Wastewater Self-Monitoring Dates for 1994

Hearst and Strawberry sanitary sewers	Building 25 metal finishing fixed treatment unit	Building 77 metal finishing fixed treatment unit
	2/14/94	2/14/94
2/21/94		
3/28/94		
	5/16/94	5/16/94
5/23/94		
		11/14/94
11/28/94		
	12/12/94	

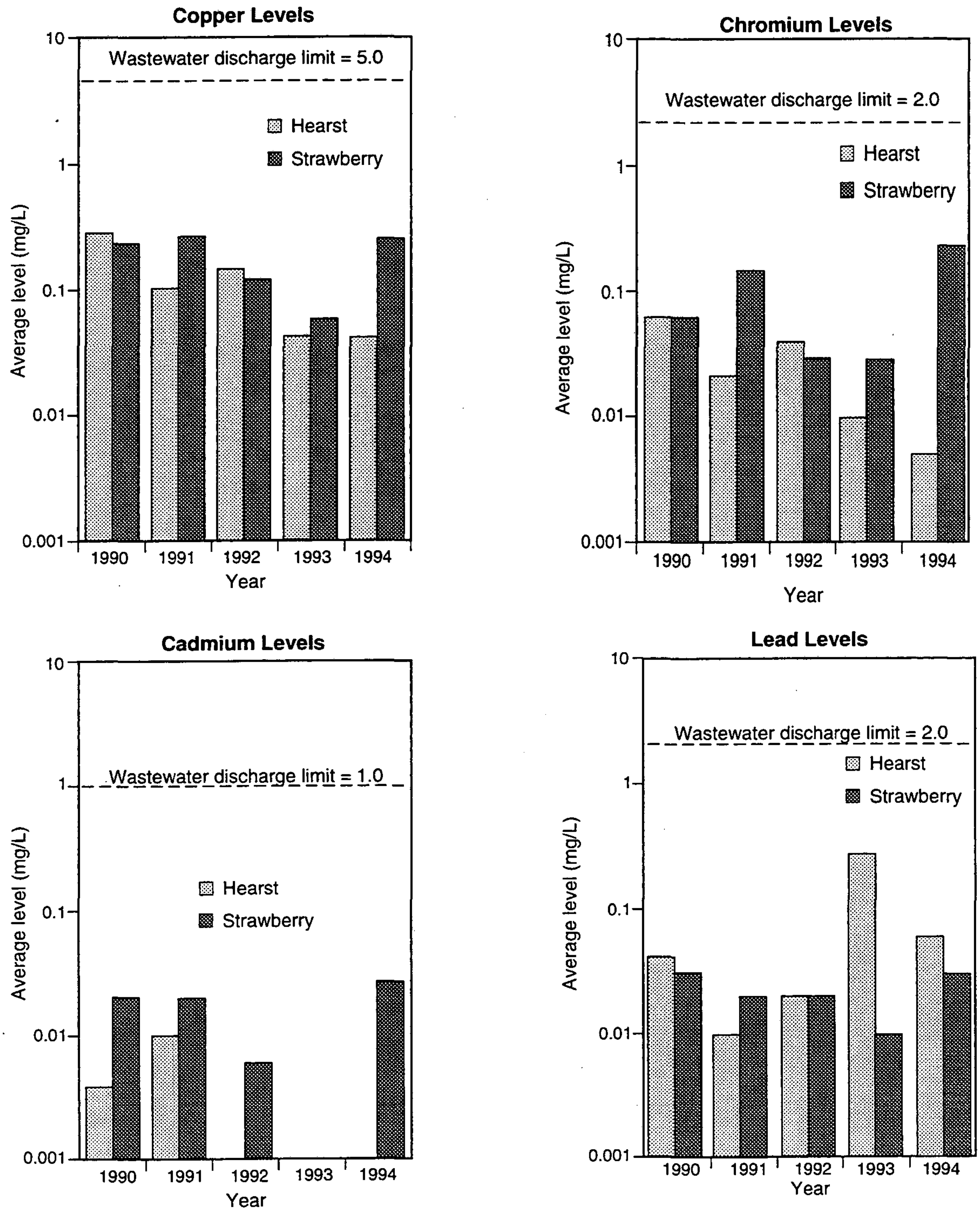


Figure 6-4. Hearst and Strawberry Monitoring Stations: Effluent Trends for Copper, Chromium, Cadmium, and Lead

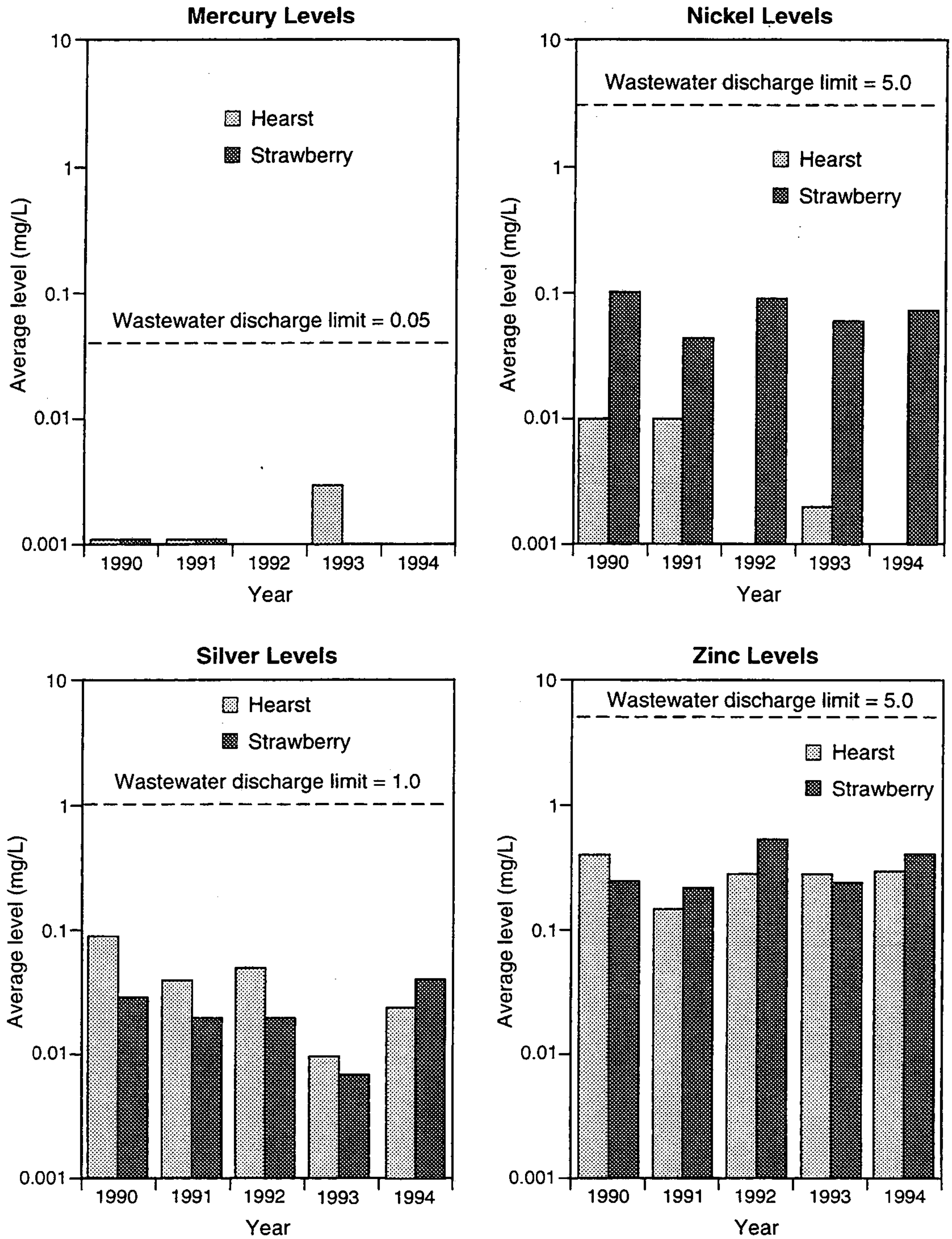


Figure 6-5. Hearst and Strawberry Monitoring Stations: Effluent Trends for Mercury, Nickel, Silver, and Zinc

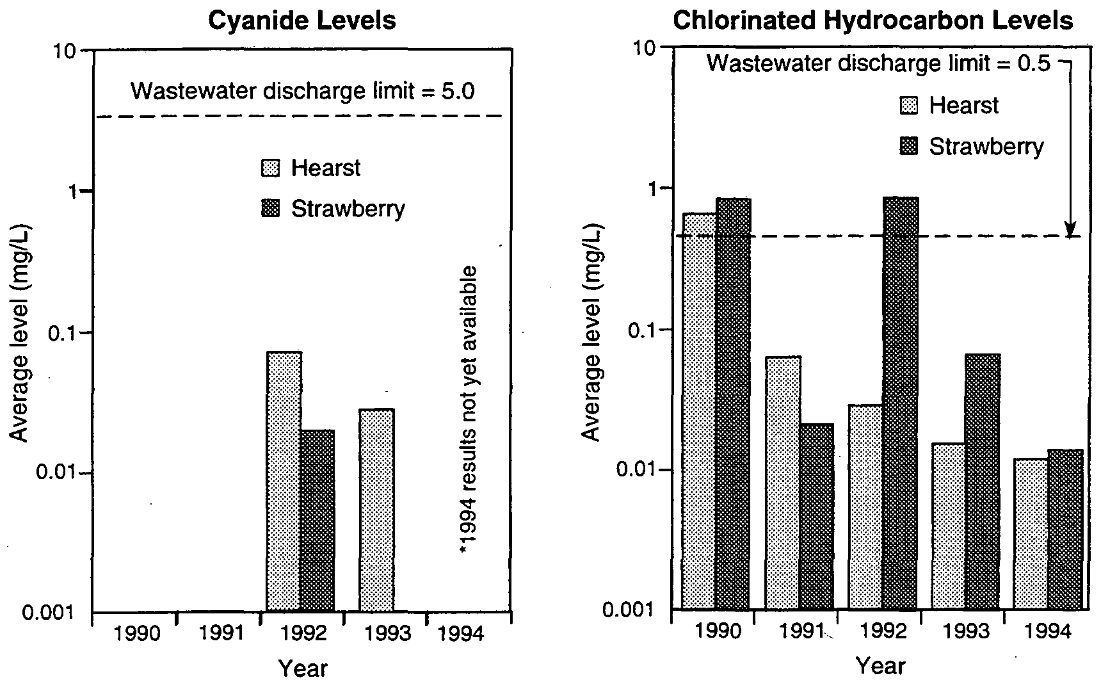


Figure 6-6. Hearst and Strawberry Monitoring Stations: Effluent Trends for Cyanide and Chlorinated Hydrocarbons

3, 1994. For this report, sewer flows are measured at the Hearst and Strawberry outfalls for the site. The Strawberry outfall is shared with some offsite UCB buildings. The flowmeters are read weekly; the results given in this report are the sum of 52 weekly readings. The flows measured at these outfalls for 1994 were 75,044,523 liters (19,825,251 gallons) and 133,408,044 liters (35,243,718 gallons) respectively. The estimated average flow per week is calculated to be 1,440,180 liters (381,000 gallons) for Hearst and 2,562,840 liters (678,000 gallons) for Strawberry.

Since the latter half of 1993, EBMUD has given permission to LBL to discharge groundwater that has been treated for contaminants of volatile organic compounds and tritium to the sanitary sewer. The treatment process consists of passing the contaminated groundwater through a double-filtered carbon adsorption system. Presently, this treatment activity occurs only around Building 51. One of the conditions for this discharge is a semiannual report on the volumes discharged and any contaminants found. In 1994 LBL submitted such reports to EBMUD on May 31 and November 29. Tests employing EPA Method 8260 were run on treated groundwater to determine levels of volatile organic carbons; all results were non-detect. Total volume treated and discharged for the six months prior to the first report was estimated at 427,000 liters (113,000 gallons). For the June through November report the total volume was approximately 264,600 liters (70,000 gallons). Flow from the hydraugers that collect this groundwater varies widely throughout the year, depending on rainfall and various other factors. More on the treatment of groundwater on the LBL site can be found in Section 7, *Groundwater Protection.*

Building 25 Photofabrication Shop

After over a year of down time for repairs, the Building 25 fixed treatment unit began operating in batch mode during the week of December 13, 1993. In cooperation with EBMUD, LBL has since developed the following sequence of events prior to discharging the batch effluent. When Building 25 is ready to discharge, the operators sample the wastewater in the treated water tank and send it to a state-certified laboratory for analysis. No treated water is released until the operators are satisfied, by certified analyses, that the water quality does not exceed permit limits. When the results come back, usually within five days, the operators call and give EBMUD's LBL Wastewater Control Inspector 48 hours notice of their intent to discharge. In this manner EBMUD can arrange for its inspector to be present and sample the batch discharge if it is during a week when EBMUD is scheduled to sample LBL's discharges concurrently with a self-monitoring.

Currently Building 25 discharges 1–2 times per week, depending on production volume. The treatment system has operated within specifications since the improvements of 1993, and all levels of metals have remained within permit limits. Table 3 in Appendix A, *Data Tables*, gives details of the analytical results for 1994.

Building 77 Fixed Treatment Unit

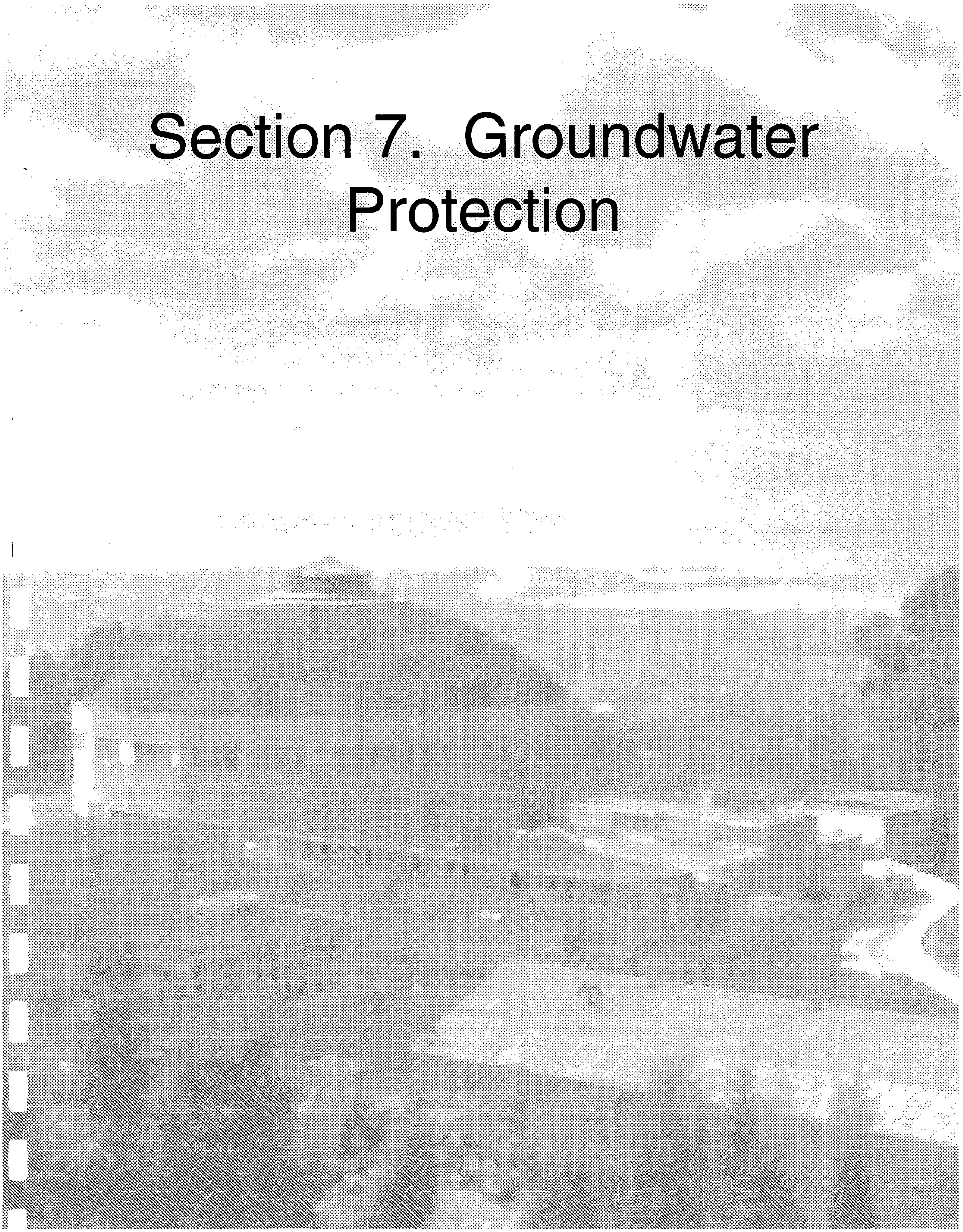
During 1994 the plating shop at Building 77 closed down for a complete rebuilding of the facility. To take its place, a temporary Ultra High Vacuum Cleaning Facility was built in Building 77H in order to meet LBL's interim cleaning and coating demands. The use of cyanide has been completely eliminated from the facility, and no plating has been performed in the temporary facility.

Three self-monitoring samples were taken from the Building 77 FTU during 1994. None of the sample analyses exceeded any of the discharge limits set by EBMUD. Table 3 in Appendix A summarizes the analytical results for 1994.

Hearst and Strawberry Sewer Outfalls

Four self-monitoring samples were taken from the Hearst and Strawberry outfalls during 1994. None of the samples exceeded any of the discharge limits set by EBMUD. In addition to Figures 6-4, 6-5, and 6-6, Table 3 in Appendix A, *Data Tables*, summarizes the analytical results for 1994.

Section 7. Groundwater Protection



Groundwater Protection Responsibilities

LBL seeks to ensure that protection of groundwater results in a net benefit to overall environmental quality. LBL strives to protect groundwater by preventing future groundwater contamination, monitoring to ensure that present groundwater quality is preserved, and remediating contamination to prevent the degradation of uncontaminated groundwater and to restore groundwater quality. The Laboratory involves local and state government agencies in LBL's groundwater protection and remediation programs. Further, the Laboratory informs the public of efforts made to protect groundwater quality through the LBL Community Relations office.

LBL's *Groundwater Protection Management Program Plan* provides a framework for preventing future groundwater contamination and remediating existing contamination at the site. Responsibility for implementation of this program belongs to the Environmental Protection and Environmental Restoration Groups of the EH&S Environmental Department. The Office of Planning and Communications is associated with this program by incorporating groundwater protection review into their NEPA and CEQA planning activities.

The purpose of this chapter is to review the characteristics of groundwater at LBL and related programs designed to protect it.

Hydrogeologic Characterization

This section will discuss the hydrogeological setup at LBL. Hydrogeologic units will be briefly reviewed, a piezometric map of groundwater will be presented, hydrologic properties of shallow water-bearing zones will be discussed, and direction of groundwater flow will be given. More detailed information on this subject is provided in the 1994 *LBL RCRA Facility Investigation Progress Report*.[37]

Hydrogeologic Units

There are five geological bedrock units at the LBL site. Moraga formation volcanic rocks, Orinda formation sediments, and Great Valley Group sediments constitute major rock units at the site. The Claremont formation and the San Pablo Group crop out only in the easternmost area of LBL and are of limited extent. The hydrogeological characteristics of the main three units are discussed below.

The Moraga formation consists mainly of lava flows, flow breccia, and agglomerates. The lavas are typically highly fractured, jointed, or brecciated. The matrix permeability of these rocks is low, except where they are deeply weathered. Due to the presence of moderately spaced open fractures and low matrix permeability, groundwater flow is primarily through fractures The hydraulic conductivity of these rocks is relatively high (10^{-4} to 10^{-6} meters per second [10^{0} to 10^{-2} feet per second]), and they constitute the main water-bearing unit at LBL. Where the formation is present at LBL, the thickness varies from less than 1 meter (3.3 feet) to approximately 30 meters (98 feet). The presence of low-permeability interbeds of clay and other sediments as well as zones with little fracturing within this formation create multiple-perched water conditions at many locations. As a result, differences in the elevation of the water table of as much as 8 meters (26 feet) can be observed over short distances.

The Orinda formation consists primarily of low-permeability siltstones, sandstones, mudstones, and conglomerates. The unit is poorly indurated, and, as a result, fractures tend to heal. Extensive cross-cutting fractures have not been observed in cores from boreholes. The Orinda formation generally has a low hydraulic conductivity (10^{-7} to 10^{-9} meters per second [10^{-3} to 10^{-5} feet per second]) and underlies the Moraga formation, constituting a relatively impermeable boundary for groundwater flow. Zones of coarser-grained, more permeable sandstone and conglomerate channel fills occur locally in the Orinda formation. The sandstones and conglomerates may form confined aquifers, especially where they are fractured.

A review of archived LBL geological logs of boreholes drilled for slope-stability purposes and foundation investigations, indicates that the water table was seldom encountered in the Orinda formation during drilling. Exceptions are those boreholes drilled close to old ravines or creeks where coarse-grained sediments were deposited along the stream beds. These areas often form a relatively narrow high-permeability aquifer along the axis of paleochannels. Water in the Orinda formation typically has a high total dissolved solids concentration, indicating a long resident time. Water in this formation is also typically high in calcium, magnesium, potassium, and sodium. Concentrations of these metals can reach up to 200 mg/L. Concentrations of other metals in the groundwater are generally very low, less than 1 mg/L.

The Great Valley Sequence consists primarily of low permeability shales, mudstones, and sandstones and crops out along the western and southern parts of LBL. Most of the borings drilled into this formation have encountered the water table. Examination of outcrops of the Great Valley Sequence in excavation exposures at LBL indicate that the fractures are moderately spaced at about 10 to 15 centimeters (4 to 6 inches). The formation is intensely fractured near the Hayward Fault. Due to the presence of the moderately spaced open fractures and low matrix permeability, groundwater flow is primarily through fractures. The hydraulic conductivity varies between approximately 10^{-5} and 10^{-7} meters per second (10^{-1} and 10^{-3} feet per second).

Groundwater Flow

The direction and the magnitude of groundwater flow are controlled primarily by the distribution of hydraulic conductivity and hydraulic head. Values of hydraulic conductivity of different water-bearing formations at LBL have been determined through a large number of single-well and multiple-wells hydraulic tests. Interpretation of these tests results has shown a wide range of hydraulic conductivity at LBL as mentioned above.

A groundwater piezometric map of LBL providing the hydraulic head distribution is given in Figure 7-1. The groundwater piezometric surface generally follows topography. Groundwater velocity at LBL varies widely, between approximately 1 meter per day (3.3 feet per day) and 0.001 meter per year (0.003 feet per year). In the western part of LBL, groundwater generally flows to the west; over the rest of LBL, flow is generally toward the south. The depth to groundwater at LBL varies between 1 and 30 meters (3.3 and 98 feet).

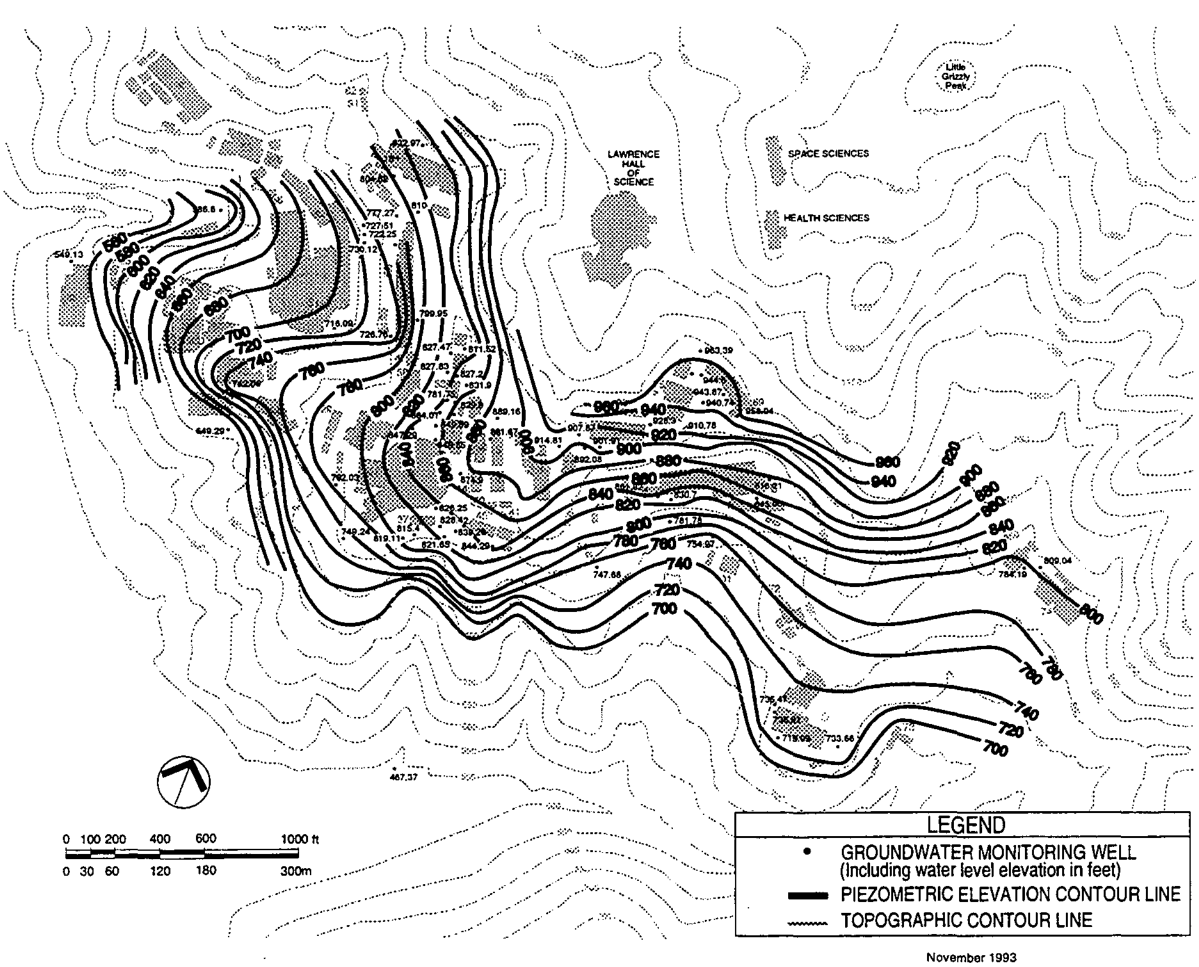


Figure 7-1. Groundwater Piezometric Map at LBL

Groundwater Fluctuations

Depth to groundwater is measured on a monthly basis at all LBL monitoring wells. Fluctuations in monthly groundwater elevation generally show a good correlation with rainfall data, as illustrated by comparison of site rainfall data with groundwater elevation data from well 91-8 in the "Old Town" area (Figure 7-2). Fluctuations in groundwater elevations were significantly greater during the 1994–95 rainfall season than during the previous rainfall season, which had significantly lower rainfall. Generally there has been a fairly rapid response (i.e., days) of water levels in most site wells after rainfall occurs.

Groundwater Quality

Groundwater samples from monitoring wells include tests for total dissolved solids, cations, and anions. The results of these tests have been illustrated in the form of Stiff Diagrams. The shape of these diagrams is representative of the chemical character of groundwater at different locations. As an example, Figure 7-3 shows the Stiff Diagram for three wells in the East Canyon in the vicinities of Buildings 74 and 83. These diagrams demonstrate how ground-

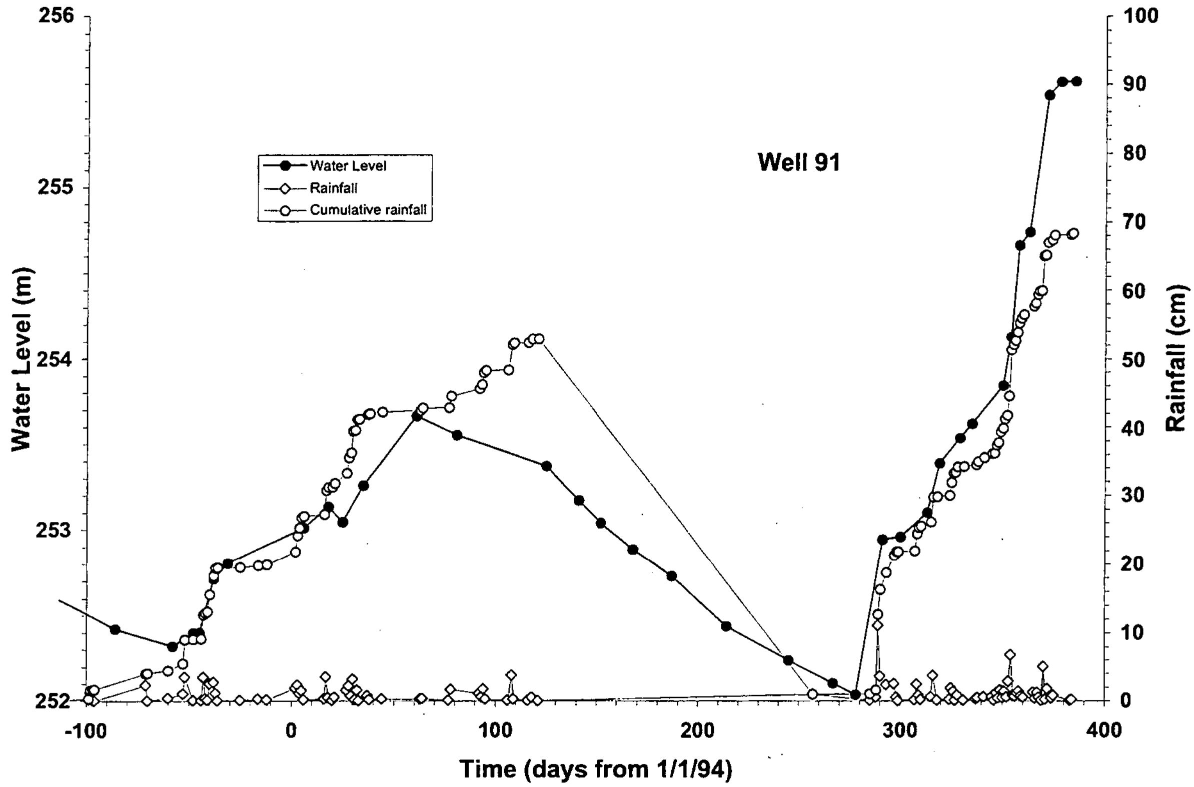


Figure 7-2. Comparison of Groundwater Level at Well 91 with Cumulative Rainfall

water quality can change in wells located very close to each other. The ionic charge measure milliequivalent per liter for a substance is proportionally related to the concentration of that substance in the groundwater. The locations of the wells are shown in Figure 7-4. Total dissolved solids of groundwater at LBL varies between 250 and 2,200 mg/L. Details of this study are available in LBL RFI progress report.

Groundwater Monitoring Program

The groundwater monitoring program at LBL began in 1991. By the end of 1994, LBL had installed about 85 environmentally related wells. These wells are essentially of two categories. Some of these monitoring wells are located close to the boundary of the LBL property, and others are downgradient from the active and removed or decommissioned underground storage tanks. The purpose of these wells is to monitor the quality of groundwater leaving the LBL property and the impact of past UST leaks on the groundwater. These wells are generally sampled every quarter and tested for volatile organic compounds (VOCs) and total petroleum hydrocarbons, respectively.

Currently, LBL has 16 monitoring wells installed close to the boundary and two wells installed off site, immediately downgradient from LBL. Figure 7-5 shows the approximate locations of these wells. One well has shown trichloroethene and a trace amount of other VOCs; however, the rest are free from any contaminants. To stop further migration of contaminants, groundwater from this well is being pumped and treated.

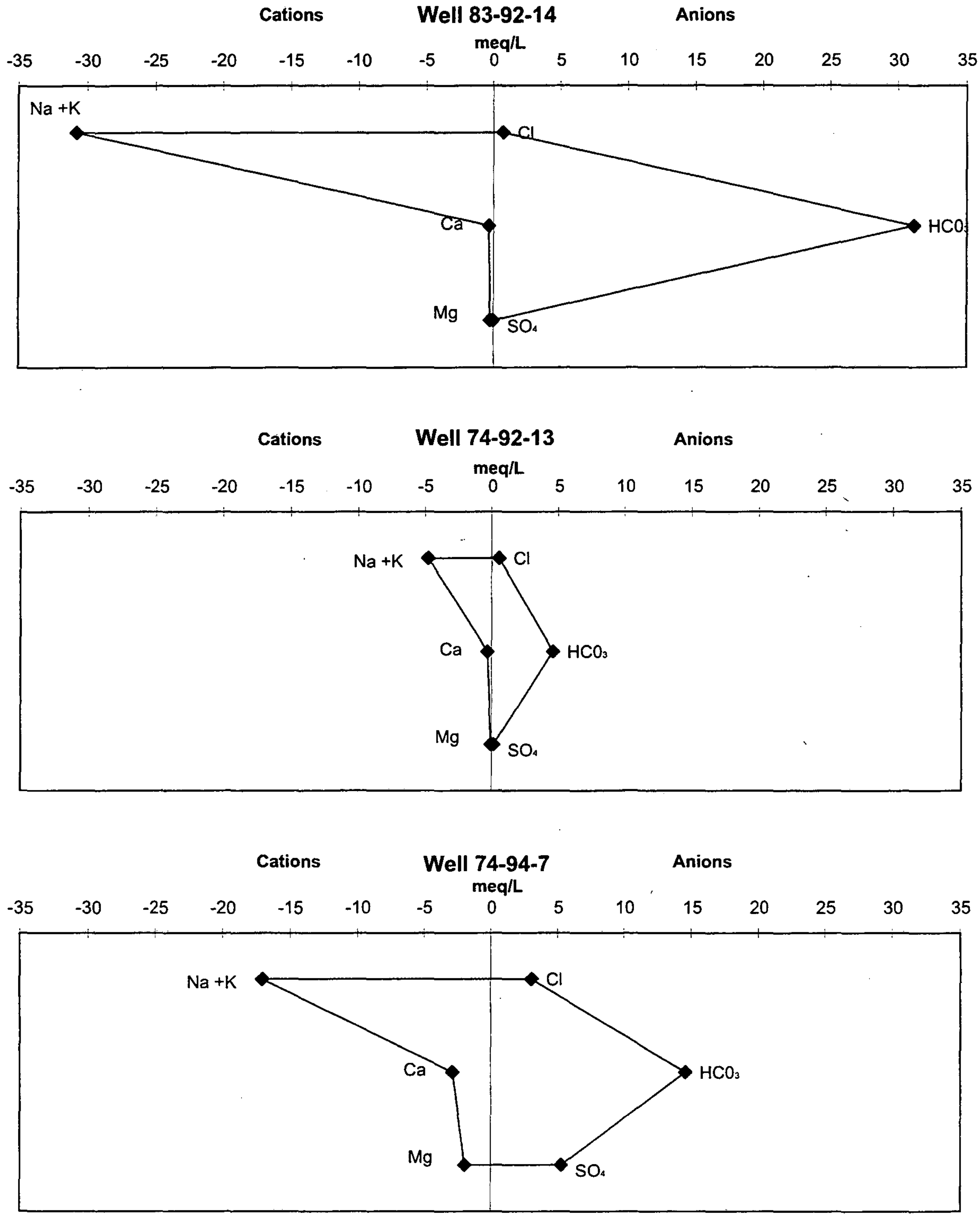


Figure 7-3. Stiff Diagrams for Wells 83-92-14, 74-92-13, and 74-94-7 in the East Canyon

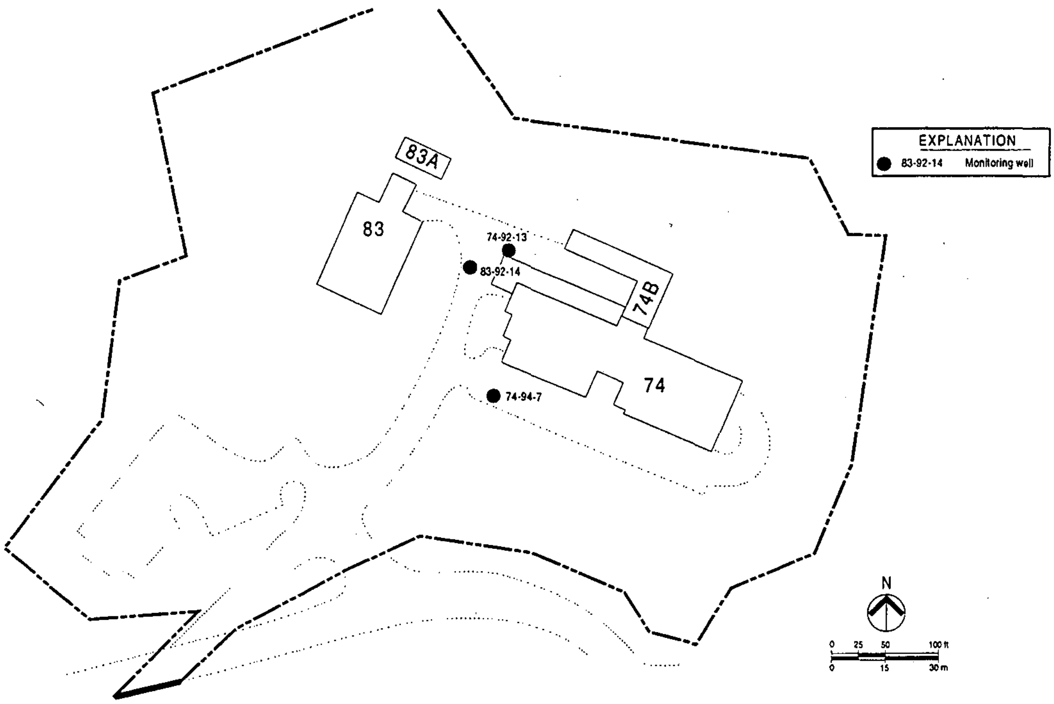


Figure 7-4. Approximate Locations of Monitoring Wells in the East Canyon

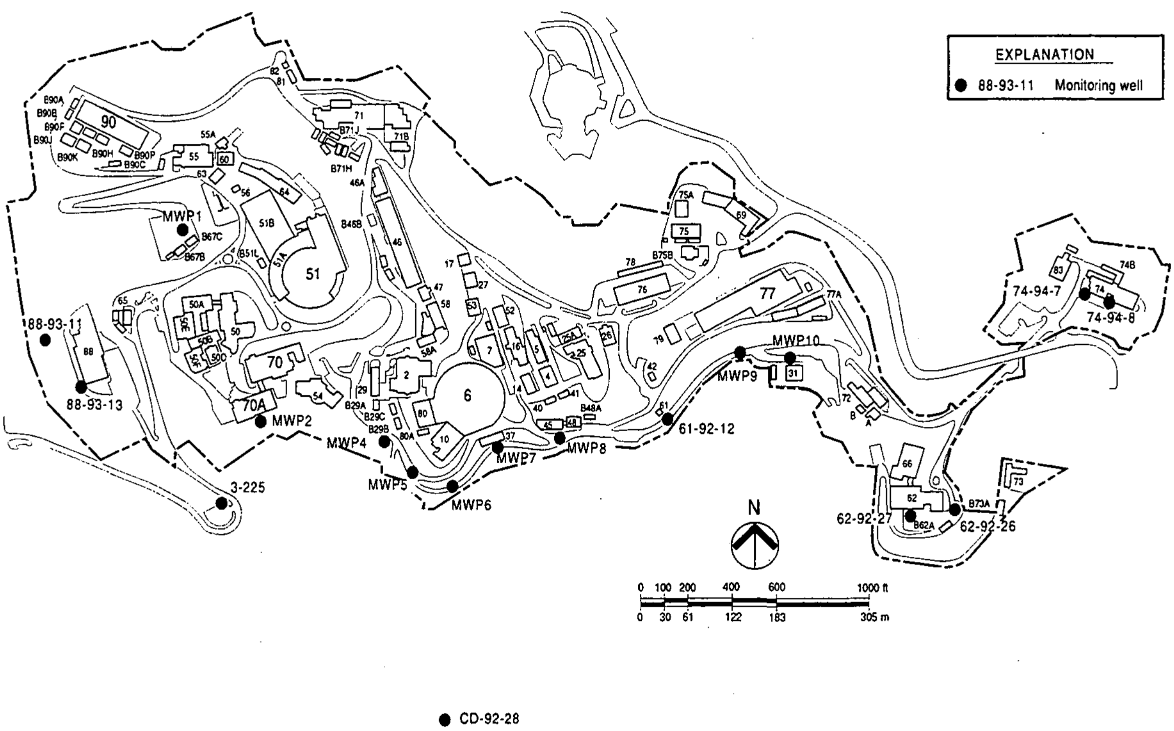


Figure 7-5. Approximate Locations of Monitoring Wells Close to the LBL Property Line

A total of eight monitoring wells have been installed downgradient from one decommissioned and four removed USTs. Seven of these eight wells identified contaminants in the groundwater. Figure 7-6 shows approximate locations of these wells.

The second category of wells is those installed for the site characterization purpose. The purpose of these wells is to investigate groundwater contamination. The groundwater sampling schedule from these wells is dictated by the type of information needed for the assessment process. These wells are generally sampled quarterly. The frequency of sampling, however, may be reduced if appropriate. Concurrence from regulatory agencies is obtained for such actions. Water samples from these wells are tested for the potential contaminants.

Contamination Prevention

Over the years, LBL has installed a large number of wells for slope stability investigations, and dewatering slide areas. Some of these wells have borehole diameters as large as 0.75 meters (2.5 feet), and their construction designs are not consistent with requirements for water supply wells or monitoring wells. To be able to drain the formation, the casings are usually perforated all the way to the surface, and the wells lack annulus seals. As a result, these wells provide fast pathways for surface contaminants to reach the groundwater.

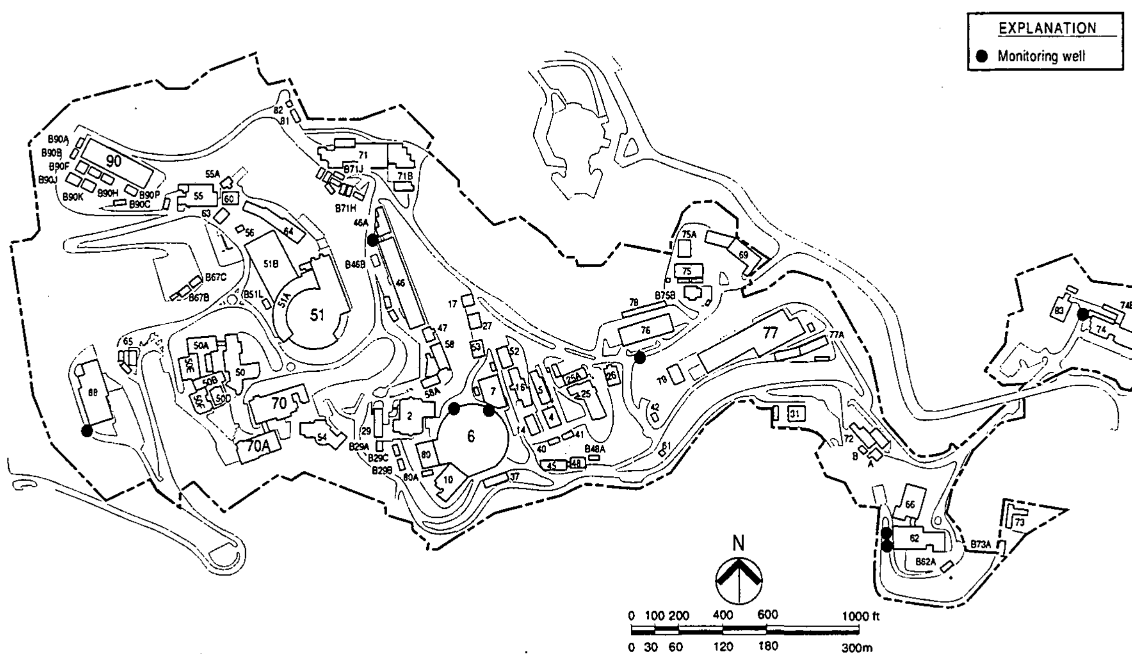


Figure 7-6. Approximate Locations of Monitoring Wells Associated With Underground Storage Tanks

To prevent future groundwater contamination, LBL initially prepared an inventory of all wells. All files were reviewed, each well was visually inspected, and a report was prepared. In the report, construction details of all wells were carefully reviewed, and their present usefulness for stabilizing the slope was reevaluated. Those wells not needed any longer are being properly abandoned. Those that are needed are reconstructed with a seal at least 7 meters (23 feet) long.

Another step toward groundwater protection that LBL has taken, was to survey the majority of sanitary sewer lines with a video camera. Any root intrusion or sewer displacement has been identified and reported. Some of these displacements have already been fixed, and others will be fixed in the near future. In addition, all improper drainage systems have been identified and have been corrected.

Contaminated soils related to solid waste management units and areas of concern have been and are being identified. To prevent leaching from these contaminated soils, either they are removed, or *in situ* remediation will be implemented to eliminate the threat to the groundwater.

Groundwater Contamination

During the RCRA Facility Investigation phase, the Environmental Restoration Program has identified seven groundwater contamination plumes, as shown in Figure 7-7. Contamination has also been found in other areas. These areas are represented by the small circles in Figure 7-7 and are scat-

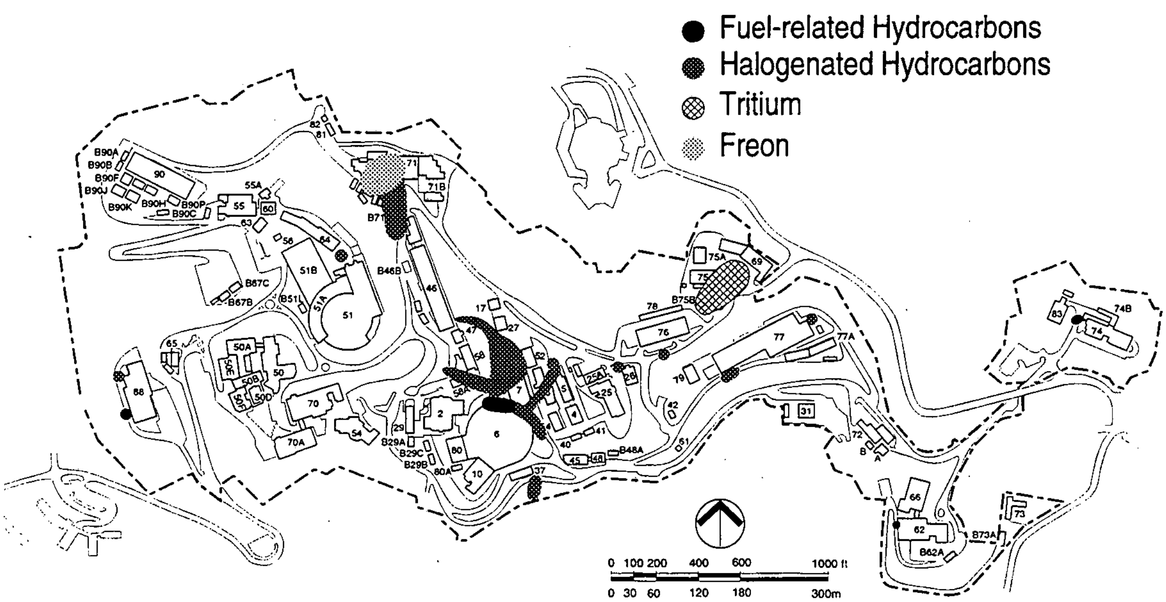


Figure 7-7. Groundwater Contamination Plumes (December 1994)

tered across the site. However, based on the present information, the extent of this contamination is very limited. Details of these investigations are given in the LBL RFI progress report. The largest plume, which covers areas under Buildings 7, 53, 27, 58A, and the slope west of Building 53, consists of VOCs such as perchloroethene, trichloroethene (TCE), carbon tetrachloride, vinyl chloride and other compounds. The maximum total VOCs concentration observed in groundwater in this plume is about 56,000 μg/L. Figure 7-8 shows contaminant distribution in this area, which is referred to as "Old Town Plume." Another significant plume is located south of Building 71 and is mainly made of Freon 113. Freon 113 is a coolant that was routinely used inside Building 71. Maximum concentration of Freon 113 detected in this area is about 9,000 μg/L. Other types of contamination discovered in groundwater at LBL are tritium and fuel-related hydrocarbons. The tritium contamination is limited to the vicinities of Building 75, 76, and 78. The source of tritium in groundwater is emissions from the NTLF stack near Building 75. Monitoring data from the past several years indicates that the tritium plume has not migrated outside the LBL Corporation Yard. The maximum tritium concentration detected in the monitoring wells in this area is about 10,000 pCi/L, which is about half of the maximum contaminant level in the drinking water. The main plume of fuel-related contamination is located north of Building 6. This contamination came from past leakage at underground storage tanks previously removed from service.

Interim Corrective Measures

It is the policy of the LBL Environmental Restoration Program to prevent further migration of groundwater plumes, once their extent is identified. While further assessment is continuing, as an interim corrective measure, LBL tries to stop further contaminant migration and prevent discharges of contaminated groundwater into surface water bodies. This is usually achieved by collecting and treating contaminated water at the front of the plume.

Several of these measures have already been undertaken. Over a million gallons of contaminated groundwater have been collected and treated from the front of "Old Town Plume" at the east side of Building 46. A small TCE plume located southeast of B37 is being managed by a simple pump-and-treat system. In addition, effluents from five hydraugers, located east of Building 51, that are contaminated with VOCs are being collected and treated.

To minimize the extent of tritium in the groundwater, as well as the environment in general, tritium emissions from the NTLF have been reduced by about 80% since the late 1980's (Figure 5-2). Tritium emissions have stabilized at around 100 Curies per year since 1991.

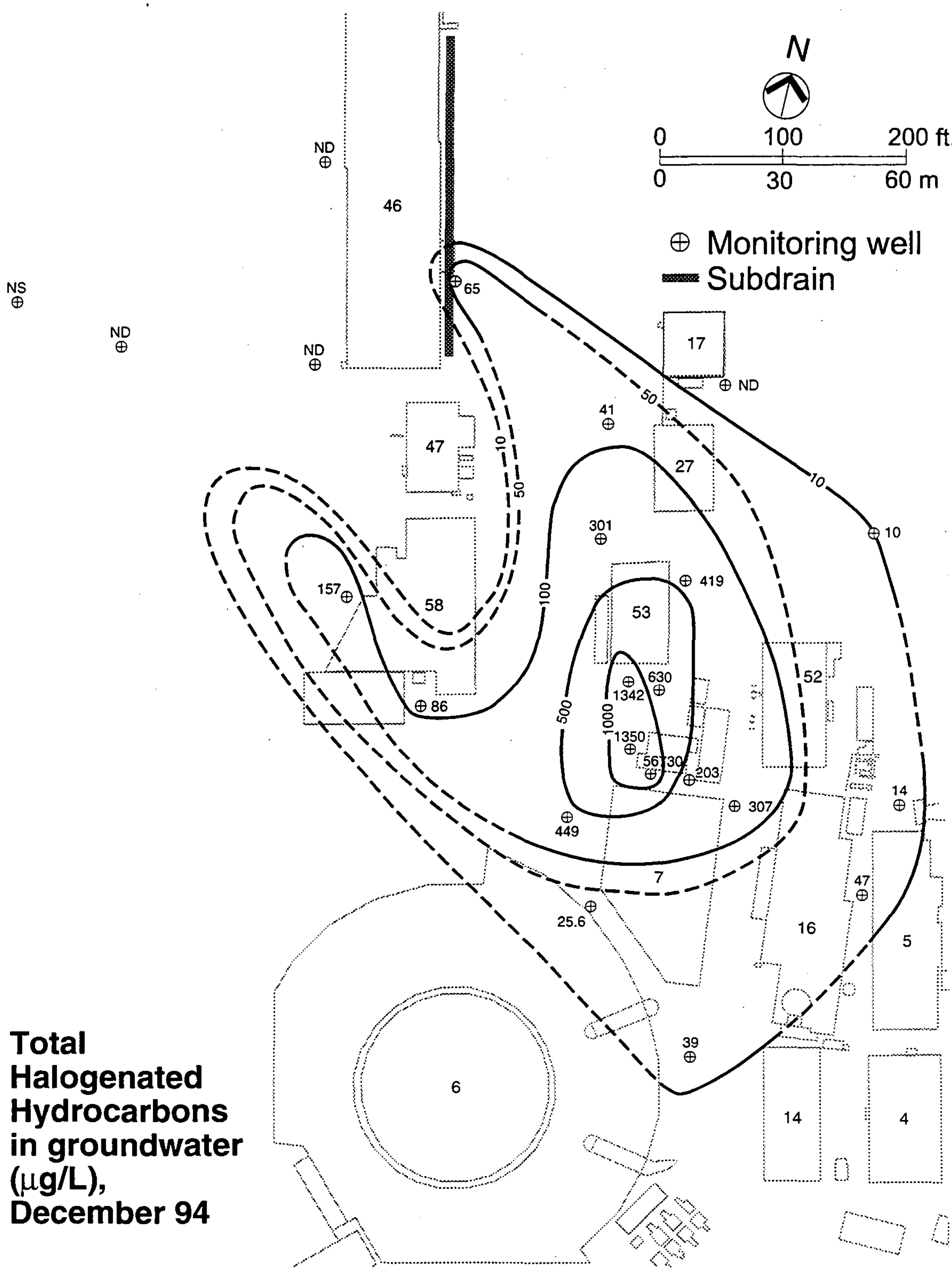
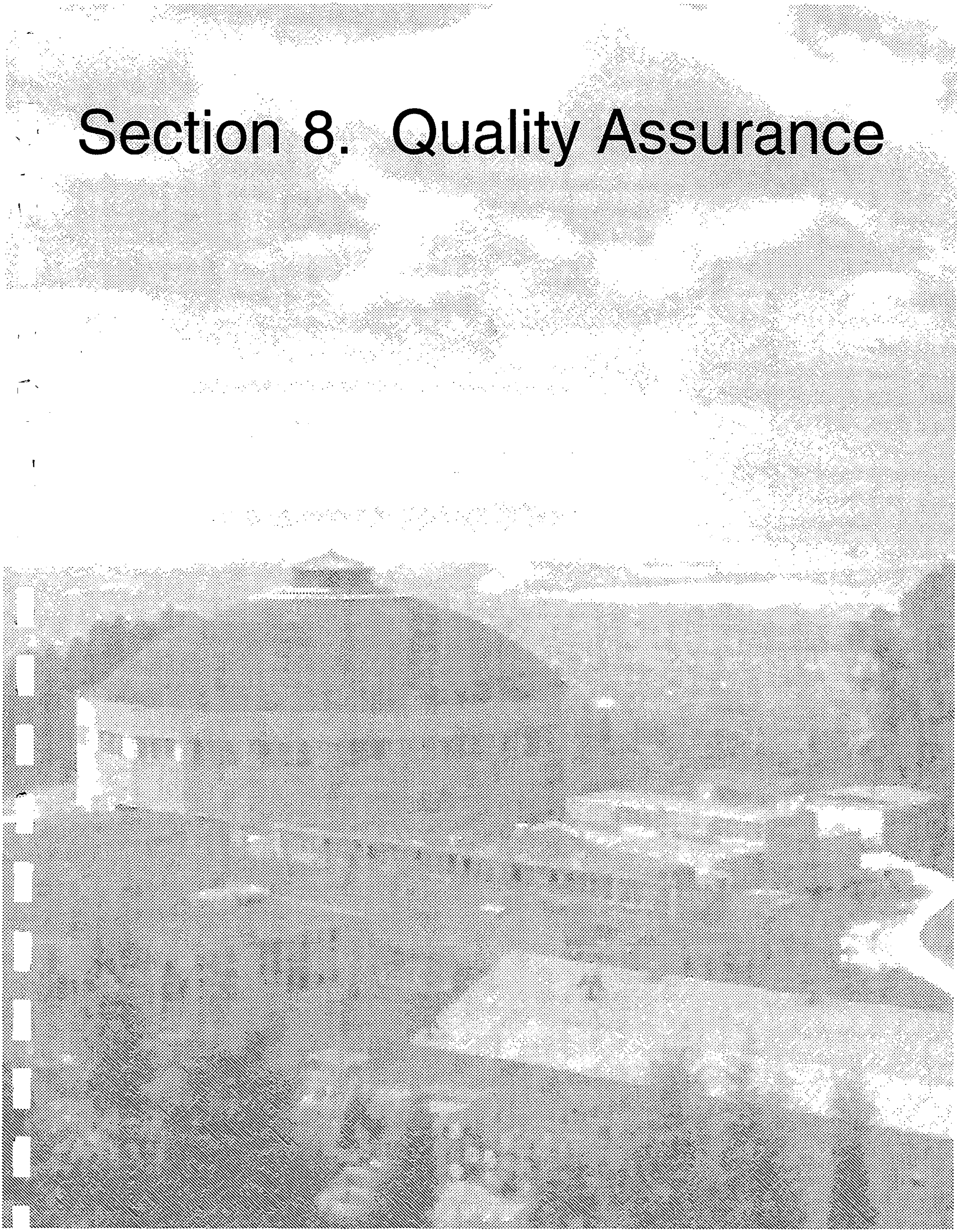


Figure 7-8. Groundwater Contamination in the "Old Town" Area (December 1994)

Section 8. Quality Assurance



General

For environmental programs, quality assurance (QA) consists of all activities conducted to ensure that data acquired provide a valid representation of actual conditions. QA at LBL is implemented through the LBL *Operating and Assurance Program* (OAP), PUB-3111. This document incorporates the guidance of DOE Order 5700.6C, *Quality Assurance*,[54] DOE Order 5480.19, *Conduct of Operations*,[68] and DOE Order 4330.4B, *Maintenance Management Program*.[69] Additionally, LBL used draft US/EPA guidance on QA (ANSI/ASQC E-4)[70] and US/EPA QA requirements from 40 CFR 61, Subpart H, Appendix B, Method 114[4] in creating the OAP.

Implementing the OAP is achieved through the creation of notebooks at all organizational levels within LBL. There are three types of notebooks. Function notebooks provide guidance in the performance of support services such as environmental program activities. Facility notebooks are created to provide guidance in the operations of facilities to preclude operational incidents or environmental releases. Project notebooks provide guidance to researchers regarding their activities.

The function notebooks for the environmental programs (i.e., Environmental Protection, Waste Management, Environmental Restoration, Analytical Services) includes provisions for documenting items such as:

- The organizational structure, functional responsibilities, levels of authority, and lines of communications for all activities related to the emissions measurement program.
- Administrative controls prescribed to ensure prompt response in the event that emission levels increase due to unplanned operations.
- Identification of sampling sites and number of sampling points, including the rationale for site selections.
- Sampling probes and representativeness of the samples.
- Any continuous monitoring system used to measure emissions, including the sensitivity of the system, calibration procedures, and frequency of calibration.
- Sample collection systems for each radionuclide measured, including frequency of analysis, calibration procedures, and frequency of calibration.
- Laboratory analysis procedures used for each radionuclide measured, including frequency of analysis, calibration procedures, and frequency of calibration.
- Vendor control practices, which provide the basis for selection of vendors and include verification activities related to the vendor calibration practices.
- Sample flow-rate measurement systems or procedures, including calibration procedures and frequency of calibration.
- Effluent flow rate measurement procedures, including frequency of measurements, calibration procedures, and frequency of calibration.
- Documented objectives of the QA program, which state the required precision, accuracy, and completeness of the emission measurement data, including a description of the procedures used to assess these parameters. Accuracy is the degree of agreement of a measurement with a true or known value. Precision is

a measure of the agreement among individual measurements of the same parameters under similar conditions. Completeness is a measure of the amount of valid data obtained compared to the amount expected under normal conditions.

- A quality control program established to evaluate and track the quality of the emissions measurement data against preset criteria. The program includes, where applicable, a system of replicates, spiked samples, split samples, blanks, and control charts. The number and frequency of such quality control checks are identified.
- A sample-tracking system established to provide for positive identification of samples and data through all phases of the sample collection, analysis, and reporting system.
- Sample handling and preservation programs to maintain the integrity of samples during collection, storage, and analysis.
- Periodic internal and external audits to monitor compliance with the QA program. These audits are performed in accordance with written procedures and conducted by personnel who do not have responsibility for performing any of the operations being audited.
- The corrective action program, including criteria for when corrective action is needed, what corrective actions will be taken, and who is responsible for taking the corrective action.
- Periodic reports prepared for management that describe the performance of the emissions measurements program. These reports include assessment of the quality of the data, results of audits, and descriptions of corrective actions.

An internal assessment of the NESHAPs Program Plan was conducted in April 1994, with a focus on the adequacy of planning documentation. The EH&S Quality Manager reviewed draft NESHAPs procedures to verify that adequate procedures had been drafted to meet QA program requirements. Criteria used in the assessment included 40 CFR 61, Appendix B, Method 114. The assessments concluded that there were four missing procedures needed to meet NESHAPS requirements. These procedures should address the following:

- documenting how design reviews are performed, referencing ANSI standard ANSI-N13.1-1969,[71] and interfacing with design and installation contractors
- reviewing emission data with corresponding action taken if emissions increase
- specifying the basis for selecting vendors, which should include verification activities of their calibration practices
- modifying EPG Procedure 254 or developing a new NESHAPs quality control (QC) procedure that will state the preset criteria and the frequency of data verification and validation, and for which analytes these criteria must be performed

In April, the LBL Office of Assessment and Assurance (OAA) performed an independent audit of a subcontractor analytical laboratory. In September, OAA audited LBL's Environmental Measurement Laboratory. OAA is LBL's organizational structure which provides the independent oversight function for LBL. The audits indicated that the laboratories provided representative and accurate analytical results.

Analytical Services Group

Radiochemical analyses of environmental samples are performed by the LBL Analytical Services Group (ASG), which is part of LBL's Health Department.

The ASG continued its participation in the US/EPA Intercomparison Studies program. During 1994, the lab performed 23 various analyses. Table 8-1 summarizes these analytical results.

The ASG is accredited by the State DHS and is fully compliant with both DOE Order 5700.6c and 40 CFR 61. Additionally, its analytical program was submitted to two DOE external audits in 1994: one for technical merit by DOE EH-13, and one for

Table 8-1. Summary of EPA Intercomparison Studies for Various Radionuclides

Date Received	Analysis	Media	LBL Mean Value (pCi/L)*	LBL Std. Deviation (pCi/L)*	EPA Value (pCi/L)*	EPA Precision (pCi/L)*	Deviation
1/28/94	Gross α	water	33.3	3.2	15.0	8.7	6.35**
	Gross β	water	57.7	4.0	62.0	17.3	-0.75
3/4/94	Tritium	water	5,452	323.0	4,936	857.0	1.81
4/19/94	Gross β	water	78.7	3.2	117.0	31.2	-3.69**
	Gross α	water	113.0	14.1	86.0	38.2	2.13
	Strontium-89	water	22.7	1.5	20.0	8.7	0.92
	Strontium-90	water	16.0	2.0	22.7	8.7	0.69
	Cobalt-60	water	20.7	2.9	20.0	8.7	0.23
	Cesium-134	water	23.7	6.1	34.0	8.7	-3.58**
	Cesium-137	water	28.0	2.6	29.0	8.7	-0.35
	Radium-228	water	14.8	0.7	20.1	8.7	-1.85
6/22/94	Gross α	water	27.3	1.5	32.0	13.9	-1.01
7/15/94	Strontium-89	water	23.0	1.7	30.0	8.7	-2.42
	Strontium-90	water	16.0	1.0	20.0	8.7	-1.39
8/5/94	Tritium	water	10,273	585	9,951	1,726	0.56
8/26/94	Gross α	filter	34.0	0	35.0	15.6	-0.19
	Gross β	filter	59.7	3.2	56.0	17.3	0.64
	Strontium-90	filter	25.0	1.7	20.0	8.7	1.73
	Cesium-137	filter	13.0	1.0	15.0	8.7	-0.69
10/18/94	Gross α	water	117.3	3.1	57.0	24.3	7.46**
	Gross β	water	120.3	2.5	142.0	36.4	-1.79
	Strontium-89	water	19.3	1.2	25.0	8.7	-1.96
	Strontium-90	water	14.0	1.0	15.0	8.7	-0.35

* Dimensions are pCi/L except for air filter results which are pCi/sample.
** Failed analysis. See text for discussion.

Quality Assurance by DOE EH-24. In both reviews, no findings or observations were made.

Four analyses did not pass the US/EPA intercomparison test. Two gross alpha results, January 28 and October 18, incorrectly used a dilution factor for the aliquot of 1/16 rather than 1/8. The other two analyses were performed on April 19 and were due to changes in efficiency corrections. The Gross β result was incorrect because the curve used to adjust for Crosstalk had not been updated. The ^{134}Cs analytical value was off because the mean peak on the calibration curve was too close to that of ^{137}Cs. LBL responded by redoing the calculations with the correct parameters.

Environmental Protection Group

Quality assurance for the Environmental Protection Group is documented in the EPG function notebook and the NESHAP Quality Assurance Project Plan (QAPP). It provides for self and independent assessments of environmental quality assurance programs, including the Environmental Monitoring Unit (EMU). The rationale for all routine sampling and monitoring activities is described in the *Environmental Monitoring Plan*. The *Parameter Review Plan* describes the pathways, monitoring and sampling criteria, and action limits for all sample media and analytes.

The QA activities of this group were reviewed during the DOE EH-24 audit that was discussed in Section 3, *Compliance Summary*. The auditors determined that certain environmental activities were performed informally or with nonapproved standard operating procedures, and certain environmental records and reports are incomplete. Corrections for these shortcomings have been addressed in LBL's draft corrective action plan.

All EMU personnel are trained in the performance and execution of their duties. Since there are few specific formal environmental monitoring and sampling training courses, EMU personnel are trained in areas and skills closely aligned with their specific duties. Training records are maintained for EMU personnel, who periodically review their records to ensure that their training is current.

Accuracy and precision requirements cited in the *Parameter Review Plan* form the basis of the EMU data quality objectives (DQOs). Three data management procedures were completed in 1993: *Data Quality Objectives*, *Data Validation And Verification*, and *Data Analysis*. These procedures were implemented in 1994. They form the basis for quality improvement within the EMU. Analytical data are assessed by applying the data validation and verification procedures with respect to the DQOs. If the precision and accuracy criteria set forth in the DQOs are met, then no further change in sampling/analytical procedure is required. If the DQOs are not met, then the sampling and analytical procedures will be reviewed to identify any required corrective actions.

In November 1994, environmental data management procedures were implemented which establish data quality objectives for all environmental sampling and monitoring media. Data validation, verification, and statistical analysis procedures applied to analytical data determine the "goodness" of the sampling and analyses, and provide a statistically defensible means of demonstrating compliance with regulatory agency and DOE Order requirements.

Data Completeness

Data management procedures require computation of an annual completeness ratio of data capture for analytical data, using the following formula:

$$\frac{\text{Number of values in data set}}{\text{Number of values planned}} \bullet 100$$

For radiological data, 12,295 analyses were conducted out of 13,327 planned, for a completeness ratio of 92%. Missing values were due to sampling equipment faults rather than missing analyses. For nonradiological data, 530 samples were taken, with a completeness ratio of 100%. A value of greater than 85% is considered acceptable under the procedures.

Data Validation

In order to determine whether a stated sample analytical accuracy or precision is being met, sample duplicates and blanks are taken. Obtaining duplicates is relatively simple when sampling surface waters, wastewater effluent, and radiological deposition. However, taking representative duplicate samples from air point sources (exhaust stacks) and ambient air poses significantly greater challenges. For this reason, the precision and accuracy procedures were applied only to surface water, sewer, and deposition radiological samples from 1994. Nonradiological data sets did not contain enough duplicate samples to allow precision or accuracy testing.

Environmental data are most commonly distributed either normally or log-normally. If the sample analysis is close to the instrument detection limit or minimum detectable activity (MDA), the analytical standard deviation is quite large and the data distribution tends to be log-normal. If the sample analysis is far from the instrument MDA, the data tend to be distributed normally. Tests are applied to all the data to determine whether or not they are normally or log-normally distributed (there are other distribution modalities whose analyses become increasingly complex. If other modalities are observed in the data, then the procedures will be modified to accommodate the change). Knowledge of the distribution modality is important, as the analysis procedures assume a normally distributed data set. If the data are found to be log-normally distributed, a log transfer is applied to transform them to a normally distributed data set.

Aqueous samples are taken weekly and are analyzed for gross alpha, beta, and tritium. Figures 8-1 and 8-2 are plots of the expected versus observed values for the tritium and tritium duplicate analytical data, assuming a normal distribution. Figures 8-3 and 8-4 are comparison plots of the same parameters, assuming a log-normal distribution of the data. The degree of agreement is slightly better in Figures 8-1 and 8-2 than in Figures 8-3 and 8-4. For this reason, the data were assumed to be normally distributed; however in the discussion of statistical analysis which follows, treating the data distribution as either normal or log-normal had no effect on the conclusions.

The same tests for normality versus log-normality were applied to the gross alpha and beta analytical data sets. Figures 8-5 and 8-6 are plots of the alpha and beta analytical data testing for normality. Figures 8-7 and 8-8 are plots of the data testing for log-normality. The stronger correlations in the latter figures indicate that the alpha and beta

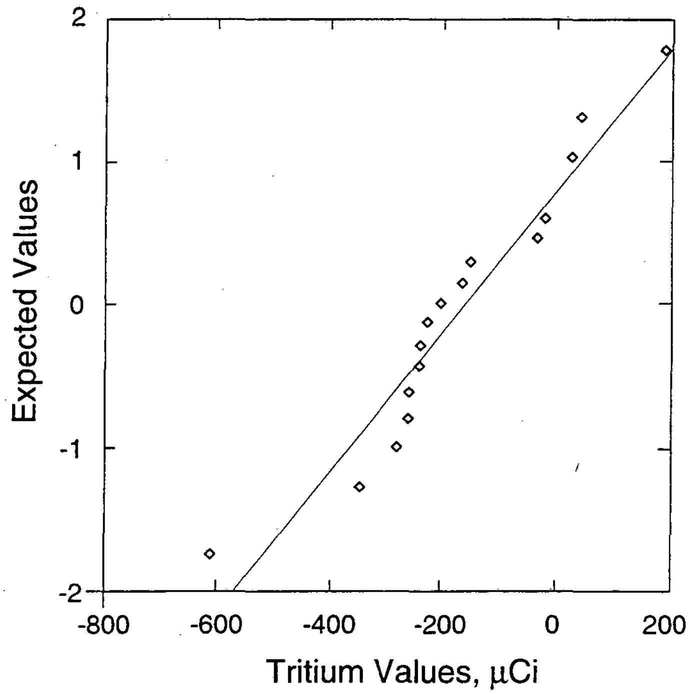


Figure 8-1. Expected Versus Observed Tritium Values, Normal Distribution

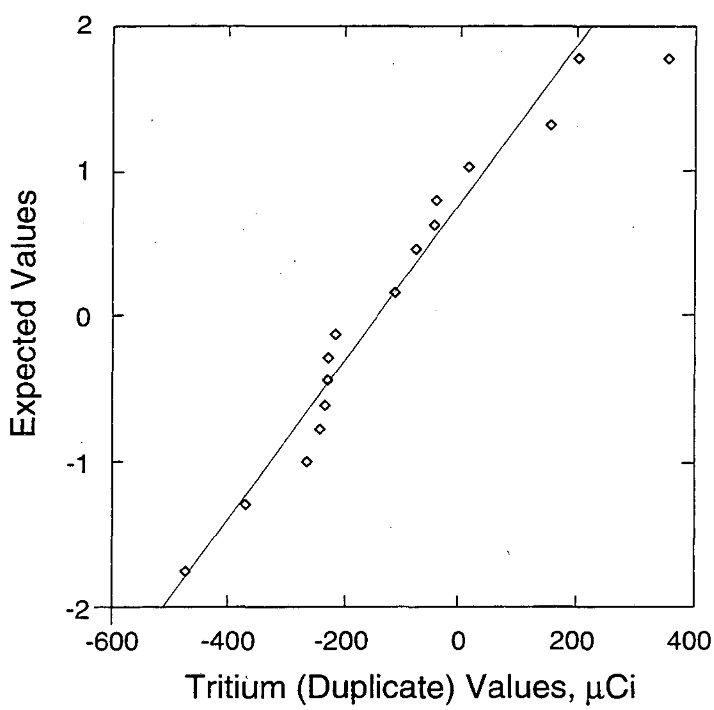


Figure 8-2. Expected Versus Observed Tritium Duplicate Values, Normal Distribution

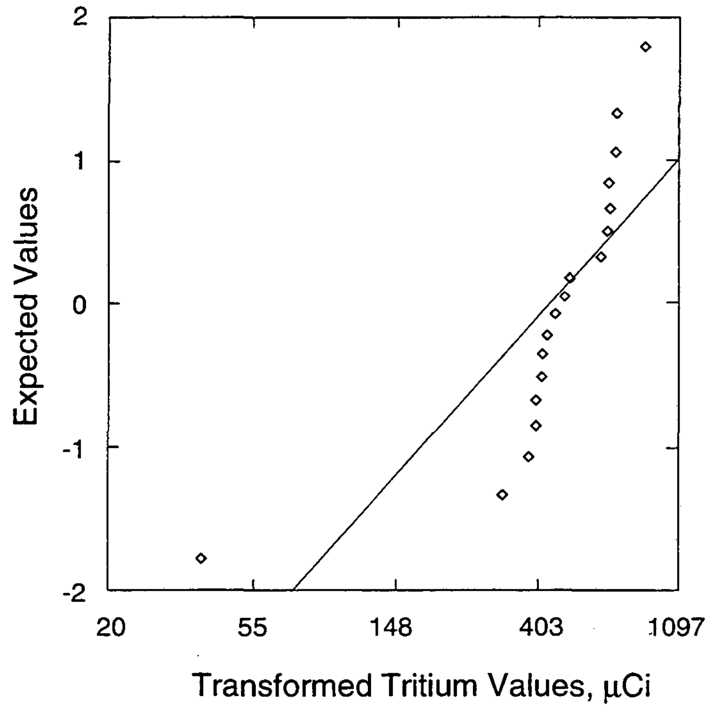


Figure 8-3. Expected Versus Observed Tritium Values, Log-Normal Distribution

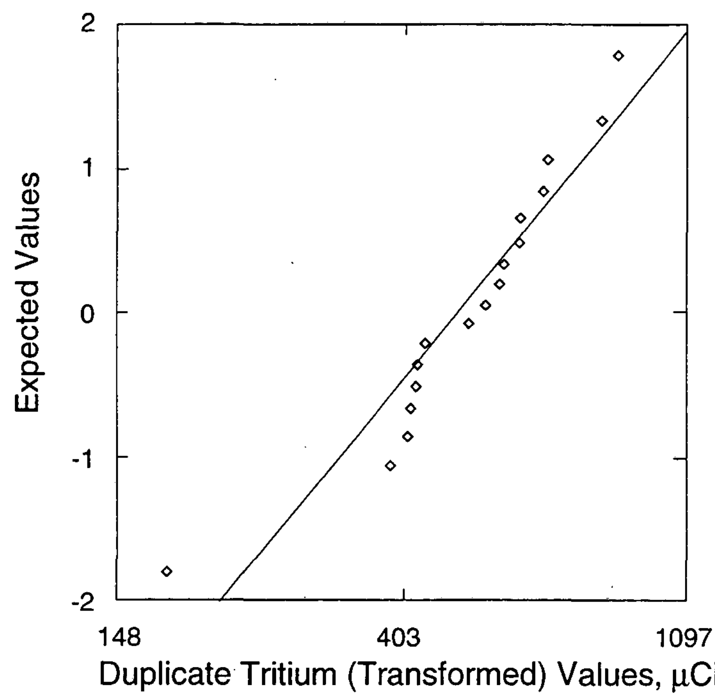


Figure 8-4. Expected Versus Observed Tritium Duplicate Values, Log-Normal Distribution

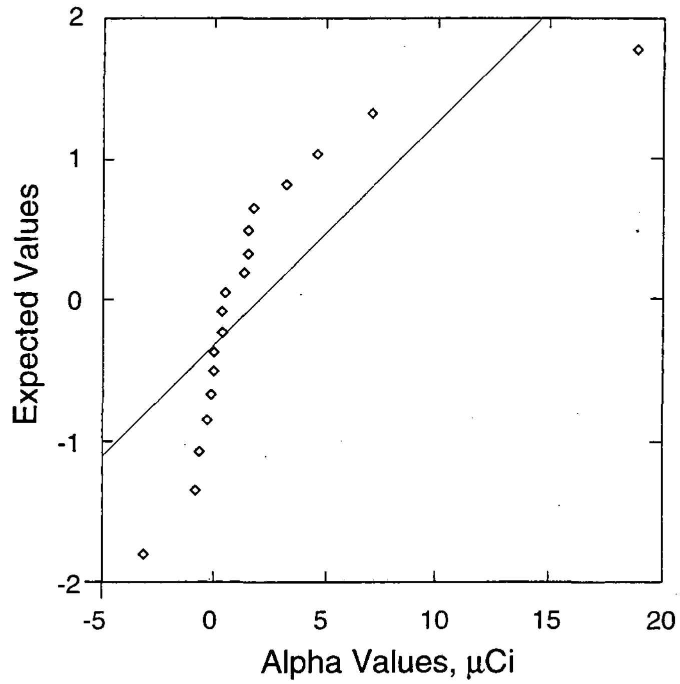


Figure 8-5. Expected Versus Observed Values, Alpha, Normal Distribution

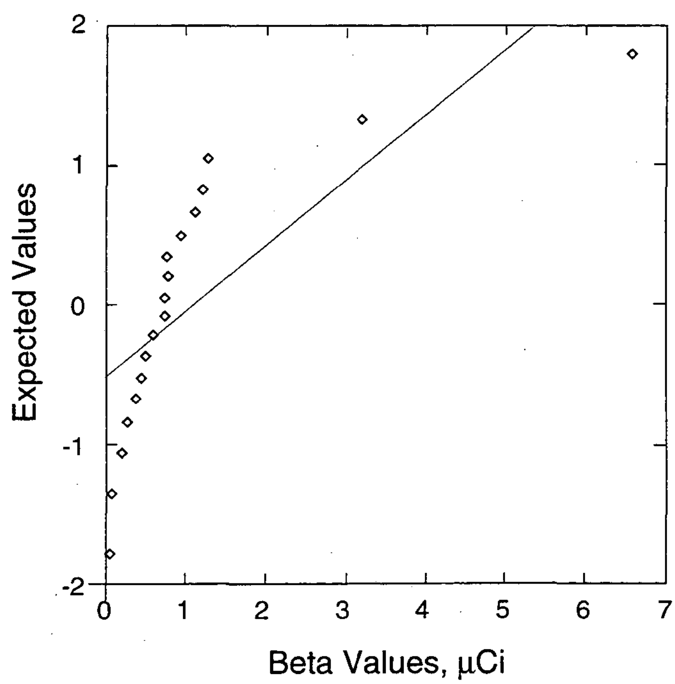


Figure 8-6. Expected Versus Observed Values, Beta, Normal Distribution

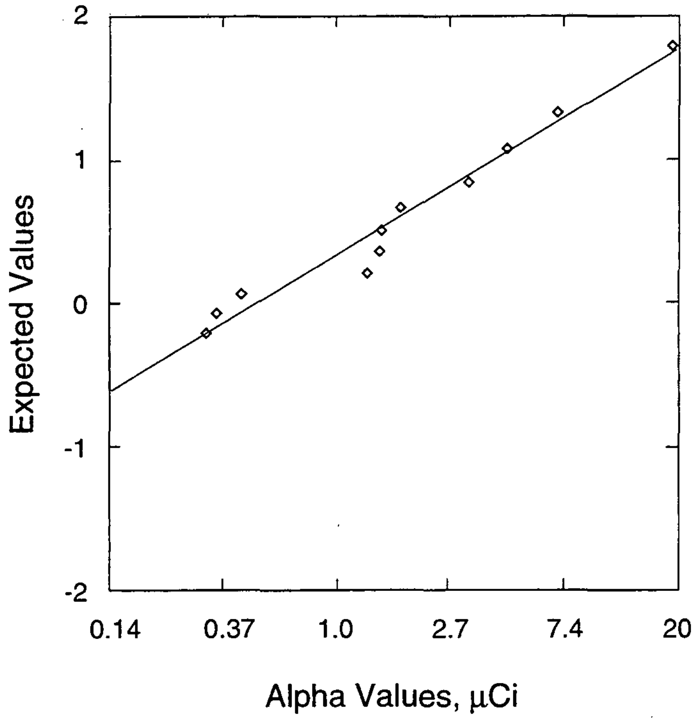


Figure 8-7. Expected Versus Observed Values, Alpha, Log-normal Distribution

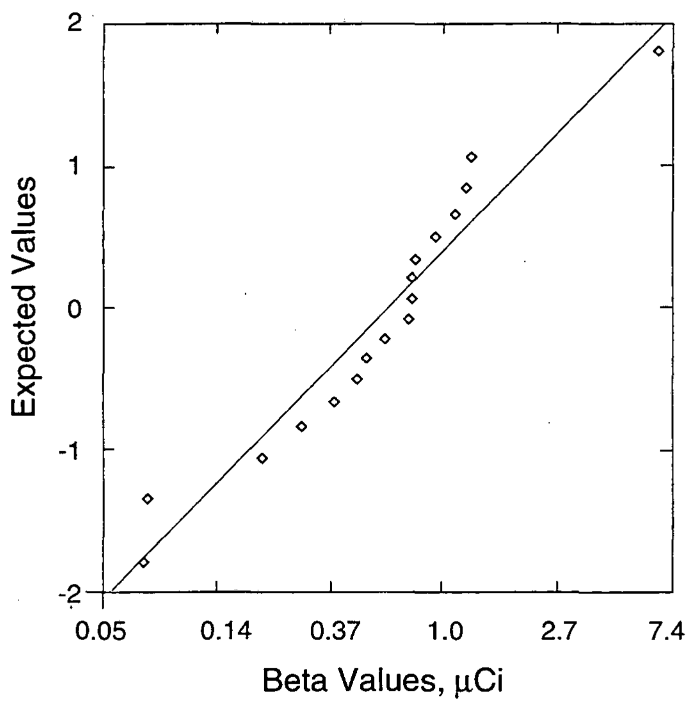


Figure 8-8. Expected Versus Observed Values, Beta, Log-normal Distribution

analytical data sets have a log-normal distribution.

Statistical Analysis

Data management procedures require performing a paired-sample t-test to determine if there are statistically significant differences between duplicate and routine samples whenever eight or more duplicate or routine data pairs exist. Table 8-2 summarizes the results of the paired-sample t-test applied to suites of aqueous tritium sample analyses. The statistical analysis tests the null hypothesis that there is no difference between sample and duplicate analyses against the alternate hypothesis that duplicate data differ statistically from the sample data. Accepting the null hypothesis at a 95% confidence level indicates that the error introduced by either sampling or analytical methods is at an acceptable level. The null hypothesis is accepted if the absolute value of the calculated t statistic is less than the predicted t statistic. This is a function of the number of samples taken and is derived from tables. All tritium sample analytical data sets are normally distributed, and the absolute value of their t statistic is always less than the predicted t statistic, or t critical two-tail. This means that the null hypothesis is accepted and that errors in sampling and analysis are acceptable at a 95% confidence level.

Table 8-3 summarizes the results of the two-tailed t-test applied to the log-normally distributed alpha and beta data sets. It should be noted that since a portion of the data set has negative values, in testing the log of the data a large positive linear transform is applied. This is allowable since, in the t-test, we are interested in the shape of the distribution and not the absolute value of the data. Again the absolute value of the calculated t statistic is always less than the t-critical two-tail value, indicating that the null hypothesis, that there is no difference between the routine and duplicate samples, may be accepted.

Environmental Restoration Group

The Environmental Restoration Group prepared a function notebook in 1993, which is designed to comply with LBL's institutional QA requirements.

QA requirements and procedures are further specified in the QAPP, dated July 1994, and

Table 8-2. Paired Tritium Data Statistical Testing

t-Test: Paired Two Sample for Means, Tritium

	1994 Creek samples, duplicates		1994 Creek samples, splits		1994 Deposition samples, duplicates		1994 Sanitary Sewer samples, duplicates	
	Tritium	Tritium dup	Tritium	Tritium split	Tritium	Tritium dup	Tritium	Tritium dup
Mean	-163.7	-141.4	-93.3	-75.5	-91.6	49.5	400.2	421.6
Variance	34420	29468	27848	36446	69215	401512	2331696	2415807
Observations	17	17	16	16	8	8	8	8
Pearson Correlation	0.763		0.692		0.979		0.999	
Hypothesized Mean Difference	0		0		0		0	
degrees of freedom	16		15		7		7	
t Stat	-0.743		-0.502		-1.050		-0.821	
P(T<=t) two-tail	0.468		0.623		0.328		0.439	
t Critical two-tail	2.120		2.131		2.365		2.365	

Table 8-3. Transformed Paired Alpha, Beta, and ^{125}I Sample Data, Statistical Testing

t-Test: Paired Two Sample for Means, alpha

	Transformed data*, Creek duplicates		Transformed data*, Creek splits		Transformed data*, Deposition duplicates		Sanitary Sewer duplicates	
	log Alpha	log Alpha duplicate	log Alpha	log Alpha split	log Alpha	log Alpha duplicate	log Alpha	log Alpha duplicate
Mean	0.685	0.677	0.752	0.690	0.689	0.690	0.646	0.681
Variance	0.083	0.056	0.022	0.031	0.011	0.006	0.017	0.007
Observations	18	18	16	16	8	8	8	8
Pearson Correlation	0.843		0.734		0.604		0.091	
Hypothesized Mean Difference	0.000		0.000		0.000		0.000	
degrees of freedom	17		15		7		7	
t Stat	0.220		2.032		-0.056		-0.672	
P(T<=t) two-tail	0.828		0.060		0.957		0.523	
t Critical two-tail	2.110		2.131		2.365		2.365	

t-Test: Paired Two Sample for Means, beta

	Transformed data*, Creek duplicates		Transformed data*, Creek splits		Transformed data*, Deposition duplicates		Sanitary Sewer duplicates	
	log Beta	log Beta duplicate	log Beta	log Beta split	log Beta	log Beta duplicate	log Beta	log Beta duplicate
Mean	0.695	0.709	0.736	0.721	0.733	0.739	0.937	0.948
Variance	0.010	0.012	0.021	0.017	0.018	0.015	0.038	0.038
Observations	18	18	16	16	8	8	8	8
Pearson Correlation	0.951		0.953		0.969		0.990	
Hypothesized Mean Difference	0.000		0.000		0.000		0.000	
degrees of freedom	17		15		7		7	
t Stat	-1.676		1.334		-0.521		-1.118	
P(T<=t) two-tail	0.112		0.202		0.619		0.301	
t Critical two-tail	2.110		2.131		2.365		2.365	

t-Test: Paired Two Sample for Means, 125I

	Transformed data*, Sanitary Sewer duplicates	
	log I125	log I125 duplicate
Mean	0.925	0.934
Variance	0.040	0.039
Observations	8	8
Pearson Correlation	0.961	
Hypothesized Mean Difference	0.000	
degrees of freedom	7	
t Stat	-0.456	
P(T<=t) two-tail	0.662	
t Critical two-tail	2.365	

*See text for details of data transformation

in updated ERG *Standard Operating Procedures*. The QAPP and the SOPs are applicable to all field and laboratory activities conducted in support of the ERG. QA requirements include definition and implementation of controls on accuracy, precision, completeness, comparability, and representativeness of sample data; and controls on data reduction and reporting.

The overall QA objective is to collect and analyze environmental samples in a manner that ensures that all technical data generated during site investigations withstand scientific scrutiny and are useful in planning environmental restoration activities at the LBL site. The revised QAPP describes the ERG organization and responsibilities, including an assigned Quality Assurance Manager (QAM). The QAM conducts general oversight of the ERG QA program and is responsible for conducting and documenting annual assessment audits to ensure that requirements of the QAPP are fulfilled. The QAM also documents compliance with pertinent DOE and LBL QA policies.

Sample collection, preservation, and custody activities are performed according to procedures specified in the QAPP and SOPs. All required sample analyses are completed by laboratories certified by the State of California Department of Health Services *Environmental Laboratory Accreditation Program.* Internal QC checks for field operations include the collection of equipment (rinse) blanks, trip blanks, and sample duplicates or replicates. Table 8-4 lists the number of QC samples that were collected during quarterly groundwater sampling in 1993.

Table 8-4. Quality Control Samples, Groundwater

Analysis	Number of Samples	Duplicate Samples	Equipment Blanks	Trip Blanks
Volatile Organic Compounds	455	29	26	38
8270 Semi-Volatile Organic Compounds	95	6	0	7
Title 22 Metals	113	7	0	0
Minerals	94	3	0	7
Total Petroleum Hydrocarbons	84	4	4	0
Oil and Grease	5	1	0	1
Radionuclides/Tritium	153	8	6	2

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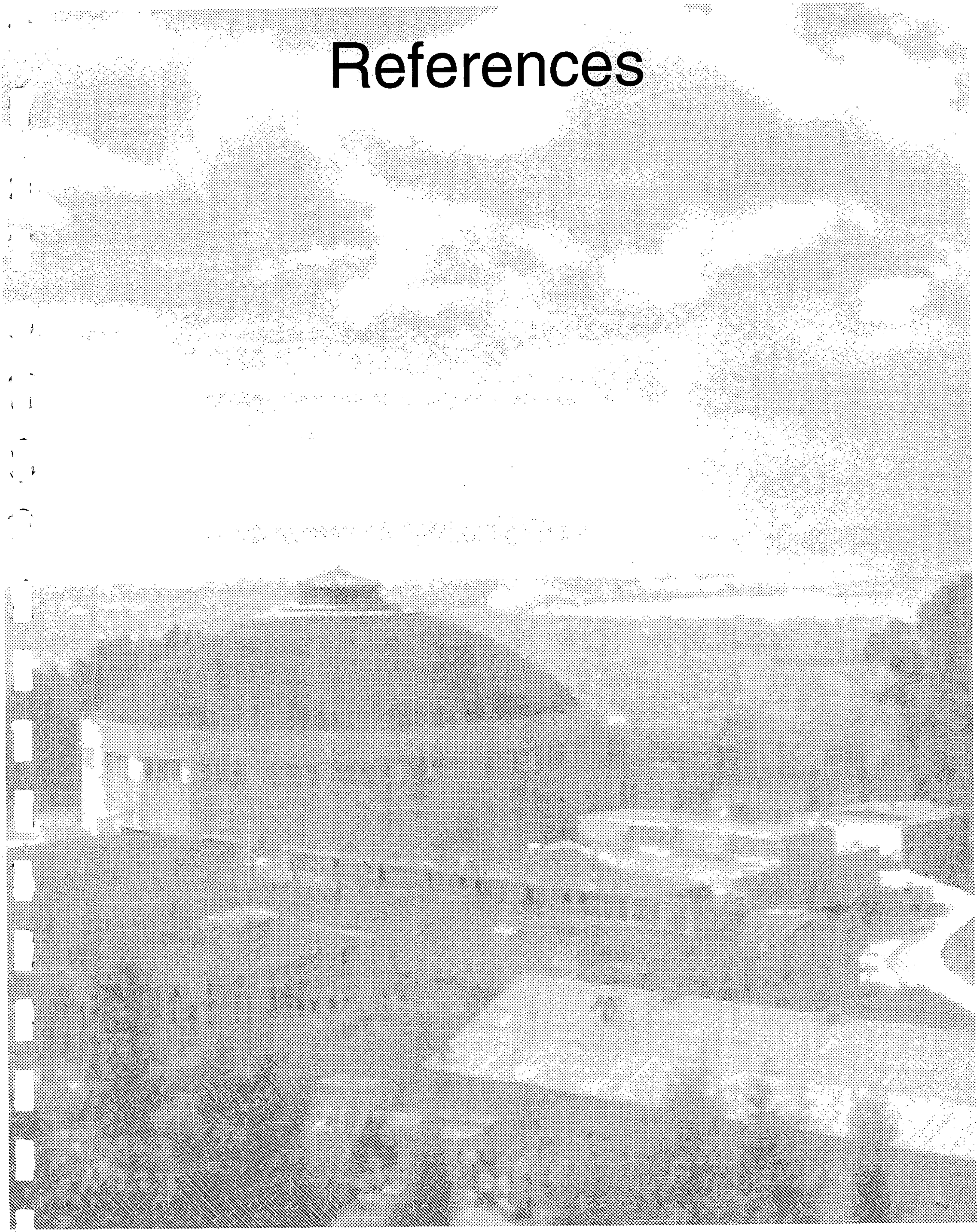

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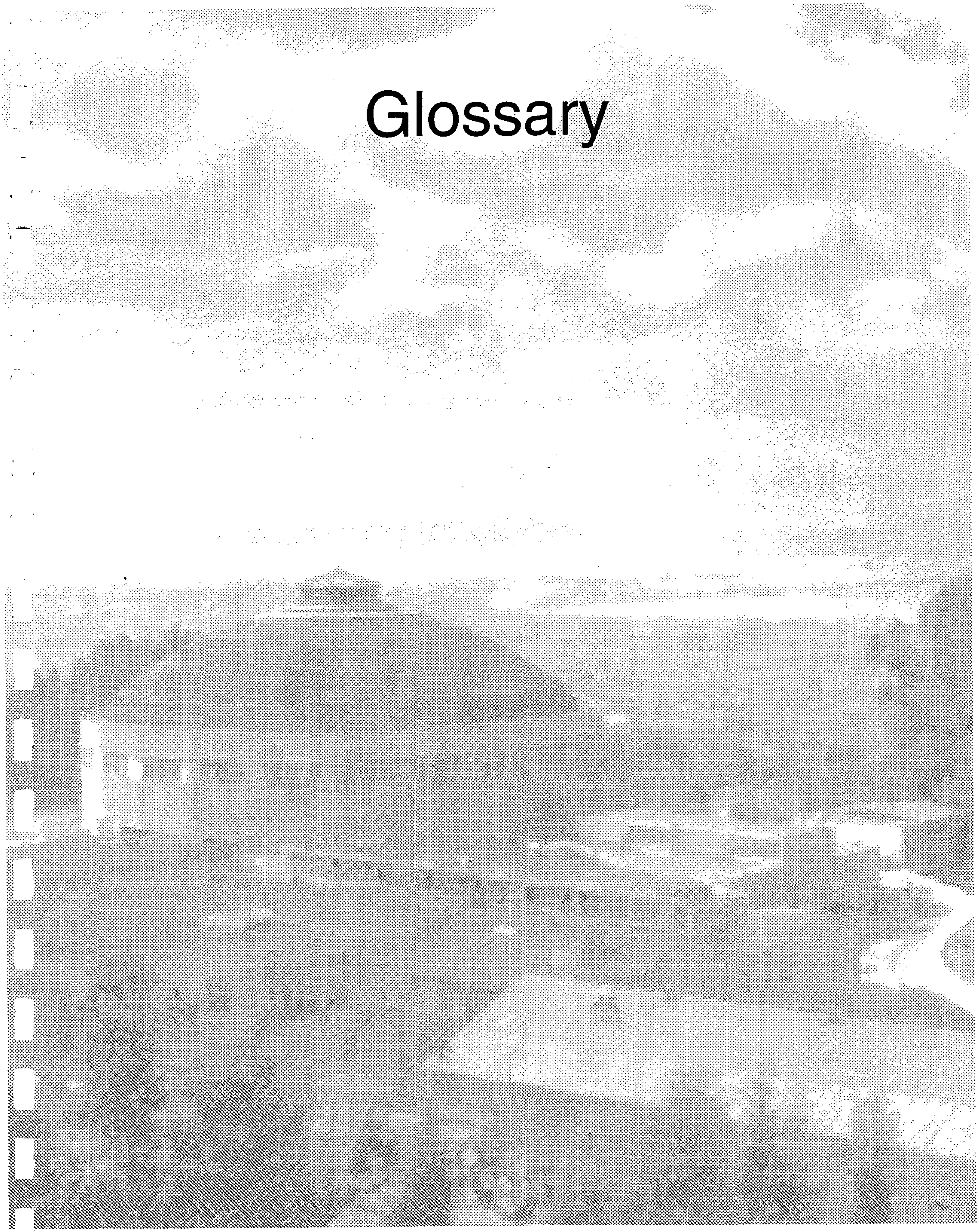
Glossary



Acronyms and Abbreviations

A	ampere
Å	angstrom
ADS	Activity Data Sheet
AIP	Agreement in Principle (DOE and California)
ALARA	as low as reasonably achievable
ALS	Advanced Light Source (LBL)
ANSI	American National Standards Institute
ASG	Analytical Services Group (LBL)
AST	Aboveground Storage Tank
BAAQMD	Bay Area Air Quality Management District
BAD	Bay Area Drum Company.
BMP	best management practice
Bq	becquerel
°C	degrees Celsius
CAA	Clean Air Act (federal)
Cal/EPA	California Environmental Protection Agency
CCR	California Code of Regulations
CED	Chemical Exchange Database
CEDE	collective effective dose equivalent
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeter

COB	City of Berkeley
CWA	Clean Water Act (federal)
CY	Calendar Year
DHS	Department of Health Services (California)
DOE	Department of Energy
DOE EH-13	Department of Energy, Office of Nuclear Science
DOE EH-24	Department of Energy, Office of Environmental Audit
DOE/BSO	Department of Energy/Berkeley Site Office
DOE/HQ	Department of Energy, Headquarters Office
DOE/OAK	Department of Energy/Oakland Operations Office
DOT	Department of Transportation (federal)
DQO	Data quality objectives
DTSC	Department of Toxic Substances Control (California)
EA	Environmental Assessment
EBMUD	East Bay Municipal Utility District
EDE	effective dose equivalent
EH&S	Environment, Health, and Safety
EIR	Environmental Impact Report
EM	Environmental Management
EMP	Environmental Monitoring Plan
EMS	Environmental Monitoring Stations
EMU	Environmental Monitoring Unit (LBL)
EPCRA	Emergency Planning and Community Right-to-Know Act
EPG	Environmental Protection Group (LBL)

ERG	Environmental Restoration Group (LBL)
ERWM	Environmental Restoration and Waste Management (DOE)
ES&H	Environment, Safety, and Health
ESA	Endangered Species Act
∞F	degrees Fahrenheit
FFCA	Federal Facilities Compliance Agreement
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FONSI	Finding of No Significant Impact
ft	foot or feet
FTU	Fixed Treatment Unit
FY	Fiscal Year
gsf	gross square feet
gsm	gross square meters
HCFC	hydrochlorofluorocarbon
HGL	Human Genome Laboratory (LBL)
HMMU	Hazardous Materials Management Unit (LBL)
HTO	Tritium Oxide (Tritiated Water)
HWHF	Hazardous Waste Handling Facility (LBL)
IH	Industrial Hygiene
in	inch
JHQ	Job Hazards Questionnaire (LBL)
km	kilometer
L	liter
LBL	Lawrence Berkeley Laboratory

LLNL	Lawrence Livermore National Laboratory
LLW	Low-Level Waste
m	meter
M&O	Maintenance and Operations (LBL)
MDA	Minimum detectable activity
Mgsf	million gross square feet
MEI	Maximally Exposed Individual
mL	milliliter
mrem	millirem
MSDS	Material Safety Data Sheet
mSv	millisievert
NAE	North American Environmental, Inc.
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
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NTLF	National Tritium Labeling Facility (LBL)
OAA	Office of Assessment and Assurance (LBL)
OAP	Operating and Assurance Program
ODS	ozone-depleting substance
OMB	Office of Management and Budget (federal)

pCi	picocurie (one billionth)
PCB	polychlorinated biphenyl
PM	Performance Measure
POTW	Publicly Owned Treatment Works
ppm	parts per million
PPOA	Pollution Prevention Opportunity Assessment
PRP	Potentially Responsible Party
PWA	Process Waste Assessment
QA	Quality Assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RMPP	Risk Management and Prevention Program
RMW	Radioactive Mixed Waste
RWQCB	Regional Water Quality Control Board
SAA	Satellite Accumulation Area
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SI	Systéme Internationale or International System of Units (the metric system)
SIC	Standard Industrial Code
SNAP	Significant New Alternatives Policy (US/EPA)
SODAR	Sonic Detection and Ranging

SOP	Standard Operating Procedure
Sv	sievert
SWMP	Storm Water Monitoring Program
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TBq	terabecquerel (one trillion)
TCE	trichloroethylene
TICH	Total Identifiable Chlorinated Hydrocarbons
TLD	Thermoluminescent Dosimeter
TOC	Total Organic Carbon
TRI	Toxic Release Inventory
TRS	Tritiation and Recovery System
TSCA	Toxic Substance Control Act
TTO	Total Toxic Organics
UC	University of California
UCB	University of California at Berkeley
UCOP	University of California Office of the President
UHVCF	Ultra-High Vacuum Cleaning Facility
US/EPA	U.S. Environmental Protection Agency
UST	Underground Storage Tank
VOC	volatile organic compound
WAA	Waste Accumulation Area
WM	Waste Management Group (LBL)

Common Radionuclide Elements and Corresponding Symbols

Actinium	Ac	Germanium	Ge	Promethium	Pm
Aluminum	Al	Gold	Au	Protactinium	Pa
Americium	Am	Hafnium	Hf	Radium	Ra
Antimony	Sb	Holmium	Ho	Radon	Rn
Argon	Ar	Hydrogen	H	Rhenium	Re
Arsenic	As	Indium	In	Rhodium	Rh
Astatine	At	Iodine	I	Rubidium	Rb
Barium	Ba	Iridium	Ir	Ruthenium	Ru
Berkelium	Bk	Iron	Fe	Samarium	Sm
Beryllium	Be	Lanthanum	La	Scandium	Sc
Bismuth	Bi	Lead	Pb	Selenium	Se
Bromine	Br	Lutetium	Lu	Silicon	Si
Cadmium	Cd	Magnesium	Mg	Silver	Ag
Calcium	Ca	Manganese	Mn	Sodium	Na
Californium	Cf	Mendelevium	Md	Strontium	Sr
Carbon	C	Mercury	Hg	Sulfur	S
Cerium	Ce	Molybdenum	Mo	Tantalum	Ta
Cesium	Cs	Neodymium	Nd	Technetium	Tc
Chlorine	Cl	Neptunium	Np	Tellurium	Te
Chromium	Cr	Nickel	Ni	Terbium	Te
Cobalt	Co	Niobium	Nb	Thallium	Tl
Copper	Cu	Nitrogen	N	Thorium	Th
Curium	Cm	Osmium	Os	Thulium	Tm
Dysprosium	Dy	Oxygen	O	Tin	Sn
Einsteinium	Es	Palladium	Pd	Titanium	Ti
Erbium	Eu	Phosphorus	P	Tungsten	W
Fermium	Fm	Platinum	Pt	Uranium	U
Fluorine	F	Plutonium	Pu	Vanadium	V
Francium	Fr	Polonium	Po	Ytterbium	Yb
Gadolinium	Gd	Potassium	K	Yttrium	Y
Gallium	Ga	Praesodymium	Pr	Zinc	Zn

Technical Terms

accuracy — The closeness of the result of a measurement to the true value of the quantity measured.

air particulates — Airborne particles that include dust, dirt, and other pollutants that occur as particles, and any pollutants that may be associated with or carried on the dust or dirt.

aliquot — An exact fractional portion of a sample taken for analysis.

Angstrom — A unit of length equal to one ten-billionth (0.0000000001 or 1×10^{-10}) of a meter.

alpha particle — A charged particle, identical to the helium nucleus, comprising two protons and two neutrons that are emitted during decay of certain radioactive atoms. Alpha particles are stopped by several centimeters of air or a sheet of paper.

ambient air — The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. It does not include the air next to emission sources.

aquifer — A saturated layer of rock or soil below the ground surface that can supply usable quantities of ground water to wells and springs. Aquifers can be a source of water for domestic, agricultural, and industrial uses.

background radiation — Ionizing radiation from sources other than LBL. Background may include cosmic radiation; external radiation from naturally occurring radioactivity in the earth (terrestrial radiation), air, and water; internal radiation from naturally occurring radioactive elements in the human body; and radiation from medical diagnostic procedures.

becquerel (Bq) — Unit of radioactive decay equal to one disintegration per second (SI unit).

beta particle — A charged particle, identical to the electron, that is emitted during decay of certain radioactive atoms. Most beta particles are stopped by less than 0.6 centimeters of aluminum.

categorical process	An industrial process governed by federal regulation(s) of wastewater discharges.
collective effective dose equivalent	The sum of the effective dose equivalents of all individuals in an exposed population within a certain radius, usually 80 kilometers for NESHAPs compliance. This value is expressed in units of person-sievert (SI) or person-rem (conventional).
contaminant	Any hazardous or radioactive material present in an environmental medium, such as air, water, or vegetation.
controlled area	Any Laboratory area to which access is controlled to protect individuals from exposure to radiation and radioactive materials.
cosmic radiation	High-energy particulate and electromagnetic radiation that originates outside the earth's atmosphere. Cosmic radiation is part of the natural background radiation.
discharge	A release of a liquid into an area not controlled by LBL.
dose	The quantity of radiation energy absorbed during a given period of time.
dose, absorbed	The energy imparted to matter by ionizing radiation per unit mass of irradiated material. The unit of absorbed dose is the gray (SI) or rad (conventional).
dose, effective	The hypothetical whole-body dose that would give the same risk of cancer mortality and/or serious genetic disorder as a given exposure and that may be limited to just a few organs. The effective dose equivalent is equal to the sum of individual organ doses, each weighted by degree of risk that the organ dose carries. For example, a 1-millisievert dose to the lung, which has a weighting factor of 0.12, gives an effective dose that is equivalent to 0.12 millisievert (1 x 0.12).
dose, equivalent	A term used in radiation protection that expresses all types of radiation (alpha, beta, and so on) on a common scale for calculating the effective absorbed dose. It is the product of the absorbed dose and certain modifying factors. The unit of dose equivalent is the sievert (SI) or rem (conventional).

dose, maximum boundary	The greatest dose commitment, considering all potential routes of exposure, from a facility's operation to a hypothetical individual who is in an uncontrolled area where the highest dose rate occurs. It assumes that the hypothetical individual is present 100% of the time (full occupancy), and it does not take into account shielding by obstacles such as buildings or hillsides.
dose, maximum individual	The greatest dose commitment, considering all potential routes of exposure, from a facility's operation to an individual at or outside the LBL boundary where the highest dose rate occurs. It takes into account shielding and occupancy factors that would apply to a real individual.
dose, population	The sum of the radiation doses to individuals of a population. It is expressed in units of person-sievert (SI) or person-rem (conventional). For example, if 1000 people each received a radiation dose of 1 sievert, their population dose would be 1000 person-sievert.
dosimeter	A portable detection device for measuring the total accumulated exposure to ionizing radiation. See also thermoluminescent dosimeter.
downgradient	Commonly used to describe the flow of groundwater from higher to lower concentration. The term is analogous to downstream.
effective dose equivalent	Abbreviated EDE, it is the sum of the products of the dose equivalent received by specified tissues of the body and a tissue-specific weighting factor. This sum is a risk-equivalent value and can be used to estimate the health risk of the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The EDE includes the committed EDE from internal deposition of radionuclides and the EDE due to penetrating radiation from sources external to the body. EDE is expressed in units of sievert (SI) or rem (conventional).
effluent	A liquid waste discharged to the environment.

emission	A release of air to the environment containing gaseous or particulate matter having one or more contaminants.
environmental remediation	The process of restoring a contaminated area to a non-contaminated or safe condition.
exposure	A measure of the ionization produced in air by X-ray or gamma radiation. The unit of exposure is the coulomb per kilogram (SI) or roentgen (conventional).
external radiation	Radiation originating from a source outside the body.
extractable pollutants	Pollutants that can be removed from a contaminated sample by passing water through the sample.
gamma radiation	Short-wavelength electromagnetic radiation of nuclear origin that has no mass or charge. Because of its short wavelength (high energy), gamma radiation can cause ionization. Other electromagnetic radiation, such as microwaves, visible light, and radio waves, have longer wavelengths (lower energy) and cannot cause ionization.
groundwater	A subsurface body of water in a zone of saturated soil sediments.
half-life, radioactive	The time required for the activity of a radioactive substance to decrease to half its value by inherent radioactive decay. After two half-lives, one-fourth of the original activity remains (1/2 x 1/2); after three half-lives, one-eighth (1/2 x 1/2 x 1/2); and so on.
hazardous waste	Waste exhibiting any of the following characteristics: ignitability, corrosivity, reactivity, or EP-toxicity (yielding toxic constituents in a leaching test). Because of its concentration, quantity, physical, or chemical characteristics, it may: 1) cause or significantly contribute to an increase in mortality rates or cases of serious irreversible illness; or 2) pose a substantial present or potential threat to human health or the environment when improperly treated, stored, transported, disposed of, or handled.

internal radiation	Radiation from a source within the body as a result of deposition of radionuclides in body tissues by processes such as ingestion, inhalation, or implantation. Potassium (^{40}K), a naturally occurring radionuclide, is a major source of internal radiation in living organisms.
nonattainment area	An area that does not meet the National Ambient Air Quality Standards.
nuclide	A species of atom characterized by what constitutes the nucleus, which is specified by the number of protons, number of neutrons, and energy content; or, alternatively, by the atomic number, mass number, and atomic mass. To be regarded as a distinct nuclide, the atom must be able to exist for a measurable length of time.
organic compound	A chemical whose primary constituents are carbon and hydrogen.
Part B permit	The second, narrative section submitted by generators in the RCRA permitting process. It details the procedures followed at a facility to protect human health and the environment.
pH	A measure of hydrogen ion concentration in an aqueous solution. Acidic solutions have a pH less than 7, basic solutions have a pH greater than 7, and neutral solutions have a pH of 7.
piezometer	Generally, a small-diameter, nonpumping well used to measure the elevation of the water table or potentiometric surface. The water table is an imaginary surface that represents the static head of groundwater and is defined by the level to which water will rise.
pollutant	Any hazardous or radioactive material present in an environmental medium, such as air, water, or vegetation.
pretreatment	Any process used to reduce a pollutant load before wastewater enters the sewer system.

pretreatment regulations	National wastewater pretreatment regulations (40 CFR 403) adopted by the EPA in compliance with the 1977 amendments to the Clean Water Act, which required that the EPA establish pretreatment standards for existing and new industrial sources.
priority pollutants	A set of organic and inorganic chemicals identified by the EPA as indicators of environmental contamination
purgeable pollutants	Pollutants that can be removed from a sample by passing nitrogen gas through the sample.
radiation protection standard	Limits on radiation exposure regarded as necessary for protection of public health. These standards are derived based on acceptable levels of risk to individuals.
radiation	Energy emitted from the nucleus of an atom in the form of waves or particles.
radioactivity	The property or characteristic of a nucleus of an atom to spontaneously disintegrate accompanied by the emission of energy in the form of radiation.
radiological	Arising from radiation or radioactive materials.
radionuclide	An unstable nuclide. See nuclide and radioactivity.
recharge zone	An area of the ground in which surface water migrates to the groundwater.
remediation	See environmental remediation.
scintillation cocktail	A solution of organic compounds that emits light upon interacting with radiation. For the purposes of this report, it is used primarily for the analysis of tritium.
source	Any operation or equipment that produces, discharges, and/or emits pollutants (e.g., pipe, ditch, well, or stack).
terrestrial	Pertaining to or deriving from the earth.
terrestrial radiation	Radiation emitted by naturally occurring radionuclides, such as ^{40}K; the natural decay chains ^{235}U, ^{233}U, or ^{232}Th; or cosmic-ray induced radionuclides in the soil.

thermoluminescent dosimeter (TLD) A type of dosimeter. After being exposed to radiation, the material in the dosimeter (lithium fluoride) luminesces upon being heated. The amount of light the material emits is proportional to the amount of radiation (dose) to which it was exposed. See also dosimeter.

tritium — A radionuclide of hydrogen with a half-life of 12.3 years. The very low energy of its radioactivity decay makes it one of the least hazardous radionuclides.

uncontrolled area — An area beyond the boundaries of a controlled area. See controlled area.

upgradient — Opposite of the direction of groundwater flow from a designated area of interest. Analogous to upstream.

uranium — A metallic element that is highly toxic and radioactive.

uranium, depleted — Uranium consisting primarily of ^{238}U and having less than 0.72 wt% ^{235}U. Except in rare cases occurring in nature, depleted uranium is man-made.

uranium, total — The amount of uranium in a sample, assuming that the uranium has the isotopic content of uranium in nature (99.27 wt% ^{238}U, 0.72 wt% ^{235}U, and 0.0057 wt% ^{234}U)

vadose zone — The partially saturated or unsaturated region of the ground above the water table that does not yield water to wells.

wind rose — A diagram that shows the frequency and intensity of wind from different directions at a particular place.

Radiological Units

becquerel (Bq) — Unit of radioactive decay equal to one disintegration per second. (SI unit)

curie (Ci) — Unit of radioactive decay equal to 2.22 x 10^{12} disintegrations per minute. (conventional units)

mrem — millirem (10^{-3} rem). See rem.

person-rem — The unit of population dose, which expresses the sum of radiation exposures received by a population. For example, two persons, each with a 0.5-rem exposure, receive 1 person-rem, and 500 people, each with an exposure of 0.002 rem, also receive 1 person-rem.

rad — A unit of absorbed dose from ionizing radiation (0.877 rad/R).

rem — Stands for roentgen equivalent man; a unit of ionizing radiation, equal to the amount of radiation needed to produce the same biological effect to humans as 1 rad of high-voltage x-rays. It is the product of the absorbed dose (rad), quality factor (Q), distribution factor, and other necessary modifying factors. It describes the effectiveness of various types of radiation in producing biological effects.

roentgen (R) — A unit of radiation exposure that expresses exposure in terms of the amount of ionization produced by x or gamma rays in a volume of air. One roentgen (R) is 2.58 x 10^4 coulombs per kilogram of air.

sievert (Sv) — A unit of radiation dose equivalent. The sievert is the SI unit equivalent to the rem. It is the product of the absorbed dose (gray), quality factor (Q), distribution factor, and other necessary modifying factors. It describes the effectiveness of various types of radiation to produce biological effects; 1 Sv = Gy x Q x N = 100 rem.

Units of Measure

Throughout this report, an attempt has been made to reference the International System of Units (SI) or metric system of measurements, where ever possible. Radiological quantities (activity—curies (Ci), exposure—roentgen (R), and dose—rad and rem) have also been reported in U.S. conventional units because current standards are written in terms of these units. The equivalent SI units are the becquerel (Bq), coulomb per kilogram (C/kg), gray (Gy), and sievert (Sv), respectively.

Table GLS-1 presents prefixes used with SI units of measurement. Table GLS-2 presents conversion factors for converting from SI units to U.S. conventional units.

Table GLS-1. Prefixes Used with SI (Metric) Units

Prefix	Factor	Symbol
exa	1,000,000,000,000,000,000 = 10^{18}	E
peta	1,000,000,000,000,000 = 10^{15}	P
tera	1,000,000,000,000 = 10^{12}	T
giga	1,000,000,000 = 10^{9}	G
mega	1,000,000 = 10^{6}	M
kilo	1,000 = 10^{3}	k
hecto	100 = 10^{2}	h[A]
deka	10 = 10^{1}	da[A]
deci	0.1 = 10^{-1}	d[A]
centi	0.01 = 10^{-2}	c[A]
milli	0.001 = 10^{-3}	m
micro	0.000001 = 10^{-6}	µ
nano	0.000000001 = 10^{-9}	n
pico	0.000000000001 = 10^{-12}	p
femto	0.000000000000001 = 10^{-15}	f
atto	0.000000000000000001 = 10^{-18}	a

[A]Avoid where practical

Table GLS-2. Conversion Factors for Selected Sl (Metric) Units

To Convert SI Unit	to U.S. Conventional Unit	Multiply By
Area		
square centimeters	square inches	0.155
square meters	square feet	10.764
square kilometers	square miles	0.3861
hectares	acres	2.471
Concentration		
micrograms per gram	parts per million	1
milligrams per liter	parts per million	1
Length		

centimeters	inches	0.3937
meters	feet	3.281
kilometers	miles	0.6214
Mass		
grams	ounces	0.03527
kilograms	pounds	2.2046
kilograms	ton	0.00110
Pressure		
pounds per square foot	pascal	0.000145
Radiation		
becquerel	curie	2.7×10^{11}
gray	rad	100
sievert	rem	100
coulomb per kilogram	roentgen	3876
Temperature		
degrees Celsius	degrees Fahrenheit	1.8, then add 32
Velocity		
meters per second	miles per hour	2.237
Volume		
cubic meters	cubic feet	35.315
liters	gallons	0.2642

Appendix A - Data Tables

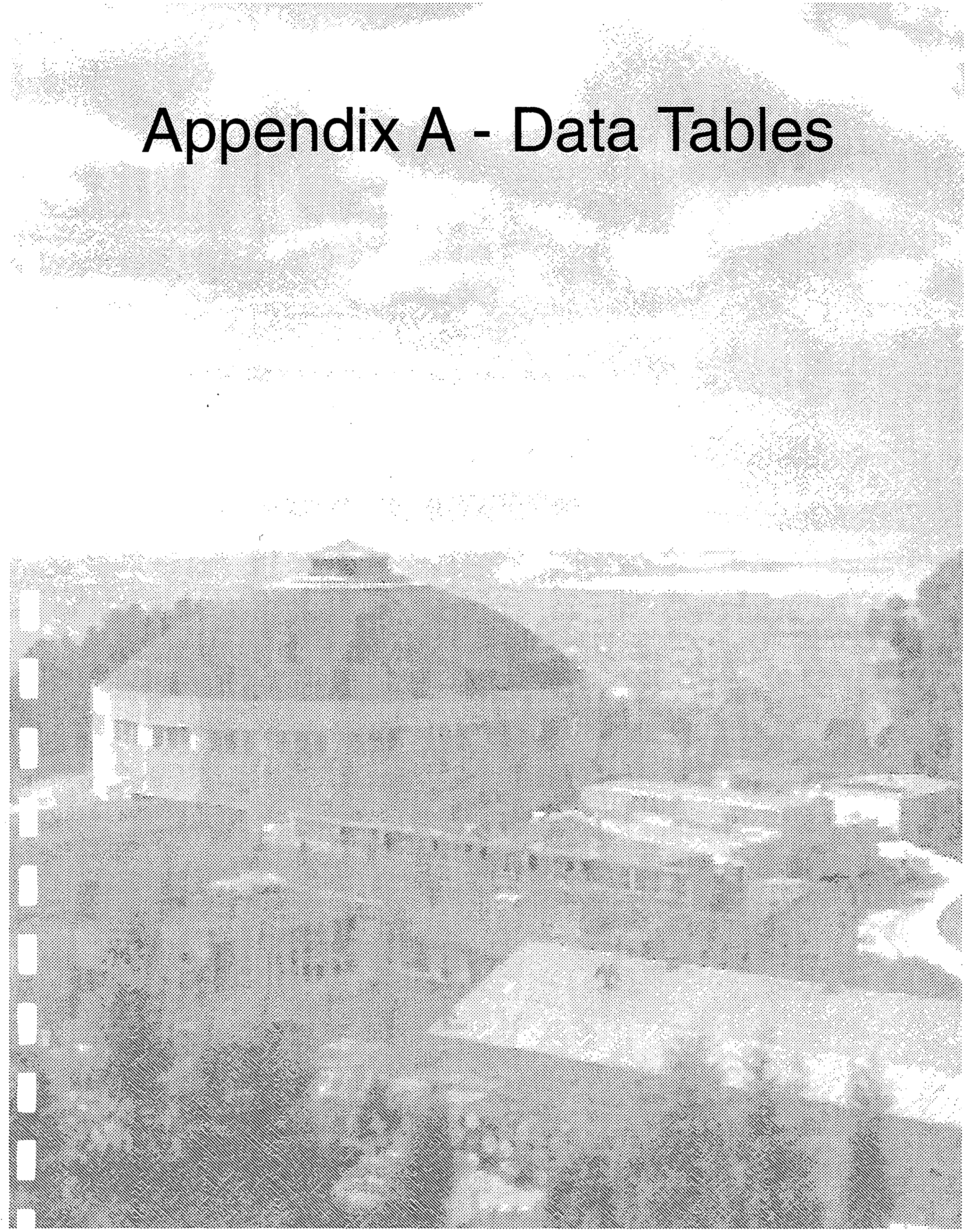


Table A-1. Stormwater Sampling Summary

Location	Parameter	Average	Maximum	Minimum	Std. Dev.	Sample Size	Basin Plan Limit	% of Basin Plan Limit
STW2	Toxic Organics, µg/L	22	—	—	N/A	1	—	—
	Cyanide, mg/L	0	—	—	N/A	3	—	—
	PCB's, mg/L	0	—	—	N/A	1	—	—
	pH, S.U.	7.2	—	—	N/A	1	—	—
	TPH-Diesel, mg/L	3300	—	—	N/A	1	—	—
	TPH-Gasoline, mg/L	0	—	—	N/A	1	—	—
	Oil & Grease, mg/L	3	—	—	N/A	1	—	—
	Total Susp. Solids, mg/L	95.3	229	13	117	3	—	—
	Antimony, mg/L	0	0	0	0	6	None	—
	Arsenic, mg/L	0.0028	0.004	0	0.0016	6	0.005 mg/L	56.7
	Barium, mg/L	0.02	0.12	0	0.049	6	None	—
	Beryllium, mg/L	0	0	0	0	5	None	—
	Cadmium, mg/L	0	0	0	0	6	0.01 mg/L	0
	Chromium, mg/L	0.162	0.033	0	0.0107	6	0.05 mg/L	32.3
	Cobalt, mg/L	0.0037	0.022	0	0.00898	6	None	—
	Copper, mg/L	0.028	0.056	0.015	0.16	6	1 mg/L	2.82
	Lead, mg/L	0.0155	0.038	0	0.126	6	0.05 mg/L	31
	Mercury, mg/L	0.0007	0.0042	0	0.00171	6	0.0001 mg/L	700
	Molybdenum, mg/L	0	0	0	0	6	None	—
	Nickel, mg/L	0	0	0	0	6	0.6 mg/L	0
	Selenium, mg/L	0	0	0	0	6	0.1 mg/L	0
	Silver, mg/L	0	0	0	0	6	0.05 mg/L	0
	Thallium, mg/L	0	0	0	0	6	None	—
	Vanadium, mg/L	0	0	0	0	6	None	—
	Zinc, mg/L	0.134	0.26	0	0.0945	6	5 mg/L	2.7
STW3	Toxic Organics, µg/L	0	—	—	N/A	1	—	—
	Cyanide, mg/L	0	0	0	0	2	—	—
	PCB's, mg/L	0	—	—	N/A	1	—	—
	pH, S.U.	7.7	—	—	N/A	1	—	—
	TPH-Diesel, mg/L	0	—	—	N/A	1	—	—
	TPH-Gasoline, mg/L	0	—	—	N/A	1	—	—
	Oil & Grease, mg/L	4	—	—	N/A	1	—	—
	Total Susp. Solids, mg/L	82.25	132	32.5	70.4	2	—	—
	Antimony, mg/L	0	0	0	0	6	None	—
	Arsenic, mg/L	0.0022	0.01	0	0.00402	6	0.005 mg/L	43.3
	Barium, mg/L	0.067	0.4	0	0.163	6	None	—
	Beryllium, mg/L	0	0	0	0	6	None	—
	Cadmium, mg/L	0.0012	0	0	0.00286	6	0.01 mg/L	11.7
	Chromium, mg/L	0.0098	0.022	0	0.00854	6	0.05 mg/L	19.7
	Cobalt, mg/L	0.0183	0.11	0	0.0449	6	None	—
	Copper, mg/L	0.1082	0.45	0.03	0.1677	6	1 mg/L	10.82
	Lead, mg/L	0.20533	0.866	0.032	0.3293	6	0.05 mg/L	411
	Mercury, mg/L	0.0015	0.009	0	0.00367	6	0.0001 mg/L	1500
	Molybdenum, mg/L	0	0	0	0	6	None	—
	Nickel, mg/L	0.01617	0.097	0	0.0396	6	0.6 mg/L	2.69
	Selenium, mg/L	0.00167	0.005	0	0.00207	6	0.1 mg/L	16.67
	Silver, mg/L	0	0	0	0	6	0.05 mg/L	0
	Thallium, mg/L	0	0	0	0	6	None	—
	Vanadium, mg/L	0.02	0.12	0	0.049	6	None	—
	Zinc, mg/L	0.5783	2.5	0.12	0.951	6	5 mg/L	11.6

Table A-1. Stormwater Sampling Summary (Continued)

Location	Parameter	Average	Maximum	Minimum	Std. Dev.	Sample Size	Basin Plan Limit	% of Basin Plan Limit
STW4	Toxic Organics, µg/L	0	—	—	N/A		—	—
	Cyanide, mg/L	0	0	0	0	4	—	—
	PCB's, mg/L	0	—	—	N/A	1	—	—
	pH, S.U.	6.7	—	—	N/A	1	—	—
	TPH-Diesel, mg/L	0	—	—	N/A	1	—	—
	TPH-Gasoline, mg/L	0	—	—	N/A	1	—	—
	Oil & Grease, mg/L	3	—	—	N/A	1	—	—
	Total Susp. Solids, mg/L	293	821	101	352.6	4	—	—
	Antimony, mg/L	0	0	0	0	6	None	—
	Arsenic, mg/L	0.00567	0.01	0	0.00362	6	0.005 mg/L	113.3
	Barium, mg/L	0.065	0.27	0	0.1113	6	None	—
	Beryllium, mg/L	0	0	0	0	6	None	—
	Cadmium, mg/L	0.00117	0	0	0.00286	6	0.01 mg/L	11.7
	Chromium, mg/L	0.0248	0.052	0	0.0189	6	0.05 mg/L	49.7
	Cobalt, mg/L	0.01717	0.093	0	0.0374	6	None	—
	Copper, mg/L	0.0545	0.12	0	0.0405	6	1 mg/L	5.4
	Lead, mg/L	0.0283	0.038	0	0.0144	6	0.05 mg/L	56.7
	Mercury, mg/L	0.00022	0.0007	0	0.000286	5	0.0001 mg/L	220
	Molybdenum, mg/L	0	0	0	0	6	None	—
	Nickel, mg/L	0.0235	0.088	0	0.038	6	0.6 mg/L	3.92
	Selenium, mg/L	0.00033	0.002	0	0.000816	6	0.1 mg/L	3.3
	Silver, mg/L	0	0	0	0	6	0.05 mg/L	0
	Thallium, mg/L	0	0	0	0	6	None	—
	Vanadium, mg/L	0.172	0.053	0	0.0266	6	None	—
	Zinc, mg/L	0.3743	1.1	0	0.3949	6	5 mg/L	7.5
STW5	Aquatic Tox., 96 Hr., % Survival	100	—	—	N/A	1	—	—
STW6	Aquatic Tox., 96 Hr., % Survival	100	—	—	N/A	1	—	—
STW9	Aquatic Tox., 96 Hr., % Survival	100	—	—	N/A	1	—	—
STW12	Aquatic Tox., 96 Hr., % Survival	100	—	—	N/A	1	—	—
STW15	Aquatic Tox., 96 Hr., % Survival	100	—	—	N/A	1	—	—

Table A-2. Soils and Sediment Sampling

Parameter	Maximum*	Minimum*	Average*	Std. Deviation	Number of Samples
Total Organics	1	N.D.**	0.04	0.00	17
Total Petroleum Hydrocarbons (gas)	5	N.D.	0.85	1.43	17
Hexavalent Chromium	1	N.D.	0.18	0.39	17
Total PCB's	N.D.	N.D.	N.D.	0.00	17
pH	9.8	5.3	6.95	0.90	17
Arsenic	49	1	6.29	11.27	17
Barium	148	66	105.29	27.45	17
Beryllium	N.D.	N.D.	N.D.	0.00	17
Cadmium	1	N.D.	0.07	0.19	17
Chromium	77	13	47.35	20.49	17
Cobalt	16	4	11.45	3.51	17
Copper	81	13	25.59	15.29	17
Lead	171	6	45.11	41.16	17
Mercury	N.D.	N.D.	N.D.	0.00	17
Molybdenum	N.D.	N.D.	N.D.	0.00	17
Nickel	96	N.D.	37.18	21.46	17
Selenium	63	N.D.	3.71	15.28	17
Silver	N.D.	N.D.	N.D.	0.00	17
Thallium	N.D.	N.D.	N.D.	0.00	17
Vanadium	71	17	44.18	14.26	17
Zinc	322	41	101.29	82.47	17
Total Oil & Grease	380	N.D.	104.18	133.10	17

* All results are expressed in mg/kg, except for pH, which is expressed in standard units (S.U.)

** N.D. = non-detectable

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results

Location	Date	Test Method	Parameter	Value	Units
Building 25FTU	02/16/94	624-VOC	1,1,1-Trichloroethane	0	µg/L
	02/16/94	624-VOC	1,1,2,2-Tetrachloroethane	0	µg/L
	02/16/94	624-VOC	1,1,2-Trichloroethane	0	µg/L
	02/16/94	624-VOC	1,1-Dichloroethane	0	µg/L
	02/16/94	625	1,2,4-Trichlorobenzene	0	µg/L
	02/16/94	624-VOC	1,2-Dichlorobenzene	0	µg/L
	02/16/94	625	1,2-Dichlorobenzene	0	µg/L
	02/16/94	624-VOC	1,2-Dichloroethane	0	µg/L
	02/16/94	624-VOC	1,2-Dichloropropane	0	µg/L
	02/16/94	624-VOC	1,3-Dichlorobenzene	0	µg/L
	02/16/94	625	1,3-Dichlorobenzene	0	µg/L
	02/16/94	624-VOC	1,4-Dichlorobenzene	0	µg/L
	02/16/94	625	1,4-Dichlorobenzene	0	µg/L
	02/16/94	625	2,4,5-Trichlorophenol	0	µg/L
	02/16/94	625	2,4,6-Trichlorophenol	0	µg/L
	02/16/94	625	2,4-Dichlorophenol	0	µg/L
	02/16/94	624-VOC	2-Chloroethyl Vinyl Ether	0	µg/L
	02/16/94	625	2-Chloronaphthalene	0	µg/L
	02/16/94	625	2-Chlorophenol	0	µg/L
	02/16/94	625	3,3-Dichlorobenzidine	0	µg/L
	02/16/94	625	4-Chloro-3-methylphenol	0	µg/L
	02/16/94	625	4-Chloroaniline	0	µg/L
	02/16/94	625	4-Chlorophenyl phenyl ether	0	µg/L
	02/16/94	625	Bis(2-chloroethoxy)methane	0	µg/L
	02/16/94	625	Bis(2-chloroethyl)ether	0	µg/L
	02/16/94	625	Bis(2-chloroisopropyl)ether	0	µg/L
	02/16/94	624-VOC	Bromodichloromethane	0	µg/L
	02/16/94	624-VOC	Carbon Tetrachloride	0	µg/L
	02/16/94	624-VOC	Chlorobenzene	0	µg/L
	02/16/94	624-VOC	Chloroethane	0	µg/L
	02/16/94	624-VOC	Chloroform	0	µg/L
	02/16/94	624-VOC	Chloromethane	0	µg/L
	02/16/94	624-VOC	cis-1,2-Dichloroethene	0	µg/L
	02/16/94	624-VOC	cis-1,3-Dichloropropene	0	µg/L
	02/16/94	624-VOC	Dibromochloromethane	0	µg/L
	02/16/94	625	Hexachlorobenzene	0	µg/L
	02/16/94	625	Hexachlorobutadiene	0	µg/L
	02/16/94	625	Hexachlorocyclopentadiene	0	µg/L
	02/16/94	625	Hexachloroethane	0	µg/L
	02/16/94	624-VOC	Methylene Chloride	0	µg/L
	02/16/94	625	Pentachlorophenol	0	µg/L
	02/16/94	624-VOC	Tetrachloroethene	0	µg/L
	02/16/94	624-VOC	trans-1,2-Dichloroethene	0	µg/L
	02/16/94	624-VOC	trans-1,3-Dichloropropene	0	µg/L
	02/16/94	624-VOC	Trichloroethene	0	µg/L
	02/16/94	624-VOC	Vinyl Chloride	0	µg/L
	12/15/94	624-VOC	1,1,1-Trichloroethane	0	µg/L
	12/15/94	624-VOC	1,1,2,2-Tetrachloroethane	0	µg/L
	12/15/94	624-VOC	1,1,2-Trichloroethane	0	µg/L

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
	12/15/94	624-VOC	1,1-Dichloroethane	0	μg/L
	12/15/94	624-VOC	1,2-Dichlorobenzene	0	μg/L
	12/15/94	624-VOC	1,2-Dichloroethane	0	μg/L
	12/15/94	624-VOC	1,2-Dichloropropane	0	μg/L
	12/15/94	624-VOC	1,3-Dichlorobenzene	0	μg/L
	12/15/94	624-VOC	1,4-Dichlorobenzene	0	μg/L
	12/15/94	624-VOC	2-Chloroethyl Vinyl Ether	0	μg/L
	12/15/94	624-VOC	Bromodichloromethane	0	μg/L
	12/15/94	624-VOC	Carbon Tetrachloride	0	μg/L
	12/15/94	624-VOC	Chlorobenzene	0	μg/L
	12/15/94	624-VOC	Chloroethane	0	μg/L
	12/15/94	624-VOC	Chloroform	14	μg/L
	12/15/94	624-VOC	Chloromethane	0	μg/L
	12/15/94	624-VOC	cis-1,2-Dichloroethene	0	μg/L
	12/15/94	624-VOC	cis-1,3-Dichloropropene	0	μg/L
	12/15/94	624-VOC	Dibromochloromethane	0	μg/L
	12/15/94	624-VOC	Methylene Chloride	0	μg/L
	12/15/94	624-VOC	Tetrachloroethene	0	μg/L
	12/15/94	624-VOC	trans-1,2-Dichloroethene	0	μg/L
	12/15/94	624-VOC	trans-1,3-Dichloropropene	0	μg/L
	12/15/94	624-VOC	Trichloroethene	0	μg/L
	12/15/94	624-VOC	Vinyl Chloride	0	μg/L
Total				**14**	**μg/L**
Average				**7**	**μg/L**
Std. Dev.				**9.90**	**μg/L**
High				**14**	**μg/l**
EBMUD Permit Limit:	**Total Identifiable Chlorinated Hydrocarbons (Daily Max):**			**500**	**μg/l**
	Total Toxic Organics (Daily Maximum):			**2130**	**μg/l**
Building 25FTU	02/16/94	Cyanide-25FTU	Cyanide	0.00	mg/L
	12/15/94	Cyanide-25FTU	Cyanide	0.00	mg/L
	12/15/94	Cyanide-25FTU	Cyanide	0.00	mg/L
Total				**0.00**	**mg/L**
Average				**0.00**	**mg/L**
Std. Dev.				**0.00**	**mg/L**
High				**0.00**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**1.20**	**mg/L**
	Monthly Average Maximum			**0.65**	**mg/L**
Building 25FTU	02/16/94	pH	pH	7.2	S.U.
	05/20/94	pH	pH	7.2	S.U.
	12/15/94	pH	pH	8.9	S.U.
Average				**7.8**	**S.U.**
Std. Dev.				**1.0**	**S.U.**
Low				**7.2**	**S.U.**
EBMUD Permit Limit:	**Not less than (Daily Maximum):**			**5.5**	**S.U.**
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Antimony	0.0	mg/L
	05/20/94	Title 22 Metals-25FTU	Antimony	0.0	mg/L

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
	12/15/94	Title 22 Metals-25FTU	Antimony	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Arsenic	0.000	mg/L
	05/20/94	Title 22 Metals-25FTU	Arsenic	0.002	mg/L
	12/15/94	Title 22 Metals-25FTU	Arsenic	0.000	mg/L
Total				**0.002**	**mg/L**
Average				**0.001**	**mg/L**
Std. Dev.				**0.001**	**mg/L**
High				**0.002**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**2**	**mg/L**
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Barium	0.00	mg/L
	05/20/94	Title 22 Metals-25FTU	Barium	0.00	mg/L
	12/15/94	Title 22 Metals-25FTU	Barium	0.00	mg/L
Total				**0.00**	**mg/L**
Average				**0.00**	**mg/L**
Std. Dev.				**0.00**	**mg/L**
High				**0.00**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Beryllium	0.00	mg/L
	05/20/94	Title 22 Metals-25FTU	Beryllium	0.00	mg/L
	12/15/94	Title 22 Metals-25FTU	Beryllium	0.00	mg/L
Total				**0.00**	**mg/L**
Average				**0.00**	**mg/L**
Std. Dev.				**0.00**	**mg/L**
High				**0.00**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Cadmium	0.00	mg/L
	05/20/94	Title 22 Metals-25FTU	Cadmium	0.00	mg/L
	12/15/94	Title 22 Metals-25FTU	Cadmium	0.00	mg/L
Total				**0.00**	**mg/L**
Average				**0.00**	**mg/L**
Std. Dev.				**0.00**	**mg/L**
High				**0.00**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**0.69**	**mg/L**
	Monthly Average Maximum			**0.26**	**mg/L**
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Chromium	0.00	mg/L
	05/20/94	Title 22 Metals-25FTU	Chromium	0.00	mg/L
	12/15/94	Title 22 Metals-25FTU	Chromium	0.00	mg/L
Total				**0.00**	**mg/L**
Average				**0.00**	**mg/L**

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
Std. Dev.				**0.00**	**mg/L**
High				**0.00**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**2.77**	**mg/L**
	Monthly Average Maximum			**1.71**	**mg/L**
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Cobalt	0.0	mg/L
	05/20/94	Title 22 Metals-25FTU	Cobalt	0.0	mg/L
	12/15/94	Title 22 Metals-25FTU	Cobalt	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**-**	
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Copper	0.70	mg/L
	05/20/94	Title 22 Metals-25FTU	Copper	0.00	mg/L
	12/15/94	Title 22 Metals-25FTU	Copper	0.75	mg/L
Total				**1.45**	**mg/L**
Average				**0.48**	**mg/L**
Std. Dev.				**0.42**	**mg/L**
High				**0.75**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**3.38**	**mg/L**
	Monthly Average Maximum			**2.07**	**mg/L**
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Lead	0.011	mg/L
	05/20/94	Title 22 Metals-25FTU	Lead	0.510	mg/L
	12/15/94	Title 22 Metals-25FTU	Lead	0.000	mg/L
Total				**0.521**	**mg/L**
Average				**0.174**	**mg/L**
Std. Dev.				**0.291**	**mg/L**
High				**0.510**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**0.69**	**mg/L**
	Monthly Average Maximum			**0.43**	**mg/L**
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Mercury	0.00	mg/L
	05/20/94	Title 22 Metals-25FTU	Mercury	0.00	mg/L
	12/15/94	Title 22 Metals-25FTU	Mercury	0.00	mg/L
Total				**0.00**	**mg/L**
Average				**0.00**	**mg/L**
Std. Dev.				**0.00**	**mg/L**
High				**0.00**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**0.05**	**mg/L**
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Molybdenum	0.017	mg/L
	05/20/94	Title 22 Metals-25FTU	Molybdenum	0.000	mg/L
	12/15/94	Title 22 Metals-25FTU	Molybdenum	0.022	mg/L
Total				**0.039**	**mg/L**
Average				**0.013**	**mg/L**
Std. Dev.				**0.012**	**mg/L**

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
High				**0.022**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Nickel	0.13	mg/L
	05/20/94	Title 22 Metals-25FTU	Nickel	0.72	mg/L
	12/15/94	Title 22 Metals-25FTU	Nickel	0.27	mg/L
Total				**1.12**	**mg/L**
Average				**0.37**	**mg/L**
Std. Dev.				**0.31**	**mg/L**
High				**0.72**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**3.98**	**mg/L**
	Monthly Average Maximum			**2.38**	**mg/L**
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Selenium	0.000	mg/L
	05/20/94	Title 22 Metals-25FTU	Selenium	0.002	mg/L
	12/15/94	Title 22 Metals-25FTU	Selenium	0.000	mg/L
Total				**0.002**	**mg/L**
Average				**0.001**	**mg/L**
Std. Dev.				**0.001**	**mg/L**
High				**0.002**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Silver	0.00	mg/L
	05/20/94	Title 22 Metals-25FTU	Silver	0.00	mg/L
	12/15/94	Title 22 Metals-25FTU	Silver	0.00	mg/L
Total				**0.00**	**mg/L**
Average				**0.00**	**mg/L**
Std. Dev.				**0.00**	**mg/L**
High				**0.00**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**0.43**	**mg/L**
	Monthly Average Maximum			**0.24**	**mg/L**
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Thallium	0.0	mg/L
	05/20/94	Title 22 Metals-25FTU	Thallium	0.0	mg/L
	12/15/94	Title 22 Metals-25FTU	Thallium	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Vanadium	0.0	mg/L
	05/20/94	Title 22 Metals-25FTU	Vanadium	0.0	mg/L
	12/15/94	Title 22 Metals-25FTU	Vanadium	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
Building 25FTU	02/16/94	Title 22 Metals-25FTU	Zinc	0.00	mg/L
	05/20/94	Title 22 Metals-25FTU	Zinc	0.00	mg/L
	12/15/94	Title 22 Metals-25FTU	Zinc	0.00	mg/L
Total				**0.00**	**mg/L**
Average				**0.00**	**mg/L**
Std. Dev.				**0.00**	**mg/L**
High				**0.00**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**2.61**	**mg/L**
	Monthly Average Maximum			**1.48**	**mg/L**
Building 77FTU	02/16/94	624-VOC	1,1,1-Trichloroethane	5.2	µg/L
	02/16/94	624-VOC	1,1,2,2-Tetrachloroethane	0.0	µg/L
	02/16/94	624-VOC	1,1,2-Trichloroethane	0.0	µg/L
	02/16/94	624-VOC	1,1-Dichloroethane	0.0	µg/L
	02/16/94	624-VOC	1,2-Dichlorobenzene	0.0	µg/L
	02/16/94	624-VOC	1,2-Dichloroethane	0.0	µg/L
	02/16/94	624-VOC	1,2-Dichloropropane	0.0	µg/L
	02/16/94	624-VOC	1,3-Dichlorobenzene	0.0	µg/L
	02/16/94	624-VOC	1,4-Dichlorobenzene	0.0	µg/L
	02/16/94	624-VOC	2-Chloroethyl Vinyl Ether	0.0	µg/L
	02/16/94	624-VOC	Bromodichloromethane	1.9	µg/L
	02/16/94	624-VOC	Chlorobenzene	0.0	µg/L
	02/16/94	624-VOC	Chloroethane	0.0	µg/L
	02/16/94	624-VOC	Chloroform	33.0	µg/L
	02/16/94	624-VOC	Chloromethane	0.0	µg/L
	02/16/94	624-VOC	cis-1,2-Dichloroethene	0.0	µg/L
	02/16/94	624-VOC	cis-1,3-Dichloropropene	0.0	µg/L
	02/16/94	624-VOC	Dibromochloromethane	0.0	µg/L
	02/16/94	624-VOC	Methylene Chloride	0.0	µg/L
	02/16/94	624-VOC	Tetrachloroethene	0.0	µg/L
	02/16/94	624-VOC	trans-1,2-Dichloroethene	0.0	µg/L
	02/16/94	624-VOC	trans-1,3-Dichloropropene	0.0	µg/L
	02/16/94	624-VOC	Trichloroethene	0.0	µg/L
	02/16/94	624-VOC	Vinyl Chloride	0.0	µg/L
	02/16/94	625	1,2,4-Trichlorobenzene	0.0	µg/L
	02/16/94	625	1,2-Dichlorobenzene	0.0	µg/L
	02/16/94	625	1,2-Diphenylhydrazine	0.0	µg/L
	02/16/94	625	1,3-Dichlorobenzene	0.0	µg/L
	02/16/94	625	1,4-Dichlorobenzene	0.0	µg/L
	02/16/94	625	2,4,5-Trichlorophenol	0.0	µg/L
	02/16/94	625	2,4,6-Trichlorophenol	0.0	µg/L
	02/16/94	625	2,4-Dichlorophenol	0.0	µg/L
	02/16/94	625	2-Chloronaphthalene	0.0	µg/L
	02/16/94	625	2-Chlorophenol	0.0	µg/L
	02/16/94	625	3,3-Dichlorobenzidine	0.0	µg/L
	02/16/94	625	4-Chloro-3-methylphenol	0.0	µg/L
	02/16/94	625	4-Chloroaniline	0.0	µg/L
	02/16/94	625	4-Chlorophenyl phenyl ether	0.0	µg/L

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
	02/16/94	625	Bis(2-chloroethoxy)methane	0.0	µg/L
	02/16/94	625	Bis(2-chloroethyl)ether	0.0	µg/L
	02/16/94	625	Bis(2-chloroisopropyl)ether	0.0	µg/L
	02/16/94	625	Hexachlorobenzene	0.0	µg/L
	02/16/94	625	Hexachlorobutadiene	0.0	µg/L
	02/16/94	625	Hexachlorocyclopentadiene	0.0	µg/L
	02/16/94	625	Hexachloroethane	0.0	µg/L
	02/16/94	625	Pentachlorophenol	0.0	µg/L
Total				**40.1**	**µg/L**
Average				**20.1**	**µg/L**
Std. Dev.				**N/A**	
High				**33.0**	**µg/L**
EBMUD Permit Limit:	**Total Identifiable Chlorinated Hydrocarbons (Daily Max):**			**500.0**	**µg/l**
	Total Toxic Organics (Daily Maximum):			**2130.0**	**µg/l**
Building 77FTU	02/16/94	Cyanide-77FTU	Cyanide	0.00	mg/L
EBMUD Permit Limit:	**Daily Maximum:**			**1.20**	**mg/L**
	Monthly Average Maximum			**0.65**	**mg/L**
Building 77FTU	02/16/94	pH	pH	10.2	S.U.
	05/18/94	pH	pH	10.0	S.U.
	05/18/94	pH	pH	10.0	S.U.
Average				**10.1**	**S.U.**
Std. Dev.				**0.12**	**S.U.**
Low				**10.0**	**S.U.**
EBMUD Permit Limit:	**Not less than (Daily Maximum):**			**5.5**	**S.U.**
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Antimony	0.0	mg/L
	05/18/94	Title 22 Metals-77FTU	Antimony	0.0	mg/L
	11/17/94	Title 22 Metals-77FTU	Antimony	0.0	mg/L
	11/17/94	Title 22 Metals-77FTU	Antimony	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Arsenic	0.008	mg/L
	05/18/94	Title 22 Metals-77FTU	Arsenic	0.018	mg/L
	11/17/94	Title 22 Metals-77FTU	Arsenic	0.010	mg/L
	11/17/94	Title 22 Metals-77FTU	Arsenic	0.000	mg/L
Total				**0.036**	**mg/L**
Average				**0.009**	**mg/L**
Std. Dev.				**0.007**	**mg/L**
High				**0.018**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**2**	**mg/L**
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Barium	0.0	mg/L

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
	05/18/94	Title 22 Metals-77FTU	Barium	0.0	mg/L
	11/17/94	Title 22 Metals-77FTU	Barium	0.0	mg/L
	11/17/94	Title 22 Metals-77FTU	Barium	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			–	
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Beryllium	0.0	mg/L
	05/18/94	Title 22 Metals-77FTU	Beryllium	0.0	mg/L
	11/17/94	Title 22 Metals-77FTU	Beryllium	0.0	mg/L
	11/17/94	Title 22 Metals-77FTU	Beryllium	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			–	
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Cadmium	0.043	mg/L
	05/18/94	Title 22 Metals-77FTU	Cadmium	0.008	mg/L
	11/17/94	Title 22 Metals-77FTU	Cadmium	0.000	mg/L
	11/17/94	Title 22 Metals-77FTU	Cadmium	0.000	mg/L
Total				**0.051**	**mg/L**
Average				**0.013**	**mg/L**
Std. Dev.				**0.021**	**mg/L**
High				**0.043**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**0.69**	**mg/L**
	Monthly Average Maximum			**0.26**	**mg/L**
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Chromium	0.34	mg/L
	05/18/94	Title 22 Metals-77FTU	Chromium	0.11	mg/L
	11/17/94	Title 22 Metals-77FTU	Chromium	0.16	mg/L
	11/17/94	Title 22 Metals-77FTU	Chromium	0.00	mg/L
Total				**0.61**	**mg/L**
Average				**0.15**	**mg/L**
Std. Dev.				**0.14**	**mg/L**
High				**0.34**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**2.77**	**mg/L**
	Monthly Average Maximum			**1.71**	**mg/L**
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Cobalt	0.0	mg/L
	05/18/94	Title 22 Metals-77FTU	Cobalt	0.0	mg/L
	11/17/94	Title 22 Metals-77FTU	Cobalt	0.0	mg/L
	11/17/94	Title 22 Metals-77FTU	Cobalt	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Copper	0.48	mg/L
	05/18/94	Title 22 Metals-77FTU	Copper	0.67	mg/L
	11/17/94	Title 22 Metals-77FTU	Copper	0.15	mg/L
	11/17/94	Title 22 Metals-77FTU	Copper	0.00	mg/L
Total				**1.30**	**mg/L**
Average				**0.33**	**mg/L**
Std. Dev.				**0.31**	**mg/L**
High				**0.67**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**3.38**	**mg/L**
	Monthly Average Maximum			**2.07**	**mg/L**
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Lead	0.01	mg/L
	05/18/94	Title 22 Metals-77FTU	Lead	0.00	mg/L
	11/17/94	Title 22 Metals-77FTU	Lead	0.00	mg/L
	11/17/94	Title 22 Metals-77FTU	Lead	0.00	mg/L
Total				**0.01**	**mg/L**
Average				**0.00**	**mg/L**
Std. Dev.				**0.01**	**mg/L**
High				**0.01**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**0.69**	**mg/L**
	Monthly Average Maximum			**0.43**	**mg/L**
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Mercury	0.00	mg/L
	05/18/94	Title 22 Metals-77FTU	Mercury	0.00	mg/L
	11/17/94	Title 22 Metals-77FTU	Mercury	0.00	mg/L
	11/17/94	Title 22 Metals-77FTU	Mercury	0.00	mg/L
Total				**0.00**	**mg/L**
Average				**0.00**	**mg/L**
Std. Dev.				**0.00**	**mg/L**
High				**0.00**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**0.05**	**mg/L**
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Molybdenum	0.012	mg/L
	05/18/94	Title 22 Metals-77FTU	Molybdenum	0.000	mg/L
	11/17/94	Title 22 Metals-77FTU	Molybdenum	0.000	mg/L
	11/17/94	Title 22 Metals-77FTU	Molybdenum	0.000	mg/L
Total				**0.012**	**mg/L**
Average				**0.003**	**mg/L**
Std. Dev.				**0.006**	**mg/L**
High				**0.012**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Nickel	0.76	mg/L
	05/18/94	Title 22 Metals-77FTU	Nickel	1.03	mg/L
	11/17/94	Title 22 Metals-77FTU	Nickel	0.70	mg/L
	11/17/94	Title 22 Metals-77FTU	Nickel	0.00	mg/L
Total				**2.49**	**mg/L**

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
Average				**0.62**	**mg/L**
Std. Dev.				**0.44**	**mg/L**
High				**1.03**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**3.98**	**mg/L**
	Monthly Average Maximum			**2.38**	**mg/L**
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Selenium	0.0	mg/L
	05/18/94	Title 22 Metals-77FTU	Selenium	0.0	mg/L
	11/17/94	Title 22 Metals-77FTU	Selenium	0.0	mg/L
	11/17/94	Title 22 Metals-77FTU	Selenium	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Silver	0.013	mg/L
	05/18/94	Title 22 Metals-77FTU	Silver	0.320	mg/L
	11/17/94	Title 22 Metals-77FTU	Silver	0.000	mg/L
	11/17/94	Title 22 Metals-77FTU	Silver	0.000	mg/L
Total				**0.333**	**mg/L**
Average				**0.083**	**mg/L**
Std. Dev.				**0.158**	**mg/L**
High				**0.320**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**0.43**	**mg/L**
	Monthly Average Maximum			**0.24**	**mg/L**
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Thallium	0.0	mg/L
	05/18/94	Title 22 Metals-77FTU	Thallium	0.0	mg/L
	11/17/94	Title 22 Metals-77FTU	Thallium	0.0	mg/L
	11/17/94	Title 22 Metals-77FTU	Thallium	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Vanadium	0.0	mg/L
	05/18/94	Title 22 Metals-77FTU	Vanadium	0.0	mg/L
	11/17/94	Title 22 Metals-77FTU	Vanadium	0.0	mg/L
	11/17/94	Title 22 Metals-77FTU	Vanadium	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Building 77FTU	02/16/94	Title 22 Metals-77FTU	Zinc	0.27	mg/L
	05/18/94	Title 22 Metals-77FTU	Zinc	0.07	mg/L

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
	11/17/94	Title 22 Metals-77FTU	Zinc	0.10	mg/L
	11/17/94	Title 22 Metals-77FTU	Zinc	0.00	mg/L
Total				**0.44**	**mg/L**
Average				**0.11**	**mg/L**
Std. Dev.				**0.11**	**mg/L**
High				**0.27**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**2.61**	**mg/L**
	Monthly Average Maximum			**1.48**	**mg/L**
Hearst Sewer	02/23/94	624-VOC	1,1,1-Trichloroethane	0.0	µg/L
	02/23/94	624-VOC	1,1,2,2-Tetrachloroethane	0.0	µg/L
	02/23/94	624-VOC	1,1,2-Trichloroethane	0.0	µg/L
	02/23/94	624-VOC	1,1-Dichloroethane	0.0	µg/L
	02/23/94	624-VOC	1,2-Dichlorobenzene	0.0	µg/L
	02/23/94	624-VOC	1,2-Dichloroethane	0.0	µg/L
	02/23/94	624-VOC	1,2-Dichloropropane	0.0	µg/L
	02/23/94	624-VOC	1,3-Dichlorobenzene	0.0	µg/L
	02/23/94	624-VOC	1,4-Dichlorobenzene	0.0	µg/L
	02/23/94	624-VOC	2-Chloroethyl Vinyl Ether	0.0	µg/L
	02/23/94	624-VOC	Bromodichloromethane	0.0	µg/L
	02/23/94	624-VOC	Carbon Tetrachloride	0.0	µg/L
	02/23/94	624-VOC	Chlorobenzene	0.0	µg/L
	02/23/94	624-VOC	Chloroethane	0.0	µg/L
	02/23/94	624-VOC	Chloroform	4.6	µg/L
	02/23/94	624-VOC	Chloromethane	0.0	µg/L
	02/23/94	624-VOC	cis-1,2-Dichloroethene	0.0	µg/L
	02/23/94	624-VOC	cis-1,3-Dichloropropene	0.0	µg/L
	02/23/94	624-VOC	Dibromochloromethane	0.0	µg/L
	02/23/94	624-VOC	Methylene Chloride	1.6	µg/L
	02/23/94	624-VOC	Tetrachloroethene	0.0	µg/L
	02/23/94	624-VOC	trans-1,2-Dichloroethene	0.0	µg/L
	02/23/94	624-VOC	trans-1,3-Dichloropropene	0.0	µg/L
	02/23/94	624-VOC	Trichloroethene	0.0	µg/L
	02/23/94	624-VOC	Vinyl Chloride	0.0	µg/L
	03/31/94	624-VOC	1,1,1-Trichloroethane	0.0	µg/L
	03/31/94	624-VOC	1,1,2,2-Tetrachloroethane	0.0	µg/L
	03/31/94	624-VOC	1,1,2-Trichloroethane	0.0	µg/L
	03/31/94	624-VOC	1,1-Dichloroethane	0.0	µg/L
	03/31/94	624-VOC	1,2-Dichlorobenzene	0.0	µg/L
	03/31/94	624-VOC	1,2-Dichloroethane	0.0	µg/L
	03/31/94	624-VOC	1,2-Dichloropropane	0.0	µg/L
	03/31/94	624-VOC	1,3-Dichlorobenzene	0.0	µg/L
	03/31/94	624-VOC	1,4-Dichlorobenzene	0.0	µg/L
	03/31/94	624-VOC	2-Chloroethyl Vinyl Ether	0.0	µg/L
	03/31/94	624-VOC	Bromodichloromethane	1.1	µg/L
	03/31/94	624-VOC	Carbon Tetrachloride	0.0	µg/L
	03/31/94	624-VOC	Chlorobenzene	1.4	µg/L
	03/31/94	624-VOC	Chloroethane	0.0	µg/L

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
	03/31/94	624-VOC	Chloroform	10.0	μg/L
	03/31/94	624-VOC	Chloromethane	0.0	μg/L
	03/31/94	624-VOC	cis-1,2-Dichloroethene	0.0	μg/L
	03/31/94	624-VOC	cis-1,3-Dichloropropene	0.0	μg/L
	03/31/94	624-VOC	Dibromochloromethane	0.0	μg/L
	03/31/94	624-VOC	Methylene Chloride	0.0	μg/L
	03/31/94	624-VOC	Tetrachloroethene	0.0	μg/L
	03/31/94	624-VOC	trans-1,2-Dichloroethene	0.0	μg/L
	03/31/94	624-VOC	trans-1,3-Dichloropropene	0.0	μg/L
	03/31/94	624-VOC	Trichloroethene	0.0	μg/L
	03/31/94	624-VOC	Vinyl Chloride	0.0	μg/L
	5/26/94	624-VOC	1,1,1-Trichloroethane	0.0	μg/L
	5/26/94	624-VOC	1,1,2,2-Tetrachloroethane	0.0	μg/L
	5/26/94	624-VOC	1,1,2-Trichloroethane	0.0	μg/L
	5/26/94	624-VOC	1,1-Dichloroethane	0.0	μg/L
	5/26/94	624-VOC	1,2-Dichlorobenzene	0.0	μg/L
	5/26/94	624-VOC	1,2-Dichloroethane	0.0	μg/L
	5/26/94	624-VOC	1,2-Dichloropropane	0.0	μg/L
	5/26/94	624-VOC	1,3-Dichlorobenzene	0.0	μg/L
	5/26/94	624-VOC	1,4-Dichlorobenzene	0.0	μg/L
	5/26/94	624-VOC	2-Chloroethyl Vinyl Ether	0.0	μg/L
	5/26/94	624-VOC	Bromodichloromethane	1.2	μg/L
	5/26/94	624-VOC	Carbon Tetrachloride	0.0	μg/L
	5/26/94	624-VOC	Chlorobenzene	0.0	μg/L
	5/26/94	624-VOC	Chloroethane	0.0	μg/L
	5/26/94	624-VOC	Chloroform	15.0	μg/L
	5/26/94	624-VOC	Chloromethane	0.0	μg/L
	5/26/94	624-VOC	cis-1,2-Dichloroethene	0.0	μg/L
	5/26/94	624-VOC	cis-1,3-Dichloropropene	0.0	μg/L
	5/26/94	624-VOC	Dibromochloromethane	0.0	μg/L
	5/26/94	624-VOC	Methylene Chloride	0.0	μg/L
	5/26/94	624-VOC	Tetrachloroethene	0.0	μg/L
	5/26/94	624-VOC	trans-1,2-Dichloroethene	0.0	μg/L
	5/26/94	624-VOC	trans-1,3-Dichloropropene	0.0	μg/L
	5/26/94	624-VOC	Trichloroethene	0.0	μg/L
	5/26/94	624-VOC	Vinyl Chloride	0.0	μg/L
	12/01/94	624-VOC	1,1,1-Trichloroethane	0.0	μg/L
	12/01/94	624-VOC	1,1,2,2-Tetrachloroethane	0.0	μg/L
	12/01/94	624-VOC	1,1,2-Trichloroethane	0.0	μg/L
	12/01/94	624-VOC	1,1-Dichloroethane	0.0	μg/L
	12/01/94	624-VOC	1,2-Dichlorobenzene	0.0	μg/L
	12/01/94	624-VOC	1,2-Dichloroethane	0.0	μg/L
	12/01/94	624-VOC	1,2-Dichloropropane	0.0	μg/L
	12/01/94	624-VOC	1,3-Dichlorobenzene	0.0	μg/L
	12/01/94	624-VOC	1,4-Dichlorobenzene	0.0	μg/L
	12/01/94	624-VOC	2-Chloroethyl Vinyl Ether	0.0	μg/L
	12/01/94	624-VOC	Bromodichloromethane	1.0	μg/L
	12/01/94	624-VOC	Carbon Tetrachloride	0.0	μg/L
	12/01/94	624-VOC	Chlorobenzene	0.0	μg/L

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
	12/01/94	624-VOC	Chloroethane	0.0	μg/L
	12/01/94	624-VOC	Chloroform	13.0	μg/L
	12/01/94	624-VOC	Chloromethane	0.0	μg/L
	12/01/94	624-VOC	cis-1,2-Dichloroethene	0.0	μg/L
	12/01/94	624-VOC	cis-1,3-Dichloropropene	0.0	μg/L
	12/01/94	624-VOC	Dibromochloromethane	0.0	μg/L
	12/01/94	624-VOC	Methylene Chloride	0.0	μg/L
	12/01/94	624-VOC	Tetrachloroethene	0.0	μg/L
	12/01/94	624-VOC	trans-1,2-Dichloroethene	0.0	μg/L
	12/01/94	624-VOC	trans-1,3-Dichloropropene	0.0	μg/L
	12/01/94	624-VOC	Trichloroethene	0.0	μg/L
	12/01/94	624-VOC	Vinyl Chloride	0.0	μg/L
Total				**48.9**	**μg/L**
Average				**12.2**	**μg/L**
Std. Dev.				**4.3**	**μg/L**
High				**16.2**	**μg/L**
EBMUD Permit Limit:	**Total Identifiable Chlorinated Hydrocarbons (Daily Max):**			**500.0**	**μg/l**
Hearst Sewer	02/23/94	COD-F	COD-F	233.0	mg/OL
	03/31/94	COD-F	COD-F	48.9	mg/OL
	12/01/94	COD-F	COD-F	144.0	mg/OL
	5/26/94	COD-F	COD-F	97.0	mg/OL
	5/26/94	COD-F	COD-F	80.0	mg/OL
Total				**602.9**	**mg/OL**
Average				**120.6**	**mg/OL**
Std. Dev.				**71.6**	**mg/OL**
High				**233.0**	**mg/OL**
EBMUD Permit Limit:	**None (sewage charges based in part on this measurement)**			**–**	
Hearst Sewer	02/23/94	pH	pH	7.4	S.U.
	03/31/94	pH	pH	8.7	S.U.
	5/26/94	pH	pH	8.6	S.U.
Average				**8.2**	**S.U.**
Std. Dev.				**0.7**	**S.U.**
Low				**7.4**	**S.U.**
EBMUD Permit Limit:	**Not less than (Daily Maximum):**			**5.5**	**S.U.**
Hearst Sewer	02/23/94	Title 22 Metals-HS	Antimony	0.0	mg/L
	03/31/94	Title 22 Metals-HS	Antimony	0.0	mg/L
	5/26/94	Title 22 Metals-HS	Antimony	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Hearst Sewer	02/23/94	Title 22 Metals-HS	Arsenic	0.002	mg/L
	03/31/94	Title 22 Metals-HS	Arsenic	0.000	mg/L
	5/26/94	Title 22 Metals-HS	Arsenic	0.000	mg/L

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
Total				**0.002**	**mg/L**
Average				**0.001**	**mg/L**
Std. Dev.				**0.001**	**mg/L**
High				**0.002**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**2**	**mg/L**
Hearst Sewer	02/23/94	Title 22 Metals-HS	Barium	0.0	mg/L
	03/31/94	Title 22 Metals-HS	Barium	0.0	mg/L
	5/26/94	Title 22 Metals-HS	Barium	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Hearst Sewer	02/23/94	Title 22 Metals-HS	Beryllium	0.0	mg/L
	03/31/94	Title 22 Metals-HS	Beryllium	0.0	mg/L
	5/26/94	Title 22 Metals-HS	Beryllium	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Hearst Sewer	02/23/94	Title 22 Metals-HS	Cadmium	0.0	mg/L
	03/31/94	Title 22 Metals-HS	Cadmium	0.0	mg/L
	5/26/94	Title 22 Metals-HS	Cadmium	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**1**	**mg/L**
Hearst Sewer	02/23/94	Title 22 Metals-HS	Chromium	0.014	mg/L
	03/31/94	Title 22 Metals-HS	Chromium	0.000	mg/L
	5/26/94	Title 22 Metals-HS	Chromium	0.000	mg/L
Total				**0.014**	**mg/L**
Average				**0.005**	**mg/L**
Std. Dev.				**0.008**	**mg/L**
High				**0.014**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**2**	**mg/L**
Hearst Sewer	02/23/94	Title 22 Metals-HS	Cobalt	0.0	mg/L
	03/31/94	Title 22 Metals-HS	Cobalt	0.0	mg/L
	5/26/94	Title 22 Metals-HS	Cobalt	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Hearst Sewer	02/23/94	Title 22 Metals-HS	Copper	0.057	mg/L
	03/31/94	Title 22 Metals-HS	Copper	0.040	mg/L
	5/26/94	Title 22 Metals-HS	Copper	0.030	mg/L
Total				**0.127**	**mg/L**
Average				**0.042**	**mg/L**
Std. Dev.				**0.014**	**mg/L**
High				**0.057**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**5**	**mg/L**
Hearst Sewer	02/23/94	Title 22 Metals-HS	Lead	0.170	mg/L
	03/31/94	Title 22 Metals-HS	Lead	0.006	mg/L
	5/26/94	Title 22 Metals-HS	Lead	0.005	mg/L
Total				**0.181**	**mg/L**
Average				**0.060**	**mg/L**
Std. Dev.				**0.095**	**mg/L**
High				**0.170**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**2**	**mg/L**
Hearst Sewer	02/23/94	Title 22 Metals-HS	Mercury	0.000	mg/L
	03/31/94	Title 22 Metals-HS	Mercury	0.000	mg/L
	5/26/94	Title 22 Metals-HS	Mercury	0.001	mg/L
Total				**0.001**	**mg/L**
Average				**0.000**	**mg/L**
Std. Dev.				**0.000**	**mg/L**
High				**0.001**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**0.05**	**mg/L**
Hearst Sewer	02/23/94	Title 22 Metals-HS	Molybdenum	0.49	mg/L
	03/31/94	Title 22 Metals-HS	Molybdenum	0.14	mg/L
	5/26/94	Title 22 Metals-HS	Molybdenum	0.06	mg/L
Total				**0.69**	**mg/L**
Average				**0.23**	**mg/L**
Std. Dev.				**0.23**	**mg/L**
High				**0.49**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Hearst Sewer	02/23/94	Title 22 Metals-HS	Nickel	0.0	mg/L
	03/31/94	Title 22 Metals-HS	Nickel	0.0	mg/L
	5/26/94	Title 22 Metals-HS	Nickel	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**5**	**mg/L**
Hearst Sewer	02/23/94	Title 22 Metals-HS	Selenium	0.0	mg/L
	03/31/94	Title 22 Metals-HS	Selenium	0.0	mg/L

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
	5/26/94	Title 22 Metals-HS	Selenium	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Hearst Sewer	02/23/94	Title 22 Metals-HS	Silver	0.012	mg/L
	03/31/94	Title 22 Metals-HS	Silver	0.010	mg/L
	5/26/94	Title 22 Metals-HS	Silver	0.050	mg/L
Total				**0.072**	**mg/L**
Average				**0.024**	**mg/L**
Std. Dev.				**0.023**	**mg/L**
High				**0.050**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**1**	**mg/L**
Hearst Sewer	02/23/94	Title 22 Metals-HS	Thallium	0.0	mg/L
	03/31/94	Title 22 Metals-HS	Thallium	0.0	mg/L
	5/26/94	Title 22 Metals-HS	Thallium	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Hearst Sewer	02/23/94	Title 22 Metals-HS	Vanadium	0.0	mg/L
	03/31/94	Title 22 Metals-HS	Vanadium	0.0	mg/L
	5/26/94	Title 22 Metals-HS	Vanadium	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Hearst Sewer	02/23/94	Title 22 Metals-HS	Zinc	0.63	mg/L
	03/31/94	Title 22 Metals-HS	Zinc	0.11	mg/L
	5/26/94	Title 22 Metals-HS	Zinc	0.17	mg/L
Total				**0.91**	**mg/L**
Average				**0.30**	**mg/L**
Std. Dev.				**0.28**	**mg/L**
High				**0.63**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**5**	**mg/L**
Hearst Sewer	02/23/94	TSS	TSS	339	mg/kg
	03/31/94	TSS	TSS	160	mg/kg
	12/01/94	TSS	TSS	33	mg/kg
	5/26/94	TSS	TSS	118	mg/kg
Total				**650**	**mg/kg**
Average				**163**	**mg/kg**

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
Std. Dev.				**129**	**mg/kg**
High				**339**	**mg/kg**
EBMUD Permit Limit:	**None (sewage charges based in part on this measurement)**			**-**	
Strawberry Sewer	02/23/94	624-VOC	1,1,1-Trichloroethane	3.2	μg/L
	02/23/94	624-VOC	1,1,2,2-Tetrachloroethane	0.0	μg/L
	02/23/94	624-VOC	1,1,2-Trichloroethane	0.0	μg/L
	02/23/94	624-VOC	1,1-Dichloroethane	0.0	μg/L
	02/23/94	624-VOC	1,2-Dichlorobenzene	0.0	μg/L
	02/23/94	624-VOC	1,2-Dichloroethane	0.0	μg/L
	02/23/94	624-VOC	1,2-Dichloropropane	0.0	μg/L
	02/23/94	624-VOC	1,3-Dichlorobenzene	0.0	μg/L
	02/23/94	624-VOC	1,4-Dichlorobenzene	0.0	μg/L
	02/23/94	624-VOC	2-Chloroethyl Vinyl Ether	0.0	μg/L
	02/23/94	624-VOC	Bromodichloromethane	0.0	μg/L
	02/23/94	624-VOC	Carbon Tetrachloride	0.0	μg/L
	02/23/94	624-VOC	Chlorobenzene	0.0	μg/L
	02/23/94	624-VOC	Chloroethane	0.0	μg/L
	02/23/94	624-VOC	Chloroform	2.0	μg/L
	02/23/94	624-VOC	Chloromethane	0.0	μg/L
	02/23/94	624-VOC	cis-1,2-Dichloroethene	0.0	μg/L
	02/23/94	624-VOC	cis-1,3-Dichloropropene	0.0	μg/L
	02/23/94	624-VOC	Dibromochloromethane	0.0	μg/L
	02/23/94	624-VOC	Methylene Chloride	21.0	μg/L
	02/23/94	624-VOC	Tetrachloroethene	0.0	μg/L
	02/23/94	624-VOC	trans-1,2-Dichloroethene	0.0	μg/L
	02/23/94	624-VOC	trans-1,3-Dichloropropene	0.0	μg/L
	02/23/94	624-VOC	Trichloroethene	0.0	μg/L
	02/23/94	624-VOC	Vinyl Chloride	0.0	μg/L
	03/31/94	624-VOC	1,1,1-Trichloroethane	1.2	μg/L
	03/31/94	624-VOC	1,1,2,2-Tetrachloroethane	0.0	μg/L
	03/31/94	624-VOC	1,1,2-Trichloroethane	0.0	μg/L
	03/31/94	624-VOC	1,1-Dichloroethane	0.0	μg/L
	03/31/94	624-VOC	1,2-Dichlorobenzene	0.0	μg/L
	03/31/94	624-VOC	1,2-Dichloroethane	0.0	μg/L
	03/31/94	624-VOC	1,2-Dichloropropane	0.0	μg/L
	03/31/94	624-VOC	1,3-Dichlorobenzene	0.0	μg/L
	03/31/94	624-VOC	1,4-Dichlorobenzene	0.0	μg/L
	03/31/94	624-VOC	2-Chloroethyl Vinyl Ether	0.0	μg/L
	03/31/94	624-VOC	Bromodichloromethane	0.8	μg/L
	03/31/94	624-VOC	Carbon Tetrachloride	0.0	μg/L
	03/31/94	624-VOC	Chlorobenzene	0.0	μg/L
	03/31/94	624-VOC	Chloroethane	0.0	μg/L
	03/31/94	624-VOC	Chloroform	9.0	μg/L
	03/31/94	624-VOC	Chloromethane	0.0	μg/L
	03/31/94	624-VOC	cis-1,2-Dichloroethene	0.0	μg/L
	03/31/94	624-VOC	cis-1,3-Dichloropropene	0.0	μg/L
	03/31/94	624-VOC	Dibromochloromethane	0.0	μg/L

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
	03/31/94	624-VOC	Methylene Chloride	0.0	μg/L
	03/31/94	624-VOC	Tetrachloroethene	0.0	μg/L
	03/31/94	624-VOC	trans-1,2-Dichloroethene	0.0	μg/L
	03/31/94	624-VOC	trans-1,3-Dichloropropene	0.0	μg/L
	03/31/94	624-VOC	Trichloroethene	0.0	μg/L
	03/31/94	624-VOC	Vinyl Chloride	0.0	μg/L
	5/26/94	624-VOC	1,1,1-Trichloroethane	1.3	μg/L
	5/26/94	624-VOC	1,1,2,2-Tetrachloroethane	0.0	μg/L
	5/26/94	624-VOC	1,1,2-Trichloroethane	0.0	μg/L
	5/26/94	624-VOC	1,1-Dichloroethane	0.0	μg/L
	5/26/94	624-VOC	1,2-Dichlorobenzene	0.0	μg/L
	5/26/94	624-VOC	1,2-Dichloroethane	0.0	μg/L
	5/26/94	624-VOC	1,2-Dichloropropane	0.0	μg/L
	5/26/94	624-VOC	1,3-Dichlorobenzene	0.0	μg/L
	5/26/94	624-VOC	1,4-Dichlorobenzene	0.0	μg/L
	5/26/94	624-VOC	2-Chloroethyl Vinyl Ether	0.0	μg/L
	5/26/94	624-VOC	Bromodichloromethane	1.0	μg/L
	5/26/94	624-VOC	Carbon Tetrachloride	0.0	μg/L
	5/26/94	624-VOC	Chlorobenzene	0.0	μg/L
	5/26/94	624-VOC	Chloroethane	0.0	μg/L
	5/26/94	624-VOC	Chloroform	9.4	μg/L
	5/26/94	624-VOC	Chloromethane	0.0	μg/L
	5/26/94	624-VOC	cis-1,2-Dichloroethene	0.0	μg/L
	5/26/94	624-VOC	cis-1,3-Dichloropropene	0.0	μg/L
	5/26/94	624-VOC	Dibromochloromethane	0.0	μg/L
	5/26/94	624-VOC	Methylene Chloride	0.0	μg/L
	5/26/94	624-VOC	Tetrachloroethene	0.0	μg/L
	5/26/94	624-VOC	trans-1,2-Dichloroethene	0.0	μg/L
	5/26/94	624-VOC	trans-1,3-Dichloropropene	0.0	μg/L
	5/26/94	624-VOC	Trichloroethene	0.0	μg/L
	5/26/94	624-VOC	Vinyl Chloride	0.0	μg/L
	12/01/94	624-VOC	1,1,1-Trichloroethane	0.0	μg/L
	12/01/94	624-VOC	1,1,2,2-Tetrachloroethane	0.0	μg/L
	12/01/94	624-VOC	1,1,2-Trichloroethane	0.0	μg/L
	12/01/94	624-VOC	1,1-Dichloroethane	0.0	μg/L
	12/01/94	624-VOC	1,2-Dichlorobenzene	0.0	μg/L
	12/01/94	624-VOC	1,2-Dichloroethane	0.0	μg/L
	12/01/94	624-VOC	1,2-Dichloropropane	0.0	μg/L
	12/01/94	624-VOC	1,3-Dichlorobenzene	0.0	μg/L
	12/01/94	624-VOC	1,4-Dichlorobenzene	0.0	μg/L
	12/01/94	624-VOC	2-Chloroethyl Vinyl Ether	0.0	μg/L
	12/01/94	624-VOC	Bromodichloromethane	0.7	μg/L
	12/01/94	624-VOC	Carbon Tetrachloride	0.0	μg/L
	12/01/94	624-VOC	Chlorobenzene	0.0	μg/L
	12/01/94	624-VOC	Chloroethane	0.0	μg/L
	12/01/94	624-VOC	Chloroform	7.8	μg/L
	12/01/94	624-VOC	Chloromethane	0.0	μg/L
	12/01/94	624-VOC	cis-1,2-Dichloroethene	0.0	μg/L
	12/01/94	624-VOC	cis-1,3-Dichloropropene	0.0	μg/L

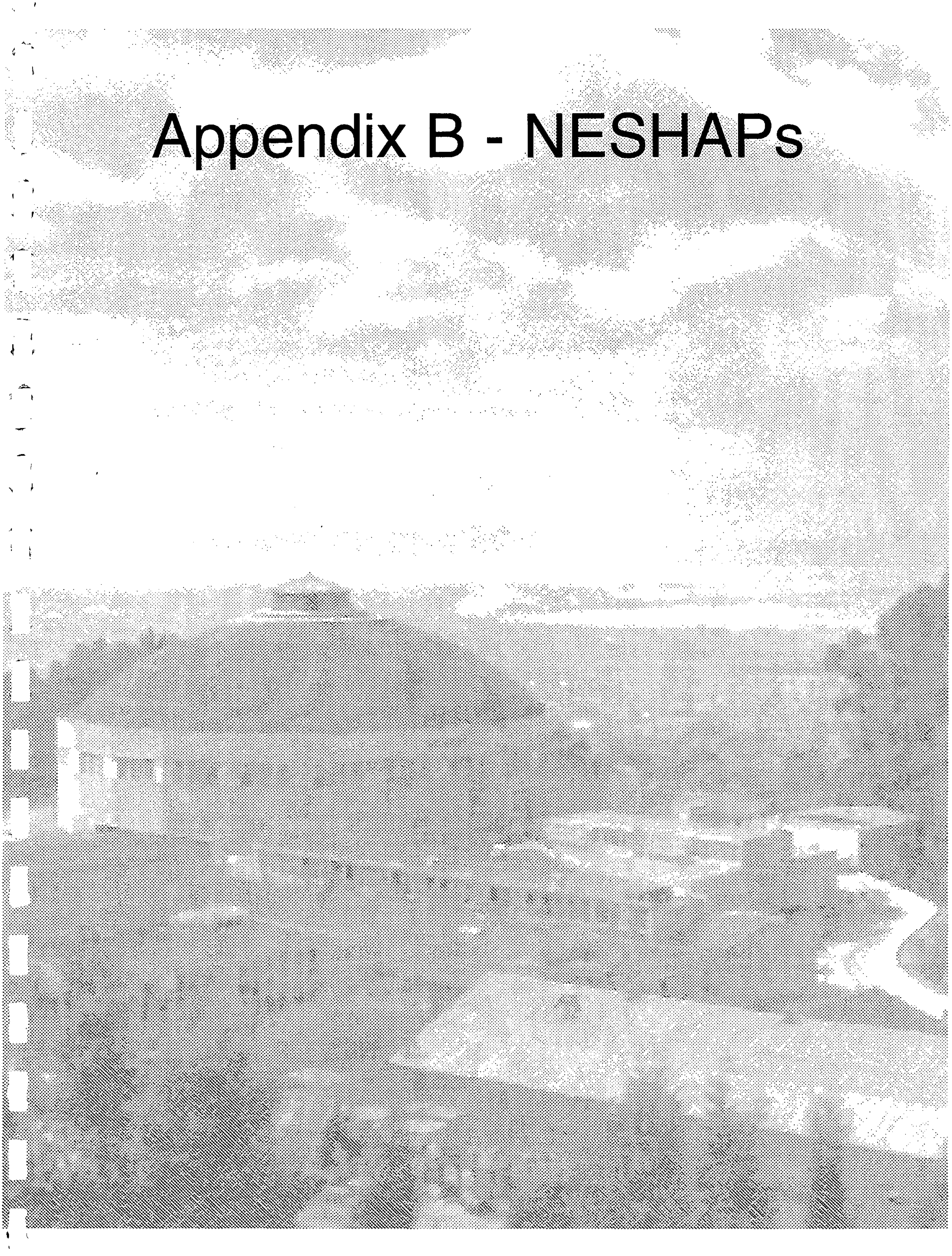
Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
	12/01/94	624-VOC	Dibromochloromethane	0.0	µg/L
	12/01/94	624-VOC	Methylene Chloride	0.0	µg/L
	12/01/94	624-VOC	Tetrachloroethene	0.0	µg/L
	12/01/94	624-VOC	trans-1,2-Dichloroethene	0.0	µg/L
	12/01/94	624-VOC	trans-1,3-Dichloropropene	0.0	µg/L
	12/01/94	624-VOC	Trichloroethene	0.0	µg/L
	12/01/94	624-VOC	Vinyl Chloride	0.0	µg/L
Total				**57.4**	**µg/L**
Average				**14.4**	**µg/L**
Std. Dev.				**8.0**	**µg/L**
High				**26.2**	**µg/L**
EBMUD Permit Limit:	**Total Identifiable Chlorinated Hydrocarbons (Daily Max):**			**500**	**µg/l**
Strawberry Sewer	02/23/94	COD-F	COD-F	33.6	mg/L
	03/31/94	COD-F	COD-F	28.0	mg/OL
	12/01/94	COD-F	COD-F	57.5	mg/OL
	5/26/94	COD-F	COD-F	161.0	mg/OL
	5/26/94	COD-F	COD-F	148.0	mg/OL
Total				**428.1**	**mg/OL**
Average				**85.6**	**mg/OL**
Std. Dev.				**64.0**	**mg/OL**
High				**161**	**mg/OL**
EBMUD Permit Limit:	**None (sewage charges based in part on this measurement)**			**–**	
Strawberry Sewer	02/23/94	pH	pH	7.5	S.U.
	03/31/94	pH	pH	8.3	S.U.
	5/26/94	pH	pH	8.1	S.U.
Average				**8.0**	**S.U.**
Std. Dev.				**0.42**	**S.U.**
Low				**7.5**	**S.U.**
EBMUD Permit Limit:	**Not less than (Daily Maximum):**			**5.5**	**S.U.**
Strawberry Sewer	02/23/94	Title 22 Metals-SS	Antimony	0.0	mg/L
	03/31/94	Title 22 Metals-SS	Antimony	0.0	mg/L
	5/26/94	Title 22 Metals-SS	Antimony	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Strawberry Sewer	02/23/94	Title 22 Metals-SS	Arsenic	0.003	mg/L
	03/31/94	Title 22 Metals-SS	Arsenic	0.002	mg/L
	5/26/94	Title 22 Metals-SS	Arsenic	0.003	mg/L
Total				**0.008**	**mg/L**
Average				**0.003**	**mg/L**
Std. Dev.				**0.001**	**mg/L**
High				**0.003**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**2**	**mg/L**

Table A-3. Fixed Treatment Unit and Sanitary Sewer Test Results (continued)

Location	Date	Test Method	Parameter	Value	Units
Strawberry Sewer	02/23/94	Title 22 Metals-SS	Barium	0.0	mg/L
	03/31/94	Title 22 Metals-SS	Barium	0.0	mg/L
	5/26/94	Title 22 Metals-SS	Barium	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Strawberry Sewer	02/23/94	Title 22 Metals-SS	Beryllium	0.0	mg/L
	03/31/94	Title 22 Metals-SS	Beryllium	0.0	mg/L
	5/26/94	Title 22 Metals-SS	Beryllium	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Strawberry Sewer	02/23/94	Title 22 Metals-SS	Cadmium	0.005	mg/L
	03/31/94	Title 22 Metals-SS	Cadmium	0.005	mg/L
	5/26/94	Title 22 Metals-SS	Cadmium	0.070	mg/L
Total				0.080	mg/L
Average				0.027	mg/L
Std. Dev.				0.038	mg/L
High				0.070	mg/L
EBMUD Permit Limit:	Daily Maximum:			1	mg/L
Strawberry Sewer	02/23/94	Title 22 Metals-SS	Chromium	0.028	mg/L
	03/31/94	Title 22 Metals-SS	Chromium	0.030	mg/L
	5/26/94	Title 22 Metals-SS	Chromium	0.640	mg/L
Total				**0.698**	**mg/L**
Average				**0.233**	**mg/L**
Std. Dev.				**0.353**	**mg/L**
High				**0.640**	**mg/L**
EBMUD Permit Limit:	**Daily Maximum:**			**2**	**mg/L**
Strawberry Sewer	02/23/94	Title 22 Metals-SS	Cobalt	0.0	mg/L
	03/31/94	Title 22 Metals-SS	Cobalt	0.0	mg/L
	5/26/94	Title 22 Metals-SS	Cobalt	0.0	mg/L
Total				**0.0**	**mg/L**
Average				**0.0**	**mg/L**
Std. Dev.				**0.0**	**mg/L**
High				**0.0**	**mg/L**
EBMUD Permit Limit:	**None (hazardous waste limits apply)**			**–**	
Strawberry Sewer	02/23/94	Title 22 Metals-SS	Copper	0.12	mg/L
	03/31/94	Title 22 Metals-SS	Copper	0.43	mg/L
	5/26/94	Title 22 Metals-SS	Copper	0.22	mg/L

Appendix B - NESHAPs



NUS Department of Energy
Radionuclide Air Emission Annual Report
(Subpart H of 40 CFR 61)
Calendar Year 1994

Site Name:	**Lawrence Berkeley Laboratory (LBL)**		

<u>Operation Office Information</u>

Office:	Oakland Operations Office		
Address:	1301 Clay St. Room 700 N Oakland, CA 94612		
Contact:	Steven Lasell	Phone:	(510) 637-1602

<u>Site Information</u>

Operator:	Lawrence Berkeley Laboratory		
Address:	1 Cyclotron Road Berkeley, CA 94720		
Contractor Contact:	Henry Tran	Phone:	(510) 486-7623
DOE Site Contact:	Carl Schwab	Phone:	(510) 486-4298

Section I. Facility Information

Site Description:

Laboratory Operations

The Lawrence Berkeley Laboratory (LBL) is a multi-program national laboratory managed by the University of California (UC) for the US Department of Energy (DOE). LBL's major role is to conduct basic and applied researches in biology, physics, chemistry, materials, and energy. LBL, birthplace of the cyclotron, was founded by the late Nobel Laureate Ernest Orlando Lawrence in 1931.

LBL also supports nationwide university-based research by providing national facilities, including:

- National Center for Electron Microscopy (Building 72)
- National Tritium Labeling Facility (Building 75)

Other LBL facilities that are relevant to the radioactive air emission program governed by "National Emission Standard for Hazardous Airborne Pollutants other than Radon from DOE Facilities" (NESHAPs) include:

- 88-inch Cyclotron (Building 88)
- Advanced Light Source (Building 6)
- A number of radiochemical and radiobiological laboratories located in Buildings 1, 2, 3, 26, 55, 62, 70, 70A, 74, 74B, 83, 88, and 934.
- Hazardous Waste Handling Facility (Buildings 75 and 75A)

Figure 1 illustrates the LBL general site configuration and locations of potential NESHAPs source terms. Table 1 identifies the buildings illustrated in Figure 1. Figure 2 identifies other LBL off site locations (Buildings 1, 3, and 934) that potentially involve radioactive air emissions.

Radiochemical and radiobiological studies performed in many on site/off site laboratories at LBL typically use millicurie quantities of a great variety of radionuclides. (One millicurie is equal to 3.7×10^7 Becquerel (Bq).)

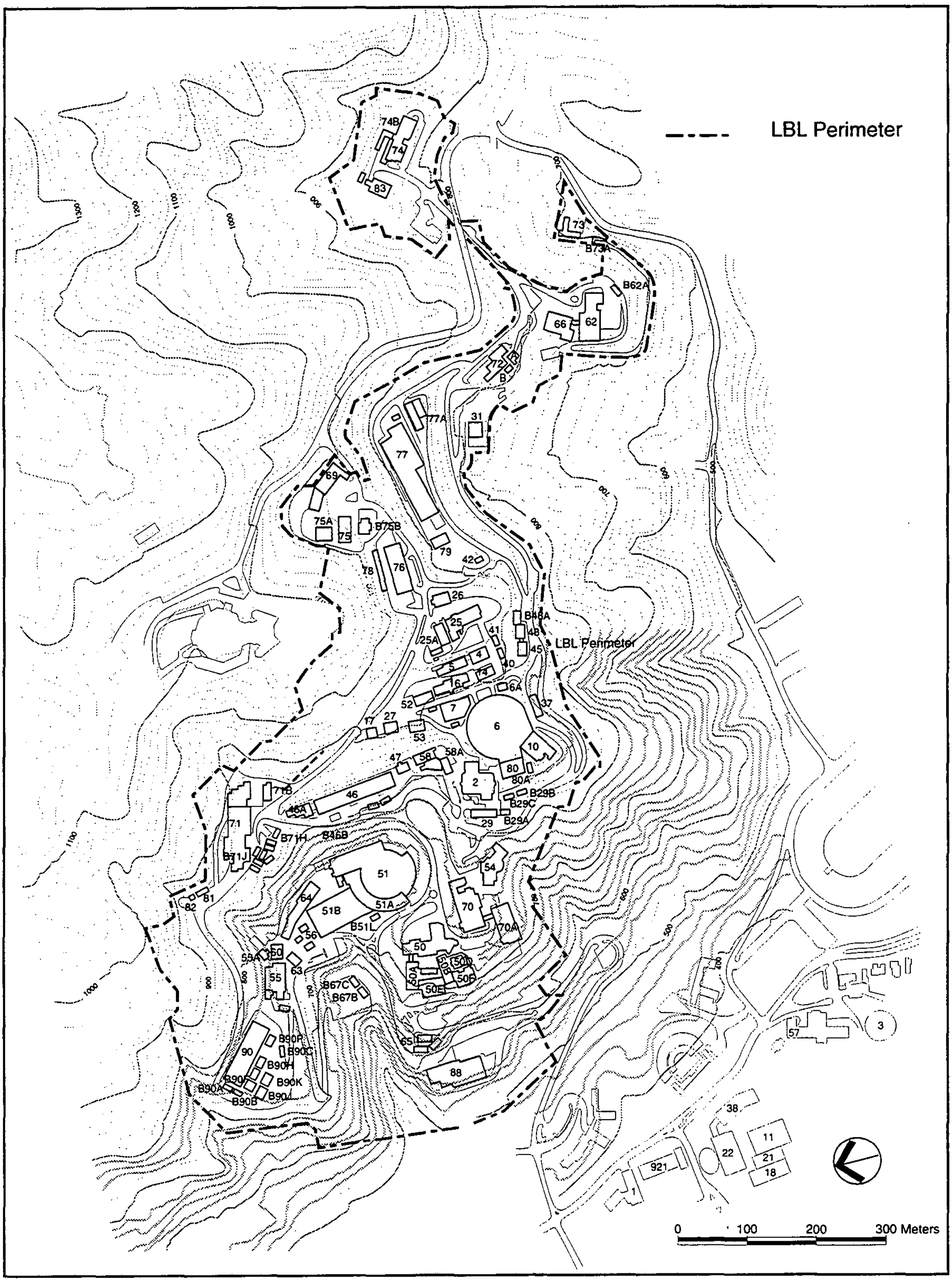


Figure 1. LBL On site Buildings

HILL-SITE BUILDINGS

2	Advanced Materials Laboratory (AML) & Center for X-ray Optics (CXRO)
4	Magnetic Fusion Energy (MFE)
5	Magnetic Fusion Energy (MFE)
6	Advanced Light Source (ALS)
7	Central Stores & Electronics Shops
10	Cell & Molecular Biology Research & Photography
14	Accelerator & Fusion Research & Earth Sciences
16	Magnetic Fusion Energy Laboratory
17	EH&S/Applied Sciences Lab
25	Mechanical Technology
25A	Electronics Shops
26	Medical Services
27	High Voltage Test Facility & Cable Shop
29	Electronics Engineering, Research Medicine/Radiation Biophysics Offices
31	Chicken Creek Maintenance Bldg.
36	Grizzly Substation Switchgear Bldg.
37	Utilities Service
40	Electronics Development Lab
41	Magnetic Measurements Lab
42	Salvage
43	Compressor Bldg.
44	Indoor Air Pollution Studies
45	Fire Apparatus
46	RTSS, ALS, Accelerator Development
46A	Real Time Systems Section (RTSS)
47	Advanced Accelerator Study
48	Fire Station
50	Physics, Accelerator & Fusion Research & Nuclear Science
50A	Director's Office, Environment & Laboratory Development, Administration Division, Patents
50B	Physics, Computer Center, IRD & ICSD
50C	PID, Physics
50D	MCSD & Nuclear Science
50E	Earth Sciences
50F	Computing Services, IRD
51	Bevalac/Bevatron (decommissioned)
51A	Bevatron Experimental Area
51B	External Particle Beam (EPB) Hall
52	Magnetic Fusion Energy Laboratory
53	SuperHILAC Development
54	Cafeteria
55	Research Medicine/Radiation Biophysics
55A	Nuclear Magnetic Resonance (NMR)
56	Cryogenic Facility
58	Accelerator Research & Development
58A	Accelerator Research & Development Addition
60	High Bay Laboratory
61	Standby Propane Plant
62	Materials & Chemical Sciences
63	Accelerator & Fusion Research
64	Accelerator & Fusion Research

65	Data Processing Services
66	Surface Science & Catalysis Lab
68	Upper Pump House
69	Business Services, Materiel Management, Mail Room & Purchasing
70	Nuclear Science, Applied Science & Earth Sciences
70A	Nuclear Science, Materials & Chemical Sciences & Earth Sciences
71	Heavy Ion Linear Accelerator (HILAC)
71A	HILAC Rectifier
71B	HILAC Annex
72	National Center for Electron Microscopy (NCEM)
72A	High Voltage Electron Microscope (HVEM)
72B	Atomic Resolution Microscope (ARM)
72C	ARM Support Laboratory
73	Atmospheric Aerosol Research
74	Research Medicine/Radiation Biophysics, Cell & Molecular Biology Laboratory
74B	Research Medicine/Radiation Biophysics, Cell & Molecular Biology Laboratory Annex
75	Radioisotope Service & National Tritium Facility (NTLF)
75A	Compactor, Processing & Storage Facility
76	Construction & Maintenance & Craft Shops
77	Mechanical Shops
77A	Ultra High Vacuum Assembly Facility (UHV)
78	Craft Stores
79	Metal Stores
80	Electronics Engineering
80A	Office Building
81	Liquid Gas Storage
82	Lower Pump House
83	Lab Cell Biology
88	88-Inch Cyclotron
90	Applied Science, Employment, Engineering, Occupational Health, Personnel, Protective Services

SMALL BUILDINGS AND TRAILERS

B-13A	Environmental Monitoring West of 88
B-13B	Environmental Monitoring West of 90
B-13C	Environmental Monitoring South of UC Recreation Area
B-13D	Environmental Monitoring North of 71
B-13E	Sewer Monitoring Station, Hearst Avenue
B-13F	Sewer Monitoring Station, Strawberry Canyon
B-13G	Waste Monitoring Station, West of 70

Table 1. Key to LBL Buildings Shown in Figure 1

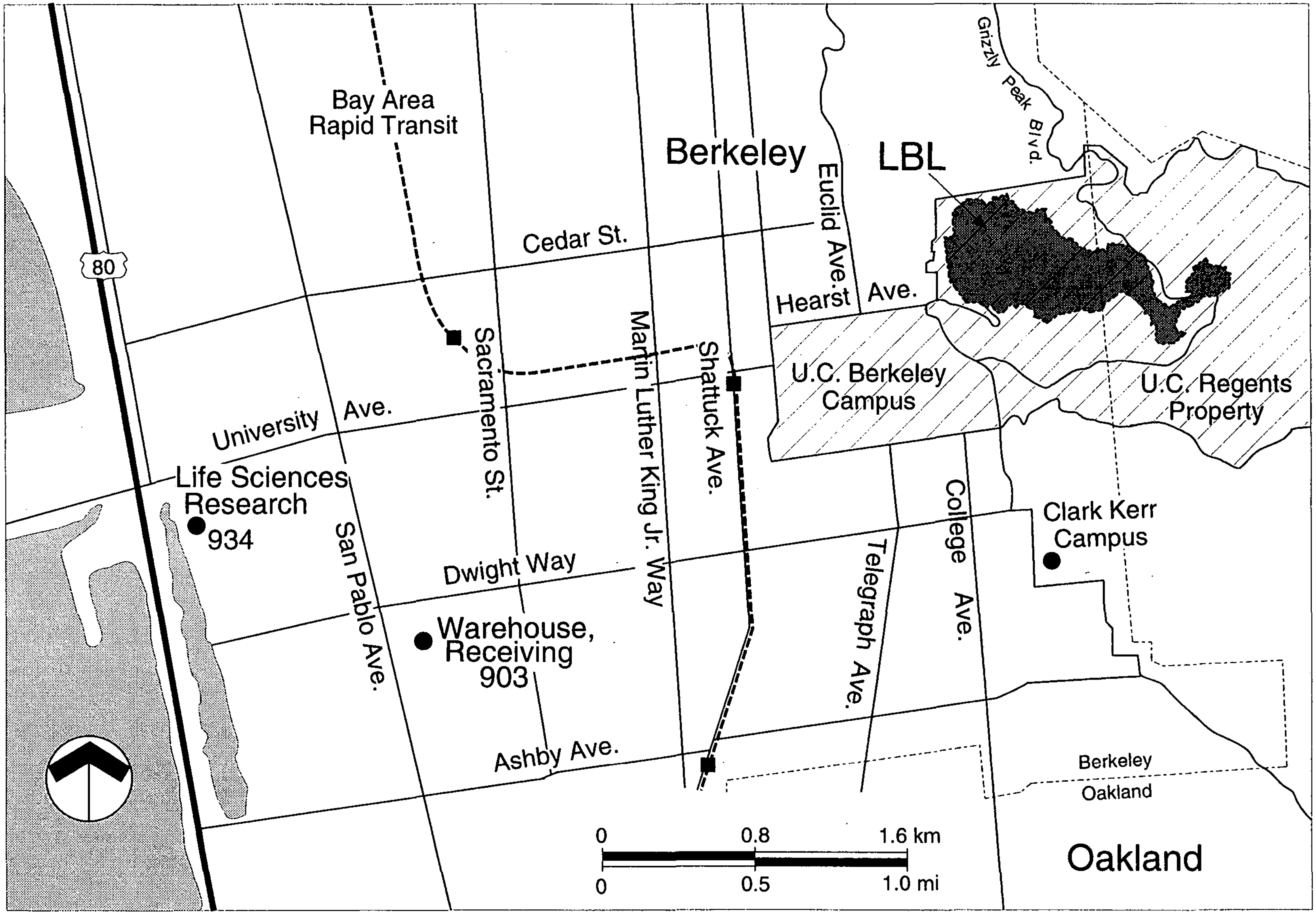


Figure 2. LBL Off site Laboratories & Vicinity Map

The Site

LBL is situated upon a hillside above the main campus of UC. The 54-hectare (134-acre) site is located on the west-facing slope of the Berkeley Hills, at elevations ranging from 150 to 300 meters (500 to 1,000 feet) above sea level within the Cities of Berkeley and Oakland. It is located about five kilometers (three miles) east of San Francisco Bay and about 25 kilometers (fifteen miles) east of the City of San Francisco (Figure 3).

LBL is located in an urban environment on land owned by UC. On all sides of the Laboratory is a buffer zone of UC land. In addition, the Laboratory maintains a landscape buffer zone between its facilities and the site boundary. Beyond the northern side of the buffer zone there are predominantly single-family homes and beyond the west side are multiunit dwellings, student residence halls, and commercial districts. The area to the east and south, which is part of the University lands, is maintained in a largely natural state and includes recreational facilities and the University Botanical Garden. The population within an 80-km (50-mi) radius of the Laboratory is approximately 5.1 million (1980 census).

The Laboratory's activities are conducted on site and off site. LBL activities take place in structures totaling 180,000 gross square meters (gsm), or 1.97M gross square feet (gsf). The buildings are on the LBL hillside site, plus additional facilities located on the University campus, notably the Donner Laboratory of Biology and Medicine (Building 1) and the Melvin Calvin Laboratory (Building 3). The on site space consists of 125,000 gsm in about 60 buildings: 121,000 gsm in DOE buildings and trailers, and 4,000 gsm in University-owned buildings. Off site space utilized by LBL consists of 25,000 gsm in various University buildings on the UC at Berkeley (UCB) campus and 14,000 gsm in leased facilities in Emeryville and Berkeley.

In 1994 the Laboratory's total population was approximately 4,200, including about 700 visiting scientists and engineers. Of this total, about 3,500 are located at the main site, 500 are located in UC Berkeley campus buildings, and about 100 are in off site leased buildings.

The Climate

The climate of the LBL site is greatly influenced by its close proximity to the Pacific Ocean and its exposure to the maritime air that flows in from San Francisco Bay. Seasonal temperature variations are small, with a mean temperature difference between the summer 17°C (63°F) and winter 9°C (48°F) of only 8.5°C (15°F). Relative humidity ranges from 85%-90% in the early morning to 65%-75% in the afternoon. The average annual rainfall is 64 cm (25 inches). About 95% of the rainfall occurs from October through April, and intensities are seldom greater than 1.3 cm/hr (0.5 in/hr). Thunderstorms, hail and snow are extremely rare. Winds are usually light, but summer sea breezes range up to 9-13m/s (20-30 mph). Winter storm winds from the south or southwest have somewhat lesser velocities.

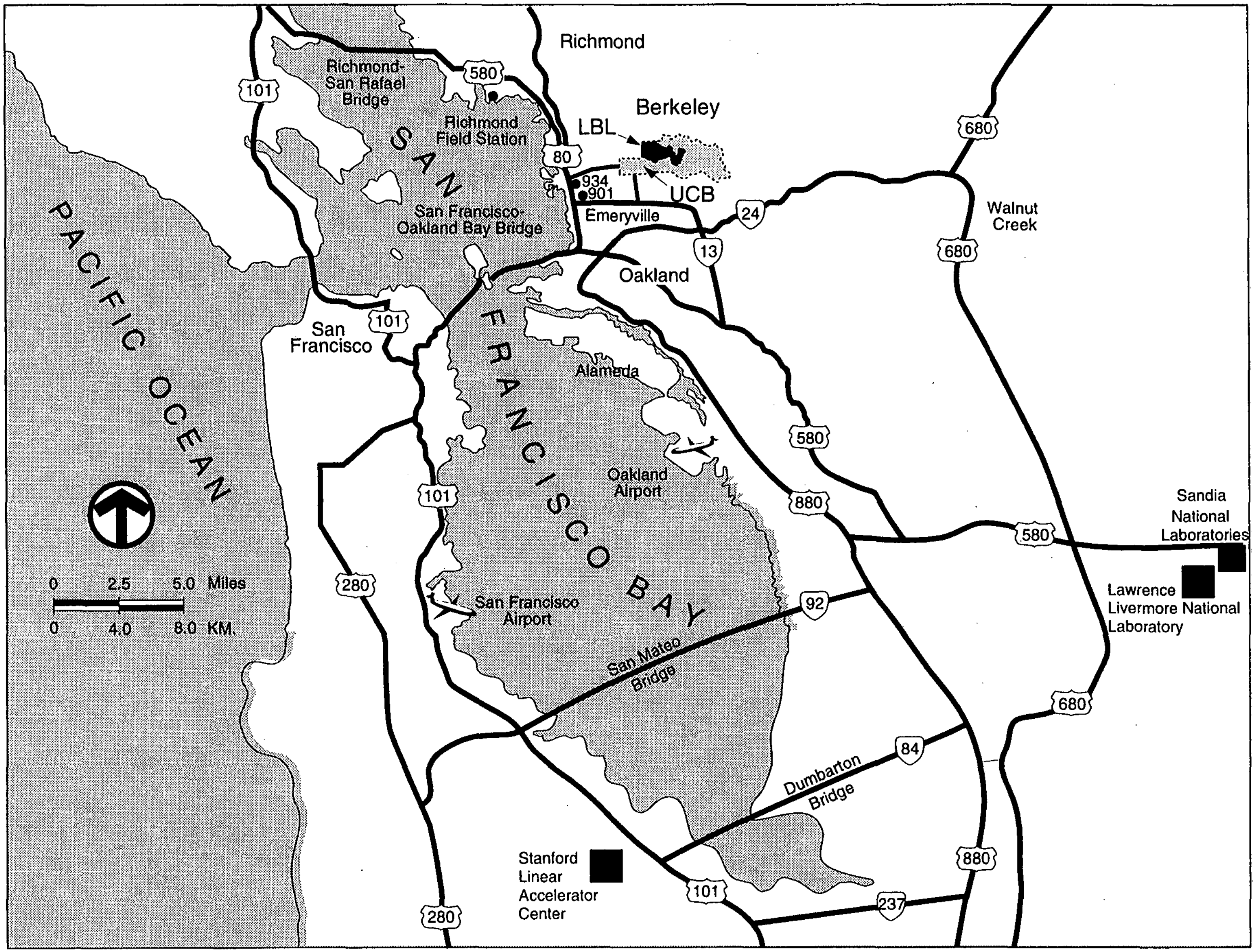


Figure 3. San Francisco Bay Area Map

Compliance Status of Lawrence Berkeley Laboratory :

On April 23, 1991, LBL received a Finding of Violation (FOV) from Region IX of the United States Environmental Protection Agency (EPA). The FOV was for the failure to evaluate *all* radionuclide release points and determine the monitoring requirements at LBL in accordance with Section 61.93, 40 CFR 61 Subpart H of the National Emission Standard for Hazardous Air Pollutants: Radionuclides (NESHAP). Even though LBL is fully in compliance with the exposure standard of 10 mrem to a maximally exposed off site individual (MEI), the laboratory is not in compliance with the monitoring requirements of the regulation. During CY91, LBL identified all actual and potential sources of dispersible radionuclides, evaluated all release point discharges, and proposed monitoring strategies to EPA for each stack or vent (see Table 2). During CY92 LBL obtained funding and initiated 3 monitoring upgrade projects, completed preliminary designs for the proposed monitoring systems, and prepared bid documents for Project 1 (Project 1 included stacks subject to periodic confirmatory monitoring). Proposals were received and vendors hired for the remaining projects 2 and 3 by November 1993. A Federal Facilities Compliance Agreement (FFCA) with Region IX EPA was finalized and executed in August 1993. In accordance with the FFCA compliance schedule, LBL completed the 3 NESHAPs monitoring upgrade projects in February 1995.

Table 2. Summary of NESHAPs Compliance Strategy for Monitoring Emissions in 1995

EDE Criteria [mrem/year]	Category	Descriptions	Number of Sources (1993)
EDE $\geq$ 10.0	Non-compliant	Reduce or relocate source term and re-evaluate prior to authorization.	0
10.0 > EDE $\geq 1.0 \times 10^{-1}$	I	• Continuous sampling required • Telemetry for nuclides with half-lives < 100 hours • EPA Application to Construct or Modify required.	4
1.0×10^{-1} > EDE $\geq 5.0 \times 10^{-2}$	II	Continuous sampling with weekly analysis.	0
5×10^{-2} > EDE $\geq 1.0 \times 10^{-2}$	III	Continuous sampling with monthly analysis.	1
1.0×10^{-2} > EDE $\geq 1.0 \times 10^{-3}$	IV	Sampled annually during project activity.	6
EDE $< 1.0 \times 10^{-3}$	V	Inventory controlled by Radiation Work Permit and periodic evaluation. No monitoring required	57

Source Description:

LBL employs a wide variety of radionuclides in its radiochemical and biomedical research programs. In addition, radioactive materials are inevitably produced by the operations of the charged particle accelerators, such as the 88-Inch Cyclotron. Table 3 characterizes most of the dominant radionuclides used/monitored at LBL during CY94.

Table 3. Radionuclides Used/Monitored at LBL During CY94

Nuclide Name (Atomic Number)	Radio - Nuclide Symbol	Principal Radiation Types*	Principal Energy (MeV)	Half-Life
Americium (95)	Am-241	α γ	5.4 0.059	432 years
Argon (18)	Ar-41	β γ	1.2 1.3	1.83 hours
Carbon (6)	C-11	β^+/γ	0.511	20.5 minutes
Carbon (6)	C-14	β	0.156	5730 years
Curium (96)	Cm-248	α	5.08	3.39E+5 years
Cobalt (27)	Co-60	β γ	0.318 1.33	5.27 years
Fluorine (9)	F-18	β^+/γ	0.511	109.7 minutes
Hydrogen /Tritium (1)	H-3	β	0.0186	12.28 years
Iodine (53)	I-125	γ	0.027	60.14 days
Nitrogen (7)	N-13	β^+/γ	0.511	9.97 minutes
Nickel (28)	Ni-63	β	0.066	100.1 years
Oxygen (8)	O-15	β^+/γ	0.511	122 seconds
Phosphorus (15)	P-32	β	1.71	14.3 days
Rubidium (37)	Rb-86	β γ	1.77 1.08	18.66 days
Sulfur (16)	S-35	β	0.167	87.44 days
Strontium (38)	Sr-90	β	0.546	28.6 years
Thorium (90)	Th-232	α β	4.01 0.04	1.4E+10 years
Uranium (92)	U-238	α β	4.2 0.029	4.47E+9 years
Zinc (30)	Zn-65	γ	1.12	244 days
Zirconium (40)	Zr-95	β γ	0.4 0.757	64 days

(*) α = Alpha Particles β =Beta Particles γ =Gamma Rays

Of these radionuclides, the most commonly and widely used radionuclides in the research program are: H-3, C-14, F-18, P-32, S-35, and I-125. Radioactive gases produced by the accelerator operations are mainly short-lived radionuclides such as C-11, N-13, O-15, and Ar-41. These induced radioactive gases are normally produced in areas where the beam strikes beamline components.

LBL conducts operations in 18 laboratory buildings which have the potential to emit radionuclides into the atmosphere. Based on past/historical emission experience, LBL has identified 4 release points that are potentially subject to the continuous monitoring requirement of Section 61.93 of NESHAPs standard. However, only 1 of these release points, the National Tritium Labeling Facility (NTLF) stack in Building 75 was continuously monitored during CY94. Except for the Building 75 Tritium Stack, all other LBL's sources which were operational during CY94 are "small sources". That is, the effective dose equivalent (EDE) from each source is much less than 0.1 mrem/yr (1.0E-3 mSv/yr), the NESHAPs threshold limit for continuous monitoring.

During CY94, discharge points with the most significant potential for routine or accidental release are continuously or periodically sampled. The exception to this are the air activation product discharges from accelerators, which were not monitored during CY94. However, monitoring equipment has been recently installed to these accelerator stacks and will be in full operation by January 1995. The CY94 discharges from LBL accelerators were estimated using a model developed in Patterson, H.W., and Thomas, R.H., *Accelerator Health Physics*, Academic Press, New York, NY, 1973, pp. 519-531. Very small sources, that is, sources with potential for routine annual off site EDE impacts of less than 1.0E-2 mrem (1.0E-4 mSv) are, in general, <u>not</u> sampled continuously. As a part of the FFCA, LBL formalized the foregoing process and proposed a graded strategy for performing the "periodic confirmatory monitoring" called for in Section 61.93 (b)(4)(i) of the 40 CFR 61. Monitoring requirements are based on dose modeling with no emission controls in place. Table 2 summarizes the NESHAPs compliance strategy for monitoring requirements at LBL which will be implemented in 1995.

Research activities with low potential impact (EDE < 0.01 mrem (< 10^{-4} mSv) in a year) are carried out in unfiltered fume hoods. Activities with higher potential impact are performed in systems with appropriate exhaust filters or absorbers in place.

Many of LBL release points qualify as "grouped sources" as described in the DOE guidance for the preparation of this document. The following grouping criteria were used:

- The sum of the EDEs attributable to all stacks in the group must be < 0.1 mrem (< 10^{-3} mSv).
- Sources must be in close proximity (same or nearby building), and/or similar operations with similar nuclides are carried out in the facilities.

- Sources grouped in the description section may not be grouped in the dose assessment section if the critical receptors are not the same.

As identified in Figure 2, Buildings 1, 3, and 934 are located outside of LBL's main perimeter and should technically be labeled as three separate "facilities" since they are not on one "contiguous site". However, Building 1 and Building 3 are located on UC land and are within walking distances from the main LBL site. Building 934 is about five kilometers from the main site. Annual radioactive air emissions from these off site buildings are very small compared to other on site emission sources. In fact, the EDE of each local MEI due to local airborne releases associated with these off site buildings is several orders of magnitude lower than the contribution due to the tritium release from the main LBL site. Thus, it would be inappropriate and misleading to model and report these much lower EDEs separately. Therefore, for reporting and dose modeling purposes, all of these off site buildings will be considered as being on one contiguous LBL site.

For each release point, the EPA-approved atmospheric dispersion dose calculation computer code, CAP88-PC, was used to estimate the Effective Dose Equivalent (EDE) to an off site maximally exposed individual (MEI). A total of fourteen CAP88-PC computer model assessments were separately performed to simulate five point sources, eight grouped sources, and one non-point (diffuse) source for dose assessment during CY94. These release points are discussed below:

1. Building 1 (Donner Laboratory): Cell and molecular biology studies are performed in this facility. The building is located on the University of California campus. The predominant nuclides used are H-3, C-14, P-32, S-35, and I-125 as labeled amino acids and DNA precursors. Many non-LBL employees (i.e., UC) also share this building for various other researches. Work is mostly done on bench tops and in hoods. Releases are from building vents and hoods (11 stacks). Five Stacks in Building 1 are sampled periodically. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 4.

Table 4. Building 1 Release Point Characteristics

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	CAP88 MEI EDE [mrem** /yr]	% Total EDE
9	10	ESE	School	U-238	2.4E-07	3.20E-04	96.46%
				P-32	1.6E-07	2.68E-08	0.01%
				I-125	1.1E-06	1.17E-05	3.53%
					TOTAL:	**3.32E-4**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

2. Building 2 (Advanced Material Laboratory & Center for X-ray Optics): One semiconductor research group uses germanium which contains nanocurie (nCi) quantities (a nanocurie is 37 Bq) of activation impurities. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 5.

Table 5. Building 2 Release Point Characteristics

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	CAP88 MEI EDE [mrem** /yr]	% Total EDE
20	370	NE	School	Co-60	3.4E-14	7.78E-13	100.00%
					TOTAL:	**7.78E-13**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

3. Building 3 (Calvin Laboratory): Cell and molecular biology studies are performed in this laboratory. As with to the Building 1, this buildings is also located on the University of California campus. The predominant nuclides used are H-3, P-32, S-35, and ^{14}C as labeled amino acids and DNA precursors. $^{14}CO_2$ is also used in this laboratory as an "incubant." Building 3 is wholly occupied by LBL personnel. Work is done on bench tops and in hoods. Releases are from building vents and hoods (5 stacks). Four stacks in Building 3 are sampled periodically. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 6.

Table 6. Building 3 Release Point Characteristics

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	CAP88 MEI EDE [mrem** /yr]	% Total EDE
15	60	S	Res. & Business	C-14	4.1E-04	1.06E-05	1.25%
				Th-232	6.3E-07	8.11E-04	95.5%
				I-125	6.9E-06	2.76E-05	3.25%
					TOTAL:	**8.49E-4**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

4. Building 6 (Advanced light Source): The Advanced Light Source (ALS) came on line in August 1993. The Advanced Light Source is an electron accelerator/storage ring which was designed to produce intense beams of soft X-rays. The ALS injector produces stray neutrons during its operation which activate the air in the injector vault. As the ALS is a low power accelerator, compared to LBL's other accelerators, its inventory of air activation products is substantially lower than the 88-inch Cyclotron. The maximum potential annual releases of N-13 and O-15 (the important air activation products of the ALS) are computed to be 0.084 Ci (3 x 10^9 Bq) and 0.006 Ci (2 x 10^8 Bq) respectively. Thus, the ALS is a very small source and continuous monitoring is not necessary. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 7.

Table 7. Building 6 Release Point Characteristics

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	CAP88 MEI EDE [mrem** /yr]	% Total EDE
19	360	NE	School	N-13	8.4E-02	1.10E-04	94.82%
				O-15	5.9E-03	6.01E-06	5.18%
					TOTAL:	**1.16E-04**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

5. Building 26 (Medical Services & Bioassay/Radioanalytical Laboratory): The LBL bioassay/radioanalytical laboratory is the only radionuclide user in this building. Trace quantities of a variety of radionuclides are used in sample spiking and standards preparation. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 8.

Table 8. Building 26 Release Point Characteristics

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	CAP88 MEI EDE [mrem** /yr]	% Total EDE
8	240	N	School	S-35	3.0E-05	1.21E-06	100.00%
					TOTAL:	**1.21E-06**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

6. Building 55 (Research Medicine & Radiation Biophysics): The primary radiological activities carried out in Building 55 are positron emission tomography (PET) and metabolic studies using F-18. The radiological activities take place in 2 laboratories and a PET camera room. Operations with radioiodine are done in a HEPA and Tetraethylene Diamine (TEDA)-doped carbon-filtered enclosures. Two radioisotope hoods and the radioiodine box stacks are sampled continuously. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 9.

Table 9. Building 55 Release Point Characteristics

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	CAP88 MEI EDE [mrem** /yr]	% Total EDE
9	170	N	Residence	Rb-86	1.6E-06	3.69E-07	0.01%
				I-125	1.7E-05	1.97E-04	5.90%
				P-32	4.6E-05	7.24E-06	0.22%
				Th-232	8.7E-8	3.54E-04	10.60%
				F-18	3.0E-01	2.78E-03	83.27%
					TOTAL:	**3.34E-3**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

7. Buildings 62 (Material & Chemical Science): Building 62 has only one radionuclide user. A thorium aerosol study with milligram quantities of 0.1 μCi thorium spheres is performed in one lab in Building 62. Operations in Building 62 are carried out in enclosures whose exhaust streams are HEPA filtered. The 62 stack is sampled periodically. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 10.

Table 10. Building 62 Release Point Characteristics

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	CAP88 MEI EDE [mrem** /yr]	% Total EDE
13	240	E	Workplace	Th-232	2.8E-09	5.02E-06	100.00%
					TOTAL:	**5.02E-06**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

8. Buildings 70 & 70A (Nuclear, Material, Chemical, and Earth Sciences): Programs carried out in these facilities include super heavy nuclear studies, waste migration studies (tracer amounts), and nuclear chemical studies. There are also two biological science groups in 70A. The radioactive works are carried out by five research groups in 14 of the many small laboratories within the two buildings. Emissions are released through 21 stacks, 19 of which are sampled continuously. Discharges from the two stacks from the biology group's Laboratories are controlled by inventory of the Radiation Work Authorization (RWA) and periodic evaluation. In addition, there is also a pit storage room where radionuclides are stored in a fireproof pit in closed containers. A summary of the CAP88-PC source term input parameters and EDE results for these release points is presented in Table 11.

Table 11. Buildings 70&70A Release Point Characteristics

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	CAP88 MEI EDE [mrem** /yr]	% Total EDE
13	330	W	Dormitory	Th-232	1.6E-5	2.87E-2	93.19%
				Cm-248	2.0E-07	2.05E-3	6.66%
				Zr-95	9.0E-5	4.68E-5	0.15%
				I-125	3.5E-7	2.01E-6	0.01%
					TOTAL:	**3.08E-2**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

9. Buildings 74/74B (Research Medicine) & 83 (Cell Biology): These buildings include a wide variety of cell biology, virology, research medicine, and human genome projects. Releases from 74 and 74B come from hoods and stacks that vent individual workplaces. The Research Medicine Group prepares ^{18}Fluorodeoxyglucose (F-18) for administration to patients in Building 55. Building 83 vents are through HEPA-filtered biological cabinets. Research activities which involve I-125 are normally carried out in TEDA-doped activated-carbon-filtered enclosures. Eleven stacks in Building 74, three stacks in Building 74B, and one stack from Building 83 (a total of 14) are sampled. A summary of the CAP88-PC source term input parameters and EDE results for these release points is presented in Table 12.

Table 12. Buildings 74/74B&83 Release Point Characteristics

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	CAP88 MEI EDE [mrem** /yr]	% Total EDE
7	120	S	School	Ni-63	2.6E-06	1.82E-7	0.00%
				I-125	4.4E-05	7.40E-4	1.43%
				Am-241	3.6E-08	3.41E-4	0.66%
				Sr-90	3.9E-05	6.08E-4	1.17%
				S-35	3.8E-06	2.81E-7	0.00%
				F-18	2.0E-00	2.94E-2	56.77%
				Th-232	3.3E-6	2.07E-2	39.97%
				H-3	6.1E-4	2.5E-6	0.00%
					TOTAL:	**5.2E-02**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

10. Building 75 (National Tritium Labeling Facility): The NTLF is mainly used for activities in which a wide variety of molecules are labeled with tritium and purified for further use in chemical, biochemical, and radio pharmaceutical studies. There are two stack release points for these activities, both of which are continuously sampled. The radionuclide releases are in the form of gaseous tritium (HT, T_2) or tritiated water (HTO, T_2O).

Currently, only tritiated water releases are quantified. Gaseous tritium releases are not quantified because its impacts are 1/25,000 of those of comparable releases of tritiated water. However, LBL will soon be quantifying both forms of tritium release on the continuous basis when the installation of the new real-time tritium monitoring stations being completed in February 1995. Normally, about 97% of tritium release comes from the stack (tritium trunk) located in the northern hillside from Building 75. This stack is the closest discharge point to the maximally exposed off site individuals (MEI). The other discharge point from the NTLF, located on the roof of Building 75, is further from off site individuals and released less than 3% of the yearly discharges. For CAP88-PC modeling, all tritium releases from the NTLF are conservatively assumed to be originated from the first stack (tritium trunk). This release point is the only "major source" at LBL that results in more than 1% of the NESHAPs EDE dose standard. For reporting purposes, the MEI of this release point is also identified as the MEI for the whole LBL site during CY94. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 13.

Table 13. Building 75 Release Point Characteristics

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	CAP88 MEI EDE [mrem** /yr]	% Total EDE
10	110	NW	School	H-3	1.15E+02	2.6E-01	100.00%
					TOTAL:	**2.36E-01**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

11. Building 75A (Hazardous Waste Handing Facility / Point Source): The LBL hazardous waste handling facility is located in Buildings 75A and part of Building 75. Bags of radioactive waste stored in a ventilated cabinet in Building 75A outgassed about 60 µCi (2.2 x 10^6 Bq) of ^{125}I. Summaries of the CAP88-PC's source term input parameters and EDE results for this point source Building 75A are presented in Table 14.

Table 14. Building 75A Release Point Characteristics (Point Source)

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	CAP88 MEI EDE [mrem** /yr]	% Total EDE
8	150	NW	School	H-3	3.0E-02	1.03E-04	4.02%
				Th-232	4.7E-07	2.39E-03	93.37%
				Sr-90	1.3E-07	2.86E-06	0.11%
				I-125	1.6E-06	2.48E-05	0.97%
				C-14	4.1E-04	3.90E-05	1.52%
					TOTAL:	**2.56E-3**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

12. Building 75A (Hazardous Waste Handing Facility / Diffuse Source): In addition, Building 75A is also considered as a diffuse source of HTO, as HTO waste is processed and stored in the building. Summaries of the CAP88-PC's source term input parameters and EDE results for this diffuse source of Building 75A are presented in Table 15.

Table 15. Building 75A Release Point Characteristics (Diffuse Source)

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	CAP88 MEI EDE [mrem** /yr]	% Total EDE
1	150	NW	School	H-3	3.0E-02	1.29E-03	100.00%
					TOTAL:	**1.29E-03**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

13. Building 88 (88-inch Cyclotron): This building houses an 88-inch diameter sector-focused cyclotron used in a wide variety of research applications. Beams of ions from H+ through uranium are accelerated onto targets used for nuclear studies. The primary airborne impact to an off site individual from this facility is attributable to short-lived air activation radionuclides (mostly positron emitters) produced in the cyclotron vault during the fraction of the beam year when intense light ions are accelerated, approximately 10% of the time during CY94. There is presently no active stack monitor for these activation products. Releases were estimated as described previously in this report. However, LBL is currently upgrading these facilities with positron monitoring devices to fully quantify/characterize for these air activation radionuclides. The CY94 releases were estimated at 10% of the theoretical maximum. The quantity of activation products is controlled by the fraction of the beam year spent running light ions, and limits on circulating beam current. Small amounts of actinide radionuclides and other radioactive targets are monitored at experimental cave, fume hood, and glove box discharges. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 16.

Table 16. Building 88 Release Point Characteristics

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	CAP88 MEI EDE [mrem** /yr]	% Total EDE
12	110	W	Residence	N-13	1.5E+00	5.53E-03	30.63%
				O-15	8.1E-01	2.54E-03	14.07%
				C-11	1.0E+00	3.88E-03	21.49%
				I-125	8.9E-06	6.32E-05	0.35%
				Ar-41	6.5E-02	3.06E-04	1.70%
				Cm-248	4.8E-07	5.72E-03	31.69%
				Zn-65	4.8E-06	1.27E-05	0.07%
					TOTAL:	**1.81E-02**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel (**) 1 mrem = 1.0E-2 mSv

14. Building 934 (Molecular and Cell Biology): This building is located off site, roughly 5 kilometers (3 miles) from LBL. The radiological activities include cell and molecular biology research. Also, forensic DNA investigations are carried out by a group from the California Department of Justice. The research employs RNA and DNA precursors and amino acids labeled with H-3, C-14, P-32, S-35, and I-125. Metabolism of S-35 amino acids produces $^{35}SO_2$, which is released to the atmosphere. Previous studies indicated that less than 0.1% of the activity incubated is available for release. Currently, no stacks are sampled at this location. A summary of the CAP88-PC source term input parameters and EDE results for this release point is presented in Table 17.

Table 17. Building 934 Release Point Characteristics

Release Height [meter]	Local MEI Distance [meter]	Local MEI Dir.	Local MEI Description	Radio Nuclide	Annual Release [Ci*/yr]	CAP88 MEI EDE [mrem** /yr]	% Total EDE
4	38	N	Business	S-35	3.0E-04	3.84E-05	3.66%
				I-125	2.0E-05	1.01E-03	96.34%
					TOTAL:	**1.05E-03**	**100.00%**

(*) 1 Ci = 3.7E10 Becquerel

(**) 1 mrem = 1.0E-2 mSv

Section II. Air Emissions Data

Point Source	# of Stacks	Type Control	Efficiency [%]	Distance to Nearest Receptor
Building 2	1	None	0	370 m (School)
Building 6	1	None	0	360 m(School)
Building 62	1	HEPA	> 99	240 m (Workplace)
Building 75A	1	TEDA-DAC HEPA(2)	> 75	150 m (School)
Building 88 Vault	1	None(1)	0	110 m (Residence)

Grouped Source	# of Stacks	Type Control	Efficiency [%]	Distance to Nearest Receptor
Building 1 Stacks	11	None(3)	0	10 m (School in the same Building)
Building 3 Stacks	3	None(3)	0	60 m (Workplace)
*Buildings 26	2	HEPA	>99	240 m (School)
Building 55 Stacks	5	HEPA TEDA-DAC(2)	>99 >75	170 m (Residence)
Buildings 70 & 70A(4) Stacks	20	HEPA (Manifolds) None (Hood)	>99 0	330 m (Dormitory)
Buildings 74, 74B & 83 Stacks	14	TEDA-DAC(2) None	>75 0	120 m (School)
Building 75 (NTLF)	2	Silica Gel(5)	>99	110 m (School)
*Building 934 Stacks	9	None(3)	0	38 m (Business)

* Not monitored, emissions estimated.

Non-Point Source	Radionuclide	Annual Quantity
Building 75A (Waste processing Area)	HTO	0.06 Ci (2.0 x 10^9 Bq)

Notes:

(1) The Radionuclides released from the accelerators are air activation products which are impractical to control.

(2) Tetraethylene Diamine (TEDA) -doped activated carbon traps.

(3) The uncontrolled releases are from LBL fume hoods which are unfiltered.

(4) The stacks included in this group source vent a number of laboratories whose research employs µCi and mCi (between 3.7 x 10^4 and 3.7 x10^7 Bq) quantities of a number of actinides. The most conservative dose-equivalent representative of the actinides was used.

(5) Silica gel traps are >99% efficient traps for HTO as long as they are changed before breakthrough. NTLF personnel regularly change traps when working in the facility.

Quantities of nuclides released from LBL stacks contributing more than 10% of the EDEs from a release point during CY94 are given in Table 18. These data are used to calculate the collective population dose for CY94.

Table 18. Total Air Effluent Potentially released During CY94

Nuclide	**Total Air Effluent** [Ci/yr]	[Bq/yr]	**% Total Effluent**
H-3	1.2E+02	4.26E+12	93.89%
F-18	2.3E+00	8.66E+10	1.91%
N-13	2.3E+00	8.57E+10	1.89%
O-15	1.4E+00	5.18E+10	1.14%
C-11	1.4E+00	5.00E+10	1.10%
Ar-41	8.0E-02	2.97E+09	0.07%
C-14	8.2E-04	3.03E+07	0.00%
S-35	3.4E-04	1.24E+07	0.00%
I-125	1.0E-04	3.70E+06	0.00%
Zr-95	9.0E-05	3.33E+06	0.00%
P-32	4.8E-05	1.76E+06	0.00%
Sr-90	4.0E-05	1.47E+06	0.00%
Th-232	2.1E-05	7.66E+05	0.00%
Zn-65	4.8E-06	1.78E+05	0.00%
Ni-63	2.6E-06	9.58E+04	0.00%
Rb-86	1.6E-06	5.92E+04	0.00%
Cm-248	6.8E-07	2.52E+04	0.00%
U-238	2.4E-07	8.88E+03	0.00%
Am-241	3.6E-08	1.35E+03	0.00%
Co-60	3.4E-14	1.26E-03	0.00%
TOTAL:	**1.23E+02**	**4.53E+12**	**100%**

Section III. Dose Assessments

Description of Dose Model

To meet DOE guidance, the EPA atmospheric dispersion/radiation dose calculation computer code, CAP88-PC version 1.0, was used to calculate the Effective Dose Equivalent dose to an individual within each population segment at various distances and from various release points. A total of fourteen CAP88-PC "individual" runs were executed to model 14 single/grouped release points as described in Section II. As mentioned previously, the NTLF (Building 75) was identified as the major release point at LBL, therefore, the Maximally Exposed Individual associated with this facility was also specified (with appropriate distances and directions) in each of these fourteen "individual" CAP88-PC runs. The reported EDE to a MEI at LBL includes contributions from all of these fourteen CAP88-PC models (see Table 19).

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. One "population" CAP88-PC run was used to carry out this population dose assessment. This CAP88-PC model is based on the input parameters from the Building 75 computer run, with the source terms replaced by all the radionuclides listed in Table 18. A summary of this collective dose assessment attributed to each radionuclides is given in Table 20.

Summary of Input Parameters

The CY94 radioactivity air emissions were either measured or conservatively derived are shown in Table 18 in Section II.

As on site meteorology was not available, the meteorological data used with CAP88-PC was taken from the OAK0319.WND file that came with the CAP88-PC distribution diskette. These meteorological data were measured at the Oakland airport. The use of these data had been formally approved by EPA region IX. LBL is taking steps to collect and use on site meteorological data for performing dose assessments. LBL completed a preliminary study of meteorological monitoring, siting, equipment, and quality assurance requirements during CY91. Meteorological monitoring equipment was installed at the LBL site in 1993 and has been collecting data since January 1994. These data must be quality assured against specific criteria before deemed acceptable for use with CAP88-PC modeling.

Table 19. Summaries of Dose Assessment from All LBL Release Points

		Relative to the Specified Building					Relative to the MEI of Building 75			
Building Number	**Building Name**	**Release Height [meter]**	**Local MEI Distance [meter]**	**Local MEI Dir.**	**Local MEI Description**	**Local MEI Dose [mrem*/yr]**	**BLD-75 MEI Distance [meter]**	**BLD-75 MEI Dir.**	**BLD-75 MEI Dose [mrem*/yr]**	**% Total EDE**
BLD-1	Donner Laboratory @UCB	9	10	ESE	School	1.3E-05	980	ENE	2.1E-05	0.01%
BLD-2	Advanced Material Lab.	20	370	NE	School	1.3E-13	370	NE	1.3E-13	0.00%
BLD-3	Calvin Lab @UCB	15	60	S	Res. & Business	1.1E-04	1070	NE	7.6E-05	0.05%
BLD-6	Advanced Light Source (ALS)	19	360	NE	School	2.6E-05	370	NNE	1.8E-05	0.01%
BLD-26	Medical Services & Counting Lab.	8	240	N	School	9.6E-07	240	N	9.60E-07	0.00%
BLD-55	Research Med & Rad Bio	9	170	N	Residence	8.2E-04	490	E	6.3E-04	0.44%
BLD-62	Materials & Chem. Science	13	240	E	Workplace	3.4E-06	650	NW	7.5E-07	0.00%
BLD-70 & 70A	Nuclear / Applied Science	13	330	W	Dormitory	5.4E-03	510	NE	3.6E-03	2.54%
BLD-74, 74B & 83	Buildings 74/74B/83 Research Med.	7	120	S	School	1.5E-02	730	WNW	4.2E-03	2.96%
BLD-75	National Tritium Labeling Facility	10	110	NW	School	1.3E-01	110	NW	1.3E-01	91.66%
BLD-75-127 & 75A	Hazardous Waste Handling Facility	8	150	NW	School	6.7E-04	150	NW	6.7E-04	0.47%
BLD-75A (D)	Waste Storage Area (Diffuse)	1	150	NW	School	3.7E-04	150	NW	3.7E-04	0.26%
BLD-88	88-Inch Cyclotron	12	110	W	Residence	2.5E-03	670	ENE	1.7E-03	1.20%
BLD-934	Molecular & Cell Bio. (off site)	4	38	N	Business	7.0E-04	4900	ENE	5.4E-04	0.38%
								TOTAL:	**1.42E-01**	**100.00%**

(*) 1 mrem = 1.0E-2 mSv

Table 20. Summary of Collective (Population within 80 km of LBL) EDE Assessment

Nuclide	Collective EDE [Person-rem* /yr]	% Total Collective EDE
H-3	1.32E+00	71.70%
TH-232	3.24E-01	17.60%
F-18	5.94E-02	3.23%
CM-248	5.93E-02	3.22%
N-13	1.74E-02	0.95%
C-11	1.64E-02	0.89%
TL-208	1.57E-02	0.85%
AC-228	1.41E-02	0.77%
O-15	3.07E-03	0.17%
BI-212	2.59E-03	0.14%
PB-212	2.36E-03	0.13%
AR-41	2.32E-03	0.13%
U-238	1.21E-03	0.07%
SR-90	1.00E-03	0.05%
AM-241	8.35E-04	0.05%
ZR-95	4.10E-04	0.02%
I-125	3.77E-04	0.02%
C-14	1.62E-04	0.01%
RA-224	1.57E-04	0.01%
ZN-65	6.75E-05	0.00%
TH-228	3.98E-05	0.00%
S-35	2.32E-05	0.00%
P-32	2.10E-05	0.00%
RA-228	8.87E-06	0.00%
RN-220	7.81E-06	0.00%
RB-86	1.12E-06	0.00%
NI-63	3.39E-07	0.00%
PO-216	2.08E-07	0.00%
CO-60	1.08E-11	0.00%
TOTAL:	**1.84E+00**	**100%**

(*) 1 Person-rem = 1.0E-2 Person-Sv

Compliance Assessment

This compliance assessment uses the computer code CAP88-PC Version 1.0 to calculate the Effective Dose Equivalent to an off site Maximally Exposed Individual. This exposure represents the sum of impacts from all fourteen release points modeled to that location (the MEI of Building 75). Summaries of the dose assessment from each release point are presented in Table 20.

Effective Dose Equivalent: 1.4E-1 mrem/year (1.4E-3 mSv/year)

Location of Maximally Exposed Individual: School at 110 meters Northwest of Building 75

Certification

I certify under penalty of law that I have personally examined and am familiar with the informatio 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).

Signature: *[signature]* Date: 6/8/95
David C. McGraw
Division Director, Environment, Health and Safety

Signature: *[signature]* Date: 6/13/95
Richard H. Nolan
Director, DOE Berkeley Site Office

Section IV. Additional Information

Additions or Modifications

Building 56 (Biomedical Isotope Facility-BIF)
The BIF Title II design phase was in-progress during CY94. The facility will be located between Buildings 63 and 51. The BIF will provide dedicated equipment and workplaces for radio pharmaceutical preparation. The BIF will possess a customized commercial accelerator for radionuclide production and a separate radio pharmaceutical preparation area with glove box enclosures. Radio pharmaceuticals will be transferred from Building 56 to Building 55 for positron emission tomography (PET) scan imaging and research uses.

Dose assessments for Building 56 were conducted during NEPA review and Negative Declaration. Dose due to Building 56 emissions is anticipated to be less than 0.1 mrem/year. Radionuclide emissions will include F-18, N-13, O-15, C-11 from accelerator targets and subsequent radio pharmaceutical preparation. Smaller quantities of accelerator air activation products N-13, O-15, C-11, and Ar-41 will also be produced. Although the BIF is not a "major source," LBL has provided for continuous positron monitoring in the NESHAPs Project 3 monitoring upgrade.

Unplanned Releases

During 1994, there was one unplanned tritium release to the atmosphere from LBL. Continuous monitoring data collected from the NTLF stack revealed that approximately 29 Ci of HTO was released to the environment during the week of 09/23/94 to 09/30/94. The direct cause of this event was determined to be a malfunctioning heating tape on one Oxidation Loop of the NTLF Tritiation and Recovery System (TRS). The malfunctioning heating tape has been repaired. Thermocouples have been placed on all the critical areas of the oxidation loop and digital readouts installed inside the Tritiation Laboratory to prevent similar future occurrences. The dose impact from this unplanned release is estimated at 4.4x10-4 mSv (0.044 mrem) EDE to a maximally exposed individual (MEI) 110 meters northwest of Building 75 (NTLF). The reported EDE for CY94 in the Compliance Assessment of Section III includes this unplanned release contribution.

Diffuse Emissions

Fugitive emissions from stored tritium waste are estimated at less than 0.06 Ci (2.2×10^9 Bq) during CY94. The fugitive release estimate is the product of the annual average workplace HTO concentration where the tritium waste is packaged and stored, times the number of air changes in the storage building per year. The estimated EDE to an off site MEI from this diffuse emission was found to be about 1.2E-3 mrem/yr. (1.2E-5 mSv/yr.). This estimate is based on the "area" source CAP88-PC model which is highly conservative for the diffuse source (see the "BLD-75AD" CAP88-PC run).

Section V. Supplemental Information

- *Provide an estimate of collective effective dose equivalent (person-rem/yr.) for CY94 releases.*

The estimated collective effective dose equivalent (CEDE) to persons living within 80 km of LBL is 1.8 person-rem/year (1.8E-2 person-Sv) attributable to CY94 LBL airborne releases (see Table 21).

- *Provide information on the status of compliance with Subparts Q and T of 40 CFR Part 61 if applicable. Although exempt from Subpart H, provide information on Rn-220 emission from sources containing U-232 and Th-232 where emissions potentially can exceed 0.1 mrem/yr. (10^{-6} Sv/a) to the public or 10% of the non-radon dose to the public. Provide information on non-disposal/non-storage sources of Rn-222 emissions where emissions potentially can exceed 0.1 mrem/yr. (10^{-6} Sv/a) to the public or 10% of the non-radon dose to the public.*

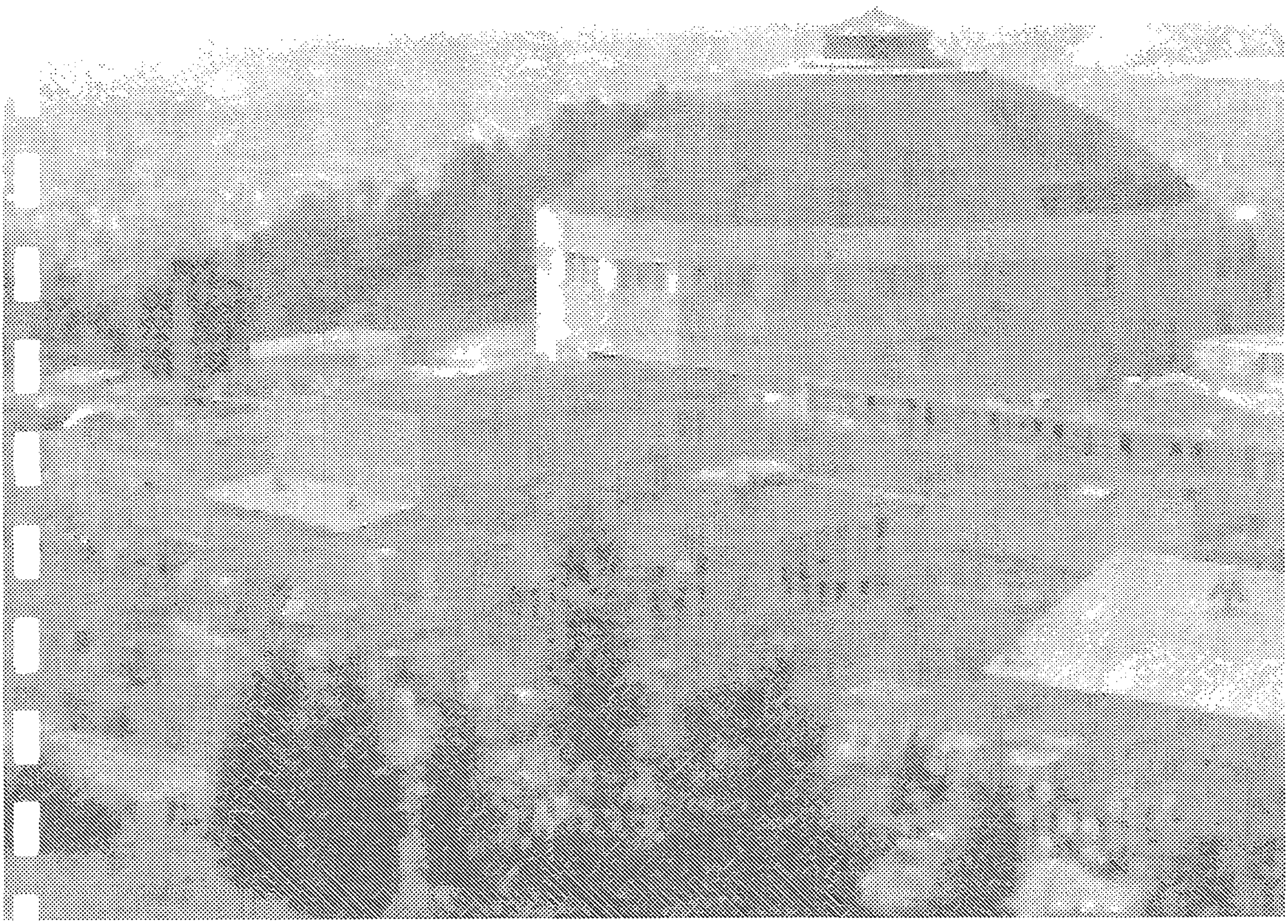
Subparts Q and T of 40 CFR 61 are not applicable to LBL, as the Laboratory does not process, manage or possess significant enough quantities of uranium mill tailings, Ra-226, U-232, or Th-232, to produce an impact of 0.1 mrem/yr. (10^{-7} Sv/a) to a member of the public.

- *For the purpose of assessing facility compliance with the NESHAPs effluent monitoring requirements of Subpart H under Section 61.93(b), give the number of emission points subject to the continuous monitoring requirements, the number of these emission points that do not comply with the Section 61.93(b) requirements, and if possible, the cost for upgrades. Describe site periodic confirmatory measurement plans. Indicate the status of the QA program described by Appendix B, Method 114.*

LBL has identified 4 points subject to the continuous monitoring requirements of 40 CFR subpart H, Section 61.93(b). During *CY94* only 1 of the 4 points produced discharges exceeding 0.1 mrem/yr (1.0E-3 mSv/yr) and was continuously monitored (sampled). The single point monitored was the NTLF main stack whose EDE was modeled at 0.2 mrem/yr (2×10^{-3} mSv). LBL has upgraded the monitoring and analytical methods to fully conform to Section 61.93(b) monitoring requirements. LBL has identified: a) all emission points and evaluated releases, b) categorized stacks by EDE, and c) suggested suitable monitoring methodology for each point. The information developed in a - c above was sent to EPA region IX during CY91 and finalized in CY93.

Under its Tiger Team action plan, LBL is upgrading all monitoring and analytical QA procedures. The program will meet or exceed all provisions contained in Appendix B method 114. The current LBL Environmental Monitoring Plan and Environmental Protection Group Procedures contain QA elements consistent with method 114. The LBL site specific NESHAPs QA plan has been developed and approved in August 1994.

Appendix C - Distribution List



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