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**Environment, Safety and Health
Office of Environmental Audit**

**Environmental Survey
Preliminary Report**

**Lawrence Berkeley Laboratory
Berkeley, California**

July 1988

MASTER

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PREFACE
TO
THE DEPARTMENT OF ENERGY
ENVIRONMENTAL SURVEY PRELIMINARY REPORT
FOR THE LAWRENCE BERKELEY LABORATORY

This report contains the preliminary findings based on the first phase of a Survey at the U.S. Department of Energy (DOE) Lawrence Berkeley Laboratory (LBL) located in Berkeley, California. The Survey is being conducted by DOE's Office of Environment, Safety and Health.

The LBL Survey is a portion of the larger, comprehensive DOE Survey encompassing all major operating facilities of DOE. The DOE Survey is one of a series of initiatives announced on September 18, 1985, by Secretary of Energy John S. Herrington, to strengthen the environmental, safety and health programs and activities within DOE. The purpose of the Survey is to identify, via a "no-fault" baseline Survey of all the Department's major operating facilities, environmental problems and areas of environmental risk. The identified problem areas will be prioritized on a Department-wide basis in order of importance in 1989.

The findings in this report are subject to modification based on comments from the San Francisco Operations Office concerning the technical accuracy of the findings. The modified preliminary findings and any other appropriate changes will be incorporated into an Interim Report. The Interim Report will serve as the site-specific source for environmental information generated by the Survey, and ultimately as the primary source of information for the DOE-wide prioritization of environmental problems in the Environmental Survey Summary Report.

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EXECUTIVE SUMMARY

Introduction

This report presents the preliminary findings from the first phase of the Survey of the U.S. Department of Energy (DOE) Lawrence Berkeley Laboratory (LBL) in Berkeley, California, conducted February 22 through 29, 1988.

The Survey is being conducted by an interdisciplinary team of environmental specialists, led and managed by the Office of Environment, Safety and Health's Office of Environmental Audit. Individual team components are being supplied by a private contractor. The objective of the Survey is to identify environmental problems and areas of environmental risk associated with the LBL. The Survey covers all environmental media and all areas of environmental regulation, and is being performed in accordance with the DOE Environmental Survey Manual. This phase of the Survey involves the review of existing site environmental data, observations of the operations at the LBL, and interviews with site personnel.

The Survey team developed a Sampling and Analysis Plan to assist in further assessing certain of the environmental problems identified during its on-site activities. The Sampling and Analysis Plan will be executed by a DOE National Laboratory or support contractor. When completed, the results will be incorporated into the Environmental Survey Interim Report for the LBL facility. The Interim Report will reflect the final determinations of the LBL Survey.

Site Description

The LBL facility occupies an area of approximately 130 acres and is adjacent to the University of California at Berkeley (UCB) campus in Alameda County, California. The LBL is 3 miles east of the San Francisco Bay and 15 miles east of the City of San Francisco. The LBL facility, which was established at its present site in 1940, is operated by the University of California for DOE. In general, the structures of the LBL are DOE-owned while the land is University-owned and leased to DOE.

The primary function of the LBL is to conduct basic energy research such as high-energy physics, nuclear physics, heavy-ion fusion, magnetic fusion energy, biology, and medicine. In addition, the LBL provides national facilities to qualified investigators, including:

- The Bevatron/SuperHILAC Complex
- The 88-Inch Cyclotron
- The National Center for Electron Microscopy
- The National Tritium Labeling Facility

A new building, currently under construction, will provide another facility for investigators. The 1 to 2 giga electron volt (GeV) Synchrotron Radiation Source will provide a source of electromagnetic radiation for use in material studies.

As part of the Survey, representatives of the City of Berkeley, the Bay Area Air Quality Management District, the Alameda County Department of Health, and Region IX of the U.S. Environmental Protection Agency (EPA) were contacted to solicit information on environmental concerns about the LBL facility. There were no issues of concern raised by representatives of these agencies.

Summary of Findings

The major preliminary findings of the Survey at the LBL facility are:

- Uncontrolled releases of potentially hazardous wastes (e.g., waste oils, solvents, etc.) from the Building 76 Motor Pool sumps may be resulting in contamination of the sanitary sewer system.
- Chlorinated organics have been detected in a groundwater monitoring well on the site east of the Bevatron. The source and extent of contamination are not known. Groundwater at the LBL, which eventually enters a stormwater system, is not used for drinking water.
- Chemical contamination of soil and groundwater may have occurred as a result of past activities at the former scrapyards (Buildings 17, 46, and 69)

and deterioration of segments of the sanitary sewer system. None of the areas of potential contamination have been characterized.

Overall Conclusions

The Survey found no environmental problems at the LBL facility that represent an immediate threat to human life. The environmental problems identified at the LBL by the Survey team do confirm that the facility is affected by several environmental problems which are the result of inadequate waste management practices. These problems vary in terms of their magnitude and risk, as described in this report. A complete understanding of the significance of some of the environmental problems identified requires a level of study and characterization that is beyond the scope of the Survey. Site characterization activities currently under way and planned at the laboratory will contribute to meeting this requirement.

Transmittal and Follow-up of Findings

The preliminary findings of the Environmental Survey of the LBL were shared with the San Francisco Operations Office (SAN) and the site contractor at the Survey closeout briefing held February 29, 1988. By May 10, 1988, SAN had developed a draft action plan to address the Survey preliminary findings. The Operations Office plans to present this plan to the State of California Department of Health Services and the EPA Region IX Office. A final action plan addressing all the Survey findings cited herein will be prepared by SAN within 45 days after receiving this Preliminary Report. Those problems that involve extended studies and multiyear budget commitments will also be the subject of the Environmental Survey Summary Report and the DOE-wide prioritization.

Within the Office of the Assistant Secretary for Environment, Safety and Health, the Office of Environmental Guidance and Compliance (OEG) has immediate responsibility for monitoring environmental compliance and the status of the LBL Survey findings. The Office of Environmental Audit will continue to assess the environmental problems through a program of systematic environmental audits that will be initiated toward the conclusion of the DOE Environmental Survey in 1989.

1.0 INTRODUCTION

The purpose of this report is to present the preliminary findings made during the Environmental Survey, February 22-29, 1988, at the U.S. Department of Energy (DOE) Lawrence Berkeley Laboratory (LBL) in Berkeley, California. The University of California operates the LBL facility for DOE.

The LBL Survey is part of the larger DOE-wide Environmental Survey announced by Secretary John S. Herrington on September 18, 1985. The purpose of this effort is to identify, via "no fault" baseline Surveys, existing environmental problems and areas of environmental risk at DOE facilities, and to rank them on a DOE-wide basis. This ranking will enable DOE to more effectively establish priorities for addressing environmental problems and allocate the resources necessary to correct them. Because the Survey is "no fault" and is not an "audit," it is not designed to identify specific isolated incidents of noncompliance or to analyze environmental management practices. Such incidents and/or management practices will, however, be used in the Survey as a means of identifying existing and potential environmental problems.

The LBL Survey was conducted by a multidisciplinary team of technical specialists headed and managed by a Team Leader and Assistant Team Leader from DOE's Office of Environmental Audit. A complete list of the LBL Survey participants and their affiliations is provided in Appendix A.

The Survey team focused on all environmental media, using Federal, state, and local environmental statutes and regulations, accepted industry practices, and professional judgment to make the preliminary findings included in this report. The team carried out its activities in accordance with the guidance and protocols of the DOE Environmental Survey Manual. Substantial use of existing information and of interviews with knowledgeable field office and site contractor personnel accounted for a large part of the on-site effort. A summary of the site-specific Survey activities is presented in Appendix B and the Survey Plan is presented in Appendix C.

The preliminary Survey findings, in the form of existing and potential environmental problems, are presented in Sections 3.0 and 4.0. Section 3.0 includes findings that pertain to a specific environmental medium (e.g., air or soil), whereas

Section 4.0 includes those that are non-media-specific (e.g., waste management, radiation, and quality assurance). The findings, being highly varied in magnitude, risk, and characterization, and consequently requiring different levels of management attention and response, are further subdivided into four categories within Sections 3.0 and 4.0.

The criteria for placing a finding into one or more of the four categories are as follows:

- Category I includes only findings that, based on information available to the Team Leader, involve immediate threat to human life. Findings of this category shall be conveyed immediately to the Environment, Safety and Health personnel at the scene or in control of the facility or location in question for action. Category I findings are environmental problems with the highest potential risk, the strongest confidence in the finding based on the information available, and the most restrictive appropriate response in terms of alternatives.
- Category II findings encompass one or more of the following situations:
 - Multiple or continuing exceedances, past or present, of a health-based environmental standard where there is immediate potential for human exposure; or a one-time exceedance where residual impacts pose an immediate potential for human exposure.
 - Evidence that a health-based environmental standard may be exceeded; as discussed in the preceding situation, within the time of the DOE-wide Survey.
 - Evidence that the likelihood is high for an unplanned release due to, for example, the condition or design of pollution abatement or monitoring equipment or other environmental management practices.
 - Noncompliance with significant regulatory procedures (i.e., substantive technical regulatory procedures designed to directly or

indirectly minimize or prevent risks), such as inadequate monitoring or failure to obtain required permits.

Category II findings include environmental problems where the risk is high but where the definition of risk is broader than in Category I. The information available to the Team Leader is adequate to identify the problem but may be insufficient to fully characterize it. Finally, in this category, most discretion is available to the Operations Offices and Program Offices as to appropriate response; however, the need for that response is such that management should not wait for the completion of the DOE-wide Survey to respond. Unlike Category I findings, a sufficient near-term response to Category II findings by the Operations Office may include further characterization before any action is taken to rectify the situation.

- Category III findings encompass one or both of the following criteria:
 - The existence of pollutants or hazardous materials in the air, water, groundwater, or soil resulting from DOE operations that pose or may pose a hazard to human health or the environment.
 - The existence of conditions at a DOE facility that pose or may pose a hazard to human health or the environment.

Category III findings are environmental problems for which the broadest definition of risk is used. As in Category II, the information available to the Team Leader may not be sufficient to fully characterize the problems. Under this category, the range of alternatives available for response and the corresponding time limits for response are the greatest. Environmental problems included within this category will typically require lengthy investigation and remediation phases, as well as multiyear budget commitments. These problems will be included in the DOE-wide prioritization to ensure that DOE's limited resources are used effectively.

In general, levels of pollutants or materials that constitute a hazard or potential hazard are those that exceed some Federal, state, or local regulations for release of, contamination by, or exposure to such pollutants or materials. However, in some cases, the Survey may determine that the concentration of some nonregulated material is sufficient to be included as an environmental problem. Likewise, concentrations of regulated materials even though below limits established by regulatory authorities, that nevertheless present a potential for hazard or concern may be classified as an environmental problem. In general, however, conditions that meet regulatory or other requirements, where such exist, should not present a potential hazard and will not be identified as an environmental problem.

Conditions that pose or may pose a hazard are generally those that are violations of regulations or requirements (e.g., improper storage of hazardous chemicals in unsafe tanks). Such conditions present a potential hazard to human health and the environment and should be identified as an environmental problem. Additionally, potentially hazardous conditions are those where the likelihood of the occurrence of release is high.

The definition of the term "environmental problem" is broad and flexible to allow for the wide differences among the DOE sites and operations. Therefore, a good deal of professional judgment must be applied to the identification of environmental problems.

- Category IV findings include instances of administrative noncompliance and of management practices that are indirectly related to environmental risk but are not appropriate for inclusion in Categories I through III. Such findings can be based on any level of information available to the Team Leader, including direct observations by the team members. Findings in this category are generally expected to lend themselves to relatively simple, straightforward resolution without further evaluation or analysis. These findings, although not part of the DOE-wide prioritization effort, will be passed along to the Operations Offices and appropriate Program Office for action.

Based on the professional judgment of the Team Leader, the findings within categories are arranged in order of relative significance. Comparing the relative significance of one finding to another, either between categories within a section or within categories between sections, is neither appropriate nor valid. The categorization and listing of findings in order of significance within this report constitute only the first step in a multistep, iterative process to prioritize DOE's problems.

The next phase of the LBL Survey will be Sampling and Analysis (S&A). The Idaho National Engineering Laboratory (INEL), the S&A team for the LBL, will collect samples over a 1-week period in fiscal year 1989. An S&A Plan is being prepared by DOE and INEL in accordance with the protocols in the DOE Environmental Survey Manual. The Survey S&A is designed to fill existing data gaps or weaknesses. Results generated by the S&A effort will be used to assist the Survey team in further defining the existence and extent of potential environmental problems identified during the Survey.

An Interim Report will be prepared 8 to 10 weeks after the completion of the S&A effort. The Interim Report will incorporate the results of the S&A effort, as well as any changes or comments resulting from review of the Preliminary Report. Based on the S&A results, preliminary findings and observations made during the on-site Survey may be modified, deleted, or moved within or between categories. The Interim Report will serve both as the site-specific repository for information generated by the Survey and, ultimately, as the site-specific source of information for the DOE-wide prioritization of environmental problems.

It is clear that certain of the findings and observations contained in this report, especially those in Category II, can and should be addressed in the near term (i.e., before the DOE-wide prioritization effort). It is also clear that the findings and observations in this report vary greatly in magnitude, risk, and characterization. Consequently, the priority, magnitude, and timeliness of near-term responses will require careful planning to ensure appropriate and effective application. The information in this Preliminary Report, albeit provisional, will assist the San Francisco Operations Office (SAN) in planning these near-term responses.

SAN has developed a draft action plan, dated May 10, 1988, in response to the preliminary findings presented at the conclusion of the on-site Survey activities and summarized in the LBL Survey Status Report, dated April 13, 1988, and addendum dated May 17, 1988, prepared for the Assistant Secretary for Environment, Safety and Health. The draft action plan for the LBL Survey has been reviewed by the Office of Environmental Guidance and Compliance (OEG), which has immediate responsibility for monitoring the status and overseeing the adequacy of corrective actions taken by the Operations Office in response to the Survey findings.

As required in the December 2, 1987, memorandum from the Assistant Secretary for Environment, Safety and Health to the Operations Office Managers entitled, Follow-up of Environmental Survey Findings, SAN will prepare and submit a final action plan to the Deputy Assistant Secretary (DAS) for Environment within 45 days after receiving this Preliminary Report. The final action plan for the LBL Survey will address all of the preliminary findings cited herein, and incorporate OEG's comments on the draft action plan.

PRELIMINARY

2.0 GENERAL SITE INFORMATION

2.1 Site Setting

The Lawrence Berkeley Laboratory (LBL) is a multiprogram national laboratory located in Berkeley, California, and operated by the University of California at Berkeley (UCB) for the U.S. Department of Energy (DOE). The major role of the LBL is to conduct basic energy research programs such as high-energy physics, nuclear physics, heavy-ion fusion, magnetic fusion energy, X-ray optics, biology, and medicine.

The LBL is located in the east bay side of the San Francisco Bay Area in Alameda County, California. The site is 3 miles east of the San Francisco Bay and 15 miles northeast of the City of San Francisco, as shown on Figure 2-1. The 130-acre site is situated on the west-facing slope of the Berkeley Hills above the main campus of the UCB. The property line between two cities divides the site, with the western three-quarters in Berkeley and the eastern quarter in Oakland. Much of the area is urbanized, with the communities abutting each other.

The LBL is located on land owned by the Regents of the University of California. DOE-owned buildings are constructed on land leased to DOE under a long-term agreement. Additional University space utilized for DOE programs is supplied under the terms of the DOE-University of California prime contract without added lease costs. The San Francisco Operations Office (SAN) is responsible for the oversight of LBL operations.

What is now known as the LBL originated on the UCB campus in 1932. In 1940, it was relocated to its present site and the first major facility, the 184-Inch Synchrocyclotron, was built with funds from both private and University sources. After 1948, the LBL was funded by the U.S. Atomic Energy Commission and its successor agencies. In 1972, the name was changed from the Lawrence Radiation Laboratory to the LBL. Today the LBL is one of nine multiprogram national laboratories operated by the University of California for the DOE. There is currently a full-time staff of approximately 3,850 at the LBL. This includes approximately 600 visiting scientists.

GENERAL LOCATION MAP
OF THE LBL FACILITY

FIGURE 2-1

As Figure 2-1 shows, the LBL lies in the northwest corner of UCB property. It is bounded on the north by private single-family homes, on the west by private multi-unit dwellings and UCB student halls, and on the south and east by UCB property. The southern portion of the UCB property includes recreational facilities and a botanical garden, while the eastern portion of the property is maintained in its natural state.

Figure 2-2 shows land use in the vicinity of the LBL. The LBL is adjacent to the UCB campus, which has a student population of approximately 29,000. The total population of the Bay Area is approximately 4.5 million. The five counties that surround the LBL are Alameda, Contra Costa, Marin, San Mateo, and Santa Clara; they have a combined total population of 3,866,727. Population growth has varied in the counties that surround the LBL; however, between 1970 and 1980 all counties experienced growth. The average population density in the counties that surround the LBL ranges from 426 to 1,501 people per square mile (U.S. Bureau of the Census, 1983). Major population centers within approximately a 25-mile radius of the LBL are listed below.

City Name	Distance from the LBL in Miles	Direction from the LBL	1980 Population
Berkeley	*	*	103,328
Oakland	*	*	339,337
San Francisco	15	southwest	678,974

Source: U.S. Bureau of the Census, 1983

* A portion of the LBL is located within the city limits.

The LBL is located in the ridges and draws of Blackberry Canyon, which receives drainage from the central part of the site, and Strawberry Canyon, which generally forms the southern boundary. Site topography is shown in Figure 2-3. Figure 2-4 shows that a large percentage of the LBL site has a slope of over 26 percent. As a result of the hilly terrain, grading and filling have often been necessary to provide suitable building sites. Areas have been filled with soil up to several tens of feet thick in some of the original ravines and depressions (LBL, 1984a).

TOPOGRAPHY OF THE LBL FACILITY

FIGURE 2-3

Source: LBL, 1986g

SLOPE ANALYSIS OF THE LBL SITE

FIGURE 2-4

The seismically active Hayward Fault, part of the San Andreas Fault System, developed as the Berkeley Hills were uplifted. The Hayward Fault trends in a northwest-southeast direction along the base of the hills below the LBL and has the potential to produce an earthquake of approximately Richter magnitude 7.0 (LBL, 1984a).

The San Andreas fault zone, which has a potential for a magnitude 8.3 earthquake, lies about 20 miles west of the site, offshore beyond the Golden Gate. This fault and the Calaveras fault zone, which lies about 15 miles east of the site, would produce less intense ground shaking at the site than would the Hayward Fault (LBL, 1984a).

The climate of the LBL site is greatly influenced by its nearness to the Pacific Ocean and its exposure to the maritime air that flows unimpeded directly toward it through the Golden Gate. Seasonal temperature variations are small, with a mean temperature difference between the summer (63°F) and winter (48°F) of only 15°F. Generally, comfortable outdoor conditions prevail summer and winter (LBL, 1984a).

Relative humidity ranges from 85-90 percent in the early morning to 65-75 percent in the afternoon. Annual insolation ranges from 65-75 percent of that theoretically available, and the average daytime cloudiness is about the same in summer and in winter. The number of heating degree-days is about 2,600 and of cooling degree-days about 150. Winds are usually light, but summer sea breezes range to 20-30 mph; winter storm winds from the south or southwest have somewhat lesser velocities (LBL, 1984a).

About 95 percent of the average annual rainfall of 25 inches at the LBL occurs from October through April, and intensities are seldom greater than one-half inch per hour. Thunderstorms, hail, and snow are extremely rare. Consequently, the LBL enjoys a Mediterranean-type climate (LBL, 1984a).

The Blackberry Canyon and Strawberry Canyon areas consist mostly of oak and laurel, with willows and brush along the water courses. There is also fairly extensive open grassland. Large numbers of eucalyptus and pine were planted in the area circa 1915, and both planted and natural redwood trees exist in certain areas (LBL, 1984a).

The population of wild animals in the LBL area is fairly extensive, consisting of birds, deer, raccoons, feral cats, skunks, and rodents. Portions of the area surrounding the LBL have been designated natural preservation and ecological study areas by the UCB (LBL, 1984a).

2.2 Overview of Major Site Operations

The LBL supports nationwide university-based research by providing facilities including the National Center for Electron Microscopy, four large accelerators, several small accelerators, a number of radiochemical laboratories, several large gamma irradiators, and the National Tritium Labeling Facility (NTLF).

The LBL's activities are located both on-site and at a number of locations off-site. Approximately 78 percent of the gross office/laboratory space utilized by the LBL is on-site. Table 2-1 shows that the on-site space consists of approximately 1,350,000 gross square feet (gsf) in 60 buildings; 1,306,142 in DOE buildings and trailers, and 43,858 in University-owned buildings. The 184-Inch Synchrocyclotron (Building 6) and Magnetic Fusion Energy (Building 5) are the on-site buildings owned by the University. At an average height of two to three stories, these buildings cover about 14 percent of the 130-acre site. The net usable on-site space is approximately 1,029,000 square feet. The on-site population is 3,850 employees and participating guests and the average net occupied office space is about 110 square feet per person (LBL, 1984a). Table 2-2 lists the permanent on-site buildings and quadrant location, which can be used to locate the building on Figure 2-5.

Two of LBL's divisions, Biology and Medicine, and Chemical Biodynamics, are housed on the UCB campus. Together, these divisions occupy about 75,000 gsf. The LBL staff also occupy other space on the UCB campus, at the University of California Richmond Field Station, the Stanford Linear Accelerator Center, the Highland Hospital in Berkeley, and the Medical Research Laboratory in Oakland. Overall, about 20 percent of the LBL staff occupies off-site space (LBL, 1984a). Appendix D lists off-site leased space and off-site buildings assigned LBL building numbers.

The natural constraints of the site coupled with the desirability of maintaining compact and interactive programmatic development have led to the delineation of the LBL site into seven functional areas, as shown on Figure 2-6. These subportions

TABLE 2-1

ON-SITE AND OFF-SITE SPACE AND POPULATION OF THE LBL

Description	Space - gsfa	Population		
		Employees	Guests	Total
On-Site				
Permanent Structures ^b	1,282,000	2,429	430	2,859
Trailers	58,000	215	14	229
Miscellaneous	10,000	0	0	0
On-Site Subtotal	1,350,000	2,644	444	3,088
UCB Space				
Campus and Richmond Field Station	259,000	580	131	711
Off-Site Leased Space				
Program and Printing Plant (Dymo)	24,000	38	5	43
Warehouse (901 and 935) ^c	103,000	8	1	9
Off-Site Subtotal	127,000	46	6	52
TOTAL	1,736,000	3,270	581	3,851

Source: LBL, 1984a

Notes: a = Gross square feet.

b = Includes UCB Buildings 5 (7,115 gsfa) and 6 (36,743 gsfa). Assigned square feet (net) = 76 percent of gsfa for on-site space and 68 percent for UCB space.

c = Includes mezzanine in 901. Actual leased area is 89,000 square feet.

TABLE 2-2
PERMANENT ON-SITE BUILDINGS OF THE LBL AND SITE LOCATION

Building No.	Description	Site Location (Quadrant)
4	Magnetic Fusion Energy	D4
5	Magnetic Fusion Energy	D4
6	184-Inch Synchrocyclotron	D4
7	Central Stores & Electronics Shops	D4
9	Experimental Staging Facility	D4
10	Biomedical Research	D4
12	Magnetic Fusion Energy - EBIS/Central Stores Annex	D4
14	Nuclear Instrumentation	D4
16	Magnetic Fusion Energy Laboratory	D4
17	Experimental Set-up	D3
25	Mechanical Technology	E4
25A	Electronics Development	E4
26	Medical Services	E4
27	Cable Shop & High Voltage Test	D3
29	Instrument Science Engineering & Biomedical Research	C4
37	Utilities Service	D4
40	Electronics Warehouse	D4
41	Electronics Drafting	D4
42	Earth Sciences Field Test Facility	E4
43	NBTF Guest Experimenters	D4
44	Indoor Air Pollution Studies	D4
45	Fire Apparatus	D4
46	Accelerator Development & Real Time-Systems Group	D3
46A	Real Time Systems Group	D3

TABLE 2-2

**PERMANENT ON-SITE BUILDINGS OF THE LBL AND SITE LOCATION
(Continued)**

Building No.	Description	Site Location (Quadrant)
47	Advance Accelerator Study	D3
48	Fire Station	D4
50	Physics, Accelerator & Fusion Division	C3
50A	Physics & Director's Office	B3
50B	Physics & Computer Center	B3
50C	Office Building	B3
50D	Office Building	B3
50E	Office Building	B3
51	Bevatron	C3
51A	Bevatron Annex	C3
51B	External Particle Beam (EPB) Hall	C3
52	Magnetic Fusion Energy Laboratory	D4
53	Accelerator Development	D4
54	Cafeteria	C4
55	Research Medicine	C4
56	Cryogenic Facility	C2
58	Accelerator Research & Development	D4
58A	Accelerator Research & Development Addition	D4
60	High Bay Laboratory	C2
61	Standby Propane Plant	E4
62	Materials & Molecular Research	F5
63	Accelerator Division	C2
63A	Accelerator Division	C2
64	Accelerator Division	C2
65	Administration Computing	B3

TABLE 2-2
PERMANENT ON-SITE BUILDINGS OF THE LBL AND SITE LOCATION
(Continued)

Building No.	Description	Site Location (Quadrant)
68	Upper Pump House	E3
69	Supply Services	F3
69A	Supply Services	
70	Nuclear Science and Applied Science	C4
70A	Nuclear Science, Materials, Molecular Research & Earth Science	C4
71	Heavy Ion Linear Accelerator (SuperHILAC)	D2
71A	SuperHILAC Rectifier	D2
71B	SuperHILAC Annex	D2
72	National Center for Electron Microscopy	F5
73	Atmospheric Aerosol Research	G5
74	Biomedical Laboratory	H4
74B	Biomedical Laboratory Annex	H4
75	Radioisotope Services	E3
76	Craft & Maintenance Shops	E4
77	Mechanical Shops	E4
78	Craft Stores	E4
79	Metal Stores	E4
80	General Research Laboratory	D4
80A	Telephone Services	D4
81	Liquid Gas Storage	C2
82	Lower Pump House	C2
83	Cell Culture Laboratory I	H4
88	88-Inch Cyclotron	B3
90	Earth Sciences, Applied Science, Administration, Engineering	B-2

Source: LBL, 1984a

Note: Refer to Figure 2-5 for a site map with quadrants identified to locate buildings

BUILDING LOCATOR MAP
FOR THE LBL

FIGURE 2-5

FIGURE 2-6

LBL FUNCTIONAL AREAS

Source: LBL, 1984a

of the site, which are identified with specific research programs and/or support facilities, are the Central Research Facilities Area, Bevalac Accelerator Facilities Area, 88-Inch Cyclotron Facilities Area, Original Laboratory Site Area, East Canyon Materials Sciences Area, East Canyon Research Facilities Area, and Shops and Support Facilities Area.

The functional area designated "Central Research Facilities" houses the LBL Director's Offices including Planning and Development and the main divisional offices for Administration, Engineering and Technical Services, Applied Science, Earth Sciences, Nuclear Science, Physics, Accelerator and Fusion Research, Computing, and the Center for Advanced Materials. It includes the majority of the LBL's light laboratories (i.e., small-scale experimental setups) and support offices as well as the central cafeteria.

The functional area designated "Bevalac Accelerator Facilities" encompasses the Bevatron/SuperHILAC Accelerator Complex including heavy laboratory (i.e., equipment for moving large-scale experimental setups) experimental areas, cryogenic support facilities, staging areas, associated offices, and facilities for Advanced Accelerator Research and Development. The area has an extensive array of support utilities, heavy handling equipment, and related resources.

The functional area designated "88-Inch Cyclotron Facilities" is located on a hillside terrace near the main entrance to the LBL. Functionally, the area is dedicated entirely to the 88-Inch Cyclotron and its close support facilities.

The functional area designated "Original Laboratory Site" encompasses 15 acres and includes 25 existing buildings with 210,000 gsf of space. The dominant feature of the area is the dome of Building 6, which houses the 184-Inch Synchrocyclotron and the Neutral Beam Engineering Test Facility. The 184-Inch Synchrocyclotron is now being decontaminated and decommissioned and will be replaced by the new 1 to 2 giga electron volt (GeV) Synchrotron Radiation Source. In recent years, major research work housed in the Original Laboratory Site has been focused on the Magnetic Fusion Energy Program and the Biomedical Program. This functional area also includes the LBL occupational medicine facility, the new LBL fire station, central stores, printed circuit board etching shop, electronic and mechanical technician shops.

The functional area designated "East Canyon Materials Sciences" encompasses the Materials and Molecular Research Laboratory including Divisional Offices, the National Center for Electron Microscopy, and the Surface Science and Catalysis Laboratory.

The functional area designated "East Canyon Research Facilities" encompasses 7 acres in the upper reaches of Strawberry Canyon and includes potential sites for expansion of the Biosciences Complex, other research laboratories, and a new LBL Corporation Yard. Existing buildings include the Biomedical Laboratory and the Cell Culture Laboratory.

The functional area designated "Shops and Support Facilities" encompasses the Craft Shops, which include a plating shop, lead melting and plasma torch cutting areas, Transportation, Motor Pool, Mechanical Shops, the Environmental Health and Safety Department, Supply Services, and the NTLF. Appendix E describes LBL buildings and the operational activities occurring in these buildings.

2.3 Scope of Survey

The Survey covered all aspects of the research and support activities at the LBL facility, including several off-site buildings. These buildings included two warehouses (Buildings 901 and 935) used for storage, a center for biomedical research and printing (Building 934), and two buildings leased to DOE by the Regents of the University of California on the UCB campus (Buildings 1 and 3).

The Survey was not cleared for access by the UCB to several other buildings on the campus where the UCB assigns space to DOE under the existing lease agreements to carry out research projects, and where the UCB has responsibility for environment, safety and health issues. This space amounts to approximately 200,000 gsf (see Appendix D). In addition, Gilman Hall is a building on the campus that was formerly used by DOE and later cleaned up under the Formerly Utilized Sites Remedial Action Program (FUSRAP). It has been determined by SAN that Gilman Hall is acceptable for restricted use under the UCB's California State General License.

2.4 State and Federal Concerns

Representatives of the Survey team met with representatives of the City of Berkeley, the Bay Area Air Quality Management District, and the Alameda County Department of Environmental Health on January 14, 1988, as part of the pre-Survey visit to the LBL. Region IX U.S. Environmental Protection Agency (EPA) was also contacted to solicit information on environmental concerns about the LBL facility. There were no issues of concern raised by representatives of these agencies.

PRELIMINARY

3.0 MEDIA-SPECIFIC SURVEY FINDINGS AND OBSERVATIONS

The discussions in this section pertain to existing or potential environmental problems in the air, soil, water, and groundwater media at the Lawrence Berkeley Laboratory (LBL) in Berkeley, California. The discussions include a summary of the available background environmental information related to each medium, a description of the sources of pollution and their control techniques, a review of the environmental monitoring program specific to each medium, and a categorization and explanation of the environmental problems as they relate to each medium.

3.1 Air

3.1.1 Background Environmental Information

The LBL facility is located in Alameda County, California, which is part of the San Francisco Bay Area Intrastate Air Quality Control Region (AQCR) 30. Radioactive and nonradioactive emissions from the LBL and other sources within this area are limited by the requirements of the Bay Area Air Quality Management District (BAAQMD), the California Air Resources Board (ARB), the California Department of Health Services, and Region IX of the U.S. Environmental Protection Agency (EPA).

3.1.1.1 Background Radioactivity

Worldwide background atmospheric radioactivity is composed largely of fallout from past atmospheric nuclear weapons tests, natural radioactive constituents from the decay chains of thorium and uranium in soil, and materials resulting from interactions with cosmic radiation (e.g., natural tritiated water vapor produced by interactions of cosmic radiation and stable water). Atmospheric particulates result in part from soil particles that are blown by the wind. Consequently, changing meteorological conditions often cause large daily and seasonal fluctuations in airborne radioactivity levels. Windy, dry days can result in relatively high concentrations of airborne particulates, whereas precipitation (rain or snow) can wash out many particles from the atmosphere.

The EPA determines airborne radiation levels at major cities throughout the United States by monitoring fallout from nuclear devices and other forms of radioactive

contamination of the environment. The closest EPA monitoring station to the LBL is in Berkeley. The most recent data from Berkeley and other U.S. cities available as of this writing are summarized below:

Radionuclide	Average Berkeley Concentration (10 ⁻⁶ pCi/m ³) ^a	Concentration Range for 62 U.S. Cities (10 ⁻⁶ pCi/m ³) ^a
gross betab	3 x 10 ⁴	Not Available
plutonium-238 ^c	0.6	0 - 2.6
plutonium-239, 240 ^c	0.7	0 - 1.4
uranium-234 ^c	9.1	4.5 - 124.5
uranium-235 ^c	0	0 - 5.3
uranium-238 ^c	7.7	4.7 - 69.3

Source: EPA, 1986b; 1987a, b, c

a pCi/m³ = 10⁻¹² Ci/m³

b Data collected from April 1986 to March 1987

c Data collected from July 1986 to December 1986

Background airborne radioactivity at Berkeley falls within the range of values measured at other U.S. cities.

3.1.1.2 Ambient Air Quality

Table 3-1 lists the National Ambient Air Quality Standards (NAAQS), and the California ARB Air Quality Standards. Ambient air quality standards are established to protect the health and welfare of the general public. The air quality in Alameda County in AQCR 30 has been designated by EPA as being (a) better than the NAAQS for total suspended particulates (TSP) and sulfur dioxide (SO₂); (b) cannot be classified or better than the NAAQS for nitrogen dioxide (NO₂); and (c) not meeting primary standards for ozone (O₃) and carbon monoxide (CO) (BNA, 1986). In July 1987, EPA replaced TSP as the indicator for particulate matter for the ambient standards with a new indicator that includes only those particles with an aerodynamic diameter less than or equal to a nominal 10 microns (PM₁₀). Because sufficient PM₁₀ ambient data are not yet available, EPA has not determined the PM₁₀ attainment status for the AQCRs.

TABLE 3-1

FEDERAL AND CALIFORNIA AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Time	Federal Standards ^a		California Standards ^b
		Primary ^c	Secondary ^d	
Oxidant ^e	1-Hour	-	-	0.10 ppm
Ozone	1-Hour	0.12 ppm	0.12 ppm	-
Carbon Monoxide	8-Hour 1-Hour	9 ppm 35 ppm	9 ppm 35 ppm	9 ppm 20 ppm
Nitrogen Dioxide	Annual Average 1-Hour	0.05 ppm -	0.05 ppm -	0.25 ppm
Sulfur Dioxide	Annual Average 24-Hour 3-Hour 1-Hour	0.03 ppm 0.14 ppm - -	- - 0.5 ppm -	- 0.05 ppm - 0.25 ppm
Particulate Matter (PM ₁₀)	Annual Arithmetic Mean Annual Geometric Mean 24-Hour	50 µg/m ³ - 150 µg/m ³	50 µg/m ³ - 150 µg/m ³	- 30 µg/m ³ 50 µg/m ³
Sulfates	24-Hour	-	-	25 µg/m ³
Lead	30-day Average Calendar Quarter	1.5 µg/m ³	1.5 µg/m ³	1.5 µg/m ³ -
Hydrogen Sulfide	1-Hour	-	-	0.03 ppm
Vinyl Chloride (chloroethene)	24-Hour	-	-	0.010 ppm
Visibility Reducing Particles	1 observation	-	-	In sufficient amount to reduce the prevailing visibility ^f to less than 10 miles when the relative humidity is less than 70%

Source: ARB, 1987

- ^a Federal standards, other than ozone, PM₁₀, and those based on annual averages, are not to be exceeded more than once a year. The ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is equal to or less than one. For the PM₁₀ standard, no more than one expected exceedance per year is allowed. The annual averages are values that are not to be exceeded.
- ^b California standards, other than carbon monoxide, sulfur dioxide (1 hour), nitrogen dioxide and PM₁₀, are values that are not to be equaled or exceeded. The carbon monoxide, sulfur dioxide (1 hour), nitrogen dioxide and PM₁₀ standards are not to be exceeded.
- ^c Primary standards are the levels of air quality necessary, with an adequate margin of safety, to protect the public health.
- ^d Secondary Standards are the levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.
- ^e Measured as ozone.
- ^f Prevailing visibility is defined as the greatest visibility that is attained or surpassed around at least half of the horizon circle, but not necessarily in continuous sectors.

Table 3-2 presents 1986 background ambient air quality data monitored in Oakland, about 4 miles south of the LBL site, and in Richmond, about 5 miles to the northwest. The table shows that during 1986 all ambient measurements at these monitors were in attainment of Federal and ARB air quality standards. During 1987 there also were no measured excesses of the O₃ and CO standards at these two monitors (BAAQMD, 1987a).

3.1.1.3 Meteorology

The LBL site experiences the general climatic and meteorological conditions of the San Francisco Bay Region with some modification due to its hillside location at 500 to 1,500 feet above sea level overlooking San Francisco Bay to the west. The climate at the site is greatly influenced by its proximity to the Pacific Ocean and its exposure to the maritime air that flows in from the Bay. Winters are mild and summers are cool because of the prevailing westerly winds from the Pacific, where temperature varies very little between winter and summer. A 16-year record obtained from the LBL indicates that 96 percent of the annual rainfall occurs during the months of October through April (LBL, 1976).

The San Francisco Bay Region is a large, shallow basin ringed by hills. Temperature inversions are frequent in the region, occurring about 2 out of every 3 days of the year. These inversion layers act as barriers to the upward dilution of pollutants emitted within or below them. When the base of the inversion is below the elevation of the surrounding hills, and breezes are light, a stagnant air mass is formed, and "smoggy days" often result. About 40 percent of the time the Laboratory, at its elevation of 500 to 1,500 feet, is either within an inversion layer, or below one whose base is under 2,000 feet, the elevation of nearby hills. Either of these conditions results in impaired dispersion of pollutants released from the LBL site (LBL, 1976).

3.1.2 General Description of Pollution Sources and Controls

Air emissions from the LBL may be divided into categories of radiological and nonradiological. Table 3-3 summarizes the total quantities of radionuclides discharged into the atmosphere from all LBL operations in 1986. The release of 80 curies of tritium from the National Tritium Labeling Facility (NTLF) in the

TABLE 3-2
1986 BACKGROUND AMBIENT AIR QUALITY MEASUREMENTS (PARTS PER MILLION)

Pollutant	Averaging Time	Federal Standard ^a	2nd Highest Measured Concentration Oakland ^b Richmond ^c	Annual Average Measured Concentration ^d	California Standard ^e	Highest Measured Concentration Oakland ^b Richmond ^c
O ₃ ^f	1-Hour	0.12	0.09 ^g 0.07 ^g	-	0.10	0.09 0.07
CO	8-Hour 1-Hour	9.0 35	6.5 11 5.0 8	-	9.0 20	7.5 12 5.9 8
NO ₂	Annual Average 1-Hour	0.05	-	0.021	- 0.25	- 0.13
SO ₂	Annual Average 24-Hour 3-Hour 1-Hour	0.03 0.14 0.50	- 0.008	0.001	- 0.25	- 0.05

Source: ARB, 1987

a Federal standards, other than ozone and those based on annual averages, are not to be exceeded more than once a year. The ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is equal to or less than one.

b Alice Site.

c 13th St. Site.

d Measured at Richmond.

e California standards, other than carbon monoxide, are values that are not to be equaled or exceeded. The carbon monoxide standards are not to be exceeded.

f The California standard regulates oxidant, measured as ozone.

g Highest measured concentration.

TABLE 3-3

ESTIMATED 1986 LBL RADIONUCLIDE RELEASES AND OTHER INFORMATION
ON THE LBL EMISSION SAMPLING PROGRAM

Radionuclide	Number of Sampling Locations	Detection Limit ($\mu\text{Ci/mL}$)	Quantity Discharged in 1986 (Ci)
Unidentified alpha emitters	76	2×10^{-15}	$< 1 \times 10^{-7}$
Unidentified beta emitters	76	80×10^{-15}	7×10^{-5}
Carbon-14	5	2×10^{-10}	2×10^{-3}
Tritium	8	7×10^{-10}	80
Iodine-125	56	3×10^{-16}	4×10^{-3}
Iodine-131	56	3×10^{-16}	4×10^{-3}

Source: LBL, 1987a

Radioisotope Services (Building 75) constituted almost all the discharged radionuclides from the LBL. Small amounts of carbon-14, iodine-125, iodine-131, and unidentified alpha and beta-gamma emitters were also released from LBL stacks (LBL, 1987a).

With respect to nonradionuclide sources, the BAAQMD requires permits at the LBL for degreasers, and for certain shop operations such as paint spraying and sandblasting. Table 3-4 identifies the 30 LBL air pollution sources for which permits to operate are required by the BAAQMD, along with BAAQMD-estimated, annual-average emission rates. Total LBL organic compound emissions are estimated by BAAQMD to average 36 pounds per day (lb/day). Emissions of particulates, SO₂, oxides of nitrogen (NO_x), and CO were estimated to be zero. Production processes that usually release significant quantities of air pollution are not present at the LBL.

In addition to these 30 permitted air pollution sources, there are 80 additional sources at the LBL registered with the BAAQMD but exempt from permitting requirements. Of these 80 sources, the 5 that have pollution abatement equipment to comply with the BAAQMD Regulation 6 particulate emission limitation are listed in Table 3-5. During the Survey, it was revealed that there are no written standard operating procedures covering the maintenance of the pollution abatement equipment listed in Tables 3-4 and 3-5.

3.1.2.1 National Tritium Labeling Facility

The NTLF, a national facility now operated for the National Institutes of Health, utilizes tritium as a labeling agent for a variety of molecules subsequently employed in chemical and biomedical research. This facility uses approximately 10,000 curies per year (Ci/yr) of tritium gas. The tritium gas is absorbed on depleted uranium and supplied by the Oak Ridge National Laboratory.

The depleted uranium, with absorbed tritium, is heated to remove the tritium. The tritium is then injected into and reacted with organic compounds to function as a labeling agent. Impure, waste tritium from three fume hoods is oxidized to form tritiated water, which is vented to silica gel cartridges that achieve a better-than-98 percent collection efficiency of the tritiated water (LBL, 1986a). The effluent is then vented at a flow rate of 10,000 cubic feet per minute (ft³/min) from a 50-foot-high

TABLE 3-4

LBL AIR POLLUTION SOURCES CURRENTLY PERMITTED BY THE BAAQMD

Source Number	Source Name	Building Location	Control Devices	Annual Average Emission Rate* (Lb/Day)
22	Vapor Degreaser	25A	Cover, freeboard, chillers, safety switches	0
35	Vapor Spray Degreaser	51	Cover, freeboard, chillers, safety switches	0
38	Ultrasonic Degreaser	53	Cover, freeboard, chillers, safety switches	0
39	Machine Shop Tools	53	Not Required	0
46	Machine Shop Tools	58	Not Required	0
49	Vapor Degreaser	62	Cover, freeboard, chillers, safety switches	0
55	Machine Shop Tools	70A	Not Required	0
64	Sawdust Collector	74	Simple Cyclone	0
67	Air Agitated Parts Washer	76	Not Required	0
68	Machine Shop Tools (Room 133)	76	Not Required	0
72	Parts Washer with Spray	76	Not Required	0
73	Machine Shop Tools (Room 234)	76	Not Required	2
74	Paint Spray Booth	76	Dynamic Cyclone	0
76	Gasoline Dispensing Island	76	Liquid Separator	2
84	Soldering/Grinding Hood	77	Not Required	0
85	Machine Shop Tools (Room 141)	77	Not Required	0
89	Machine Shop Tools (Room 142)	77	Not Required	0
91	Ultrasonic Vapor Degreaser	77	Not Required	0
92	Vapor Spray Degreaser	77	Cover, freeboard, chillers, safety switches	2
96	Paint Spray Booth	77	Cover, freeboard, chillers, safety switches	19
97	Sandblast Exhaust	77	Dry Filter	6
104	Drying Oven	77	Baghouse	0
105	Saw	79	Not Required	2
114	Machine Shop Tools	88	Not Required	0
115	Solder Hood	88	Not Required	0
116	Saw	77	Not Required	0
118	Ink Remover	77	Simple Cyclone	0
119	Aluminum Parts Washer	25	Not Required	0
120	Vapor Degreaser	25	Not Required	2
121	Degreaser	76	Cover, freeboard, chillers, safety switches	0
		76	Cover, freeboard, chillers, safety switches	0

Source: Adapted from BAAQMD, 1987b

* Average emission rate of organic compounds, as estimated by BAAQMD.

TABLE 3-5**LBL SOURCES WITH AIR POLLUTION CONTROL EQUIPMENT
EXEMPT FROM PERMITTING REQUIREMENTS**

Source Number	Source Name	Building Location	Control Equipment
43	Plaster Casting Hood	55	Simple Baghouse
50	Grinding Operation	62	Simple Baghouse
88	Machine Shop Tools (Rooms 141A, 160, 161)	77	Simple Baghouse
101	Dental Sandblast for Ceramics	77	Simple Baghouse
102	Machine Shop Tools (Room 244F)	77	Simple Baghouse

Source: BAAQMD, 1987b

PRELIMINARY

stack on the hillside west of Building 75. The stack is partially surrounded by taller trees. However, plume rise should allow the exhaust gas to reach heights above the trees for transport and dispersion by the wind. Annual releases of tritium (as tritiated water) from 1977-1986 have ranged from about 50 curies to 500 curies (LBL, 1987a).

3.1.2.2 Laboratories

Radiochemical and radiobiological studies performed in many laboratories at the LBL typically use only millicurie quantities of a variety of radionuclides without air contaminant controls, which is typical of such research laboratories. Research involving larger quantities of radioactive materials (i.e., quantities which, if released, could result in a concentration greater than one percent of the radiation protection standard off-site) is confined to glove boxes which exhaust through high-efficiency particulate air (HEPA) filters (LBL, 1976). Glove boxes with HEPA filters are found in the Nuclear Science and Applied Science Building (Building 70) to collect radioactive particulate in connection with a selenium research project; in the NTLF in Building 75 to collect radioactive particulate in the decontamination area, Room 127; in the Biomedical Laboratory Annex (Building 74B) to collect radioactive particulate; and in the Heavy Ion Linear Accelerator (SuperHILAC) Rectifier (Building 71A) to collect particulate matter from a parts cleaner using garnet abrasives in the basement. In addition, the workplace and effluent release points of all laboratories at the LBL where the Environmental Health and Safety (EH&S) Department believes the highest potential for airborne releases exists are continuously sampled.

In laboratories engaged in nonradiological chemistry studies, research quantities [100 milliliters (mL) to 1,000 mL] of chemicals are used in fume hoods. Amounts discharged to the atmosphere range from tens to hundreds of milliliters evaporated over many hours. Typical chemicals discharged are organic solvents, mineral acids, and gaseous and organic compounds. All laboratory fume hoods at the LBL are exempt from BAAQMD permitting requirements (LBL, 1987f).

3.1.2.3 Support Shops

There are a large number of support shops throughout the LBL that provide a variety of repair, maintenance, and fabrication services to laboratory research

projects. The Mechanical Shops Building (Building 77) contains the LBL's main mechanical shops. As shown in Table 3-4, there are 8 permitted sources in Building 77, consisting of a soldering and grinding operation; 2 machine shop tool exhausts; 2 degreasers; a paint spray booth; a sandblasting operation; and a paint drying oven. In addition, about 5,000 lb/yr of lead is melted in a lead pot at Building 77 for casting discrete shapes of lead. The process temperature is reported by EH&S personnel to be carefully controlled to prevent excessive lead oxide production. The Beryllium Machine Shop in Building 77 was decommissioned in 1985.

The Craft and Maintenance Shops (Building 76) is the nucleus of the Construction and Maintenance Department and the Motor Pool. It contains a carpentry shop, a paint shop, automotive maintenance shops, a machine shop assembly, and a sheet metal shop. There are six permitted sources in Building 76 consisting of two parts washers, two machine shop tool exhausts, a paint spray booth, and a gasoline dispensing island.

There are additional shops with air pollutant releases, principally emissions of organics and particulate matter, in the following buildings:

- Donner Laboratory (Building 1)
- 184-Inch Synchrocyclotron (Building 6)
- Central Stores and Electronics Shops (Building 7)
- Magnetic Fusion Energy Laboratory (Building 16)
- Mechanical Technology (Building 25)
- Electronics Development (Building 25A)
- Earth Science Field Test Facility (Building 42)
- Accelerator Development, & Real Time-Systems Group (Building 46)
- Bevatron (Building 51)
- Accelerator Development (Building 53)
- Research Medicine (Building 55)
- Accelerator Research & Development (Building 58)
- Materials & Molecular Research (Building 62)
- Accelerator Division (Building 63)
- Accelerator Division (Building 64)
- Nuclear Science, Materials, Molecular Research & Earth Science (Building 70A)
- SuperHILAC (Building 71)
- Biomedical Laboratory (Building 74)
- Metal Stores (Building 79)

- Physics, Accelerator & Fusion Division (Building 50)
- Physics & Director's Office (Building 50A)
- Physics & Computer Center (Building 50B)
- General Research Laboratory (Building 80)
- 88-Inch Cyclotron (Building 88)

All these sources have been registered with the BAAQMD.

3.1.2.4 Accelerators

The LBL contributes to the U.S. high-energy physics program through research at its four large accelerators, and at several small accelerators. The Bevatron (Building 51), the most massive of the LBL's accelerators, is capable of accelerating ions as large as calcium-40 up to 2.1 giga electron volts (GeV). The SuperHILAC (Building 71) is a heavy-ion accelerator that produces ion beams up to 8.5 million electron volts (MeV). The 88-Inch Cyclotron (Building 88) accelerates light- and medium-mass nuclei to energies between those of the Bevatron and the SuperHILAC. The 184-Inch Synchrocyclotron (Building 6) was used for short periods for biomedical studies and tumor therapy (LBL, 1987a). This accelerator is currently undergoing decontamination and decommissioning.

Airborne radionuclides are produced in the air volume surrounding major beam absorbers such as beam dumps and targets. However, most of the radionuclides produced are extremely short-lived, such as oxygen-15, with a 2-minute half-life, and carbon-11, with a 20-minute half-life, and do not survive in significant concentrations outside of accelerator installations. Some argon-41 may be released with cooling air from the 88-Inch Cyclotron, but its short half-life (1.8 hours) reduces it to small concentrations in a brief time. The bombardment of targets where the target is transuranic also produces up to a few millicuries of various radioactive isotopes (LBL, 1986a).

3.1.3 Environmental Monitoring Program

The air monitoring program at the LBL has three major components: stack emissions monitoring for radionuclides; ambient air sampling for particulate radionuclides,

tritiated water vapor, and carbon-14; and meteorological monitoring. Data on stack emissions are modeled to estimate the off-site dose to the public on an annual basis as required by the National Emission Standard for Radionuclide Emissions from DOE Facilities (40 CFR Part 61, Subpart H). The Oak Ridge National Laboratory, under contract to the LBL, used a dose model to estimate the 1986 radiation dose to the surrounding population in the most recent annual monitoring report, which covered calendar year 1986. In this modeling analysis, Oak Ridge used a 1960-1964 climatological data base from Oakland Airport. A discussion of this modeling effort and the resulting dose estimates is presented in Section 4.3.

The LBL does not carry out stack emissions monitoring or ambient monitoring for nonradiological air pollutants because these emissions are not very significant, and such monitoring is not required by air regulatory agencies. However, the BAAQMD does estimate annual-average air pollution emission rates from emission inventory data provided by the LBL. The most current estimates are listed in Table 3-4.

3.1.3.1 Emissions Monitoring

The potential sources of radionuclide emissions are the exhausts from the various hoods and glove boxes in the numerous chemical laboratories. Approximately 80 vents or stacks are sampled weekly at the LBL for one or more types of radionuclides. Table 3-6 lists the number of stacks by building and the types of samples collected. A total of 145 samples are collected weekly, of which 56 are carbon filters for collection of reactive gases such as iodine-125 and 131, and 76 are membrane filters for collection of particulates. The remaining samples are for carbon dioxide (5 samples), an indicator for carbon-14, and tritiated water vapor (8 samples). Sampling rates are at 0.07 ft³/min for the particulate and charcoal filters, and at 4×10^{-4} ft³/min for the tritium and carbon dioxide samplers. The flow rates through the filters and the tritium samplers are monitored and controlled by flow meters. However, the sampling rate through the carbon dioxide samplers depends upon the observation of the bubbling rate (LBL, 1986h).

The carbon dioxide samples are analyzed for carbon-14, and the water vapor is analyzed for traces of tritium. The particulate filters are screened for gross alpha and gross beta activities to determine whether further analyses are needed to

TABLE 3-6
STACKS AND VENTS SAMPLED AT THE LBL, 1988

Building Number	Number of Stacks or Vents	Types of Samples*
1	7	CH, MF
3	7	CS, CH, MF
55	3	CH, MF
70	11	CH, MF
70A	13	CH, MF
71	6	CH, MF
74	9	CH, MF
74B	4	CH, MF
75	13	CH, MF, HS
83	1	CH, MF
88	5	CH, MF

Source: EH&S, 1988

- * HS = Silica gel tritium sampler
 CS = CO₂ bubbler
 MF = 25-mm-diameter membrane filter
 CH = 25-mm-diameter activated carbon filter

identify particular isotopes. Table 3-3 summarizes the radionuclide sampling programs at the LBL for 1986.

The main stack from Building 75 is sampled for tritium on a daily and weekly basis. At the time of the Survey, a new monitoring system had been installed in the NTLF, but the system operational checkout had not been completed. The system will monitor the concentration of tritium from the laboratory hoods to the main exhaust duct for Building 75 with an ion detection chamber. Readings will be taken every 10 seconds by the system computer. Air flow to the main exhaust system from the laboratory hoods averages 4,200 ft³/sec. The flow rate will be measured with a mass flow meter and recorded by the system computer every 10 seconds.

3.1.3.2 Ambient Air Monitoring

Ambient air is sampled at 15 locations on and around the LBL (Figure 3-1). At the four locations referred to as perimeter stations, suspended particulate, reactive gas, and water vapor samples are collected inside the walk-in shelters. At three of the stations, ambient air is drawn into the shelter through the louvered door and exits by an exhaust fan in the roof. The fourth station at Olympus Gate has an inlet pipe through a side wall, and the pipe is connected by tubing to the filters and pump.

Smaller sampling stations collect particulate samples and precipitation/deposition samples at nine locations within the LBL (Figure 3-1). Each of these nine stations consists of a rain gage housing with the funnel feeding any precipitation into a tube that is clamped at the bottom. Inside the shelter, a modified vacuum cleaner (Filter Queen) draws air through a glass-fiber filter (4 in. by 9 in.) at approximately 4 ft³/min. At the time of the Survey, the connecting hose between the filter and the outside air inlet was missing at four of these stations. The remaining two stations collect water vapor samples for tritium analysis at Supply Services (Building 69A) and at the Melvin Calvin Laboratory (Building 3) on the university campus. A carbon dioxide sampler is also operated on the roof of Building 3 to sample for carbon-14.

Samples are collected weekly for analysis. The methods of analysis and the detection limits are the same as those for the stack samples. Particulate samples are screened for alpha and beta activity. If the sample contains more than the predetermined number of counts in the analysis procedure, the sample goes on to

AIR MONITORING LOCATIONS
AT THE LBL

FIGURE 3-1

follow-up analysis. However, the majority of samples do not exceed the screening limits, and the sample counts are conservatively assumed to be from strontium-90 for beta activity and from thorium-232 for alpha activity. These assumptions are conservative because strontium-90 has the most restrictive Derived Concentration Guide (DCG) for beta activity, and thorium-232 has the most restrictive DCG for alpha activity. The DCG is based on interim DOE radiation standards for protection of the public (Vaughan, 1985).

Table 3-7 summarizes the results of the particulate sampling for 1986. The table shows that the average measured alpha concentration is 11 percent or less of the DCG for thorium-232, and that the average measured beta concentration is 0.6 percent or less of the DCG for strontium-90. Also, there is no discernible difference between on-site and perimeter station measurements.

Table 3-8 presents the results of the tritium and carbon-14 sample analyses for 1986. Tritium was detected at both the on-site and perimeter monitoring stations. Carbon-14 was detected also at Building 8. Both the tritium and carbon-14 concentrations, as measured by the LBL, are less than .1 percent of the applicable DCG for public exposure.

3.1.3.3 Meteorological Monitoring

An on-site meteorological tower about 40 feet high was installed on the roof of Building 70 to obtain meteorological data for input to the AIRDOS-EPA annual radiation dose model and to provide real-time wind data in case of an accidental airborne release. Wind direction, wind speed, temperature, and rainfall data are being obtained, but software has not yet been developed to process all the data in a form suitable for input to the model. EH&S also plans to obtain wind variance data from the system. The data are telemetered to Building 75, Room 124. The tower is about 100 feet away from a grove of trees of comparable height.

3.1.4 Findings and Observations

3.1.4.1 Category I

None

TABLE 3-7
SUMMARY OF PARTICULATE AIR SAMPLES, 1986

	No. of Samples	Concentration (10-15 $\mu\text{Ci/mL}$)								Average as % of Derived Concentration Guide ^b	
		Alpha				Beta					
		Avg.	Min.	Max. ^a	Avg.	Min.	Max. ^a	Alpha	Beta		
On-site average of 9 locations	487	0.27 $\pm$ 0.11	≤ 2	6 $\pm$ 2	29 $\pm$ 4	≤ 100	900 $\pm$ 100	4	0.3		
Perimeter Stations											
B-13A (Bldg. 88)	43	≤ 0.4	≤ 2	4 $\pm$ 2	50 $\pm$ 10	≤ 100	600 $\pm$ 100	6	0.6		
B-13B (Bldg. 90)	51	≤ 0.4	≤ 2	9 $\pm$ 3	40 $\pm$ 10	≤ 100	700 $\pm$ 100	6	0.4		
B-13C (Panoramic Way)	52	0.8 $\pm$ 0.3	≤ 2	5 $\pm$ 2	40 $\pm$ 10	≤ 100	600 $\pm$ 100	11	0.4		
B-13D (Olympus Gate)	49	≤ 0.3	≤ 2	3 $\pm$ 2	30 $\pm$ 10	≤ 100	600 $\pm$ 100	4	0.3		
Derived Concentration Guide ^b		7			9,000						

Source: LBL, 1987a

- ^a Highest single weekly sample. The maximum concentrations were found in samples taken on May 14 and May 21, 1986.
^b Alpha conservatively assumed to be thorium-232; beta assumed to be strontium-90 (Vaughan, 1985).

TABLE 3-8

SUMMARY OF AIRBORNE TRITIATED WATER AND CARBON-14 SAMPLING, 1986

	No. of Samples	Concentration (10^{-9} $\mu\text{Ci/mL}$)			Average as % of Derived Concentration Guide*
		Avg.	Min.	Max.	
Samples for Tritium as Tritiated Water On-Site Building 69A Building 3	48 51	0.8 ± 0.2 0.4 ± 0.1	≤ 0.7 ≤ 0.7	5 ± 1 4 ± 1	0.8 0.4
Perimeter Lawrence Hall of Science B-13D Olympus Gate	51 49	0.4 ± 0.1 0.5 ± 0.1	≤ 0.7 ≤ 0.7	3 ± 0.8 12 ± 3	0.4 0.4
Derived Concentration Guide*		100			
Samples for Carbon-14 (as Carbon Dioxide-14) On-Site Building 3	51	0.7 ± 0.2	≤ 0.2	0.4 ± 0.1	0.1
Derived Concentration Guide*		500			

Source: Adapted from LBL, 1987a

* From Vaughan, 1985

3.1.4.2 Category II

None

3.1.4.3 Category III

None

3.1.4.4 Category IV

1. Deficiencies in ambient air radiological sampling. Ambient air radiological samples are not representative of actual concentrations at several sampling locations due to poor maintenance or sample station design.

Data presented in the annual environmental monitoring report may underestimate actual concentrations. Four of the airborne particulate samplers at Buildings 75, 45, 50 and 74 had no hose between the filter cassette and the outside air intake. In this situation, air is circulated inside the small shelter housing with little chance of passing airborne pollutants to be drawn to the filter. A similar situation exists inside three of the perimeter monitoring stations, where air is drawn through the shelter, but the placement of the sample intakes and pump exhausts close to each other and near the walls encourages local recirculation of the air inside the shelter. The air flow in stations B-13A, B, and C is in through the louvered door and out through a roof fan. This situation does not guarantee a fresh supply of air to the sample intake near the wall since there is no forced mixing within the shelter. Also, samples were not being collected at an appropriate sampling height at Buildings 90 and 69A.

2. Nonrepresentative meteorological data. The use of nonrepresentative meteorological data as input to the AIRDOS-EPA dose model leads to the calculation of inaccurate estimates of radionuclide dose.

In estimating the radionuclide dose to the surrounding population in the most recent monitoring report that covers calendar year 1986, Oak Ridge National

Laboratory, which carried out the analysis for the LBL, used a 1960-1964 climatological data base from Oakland Airport. This data base is temporally and spatially unrepresentative of meteorological conditions at the LBL site. The annual dose for 1986 is dependent on 1986 meteorological conditions. Also, wind data from Oakland Airport would not be representative of airflow patterns in the complex terrain at the LBL. The use of wind data collected on-site would be more suitable. The LBL currently has an on-site meteorological tower collecting wind data and plans to use these data for input to AIRDOS-EPA in future studies when the software is developed to process and summarize the data. However, the on-site meteorological tower is sited too close to a small stand of trees, which will affect the validity of collected wind data.

Wind instruments are not located in open terrain and thus do not make measurements that are representative of the state of the atmosphere in that area. Open terrain is defined as an area where the horizontal distance between the wind sensors and any obstruction is at least 10 times the height of that obstruction. This convention has been in use for siting meteorological towers for quite a number of years and is widely accepted. There is a small stand of trees to the southwest of the LBL meteorological tower. The distance between the trees and the tower is about "2 times" the height of the trees from the meteorological tower. These trees are about as high as the wind sensors. The wind sensors are mounted on a mast about 40 feet high on the roof of Building 70; the roof line is estimated to be 25-30 feet above ground level. The trees will have an aerodynamic influence on measured winds such that unrepresentative wind data will be obtained when southwesterly winds occur. The LBL intends to use these data as input to the AIRDOS-EPA model to predict the annual dose. The use of unrepresentative meteorological data could affect validity of the model predictions.

3. Lack of written maintenance procedures for air pollution control devices. There are no written maintenance procedures for air pollution control devices for various processes at the LBL, which may lead to excessive air pollution emissions.

Among the 110 LBL air pollution sources registered with the BAAQMD, there are about 11 sources with control equipment to reduce emissions. Tables 3-4 and 3-5 identify these sources. This control equipment consists of baghouses, cyclones, and filters. Although the LBL equipment appears to be maintained to ensure that the control devices are functioning properly, and although maintenance logs are kept for each facility, a systematic maintenance program has not been established. For instance, there are no written instructions on the operation of the controls, no written procedures to ensure that the control equipment is functioning properly, and no instructions specifying the frequency of servicing. Also, the EH&S staff does not have overview of this activity. In the absence of a systematic maintenance program, control efficiencies may be reduced, and excessive air emissions could occur.

PRELIMINARY

3.2 Soils

3.2.1 Background Environmental Information

Most of the Lawrence Berkeley Laboratory (LBL) site is underlain by complex sedimentary and volcanic rock deformed by folding and faulting. In general, the bedrock is relatively weak and weathers deeply, which has produced a colluvial cover a few feet thick. The colluvium consists of silts, clays, and variable amounts of rock fragments derived from old landslide debris and weathering of the underlying volcanic bedrock. The colluvium is predominantly granular and contains abundant zones and lenses of loose gravel and rock fragments. These materials may be only moderately dense where there is a lack of silt or clay binder. Natural rock outcrops are few, although there are many rock exposures in cut slopes. The major geologic unit consists of poorly consolidated sandstones, siltstones, claystones, and conglomerates of relatively low strength and hardness. These rocks are blanketed by clay soils having high shrink-swell characteristics. The western and southern portions of the site are underlain by moderately well-consolidated shales, siltstones, sandstones, and conglomerates. Throughout most of the upper elevations, a volcanic unit overlies and is interbedded with the upper layers of the major geologic unit. Figure 3-2 is an LBL soil and geology map (LBL, 1984a).

Landslide deposits have been encountered in numerous locations within the LBL site. During the past 20 years, the LBL has carried out an aggressive program of slope stabilization to mitigate the risk of property damage due to soil movement (LBL, 1984a).

Grading and filling have often been necessary to provide suitable building sites at the LBL because of the hilly terrain. As a result, areas have been filled with soil up to several tens of feet thick in some of the original ravines and depressions. Most of these fills were mechanically compacted during placement (LBL, 1984a).

Background soil concentrations of all radionuclides and all chemicals in the vicinity of the LBL facility are not routinely analyzed for by the LBL, nor are most available in literature. However, Myrick, Berven, and Haywood (1983) have compiled background soil concentrations of naturally occurring members of the uranium and thorium decay series. Table 3-9 presents radium-226, thorium-232, and uranium-

Source: LBL, 1984a

SOIL AND GEOLOGY MAP
FOR THE LBL AND VICINITY

FIGURE 3-2

TABLE 3-9
BACKGROUND SURFACE SOIL CONCENTRATIONS
(pCi/g^a ± 2 STD Dev)

Location	Ra-226		Th-232		U-238	
	Range	Mean	Range	Mean	Range	Mean
California	0.24-1.3	0.77 ± 1.0	0.30-0.76	0.54 ± 0.45	0.19-1.3	0.78 ± 1.1
U.S.	0.23-4.2	1.1 ± 0.48	0.10-3.4	0.98 ± 0.46	0.12-3.8	1.0 ± 0.83
World	0.49-1.98	0.79	0.22-1.31	0.65	0.33-1.32	0.66

Source: Myrick, Berven, and Haywood, 1983

^a picocuries per gram (pCi/g) = 10⁻¹² curies per gram (Ci/g)

238 concentration data in soil for California, the United States, and the world. Vegetation and certain foodstuffs are indicators of radionuclide contamination in soil and therefore would be collected and analyzed as part of a comprehensive environmental monitoring program. The LBL has never routinely sampled for these parameters and no comparison with background values can be presented.

The LBL did perform a one-time sampling and analysis of soil and vegetation at the site. The sampling and analysis effort included off-site locations and provides an indication of background levels of various constituents in the soil and vegetation in the vicinity of the LBL. The sampling was limited in scope and therefore is discussed in the Environmental Monitoring Program Section (see Section 3.2.3).

The U.S. Department of Energy (DOE) has established guidelines for residual radioactivity at Formerly Utilized Sites Remedial Action Program (FUSRAP) and remote Surplus Facilities Management Program (SFMP) sites (DOE, 1985; Gilbert et al., 1985). There are no regulatory standards for nonradiological contaminant concentrations in soil as there are for drinking water supplies or for air. A determination of "safe" or "acceptable" levels in soils depends on contaminant migration pathways and potential human exposure routes. Therefore, acceptable levels must be determined on a site-specific and chemical-specific basis.

3.2.2 General Description of Pollution Sources and Controls

The major pathways for potential contamination of soil at the LBL are operation of the accelerators, routine and accidental airborne releases, routine and accidental liquid releases, and activities associated with waste disposal practices. To avoid soil contamination, the LBL has established controls on handling radioactive and hazardous materials. The controls include packaging, handling, storage, and disposal requirements; air filtration; and water treatment systems. The LBL also contains localized on-site areas of possible soil contamination by radionuclides and hazardous materials, resulting from past spills, airborne releases, releases of liquid wastes, and waste disposal practices. With the exception of the operation of accelerators, these sources and controls are discussed in Sections 3.1.2 (Air), 3.3.2 (Surface Water), 4.1.1 (Waste Management), 4.2.1 (Toxic and Chemical Materials), and 4.5.1 (Inactive Waste Sites and Releases).

Operation of the accelerators may either contaminate or activate soils. Soil contamination could occur through leakage of the cooling water or through the release of airborne emissions from ventilation stacks. Soil activation could result from particle scattering when the accelerator beam strikes targets or beam dumps, or from beam loss during particle acceleration.

Controls of soil activation consist of shielding the accelerators, target areas, and beam dump (absorbing) areas with concrete. Cooling water is passed through an ion exchange column and then discharged to the sanitary sewer, which is monitored. Other than monitoring, there are no controls on airborne emissions from the accelerators.

3.2.3 Environmental Monitoring Program

The LBL has not had in the past, nor does it currently have soil or vegetation monitoring programs. However, in 1986, the site did perform a one-time sampling of soil and vegetation at the site for various constituents.

3.2.3.1 Radiological Sampling

As part of the one-time sampling effort, a total of 11 soil and 7 vegetation samples were collected and analyzed for radiological constituents. A discussion of these results is provided below.

Soil

The soil samples were collected both on-site and off-site. The on-site locations were described as in the vicinity of the Magnetic Fusion Energy (Building 4), 184-Inch Synchrocyclotron-Biomedical Research (Buildings 6-10), Bevatron (Building 51), Nuclear Science and Applied Science/Nuclear Science, Materials, Molecular Research, and Earth Science (Buildings 70/70A) Heavy Ion Linear Accelerator (SuperHILAC) (Building 71), Biomedical Laboratory Annex (Building 74), Radioisotope Services (Building 75), and East Canyon. Figure 3-3 indicates the buildings or area where the soil samples were taken, but not the exact sampling locations. The off-site locations, which were selected as indicative of background levels, were described as

APPROXIMATE SOIL AND VEGETATION
SAMPLE LOCATIONS AT THE LBL

FIGURE 3-3

Claremont, Stern, and Tilden. The general location for these sites could not be identified from the information available (LBL, 1986c).

The soil samples were analyzed for gamma emitters, gross alpha, gross beta, and tritium. The soil analysis results are presented in Table 3-10. While it is not possible to draw specific conclusions from the data, due to the limited scope of the sampling, several on-site areas indicate higher than background levels. Approximately 2 times background levels of gross alpha activity are in the vicinity of Building 4, the site of a previous radioactive waste storage and staging area (see Section 4.5.1). Tritium activity 100 times background was found in the vicinity of Building 75, where the National Tritium Labeling Facility (NTLF) is located (see Section 3.1.2).

Vegetation

The vegetation samples, consisting of eucalyptus leaves, were collected both on-site and off-site. The on-site locations were described as in the vicinity of Buildings 70/70A, 74, 75, and East Canyon. Figure 3-3 indicates the buildings or area where the vegetation samples were taken, but not the exact sampling locations. The off-site locations, representing background, were described as Claremont, Stern, and Tilden. The general location for these sites could not be identified from the information available.

The vegetation samples were analyzed for gamma emitters, gross alpha, gross beta, and tritium. The vegetation analysis results are presented in Table 3-11. While it is not possible to draw specific conclusions from the data, due to the limited scope of the sampling, one on-site area indicates higher than background activity. Vegetation levels of tritium activity in the vicinity of Building 75, where the NTLF is located, were 1,000 times background (see Section 3.1.2).

3.2.3.2 Nonradiological Sampling

The number and locations for the nonradiological soil samples were the same as for the radiological samples. Vegetation samples were not analyzed for nonradiological constituents.

TABLE 3-10

RADIOLOGICAL RESULTS OF SOIL SAMPLES FROM THE LBL

Sample Number (Building/Location)	Collection Date	Analysis	Results pCi/g $\pm 2 \sigma$ (1)
On-Site Locations			
B-4	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: 40K 137Cs 226Ra 232Th	11 ± 5 32 ± 6 0.05 ± 0.02 7.6 ± 0.4 0.38 ± 0.02 0.42 ± 0.02 0.54 ± 0.03
B6-10	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: 40K 137Cs 226Ra 232Th	0 ± 8 34 ± 6 0.02 ± 0.01 11.7 ± 0.6 0.26 ± 0.01 0.48 ± 0.02 0.73 ± 0.04
B51	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: 40K 137Cs 226Ra 232Th	0 ± 4 28 ± 5 0.04 ± 0.01 8.6 ± 0.4 0.27 ± 0.01 0.39 ± 0.02 0.53 ± 0.03
B70/70A	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: 40K 137Cs 226Ra 232Th	0 ± 4 40 ± 6 0 ± 0.01 15.6 ± 0.8 0.33 ± 0.02 0.69 ± 0.03 1.07 ± 0.05
B71	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: 40K 137Cs 226Ra 232Th	0 ± 5 19 ± 4 0 ± 0.02 8.3 ± 0.4 0.23 ± 0.01 0.35 ± 0.02 0.48 ± 0.02

TABLE 3-10

RADIOLOGICAL RESULTS OF SOIL SAMPLES FROM THE LBL (Continued)

Sample Number (Building/Location)	Collection Date	Analysis	Results pCi/g $\pm 2 \sigma$ (1)
B-74	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: 40K 137Cs 226Ra 232Th	0 ± 10 36 ± 6 0.05 ± 0.02 5.0 ± 0.2 0.93 ± 0.05 0.84 ± 0.04 0.39 ± 0.02
B-75	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: 40K 137Cs 226Ra 232Th	0 ± 4 25 ± 5 11.1 ± 0.6 8.7 ± 0.4 0.37 ± 0.02 0.38 ± 0.02 0.49 ± 0.02
East Canyon	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: 40K 137Cs 226Ra 232Th	0 ± 4 19 ± 5 0.02 ± 0.01 7.0 ± 0.4 0.38 ± 0.02 0.43 ± 0.02 0.46 ± 0.02
Off-Site Locations (Background)			
Claremont	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: 40K 137Cs 226Ra 232Th	0 ± 5 25 ± 5 0 ± 0.01 6.9 ± 0.3 0.03 ± 0.01 0.92 ± 0.05 0.71 ± 0.04
Stern	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: 40K 137Cs 226Ra 232Th	0 ± 5 34 ± 6 0.14 ± 0.01 10.1 ± 0.5 0.15 ± 0.01 0.46 ± 0.02 0.62 ± 0.03

TABLE 3-10

RADIOLOGICAL RESULTS OF SOIL SAMPLES FROM THE LBL (Continued)

Sample Number (Building/Location)	Collection Date	Analysis	Results pCi/g $\pm 2 \sigma$ (1)
Tilden	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: ^{40}K ^{137}Cs ^{226}Ra ^{232}Th	0 ± 3 25 ± 5 0.07 ± 0.01 8.8 ± 0.4 0.33 ± 0.02 0.83 ± 0.04 0.86 ± 0.04

Source: LBL, 1986c

- (1) Results for ^3H are reported on a wet-weight basis, all other analyses are reported on a dry-weight basis.

TABLE 3-11

RADIOLOGICAL RESULTS OF VEGETATION SAMPLES FROM THE LBL

Sample Number (Building/Location)	Collection Date	Analysis	Results pCi/g $\pm 2 \sigma$ (1)
On-Site Locations			
Eucalyptus Leaves 70/70A	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: ^7Be ^{40}K ^{134}Cs ^{137}Cs ^{226}Ra	0 ± 0.3 11 ± 1 0.30 ± 0.07 1.2 ± 0.1 5.5 ± 0.3 0.03 ± 0.01 0.05 ± 0.01 0.03 ± 0.01
Eucalyptus Leaves 74	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: ^7Be ^{40}K ^{134}Cs ^{137}Cs ^{226}Ra ^{232}Th	0 ± 0.4 12 ± 1 0 ± 0.05 0.38 ± 0.04 3.1 ± 0.2 0.013 ± 0.004 0.016 ± 0.003 0.059 ± 0.006 0.017 ± 0.003
Eucalyptus Leaves 75	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: ^7Be ^{40}K ^{134}Cs ^{137}Cs ^{226}Ra ^{232}Th	0 ± 0.4 8 ± 1 107 ± 5 0.56 ± 0.05 3.9 ± 0.2 0.035 ± 0.005 0.052 ± 0.006 0.040 ± 0.005 0.020 ± 0.006
Eucalyptus Leaves East Canyon	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: ^7Be ^{40}K ^{134}Cs ^{137}Cs ^{226}Ra ^{232}Th	0 ± 0.4 12 ± 1 0.38 ± 0.06 0.38 ± 0.05 4.2 ± 0.2 0.010 ± 0.004 0.025 ± 0.006 0.010 ± 0.007 0.017 ± 0.008

TABLE 3-11

**RADIOLOGICAL RESULTS OF VEGETATION SAMPLES FROM THE LBL
(Continued)**

Sample Number (Building/Location)	Collection Date	Analysis	Results pCi/g $\pm 2 \sigma$ (1)
Off-Site Locations (Background)			
Eucalyptus Leaves Claremont	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: ^7Be ^{40}K ^{137}Cs ^{226}Ra ^{232}Th	0 ± 0.6 15 ± 1 0.06 ± 0.05 0.34 ± 0.06 3.3 ± 0.2 0.013 ± 0.006 0.06 ± 0.01 0.011 ± 0.005
Eucalyptus Leaves Stern	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: ^7Be ^{40}K ^{137}Cs ^{232}Th	0 ± 0.4 10 ± 1 0.08 ± 0.06 0.15 ± 0.04 4.1 ± 0.2 0.010 ± 0.004 0.03 ± 0.01
Eucalyptus Leaves Tilden	9/22/86	Gross Alpha Gross Beta ^3H Ge(Li) Scan: ^7Be ^{40}K ^{134}Cs ^{137}Cs ^{226}Ra ^{232}Th	0 ± 0.4 12 ± 1 0.14 ± 0.06 0.43 ± 0.04 3.0 ± 0.2 0.005 ± 0.003 0.023 ± 0.004 0.012 ± 0.006 0.03 ± 0.01

Source: LBL, 1986c

(1) Results for ^3H are reported on a wet-weight basis; all other analyses are reported on a dry-weight basis.

The soil samples were analyzed for the U.S. Environmental Protection Agency (EPA) priority pollutants. All the organics on the EPA priority pollutants list were less than the lower limit of detection, which varied depending on the analyses. The analytical results for the EPA priority pollutant metals are presented in Table 3-12. While it is not possible to draw specific conclusions from the data, due to the limited scope of the sampling, several on-site areas indicate higher than background concentrations. These include arsenic 1.5 times background around Building 71, chromium 1.5 to 4 times background around Buildings 4, 51, 70/70A, 71, 75 and East Canyon, copper 2 times background around Building 4, lead 2 times background around Building 74, and nickel 2 to 2.5 times background around Buildings 51 and 75.

3.2.4 Findings and Observations

3.2.4.1 Category I

None

3.2.4.2 Category II

None

3.2.4.3 Category III

None

3.2.4.4 Category IV

1. Lack of soil and vegetation monitoring programs. The lack of soil and vegetation monitoring programs for tritium and other contaminants precludes an accurate assessment of impacts to the environment from past and present LBL operations.

Soil samples collected in 1986 by the LBL indicate contamination 2 times background of alpha emitters around Building 4; the site of a previous radioactive waste storage and staging area; tritium activity 100 times background around Building 75, the location of the National Tritium Labeling

TABLE 3-12

INORGANIC CHEMICAL RESULTS OF SOIL SAMPLES FROM THE LBL

Constituent (mg/kg) ^a	On-Site								Off-Site (Background)		
	1274-80-35 B4	1274-80-36 B6-10	1274-80-37 B51	1274-80-38 B70/70A	1274-80-39 B71	1274-80-40 B74	1274-80-40 B75	1274-80-43 East Canyon	1274-80-42 Claremont	1274-80-44 Stern	1274-80-45 Tilden
Antimony	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6
Arsenic	12	8	8	10	17	5	9	11	9	7	5
Beryllium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<1.9	<0.2	<0.2	<0.2
Cadmium	4.0	4.0	3.9	3.8	3.7	4.0	3.9	3.8	2.0	3.9	1.9
Chromium	99	59	150	57	93	40	120	110	12	39	17
Copper	79	40	39	38	19	40	39	56	18	39	17
Lead	73	76	54	88	20	170	25	40	24	63	43
Mercury	0.12	<0.04	0.23	0.21	0.04	0.25	0.08	0.13	0.05	0.32	0.07
Nickel	62	87	140	43	49	48	180	51	14	75	11
Selenium	<0.9	<1	<0.9	<0.9	<0.9	<0.8	<0.9	<0.9	<0.8	<1	<0.9
Silver	0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Thallium	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6	<6
Zinc	110	110	87	160	71	180	68	77	53	150	64

Source: LBL, 1986c

^a Results are reported on a dry-weight basis.

Facility; arsenic 1.5 times background around Building 71; chromium 1.5 to 4 times background around Buildings 4, 51, 70/70A, 71, 75, and East Canyon; copper 2 times background around Building 4; lead 2 times background around Building 74; and nickel 2 to 2.5 times background around Buildings 51 and 75. Vegetation samples collected at the same time indicate tritium contamination 1,000 times background around Building 75.

Due to the limited scope of the sampling, it is not possible to draw specific conclusions from the data. Therefore, it is difficult to determine whether these levels represent a health risk to humans. However, the data indicate that the tritium air emissions from the NTLF may actually be accumulating in the soil and vegetation around the Building 75 stack, and are not being dispersed into the atmosphere as assumed by the LBL. Additionally, there is an indication that areas of localized soil contamination may be present from past spills and operations at the LBL (see related finding 2 in Inactive Waste Sites and Releases, Section 4.5.2.3). This contamination is then available for transport off-site in stormwater runoff or into the groundwater via rainwater. While air, surface water, and direct radiation are sampled or monitored, soil, vegetation, and groundwater are not, and contamination may not be detected because of dilution or until it is too late to minimize the impact on the environment. The lack of soil and vegetation sampling precludes a complete understanding of the transport pathway to the public of contaminants from the LBL facility.

3.3 Surface Water

3.3.1 Background Environmental Information

This section describes the environmental setting of the Lawrence Berkeley Laboratory (LBL) as it pertains to surface water. First, the geography and topography of the LBL are described, followed by the hydrology of nearby surface-water bodies. Finally, the supplies, uses, and distribution of potable and process waters are delineated for the LBL facility.

3.3.1.1 Geography and Topography

The LBL occupies 130 acres on a hillside above the main campus of the University of California at Berkeley (UCB) (LBL, 1987a). Although most of the site is within the City of Berkeley, approximately one-quarter of its eastern portion lies within the City of Oakland. The Laboratory is 3 miles east of San Francisco Bay and about 15 miles east of San Francisco. The LBL lies on the west-facing slope of the Berkeley Hills at elevations ranging from 500 feet above mean sea level at the western boundary to 1,500 feet above mean sea level at the eastern boundary (LBL, 1987a). The Laboratory property contains three main canyons with related tributary features (Korbay, 1982). The west-trending Strawberry Canyon lies along the southern border of the property, as shown in Figure 3-4. A north-south-trending canyon along the eastern portion of the property joins the head of Strawberry Canyon. Blackberry Canyon, another west-trending feature, drains the central portion of the laboratory, as shown in Figure 3-4. Extensive cut-and-fill grading of the natural steep slopes at the site has been necessary to develop level areas for construction of single and multi-story structures, roads, parking lots, and storage areas (Korbay, 1982).

3.3.1.2 Hydrology

The LBL lies in the portion of the Strawberry Creek Watershed shown on Figure 3-5 (Kuntz, 1980). This watershed also includes other University of California property, public streets of both Oakland and Berkeley, and private property. Approximately one-third of this portion is within the City of Berkeley, with the other two-thirds

STRAWBERRY CREEK WATERSHED

FIGURE 3-5

lying within the City of Oakland. This portion of the watershed, comprised of 874 acres, lies generally above Gayley Road and Highland Avenue.

The Strawberry Creek Watershed is divided into five sub-watersheds as shown on Figure 3-5. Each of these sub-watersheds is contributory to a particular main drainage culvert or system, as illustrated on the figure. The North Fork of the watershed, as it relates to the LBL, contains 141 acres comprised mostly of steep canyons and hillsides covered with brush, trees, and grass (LBL, 1986g). Within this watershed, the LBL has developed approximately 25.6 acres on which there are buildings, parking lots, pavements, and other improvements. Above the LBL, and within the 141-acre watershed, there are several UCB buildings including the Lawrence Hall of Science, the Space Science Building, and the Mathematical Sciences Research Institute, along with parking lots and roads.

Stormwater runoff generated from the LBL and from the upper parts of the North Fork watershed discharges into a 60-inch concrete culvert at the head of LeConte Avenue in Berkeley. Normally, rainfall intensities are seldom greater than one-half inch per hour (LBL, 1984a). The drainage facilities in this watershed have proven adequate during the heavier than normal rains of the past few years.

The South Fork watershed of Strawberry Creek, as it relates to the LBL, has a total area of about 733 acres and is further divided into four sub-watersheds: Upper Strawberry Creek watershed, 502 acres; Chicken Creek watershed, 66 acres; Panoramic watershed, 73 acres; and Stadium Hill watershed, 92 acres (LBL, 1986g).

Of the 502 acres in Upper Strawberry Creek watershed, the LBL has developed approximately 4 acres. Other developments within this area include UCB buildings and roads and private residential developments, all of which comprise approximately 10 acres. The remainder of the watershed is in a natural condition with trees, brush, and steep hillside canyons.

Chicken Creek watershed has a total developed area of about 12 acres, of which a little over 10 acres are in LBL territory. Panoramic watershed has a total developed area of about 15.4 acres, none of which is associated with the LBL. Stadium Hill watershed has a total developed area of about 12 acres, of which about 7.5 acres

are LBL development. A summary of the development in these watersheds is given in Table 3-13.

Strawberry Creek is comprised of two main branches: North Fork and South Fork. The North Fork is commonly referred to as Blackberry Creek, while the South Fork is known as Strawberry Creek. The headwaters of both of these creeks originate in the two canyons which the LBL straddles (LBL, 1986a). While on the LBL site, Strawberry Creek is diverted underground near the Strawberry Canyon Recreational Area. It later emerges as a surface stream near the western end of the LBL site. Strawberry and Blackberry Creeks then combine at the western end of the campus, approximately 400 feet east of the City of Berkeley's Oxford and Center Streets culvert. Runoff from the entire watershed, including the lower campus, is delivered to the entrance of this culvert (Kuntz, 1980). The runoff flows through the City of Berkeley storm drainage system, which then empties into San Francisco Bay.

As a result of its hillside location and a moderate annual rainfall, surface runoff is a prevalent feature at the LBL (Korbay, 1982). As previously mentioned, three canyons and related tributaries lie within or on the boundaries of the laboratory. Year-round springs and annual surface seeps are present. Surface stream flows vary from nearly dry conditions in the summer to large runoff flows during intense winter rains. Both Strawberry and Blackberry Creeks are perennial and are fed by springs during the summer, while their tributaries are ephemeral. These tributaries' flows are mostly limited to storm runoff and usually exist only for short times after a storm (Korbay, 1982). Several permanent springs are located in the northern portion of the site at the headwaters of Blackberry Creek. These furnished water for the City of Berkeley before establishment of the East Bay Municipal Utility District (EBMUD) water system (LBL, 1986a). Ephemeral tributaries of Strawberry Creek, whose canyon is deeply incised into the Berkeley Hills, drain the southern portion of the site in a roughly east-west direction, while Blackberry Creek drains the central portion of the site. The main portion of the laboratory occupies the prominent bluffs and spurs between the Strawberry and Blackberry Creek drainages. None of the LBL lies within a 100-year floodplain.

Before the laboratory was built, erosion was rapid due to the steepness of the slopes in the area, and continues today in areas of little ground cover (Korbay, 1982). When the LBL was constructed, extensive earthwork altered natural

TABLE 3-13
DEVELOPMENT IN STRAWBERRY CREEK WATERSHED

Watershed Name	Development (as of 1980) (Areas in Acres)									
	Total Area	All Bldgs. & Pavement	% of Total	Univ. Bldgs. & Pavement	% of Total	Residential & Pavement	% of Total	Total Bldgs. & Pavement	% of Total	Natural Area
South Fork Upper Strawberry	502	3.6	0.7	2.9	0.6	3.6	0.7	10.2	2.0	491.8
Chicken Creek	66	10.3	15.6	1.7	2.6	0.2	0.3	12.0	18.2	54.0
Panoramic	73	-	-	12.9	17.7	2.5	3.4	15.4	21.1	57.6
Stadium Hill	92	7.4	8.0	3.8	4.1	0.4	0.4	11.6	12.6	80.4
Total - South Fork	733	21.3	2.9	21.3	2.9	6.7	0.9	49.2	6.7	683.8
North Fork	141	25.6	18.2	6.5	4.6	8.0	5.7	40.2	28.5	100.8
										71.5

Source: Kuntz, 1980

drainage patterns, and extensive paving and building increased runoff volumes during storms. A drainage system was installed in the 1960s to provide for runoff intensities expected in a 25-year maximum-intensity storm (LBL, 1987a). This system, illustrated in Figure 3-5, connects to the City of Berkeley and University of California systems on the west and south boundaries of the LBL, respectively (Korbay, 1982). Prior to the installation of this system, all runoff from the LBL entered the creeks.

Groundwater drainage feeds into Blackberry Creek on the northern portion and Strawberry Creek on the southern portion of the Laboratory. During the rainy season, groundwater levels increase and cause a decrease in slope stability. Landslides are often triggered by the increased hydrostatic pressure; consequently, the Laboratory has installed an elaborate groundwater drainage system. This system consists of a number of horizontally installed pipes, commonly referred to as hydraugers, in various locations throughout the LBL hillside. Groundwater which drains from these hydraugers empties into the Laboratory's storm drain system, which leads to Strawberry and Blackberry Creeks. The groundwater drainage system and the hydraugers are discussed in further detail in Section 3.4.

3.3.1.3 Water Supplies, Uses, and Distribution

The sole source of water supplied to the LBL is EBMUD, which obtains its water from surface waters. EBMUD's main source is the Pardee Reservoir on the Mokelumne River in the Sierra, as shown on Figure 3-6 (EBMUD, ND). Water from this source is diverted to the Mokelumne Aqueducts and transported 90 miles across the San Joaquin Valley to the East Bay area, where it is stored, treated, and filtered at the Orinda treatment plant prior to distribution. Available analyses of source and finished waters for chemicals, trace metals, pesticides, and radiological parameters are given in Appendix F.

The LBL receives its water from EBMUD at two separate connections. The primary connection is the EBMUD Shasta Reservoir, which has a 2,000,000-gallon capacity. The Laboratory's high-pressure fire and domestic systems are supplied from this reservoir. The secondary connection is EBMUD's Berkeley View Tank, which has a 1,000,000-gallon capacity (LBL, 1987a). Both of these facilities are backed by many additional reservoirs, pumping facilities, aqueducts, and distribution lines.

EBMUD WATER SUPPLY
SOURCE AND DISTRIBUTION SYSTEM

FIGURE 3-6

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 (LBL, 1986g). The LBL system also supplies makeup water for cooling towers, irrigation water, and water for other miscellaneous uses, including industrial, deionized, and distilled water types. The system includes fire hydrants and fire department connections and sprinkler services to almost all buildings.

As a result of the differences in elevation at the LBL site, there are two main pressure zones which operate at the nominal pressure of about 70 pounds per square inch (psi). The system is entirely a gravity system, except for the emergency fire protection system described later. 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 the newer lines have been located to avoid potential unstable earth areas (LBL, 1986g).

The LBL emergency fire protection system consists of two 200,000-gallon water storage tanks, one near Building 75 and the other near Building 71. At each 200,000-gallon tank site, there is a diesel-driven fire pump with automatic controls which can pressurize the LBL system if EBMUD service is interrupted. In normal operation, water is slowly circulated from the LBL system through the 200,000-gallon tanks so they are always filled with potable water, and the full 400,000 gallons is always available if required. The emergency fire water system was installed in about 1979 (LBL, 1986g).

A breakdown between process water use and non-process water use is not available for the LBL. Available information from the Building 77 wastewater treatment plant (WWTP) permit indicates that water supplied to the LBL was 473,710 gal/day of operation (Damas, 1987). Of this volume, 363,252 gal/day was discharged to the sanitary sewer, while 110,458 gal/day was lost by evaporation. The water released to the sanitary sewer flows to the EBMUD sewage treatment plant. The fraction of EBMUD's total flow which is represented by LBL's discharge is not available.

The LBL drinking water is sampled by an Industrial Hygiene (IH) technician semiannually from the reservoirs, and bimonthly from selected building faucets. Analyses for coliform bacteria have been satisfactory for the past 8 years. The LBL began analyzing for lead on January 11, 1988. To date, all results have been less than the U.S. Environmental Protection Agency (EPA) primary drinking water standard of 0.05 mg/L. The samples are sent to Brown & Caldwell in Emeryville, California, for analysis. Backflow prevention devices are in place where a potential for cross-contamination of the drinking water and wastewater exists, and a regular maintenance program is also in effect.

Neither Strawberry Creek nor Blackberry Creek is used for drinking water purposes, as the surrounding communities obtain their potable water from EBMUD, as described above.

3.3.2 General Description of Pollution Sources and Controls

Wastewaters produced at the LBL include sanitary and industrial sources, as well as some sources that enter the storm sewer system and discharge to on-site surface waters. The sanitary and industrial wastewaters, which contain both chemical and radiological contaminants, are either disposed of via the sanitary sewer, or are collected and disposed of by the Environmental Health and Safety (EH&S) Department. This latter category of wastes is discussed in Section 4.1.1.

At the LBL, the ultimate responsibility for the disposal of hazardous wastes lies with the generator (LBL, 1984b). Guidelines for waste disposal, including disposal to the sanitary sewer system, are given in the LBL Health & Safety Manual (LBL, 1986f). The manual views disposal to the sanitary sewer system as "undesirable," however, and recommends that it be used "only as a last resort or under very carefully controlled circumstances after consultation with the EH&S Department" (LBL, 1986f). Examples of permissible substances to be disposed of via the sanitary sewer include "small quantities" of the following (LBL, 1986g):

- Water-soluble chemicals, including organic, water-soluble liquids, in such volumes as to present no fire hazard;

- Acids or bases if neutralized to have a pH in the range 5-10;
- Heavy metals, e.g., a few grams.

"Small quantities" is defined in an LBL news bulletin as "milliliter" quantities (LBL, 1986i). For small quantities of unknown wastes received by EH&S for disposal, similar guidelines are used. For the purposes of waste analysis prior to disposal, "small quantities" is defined as "less than 1/2 lb of solids and less than one gallon of liquids" (LBL, 1984b). Non-reactive, water-soluble liquids (based on in-house testing) and neutralized acids are flushed down the drain. All chemicals are specifically prohibited from being discharged to the storm sewers and ultimately to the creeks (LBL, 1986a).

All wastes disposed of via the sanitary sewer at the LBL flow to the EBMUD treatment plant in Oakland where they undergo primary and secondary treatment. The effluent from this system discharges into San Francisco Bay. At the LBL, the sewer line connects on the north side into the City of Berkeley 6-inch line that runs down Hearst Avenue. On the south side, the LBL 8-inch line connects into the UCB campus line which carries the effluent to the City of Berkeley (LBL, 1986a). Both lines are equipped with sewer monitoring stations, as described in Section 3.3.3.2. Since the LBL discharges its wastewaters to the EBMUD system, it does not require a National Pollutant Discharge Elimination System (NPDES) permit for its discharges.

Some of the LBL wastewaters which are disposed of via the sanitary sewer receive pretreatment prior to disposal, while others do not. This section therefore describes wastewater sources in three categories: pretreated wastewaters, direct discharges to the sanitary sewer, and potential discharges to surface waters.

3.3.2.1 Pretreated Wastewaters

Mechanical Technology (Building 25)

Mechanical Technology (Building 25) houses the printed circuit (PC) board fabrication shop and its associated WWTP. Plating solutions (20 gallons each) include copper, tin/lead, and cyanide/gold, as well as associated acids (sulfuric,

hydrochloric), etchers (ferric chloride), rinses, conditioners (HFB₄), activators and developers. Spent plating solutions are drummed and disposed of by EH&S. A copper purification chamber is used to recycle the copper plating solution. As of February 1986, all floor drains, developer solutions, and rinsewaters, except the cyanide solutions used for gold plating, flow to a 250-gallon carbon steel epoxy-lined (double-lined) sump which leads to the WWTP. Prior to the construction of the WWTP in 1986, disposal was to the sanitary sewer without treatment. The floor drains that formerly led to the sanitary sewer have been capped, but no soil sampling was performed along the sewer lines to assess whether any leaks to the soil had occurred. Plating operations have been performed at this location for 15 to 20 years.

The WWTP for the PC board fabrication shop operates as follows. Metal-containing wastewaters enter one or both of the 550-gallon polyethylene primary surge tanks from the sump. The WWTP operates on a batch basis at 2 gallons per minute (gpm) approximately every other day, although the capacity of the plant is 20 gpm (Young, 1988a). Wastewaters are treated by neutralization, precipitation of heavy metals, flocculation, clarification, and filtration using a filter press. The effluent from the process is sampled for copper by a colorimetric (Hach) test prior to release to the sanitary sewer. The dry filter cake is collected in a drum for disposal as hazardous waste at a rate of about 1/2 drum per 90 days. An analysis of the sludge sampled is shown in Table 3-14.

The wastewater from these operations is subject to the EPA Metal Finishing Pretreatment Standard (40 CFR 433) as EBMUD has adopted the Categorical Pretreatment Standards in Ordinance Number 296 (LBL, 1987a). Wastewater samples are obtained quarterly prior to the stream entering the sanitary sewer, and represent a 24-hour average discharge (LBL, 1987a). These samples are required to be analyzed for chromium, copper, lead, pH, and Total Suspended Solids (TSS). Metals analyses for 1986 are shown in Table 3-15 (1986 data). No data for pH or TSS are available. EBMUD also periodically obtains a sample from this location. Although exceedances of copper and lead have been noted in the past, these were attributed to the initial shakedown period of the WWTP and to inadequate settling of the flocculant due to the introduction of concentrated detergents to the unit. In lieu of monitoring for total toxic organics (TTOs) in accordance with the

TABLE 3-14

BUILDING 25 WASTEWATER TREATMENT PLANT SLUDGE ANALYSIS*

Analysis	Unit	2/25/86	3/14/86	3/19/86	CA Total Threshold Limit Concentrations (mg/kg)**
Moisture	%	70	64	70	--
Cyanide	mg/kg	<0.04	<0.05	<0.04	--
Cadmium	mg/kg	6	3	2	100
Chromium	mg/kg	500	1,900	1,100	2,500***
Copper	mg/kg	26,400	7,200	3,300	2,500
Lead	mg/kg	250	170	120	1,000
Fluoride (SIE)****	mg/kg	570	340	420	--

Sources: Gray, 1986; CADOHS, 1985

- * All original results except moisture and cyanide reported on a dry-weight basis. Results converted to a wet-weight basis by Survey team.
 ** Wet weight.
 *** Trivalent chromium.
 **** Specific Ion Electrode method of analysis.

TABLE 3-15

BUILDING 25 TREATED WASTEWATER SAMPLE RESULTS (1986)

Sample Date	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)
02-20-86	<0.05	16.30	<0.05
02-27-86	0.09	3.78	<0.05
02-28-86	<0.05	1.19	<0.05
03-04-86	0.74	<0.05	<0.05
03-05-86	<0.11	0.26	<0.05
03-06-86	<0.05	0.38	<0.05
03-12-86 ^a	<0.05	1.4	0.01
04-17-86	0.36	1.6	0.13
06-10-86 ^a	0.12	1.5	0.1
06-29-86	1.0	3.0	0.2
09-23-86 ^a	0.05	23.0	0.9
11-12-86	0.20	1.6	<0.05
11-25-86 ^a	0.09	1.0	0.2
Minimum:	<0.05	<0.05	0.01
Maximum:	1.0	23.0	0.9
Average:	<0.23	<4.24	<0.15
Discharge Limit ^b :	2.77	3.38	0.69
% of Limit:	<8.3	<125	<22

Source: LBL, 1987^a^aSample collected and analyzed by EBMUD.^bDaily maximum.

pretreatment standards, the LBL has prepared and is implementing a Toxic Organic Management Plan (TOMP) for the Building 25 WWTP (Kropschot, 1987).

In November 1984 and prior to the installation of the WWTP, approximately 145 gallons of 12.1 percent chromic acid and 19.8 percent sulfuric acid solution was discharged to the sanitary sewer through a drain valve which was inadvertently left open during refilling of an etching machine. At the time, no written procedures existed for emptying and refilling the etcher. This incident caused sewer discharge limits established by EBMUD for chromates to be exceeded at the LBL Hearst Monitoring Station. Measures were taken to prevent this violation from recurring (LBL, 1984c).

Mechanical Shops (Building 77)

Mechanical Shops (Building 77) contains the plating shop and its associated WWTP. Other wastewater-generating activities that occur in this building are discussed in Section 3.3.2.2.

The plating shop contains facilities for the plating of chromium, copper, nickel, silver, etc. The shop includes a vapor degreaser using 1,1,1-trichloroethane, cleaner tanks using a caustic detergent, rinse tanks, acid tanks (i.e., muriatic, sulfuric, nitric) and deionized-water tanks. The detergent solutions are stored in a 500-gallon tank prior to release to the sewer line. The solutions from the rinse tanks are directed to the WWTP. The plating baths are not emptied, but any spills to the floor are directed to two sumps of about 18 cubic feet beneath the floor, which lead to the WWTP. The floor beneath the plating shop is concrete with an epoxy coating that was resealed 3 to 4 years ago, when the WWTP was installed. Prior to this time, wastewaters from the plating shop were routed directly to the sanitary sewer. The plating shop has been in operation for about 25 years. A new plating shop is expected to be built in October 1988. The WWTP is scheduled for upgrade to a 60-gpm unit in fiscal year (FY) 1988 (Young, 1983a).

The capacity of the existing WWTP is 15 gpm but it is usually operated at 7 gpm. Wastewater from the two sumps is tested for pH prior to its entering the WWTP. This pH has always been less than 8. Cyanide wastes are segregated in a 500-gallon double-contained tank and pumped to a separate compartment in the treatment

unit for cyanide destruction. Chromium solutions and acid wastes are contained in a 700-gallon tank and pumped to a second compartment in the treatment unit for reduction of hexavalent chromium. Effluent from these two compartments overflows to a third compartment for final pH adjustment, followed by flocculation, clarification, and filtration using a filter press. Approximately one 55-gallon drum of sludge is disposed of per year from the WWTP. The analysis of this sludge is shown in Table 3-16. Effluent from the treatment process is released to the sanitary sewer after sampling. The effluent is sampled by EH&S personnel and sent to an outside laboratory for analysis, and five to six times a year by EBMUD for metals, cyanide, and pH. The pH is usually 8 to 9, which is above the lower limit of pH 5.5 established by EBMUD. An upper limit on discharge has not been specified by EBMUD, as an alkaline discharge helps neutralize discharges of acids into their sewer lines from other sources. An upper limit on pH for the WWTP is currently under discussion between LBL EH&S staff and EBMUD.

Effluent from the WWTP is subject to the EPA Metal Finishing Pretreatment Standard (40 CFR 433), and EBMUD has adopted the Categorical Pretreatment Standards in Ordinance Number 296 (LBL, 1987a). Samples are obtained from the WWTP effluent prior to its combining with other wastewaters, and represent a 24-hour average discharge (LBL, 1987a). The sampling results for 1986 are shown in Table 3-17. The LBL is also required to analyze samples for pH and TSS. All parameters shown in Table 3-17 are within discharge limits. However, exceedances were noted in 1985 for pH, copper, and cyanide; in December 1986 for low pH; and in January 1988 for cadmium. Actions have been taken to correct all these violations. In lieu of monitoring for TTOs in accordance with the pretreatment standards, the LBL has prepared and is implementing a TOMP for the Building 77 WWTP (Kropschot, 1987).

Nuclear Science, Materials, Molecular Research, and Earth Science (Building 70A)

A number of laboratories for research in nuclear science, materials and molecular research, and earth sciences are housed in Building 70A. Semiconductor fabrication activities in Room 3353 with germanium and in Room 3318 with silicon generate waste acids, primarily nitric, hydrofluoric, and hydrochloric, which are discharged via an acid drain and a temporary neutralization system installed in Room 1104. Effluent from the system is discharged to the sanitary sewer.

TABLE 3-16
BUILDING 77 WASTEWATER TREATMENT PLANT SLUDGE
ANALYSIS*

Analysis	Unit	B77 Sludge	CA Total Threshold Limit Concentration (mg/kg)**
Moisture	%	82	--
Cadmium	mg/kg	470	100
Chromium	mg/kg	2,400	2,500***
Copper	mg/kg	1,100	2,500
Lead	mg/kg	400	1,000
Nickel	mg/kg	50,400	2,000
Zinc	mg/kg	600	5,000
Cyanide	mg/kg	16	--

Source: Penfold, 1985; CADOHS, 1985.

- * All original results except moisture reported on a dry-weight basis. Results converted to a wet-weight basis by Survey team. Samples received December 13, 1984.
- ** Wet weight.
- *** Trivalent chromium.

TABLE 3-17
BUILDING 77 TREATED WASTEWATER SAMPLE RESULTS (1986)

Sample Date	Cyanide (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)
03-12-86a	<0.2	0.01	0.35	1.3	0.2	0.14	0.16
04-18-86	0.02	0.01	0.86	0.18	0.01	0.20	0.08
06-02-86a	<0.2	0.1	0.13	0.82	0.1	0.1	0.04
07-29-86	0.15	0.1	0.2	0.3	0.2	0.1	0.1
09-08-86	0.03	<0.05	<0.1	0.69	<0.02	0.21	0.1
10-20-86a	0.2	<0.01	0.07	0.21	<0.1	0.01	0.09
11-12-86	0.005	0.07	0.60	0.86	<0.05	0.50	0.05
Minimum:	0.005	<0.01	0.07	0.18	0.01	0.01	0.04
Maximum:	0.2	0.1	0.86	1.3	0.2	0.50	0.16
Average:	<0.12	<0.05	<0.33	0.62	<0.10	0.18	0.09
Discharge Limit ^b :	1.2	0.69	2.77	3.38	0.69	3.98	2.61
% of Limit:	<10	<7.2	<12	18	<14	4.5	3.4

Source: LBL, 1987a

^aSample collected and analyzed by EBMUD.

^bDaily maximum.

The acid neutralization system for this building was installed about 3 years ago. It consists of a 700-gallon cast iron sump coated with a phenolic liner within a concrete pit. A leak detection system is expected to be installed. All wastes from the building are treated via this system. Acid wastes are neutralized with sodium hydroxide when the pH falls below 5. Two pH probes with an associated strip chart and pH meter keep the pH between 5.5 and 10 for discharge to the sewer.

Prior to its being used for this system, the sump was used to receive wastewaters from Buildings 70 and 70A, which potentially contained radioactive contaminants (LBL, 1986a). Any waste streams in which radioactive contaminants were detected were diverted to one of two aboveground storage tanks and through two ion exchange units for treatment prior to release to the sanitary sewer. The presence of radioactivity was reportedly detected only one time (zinc-65). This is further discussed in Section 4.5.1.

The capacity of the neutralization system is 5 gal/hr of concentrated acids. A more typical treatment rate is 1 gal/day (Young, 1988a). This unit is scheduled to be replaced in the summer of 1988 with a unit to handle wastes from both Buildings 70A and 70 (Young, 1988a), and will be subject to the EPA pretreatment standards for semiconductor fabrication.

Nuclear Science Applied Science (Building 70)

A number of laboratories for research in nuclear and applied science are housed in Building 70. Many of these laboratories use acids that are currently collected and given to EH&S for disposal. Gallium arsenide research has been performed in Room 173 for 2-1/2 years. Acid (mainly hydrofluoric, plus hydrochloric and nitric), solvent, and some radioactive (carbon-14) wastes are generated, which are currently disposed of by EH&S. Acid wastes from this and other laboratories in this building and in Building 70A are expected to be treated with a new acid neutralization system to be installed in the summer of 1988 (Young, 1988a). Effluent from this system will then be discharged to the sanitary sewer.

Heavy Ion Linear Accelerator (Building 71)

The Heavy Ion Linear Accelerator (SuperHILAC) operations, shops, and laboratories are located in Building 71. Presently, two sinks in the building are connected to a sump that flows to a holding tank in Room 121, then to a second tank and to the sanitary sewer. Prior to 15 years ago, the first tank was sampled for radioactivity prior to discharge to the sanitary sewer (LBL, 1986a). If contamination was found, the radioactive waste was pumped out and disposed of, according to LBL personnel. However, the 1973 Site Waste Management Plan states that the two tanks were designed for use as reaction and precipitation vessels, and that from 1959 to 1973, they had been used 10 times to decontaminate radioactive wastewaters (LBL, 1986a). All laboratory drains in the past were connected to this system, and the two tanks (approximately 350 gallons each) were used alternately. No sampling is currently performed on the effluent prior to discharge, as no contaminants are expected to be discharged to this system. Some radioactive equipment assembly, vacuum pump repair, etc. occurs in this building, with associated waste solvents (e.g., Freon TF; ether; 1,1,1-trichloroethane) and waste oils produced. These wastes are drummed for EH&S disposal.

Biomedical Laboratory (Building 74)

The Biomedical Laboratory (Building 74) is located on the eastern portion of the LBL and is devoted to biomedical research involving various types of animals. In the past, radioactive wastewaters were routed to two holding tanks for sampling prior to release. Limits for holding up the waste released to the sewer were on the order of hundreds of picocuries per liter. These tanks are no longer used (see further discussion in Section 4.5.1).

Currently, 98 percent of studies performed with radioactive materials involve external irradiation from cobalt-60 sources, X-ray machines, etc., while 2 percent involve injection of radioisotopes. Ingestion studies involving radioactive materials have never been performed. Highly radioactive animal wastes (urine and feces) are collected by EH&S. When EH&S determines that the animals are no longer excreting high levels of radioactivity in their urine and feces, the excreta are routed to the sanitary sewer. These excreta from outdoor dog runs, etc., flow to the sewer via six aboveground holding tanks. Up until 1976, the wastes in these tanks were

monitored prior to release. They are no longer monitored due to the controls imposed by EH&S for minimizing the discharge of radioactive excreta to the sanitary sewer as described above.

There was reportedly only one occasion when the wastes had to be held up due to high levels of radioactivity. This was due to cage-washing activities, and the tanks were pumped out and the liquid disposed of as radioactive waste. Current practices are to allow radioisotopes in the cages to decay prior to washing. All liquid wastes from Building 74 that are not collected by EH&S for disposal flow to the sanitary sewer via the six holding tanks. Any pathological wastes are rendered innocuous by either steam sterilization or chemical disinfection prior to disposal (LBT, 1986a).

Craft and Maintenance Shops (Building 76)

The Craft and Maintenance Shops (Building 76) generate wastewaters mainly in the Motor Pool area and in the solvent/waste oil collection area. The latter contains a newly installed oil/water separator which is to be placed into service in the very near future. This unit is comprised of a 160-gallon steel receiver inside a concrete pit and has a capacity of 200 gal/day (Young, 1988a). It is to receive waste streams from various areas in and near Building 76. Water from the unit will be released to the sanitary sewer, except for any rainwater which collects at the unit, which will be released to the storm sewer. Oil from the unit will be skimmed off periodically and collected for disposal by EH&S.

The Motor Pool area lies on the lower level of Building 76. This area is used for vehicle washing/steam cleaning, and contains a sump inside a garage area and a pavement drain outside, both of which are connected to the sanitary sewer. The sludge from this sump is reportedly cleaned out annually. The disposal method of this sludge is unknown. This sump is further described in Section 4.1.

This sump may have received diesel oil from spills and solvents from floor-cleaning operations. Two cold parts-cleaners using automotive solvent, motor oil, and water are located within 10 feet of the sump. They reportedly are cleaned once a year and the solutions disposed of by EH&S. When the top to the sump was removed, an odor of paint/organics was present. Next to the sanitary sewer drain outside is a vehicle washing area, a horizontal tank labeled "mixed waste oil," and three

batteries on a pallet which may release contaminants to the sanitary sewer. This Motor Pool area and the sump are expected to be connected to the oil/water separator described above.

Photographic Laboratories

Photographic development and processing activities are performed at a number of laboratories at the LBL, including:

- Biomedical Research (Building 10)
- Mechanical Technology (Building 25)
- Medical Services (Building 26)
- General Research Laboratory (Building 80)
- Earth Sciences, Applied Science, Administration, Engineering (Building 90)

Building 10 contains six continuous photoprocessing machines, some of which utilize a silver recovery unit, while others do not. The amount of silver recovered from one machine was estimated by the operator at 20 pounds every 4 months. The recovery unit for this system was installed about 10 years ago. Prior to that time, all discharges went directly to the sanitary sewer. In addition to the silver, solutions and their contaminants which enter the sanitary sewer include fixer (sulfuric acid) and developer (potassium hydroxide, hydroquinone). Some of these solutions are diluted with water at 100 to 200:1 as carryover from the machines, however. The largest discharger of photographic solutions from Building 10 is the black-and-white-processor.

Building 25 performed standard photographic development activities in the past and discharged to the sanitary sewer. For the past 7 to 8 years, the developer solutions have been discharged to the sump which feeds into the Building 25 WWTP, as mentioned previously.

Buildings 26 and 80 also contain photographic laboratories. Both laboratories develop X-ray film. The process in Building 80 is a manual process. No further

information is available on the photographic laboratories in these areas as they were not visited during the Survey.

Building 90 contains a number of photoprocessing units. Room 2094 contains a unit equipped with a 10-micron pre-filter and a silver recovery unit. The silver recovery unit, which has been in place for about 4 years, results in the recovery of approximately 7 pounds of silver every 4 months. Photographic development has been performed at this location for about 6 years. An older machine was used prior to the current one. Approximately 300 gallons of fixer containing sulfuric acid and 150 gallons of developer containing hydroquinone are used annually at this machine. The developer and fixer are processed through the silver recovery unit and are discharged to the sanitary sewer.

Room 2002 of Building 90 contains a microfilm processor. This unit discharges about 1 to 2 quarts each of developer and fixer to the sanitary sewer annually. Nearby is a film processor, which discharges 2 to 3 quarts/week of activator to the sanitary sewer. A silver recovery unit has been in place since this area began being used about 5 years ago.

A large film processor is located in Room 0026 of Building 90. This unit has not operated for 6 months. During its 5 to 8 years of regular service, however, the unit processed approximately 1 million feet/month of film. A large silver recovery unit is located outside Building 90 in an un paved area. This unit is no longer in use. It is not known for which photoprocessor this unit was used.

3.3.2.2 Direct Discharges to the Sanitary Sewer

Ion Exchange Columns

Ion exchange columns are located throughout the LBL and are used to produce low conductivity water (LCW) for use in laboratories, process equipment, etc. Ion exchange columns are located at the following buildings:

Building Name
Utilities Service
Bevatron

Building Number
Building 37
Building 51

Materials and Molecular Research	Building 62
Accelerator Division	Building 64
Materials and Molecular Research (from Building 62)	Building 66
Heavy Ion Linear Accelerator (SuperHILAC)	Building 71
88-Inch Cyclotron	Building 88

The ion exchange columns at Buildings 37, 66, and 88 contain media that are regenerated with acid and base at the same time. Due to pH excursions at both the acidic and basic ends which were recorded at the sanitary sewer monitoring stations, six ion exchange units were evaluated during regeneration activities by LBL IH staff in May 1987. The excursions resulted in violations of EBMUD's lower pH discharge limit of 5.5. The violations were attributed to column regeneration at Buildings 62, 64, and 71 (Pauer, 1987). A summary of available information on the ion exchange columns at the LBL is given in Table 3-18. Some of the columns are planned to be replaced.

Cooling Towers

Cooling towers are located throughout the LBL. Currently there are 11 cooling towers used for process purposes and 13 used for heating, ventilation, and air conditioning (HVAC) purposes (YE Engineers, Inc., 1987). These cooling towers have used a number of different chemicals since the 1940s. Problems with releases of chromium from the cooling towers have been experienced in the past but have been corrected (LBL, 1986a). In 1983, the use of chromates, zinc, and sulfuric acid was phased out (Botello, 1988). The blowdown and any sludges produced from operation of the cooling towers have always gone to the sanitary sewer or have been solidified (LBL, 1976). The wooden cooling tower at Building 37 is scheduled for demolition and the State of California has approved its disposal in a sanitary landfill (LBL personnel, 1988).

Shops

Although most liquid hazardous wastes are collected and disposed of by LBL EH&S staff (see Section 4.1.1), some of the shops generate wastewaters which are discharged directly to the sanitary sewer. These areas are described below.

TABLE 3-18
ION EXCHANGE COLUMN SUMMARY

Building No.	Bed Type(s)	Regeneration Practice	Tank Neutralization	Planned Remediation
37	Unknown	Concurrent	NA	NA
51	Mixed	Separate	Yes	Unknown
62*	Cation, anion	Separate	Unknown	Replacement
64*	Unknown	Unknown	Unknown	Unknown
66	Unknown	Concurrent	NA	NA
71*	Cation, anion	Separate	Yes	Replacement; 5/88
88	Unknown	Concurrent	NA	NA

Source: LBL personnel, 1988

NA - Not applicable.

* - pH violations noted at sanitary sewer monitoring stations during regeneration.

- Bevatron (Building 51)

The machine shop (Room 26) of this building contains an acid dip sink, and solvents, such as 1,1,1-trichloroethane and trichloroethylene, are used for parts cleaning. The solvents are collected for disposal by EH&S. A mercury trap is present on a sink near Station 17 of the Bevatron. The uses of this sink are unknown. The floor drains in trenches radiating from the Bevatron are connected to the sanitary sewer. No evidence of any spills or discharges to these drains was apparent.

The pump room contains two tanks (250-300 gallons each) used to change out the dirty oil from the pumps and refill them via pipeline with clean oil. Spills and pools of oil were apparent on the floor, possibly due to leakage during the transfer of dirty oil to drums for disposal. A rectangular sump of about 170-gallon capacity, measuring approximately 1 foot deep by 1.5 feet wide by 15 feet long, is present to catch any spills prior to their discharge to the sanitary sewer.

Outside Building 51, a bypass pipe for cooling tower water discharges about 1 gpm to the sanitary sewer. The outlet pipe and the rectangular subsurface basin to which it discharges have a greasy appearance.

- Accelerator Research and Development (Building 58)

The main area in this building has an acid dip tank that is rarely used. This area also uses non-polychlorinated biphenyl (PCB) oils and solvents. Some cleaning of equipment is done with alcohol, which is routed to the sanitary sewer. Past oil spills in the area were routed to an underground waste tank. Radioactive substances are no longer in use as of a few years ago. No sinks are presently in use in the electronics shop.

- Materials and Molecular Research (Building 62)

Room 100 of this building houses the mechanical technicians. This shop contains an acid dip sink using chromic and nitric acids, which are

changed out by plating shop personnel. The last changeout of these solutions was in 1982. After the parts are dipped in the acids, they are rinsed with water. The sink is labeled "acid sink" and "flush with water after acid drainage." Small (1-pint) bottles of kerosene, acetone, and 1,1,1-trichloroethane are stored on the sink and used for parts washing at a total rate of 1 pint/month. A degreaser that had previously been in the shop has been removed. Cutting fluids and a coolant are also used, the latter sent to Building 77 for recycling. This area also disposes of water-soluble oils to the sanitary sewer.

- SuperHILAC Annex (Building 71B)

This area, which performs machining of parts for the SuperHILAC, contains an acid dip sink similar to that discussed above. Parts that come into this area have usually been cleaned.

- Craft and Maintenance Shops (Building 76)

A paint spray booth in this building employs a water curtain that discharges to the sanitary sewer. This water wash, comprising approximately 100 gallons, is discharged to the sewer on a monthly basis.

In the past, the plumbing shop used a drain cleaner, comprised of 70 percent sulfuric acid, which resulted in pH spikes being noted at the sanitary sewer monitoring locations. The shop has since been made aware of the problem in an attempt to ameliorate it in the future. The LBL EH&S staff have indicated that as little as 100 milliliters (mL) of acid intentionally poured into a laboratory drain produces a noticeable pH fluctuation at the sewer monitoring station.

- Mechanical Shops (Building 77)

Room 123 contains a machine tool coolant recovery unit to separate tramp oils and particulates from water-miscible oils. The tramp oils and particulates are disposed of by EH&S while the water-miscible oils are reused. Solvent and radioactively contaminated coolants are not

recycled. Until a few years ago, when this unit was installed, the machine tool coolants were disposed of via the sanitary sewer.

During the Survey, preventive maintenance was being performed on a horizontal boring mill. Detergent and disinfectant from the cleaning operations of the sump, which usually contains machine coolant, and other parts of the machine were disposed of via the sanitary sewer.

An alkaline hot vat stripper containing (biodegradable) triethanolamine is also discharged to the sewer. EBMUD approves of alkaline discharges to help counteract acidic discharges from other sources in the EBMUD lines.

The paint shop (Room 165) disposes of its waste lacquer, etc. through EH&S. No hazardous waste from this area is disposed of via the sanitary sewer.

A cutting machine, located in Room E04, contains a water table that performs gas and plasma burning of aluminum, copper, stainless steel, brass, etc. The water in this equipment contains 0.5 percent Trim Klear®. This water mixture is discharged to the sanitary sewer at a frequency varying from once a week (if burning aluminum) to once every 6 months. The slag from this unit is scraped out with the dross and disposed of either in a sanitary landfill or to salvage.

- 88-Inch Cyclotron (Building 88)

This building contains an acid dip sink, and small quantities of organic solvents (alcohol) are occasionally used at the sink. This building also contains a cold degreaser and performs vacuum pump repair. All solvents and oils from these activities are collected and disposed of by EH&S.

Research Laboratories

Most liquid hazardous wastes produced by the research laboratories are collected and disposed of by EH&S staff, as discussed in Section 4.1.1. However, some wastewaters are discharged directly to the sanitary sewer. These areas are as follows.

- Biomedical Research (Building 10)

Room 115 of this building is performing oncology research using iodine-131, chromium, benzene, etc. Organic and radiological wastes are collected and disposed of by EH&S. Other liquid wastes such as tissue cultures and stains (methylene blue, hematoxin) are disposed of via the sanitary sewer. No specific disposal procedures exist for this laboratory; hence, the guidelines stated in the LBL Policy and Procedures Manual and Health and Safety Manual are followed. Room 110Z uses carbon-14 and tritium for liquid scintillation, which are collected for disposal at a rate of 3 to 4 gallons every 6 months.

- General Research Laboratory (Building 80)

The Center for X-ray Optics performs some solvent cleaning using small quantities of acetone, alcohol, and toluene. Although a 5-gallon plastic jug is used for the collection of organics, only about 4 inches of solvents have been collected in the jug during the past year. Small amounts of organics are disposed of through the sanitary sewer. In the past, chromic acid was used for glassware cleaning, and the acid is still present under the laboratory sink. Sodium-22 is used for positron experiments, and a 100-microcurie source is stored in the laboratory shielded by lead bricks.

Radioisotope Services (Buildings 75/75A)

Building 75 contains the National Tritium Labeling Facility (NTLF) in Room 103. No wastewaters from this area are intentionally disposed of via the sanitary sewer. Liquid radioactive wastes are solidified in an adjoining room (Room 131). The

methods of hazardous and radioactive waste disposal for this area are further discussed in Section 4.1.1.

Radioactive waste compacting and drum storage occurs in Building 75A. The floor of this building is made of acid-impervious material. Some hazardous/mixed waste liquids (e.g., oils, coolants, cyclotron oil, fluorocarbon solvents, liquid scintillation vials) are stored in this area which is allowed up to a designated capacity according to the facility's Part B permit. A floor drain leading to the sanitary sewer is located in the building under the safety shower. No liquids were stored in the vicinity of this drain.

Sanitary Wastewater

Sanitary wastewater is produced in most major buildings at the LBL. The main sources of sanitary wastewater include lavatories, excreta from experimental animals, drinking water fountains, sinks, and floor drains. The sanitary wastewater effluent combines with the industrial wastewaters described previously and is directed to the EBMUD primary and secondary treatment plant in Oakland prior to discharge to San Francisco Bay. The monitoring of this system is discussed in Section 3.3.3.2. Although the contract available between the LBL and EBMUD is dated January 1, 1973 (Ordinance Number 270), site personnel indicate that the LBL has always been connected to the EBMUD sewer system.

3.3.2.3 Potential Discharges to Surface Waters

In conformance with Section 311 of the Federal Water Pollution Control Act (PL 92-500) as amended, the LBL is required to prepare and implement a plan to prevent the degradation of surface waters. The LBL has prepared a Contingency Plan for Spills of Hazardous Materials, which addresses general spill response and mitigation procedures at the facility. It has not, however, prepared a detailed Spill Prevention Control and Countermeasure (SPCC) Plan in accordance with 40 CFR Part 112.

Various potential sources of spills exist at the LBL that could impact Strawberry or Blackberry Creeks, either directly through overland transport or indirectly via the storm drain system. These potential spill sources include the following:

- unbermed drum storage of wastes (see Section 4.1.1);
- unbermed drum storage of bulk chemicals (see Section 4.2.1);
- storage tanks lacking secondary containment (see Section 4.2.1);
- unbermed transformers containing non-PCB oil (see Section 4.2.1); and
- historical spill areas (see Section 4.5.1).

Other (non-spill) sources that may impact surface waters include the following:

- tritium deposition onto the soil with subsequent runoff due to releases from Building 75 (see Section 3.1.2);
- discharge of groundwater from hydraugers and wells containing tritium and possibly other contaminants to the storm sewer (see Section 3.4.2); and
- operations close to storm sewers.

Operations close to storm sewers include:

- Outside of Building 77 Steam-cleaning of parts with cutting fluids; sandblasting with discharge to ground (50 lb/month)
- Building 77, Room 165 Sandblasting grit (garnet sand) transported outside door near storm sewer (Paint Shop)

Building 69 also contains a 200-gallon concrete sump that is connected to the storm sewer system, according to site drawings. This area has been used for over 15 years for vehicle washing and storage of drummed solvents and waste oils. Any spills from these activities would be collected in the sump. To date, no spills have reportedly occurred, and any rainwater that collects in the sump is discharged to the sewer without monitoring.

3.3.3 Environmental Monitoring Program

In addition to the source-specific effluent monitoring discussed in Section 3.3.2 in conjunction with the WWTPs, the LBL monitors nearby surface waters as well as the sanitary sewers. No monitoring of the storm sewers is conducted prior to their discharge to the creeks, nor are there any final controls (such as oil/water separators) on these discharges. The LBL environmental monitoring program for surface waters and the sanitary sewers is as follows.

3.3.3.1 Surface Waters

The LBL samples five surface-water locations as part of its environmental monitoring program. These locations, shown on Figure 3-7, include three on-site points (Blackberry Creek, Lower Strawberry Creek, and Upper Strawberry Creek) and two off-site points (Claremont Creek and Wildcat Creek). Grab samples are obtained from these locations weekly and analyzed for radiological parameters only (gross alpha and beta activity). A summary of the results for 1986 is given in Table 3-19. The average of the samples taken at each of the five sample locations is less than the reference standard in DOE Order 5480.1A, Chapter XI, as amended on August 5, 1985.

3.3.3.2 Sanitary Sewers

Except for stormwater, all the LBL's wastewaters not collected for disposal by EH&S staff enter the sanitary sewer system. There are two monitoring locations for this effluent, as shown on Figure 3-8. The Hearst Sewer, located just inside the western border of the LBL, receives wastewaters from those buildings located in the western portion of the LBL, as shown on the figure. All other buildings discharge to the Strawberry Sewer, south of the LBL's border. The Strawberry Sewer also receives discharges from other campus locations (i.e., the Campus Acid House, Botanical Gardens, Lawrence Hall of Science, Silver Laboratory, Animal Behavior Research Station, and the Mathematical Sciences Research Institute). Effluent from both sewers is directed to the EBMUD treatment plant where it undergoes primary and secondary treatment prior to discharge into San Francisco Bay (LBL, 1987a).

**SURFACE WATER
ENVIRONMENTAL MONITORING LOCATIONS
FOR THE LBL**

FIGURE 3-7

TABLE 3-19

SUMMARY OF SURFACE-WATER MONITORING RESULTS (1986)

	No. of Samples	Concentration (10 ⁻⁹ μ Ci/mL)				Average as % of Standard*	
		Alpha		Beta		Alpha	Beta
		Average	Maximum	Average	Maximum		
On-site Creeks							
Blackberry	51	<0.2	1.4 $\pm$ 1.1	2.1 $\pm$ 0.1	11 $\pm$ 2	$\leq$ 0.4	0.2
Lower Strawberry	51	$\leq$ 0.1	$\leq$ 1.3	2.8 $\pm$ 0.1	27 $\pm$ 2	$\leq$ 0.2	0.3
Upper Strawberry	50	0.3 $\pm$ 0.2	8 $\pm$ 5	2.1 $\pm$ 0.1	10 $\pm$ 2	0.6	0.2
Off-site Creeks							
Claremont	51	0.4 $\pm$ 0.3	4 $\pm$ 3	2.0 $\pm$ 0.1	10 $\pm$ 2	0.8	0.2
Wildcat	51	$\leq$ 0.2	$\leq$ 3	1.2 $\pm$ 0.1	8 $\pm$ 2	$\leq$ 0.4	0.1

Source: LBL, 1987a

* Reference standard in DOE Order 5480.1A, Chapter XI, as amended on August 5, 1985; alpha assumed to be ²³²Th; beta assumed to be ⁹⁰Sr.

SANITARY SEWER MONITORING LOCATIONS
FOR THE LBL

FIGURE 3-8

To ensure compliance with EBMUD's discharge limits, the LBL monitors its wastewater for pH, toxic metals, and radioactivity (LBL, 1987a). EBMUD also samples the LBL's wastewater on an irregular basis to enforce their discharge limits. Both of the LBL's sewer discharges pass through 6-inch Parshall flumes. Effluent pH and flow are continuously recorded, and flow-proportional composite samples are automatically collected (LBL, 1986a). Sample-to-flow ratios are designed at 10 to 20 ppm (i.e., 10 to 20 parts sample per million parts flow), and composite samples are obtained weekly by an LBL EH&S staff member. The sewers have been monitored for radiological parameters for over 30 years; metals and pH were added in 1970, while oil and grease was added in 1987. Samples obtained for EH&S are analyzed in-house for gross radioactivity. The remaining samples are collected for the IH group, and are composited every 4 weeks for analysis for eight metals plus oil and grease.

The compositing of samples at the Strawberry Station is based on flow, where 50 cubic centimeters (cc) of sample is collected per 10 liters of flow. As observed during the Survey, the sample is drawn from a stainless steel collection tank without measuring the volume of sample collected. No sample preservatives or chain-of-custody forms are used in the field. Samples and a chain-of-custody form are given to IH the day after the samples are collected. The samples are also preserved at this time. The flow meter is calibrated every 6 to 8 weeks, while the pH meter is calibrated monthly and cleaned weekly by IH. The sampling location is cleaned out weekly and checked about 3 times a week. The still well often becomes clogged with rags and other debris and must be cleaned out, as occurred during sampling observed by the Survey team. The pH meter and chart during observation of the sampling activities were at pH 8, and usually range from 7.5 through 9. The sampler marked the pH and flow charts with the date. The Strawberry Station frequently receives soapy discharges from an unknown source(s), and some soap bubbles were observed. The pH usually is at 12 during these occasions. Black sand/sediment was observed in the collected sample. This and occasional pieces of terra-cotta tile observed in the sample during collection may indicate broken sewer lines.

The Hearst Station has a sequential sampler where 50 mL of sample is collected every 20 minutes. Cleanout of this station is automatic, and calibration is performed every 2 months. The pH reading at the time of sampling was 9. This station does not experience problems with clogging, soap, and sand/sediment as

the Strawberry Station does. All other observations are the same as at the Strawberry Station.

Sewer samples are analyzed for gross alpha and beta activity, gross halogen (radioiodine) content, and tritium. A summary of the radiological results for the 1986 sewer monitoring program is given in Table 3-20. Sampling at the sanitary sewers is also performed to ensure compliance with site discharge limits mandated by EBMUD's Ordinance Number 270. The four-week composite sample is analyzed by Med-Tox Associates of Pleasant Hill, California, for cadmium, chromium, copper, iron, lead, nickel, silver, and zinc, as well as for oil and grease. A summary of the most recent data available (1987) is presented in Table 3-21.

3.3.4 Findings and Observations

3.3.4.1 Category I

None

3.3.4.2 Category II

None

3.3.4.3 Category III

None

3.3.4.4 Category IV

1. Potential surface-water contamination. The potential for surface-water contamination exists due to possible uncontrolled releases, either via direct discharge into a storm sewer or via overland transport to Strawberry and Blackberry Creeks. Contaminants that reach the creeks would be transported off-site and may impact the off-site environment.

Numerous locations were observed where contaminants have the potential to reach either Strawberry or Blackberry Creek. These locations include potential

TABLE 3-20
SUMMARY OF SANITARY SEWER RADIOLOGICAL MONITORING RESULTS (1986)*

Location	Total Quantities Discharged			
	Total Volume (10 ³ liters)	Alpha (μ Ci)	Beta (mCi)	Tritium (Ci)
Hearst Sewer	200	≤ 20	2 ± 0.5	≤ 0.02
Strawberry Sewer	110	≤ 12	40 ± 8	1.4 ± 0.3

Location	No. of Samples	Net Concentration (10 ⁻⁹ μ Ci/ml)				No. of Samples	Net Concentration (10 ⁻⁶ μ Ci/ml)		Average as % of standard**		
		Alpha		Beta			Tritium		Alpha	Beta	Tritium
		Avg.	Max.	Avg.	Max.		Avg.	Max.	%	%	%
Hearst	47	≤ 0.1	1 ± 0.3	10 ± 1	50 ± 10	49	≤ 0.07	9 ± 1	< 0.2	1	≤ 0.1
Strawberry	47	≤ 0.1	1.1 ± 0.3	400 ± 10	4200 ± 700	49	13 ± 2	150 ± 20	< 0.2	40	0.4
Standard for comparison**		50		1000			3000				

Source: LBL, 1987a

* The average and maximum values listed for sewer beta concentrations reflect the weekly activity found in the hotter of the acid or radioiodine planchets.

** Reference standard in DOE Order 5480.1A, Chapter XI, as amended on August 5, 1985; alpha assumed to be ^{232}Th ; beta assumed to be ^{90}Sr .

TABLE 3-21

SUMMARY OF SANITARY SEWER NONRADIOLOGICAL MONITORING RESULTS (1987)

Hearst Sewer

	Cadmium (ppm)	Chromium (ppm)	Copper (ppm)	Iron (ppm)	Lead (ppm)	Nickel (ppm)	Silver (ppm)	Zinc (ppm)	Oil & Grease (ppm)
Minimum:	0.003	0.010	0.091	0.280	0.010	0.010	0.005	0.130	3
Maximum:	0.040	0.250	3.000	4.900	0.630	0.110	0.320	2.950	40
Average:	0.007	0.070	0.746	1.481	0.097	0.020	0.064	0.724	15.300
Discharge Limit:	1	2	5	100	2	5	1	5	250
% of Limit:	0.7	3.5	14.9	1.5	4.8	0.4	6.0	14.5	6.1

Strawberry Sewer

	Cadmium (ppm)	Chromium (ppm)	Copper (ppm)	Iron (ppm)	Lead (ppm)	Nickel (ppm)	Silver (ppm)	Zinc (ppm)	Oil & Grease (ppm)
Minimum:	0.003	0.010	0.034	0.310	0.010	0.020	0.003	0.120	2
Maximum:	0.050	0.190	2.600	15.000	0.380	1.000	0.340	1.900	63
Average:	0.009	0.051	0.573	5.882	0.061	0.126	0.032	0.560	15.032
Discharge Limit:	1	2	5	100	2	5	1	5	250
% of Limit:	0.9	2.6	11.4	5.9	3.0	2.5	3.2	11.2	6.0

Source: LBL, 1987k

releases from unbermed drum storage of wastes or bulk chemicals, storage tanks lacking secondary containment, unbermed transformers, and past spill areas. Other potential sources of contamination include tritium deposition from Building 75 and subsequent transport via runoff, the discharge of hydraugers to the storm sewers, and operations involving potentially hazardous materials close to the storm sewers.

2. Exceedances of sanitary sewer pH limits due to regeneration of ion exchange columns. Regeneration of ion exchange columns has resulted in exceedances of sanitary sewer discharge limits. Monitoring data have shown exceedances of pH limits at the Strawberry and Blackberry Creek monitoring stations during regeneration of the units at Buildings 62, 64, and 71. Although the excursions are short in duration, the pH levels have approached values for the designation of hazardous wastes. The LBL has indicated that it plans to replace the ion exchange columns at Buildings 62 and 71.
3. Inadequate SPCC Plan. The LBL's Contingency Plans for Spills of Hazardous Materials does not adequately address the requirements for an SPCC Plan as stated in 40 CFR Part 112. An inadequate SPCC Plan may increase the risk of spills of hazardous materials into Blackberry and Strawberry Creeks, and may result in inadequate measures to prevent or mitigate any spills.

40 CFR 112.7 requires the SPCC Plan to follow a sequence of five general guidelines and to include a discussion of the facility's conformance with the guidelines. These guidelines include: (1) a written description of spill events; (2) information on the flow rate, direction, and quantity of oil released where a reasonable potential for equipment failure exists; (3) appropriate containment and/or diversionary structures or equipment; or (4) a demonstration that Number 3 (above) is not practicable; and (5) a complete discussion of conformance with other applicable guidelines, spill prevention and containment procedures, or state requirements.

The current plan does not include a discussion of any of these items specifically. Rather, it gives a general discussion regarding the prevention of spills into the storm drain systems and into the creeks, and how to respond to and clean up a spill should one occur. Except for a listing of locations where

transformers and large capacitors containing PCBs are present, no other potential release locations or other information, such as their containment or diversionary structures, are identified. Furthermore, the LBL was found to be deficient in the adequacy of secondary containment for bulk chemical and hazardous waste storage, as discussed in Sections 4.2.2.4 and 4.1.2.4, respectively. Finally, there is no written discussion of conformance with other applicable guidelines, procedures, or requirements, including any spill events, pertaining to the LBL.

4. Nonrepresentative sanitary sewer monitoring location. The LBL Strawberry sanitary sewer monitoring station is located such that samples are nonrepresentative of LBL's contribution to sewer discharges. The current location for sanitary sewer monitoring is influenced by campus discharges, leading to an inaccurate assessment of discharges from the LBL. This station is influenced by the Lawrence Hall of Science, Silver Laboratory, Animal Behavior Research Station, Mathematical Sciences Research Institute, Acid House, and Botanical Gardens.

Various problems have been noted at the Strawberry monitoring station (located off the LBL facility), which are not present at the Hearst monitoring station (located on the LBL facility). These problems include clogging of the stilling well with debris, soapy discharges, and the presence of black sand/sediment in collected samples, the latter of which is possibly indicative of broken sewer lines upstream. Values for radioactivity, particularly gross beta, at the Strawberry Station are usually much higher than at the Hearst Station. This radioactivity may be due to University disposal practices upstream of the LBL, according to LBL personnel.

In the 1990 Environmental Compliance Monitoring Project, the LBL has submitted a request for construction of a sanitary sewer which is completely separate from other campus discharges.

5. Nonadherence to sanitary sewer monitoring procedures. Written procedures for environmental monitoring of liquid effluents in the sanitary sewers are not being adequately followed, which may raise questions concerning the validity of analytical results.

Several deficiencies were observed during the sampling activities. These include:

- EH&S samples for radioactivity: total sample holding tank volume not measured; chain-of-custody broken by not keeping samples under lock and key overnight prior to analysis; and
- IH samples for metals, oil and grease: samples not preserved in field and not refrigerated; chain-of-custody broken by not keeping samples under lock and key overnight prior to analysis.

Failure to follow established procedures for sampling may lead to inaccurate results due to sample degradation prior to analysis or through tampering with the collected sample prior to analysis. In addition, even if the above did not occur, the validity of representative data could be questioned due to the possibility of the above occurring without adequate chain-of-custody procedures to prevent it.

3.4 Hydrogeology

3.4.1 Background Environmental Information

3.4.1.1 Geology

Physiographic Setting

The Lawrence Berkeley Laboratory (LBL) is located on the eastern edge of a structural depression of Late Tertiary age that forms San Francisco Bay. The bay is located within the California Coastal Ranges geomorphic province, which is characterized by northwest-trending low mountain ranges extending along the length of northern and central California. The Coastal Ranges are composed of deformed and metamorphosed Mesozoic-age marine sedimentary and volcanic rocks of the Franciscan assemblage.

Regional Geology

The geology of the San Francisco Bay region consists of a complex of igneous, metamorphic, and sedimentary rocks. The Franciscan assemblage, the oldest and most extensive bedrock unit, was deposited from 180 to 70 million years ago during Jurassic to Cretaceous time in a marine environment. Extensive tectonic activity uplifted and folded the Franciscan sedimentary and volcanic rocks, creating mountain ranges and broad shallow basins into which both continental and marine sediments were deposited. Gradual downwarping of the region created shallow depressions where younger sediments including lava flows were deposited. Sea level changes during glacial stages resulted in the deposition of a variety of recent sediments in San Francisco Bay.

Extensive faulting has occurred during the geologic history of the San Francisco Bay region. Enormous compressional forces, developed by the collision between the continental and oceanic crustal plates, uplifted, folded, and faulted the rocks of the ancestral Franciscan depositional basin. The result is a heterogeneous mixed zone containing competent rock in a matrix of highly sheared and crushed rocks. Although most of this tectonic activity has decreased, the bay region, as well as most of California, is still seismically active (Korby, 1982). A number of faults,

notably the San Andreas and the Hayward, continue to generate earthquakes, some of which are of sufficient magnitude to cause extensive damage in heavily populated areas (USGS, 1988).

Site Geology

The LBL is underlain by a sequence of sedimentary and volcanic rocks that range in age from Cretaceous to Recent. A geologic map of the LBL site is provided in Figure 3-9. In general, the bedrock is relatively weak and weathers deeply, producing a thick colluvial soil cover. The bedrock is exposed primarily in the many cut slopes throughout the site. The following is a brief description of the geologic units identified at the LBL.

Knoxville Formation - The marine shales, siltstones, sandstones, and conglomerates of the Knoxville Formation underlie the western and southern portions of the LBL. The rocks are Middle to Late Cretaceous in age, 65-70 million years old, and are occasionally sheared and tightly folded (Korbay, 1982). The siltstones and clay shales are deeply weathered, producing thick residual soils that often migrate downhill by the development of small landslides or by colluvial processes (Converse Consultants, Inc., 1984).

Claremont Formation - The Claremont Formation consists of shale and chert and is Middle Miocene in age, 20 million years old. It is found primarily east of Building 74 and the Botanical Garden. East of the Wildcat Fault, the Claremont dips steeply eastward and is separated from the overlying Orinda Formation by an angular unconformity. No Claremont outcrops have been identified west of the Wildcat Fault at the LBL (Converse Consultants, Inc., 1984).

Orinda Formation - The Orinda Formation consists of poorly consolidated sandstones, siltstones, claystones, and conglomerates of relatively low strength and hardness. The formation is Late Miocene to Early Pliocene in age, 12 million years old. The environment of deposition varied from shallow marine seas to continental lakes and floodplains. The sedimentary beds are discontinuous and deformed from extensive folding. Moderately weathered near the surface, the weak Orinda rocks are covered by clay soils having high shrink-swell characteristics. Steep slopes underlain by the Orinda Formation are generally prone to instability. The Orinda

GEOLOGICAL MAP OF THE
LAWRENCE BERKELEY LABORATORY

FIGURE 3-9

occurs as an irregular band extending across the hillside west of the Wildcat Fault. It also occurs as a steeply dipping band east of the Fault (Converse Consultants, Inc., 1984).

Moraga Formation - The Moraga Formation is present throughout most of the upper elevations of the LBL. It consists of a series of interstratified basalt and andesite flows, agglomerates, and pyroclastic tuffs of Pliocene age, approximately 8 million years old (Converse Consultants, Inc., 1984). Interfingering contacts between the Moraga and underlying Orinda sandstones and shales are typically highly altered to soft clay for at least several feet on either side of the contact. The Moraga Formation is stratigraphically and topographically the highest bedrock unit at the LBL.

Colluvium - Colluvial soils include all soils consisting of rock fragments and weathering products derived from underlying rocks subjected to slow, gravity-induced downslope transport. The soils formed during the last few thousand years. Their characteristics depend upon the source rock from which they were developed; however, they share a structure developed by slow downslope creep of soil particles. Most slopes and drainage depressions on the LBL site contain colluvial soils of variable thickness.

Seismicity

The Berkeley Hills were formed by folding and faulting during the Pliocene epoch. The bedrock underlying the LBL has been folded into a series of northwest-trending anticlines and synclines that are offset and deformed by faulting.

The seismically active Hayward Fault, part of the larger San Andreas Fault System, trends in a northwest-southeast direction and is generally parallel to the trend of the Berkeley Hills and is approximately 1/2-mile west of the LBL. Earthquakes of magnitude 5.9 have occurred in the Berkeley area as recently as 1979 (USGS, 1988). There is the potential for earthquakes of magnitude 7.0 to occur during the lifetime of the LBL structures (LBL, 1980).

The Wildcat Fault, a segment of the Hayward Fault System, cuts across the LBL and forms a series of parallel fault segments that traverse the biomedical area and

underlie Building 74. Based on the lack of geomorphic features indicating recent faulting, the Wildcat Fault is believed to be inactive (Converse Consultants, Inc., 1984).

As might be expected in a seismically active region, numerous faults have been identified and/or proposed at the LBL. Except for the nearby Hayward Fault and possibly the Wildcat Fault, none of the other faults are considered active by the most recent investigators (Converse Consultants, Inc., 1984). The Wildcat, Strawberry Canyon and Space Sciences Faults and possibly the Lawrence Hall Fault are thought to be inactive. Other faults proposed at the LBL by various investigators are, at present, thought to lack sufficient evidence to support their existence.

In addition to the numerous faults, there are areas at the LBL prone to ground failure. These areas are likely to develop landslides in the event of strong ground shaking from seismic events, and/or other conditions conducive to soil instability. Old or pre-existing landslides are also susceptible to reactivation under these conditions.

3.4.1.2 Hydrogeology

Highly complex groundwater conditions are present at the LBL. Year-round springs, annual surface seeps, and variable water levels in observation wells indicate discontinuous localized aquifers. The various rock types making up the complex geology of the LBL have different porosities, permeabilities, and transmissivities that may have changed with exposure to surface weathering. Contacts between volcanic and sedimentary rocks may have become altered, forming clay-rich zones that act as groundwater barriers. Fractures caused by past episodes of folding and faulting may become clay-filled or remain open and serve as groundwater conduits. Groundwater contour maps were made from water level measurements taken in wells, piezometers, and slope indicator casings in 1984 (Converse Consultants, Inc., 1984). The maps represented a simplification of actual groundwater conditions because of the limited numbers of data points and the inability of the computer program that generated the maps to model local fluctuations in groundwater level. Local fluctuations in groundwater are due to geologic factors such as seepage barriers, faults, formational contacts, or perched water table conditions. The

groundwater contours did, however, appear to reasonably parallel the surface topography.

Hydraugers

Superimposed on the complex hydrogeology is the influence of the horizontal slope stabilization drainage system or hydraugers. Hydraugers are slotted drains that have been drilled into the sides of potentially unstable slopes to lower the groundwater table, reduce hydrostatic pressure, and increase slope stability. Hydraugers range from 100 to over 2,000 feet in length. Figures 3-10 and 3-11 show the locations of hydraugers. Although the hydraugers are represented by straight lines in these drawings, it is difficult to control the direction of a horizontal drilling operation over these distances. Thus, the upslope location of a hydrauger may differ from the location depicted.

The complexity of the factors, both natural and man-made, that control groundwater flow at the LBL make it difficult to model. In general, groundwater flow mirrors the topography (i.e., it moves from higher elevations of the site to lower elevations). Localized departures from this general flow pattern are controlled by the complex geology of the site. Additionally, flow direction and velocity variations occur as old fractures in the bedrock are plugged with silt or new ones open as the rock weathers or responds to tectonic forces. Seeps and springs develop as groundwater table elevations rise seasonally and hydraugers begin to divert more water to surface runoff and the storm drainage system.

3.4.1.3 Groundwater Use

Groundwater is not currently used for drinking water at the LBL or in the surrounding communities. The LBL's water supply is from the East Bay Municipal Utility District (EBMUD) (LBL, 1987a). Wells and hydraugers have been installed at the LBL to lower the water table and increase the stability of slopes at the site. Well and hydrauger discharges are directed to the storm drainage system. None of these discharges are monitored for chemical or radiological contaminants before they enter the storm drainage system.

HYDRAUGER LOCATIONS
BEVATRON AREA

FIGURE 3-10

HYDRAUGER LOCATIONS
SHOPS AND SUPPORT AREA

FIGURE 3-11

3.4.2 General Description of Pollution Sources and Controls

Potential sources of groundwater pollution at the LBL include an unidentified source of solvent chemicals, releases from the National Tritium Labeling Facility (NTLF), leaks from underground storage tanks (USTs), past spills, routine and accidental releases resulting from site operations, and past leaks from broken sewer lines. The following is a description of these potential sources.

3.4.2.1 Contamination from an Unidentified Source

In 1986, the LBL conducted a one-time, limited sampling and analysis program of soil, vegetation, and groundwater. One groundwater sample was collected from the east side of Building 51. As shown on Figure 3-10, there are a number of hydraugers in this vicinity; however, the hydrauger selected for sampling was not specifically identified. This sample contained elevated concentrations of trichloroethylene and tetrachloroethylene (LBL, 1986c). Further details on the concentrations detected are provided in Section 3.4.3. The LBL has not conducted any follow-up activities to further investigate this contamination; thus the source remains unidentified.

Current activities in Building 47, 53, 58, and 58A use solvent chemicals and these buildings appear to be upgradient of the sample location. In addition, two former salvage yards and the original location of the Motor Pool also appear to be upgradient of the sample location. Sections 3.3 and 4.5 provide additional information on these potential sources.

3.4.2.2 National Tritium Labeling Facility

The NTLF is located in Building 75. As part of the one-time sampling and analysis effort in 1986, a groundwater sample was collected from Hydrauger 75/77 which, as shown on Figure 3-11, drains the area around the NTLF. The analysis for tritium reported a concentration of 2,000 picocuries per liter (pCi/L) $\pm$ 1,000 in the Hydrauger 75/77 sample, which was higher than the levels detected in the other on-site samples. In addition, there are indications that there may be tritium contamination of soil around Building 75 as described in Section 3.2.3.1 (LBL, 1986c).

One of the hillside dewatering system wells, designated Well 13130, is located in a manhole in the pavement on the northwest corner of the traffic island opposite the entrance to Building 75 as shown in Figure 3-11. It is 40 feet deep and constructed of 18-inch-diameter slotted galvanized pipe. The manhole cover over the well has a notch approximately 4 inches wide cut in it to accommodate the rubber discharge hose from a submersible pump which is in the well. The pump is automatically activated when the water level in the well reaches a predetermined elevation. Water pumped from Well 13130 flows across the pavement to a stormwater catch basin approximately 10 feet away.

Surface-water runoff from areas around Building 75, the Radioactive Waste Packaging Facility in the Building 75 yard, and Building 69 may enter Well 13130 through the opening in the manhole cover. Consequently, the well may serve as a conduit for radioactive and chemical contaminants to reach the groundwater at the LBL. Interviews with LBL personnel indicate that the well is not regularly monitored for the presence of chemical or radioactive contaminants. Approximately one week before the on-site portion of the Survey, a sample from the well was analyzed using a liquid scintillation counter. A concentration of 2,600 pCi/L of tritium above background was reported. Analyses were not performed for other potential contaminants (LBL personnel, 1988).

3.4.2.3 Underground Storage Tanks

Four USTs, two used to store diesel fuel and two used to store waste oils, are known to have leaked in the past and resulted in contamination of the soil. The contaminants may have been transported to groundwater by the downward percolation of rainwater through the soil. The locations of these tanks are shown on Figure 3-12 and a brief description of each is provided below. More detailed information on these past leaks is provided in Section 4.5.1.5 of Inactive Waste Sites and Releases.

TK-01-07 Central Stores and Electronics (Bldg. 7) - A 1,600-gallon steel UST was used in the past for waste oils and possibly other liquids such as gasoline, acetone, alcohol, and solvents. The tank was taken out of service in 1984 and emptied. In May 1987, low levels of polychlorinated biphenyl (PCB) contamination were detected in soil samples collected near the UST (LBL, 1987I).

LOCATION OF USTs THAT HAVE LEAKED

FIGURE 3-12

Source: LBL, 1987

TK-02-58 Accelerator Research and Development (Bldg. 50) - A 2,000-gallon steel UST was used to store waste oils and other liquids spilled during experiments. A leak was discovered in the piping leading to the tank. Soil samples collected near the leak were found to have concentrations of as high as 2,700 ppm total hydrocarbons (Dames & Moore, 1987a).

TK-02-62 Materials and Molecular Research (Bldg. 62) - A 750-gallon steel UST was used to store diesel fuel. In 1986, it was discovered that the tank leaked. The tank and soil contaminated with diesel fuel were removed in 1987. Also, two monitoring wells were installed (Dames & Moore, 1987b).

TK-11-74 Biomedical Laboratory (Bldg. 74) - A 1,200-gallon fiberglass tank that is used to store diesel fuel for an emergency generator was found to have leaked during an annual leak test. Repairs were made on July 22, 1986, and obviously contaminated soil was excavated and removed from the site. Two soil samples were collected and analyzed for extractable hydrocarbons. Diesel fuel was detected in one sample at a concentration of 32 ppm. The tank was tested again after the repairs and found to be tight.

3.4.2.4 Other Potential Sources

During past operations at the LBL, chemical spills are likely to have occurred and may have resulted in soil contamination. Also, historically, scrapyards have existed at three different areas at the LBL. Descriptions of these potential groundwater contamination sources are provided below. Further details are provided in Section 4.5, Inactive Waste Sites and Releases.

- **Spills** - Although there are no reports of major spills, accidental spills probably occurred during the operation of various bulk chemical storage and dispensing facilities and may have contaminated the groundwater with miscellaneous chemicals and solvents.
- **Scrapyards** - Historically, scrapyards existed at Buildings 17, 46, and 69. Spills and accidental releases from transformers, capacitors, and assorted

machinery may have contaminated the soil and groundwater with waste oils, PCBs, and miscellaneous solvents.

- Past leaks from broken sewer lines - Leaks of wastewater containing plating solutions, photographic wastes, cooling tower blowdown, and other laboratory wastes have occurred in the past along cracked segments of the sanitary sewer system.

3.4.3 Environmental Monitoring Program

3.4.3.1 Scope of Past Sampling Activities

The LBL does not have a groundwater monitoring program. Consequently, there is little information available to evaluate the quality of groundwater on a site-wide basis or relative to a specific operation or activity. The LBL does monitor changes in groundwater elevation as part of the slope stabilization program using the hydraugers and collection wells as points of measurement.

According to background information and interviews with LBL personnel, some wells and hydraugers have been sampled in the past on at least one occasion. In 1986, a study titled "East Canyon Preoperational Survey" was performed which included collection and analyses of seven groundwater samples. Four of these samples were collected on-site from hydraugers, although the actual hydrauger designations were not identified. Generally, the samples were collected from hydraugers in the vicinity of the following: the Bevatron (Building 51); Nuclear Science and Applied Science/Nuclear Science, Materials, Molecular Research, and Earth Science (Buildings 70/70A); Heavy Ion Linear Accelerator (SuperHILAC) (Building 71), Radioisotope Services (Building 75); and Chicken Creek. In addition, the study included three off-site samples. The samples were analyzed for gross alpha and beta, gamma emitters, tritium, and the U.S. Environmental Protection Agency (EPA) list of priority pollutants. The analytical results of this study are provided in the subsection below (LBL, 1986c).

Another small-scale sampling effort occurred just prior to the on-site portion of the Survey. The LBL collected two groundwater samples, one from Hydrauger 75/77 and

the other from Well 13130. These samples were analyzed for radioactive contamination, the results of which are presented below (LBL personnel, 1988).

3.4.3.2 Summary of the Analytical Results of Past Studies

The 1986 study included analyses for the EPA priority pollutants. Two volatile organic chemicals were detected in one on-site sample collected from the east side of Building 51. Trichloroethylene was identified at 13 parts per billion (ppb). The EPA-established Maximum Contaminant Level (MCL) for trichloroethylene is 5 ppb and the State of California Department of Health Services (CADOHS) Recommended Action Level is 5 ppb. Tetrachloroethylene was identified at 94 ppb near Building 51. The CADOHS Recommended Action Level for tetrachloroethylene is 4 ppb. In addition, the concentrations of several inorganic compounds were slightly higher than background in a few of the samples. Table 3-22 is a summary of those constituents where concentrations above background were detected (LBL, 1986c).

The radiological analyses of groundwater samples collected in the 1986 study indicated the presence of elevated levels of tritium in one sample collected from Hydrauger 75/77. The concentration was reported as 2,000 pCi/L $\pm$ 1,000, in comparison to other samples which were measured as having levels of 0 pCi/L $\pm$ 1,000. On-site measurements of gross alpha, beta, and gamma were similar to those recorded for the off-site samples (LBL, 1986c).

Tritium was also detected in the two samples collected in 1988. According to verbal reports from LBL personnel, the level detected in Well 13130 was 2,600 pCi/L above background. The specific concentration detected in Hydrauger 75/77 was not reported (LBL personnel, 1988).

3.4.4 Findings and Observations

3.4.4.1 Category I

None

TABLE 3-22

**SUMMARY OF THE ANALYTICAL RESULTS OF
CONSTITUENTS IDENTIFIED ABOVE THE DETECTION LIMIT
IN GROUNDWATER SAMPLES COLLECTED IN 1986
AT THE LBL**

Constituent	General Sample Locations On-Site						General Sample Locations Off-Site	
	Bldg. 51	Bldgs. 70/70A	Bldg. 71	Bldg. 75	Chicken Creek		Claremont	Tilden
Organics (ppb)								
Trichloroethylene	13	<5	<5	<5	<5		<5	<5
Tetrachloroethylene	94	<5	<5	<5	<5		<5	<5
Inorganics (ppm)								
Mercury	0.0006	<0.0005	<0.0005	<0.0005	<0.0005		<0.0005	<0.0005
Zinc	<0.03	3.3	<0.03	<0.03	<0.03		<0.02	<0.03

Source: LBL, 1986c

3.4.4.2 Category II

None

3.4.4.3 Category III

1. Organic chemical contamination in groundwater at the LBL. In 1986, a limited study was performed which included collection of four on-site and three off-site groundwater samples and analyses for EPA priority pollutants. The analytical results found trichloroethylene and tetrachloroethylene at 13 ppb and 94 ppb, respectively, in one groundwater sample collected from the east side of the Bevatron.

Coincidentally, the current activities in Buildings 47, 53, 58, and 58A use solvent chemicals, and these buildings appear to be located upgradient of the Bevatron sample location. In addition, two former salvage yards were located in the vicinity of Buildings 46 and 17, both of which also appear to be upgradient of the sample location. Environmental Health and Safety (EH&S) personnel stated that the on-site samples were collected from hydraugers, although the exact hydrauger designations were not known.

The lack of additional information on the sample location and collection techniques precludes an assessment of these contaminant levels; however, established criteria listed in the table below can be used for general comparative purposes.

Contaminant (ppb)	Concentration at the LBL	EPA MCL ¹	State Action Level ²
Trichloroethylene	13	5	5
Tetrachloroethylene	94	NA	4

1 MCL = Maximum Contaminant Level

2 State of California Department of Health Services (CADOHS) Recommended Action Levels. When these action levels are exceeded, the State of California typically requires that the Regional Water Quality Control Board be notified and that the problem be further characterized and remediated as necessary.

As shown in this table, trichloroethylene detected in the groundwater at the LBL exceeds both the EPA-established MCL and the CADOHS Recommended Action Level. The concentration of tetrachloroethylene identified in groundwater at the LBL also exceeds the CADOHS Recommended Action Level.

The groundwater at the LBL is not used for drinking water; however, the hydrauger system at the laboratory is designed to direct groundwater into the stormwater system which eventually flows into the San Francisco Bay. The LBL has not conducted any follow-up work since the 1986 study revealed the presence of organic chemical contamination. Therefore, it is not known whether the contamination is a result of past practices or is an active continuing release. Similarly, the extent of contamination remains undefined.

2. Potential for contamination of soil and groundwater from past spills and accidental releases. Potential chemical contamination of soil and groundwater may have occurred from past leaks of wastewater containing plating solutions, photographic wastes, cooling tower blowdown, and other laboratory wastes along cracked segments of the sanitary sewer systems (see related finding 1, Section 4.5.2.3). Potential chemical contamination of soil and groundwater may have occurred from past spills and accidental releases at the former scrapyards located at Buildings 17, 46, and 69. Historical photographs show that drums were stored in these areas. Interviews with LBL personnel indicate that spills probably occurred but were not documented (see related finding 2, Section 4.5.2.3). Underground storage tanks for diesel fuel, waste oils, solvents, and waste chemical solutions have leaked, resulting in contamination of the soil by hydrocarbons and PCBs. Although groundwater is not used as a source of public drinking water in and around the LBL, groundwater is discharged to surface water from the slope stabilization drainage system. These discharges flow via the storm drainage system to Strawberry and Blackberry Creeks and eventually to San Francisco Bay (see related finding 1, Section 3.3.4.4).
3. Well 13130 is a potential pathway for contaminants to enter the groundwater. Well 13130 is located in a manhole in the paved area downslope from Buildings 75 and 69. A hole cut in the manhole cover allows surface water

runoff to enter the well. A soil sample collected in 1986 near Building 75 contained tritium (see related finding 1, Section 3.2.4.4). Approximately 1 week before the on-site portion of the Survey, a water sample was collected and analyzed from Well 13130 and found to contain tritium at a concentration of 2,600 pCi/L above background. Analyses for other potential contaminants were not performed.

3.4.4.4 Category IV

1. Lack of a comprehensive groundwater monitoring program. The lack of a comprehensive groundwater monitoring program precludes an accurate assessment of past and present environmental impacts of LBL operations.

Although there is no information to indicate that significant off-site impacts have occurred from past or present operations, there are no data to support or refute this assumption. Data from a 1986 study show that trichloroethylene and tetrachloroethylene are present in groundwater near Building 51. Recent data from Well 13130 indicate the presence of elevated levels of tritium, although lower than drinking water standards. Additionally, water samples from Hydrauger 75/77, one collected in 1986 and the second in 1988, were found to contain elevated levels of tritium. The LBL has not conducted further studies to investigate these areas of contamination; however, according to LBL personnel, a groundwater monitoring plan is under development.

4.0 NON-MEDIA-SPECIFIC FINDINGS AND OBSERVATIONS

This section discusses findings and observations pertaining to waste management, toxic and chemical materials, direct radiation, quality assurance, and inactive waste sites and releases. These discussions do not include a background environmental information section because the areas addressed are not necessarily tied to one medium as was the case with the discussions in Section 3.0. The discussions include an environmental monitoring program section where appropriate and where information was available.

4.1 Waste Management

Activities at the Lawrence Berkeley Laboratory (LBL) generate a variety of solid and liquid wastes. Types of wastes generated at the LBL are:

- Hazardous wastes--solid and liquid wastes that contain hazardous constituents. Management and disposal of these wastes are regulated under California Hazardous Waste Management Regulations, which are used to implement the requirements of Subtitle C of the Federal Resource Conservation and Recovery Act (RCRA).
- Low-level radioactive wastes--solid and liquid wastes that contain radioactivity and are regulated by internal U.S. Department of Energy (DOE) Orders.
- Radioactive mixed wastes--wastes that display both hazardous and radioactive characteristics. These wastes are subject to regulation by California Hazardous Waste Management Regulations as well as by DOE Orders.
- Solid wastes--wastes that do not contain regulated amounts of hazardous or radioactive materials. Handling and disposal of these wastes are regulated by California Solid Waste Management Regulations.

Discussions of the generation and management of each of these waste categories follow. Unless otherwise referenced, descriptions of facilities and wastes are based on observations made during the Survey.

4.1.1 General Description of Pollution Sources and Controls

4.1.1.1 Hazardous Waste

General hazardous waste management practices at the LBL include on-site accumulation at the point of generation, on-site storage at a permitted storage facility, off-site disposal of containerized wastes and bulk liquids, and on-site treatment of hazardous wastewaters. The total amounts of hazardous wastes shipped from the LBL during 1987 are summarized in Table 4-1.

Sources and Types of Hazardous Wastes

Major sources of hazardous wastes at the LBL include:

- maintenance shops and facilities, which generate waste oils, solvents, and corrosives;
- fabrication shops, which generate waste oils, solvents, corrosives, and plating wastes;
- accelerators and support facilities, which generate waste oils and solvents;
- research laboratories and support shops, which generate waste reagent chemicals, solvents, oils, and corrosives; and
- decontamination and decommissioning (D&D) and remedial action activities, which generate polychlorinated biphenyl (PCB) wastes, asbestos wastes, contaminated soil, and contaminated equipment.

More detailed discussions of hazardous waste generation and management practices for each of the above sources follow.

TABLE 4-1

SUMMARY OF HAZARDOUS WASTES SHIPPED FROM THE LBL DURING 1987

Waste Type	Amount Shipped
Diesel Oil-Contaminated Soil	92 Cu. Yds.
Empty Corrosive Drums	10 Drums
Empty Solvent Drums	89 Drums
Empty Waste Oil Drums	178 Drums
Mixed Solvents (Halogenated, Aromatic, Ethers, Ketones, Alcohols, Freons)	1,870 Gallons
Waste Alcohol	55 Gallons
Waste Freons	110 Gallons
Waste Oil	2,000 Gallons
PCB-Contaminated Waste Oil	8,000 Gallons
Waste Fuel Oil	55 Gallons
Spent Plating Solutions and Acids	4,555 Gallons
Reactive Alkali Metals	15 Pounds
Metal-Contaminated Sludges	2,811 Pounds
Waste Resin Solutions	55 Gallons
Waste Poison B, N.O.S.	1,279 Pounds
Flammable Liquids, N.O.S.	1,210 Pounds
Solids, N.O.S. Flammable	862 Pounds
Waste Diesel Fuel Tank	1,000 Pounds
Asbestos Wastes	2,929 Pounds
Liquid PCB Wastes	220 Gallons
Solid PCB Wastes	5,368 Pounds

Source: LBL, 1987m

N.O.S. = Not Otherwise Specified

Maintenance shops and facilities at the LBL are used to maintain the general physical plant. Major facilities are the Craft and Maintenance Shops (Building 76) and the Utilities Service (Building 37). Building 76 houses a paint shop, carpenter shop, electrical shop, plumbing shop, and machine shop, as well as the automotive shop for the LBL Motor Pool. Hazardous wastes generated at Building 76 include:

- waste solvents [1,1,1-trichloroethane (TCA) and paint solvents] from parts and equipment cleaning and painting;
- waste oils from equipment and automotive maintenance and machine tool lubrication; and
- waste lead-acid storage batteries from automotive maintenance.

Building 37 is used to service the water treatment systems of the LBL cooling towers and to deionize water for the LBL low conductivity water (LCW) system. Associated with this facility is a small storage shed, Building 4A, which is used to store water treatment chemicals used at the cooling towers. Hazardous wastes generated at these facilities are empty chemical containers and ion exchange regenerant.

Another maintenance facility is a small shed, Building 6A, east of the 184-Inch Synchrocyclotron, which houses a compressor and generator. Hazardous waste oils are generated at this facility from equipment maintenance.

Fabrication shops at the LBL are used to fabricate components and equipment needed to support research programs. Major fabrication facilities are Mechanical Technology (Building 25), Electronics Development (Building 25A), Mechanical Shops (Building 77), and Accelerator Development (Building 53). Building 25 houses several plating shops that are used for the production of printed circuit (PC) boards and electronic components. Operations conducted in these shops include etching with ferric chloride and sulfuric peroxide, tin/lead stripping, electroless copper plating, tin/lead plating, and gold plating. Hazardous wastes generated at this facility are spent etching and plating solutions, reflow oil, and plating wastewaters. Building 25 also houses a pretreatment unit to treat plating wastewaters prior to discharge to the sanitary sewer (described in Section 3.3.2.1). This treatment unit generates hazardous waste in the form of metal-contaminated sludges. Building

25A is adjacent to Building 25 and houses electronic fabrication facilities that are used primarily for fabrication of PC boards. Equipment used in this facility includes a flow solder machine and a Freon vapor degreaser. Hazardous waste generated includes small amounts of waste solder and sludge from solvent recovery.

Building 77 houses the main LBL fabrication shops, which include a plating shop, several large machine shops, and a paint shop. Operations in the plating shop include vapor degreasing using TCA; copper, nickel, chromium, gold, and cadmium plating; anodizing; and metal cleaning. Hazardous wastes generated from plating operations include waste acids and caustics, spent TCA solvent, and plating wastewaters. The plating shop has a pretreatment plant for treatment of plating wastewaters prior to discharge to the sanitary sewer (described in Section 3.3.2.1). Operation of this plant generates hazardous waste in the form of metal-contaminated sludge. The machine shops engage in a variety of metal and plastic machining and fabrication activities. Hazardous waste generated includes:

- waste solvents [acetone, methyl ethyl ketone (MEK), alcohol, TCA, safety solvent, and kerosene] from metal and parts cleaning;
- waste oil (clean and solvent-contaminated) from machining, machine coolant recovery, and equipment repair;
- lead chips from lead fabrication; and
- spent alkaline hot stripper solution.

The paint shop has one dry-filtered paint booth. Hazardous wastes generated are waste solvents consisting of lacquer thinner and TCA. No hazardous (i.e., lead-, cadmium-, or chromium-based) paints are used.

Building 53 is used for fabrication and rebuilding of electromagnets. This building includes a Freon ultrasonic degreaser, TCA degreaser, alcohol and acetone dip tanks, chromic acid bright-dip tanks, and a spray paint booth. Hazardous wastes generated at this building include spent solvents and waste oil from vacuum pumps.

Major operating accelerators at the LBL are the Bevatron (Building 51), SuperHILAC (Building 71), and 88-Inch Cyclotron (Building 88). The accelerators all have facilities to perform light maintenance and fabrication (i.e., small machine shops and repair shops). Operations include metal and parts cleaning using small amounts of a variety of solvents, metal cleaning using chromic acid bright-dip, and vacuum pump maintenance. Hazardous wastes generated include waste solvents and waste oils. Solvents noted to be in use at these facilities are kerosene, MEK, isopropyl alcohol, trichloroethylene, TCA, and acetone. Each accelerator also has an ion exchange system for LCW cleanup. These systems generate acid and caustic ion exchange regenerant. Building 51 also has a mercury room, which is used for repair of ignitron tubes and mercury pumps. These activities generate small amounts of mercury waste.

There are a variety of research laboratories and associated support facilities at the LBL, including Donner Laboratory (Building 1); Melvin Calvin Laboratory (Building 3); Biomedical Research (Building 10); Magnetic Fusion Energy Laboratory (Building 16); Advanced Accelerator Study (Building 47); Accelerator Research and Development (Building 58); Materials and Molecular Research (Building 62); Accelerator Division (Building 64); Nuclear Science and Applied Science (Building 70); Nuclear Science, Materials, Molecular Research, and Earth Science (Building 70A); and Biomedical Laboratory (Building 74). These facilities engage in several types of research and generate many different hazardous waste streams. Buildings 1, 3, 10, and 74 are primarily involved with biomedical research. Hazardous wastes generated at these laboratories consist of small amounts of organic solvents and discarded reagent chemicals. Building 10 also generates photographic waste. Buildings 62, 70, and 70A contain chemical research laboratories. Hazardous wastes generated at these buildings consist of waste acids, small quantities of organic solvents, discarded reagents, and waste vacuum oil. Buildings 16, 47, 58, 62, and 64 contain machine shops used to fabricate and maintain equipment associated with physics research. Hazardous wastes generated in these buildings include spent solvents from cleaning and degreasing (TCA, acetone, isopropyl alcohol, Freon, kerosene, Stoddard solvent), waste oils (vacuum oils, cutting oil, dielectric oil, lubrication oil), and waste machine coolant. In addition, Buildings 62 and 64 have ion exchange units for LCW treatment and generate acid and caustic regeneration wastes.

Several ongoing or recently completed D&D and remedial action projects at the LBL also generate hazardous waste. An underground diesel fuel tank at Building 64 was recently removed because of leakage. Hazardous waste generated by this activity included oil-contaminated soil as well as the empty tank. Currently, the 184-Inch Synchrocyclotron (Building 6) is being decontaminated and decommissioned. This activity results in the generation of waste oil from oil-containing equipment in the building. Planned actions include removal of the old wooden cooling towers at the LBL. According to LBL personnel, the State of California has agreed that the wood from these towers can be disposed of in a sanitary landfill.

Hazardous Waste Management Activities

Hazardous waste management activities at the LBL are conducted by the generators of the wastes and the Environmental Health and Safety (EH&S) Department. In general, generators are responsible for proper identification and designation of hazardous wastes and on-site accumulation. EH&S is responsible for on-site collection and transportation of the wastes, on-site storage, manifesting and recordkeeping, waste packaging, and preparation for transportation for off-site treatment or disposal. Generators are responsible for proper segregation of hazardous wastes from other types of wastes. EH&S has no formal program for determining if wastes have been properly segregated by generators.

Most hazardous waste generated at the LBL is of known composition, consisting of spent or discarded chemical products (e.g., waste acids, spent solvents, waste oils, discarded chemical products). These wastes typically do not require further analysis. Unknown waste generally consists of small quantities (i.e., less than 1/2 pound of solids or less than 1 gallon of liquids) of discarded chemicals. The LBL has defined procedures to classify waste that is water-reactive, corrosive, oxidizer, flammable, or heavy metal-contaminated (LBL, 1987b). These qualitative tests are used in lieu of analytical tests because it is deemed impractical to analyze small quantities of waste. The LBL Hazardous and Radioactive Mixed Waste Management Plan (LBL, 1984b) specifies procedures whereby small quantities of water-soluble chemicals and neutralized corrosives can be discharged to the sanitary sewer. Such releases primarily involve very small quantities of chemicals from laboratories and the procedures are not intended for larger releases, such as those from maintenance facilities. In addition, EH&S has issued guidelines to laboratory staff for proper

disposal of laboratory chemicals (LBL, 1986d). Training for staff handling hazardous materials and wastes includes proper disposal procedures.

Once wastes have been properly identified by the generator, they are typically accumulated by the generator in satellite accumulation areas. Satellite accumulation area refers to a hazardous waste accumulation area which is located near the point of waste generation and which is operated by the waste generator. Under the Federal RCRA regulations, there are less stringent accumulation time limits for satellite areas than for other accumulation areas (i.e., generator less-than-90-day accumulation areas). Under the California Hazardous Waste Management Regulations, however, no distinction is made between satellite areas and other waste accumulation areas. The term, therefore, is used to refer to the location of the area and to identify those areas used by only one generator, and does not refer to regulatory status or requirements.

Containers used to accumulate waste are labeled by the generator with hazardous waste labels that include the date that accumulation started. Small flammable storage cans ("flam cans") containing several gallons are used to accumulate organic and solvent waste at facilities, such as laboratories, which generate small amounts of these wastes. Similarly, small quantities of inorganic wastes, such as acids, are typically accumulated in polyethylene carboys. Larger quantities of wastes, such as those generated in the large shops, are accumulated in 55-gallon drums. EH&S has issued guidelines to laboratory staff for proper accumulation of wastes in 55-gallon drums (LBL, 1986e; Young, 1986). These drum accumulation areas are generally located outside the generating facilities, and are typically in the open with no secondary containment. EH&S staff indicated that they inspect these satellite accumulation areas on a quarterly basis. The drummed waste satellite accumulation areas observed during the Survey are identified in Figure 4-1. The types of waste accumulated at these areas are summarized in Table 4-2.

Wastes are accumulated in the satellite areas until the container is full or 90 days has passed since the start of accumulation. At that time, EH&S is notified and requested to pick up the container. EH&S picks up the containers and transports them for storage at Building 69A or Building 75A. Wastes received and put into storage are entered into a logbook, which identifies the waste, the container it is stored in, and the date storage began. Waste containers in storage are inspected

Source: Survey team observations, 1988

LOCATION OF OUTDOOR HAZARDOUS WASTE
ACCUMULATION POINTS AT THE LBL

FIGURE 4-1

TABLE 4-2

**SUMMARY OF HAZARDOUS WASTE SATELLITE ACCUMULATION
AREAS AND WASTES OBSERVED AT THE LBL**

Location	Wastes in Storage During Survey
Building 1, Laboratories	Flam cans of organic solvents
Building 3, Laboratories	Flam cans of organic solvents
Building 4A	Empty drums of water treatment chemicals
Building 6, South Side	Drums of waste oil-water mixture
Building 6A, Inside	Drum of waste oil
Building 6A, Outside	Drum of waste oil
Building 16, West Side	Drums of waste oil and waste solvents. Solvents in use are TCE, acetone, isopropyl alcohol
Building 25, Outside Plating Shop	Drums of waste copper plating solution, waste sulfuric peroxide etchant, and waste reflow oil
Building 25, Pretreatment Plant	Drum of dewatered sludge
Building 42, Salvage Yard	Waste lead-acid batteries
Building 47, East Side	None present during Survey; drum of waste solvent usually present
Building 51, Pump Repair Shop	Drum of waste oil
Building 51, Room 14	Drum of waste solvent. Solvents in use are TCE, TCA, acetone, isopropyl alcohol
Building 53, East Side	Drum of waste alcohol, acetone, and Freon
Building 58A, South Side	Drums of waste oil and drum of waste solvent. Solvents in use are TCE, acetone, and kerosene
Building 62, South Side	Drum of waste oil and drum of solvent. Solvents in use are Freon, kerosene, acetone, TCA, MEK, and heptane
Building 64, South Side	Drum of TCA, oil, and water mixture
Building 64, East Side	Drum of waste oil and drum of waste mixed solvents
Building 64, West Side	Drum of waste vacuum oil and TCE mixture
Building 70, Southwest Corner	Drum of waste oil, carboy of waste organics

TABLE 4-2

**SUMMARY OF HAZARDOUS WASTE SATELLITE ACCUMULATION
AREAS AND WASTES OBSERVED AT THE LBL (Continued)**

Location	Wastes in Storage During Survey
Building 70, Laboratories	Carboys of waste acids and organics
Building 70A, Laboratories	Carboys of waste organics
Building 71, West Side Tunnel	Drum of waste oil
Building 76, West Side	Drums of waste TCA, oil, and solvent
Building 76, East Side	Drum of paint solvent, drum of crushed fluorescent lights
Building 76, South Side	Portable tank of waste oil, waste lead-acid batteries
Building 77, Pretreatment Plant	Tanks of waste acid and caustic, drum of dewatered sludge
Building 77, West Side	Drums of waste organic (thinner, acetone, MEK, alcohol, TCA, kerosene) and waste oil, waste lead chips
Building 77, Paint Shop	Drums of waste thinners (TCA and lacquer thinner)
Building 88, West Side	Drum of waste oil and drum of waste solvent

Source: Survey team observations

weekly by EH&S staff. When sufficient waste has been received at the storage facilities for pickup by a disposal contractor, this service is arranged by EH&S. Hazardous waste manifests are prepared by EH&S, and copies of manifests and other records are kept by EH&S in Building 75. A variety of off-site treatment and disposal contractors are used by the LBL, depending on the type of waste. Empty drums are typically sent to a drum recycler, clean oils and solvents (i.e., those not contaminated with other materials) to recyclers, dirty oils and solvents to an incinerator, inorganic liquid wastes (e.g., acids, plating wastes) to a treatment facility, and other wastes to a landfill. All of the treatment and disposal contractors used by the LBL have the necessary U.S. Environmental Protection Agency (EPA) permits.

As part of hazardous waste management practices, the LBL has implemented a program of waste minimization through staff training (LBL, 1986j; Young, 1988b). This program includes such practices as substitution with less toxic materials, use of wastes as input material to other processes, on-site recycling of waste materials, segregation of solvent and oil wastes to increase recycle potential, and process changes to reduce waste generation.

Hazardous Waste Management Facilities

The LBL has several facilities used for the treatment and storage of hazardous wastes. These facilities are operated under a Part B permit issued by the California Department of Health Services (CADOHS) in November 1983 (State of California, 1983) and due to expire in November 1988. This permit covers hazardous waste storage at Buildings 69A and 75, and in the Building 75 yard. Because of the pending expiration, and because of expansion of operations, a new Part B permit application was submitted to CADOHS by the LBL in July 1987 (LBL, 1987b). In addition to the above facilities, the new permit application includes the plating waste pretreatment plants at Buildings 25 and 77, the acid wastewater neutralization facility in Building 70A, waste storage in Building 75A, the oil/water separator at Building 76, a waste oil storage tank at Building 76, and the machine tool coolant treatment system in Building 77. The pretreatment plants were included on the LBL Part B permit application as a consolidated listing of the waste facilities, although the pretreatment plants discharge to the sanitary sewer and are permitted by the East Bay Municipal Utility District (EBMUD). The pretreatment

plants, neutralization unit, and oil/water separator are described in more detail in Section 3.3.2.1. Descriptions of the remaining facilities follow.

Building 69A is used for storage of waste oils and solvents and empty drums. The building is a covered, partially enclosed concrete and metal structure having a total area of 1,900 square feet. It has a concrete floor, which is completely contained by a 6-inch curb. The floor drains to a 200-gallon blind sump (LBL, 1987b). The LBL Part B permit application indicates that the facility has a storage capacity of 40 to 50 drums (LBL, 1987b). The building is also used to store drums containing bulk chemicals on horizontal racks. At the time of the Survey, Building 69A was being used to store drums of waste cyclotron oil from Building 6 D&D and drums of waste solvents. The area outside the building was being used to store empty solvent drums that were awaiting pickup by a vendor for reuse.

There is a 2,000-gallon underground storage tank (UST) at Building 69A that is used for storage of waste oil prior to shipment for recycling. This tank is a double-walled fiberglass tank with a leak detection system which can detect air, water, or hydrocarbons. The tank was installed and leak tested in March 1987 and is permitted under a UST permit from the City of Berkeley.

Building 75, Room 131, is used to package and store lab-pack wastes. The room has a concrete floor sealed with vinyl. As discarded chemicals are brought to the facility, they are classified according to waste type and associated hazard (e.g., oxidizer, poison, etc.). Waste containers are segregated by waste type and hazard class and are placed into appropriately labeled drums containing vermiculite absorbent. A log sheet is maintained that identifies the wastes placed in each drum. This room also contains a fume hood, which is used to solidify small quantities of liquid inorganic wastes with concrete. There is another hood used to collect elemental mercury wastes. There is also a drum filling station, used to accumulate solvent wastes, such as those collected in the "flam cans." The LBL Part B permit application indicates that this room has a total storage capacity of 8 to 10 drums. At the time of the Survey, the facility contained several drums being used to accumulate lab-pack wastes.

The Building 75 yard area has two steel cargo containers used to store drummed hazardous wastes and PCB wastes. These containers have secondary containment in

the form of steel trays placed inside the containers. These trays have a total capacity of 534 gallons (LBL, 1987b). The LBL Part B permit application indicates a storage capacity of 32 drums containing liquids and 60 drums of lab-pack wastes (LBL, 1987b). At the time of the Survey, one cargo container was being used for storage of drums of PCB waste and the other for drums of lab-pack wastes and solidified sludges and bags of asbestos waste. The wastes were segregated within the cargo container.

The Building 75 yard has a small, uncovered, diked area used for storage of drummed corrosive wastes. This area has a total area of 126 square feet and a containment capacity of 670 gallons (LBL, 1987b). The Building 75 yard is also used for outside storage of drums of unwanted chemical products. At present, these materials are not considered wastes and the LBL is attempting to find uses for them in the laboratory (LBL, 1987d).

Building 75A is used to store hazardous wastes, PCBs, radioactive mixed waste, and radioactive waste. This completely enclosed metal building has a total area of approximately 4,000 square feet. The facility has a concrete floor that is completely contained by 6-inch curbs. The LBL Part B permit application (LBL, 1987b) indicates a storage capacity of 250 drums, including 30 drums of liquid waste. At the time of the Survey, Building 75A was being used to store hazardous waste drums containing waste oil and machine coolant. The number of drums in storage at the time of the Survey was less than the capacity.

The Building 76 Motor Pool uses a 330-gallon portable skid-mounted tank for storage of waste motor oil. This steel tank is located outside the Motor Pool and has no secondary containment. It is periodically taken to Building 69A where the oil is transferred to the waste oil storage tank. Also present at Building 76 (and described in Section 3.3.2.1) is an oil/water separator. There are plans for this unit to be modified to treat uncontrolled releases of oils and solvents from a collection sump at the Motor Pool.

The Building 77 machine tool coolant treatment system is used to remove contaminants and impurities from machine tool coolant so that the coolant can be recycled. This coolant consists of a water-miscible oil which must be kept clean to prevent degradation. Approximately 500 to 600 gallons per week are treated. This

system uses a skimmer and centrifuge to remove oils and fine solids. The oils are collected in drums and disposed of as hazardous waste. Any coolant that has degraded to the point where it cannot be recycled is also drummed and disposed of as hazardous waste. Fines, consisting primarily of grindings, are bagged and disposed of as sanitary refuse. The LBL staff indicated that these grindings include stainless steel, copper, fiberglass, and a variety of other materials. This unit is included in the LBL's Part B permit application, but is noted as being exempt from regulation because the activity constitutes "on-site recycling" (LBL, 1987b). In addition to being used to treat machine coolant from the LBL, the unit is also used to treat machine oil from Lawrence Livermore National Laboratory (LLNL). The LBL has been given a variance from CADOHS to allow the "on-site recycling" designation to apply to treatment of machine coolant from LLNL.

The LBL has completed conceptual designs for a new hazardous waste storage facility that would replace the facilities at Buildings 69A, 75, and 75A (LBL, 1986b). This facility would consist of a 12,300-square-foot building and adjacent yard area. The location of this new building would be Upper Strawberry Canyon, near Buildings 74 and 83. Current plans call for completion in fiscal year 1991.

4.1.1.2 Radioactive Waste

Activities pertaining to radioactive waste at the LBL include the generation, handling, and on-site storage of low-level radioactive wastes (LLW). No other types of radioactive wastes (i.e., intermediate level, high level, transuranic) are presently being generated at the LBL. General radioactive waste management practices at the LBL include on-site accumulation of LLW at the point of generation, solidification of liquid LLW, compaction and repackaging of solid LLW, on-site storage of LLW at Building 75A, and off-site disposal of solid LLW at other DOE sites.

Sources and Types of Radioactive Waste

Radioactive waste generated at the LBL includes equipment and shielding having induced radioactivity and laboratory wastes consisting of solid and liquid LLW. The former constitutes by far the greatest volume of radioactive wastes generated at the LBL. These wastes typically consist of large blocks of concrete having induced radioactivity, generally at great depth within the concrete. Equipment removed

from accelerators may also have induced radioactivity. Generation of these wastes is sporadic, depending on the nature of accelerator maintenance operations. During 1987, a total of 150 cubic feet of these wastes, weighing 43,448 pounds, was shipped from the LBL for burial at the Hanford Site in Washington. These wastes consisted of metal and concrete containing a total induced radioactivity of 90 mCi of cobalt-60 (LBL, 1987m).

A number of concrete shielding blocks and equipment will be removed from Building 6 as a result of decommissioning efforts. Due to the nature of activities at Building 6, some of these blocks will contain induced radioactivity. The San Francisco Operations Office (SAN) and CADOHS have agreed to a procedure for determining whether or not blocks are radioactive. This procedure is based on two criteria which have been developed for determining which blocks can be disposed of as nonradioactive waste (Davis, 1987). The first requires that the total induced radioactivity (i.e., cobalt-60, europium-152, sodium-22) be less than 10 percent of the naturally occurring radioactivity (i.e., uranium, thorium, potassium-40). The second requires that the total radioactivity be less than 25 picocuries per gram (pCi/g).

If the blocks are determined to be nonradioactive, the LBL will be allowed to dispose of them at a sanitary landfill in Livermore, California. Radioactive blocks will not be disposed of as wastes, but will be sent to Los Alamos National Laboratory for use in an accelerator there. The cyclotron and other radioactive equipment will be disposed of as radioactive waste.

Solid and liquid radioactive waste is generated at several LBL laboratories, including Buildings 1, 3, 70, 70A, and 74, and from the National Tritium Labeling Facility (NTLF). Solid LLW consists mainly of dry wastes such as gloves, paper, wipes, and glassware. These wastes also include radioactively-contaminated animal carcasses and animal wastes resulting from biomedical research conducted at Buildings 1, 3, and 74. The LBL staff indicated that solid wastes from the laboratories are all classified as low specific activity (LSA) wastes and contain less than 0.3 millicuries per gram (mCi/gm) total beta-gamma activity. Total radionuclide inventories in laboratories are typically in the microcurie to millicurie range.

Liquid wastes consist of small quantities of aqueous solutions containing low levels of radioactivity. According to the LBL staff, all liquid LLW is classified as LSA wastes and contains less than 0.3 millicuries per milliliter (mCi/mL) total activity. Liquid wastes from the laboratory primarily contain medical isotopes, including carbon-14, iodine-129, iodine-131, phosphorus-32, and sulfur-35. Liquid wastes from the NTLF contain tritium at concentrations less than 0.1 mCi/mL. Liquids from the NTLF containing greater than 0.1 mCi/mL are solidified by absorption with silica gel.

The LBL staff indicated that transuranic (TRU) wastes [i.e., wastes containing greater than 100 nanocuries per gram (nCi/g) of TRU isotopes] are not currently being generated at the LBL. Some TRU wastes have been generated in the past and a small quantity is presently being stored in a vault in Building 70.

Most of the radioactive waste generated at the LBL consists of shielding and equipment containing induced radioactivity. Generation of other types of radioactive wastes is minor in comparison, and EH&S staff reported that the generation rate of these wastes typically ranges from 75 to 100 drums per year. Waste shipment records for 1987 did not indicate the shipment of any such wastes from the LBL during the year (LBL, 1987m). In the past, these wastes have been shipped to the Hanford Site for burial.

Radioactive Waste Management Activities

Radioactive waste management activities at the LBL are conducted by the generators of the wastes and EH&S staff. In general, generators are responsible for proper identification, segregation, packaging, and accumulation of radioactive wastes. EH&S is responsible for collection of wastes from generators, solidification of liquid waste, compaction of solid waste, packaging of waste for shipment, storage of waste prior to shipment, preparation of shipping papers, and maintenance of records.

The LBL has prepared procedures, presented in the LBL Part B permit application (LBL, 1987b), to assist waste generators in the identification, separation, and packaging of radioactive waste. These procedures call for wastes to be separated on the basis of the levels of radioactivity present and the types of isotopes. The procedures specify the types of containers to be used for each waste and the

maximum activity that can be present in each container. Dry LSA wastes are accumulated in laboratories in plastic bags inside 15-gallon cans. The LBL staff indicated that the total activity of each bag of solid waste is typically less than a millicurie. Liquid LSA wastes are accumulated in laboratories in polyethylene carboys. Radioactively-contaminated animal carcasses are sealed in bags and accumulated at the laboratories by storage in a freezer. When ready for disposal, the carcasses are packed into drums which contain slaked lime. Each waste accumulation container or bag has a log sheet on which the generator enters the total activity of each isotope present. In addition, liquid waste container labels identify the chemicals present and the pH of the solution.

Waste accumulation containers are picked up at the generator facilities by EH&S. Each container is first surveyed for surface dose rate. These wastes are then transferred to the Building 75 complex. Liquid waste is solidified with cement in 55-gallon drums. EH&S staff reported that each drum receives approximately 25 gallons of liquid waste. Compactible solid wastes (e.g., gloves, paper, clothing) are compacted and repackaged into drums. Large solid wastes (e.g., old glove boxes) are repackaged into large transport and burial containers. Radioactive wastes are packaged for shipment according to procedures given by the operator of the disposal facility at the Hanford Site. The wastes are transferred to the Hanford Site using a commercial transport contractor.

Radioactive Waste Management Facilities

Radioactive waste management activities occur at Buildings 75 and 75A. Building 75 is where liquid LLW is solidified by addition of cement. Solidification occurs in the same area as repackaging of hazardous waste lab-packs. This area was previously described in Section 4.1.1.1. Building 75 also contains facilities for occasional decontamination of radioactive equipment. Surface decontamination is performed manually using alcohol, solvents, or phosphoric acid. There is also a small sandblaster for use in decontamination. These activities generate very small quantities of solid waste.

Building 75A is used to compact and store solid LLW. Bags of compactible LLW are compacted and repackaged into 55-gallon drums. Because of the relatively small volume of such wastes, the LBL staff indicated that the compactor is used

approximately once a month. Building 75A is also used to store solid LLW and drums of solidified liquid LLW prior to off-site shipment. The storage area is also used for storage of hazardous waste and was previously described in Section 4.1.1.1.

4.1.1.3 Radioactive Mixed Waste

Activities involving radioactive mixed waste (RMW) at the LBL include generation, handling, and on-site storage. General RMW management practices at the LBL include on-site accumulation at the point of generation, solidification of liquid RMW and repackaging of solid RMW, on-site storage of RMW, and off-site disposal of RMW.

Sources and Types of Radioactive Mixed Waste

RMW generated at the LBL consists of tritium-contaminated silica gel filters from the NTLF, scintillation fluids from radioanalytical laboratories, and radioactively contaminated organics (i.e., oils and solvents) from laboratories. The silica gel filters from the NTLF are the largest source of RMW at the LBL. These wastes consist of metal cans containing approximately 1/2 gallon of silica gel used to remove tritium oxide from air in glove boxes. The NTLF staff indicated that each can typically contains several millicuries of tritium and that 5 to 10 cans of waste are generated each week. While the silica gel is not considered hazardous, procedures call for the sealed cans to be placed in overpack drums and sealed with tar. The presence of the tar causes the waste drum to be designated as RMW. Radioactive waste shipment records for 1987 indicated that 5,200 pounds of silica gel (28,894 pounds gross weight including containers) were sent off-site for disposal at the Hanford Site. These wastes contained a total of 24,000 curies of tritium, 11 microcuries of zinc-65, and 8 microcuries of manganese-54 (LBL, 1987m).

Scintillation fluid RMW consists of glass vials containing a mixture of toluene and xylene, as well as traces of radioactive isotopes. Radioactive waste disposal records for 1987 indicated that 400 pounds of scintillation fluid (12,556 pounds gross weight including containers) were sent off-site for disposal at the Hanford Site (LBL, 1987m). The radionuclides contained in these wastes are summarized in Table 4-3. The LBL Part B permit application (LBL, 1987b) reports that in April 1987, the LBL began a program of substituting toluene- and xylene-based scintillation fluids with

TABLE 4-3

**SUMMARY OF RADIONUCLIDE INVENTORY IN
SCINTILLATION FLUID SHIPPED FROM THE LBL DURING 1987**

Radionuclide	Amount in Waste
Hydrogen-3	10,600 microcuries
Carbon-14	1,660 microcuries
Phosphorus-32	93 microcuries
Sulfur-35	40 microcuries
Calcium-45	10 microcuries
Cadmium-109	6 microcuries
Iodine-125	370 microcuries
Iodine-131	10 microcuries
Neptunium-237	131,200 nanograms
Plutonium-238	27 nanograms
Plutonium-239	7,665 nanograms
Plutonium-240	1,994 nanograms
Plutonium-242	965 nanograms
Americium-241	1,130 nanograms
Americium-243	7 nanograms
Curium-244	0.307 nanogram

Source: LBL, 1987m

aqueous biodegradable fluids. This practice will reduce the amount of this RMW generated in the future.

Other organic RMW consists of radioactively contaminated oils and solvents. A major source of these wastes is the NTLF, which generates tritium-contaminated organic solvents and tritium-contaminated vacuum pump oil. The NTLF staff indicated that approximately 1 to 2 gallons/month of solvents were generated. The waste oil is collected in a drum filled with diatomaceous earth. The NTLF staff reported that approximately 5 years are required to fill a drum. Small quantities of radioactively-contaminated organic solvents may be generated at other radiochemical laboratories. The LBL radioactive waste disposal records for 1987 indicated that the only such waste sent from the site during the past year was one drum of tritium-contaminated waste oil, which was sent to the Hanford Site. This waste contained 400 curies of tritium (LBL, 1987m).

Radioactive Mixed Waste Management Activities

RMW management activities at the LBL are conducted by the generators of the wastes and EH&S staff. Generators are responsible for proper identification, segregation, and accumulation of RMW. EH&S is responsible for collection of wastes from generators, packaging of wastes for shipment, storage of wastes prior to shipment, preparation of shipping papers, and maintenance of records.

In general, RMW is managed using procedures equivalent to those used for both hazardous and radioactive wastes. RMW is accumulated by generators, who keep records of the total amount of each radionuclide present in the waste. Silica gel cans are accumulated at the NTLF. These wastes are not considered RMW at this point because they do not become hazardous until mixed with tar. Scintillation vials are accumulated in cans in radioanalytical laboratories. RMW solvents are accumulated in small bottles (i.e., 1 liter) because of the small amount generated. Waste oil at the NTLF is collected in a drum filled with diatomaceous earth absorbent so that no free liquid is present.

Containers of RMW are picked up at the generator facilities by EH&S when a sufficient quantity has accumulated. Each container is first inspected for surface dose rate. These wastes are then transferred to the Building 75 complex. Cans of

silica gel wastes are packed into drums and sealed with tar. Scintillation vials are placed into galvanized drums that contain vermiculite absorbent. Organic RMW is absorbed into diatomaceous earth and placed in drums. Staff at the NTLF reported that in the future, organic wastes will be absorbed into organic fibers and stored for incineration at the Idaho National Engineering Laboratory. RMW is packaged for shipment according to procedures provided by the operator of the radioactive waste disposal facility at the Hanford Site.

The last shipment of RMW from the LBL to the Hanford Site occurred in March 1987 and contained silica gel, scintillation fluid, and tritiated oil. The LBL staff indicated that the Hanford Site has agreed to continue to accept RMW from the LBL, but that there is some uncertainty over the Hanford Site's acceptance of these wastes. As a result of this uncertainty, the LBL staff indicated that a variance has been obtained from DOHS to allow for storage of RMW at the LBL for longer than the 1-year maximum storage period allowed in the Part B permit.

Radioactive Mixed Waste Management Facilities

RMW management activities occur at Buildings 75 and 75A. Building 75 is used to pack scintillation vials into drums and to solidify liquid organic RMW. These activities occur in the same area as used to repackage lab-pack wastes. This area was previously described in Section 4.1.1.1. Building 75A is where cans of silica gel wastes are packed into drums and sealed with tar. Building 75A is also used to store drums of RMW prior to shipment off-site. Drums of tritium-contaminated silica gel were being stored in this building at the time of the Survey. This storage area is also included in the LBL Part B permit and was previously described in Section 4.1.1.1.

4.1.1.4 Solid Waste

Activities centering around solid waste at the LBL include generation, handling, temporary storage, and salvage. General solid waste management practices include storage at generator facilities in contractor-provided collection containers, collection of solid wastes by an off-site contractor, and on-site storage of salvageable wastes. Solid waste generated at the LBL includes trash generated at virtually all offices and laboratories; construction wastes (e.g., concrete, wood, steel) generated during construction activities; scrap metals generated in

fabrication and maintenance shops; unwanted mechanical and electrical equipment; and uncontaminated wastes from D&D activities.

Trash and construction wastes are collected by an off-site contractor, Berkeley Sanitation Service, and disposed of at a sanitary landfill in Richmond, California. These wastes are collected at various buildings throughout the LBL in 30-gallon cans, 1- and 2-cubic-yard dump boxes, and 20-cubic-yard drop boxes. These wastes are collected 3 times a week and records provided by the LBL indicate that an average of 400 cubic yards of waste is collected each month (LBL, 1987m). Segregation of hazardous and radioactive waste from solid waste is the responsibility of the generators of these wastes. There is no formal procedure for inspection of solid waste, either by the LBL or the collection contractor, to determine if unauthorized materials are being disposed of.

Scrap metals and unwanted equipment are taken to the LBL salvage yard (Building 42) for temporary storage prior to being released as excess materials to other government agencies or sold to the public. Any materials coming to the salvage yard having the potential for radioactive contamination are first radiologically inspected by EH&S. The operators of the salvage yard are trained not to accept hazardous materials or wastes. In the past, such material has been received at the salvage yard. Bulletins have been provided to the LBL staff indicating that hazardous materials may not be sent to salvage (LBL, 1981; LBL, 1987c).

The major D&D activity currently underway at the LBL is the decontamination and decommissioning of Building 6. This activity will result in the removal of a large number of concrete shielding blocks. As described in Section 4.1.1.2, those blocks determined to be nonradioactive will be disposed of as solid waste at a landfill in Livermore, California.

4.1.2 Findings and Observations

4.1.2.1 Category I

None

4.1.2.2 Category II

1. Release of potentially hazardous waste to the sanitary sewer. Uncontrolled releases of potentially hazardous waste (waste oils, solvents, etc.) from the Building 76 Motor Pool sump may be resulting in contamination of the sanitary sewer system. Discharge of hazardous waste to the sanitary sewer constitutes improper disposal of hazardous waste.

The Motor Pool at Building 76 is used to perform light maintenance on motor vehicles assigned to the LBL. The westernmost bay of the Motor Pool has a floor sump that collects material spilled to the floor. This sump was examined during the Survey and found to contain approximately 5 to 10 gallons of unknown materials having a dark appearance. A distinct odor of solvents was noted. Materials used in the bay, and therefore potentially present in the sump, include new and waste oils and cleaning solvents. These materials, if discarded, would be considered hazardous wastes. Motor Pool staff indicated that a variety of materials used in the bay have reached the sump in the past.

The LBL EH&S staff indicated that the sump overflows to a drainage trench outside the south side of the Motor Pool. This trench is used to collect wastewater from vehicle washing and steam cleaning and discharges to the sanitary sewer. Material contained in the inside sump would therefore be discharged to the sanitary sewer. Discharge of such materials is not allowed by the LBL's discharge permit.

The LBL has submitted a job request for modifications to the Motor Pool sump system which may correct this situation (LBL, 1987j). This job request was submitted for approval in December 1987.

4.1.2.3 Category III

None

4.1.2.4 Category IV

1. Inadequately characterized releases to the sanitary sewer system. Current monitoring of liquid effluents to the sanitary sewer system is inadequate to evaluate the effectiveness of administrative controls for discharges of hazardous substances.

Current LBL practices and procedures allow for releases to the sanitary sewer of small quantities of hazardous materials and wastes from laboratories and shops. Release of materials to the sanitary sewer, other than as allowed by the LBL's discharge permit, would constitute improper disposal of these materials. As a result of the large number of drains and the wide distribution of materials used at the LBL, discharge of such materials to the sewer is controlled through administrative controls. These controls include staff training, published procedures for waste disposal, and use of signs identifying specific materials that may not be discharged to drains.

Monitoring is a means to determine the effectiveness of controls on such discharges by identifying the presence of materials improperly released to the sewer. At present, effluent monitoring is limited to gross parameters (e.g., pH) and some heavy metals; it does not include organics or other materials that may be of concern.

2. Potential releases of hazardous wastes. Conditions at hazardous waste satellite accumulation areas (i.e., in the open, uncovered, and lacking secondary containment) could result in the release of hazardous wastes to the soil or surface water.

Satellite accumulation areas are used at the LBL to accumulate hazardous wastes at the point of generation prior to transfer to the hazardous waste storage facilities. During the Survey, 21 such areas were observed that are located outside and used for accumulation of wastes in drums. All these areas lacked secondary spill containment, most areas were uncovered, many were unprotected from traffic, and some are located very near storm sewer inlets. In addition, at some of these areas, drum management practices do not meet RCRA and California requirements, increasing the potential for releases. For

example, outside the Building 25 plating shop, copper plating wastes are stored next to drums of sodium hydroxide and sulfuric acid, which are incompatible materials. At Building 6A, an open-head drum of waste oil is stored outside without a cover. Formal inspections of accumulation areas occur on a quarterly basis rather than a weekly basis, as required by California hazardous waste regulations.

Material released from drums of hazardous wastes could be released to the soil and/or the storm sewer, depending on the location of the storage area. These releases could result in contamination of the soil, Blackberry Creek, and/or Strawberry Creek with hazardous wastes.

3. Improper segregation of hazardous waste. Current waste segregation practices for solid and hazardous wastes may result in improper handling and disposal.

Segregation of hazardous and solid wastes at the LBL is the responsibility of the waste generator. Proper segregation is accomplished through administrative controls, typically in the form of training and procedures. There is no formalized means of determining if proper segregation is occurring, i.e., inspections and inventory controls. Inadequate segregation presents the opportunity for hazardous wastes to be improperly disposed of. Such disposal is of concern with respect to RCRA compliance, and could result in environmental impacts. In addition, inadequate segregation could result in safety concerns related to waste handling.

In the past, hazardous materials at the LBL have been improperly segregated from discarded materials sent for reclamation and salvage. A 1981 LBL safety bulletin discusses incidents of improper disposal of hazardous materials with salvageable wastes (LBL, 1981). A similar bulletin was issued in October 1987, after hazardous reactive metals were disposed of to the salvage yard (LBL, 1987c). During the Survey, several containers of waste oil, a hazardous waste, were observed at the salvage yard. While there was evidence of improper segregation and handling of hazardous materials on-site, observations made during the Survey do not indicate that hazardous materials are being improperly sent off-site from the LBL.

4.2 Toxic and Chemical Materials

4.2.1 General Description of Pollution Sources and Controls

Bulk chemicals, polychlorinated biphenyls (PCBs), asbestos, and pesticides are in use at the Lawrence Berkeley Laboratory (LBL). This section describes the procurement and inventory control procedures used by the LBL, along with the current storage practices and conditions of the equipment/containers associated with these materials.

4.2.1.1 Toxic Materials and Bulk Chemical Management

The overall policy for toxic materials and bulk chemical management is established by the Environmental Health and Safety (EH&S) Department and is administered by the building supervisors. The following describes LBL's procedures for procurement and inventory control of bulk chemicals.

Procurement

Development of procurement procedures for hazardous materials is the responsibility of the Toxic Substances Subcommittee of the Laboratory Safety Review Committee. These procedures are presented in the LBL Procurement Guide manual (LBL personnel, 1988). It is LBL policy that every work area, with the exception of individual research laboratories, must have readily accessible to the employees a Material Safety Data Sheet (MSDS) for every hazardous material used in the area. Individual research laboratories within the LBL are required to maintain only those MSDSs received with incoming shipments, and are not required to obtain an MSDS for every hazardous material found in each laboratory. If an MSDS is not received at the time of shipment, a copy may be obtained from the MSDS master file maintained by the Industrial Hygiene (IH) group. If the MSDS is not on file, the IH group will contact the manufacturer and obtain one.

Bulk oils and solvents can be requisitioned directly from stock at Supply Services (Building 69), and laboratory reagent chemicals from Central Stores (Building 7). Alternatively, chemicals may be ordered directly through the site Purchasing Department. Purchase orders must be screened by EH&S for restricted materials before ordering. This screening process allows EH&S to require additional safeguards, if needed, before the material is delivered.

Inventory Control

Inventory records at the LBL are kept by the Purchasing Department and the building managers. Bulk and laboratory chemicals ordered through Purchasing arrive at the Emeryville Warehouse (LBL Central Receiving) where the receipt records are filed by date. Building managers also file, by date, records of the bulk chemicals they requisition. Examples of the types of bulk chemicals used at the LBL are presented in Table 4-4. Currently, however, there is no site-wide listing of annual chemical usage. EH&S is working on a program that will track all chemical purchases by building so that inventory data can be readily accessed.

As an additional control, EH&S indicated that a waste minimization plan will be instituted. The plan is to include:

- A recommendation that researchers and buyers limit quantities purchased to fit actual needs;
- The establishment of an on-site facility to provide an avenue for recycling excess but usable chemicals within the LBL; and
- The use of commercial recyclers.

4.2.1.2 Toxics and Bulk Chemical Storage

Bulk chemicals are stored throughout the LBL in drums--at ground level or on dispensing racks--and in aboveground and underground tanks. Table 4-5 lists the drum bulk chemical storage areas that were reviewed. The storage location, chemicals stored, and observations are presented. Also, Tables 4-6 and 4-7 list information and observations on the aboveground and underground tanks, respectively. The locations of these tanks and the bulk chemical storage areas are shown in Figure 4-2. As indicated in these tables, there are many drum storage and dispensing areas on the LBL that do not have berms to contain accidental spills or releases. In addition, some of these drums are located near storm drains and some are not protected from weathering. Two of the three aboveground storage tanks (ASTs) are located indoors but have no measures to prevent leaks from entering a

TABLE 4-4

ANNUAL QUANTITY OF BULK CHEMICALS USED AT THE LBL

Chemical	Annual Usage
Diesel Fuel, Type D2	22,661 gallons
Hydrochloric Acid	1,474 pounds
Isopropyl Alcohol	495 gallons
Kerosene	550 gallons
Methyl Ethyl Ketone	220 gallons
Motor Oil	330 gallons
Nitric Acid	2,800 pounds
Propane	2,342 gallons
Sodium Hydroxide, Flakes	2,700 pounds
Sodium Hydroxide, Liquid	385 gallons
Solvent, Freon	660 gallons
Solvent, Stoddard	220 gallons
Sulfuric Acid	2,400 pounds
Vacuum Pump Oil	550 gallons
1,1,1-Trichloroethane	1,815 gallons

Source: LBL, 1987e

TABLE 4-5

BULK CHEMICAL STORAGE AREAS AT THE LBL

Area	Chemicals Stored	Observations
Building 25	Caustic Soda Sulfuric Acid Surfactants Phosphoric Acid	Caustic soda is stored next to sulfuric acid; the area is unbermed and unprotected. Five 10-gallon containers are stored outside the printed circuit board effluent treatment unit in an unbermed and unprotected area.
Building 4A	Cooling Tower Water Treatment Chemicals	Materials are stored in an unbermed room. The area immediately outside the room is sloped downhill.
Building 77	Acids Acids Solvents Custodial Supplies Shop Cleaning Solutions	Acids are stored in an undiked metal shed on shelves that do not have sturdy barriers to prevent chemicals from falling off. Tygon tubing is used as a barrier. Chemicals are stored adjacent to the metal shed in an unbermed and unprotected area. The chemical storage drum rack outside room 123 in area E20/E21 is unprotected. The rack has drip pans but the drums are not protected with a guardrail.
Building 77D	Machine Oil Kerosene Solvents	The area is totally protected and the drum rack is equipped with drip pans, guardrails, and a sump to collect spillage. The area is well maintained.
Building 69	Solvents Cyclotron Oil Mineral Oil	There are guardrails on all the storage shelves and the floor is sloped to a 200-gallon sump. The area is well maintained.
Building 76	Solvents Motor Oils	The drum rack is equipped with drip pans and guard rails. The floor is sloped to a 250-gallon sump. The area is well maintained, although the rack is exposed to rain.
Building 64	Oils Solvents	The drum rack does not have guardrails and a drip pan is missing.
Building 51	Oils Solvents	The drum rack does not have guardrails or drip pans.
Building 71 (East)	Solvents Sulfuric Acid Caustic Soda Water Treatment Cooling Tower Chemicals	One 55-gallon drum of 1,1,1-trichloroethane and one 55-gallon drum of isopropanol are stored in an unbermed and unprotected area near a storm drain. Chemicals are stored in an unbermed area.

TABLE 4-5

BULK CHEMICAL STORAGE AREAS AT THE LBL (Continued)

Area	Chemicals Stored	Observations
Building 62	Acetone	One 55-gallon drum of acetone is stored without secondary containment near a storm drain.
Building 53	Solvents	There is no containment for the drum dispensing units. The drip pans are cluttered.
Building 58	Kerosene Solvents Oils	The drum dispensing units are not contained and are not equipped with drip pans. One 55-gallon drum of acetone is stored without secondary containment near a storm drain.

Source: Survey team observations

PRELIMINARY

TABLE 4-6
ABOVEGROUND BULK CHEMICAL STORAGE TANKS AT THE LBL

Tank Number	Location (Building #)	Construction Material	Use	Observations
TK-03-68	68 (Pump house)	Steel	Diesel fuel for emergency water pump	Unit indoors; no secondary containment; leakage could spill into floor drain
Unknown	83	Steel	Diesel fuel for emergency generator	Unit indoors; no secondary containment
Unknown	51	Steel	Supplemental diesel fuel "day" tank, fueled from underground tank TK-35-51	No secondary containment; located over a storm drain
TK-3-82	82 (Pump house)	Steel	Diesel fuel for emergency water pump	Unit indoors, no secondary containment; leakage could spill into floor drain

Source: Survey team observations

TABLE 4-7

UNDERGROUND BULK CHEMICAL STORAGE TANKS AT THE LBL

Tank Number	Year	Capacity (gallon)	Material Stored	Construction Material	Comments
TK-35-51	1968	550	Diesel	Steel	Stores fuel for emergency generator; passed leak test; to be replaced with double-walled fiberglass tank
TK-01-55	--	1,000	Diesel	Fiberglass-lined steel	None
TK-10-70	1953	600	Diesel	Carbon steel	Stores fuel for emergency generator; passed leak test; to be replaced with double-walled fiberglass tank
TK-10-70A	1975	1,000	Diesel	Fiberglass (single wall)	Stores fuel for emergency generator; passed leak test; to be replaced with double-walled fiberglass tank
TK-11-74	1979	12,000	Diesel	Fiberglass (single wall)	Stores fuel for emergency generator; failed leak test; leak repaired; to be replaced with double-walled fiberglass tank
TK-20-76	1979	10,000	Unleaded gasoline	Fiberglass (single wall)	Fuel for LBL fleet vehicles; passed leak test; to be replaced with double-walled fiberglass tank
TK-03-76	1964	10,000	Diesel	Fiberglass	Fuel for LBL fleet vehicles; passed leak test; to be replaced with double-walled fiberglass tank

Source: LBL, 1986a; LBL, 1987l

AST, UST, AND BULK CHEMICAL STORAGE AREAS
THAT ARE CURRENTLY IN USE

FIGURE 4-2

floor drain. The fourth AST is located outside Building 51 with no containment structure and is situated over a storm drain.

A program to correct the drum dispensing rack deficiencies is in the planning stages, according to LBL personnel. The LBL Engineering Department designed and built a rack that is sheltered and incorporates drum braces, guardrails, drip trays, and a spill catch sump. According to LBL personnel, all new site drum dispensing racks will be built to these specifications and existing racks will either be modified to meet the new design or replaced with new racks.

In addition to bulk storage of liquids, metallic lead materials are stored at two outdoor locations: in Section B-5 of the Bevalac Complex (Building 51-B) and in the yard of the Emeryville Warehouse facility. The LBL does not have an inventory of the locations of the storage areas for shielding materials which may contain lead.

4.2.1.3 Polychlorinated Biphenyls

The LBL PCB Inventory Report of December 15, 1987, lists 130 transformers that were tested for PCBs. Currently, there are 11 on-site transformers which contain 500 parts per million (ppm) or greater PCBs, and 16 transformers which contain 50-500 ppm PCBs. PCBs less than 50 ppm are not regulated by the Toxic Substances Control Act (TSCA) but the State of California regulates PCBs down to 5 ppm. Table 4-8 lists the location, dielectric oil quantity, and PCB content of the PCB (>500 ppm) and PCB-contaminated (>50, <500 ppm) transformers. Also included in the table are observations and comments including proposed action and projected completion date information obtained from the LBL transformer replacement/retrofit program dated October 12, 1987 (LBL, 1987g). The locations of the PCB and PCB-contaminated transformers are shown in Figure 4-3. Table 4-9 lists information on several non-PCB (<50 ppm) transformers which were reviewed, and additional information is presented in the Surface Water Section (3.3.2). Several of the PCB and non-PCB transformers were on unbermed pads and rainwater drain valves were opened at two transformer pads which have PCB-contaminated units.

Inspection of transformers is the responsibility of EH&S and the electrical group of the Construction and Maintenance (C&M) Department. The PCB transformers are

TABLE 4-8

PCB AND PCB-CONTAMINATED TRANSFORMERS AT THE LBL

Location	Quantity (gallon)	PCB (ppm)	Observations and Comments
Building 6	52	1,384	Area fenced and diked; transformer and access door have a PCB label; transformer scheduled for removal with light source project FY88/89
Building 46	245	30,112	Area diked but not fenced; unit has a PCB label but access to area not labeled; transformer scheduled for removal in 1989
Building 50B	165	600,000	Indoor unit, PCB label on outer and inner access doors; area fenced but not diked; sanitary sewer drain in floor adjacent to transformer; unit scheduled for removal in 1988
Building 51	225	950,000	Four indoor units, all scheduled for removal in 1988
	225	950,000	
	225	950,000	
	225	950,000	
Bank 112	550	5563	Blackberry Canyon, area not bermed, PCB label on each unit, both transformers scheduled for retrofit in 1988
Bank 113	550	7526	
Building 88			Area fenced and diked; PCB label on each unit; transformer 198 scheduled for removal in 1988; transformer GE20 scheduled for retrofit in 1989
GE20	250	615	
Bank 198	665	1098	
Building 6			All six units will be removed with the light source project of FY 88/89
Bank 1	156	91	
Bank 1	156	104	
Bank 1	156	130	
Bank 2	312	92	
Bank 3	369	193	
Bank 7	50	71	
Building 16			Area fenced and diked; drain valve in dike opened; break in the dike; cable conduit within the dike area; units scheduled for retrofit in 1988
Bank 15C	52	174	
Bank 10	1130	63	
Bank 16	540	76	Area fenced and diked; drain valve in dike opened; oil stain at base of all these transformers; no evidence of a stain at the drain pipe; units scheduled for retrofit in 1989
Bank 16	540	57	
Bank 16	540	91	

TABLE 4-8

PCB AND PCB-CONTAMINATED TRANSFORMERS AT THE LBL (Continued)

Location	Quantity (gallon)	PCB (ppm)	Observations and Comments
Building 62	485	71	Scheduled for retrofill in 1988
Building 70A	240	103	Scheduled for retrofill in 1990
Building 71	420	383	Area fenced and bermed; oil-stained soil beneath sump drain valve, but no evidence of oil beneath transformer; unit scheduled for retrofill in 1988
Building 88			Area fenced and bermed; units scheduled for retrofill in 1989
GE10	1140	59	
GE60	536	219	

Source: LBL, 1987g

PCB AND PCB-CONTAMINATED TRANSFORMERS

FIGURE 4-3

TABLE 4-9
NON-PCB TRANSFORMERS AT THE LBL

Location	Quantity (gallon)	PCB (ppm)	Comments
Building 7 Bank 8	196 196 196	7 11 16	Cooling tower area- transformer pad not bermed
Building 25 Bank 14	244	0	Transformer pad not bermed
Building 50 Bank 25	265	22	Transformer pad not bermed
Building 71 TC 117	460	0	Transformer pad not bermed

Source: Survey team observations

Note: These units are not regulated by TSCA since they contain less than 50 ppm PCBs. However, California regulates PCBs at a concentration greater than or equal to 5 ppm.

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inspected quarterly by EH&S and all observations and/or actions taken are recorded in a PCB information logbook. In addition, the electrical group of C&M is responsible for performing routine maintenance and inspection of all the LBL transformers and is responsible for cleanup of any leaks or spills.

PCBs are stored prior to disposal in a fenced and secured area in the yard of Radioisotope Services (Building 75). The storage unit is a metal shed which has a diked area consisting of two 8-foot-wide by 9-foot-long by 6-inch-high sections. The storage unit is properly labeled and the PCB containers are inspected daily for leaks. There was no evidence of past releases.

PCB wastes are placed into 55-gallon drums and the accumulation start date of each drum is kept in a logbook and stenciled on the drum. When a pickup is scheduled, labels with accumulation start dates are placed on the drums. All PCB liquids, contaminated solids, capacitors, and transformer carcasses are sent to sites approved by the U.S. Environmental Protection Agency (EPA) for incineration.

4.2.1.4 Asbestos

There has not been a comprehensive analysis for asbestos performed on LBL buildings although the lagging in the boiler rooms and around water pipes in almost all buildings is assumed to contain asbestos. Site maintenance employees assigned to daily equipment inspections have been instructed by EH&S to inspect covered piping and report any breaks. Only very minor repairs are conducted by the LBL and work orders issued by EH&S to maintenance personnel include written instructions which require that asbestos materials be wet thoroughly and double bagged. Any major repairs or removals are handled by off-site contractors with EH&S supervision. Site work orders to contractors specify that all work be performed according to EPA, Occupational Safety and Health Administration (OSHA), State of California, and Bay Area Air Quality Management District (BAAQMD) regulations. The contractor is responsible for removal and packaging, while the LBL is responsible for notification to the BAAQMD and for storage and disposal. Asbestos is stored prior to disposal in a fenced and secured area in the yard of Building 75. During 1986 and 1987, approximately 2,600 pounds of asbestos-containing materials were removed from the LBL and disposed of in EPA-approved sanitary landfills.

4.2.1.5 Pesticides

Pesticides used at the LBL are applied by both a State of California certified off-site contractor and a site employee. The Alameda County Health Services Department does not require certification to apply the types of pesticides currently stored on-site, according to the information received from the LBL. Based on interviews with LBL personnel, the types of pesticides used at the LBL have not changed significantly over the past several years although historical records were not available for review.

The site-applied pesticides are stored in a fenced and secured area adjacent to Building 46. Storage is in a wooden shed which is locked and posted with a warning sign -- Danger Insecticide Storage. Table 4-10 presents the pesticide inventory for 1987.

4.2.2 Findings and Observations

4.2.2.1 Category I

None

4.2.2.2 Category II

None

4.2.2.3 Category III

None

4.2.2.4 Category IV

1. Inadequate secondary containment for PCB and PCB-contaminated transformers. The lack of secondary containment for PCB transformers in the Physics and Computer Center (Building 50B) and at the Bevatron (Building 51) - Blackberry Canyon Transformer pad may result in potential contamination of the sanitary sewer system and the environment. In addition, inadequate

TABLE 4-10
1987 PESTICIDE INVENTORY AT THE LBL

Applicator	Pesticide Trade Name	Amount Used	Amount Stored	EPA Number	Purpose
Contractor	Diazinon AG-500	2 quarts	N/A	655-459	Insects/outdoors
	Ficam W	8 ounces	N/A	40546-1-AA	Insects/indoors
	Maki Meal	12 ounces	N/A	7173-186	Mice/rats
	Surflan	3 gallons	N/A	1471-113	Herbicide
	Princep Caliber	0	N/A	100-603	
	Roundup	1.5 gallons	N/A	324-308-AA	Herbicide
	Dursban 2E	1 quart	N/A	464-586	Cockroaches
	Orthene	2 lb	N/A	239-2418-AA	Insects
	Sevin SL	2 gallons	N/A	264-335	Oak Moth
LBL	Magnesium Chloride	1,200 lb	2,400 lb	-	Herbicide
	Brush B	0	0.5 pint	-	Brush
	Dowpon M	0	14 lb	-	Grass
	Diazinon AG-500	0	3 gallons	655-459	Insects/outdoors
	Amintril T	0	1 quart	-	Poison Oak
	Roundup	7 gallons	11.5 gallons	324-308-AA	Herbicide
	Surflan	2.5 gallons	2.75 gallons	1471-113	Herbicide
	No Foam A	0	4.5 gallons	-	Additive
	Mayes 20	0	15 gallons	-	Weed Killer

Source: LBL, 1987h

secondary containment of PCB-contaminated transformers exists at many outdoor transformer pads, which may result in environmental contamination in the event of a leak or spill.

The transformer in Building 50B contains 165 gallons of PCB transformer oil at 600,000 ppm PCBs. The transformer has no secondary containment and is located near a floor drain that discharges to the sanitary sewer system. The two transformers at the Building 51 location contain 550 gallons of transformer oil at 5,563 ppm and 7,526 ppm PCBs, respectively. The transformers have no secondary containment and if they were to leak, contamination of the soil and ultimately Blackberry Creek could occur. The LBL has indicated that, in the plans for 1988, the Building 51 transformers are to be retrofilled and the transformer pad bermed, while the Building 50B transformer is scheduled for replacement.

At other outdoor transformer locations, the secondary containment for the Heavy Ion Linear Accelerator (Building 71) and the Magnetic Fusion Energy Laboratory (Building 16) transformer pads are provided with valves to drain rainwater. The valves have no locking mechanism to ensure that they are not accidentally opened. In addition, there is a crack in the berm of the Building 16 pad and a cable conduit within the bermed area that can provide a pathway to the environment should a leak occur. The LBL has indicated that the transformers which contain PCB-contaminated oil -- Building 71, 420 gallons at 383 ppm; Building 16, 540 gallons at 76 ppm, 540 gallons at 57 ppm, 540 gallons at 91 ppm, and 1,130 gallons at 63 ppm -- will be retrofilled in 1988-1989.

2. Inadequate secondary containment of bulk chemicals in drum racks, at ground level adjacent to buildings, and in aboveground tanks. The potential for soil and surface-water contamination exists from the uncontrolled release of bulk chemicals from improperly contained storage areas.

Bulk chemicals are stored throughout the LBL on drum racks, some of which (7 out of 10 visited), were not covered or equipped to handle spillage (refer to Table 4-5). A drum storage rack has been designed and built that is protected and incorporates drum braces, guardrails, drip trays, and a spill catch sump.

According to LBL personnel, all new site drum storage racks will be built to these specifications and existing racks will either be modified to meet the new design or replaced with a new rack.

Eight areas were found where chemicals were stored at ground level without secondary containment (refer to Table 4-5). Also, the four ASTs reviewed did not have secondary containment. Two of these units, Pump House B-68 and Pump House B-82, were located in an area adjacent to a floor drain (refer to Table 4-6). One was located over a storm drain. The LBL Spill Prevention Control and Countermeasure Plan does not adequately discuss appropriate containment measures for spills of hazardous materials (see related finding 3 in Surface Water, Section 3.3.4.4).

3. Potential for soil and groundwater contamination from the storage of lead materials. Metallic lead materials are being stored at two locations:

- In Section B-5 of the External Particle Beam (EPB) Hall (Building 51-B), lead shielding materials are stored outdoors in an unprotected area.
- Lead materials are stored in an unpaved and unprotected area of the Emeryville Warehouse yard.

Weathering effects may eventually cause lead to be oxidized and leached from these materials and contaminate soil, creek sediments, and groundwater. Exposed lead can be readily oxidized to form lead oxide which is soluble in water. Other lead compounds may also be formed and be released to the environment through erosion or agitation of the materials.

Based on a limited soil sampling and analysis effort conducted in 1986 (see Soils, Section 3.2), lead concentrations appear to be slightly higher than background levels at a few locations on the LBL. The scope of this study included such a small number of samples that a detailed evaluation of the potential for lead contamination to exist at the LBL cannot be performed.

4.3 Radiation

4.3.1 Background Environmental Information

This section discusses the actual or potential impacts to the environment that are multi-media in nature (i.e., air, soils, surface water, and hydrogeology). Radionuclides can be transported via any or all of the primary media and result in contamination of ambient air, soils, drinking water, groundwater, vegetation, and food. Figure 4-4 depicts some of these transport/exposure scenarios (MEPAS, 1987).

Background radiation in the vicinity of the Lawrence Berkeley Laboratory (LBL) is a consequence of both natural and man-made sources. These sources include natural cosmic radiation; natural radioactive materials in soils and building materials; fallout from past atmospheric weapons detonations; releases of radioactive materials from nuclear power plants and other facilities handling radioactive materials worldwide; and the intake of natural and man-made radioactive materials in air, drinking water, and food. The most significant exposure is that to the lungs from background levels of radon. The annual average effective dose equivalent (EDE) from natural background radiation in the United States is approximately 189 millirem/year (mrem/yr) (EPA, 1986a). This dose is detailed in Table 4-11. About one-half of the EDE is attributable to the inhalation of naturally occurring radon-222 and its decay products. Previously accepted estimates of the background radiation dose did not include the radon contribution and were set at about 100 mrem/yr EDE.

The data in Table 4-11 were derived in accordance with the approach recommended by the International Commission on Radiological Protection (ICRP) in ICRP Reports 26 and 30. This approach allows direct comparison of the effective dose for different organs by reflecting the distribution of and organ sensitivity to various radionuclides. This is accomplished by applying "weighting factors" to the effective doses received by individual organs. The weighting factors are expressed as the fraction of the total risk for the entire body attributable to the organ. The sum of the resulting dose equivalents (DEs) for the individual organs provides an estimate of the total effect of the radiation on the whole body.

TRANSPORT/EXPOSURE SCENARIOS

FIGURE 4-4

TABLE 4-11**AVERAGE ANNUAL EFFECTIVE DOSE EQUIVALENT TO HUMANS FROM
NATURAL BACKGROUND RADIATION**

Organ	Annual Effective Dose Equivalent (mrem)
Gonads	24
Breast	14
Lung (Total)	100
Red Bone Marrow	13
Bone Surfaces	6
Thyroid	3
Other	29
Total	189

Source: Adapted from EPA, 1986a

The U.S. Environmental Protection Agency (EPA) reports on a quarterly basis ambient gamma exposure rates, including those from natural cosmic radiation, for selected locations throughout the continental United States. These ambient gamma exposure rates do not measure the contribution attributable to the inhalation of naturally occurring radon-222 and its decay products. The latest available data are for the 12-month period from April 1986 to March 1987. For this period, the EPA reported ambient gamma exposure rates equivalent to annual doses of between 136 ± 82 mrem DE in Denver, Colorado, and 58 ± 43 mrem DE in Berkeley, California. The average measured ambient gamma exposure rate equivalent to an annual dose at the 22 locations monitored was 89 ± 45 mrem DE (EPA, 1986b; 1987a, b, c).

The U.S. Department of Energy (DOE) establishes radiation protection guidelines for its facilities. Radiation standards for the protection of the public in the vicinity of the LBL are given in DOE Order 5480.1A, Chapter XI, as amended on August 5, 1985 (Vaughan, 1985). These standards are based on the recommendations of the ICRP and the National Council on Radiation Protection and Measurements (NCRP). The amended order also included the EPA limits for the atmospheric pathway radiation dose received from DOE facilities as contained in 40 CFR 61, Subpart H. The DOE dose limit is 100 mrem/yr EDE, excluding natural background and medical exposures, for all pathways to any member of the general public for a prolonged exposure from normal DOE operations. The previously recommended limit of 500 mrem/yr EDE is retained for non-continuous exposures. In addition, as stated in EPA regulations (40 CFR 61, Subpart H), any member of the general public shall not receive a radiation dose from the air pathway of greater than 25 mrem/yr DE to the whole body or 75 mrem/yr DE to any organ from normal DOE operations.

DOE Order 5484.1 requires its facilities to make an annual assessment of releases and potential dose to the public. The results are to be reported in an annual environmental summary or annual environmental monitoring report.

4.3.2 General Description of Pollution Sources and Controls

Direct penetrating radiation sources and controls and radioactive contamination in buildings are discussed in this section. The radioactive sources and controls for air,

soil, surface water, and groundwater are discussed in Sections 3.1.2, 3.2.2, 3.3.2, and 3.4.2, respectively.

The major sources of direct penetrating radiation at the LBL can be divided into two categories. These categories are operation of the accelerators and use of the large gamma irradiators. Radioactive contamination in buildings will also be discussed in Section 4.3.2.3.

4.3.2.1 Operation of the Accelerators

There are four large accelerators and several small accelerators at the LBL. The large accelerators are the Bevatron, Heavy Ion Linear Accelerator (SuperHILAC), 88-Inch Cyclotron, and 184-Inch Synchrocyclotron. Figure 4-5 shows the location of the four large accelerators. The large accelerators are used for research, radioactive isotope production, and radiotherapy. The small accelerators are used to test accelerator component theory and design. These accelerators are operated at low energy and intensity, and their size is a fraction of the size of the large accelerators. Since the small accelerators are operated at low energies and intensities, they do not produce direct penetrating radiation outside the shielding or buildings in which they are located. Therefore, they are not a source of off-site direct penetrating radiation and are not discussed further.

The Bevatron is the most massive of LBL's accelerators and was originally designed as a 6-giga electron volt (GeV) proton synchrotron. It is presently capable of accelerating ions with atomic numbers up to calcium-40 from 20 million electron volts per nucleon (MeV/nucleon) to 2.1 GeV/nucleon, and ions with atomic numbers up to uranium to 1 GeV/nucleon, when using the SuperHILAC as an injector. The combination of using the SuperHILAC as an injector for ions into the Bevatron is called the Bevalac. The SuperHILAC is a multiprogrammable heavy-ion accelerator that produces ion beams up to 8.5 MeV/nucleon. The 88-Inch Cyclotron produces intense beams of protons to 60 MeV, alpha particles to 140 MeV, and heavy ions with atomic numbers up to calcium-40 to energies of 350 MeV. The 184-Inch Synchrocyclotron was used to provide alpha particle beams with energies up to 1 GeV (LBL, 1987a). However, it is currently being decontaminated and decommissioned and will be replaced by a new 1 to 2 GeV Synchrotron Radiation Source (Light Source). The Light Source will consist of an injector system comprising

Source: LBL, 1984s

LOCATIONS OF LARGE
ACCELERATORS AND GAMMA IRRADIATORS AT THE LBL

FIGURE 4-5

a 50-MeV linear accelerator and a booster synchrotron and a low emittance storage ring. This new accelerator and storage ring will produce electromagnetic radiation in the wavelengths from infrared to X-rays, which will be used for materials research.

Operation of the three large accelerators results in direct penetrating radiation outside the shielding that surrounds the accelerators, target areas, and beam dump or absorbing areas. Target areas are the locations where the accelerator beam is collided with a target material to study or change the material or study the particles emitted by the collision. The beam dump (absorbing) areas are the locations where the accelerator beam is safely terminated after use. This is accomplished by dissipating the energy in a mass of material (e.g., concrete, iron, etc.). The two forms of direct penetrating radiation produced by accelerator operation are neutrons and gamma rays.

Controls employed at the LBL for these sources of direct penetrating radiation are primarily shielding, distance from the source, and monitoring. The other generally accepted direct penetrating radiation control method, limiting the time of exposure, is used to control occupational and visitor personnel exposures. Exposure time is limited by administrative controls, posting of radiation areas that exceed 2 milliroentgen per hour (mR/hr) and prohibiting access in accelerators during operation with interlocked key capture control systems.

Other environmental radiation concerns associated with accelerator operation are the radioactivation of air, soil, accelerator component cooling water and groundwater by interaction of the beam or spray of secondary particles resulting from beam contact with accelerator components and these media. See Sections 3.1.2, 3.2.2, 3.3.2, and 3.4.2, respectively, for a more detailed discussion.

4.3.2.2 Use of Large Gamma Irradiators

There are several multi-curie gamma irradiators in use at the LBL. For a more detailed discussion of these gamma irradiators, see Section 4.3.3.1. Only two are close enough to the site perimeter to require monitoring. They are located in the instrument calibration facility south of the Radioisotope Services (Building 75) and in the Biomedical Laboratory (Building 74). Figure 4-5 shows the location of these

gamma irradiators. Shielding, distance from the source, monitoring, and limiting the time of exposure are the controls employed for these sources of direct penetrating radiation.

4.3.2.3 Radioactive Contamination in Buildings

There are a total of 20 LBL utilized buildings that may contain accelerator-induced radioactivity in materials and/or that have known fixed contamination. Table 4-12 shows that there are 13 buildings that may contain accelerator-induced radioactivity in materials and 13 buildings that have known small, localized areas of fixed contamination. The radioactivity is either part of the material itself or is non-removable (fixed) from the material. These buildings do not contribute to off-site direct penetrating radiation levels. Controls employed at the LBL for the radioactive contamination in buildings include administrative, shielding, distance from the source, monitoring, and limiting the time of exposure.

Due to the decontamination and decommissioning activities at the 184-Inch Synchrocyclotron, the LBL will be sending materials to the Los Alamos National Laboratory and releasing materials to the general public via burial in a public landfill at Livermore, California. This material has the potential for containing accelerator-induced radioactivity. The LBL has designed and documented a program for the screening and release of these materials. The program's release criteria and the techniques used to determine that these criteria are met have been reviewed by the San Francisco Operations Office (SAN) and the State of California. Both have approved the program in principle (Davis, 1987). The screening and release program determines if a material is radioactive or nonradioactive. Radioactive materials will be sent to the Los Alamos National Laboratory for use in an accelerator there and nonradioactive materials will be sent for burial in a public landfill at Livermore, California. For a more detailed discussion of the release criteria, see Waste Management Section 4.1.1.2. Administrative controls and procedures have prevented the release of induced radioactive material from the LBL to the general public in the past.

TABLE 4-12

**LBL BUILDINGS THAT MAY CONTAIN ACCELERATOR-INDUCED
RADIOACTIVITY IN MATERIALS AND/OR KNOWN FIXED
CONTAMINATION**

Building Number	Description	Code
1	Donner Laboratory	2
3	Melvin Calvin Laboratory	2
5	Magnetic Fusion Energy	1,2
6	184-Inch Synchrocyclotron	1,2
7	Central Stores & Electronics Shops	2
50	Physics, Accelerator & Fusion Division	2
51	Bevatron	1
53	Accelerator Development	1
55	Research Medicine	2
63	Accelerator Division	1
64	Accelerator Division	1
70	Nuclear Science and Applied Science	1,2
70A	Nuclear Science, Materials, Molecular Research & Earth Science	1,2
71	Heavy Ion Linear Accelerator (SuperHILAC)	1,2
74	Biomedical Laboratory	2
75	Radioisotope Services	1,2
76	Craft & Maintenance Shops	1
88	88-Inch Cyclotron	1
901	1450 64th St., Emeryville, Warehouse	1
934	91 Bolivar Drive, Berkeley, Printing Biomed (Dymo Bldg.)	2

Source: Haley, 1987

Code 1: Accelerator-induced radioactivity possibly present in equipment or structure.

Code 2: Known fixed contamination in building (under tiles, etc.).

Note: All building numbers listed include trailers or small buildings adjacent to the main building.

4.3.3 Environmental Monitoring Program

This section discusses LBL's direct penetrating radiation environmental monitoring program (Section 4.3.3.1) and dose assessments for the general public (Section 4.3.3.2). A comparison of each reported dose assessment of the radiological releases at the LBL will be made with the applicable standards. The environmental monitoring programs for individual media are discussed in the appropriate sections for Air (3.1.2), Soil (3.2.2), Surface Water (3.3.2), and Groundwater (3.4.2).

4.3.3.1 Direct Penetrating Radiation Monitoring Program

To determine the direct penetrating radiation impacts of the operation of LBL accelerators, four monitoring stations are maintained about LBL's perimeter in permanent enclosures. Figure 4-6 shows their locations. Each station contains one neutron and one gamma pulse counter. The neutron detectors are ~500-cubic-centimeter (cm^3) cylindrical boron fluoride (BF_3) gas-proportional counters housed in 2.5-inch-thick cylindrical paraffin moderators. The moderators slow down the neutrons so the BF_3 gas-proportional counters can detect them. The gamma detectors are energy-compensated Geiger-Mueller (GM) chambers. The output pulses from each detector are prescaled and telemetered to Building 75 for continuous recording. Each LBL accelerator building contains a smaller moderated BF_3 neutron detector, whose output pulses are also prescaled and telemetered to Building 75. By comparing the accelerator's neutron monitor output with the output of the perimeter-stations' neutron monitors, the perimeter dose equivalent can be assigned to the accelerator responsible for it. Operational checks of the system are performed daily, and detectors are calibrated semiannually.

Table 4-13 lists the accelerator-produced fencepost EDEs measured at each environmental monitoring station during 1986. The 1986 Annual Environmental Monitoring Report (LBL, 1987a) states that the fencepost neutron EDE and gamma-ray EDE attributable to the operation of the LBL accelerators in 1986 were characterized as follows:

FIGURE 4-6

LOCATIONS OF PERIMETER
AND GAMMA IRRADIATORS MONITORING STATIONS

TABLE 4-13

**FENCEPOST ANNUAL EFFECTIVE DOSE EQUIVALENTS AT THE
LBL BOUNDARY DUE TO ACCELERATOR OPERATIONS, 1986**

Station	1986 Total Dose Above Background		
	gamma (mrem)	neutron (mrem)	Total (mrem)
Olympus Gate MS (B-13D)	0	3.5 ± 0.6^a	3.5 ± 0.6
Building 90 MS (B-13B)	0	< 0.9	< 0.9
Building 88 MS (B-13A)	0	0.6 ± 0.1	0.6 ± 0.1
Panoramic MS (B-13C)	0	0	0

Source: LBL, 1987a

^a The errors shown are those associated with the actual counts and calibration-source uncertainties. Neutron flux-to-dose equivalent conversion factors are not known to this accuracy.

- 1) The 184-Inch Synchrocyclotron produced no dose-discernible radiation above background, as measured at the Panoramic Environmental Monitoring Station.
- 2) The SuperHILAC and Bevatron each contributed 50 percent to the fencepost dose equivalent measured at the Olympus Gate Environmental Monitoring Station. The 3.5 ± 0.6 mrem EDE was delivered fairly uniformly during the operating year.
- 3) The 88-Inch Cyclotron fencepost dose equivalent measured at the Building 88 Environmental Monitoring Station of 0.6 ± 0.1 mrem EDE is primarily attributable to 16 light-ion (i.e., helium-3, p+, D+, helium-4) runs that occurred at roughly even intervals during 1986.
- 4) The continuous gamma measurements telemetered from the four monitoring stations showed no significant correlation with operation of the LBL accelerators and were thus interpreted as constituting the natural background for 1986.

As previously discussed in Section 4.3.2.2, LBL's Environmental Health and Safety Department (EH&S) operates an instrument calibration facility south of Building 75. A recording GM instrument in the southeast corner of the Biomedical Laboratory Annex (Building 75B) continuously monitors impacts from calibration activities. The instrument recorded a net annual EDE of 58 ± 9 mrem above background for 1986. The sources of radiation are located roughly 10 meters (m) from the instrument, 70 m from the perimeter fence, 270 m from the nearest commercial, 40 hours per week occupancy, the University of California at Berkeley (UCB) Lawrence Hall of Science, and 500 m from the nearest home. The 58 mrem EDE net exposure at Building 75B for 1986 predicts an EDE impact of approximately 1.4 mrem/yr at the perimeter; <0.02 mrem/yr for 40 hr/wk occupancy at the LHS; and <0.03 mrem/yr at the nearest home (LBL, 1987a).

Additionally, the LBL has several multi-curie gamma irradiators used in radiobiological and radiochemical research. The largest of these units is a 160-curie cobalt-60 unit housed in an interlocked and reinforced-concrete-covered labyrinth built as part of LBL's Building 74. This unit is also the irradiator closest to the LBL

perimeter. Studies taken when the irradiator was upgraded and loaded found no area where the stray radiation field exceeded 1 mrem/hr EDE at 1 m from the outside walls or ceiling. This irradiator is approximately 80 m from the LBL perimeter fence, 150 m from the nearest commercial occupancy which is the UCB Botanical Garden building, and more than 700 m from the nearest house. The projected annual EDE to members of the public would be <1.4 mrem/yr at the perimeter fence; <0.1 mrem/yr at the 40-hr/wk occupancy Botanical Garden building; and <0.02 mrem/yr at the nearest house (LBL, 1987a).

A review of the LBL Radiological Monitoring Program (RMP) and supporting documentation, including the Quality Assurance Program (QAP) for the RMP, was conducted. There are written procedures covering various aspects of the RMP. These procedures incorporate task-specific quality control requirements. However, there is no mechanism or documentation in place to ensure that the RMP procedures and quality control requirements are adequate or being followed. Additionally, there is no mechanism or documentation for review of overall program integrity. A finding associated with this observation is discussed in Quality Assurance Section 4.4.2.4, Finding 1. Other aspects of the RMP were observed by Survey team members and are discussed in sections for Air (3.1.3), Soil (3.2.3), Surface Water (3.3.3), and Groundwater (3.4.3).

4.3.3.2 Summary of Exposures

In the 1986 Annual Environmental Monitoring Report, the maximum EDE delivered to a hypothetical member of the community was defined as the maximum perimeter dose. That value for 1986 was 3.5 mrem EDE for penetrating radiation (see Section 4.3.3.1), or 3.5 percent of the DOE dose limit of 100 mrem/yr EDE.

The hypothetical maximum exposure to an individual from airborne radionuclides, using the AIRDOS-EPA and RADRISK computer codes, would be to a person residing just outside the east-southeast LBL perimeter. The 1986 EDE to this hypothetical person was 0.2 mrem, or 0.2 percent of the DOE dose limit. See Section 3.1.2 for a more detailed discussion of airborne radionuclide releases.

There were no radioactive liquid releases reported for 1986. Consequently, no dose assessment was performed for this pathway (LBL, 1987a).

If the same individual were to have received both of these maximum pathway doses, the total exposure for 1986 would be 3.7 mrem or 3.7 percent of the DOE dose limit of 100 mrem/yr EDE for all pathways to any member of the general public for a prolonged exposure from normal DOE operations.

4.3.4 Findings and Observations

4.3.4.1 Category I

None

4.3.4.2 Category II

None

4.3.4.3 Category III

None

4.3.4.4 Category IV

None

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4.4 Quality Assurance

This section reviews the procedures for the collection and analysis of environmental data with emphasis on the program used to ensure the quality of the data produced. Two aspects of quality assurance (QA) are considered: quality control (QC) and quality assessment. QC refers to those actions taken in the laboratory to ensure that the measurement system is in control. Examples would be running reference standards through the system, calibrating the instruments, and running splits, spikes, and surrogates. Quality assessment refers to the system or program whereby management assures itself that the QC measures are being applied.

An adequate QA program should include the following:

- Chain-of-custody
- Good laboratory practices
- Good measurement practices
- Standard operating procedures
- Inspections/audits
- Documentation
- Training.

4.4.1 General Description of Sampling and Data Handling Procedures

Environmental surveillance at the Lawrence Berkeley Laboratory (LBL) is the responsibility of the Environmental Health and Safety (EH&S) Department and the Industrial Hygiene (IH) group. The surveillance program consists of radiological, sewer outfall, and process wastewater sampling and analysis. Data from this program are incorporated in the site annual monitoring report (LBL personnel, 1988).

EH&S is responsible for the collection and analysis of radiological monitoring samples covering air, rainwater, surface water, sewer, and groundwater media. In addition, EH&S conducts continuous radiation monitoring (LBL personnel, 1988). A review of the site Radiological Monitoring Program (RMP) and supporting documentation was conducted by the Survey radiation specialist and observations are discussed in Section 4.3.3. There is no mechanism or documentation in place to

ensure that the procedures and QC requirements of the RMP Quality Assurance Plan (QAP) are adequate or are being followed.

EH&S and the IH group are jointly responsible for the collection and analysis of nonradiological monitoring samples. Although EH&S collects the samples, it does so under the guidance of the IH group, which provides written formal sampling procedures. The procedures cover the sampling of the site sanitary sewer systems and the wastewater treatment units. These procedures were reviewed and found to contain extensive and clear directions on safety precautions, preservation requirements, labeling, and chain-of-custody requirements. The collected samples are relinquished by EH&S to the IH group, which transports them, with chain-of-custody, to a contract laboratory. The IH group is responsible for all contact with the contract laboratory and retains copies of the chain-of-custody records and monitors all the analytical results to ensure that the contract laboratory meets the specified QA requirements. However, there are no formal written procedures specifying what steps management must take to ensure that the sampling and the contract laboratory QC requirements are carried out.

Sewer samples are collected at both the LBL systems (i.e., Strawberry and Hearst). Each week effluent from each sewer system is collected at its respective discharge site from the LBL into the East Bay Municipal Utility District (EBMUD) System. Equal amounts of each sample, collected during four successive 1-week periods are combined and sent to a contract laboratory for analysis. Samples are analyzed for cadmium, chromium, copper, iron, lead, nickel, silver, zinc, and oil and grease (LBL personnel, 1988). The Survey team surface water specialist observed the EH&S sewer outfall sampling techniques, and observations are presented in Section 3.3.3.

Effluent samples are also collected at the Wastewater Treatment Plants (WWTPs) located at the Mechanical Shops (Building 77), Plating Shop, and the Mechanical Technology (Building 25) Printed Circuit Board Shop. As required by the EBMUD, 24-hour composite samples are collected from the sample spigot at each unit's discharge to the sanitary sewer. Samples must be collected at least once each quarter and are sent to a contract laboratory for analysis. Building 77 samples are required to be analyzed for cyanide, cadmium, chromium, copper, lead, nickel, and zinc, while Building 25 samples are analyzed for chromium, copper, and lead.

EBMUD also samples these units quarterly, and the results are included in the site annual environmental monitoring report.

Med-Tox Associates of Pleasant Hill, California, is the contract laboratory that analyzes the LBL wastewater and sewer samples. Prior to awarding the contract, IH personnel visited Med-Tox to evaluate the analytical facilities and review the QA practices. The laboratory is accredited by the American Industrial Hygiene Association and the California Department of Health Services.

The Med-Tox laboratory has a formal and extensive QA manual (Med-Tox Associates, Inc., 1986). For example, the laboratory's QA requirements include the following:

- U.S. Environmental Protection Agency (EPA), American Society for Materials and Testing (ASTM), and National Institute of Occupational Safety and Health (NIOSH) approved analytical methods are used;
- Standard, blank, replicate, and spike samples are routinely analyzed to evaluate precision and accuracy performance;
- Standard reference materials, EPA or National Bureau of Standards, of known composition are analyzed with each set of samples; and
- Blind samples, prepared by the laboratory director, are submitted without laboratory personnel having knowledge of their origin.

4.4.2 Findings and Observations

4.4.2.1 Category I

None

4.4.2.2 Category II

None

4.4.2.3 Category III

None

4.4.2.4 Category IV

1. Inadequate QAP for environmental monitoring. The QAP is inadequate to ensure that QC requirements for environmental monitoring, as well as sampling and analysis procedures, are adequate or are being followed. This may raise questions as to the validity of analytical results. Since these results are used to determine the impacts on the environment and general public from site operations, these conclusions may also be questioned.

There are written procedures covering various aspects of the RMP. These procedures incorporate task-specific QC requirements. Since the QAP is inadequate, there is no mechanism or documentation in place to ensure that the RMP procedures and QC requirements are adequate or are being followed. Additionally, there is no mechanism or documentation for review of overall program integrity. This could result in questionable radiological monitoring data.

There are written procedures covering the sampling of sewer outfalls and WWTPs for nonradiation parameters. There is also a formal QAP covering the QC requirements for the contract analytical laboratory. However, there are no formal written procedures specifying what steps management should take to ensure that the sampling and the contract laboratory QC requirements are carried out. This could result in questionable data.

4.5 Inactive Waste Sites and Releases

4.5.1 General Description of Pollution Sources and Controls

This section provides an inventory and description of areas on the Lawrence Berkeley Laboratory (LBL) that may be sources of environmental pollution due to past spills or accidental releases. From the review of available background information, there is no indication that land disposal of hazardous or radioactive waste has occurred on the LBL. An overview of past waste disposal practices is presented in this section along with more detailed information on areas where leaks have occurred in the past or where there is a potential for past spillage. Inactive underground storage tanks (USTs) and aboveground storage tanks (ASTs) are also included in this section.

4.5.1.1 Overview of Past Waste Disposal Practices

Operation of the LBL accelerators, radiochemistry laboratories, materials science laboratories, biomedical research laboratories, electronics shops, photographic laboratories, and plating shops since 1939 has resulted in generation of a variety of waste streams. Historically, the types of waste generated by the LBL include the following:

- liquid and solid low-level radioactive waste;
- nonradioactive liquid waste, including corrosives, organic solvents, laboratory reagents, waste oils - some contaminated with polychlorinated biphenyls (PCBs) - and effluent with high concentrations of metals;
- biological wastes; and
- dry and/or solid wastes, including general office and cafeteria trash.

Liquid low-level radioactive waste has been disposed of by one of two methods. Wastewater at concentrations less than the criteria listed below was discharged to

the sanitary sewer (see Sections 3.3 and 4.1 for additional information on current practices).

Radioactivity	Criterion
Alpha Emitters	400 pCi/L
Beta Emitters	3,000 pCi/L

Source: LBL, 1986a

Wastewater with higher levels of activity has been collected and taken to a central staging area where it is concentrated and packaged for shipment off-site. The off-site disposal locations have varied. From the 1940s to 1963, the waste was packaged for sea burial and disposed of at the ocean site known as the Farallon Islands (Jackson and Young, 1986; LBL personnel, 1988). A more detailed discussion of radioactive waste disposal at the Farallon Islands is presented in Appendix G. Later, a disposal site in Nevada was used (LBL, 1986a). Recently, wastes have been transported to the Hanford Site in Richland, Washington, for burial. In addition, in the past, the LBL has used the services of several commercial low-level radioactive waste disposal firms licensed by the U.S. Atomic Energy Commission (AEC) (LBL, 1986a).

Most nonradioactive liquid effluents have been discharged to the sanitary sewer system, which is connected to the East Bay Municipal Utility District (EBMUD) wastewater treatment plant (WWTP) (LBL, 1986a; Jackson and Young, 1986). In some cases, oils were collected separately for recycling, as was mercury. In the early years of laboratory operations, particularly toxic or hazardous wastes were collected and disposed of at the sea burial location in the vicinity of the Farallon Islands, similar to the practices used for radioactive wastes (Jackson and Young, 1986). In the more recent past, hazardous wastes were collected and handled by the Environmental Health and Safety (EH&S) staff of the LBL for disposal at approved off-site facilities (see discussion in Section 4.1). Also, in the early to mid-1980s, the LBL installed pretreatment systems for corrosive wastes generated at the Mechanical Shops (Building 77) and Mechanical Technology (Building 25). Up until this time, the effluent from these operations was discharged without treatment to the sanitary sewer system.

Biological wastes at the LBL include animal carcasses, bedding material, and excreta. Prior to 1966, the carcasses were incinerated at the University of California at Berkeley (UCB). It is unclear when this practice first began (LBL personnel, 1988). Excreta and waste from washing out the animal cages have been directed to a series of holding tanks and if the levels of radiation were acceptable, the effluent was released to the sanitary sewer system. According to LBL personnel, only on one occasion have these holding tanks been found to have unacceptable levels of radioactivity requiring pumping out. In 1973, approximately 1,200 gallons of wastewater containing 5.2 millicuries of mixed fission products were removed from the tanks and disposed of off-site by an approved contractor. Pathological nonradioactive biological wastes have been sterilized, using steam or chemical disinfectants, and disposed of through the sanitary sewer or at a municipal landfill (LBL, 1986a).

Dry and/or solid waste has been disposed of at municipal sanitary landfills, such as the landfill in Richmond, California (LBL, 1986a). Some records also indicate that other Berkeley-area landfills have received waste from the laboratory, but the specific landfill name or location has not been provided.

There are three off-site locations used in the past as warehouses and storage areas. These areas are listed below.

Location	Dates Used
2nd and Gilman Avenues	1960 - 1961
Oakland Army Base (Warehouses 805 and 807)	1961 - 1967
Howard Terminal near Market Street	1967 - 1979

Records regarding the types of materials stored and the specific uses of these warehouses were not available (LBL personnel, 1988). In 1979, the LBL moved its

warehousing operations to Buildings 901 and 935 in Emeryville. These buildings are still in use.

4.5.1.2 Former Radioactive Waste Storage and Staging Area

From the 1940s to 1963, radioactive waste was accumulated in the vicinity of Building 5, currently known as the Magnetic Fusion Energy Building. Past activities in this building were the responsibility of the EH&S staff and included decontamination of radioactively contaminated equipment. In the open area outside the building, primarily on the north side, radioactive waste was stored and transferred to containers for off-site shipment and disposal. In 1963, this EH&S activity was moved to its present-day location in Radioisotope Services (Building 75) and the annex (Building 75A). Over the approximately 20 years of use, spills occurred in the waste storage/staging area at Building 5 (LBL, 1986a).

Three other buildings adjacent to Building 5 were used during the 1940s and 1950s for work involving radioisotopes. Building 4 was used for experiments conducted by the Nuclear Chemistry Division that involved a number of different radionuclides. Building 5A was used by the Biomedical Division for the purification of strontium-90 and yttrium-90. Building 44B was used for the chemical separation of small amounts of heavy elements. The wastes from each of these activities were temporarily stored outdoors near the buildings (LBL, 1986a).

In October 1985, the EH&S staff noted radioactive contamination in the former outdoor storage area at Building 5. Elevated beta/gamma measurements were detected, with the highest readings reported as greater than 50 milliroentgen per hour (mR/hr). The contamination was determined to be in the concrete pavement, having moved downward through existing cracks into the gravel and soil strata beneath the concrete. Analyses performed by the LBL identified the following contaminants: strontium-90/yttrium-90, cesium-137, and europium-152 and 154. The LBL removed the concrete, gravel, and soils where the contaminants were detected. Documentation of this work does not exist as a formal report, but rather as notes in a log available through EH&S personnel (Haley, 1985). Soils from the contaminated areas, or from the topographically downgradient areas, were not analyzed to determine if chemical contaminants are present.

4.5.1.3 Former Scrapyards and Storage Areas

On the LBL, three locations have been used in the past for storage of salvageable materials and equipment; a fourth location is currently the active salvage yard. These locations are shown on Figure 4-7 and listed below in chronological order of their use.

Period of Use	Location*
1930s to ~ 1960 (based on historical aerial photographs)	Accelerator Development, Electronics Projects & Real Time-Systems Group Building (Building 46)
~1960 to 1974	Experimental Set-up Building (Building 17)
1974 to 1984	Supply Services (Building 69)
1984 to 1987	Returned to Building 17
1987 to present	Earth Sciences Field Test Facility (Building 42)

Source: LBL personnel, 1988

* Present-day names of buildings are used to refer to these locations.

The LBL has no record on the condition of any of these former salvage yards. Based on records of interviews with LBL employees, the original Motor Pool location was also at Building 46, the original scrapyard location (Jackson and Young, 1986). In addition, historical photographs indicate that numerous drums were stored at the scrapyard when it was operating at Building 17.

According to a 1981 LBL Safety News bulletin (LBL, 1981), personnel were reminded not to discard hazardous, toxic, or radioactive materials in the bins designated for salvageable scrap. Although issuance of this bulletin implies that there may have been a problem with receipt of improper materials at the salvage yard, it also demonstrates that the LBL has a program in place to discourage improper waste disposal. An incident occurred in 1987 where a vessel containing sodium was transferred to the salvage yard (LBL, 1987c), and observations made during the on-site portion of the Survey noted an open container of waste oil stored at the current salvage yard. These practices suggest that spills may have occurred in the past at the former salvage yards.

Source: LBL personnel, 1988

LOCATIONS OF THREE FORMER SCRAPYARDS
AND THE ACTIVE SALVAGE YARD AT THE LBL

FIGURE 4-7

Historical photographs available at the LBL indicate that drums were stored in locations other than salvage yards, such as in the vicinity of the present-day Magnetic Fusion Energy Laboratory (Building 16) and Accelerator Development (Building 53). The LBL does not have an inventory of the locations of these formerly-used bulk chemical or waste drum storage areas.

The LBL has not sampled surface soils in the vicinity of Buildings 46, 17, and 69 or surface soils in the vicinity of the former drum storage areas, such as those noted near Buildings 16 and 53, for the purpose of identifying possible environmental contamination problems associated with past management of these areas. Consequently, the LBL has no analytical data to assess the potential for surface soil contamination in these areas.

A one-time groundwater sampling effort was conducted in 1986 that involved collecting samples from hydraugers and analyzing the groundwater for a limited suite of radionuclides and for U.S. Environmental Protection Agency (EPA) priority pollutants. The results from this study showed organic chemical contamination in one sample collected from the east side of the Bevatron (Building 51). The contaminants included trichloroethylene, detected at 13 parts per billion (ppb), and tetrachloroethylene, identified at 94 ppb. The specific hydrauger or combination of hydraugers sampled was not reported by LBL personnel; therefore, the area represented by this sample is uncertain (LBL, 1986c). Generally, however, the former locations of some of the salvage/scrapyards and the drum storage areas appear to be upgradient of the sample collected near the Bevatron (see related discussion in Hydrogeology, Section 3.4).

4.5.1.4 Past Leaks from the Sanitary Sewer System

In October 1977, the LBL contracted with the Pacific NW Pipeline Survey Co., Inc., to conduct a photographic examination of the sanitary sewer system. Only those lines 6 inches in diameter were large enough for access with the equipment used in the study. The films generated in this study were not reviewed during the Survey; instead, LBL personnel provided pertinent excerpts from the contractor's report which were reviewed (Pacific NW Pipeline Survey Co., Inc., 1977).

The LBL has approximately 15,000 feet of sanitary sewer lines, of which about 10,000 feet were included in the photographic study. In the interpretation of the films, the contractor identified segments of the sewer that appeared to be in good condition, along with segments that appeared to have problems which may result in infiltration or conversely, exfiltration. The signs or indications of problems included chemical corrosion, cracks, holes, joint separations, joint offsets, root intrusions, and sediment or debris buildup (Pacific NW Pipeline Survey Co., Inc., 1977).

The study found evidence of chemical corrosion in four sequential segments of the sanitary sewer. These deteriorated segments of the sewer line system are depicted on Figure 4-8. The first segment received effluent solely from the Mechanical Shops Building (Building 77), which includes a metals plating shop and other activities using acid and caustic solutions, degreasers, and various detergents. The next section, downstream from the first, received additional wastewater from Metal Stores (Building 79). Wastewater entering the remaining two sections included that from Buildings 77 and 79 along with effluent from most of the northeast section of the laboratory. The operations ongoing in the northeast section of the site include Supply Services (Building 69), which involves materials receiving and shipping; Radioisotope Services (Building 75), which is the location of the National Tritium Labeling Facility (NTLF); the Radioisotope Services annex (Building 75A), where hazardous and radioactive waste is stored; the Craft and Maintenance Shops (Buildings 76 and 78), which includes the Motor Pool servicing area; Electronics Development (Building 25A), which is involved with plastics, soldering, and electronics fabrication; and Medical Services (Building 26) (Pacific NW Pipeline Survey Co., Inc., 1977; LBL personnel, 1988).

The LBL repaired three of the manholes associated with the chemically corroded sections of the sanitary sewer. At the time of these repairs, the LBL did not collect subsurface soil samples to determine if soil contamination is also a problem in the vicinity of these deteriorated lines (LBL personnel, 1988). In the early 1980s, the LBL installed two wastewater pretreatment systems at the buildings contributing the major quantity of corrosive wastes - Buildings 77 and 25. In the January 1987 Project Management Plan for Rehabilitation of Site Mechanical Utilities - Phase I, the LBL stated plans for upgrading portions of the sanitary sewer that have been damaged by corrosive wastes (LBL, 1987i).

Other segments of the sanitary sewer were found to have problems such as joint offsets, root intrusion, joint separation, or cracks. The LBL has completed minor

LOCATION OF CHEMICALLY CORRODED SEGMENTS
OF THE SANITARY SEWER SYSTEM AT THE LBL

FIGURE 4-8

repairs (e.g., tree removal to eliminate root intrusion); however, work to repair line joints and cracks has not been completed (Pacific NW Pipeline Survey Co., Inc., 1977; LBL personnel, 1988).

4.5.1.5 Underground and Aboveground Storage Tanks

At the LBL, four inactive USTs have been identified, two of which have reportedly leaked in the past. In addition, two active USTs have leaked in the past. Inactive ASTs have been identified at two locations but there is no evidence that they have leaked in the past. The locations of these tanks are provided on Figure 4-9. The following summarizes available information on the past use, capacity, construction materials, and current status of each of these tanks.

- Inactive UST TK-1-07 at the Central Stores and Electronics Shops (Building 7) - A 1,600-gallon steel tank that was used in the past for the storage of waste oils and other liquids which may have included gasoline, acetone, alcohol, kerosene, and solvents. Waste liquids entered the tank via buried fill lines from the Accelerator Development Building (Building 53), the Magnetic Fusion Energy Laboratory (Building 16), and a sump in Building 7. The tank was taken out of service in 1964 and emptied. It was not removed, however, because it had been incorporated into the foundation of a building, leaving only one face of the tank exposed (LBL, 1987I).

In May 1986, surface and near-surface soil samples were collected from an unpaved area near the tank and analyzed for PCBs. The analytical results indicated the presence of low-level PCB contamination [i.e., ranging from 3 to 7 parts per million (ppm)] in several soil samples (Dames & Moore, 1986a).

Additional characterization studies have been performed; however, the results are pending. The LBL plans to clean the tank, fill it with an inert material, and abandon it in place. The fill lines have not been pressure-tested but the LBL plans to separate them from the tank, install end caps, and abandon them in place (LBL personnel, 1988).

FIGURE 4-9

- Inactive UST TK-02-62 at Materials and Molecular Research (Building 62) - A 750-gallon steel single-wall UST, used for the storage of diesel fuel, was located near the northwest corner of Building 62 along the ridge of a hillside. The tank was installed in 1965 (LBL, 1987I). In 1986, the tank was discovered to be leaking; both soil and groundwater in the immediate vicinity of the tank were found to be contaminated with diesel fuel. Concentrations of total hydrocarbons in the soil ranged from 30 to 9,000 ppm. The levels of petroleum hydrocarbons in the groundwater were reported as 2.3 ppm and 4.0 ppm in samples collected from two shallow monitoring wells next to the tank. In May 1987, the two monitoring wells were resampled and analyzed for benzene, toluene, and xylenes (BTX). Benzene was detected in one well at a concentration of 5.7 ppb. The wells were sampled a third time in June 1987 and again tested for the presence of BTX. Contaminants were not detected in this last round of sampling (Dames & Moore, 1987b).

In September 1987, the tank was removed and soil beneath and around it was excavated. Soil was removed to a total depth of approximately 20 to 25 feet in the immediate vicinity of the tank. According to the report documenting the removal, concentrations of hydrocarbons in the soil remaining in the excavation were below 100 ppm with two exceptions where concentrations of 140 and 450 ppm remained. The criterion used for comparison in the report is the requirement of the Regional Water Quality Control Board that soil contaminated with greater than 1,000 ppm total petroleum hydrocarbon be excavated. Soil contaminated at levels between 100 and 1,000 ppm must be evaluated for possible removal based on the hydrologic setting and uses of groundwater in the area. Two monitoring wells exist at the site, one in the backfilled excavation drilled to a depth of 33 feet and the other on the northwest corner of the excavation. However, no additional groundwater samples have been collected since the removal operation was completed (Dames & Moore, 1987b).

- Inactive UST TK-02-88 at Heavy Ion Research (Building 88) - A 500-gallon diesel fuel storage tank located in a grove of trees near Building 88. The tank has been taken out of service, leak-tested, and found to be tight. In

addition, two 21.5-foot-deep borings were drilled and soil samples from the 12.5-foot depth interval were analyzed for total hydrocarbons. The interval selected for sampling was reportedly 2 feet below the bottom of the tank. Hydrocarbons were not identified above the detection limit of 10 mg/kg. It was determined that the tank could not be removed without destroying the grove of trees; therefore, with the concurrence of the Department of Health Services, City of Berkeley, the tank was abandoned in place and filled with concrete. Lines to the tank were pressure-tested and capped (Dames & Moore, 1986b).

- Inactive UST TK-09-50A at the Physics & Director's Office (Building 50A) - Sometime in the early 1970s, a 2,000-gallon steel single-wall tank was installed for the collection and storage of waste photographic solutions in connection with a silver recovery operation. The tank is empty and has been tested and found leak-free. The fill line from Building 50 is disconnected and capped. The LBL plans to remove the tank (LBL, 1986a, 1987I).
- Active UST TK-02-58 at Accelerator Research and Development (Building 58) - The 2,000-gallon steel single-wall UST is located across the road from Building 58 and is used to store oils and other fluids spilled during experiments. A leak was discovered in the piping leading to the tank. The pipe leak was repaired and the tank remains active.

Two soil samples were taken from a depth of 6 to 8 inches beneath the pipe and analyzed for extractable hydrocarbons. The analytical results indicated that extractable hydrocarbons were present in each of the samples at concentrations of 2,500 ppm and 200 ppm, respectively. The samples were re-analyzed and the levels detected were reported as 2,700 ppm and 170 ppm. The laboratory described the contaminant as motor oil. As discussed previously (see Inactive UST TK-02-62), these concentrations are above the guidelines established by the Regional Water Quality Control Board where, generally, soil removal is required or must be evaluated for possible removal (Dames & Moore, 1987a). No additional sampling or soil removal has taken place. The LBL reports that the tank has been leak-tested and found satisfactory (LBL, 1987I).

- Active UST TK-11-74 at the Biomedical Laboratory (Building 74) - A 1,200-gallon fiberglass UST north of Building 74 has been used since 1979 to store diesel fuel for an emergency generator. In 1986, it was determined that the tank had leaked. Repairs were made to the tank and the soil that appeared contaminated was removed. Following this activity, two subsurface soil samples were collected from the vicinity of the tank at depths of 37 and 30 feet, respectively. The samples were analyzed for extractable hydrocarbons. The results showed that the deeper sample contained diesel fuel at a concentration of 32 ppm. Hydrocarbons were not detected in the 30-foot sample above the detection limit of 10 ppm (Dames & Moore, 1986c). The tank remains in use (LBL, 1987).
- Inactive ASTs at Nuclear Science and Applied Science/Nuclear Science, Materials, Molecular Research, and Earth Science (Buildings 70/70A) - Two ASTs were constructed on the western side of the Building 70/70A complex. These tanks were designed as holding tanks to receive effluent from Building 70/70A experiments and fabrication activities involving radioisotopes. Based on the radioactivity in the wastewater, the liquid could be diverted from these tanks through two ion exchange columns for treatment prior to release to the sanitary sewer. According to LBL personnel, activity associated with zinc-65 was detected on one occasion; otherwise, the levels were acceptable for discharge into the sanitary sewer. These ASTs are no longer used but are still present next to Buildings 70/70A (LBL personnel, 1988).
- Inactive ASTs at the Biomedical Laboratory (Building 74) - Two ASTs were constructed next to Building 74 and used as holding tanks for the radioactive wastewater generated from biomedical experiments. According to LBL personnel, the tanks were last used in 1976 and were filled with sand in 1983. The tanks were subsequently abandoned/buried in place when modifications were made to Building 74 and the parking lot was regraded (LBL personnel, 1988).

4.5.1.6 Documented Past Spills

At the LBL, spills have occurred in the past, entering the storm drains which flow from the facility through the City of Berkeley and eventually into San Francisco Bay. Specific documentation of these spills is lacking, but rather presented in a general perspective.

Apparently there were incidents in the past of various cooling towers discharging into the storm drains. Prior to 1983, an assortment of chromate-based inhibitors were used in the cooling towers, in addition to other compounds containing copper and zinc (Botello, 1988). Based on the few soil samples available (see Section 3.2), there is some indication of elevated levels of chromium in surface soils near the cooling towers (LBL, 1986c). Further information on the sediments in the storm drains is not available.

Other past releases from the LBL into the storm drains include foam-causing substances and possibly residual petroleum hydrocarbons from training exercises conducted by the LBL Fire Department. The Fire Department no longer conducts these exercises on the facility. According to LBL records, in 1971 there were incidents of spills possibly entering the storm drain system from acid and chromate solution baths that were being used in the yard outside Building 77. In addition, this area was apparently used to wash equipment and parts (Jackson and Young, 1986).

The LBL has issued directives to all laboratory personnel that restrict any discharges of toxic substances into the storm drains. During the Survey, small stained areas from apparently minor spills were noted next to two storm drains. One stain appeared to be from a past leak in a vehicle fuel tank and the other was the result of an oil-like substance leak from a piece of equipment in storage. Further discussion of the current condition of the storm drainage system is presented in Surface Water, Section 3.3.

4.5.1.7 Overview of the LBL Phase I Installation Assessment

DOE Order 5480.14 of 1985 requires that a Phase I Installation Assessment Report be developed to evaluate past waste management practices and to locate those

inactive waste disposal sites that may pose an environmental or public health risk due to migration of hazardous substances. The LBL prepared this report by April 1986 as required by the Order.

The sites identified in the Phase I Assessment of the LBL included the USTs at Buildings 50, 46, and 7 (see Section 4.5.1.5) and the Radioactive Materials Operations and Storage Complex, which included Buildings 4, 5, 5A, and 44B (see Section 4.5.1.2). No other sites were identified in the assessment. Of the sites included in the assessment, only the UST at Building 7 was recommended for additional characterization. The results of this additional study are pending.

4.5.2 Findings and Observations

4.5.2.1 Category I

None

4.5.2.2 Category II

None

4.5.2.3 Category III

1. Potential chemical contamination of soil and groundwater from past leaks of the sanitary sewer system. Chemical corrosion has occurred along segments of the sanitary sewer system to the extent that major repairs were required for three manholes in 1980. One major source of the corrosive effluent was the Mechanical Shops (Building 77) where plating solutions were discharged without treatment to the sanitary sewer system over an approximately 25-year period. In the early 1980s, the LBL installed a pre-treatment system for the effluent from this building. Soil samples have not been collected from the vicinity of the deteriorated sewer line segments to assess the potential for contamination. Similarly, the potential for groundwater contamination has not been assessed.

A study was performed in 1978 to evaluate the integrity of the sanitary sewer lines at the LBL. As a result of this study, four segments of the sewer were found to be chemically corroded, all of which were downstream of Building 77. Activities in this building include metals plating, which produces both highly acidic and caustic effluents. In addition, machine coolants containing oils and fines, along with vapor degreaser solutions and detergents, have been discharged to the sanitary sewer from this building. Portions of the chemically corroded sections of the sewer also received wastewater from seven other major buildings on the LBL facility. Activities in these buildings include tritium labeling, hazardous and radioactive waste storage and packaging, plastics and soldering work, and Motor Pool servicing. Contaminants from these operations may also have contributed to the corrosion of the sewer lines and subsequently, to potential soil and/or groundwater contamination (see related finding 2 in Hydrogeology, Section 3.4.4.3).

The study also identified sections of the sewer lines with cracks, joint separations and offsets, and root intrusion. Conditions such as these along the sewer lines may allow wastewater to seep out and contaminate subsurface soils. The LBL has future plans for sewer system upgrades, according to the 1987 Project Management Plan for Rehabilitation of the Site Mechanical Utilities.

2. Potential chemical contamination of soil and groundwater from past spills that may have occurred at former scrapyards and storage areas. There are three locations on the LBL facility that have been used for various periods over the past 40 years as accumulation areas for parts, equipment, and other salvageable materials. Spills likely occurred in these areas; yet the LBL has no analytical data to assess the potential for soil or groundwater contamination in the vicinity of these storage yards.

Scrapyards and/or storage areas have been located outside three LBL buildings in the past--Buildings 46, 17, and 69. Particularly in the past, storage areas such as these may have received old equipment that still contained oil, contaminated parts susceptible to weathering, or drums containing spent chemicals. Items such as these are prone to leakage or accidental spills. Based on historical photographs, drums were once stored in the area outside

Building 17 and in locations other than salvage yards, such as outside Buildings 16 and 53. The LBL has no record of the condition in which these scrapyards and storage areas were maintained, such as past internal memorandums or inspections.

In both 1961 and 1987, the LBL published a Safety News bulletin to remind personnel not to improperly dispose of hazardous, toxic, or radioactive materials in the bins designated for scrap material. These bulletins indicate that problems have occurred in the past at the scrapyards, but that the LBL has a program in place to try to prevent improper disposal from occurring in the future.

The LBL has not identified the inactive scrapyards and storage areas in the Phase I Installation Assessment and consequently has not evaluated whether the sites require further study. In addition, there are no analytical data for surface soil available to assess the potential for contamination in these areas. In 1986, groundwater samples were collected from hydraugers at the LBL, one of which may serve to drain the area in the general vicinity of some of the former scrapyards and storage areas. Volatile organic chemical contamination was detected in this sample and is possibly related to these past practices (see related Finding 1 in Hydrogeology, Section 3.4.4.3).

Survey-related sampling and analysis is planned to determine the presence of contamination in soil and groundwater in the vicinity of these inactive scrapyards and storage areas.

4.5.2.4 Category IV

None

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PRELIMINARY

APPENDIX A
SURVEY PARTICIPANTS

PRELIMINARY

Lawrence Berkeley Laboratory
Survey Participants
February 22-29, 1988

DOE

Team Leader
Assistant Team Leader
Operations Office Representatives

V. Fayne
M. Kleinrock
R. Roberts
G. Lavagnino

NUS Corporation

Coordinator/Inactive Waste Sites

J. Clay

Air

T. Koss
R. Andes

Surface Water

M. Hlavacik

Hydrogeology

R. Germeroth

Toxic and Chemical Materials/ QA

D. Olson

Radiation

E. Harr

ICF Technology

Waste Management

J. English

APPENDIX B

SITE-SPECIFIC SURVEY ACTIVITIES

PRELIMINARY

B.1 Pre-Survey Preparation

The DOE Assistant Secretary for Environment, Safety and Health, Office of Environmental Audit selected a Survey team for the Lawrence Berkeley Laboratory (LBL) in the spring of 1987. The site is operated for the DOE by the University of California. Mr. Vincent Fayne was designated the DOE Team Leader, and Mr. Michael Kleinrock the Assistant Team Leader. The remainder of the team was composed of contractor specialists from the NUS Corporation and ICF Corporation.

The Survey team members began reviewing the LBL general environmental documents and reports in December 1987. Messrs. Fayne, Kleinrock, Harr, and Ms. Clay conducted a pre-Survey site visit on January 11-12, 1988, to gain familiarity with key DOE and LBL personnel and the site. An orientation meeting was held and the facility was toured. A cursory review of the data generated in response to an information request of December 2, 1987, was also conducted during the pre-Survey site visit. The request listed environmental information of interest to the Survey team for planning purposes. The Survey team intensively reviewed the information generated during the pre-Survey visit, and during the week of January 25, 1988, prepared a Survey Plan for the LBL. This plan discussed the specific approach to the Survey for each of the technical disciplines and included a proposed schedule of activities for on-site activities. The Survey Plan was transmitted to the San Francisco Operations Office (SAN) on February 9, 1988.

B.2 On-site Activities

The on-site portion of the Survey was conducted during the period of February 22-29, 1988. The opening meeting held on February 22, 1988, at the site was attended by representatives from DOE Headquarters, SAN, LBL personnel, and the Survey team members. Discussions during this meeting centered on the purpose of the Survey, logistics at the LBL, and an introduction of the key personnel involved.

During the Survey, team members reviewed file materials, permits and applications, background studies, engineering drawings, accident reports, and operating logbooks. The laboratory activities were thoroughly analyzed to identify existing and potential pollutants. Site operations and monitoring procedures were observed. Extensive interviews were conducted with plant personnel regarding

environmental controls, operations, monitoring and analysis, past operations, regulatory permits, and waste management.

Daily meetings of the Survey team members were held to report observations and compare findings. A representative from the Environmental Health and Safety Group of the LBL met daily and often more frequently with the DOE Team Leader, Assistant Team Leader, and the NUS Coordinator to arrange for specific site personnel and facilities to be available, as needed, on the following day. LBL or SAN personnel accompanied Survey team members on all field reconnaissances.

A site closeout briefing was held on February 29, 1988, where the DOE Team Leader presented the preliminary observations of the Survey team. These observations were classified as preliminary, because additional research and, in some cases, additional field sampling were required to positively confirm the observations.

The Survey team members identified further Sampling and Analysis (S&A) requirements necessary to complete the Survey effort. The S&A requirements were discussed by the team on May 24, 1988. The S&A request package was transmitted to Idaho National Engineering Laboratory (INEL), the laboratory designated by DOE to provide a sampling team for the LBL and to perform the analytical services.

B.3 Sampling and Analysis

INEL will perform the Sampling and Analysis portion of the LBL Survey. INEL evaluated the S&A requests made by the Survey team and determined logistics, costs, and schedules. The S&A Plan prepared by INEL includes a quality assurance plan and a health and safety plan. The S&A Plan will be completed during fall of 1988 and the sampling team will begin work at the site during the early spring of 1989.

B.4 Report Preparation

An Environmental Survey Preliminary Report for the LBL will be prepared to summarize the findings from the on-site Survey effort. This report will be provided to the SAN and the LBL for review. The findings presented in the Preliminary Report are considered preliminary until comments are received and S&A results are

available. At that time, the comments and S&A results will be evaluated and an Interim Report will be prepared.

PRELIMINARY

APPENDIX C
SURVEY PLAN

PRELIMINARY

**ENVIRONMENTAL SURVEY
LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA AT BERKELEY
February 22 through 26, 1988
Berkeley, California**

1.0 INTRODUCTION

The Environmental Survey is a one time baseline inventory of existing environmental information and environmental problems and risks at DOE operating facilities. The Survey will be conducted in accordance with the principles and procedures contained in the DOE Environmental Survey Manual.

The Survey is an internal management tool to aid the Secretary and Under Secretary in allocating resources for maintaining aggressive environmental programs and for mitigating environmental problems at DOE facilities.

2.0 SURVEY IMPLEMENTATION

The Lawrence Berkeley Laboratory (LBL) is operated by the University of California (U.C.) and is located adjacent to the U.C. Berkeley campus. This Survey will address the LBL facility activities and other facilities on and off the U.C. Berkeley campus that support activities or operations at the LBL.

The Environmental Survey at the LBL facility will be managed by DOE Team Leader Vincent Payne and Assistant Team Leader, Michael Kleinrock. Russell Roberts will serve as the San Francisco Operations Office (SAN) representative on the Survey team. Technical support will be provided by contractor personnel as follows:

Air: Ted Koss, NUS Corporation

Radiation: Ernest Harr, NUS Corporation

Surface Water/Drinking Water: Mara Hlavacik, NUS Corporation

Waste Management:	Joe English, ICF Technology
Inactive Waste Sites/Releases:	Jennifer Clay, NUS Corporation
Hydrogeology:	Robert Germeroth, NUS Corporation
QA/Toxic & Chemical Materials:	David Olson, NUS Corporation

2.1 Pre-Survey Activities

Survey team members began reviewing the LBL facility general environmental documents and reports in December 1987. Mr. Fayne and Mr. Kleinrock, along with Ms. Clay and Mr. Harr conducted a pre-Survey site visit on January 11-12, 1988 to gain a familiarization with key DOE staff and contractor personnel. The facility was toured, a cursory review of documents was completed, and data that were generated in response to an information request letter of December 2, 1988 were discussed. The letter proposed the Survey schedule and listed environmental information of interest to the Survey team for planning purposes.

A meeting was held with representatives of the City of Berkeley, the Bay Area Air Quality Management District, and the Alameda County Department of Environmental Health on January 14, 1988 to review environmental issues and to explain the purpose and scope of the Survey. Region IX EPA was also contacted to solicit their opinion on the environmental status of LBL. These discussions identified issues of Federal, state and county governmental concern which will be addressed during the Survey.

This Survey Plan will be transmitted to the San Francisco Operations Office prior to the Survey.

2.2 On-Site Activities

The Survey will be conducted from February 22-26, 1988 at the LBL facility. The agenda is as shown in Table 1. Modifications may be made as appropriate, to minimize disruption of site activities and to enhance the efficiency and effectiveness of the Survey.

**TABLE 1
LBL ON-SITE SURVEY AGENDA**

Week of	Air	Radiation	Surface Water/Drinking Water	Waste Management	Inactive Waste Sites/Releases	Hydrogeology	QA/TSCA
2/22/88 Monday	AM Site Briefing and Tour PM Overview of radiological monitoring program - dose calculations and models used (with radiation survey team member); overview of emission inventory (radiological and nonradiological) and controls.	AM Site Briefing and Tour PM Overview on radiological monitoring program - potential and actual sources; site location criteria; location review; sampling procedures and frequency; analysis procedures; and frequency performed and frequency laboratories that perform analyses; QA/QC; dose calculations and models used.	AM Site Briefing and Tour PM Bldg 10 - photo lab, other treatment lab, shop, cooling tower water treatment system.	AM Site Briefing and Tour PM Meet with ESH staff; review waste management procedures and documentation.	AM Site Briefing and Tour; obtain records of interviews conducted in CERCLA assessment effort (Phase I). PM Review historical photographs, meet with engineering department to obtain information on past laboratory expansion projects and sewer maintenance work conducted in the past.	AM Site Briefing and Tour PM Slope Stabilization Drainage System - review as-built drawings and visit field installations to obtain information on the impact of the system on localized groundwater flow; Fault Hazard Study - discuss study with personnel familiar with the project.	AM Site Briefing and Tour PM Meet with LBL Environmental Health and Safety personnel to obtain an overview of the facility hazardous materials, PCBs, asbestos, pesticide, and environmental monitoring programs. Check availability of the documentation requested in the Survey Plan. Visit on-site labs involved in environmental monitoring analyses (wastewater, treatment facility and sewer outfalls for heavy metals, and transformer oils for PCBs).
Tuesday	AM Bldgs. 51, 71, and 6 - heavy laboratories, ultrasonic degreaser, machine shops, and other air emission sources. (May need separate escort). PM Bldgs. 77 and 76 - permitted sources, paint shop, and air emission sources.	AM Bldgs. 51, 51A, 51B, 63, 71, 77, 78, 79, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.	AM Bldg. 25 - technician shops and P.C. board shop; wastewater treatment plant; Bldg. 25A - plastic shop, electronics fabrication shop, soldering facility; Bldg. 77 - plating shop, lead treatment plant, machine coolant recovery unit; Bldg. 76 - oil/water separator, solvent collection unit. PM Bldg. 75 - decon area, tritium labeling facility; Bldg. 69 - hazardous waste storage; Bldg. 76 - decontamination facility, laboratories, tritium labeling facility.	AM Bldgs. 4, 5, 5A, 48, and 6 - discuss decontamination work; tank TK-01-07 - discuss removal; and Bldgs. 7, 9, 12, 14, 40, 45, and 48 - review storage practices. PM Bldgs. 42, 69, 77, 78, 79, 31, 72, 62, 65, 63, 74 - review storage yard at electrical substation; Bldg. 69 storage tanks; review test data from leak study; Bldg. 68 - diesel water pumps.	AM Off-site locations including buildings at Berkeley and Emeryville-SPEC concerns.	AM Off-site buildings (main campus, Berkeley and Emeryville) involved in projects which have QA/TSCA activities. The scope of these projects will be defined in the Monday PM meeting.	
Wednesday	AM Ambient air and emission radiological monitoring and sampling locations (with radiation survey team member)	AM Radiological environmental monitoring and sampling locations - calibration procedures and frequency; specifications for monitoring equipment; equipment maintenance, reliability and down time; emergency (uninspected or accidental release) mapping/emergency capabilities.	AM Bldg. 70 - waste tanks, acid neutralization system, acid etching operations, Rm. 173, laboratories; Bldg. 70A - Rms. 3318 and 3353, laboratories; Bldg. 90 - photo lab.	AM Bldg. 70 - laboratories; electronics shop, acid waste neutralization facility; Bldg. 70A - laboratories and shops; Bldg. 50 - laboratories, shops; Bldg. 60 - laboratories, shops.	AM Off-site locations including buildings at Berkeley and Emeryville.	AM Off-site locations including buildings at Berkeley and Emeryville-SPEC concerns.	AM Off-site buildings (main campus, Berkeley and Emeryville) involved in projects which have QA/TSCA activities. The scope of these projects will be defined in the Monday PM meeting.

TABLE 1
LBL ON-SITE SURVEY AGENDA

	Air	Radiation	Surface Water/Drinking Water	Waste Management	Inactive Waste Sites/Releases	Hydrogeology	QATSCA
Wednesday	PM Bldg 50 - machine shops and laboratories; Bldg 70A - toxic sources in rooms 3318 and 3353; Bldg 70 - toxic sources in Room 173.	PM Radiochemical laboratories in Bldgs 1, 57, 18, and 3 - controls on releases; environmental monitoring; radioactive materials storage areas; and radioactive waste handling procedures.	PM Environmental monitoring (sampling of sanitary sewer, creek, storm drain line, domestic tap water); Bldg 25 or 77 - wastewater; Bldgs 70/70A, 71, or 74 - waste tank. Review/operating records; site compliance reports; site water balance calculations.	PM Bldg 6 - construction/renovation wastes; Bldg 16 - laboratories and shops; Bldg 1C - laboratories; photographic laboratory; Bldg 7 - electronic shops.	PM Off-site locations continued.	PM Off-site locations continued.	PM PCB storage area Bldgs 42, 74, and 82 - bulk chemical storage; laboratories; asbestos, and transformers
Thursday	AM Selected laboratories at Bldgs 5, 10, and 80 - emission sources; Bldg 25 - circuit production shop and other shops. PM Bldgs 75, 44 and 58 - tritium facility, compressor and air emission sources.	AM Radiochemical laboratories in Bldgs 51, 50, 70, 18, 65, 62, 74, and 13 - controls on releases; environmental monitoring; radioactive material storage areas; and radioactive waste handling procedures. PM Bldgs 75 and 74 - controls; monitoring (including detectors of telemetered detectors, and environmental perimeter stations); past and present radiological releases (normal or accidental); and any monitoring or surveillance of gamma irradiators performed. Copies of UORs for these facilities should be provided.	AM Bldg 71 - off-exchangers, Bldg 72 - unit accelerator; Bldg 1 - effluents; Bldg 38 - laboratories; Bldg 3 - Bldg 38 and support facilities; potential liquid effluents; Bldg 74 - waste tank; laboratories. PM Bldg 3 - laboratories; Bldg 21 - laboratories; Bldg 57 - laboratories.	AM Bldg 51 - experimental areas; shops; Bldg 71 - laboratories; shops; Bldg 46 - laboratories and shops; Bldg 13 - laboratories and shops; Bldg 58 - electronic fabrication shop. PM Bldg 1 - laboratories; mechanical shop; Bldg 3 - laboratories; Bldg 21 - laboratories; Bldg 57 - laboratories.	AM Bldgs 50, 51, 70, 70A, 58, and 88 - storage areas, cooling towers and tanks. PM Bldgs 90, 55, 60, and 64 - storage areas, cooling towers and tanks.	AM TK-02-88 - review tank closure methods; TK-02-58 - review status of soil contamination study; Bldg 46 - abandoned gasoline tank; review test data from soil contamination study. PM Bldg 25 - printed circuit shop; Bldg 75 - national tritium labeling lab; Bldgs 70, 70A and 56 - toxic chemical storage; TK-09-50 - review leak test data and status of permitting and removal; Bldg 82 - diesel water pumps.	AM Bldgs 25, 70, 70A, 50, 50A, and 88 - bulk chemical storage; laboratories; asbestos, and transformers. PM Bldgs 51, 64, 55, 90, 71, 71B, and 46 - bulk chemical storage; laboratories; asbestos, and transformers.
Friday	AM Bldgs 73 and 74 - laboratories using plutonium and viruses; Bldg 62 - air emission sources. PM Pre-Closeout Meeting with Survey Team Leader and Assistant Team Leader. Followup activities and document review.	AM Overview and review of data on soil sampling performed for radiological or non-radiological constituents for either background or investigative purposes. Review records of radioactive sources ordered by LBL (including those drop shipped off-site). Review of records on decontaminated or decommissioned buildings. PM Pre-Closeout Meeting with Survey Team Leader and Assistant Team Leader. Followup activities and document review.	AM Cooling towers; lyttrons; system retention basins; water distribution system/tank/servicereservoirs. PM Pre-Closeout Meeting with Survey Team Leader and Assistant Team Leader. Followup activities and document review.	AM Bldgs 62 and 66 - laboratories; Bldg 74 - laboratories; Bldg 58 - electronic fabrication shop. PM Pre-Closeout Meeting with Survey Team Leader and Assistant Team Leader. Followup activities and document review.	All Day with Survey Team Leader and Assistant Team Leader. Followup activities and document review.	AM Document review and revisits as required. PM Pre-Closeout Meeting with Survey Team Leader and Assistant Team Leader. Followup activities and document review.	AM Document review and revisits as required. PM Pre-Closeout Meeting with Survey Team Leader and Assistant Team Leader. Followup activities and document review.

Table 2 is a listing of specific areas that each Survey team member will evaluate. This list is intended to assist SAN and their contractor in identifying the most appropriate technical contacts who should be matched with individual Survey team members.

Interviews and consultations will be conducted with environmental, safety, research, operations, waste management, purchasing, and engineering personnel, among others, in the course of the Survey. Also, the Survey team will continue their review of records and other documentation during the Survey. These records are identified in the "Records Required" sections of this plan. The Survey team has already reviewed some of these documents, so copies need not be made of documents previously submitted by SAN and their contractor. However, the original documents should be readily available for reference during the on-site activities.

2.3 Sampling and Analysis

It is not expected that Survey Sampling and Analysis (S&A) will be necessary at the LBL. However, a final determination shall be made based on results of the on-site Survey activities. If it is determined that S&A is necessary, it will be conducted by a DOE Survey laboratory.

2.4 Conclusions and Reporting on the Survey

A closeout briefing will be conducted the Monday following the end of the one-week Survey to describe the general conclusions of the on-site activities. Within 10-12 weeks of the on-site Survey team visit, an Environmental Survey Preliminary Report will be developed for LBL. An Interim Report will then be completed which reflects additional data received or changing conditions.

TABLE 2
LAWRENCE BERKELEY LABORATORY
AREAS OF INTEREST FOR TECHNICAL SPECIALISTS

AIR

Ted Koss

Meteorology
Local Air Quality Data
Radioactive and Non-Radioactive Emission Sources,
Controls and Monitoring
Environmental Monitoring - Air
Air Permits and Air Emissions Inventory
Fugitive Airborne Emissions
Accidental Releases to Air

RADIATION

Ernest Harr

Radioactive Emissions and Effluents
Source Controls and Monitoring
Environmental Monitoring - Radioactive
Laboratory Analysis - Radioactive
Radioactive Waste
Soil Contamination - Radioactive and Non-
Radioactive

SURFACE WATER/DRINKING WATER

Mara Hlavacik

Effluent Sources
Process and Sanitary Wastewater Treatment
Facilities
Stormwater Management
Cooling Water Systems
Environmental Monitoring-Water
Drinking Water Sources and Distribution

WASTE MANAGEMENT

Joe English

Hazardous Waste
Radioactive Waste
Non-Hazardous Solid Waste
RCRA/Solid Waste Permits
Mixed Waste

INACTIVE WASTE SITES/RELEASES

Jennifer Clay

Characterization Studies
Remediation Work
Spill/Accident Locations
Former Research Locations
Past Waste Storage and Disposal Sites

TABLE 2 (Continued)

LAWRENCE BERKELEY LABORATORY
AREAS OF INTEREST FOR TECHNICAL SPECIALISTS

HYDROGEOLOGY

Robert Germeroth

Regional Geology and Groundwater
Well Inventory and Construction (drinking water
supplies, irrigation, private and monitoring
wells)
Groundwater Monitoring Program and Studies
Underground Storage Tanks
Warehousing and Storage Tanks for Process
Chemicals
Spill Prevention, Control and Countermeasure Plan
Spill/Accident Locations

QUALITY ASSURANCE

David Olson

Environmental Sampling Program
Environmental Analytical Program
Data Management and Handling
QA Program Overview

TOXIC AND CHEMICAL MATERIALS

David Olson

Process Chemicals and Substances Inventory
Asbestos Removal and Disposal
PCBs in Service, Storage, and Disposal
Pesticide Use, Storage, and Disposal

3.0 AIR

3.1 Issue Identification

The radioactive and regulated/hazardous air-related Survey activities involve an assessment of the facility-wide air emissions and emissions controls, a review of the monitoring program and equipment, and the acquisition of ambient air quality data. Areas of investigation will include the laboratory and shop emissions of radionuclides and toxic pollutants, and emissions of acid fumes, organics, and volatile hydrocarbons (VOCs). Operational and procedural practices associated with emission controls and emission monitoring equipment will be evaluated. Fugitive sources of radioactive and regulated/hazardous particulate and gaseous emissions, including emissions from chemical and waste storage/handling areas, will be examined.

The general approach to the Survey will involve a review of existing environmental reports, chemical inventories, operating procedures, ventilation diagrams, stack monitoring reports, radioactive effluent reports, regulatory requirements and other relevant documents to identify sources of air emissions. Following the document review will be the physical inspection of most laboratory and shop sources, control and monitoring equipment, and other potential emission sources. The Survey will identify air contaminants from significant sources at the LBL, (such as the National Tritium Labeling Facility and vapor deicers) identify and evaluate existing control equipment for air contaminants, and assess the potential for environmental problems from the emissions.

Several areas for specific investigation have been identified during a review of available documentation:

- Toxic and radioactive emissions and controls;
- Laboratory emissions compared with Bay Area Air Quality Management District thresholds for source permits; and
- Potential for abnormal tritium releases from the National Tritium Labeling Facility.

3.2 Records Required

The following records should be available for on-site review:

- Source and emission inventories for both radiological and regulated/hazardous emission sources;
- Description of current air contaminant producing operations (flow diagrams, narratives, and sketches);
- Identification of fugitive/accidental release points;
- Ambient air dispersion and dose calculations;
- Descriptive documentation on existing emission controls and ventilation system drawings;
- Operating, testing, and maintenance procedures for control equipment;
- Correspondence between LBL and regulatory agencies related to air/radiological issues;
- Reports on accidental releases/unusual occurrences relating to radiological and regulated/hazardous and toxic airborne releases;
- Radiological stack monitoring/sampling program procedures and documentation, including:
 - Calibration procedures and records
 - Unsummarized emission rate data from individual sources; and
- Ambient air monitoring program procedures and documentation, including calibration procedures and records.

4.0 RADIATION

4.1 Issue Identification

The radiological focus of the Environmental Survey will involve identification of the species and quantities of radioactive materials processed and/or handled at the facility since its inception and determination of whether hazardous quantities of those materials could or do currently exist in the environment. Information concerning the past liquid waste streams and atmospheric effluents will be collected, and the possibility of hazardous quantities remaining will be examined.

The Survey will involve an assessment of the site-wide radioactive release controls, on-site and off-site monitoring equipment, and the associated impact on the environment and general off-site population. The radiological assessment will encompass three major areas: 1) airborne radioactive emissions; 2) liquid radioactive effluents; and 3) liquid and solid radioactive waste management. The radiological aspects will be coordinated with the air, surface water, waste management (CERCLA/RCRA), hydrogeology, and the quality assurance specialist.

The Survey will determine whether radioactive materials released to the environment from the site, or potentially released, create any actual or potential environmental problems. Existing environmental standards, regulations, and guidelines will be used for comparison to assess the potential magnitude of these problems. The review will also determine if appropriate actions are being taken or planned to minimize accidental releases and/or mitigate the consequences of such releases and whether there are conditions that potentially may lead to environmental problems.

Several areas for specific investigation have been identified during a review of available documentation:

- Review of radiological monitoring program;
- National Tritium Labeling Facility's release controls and effluent monitoring;

- Residual radioactive soil contamination at Gilman Hall;
- Possible activation of soil and groundwater from accelerator operations;
- Radioactive material inventory tracking and storage;
- Monitoring and surveillance performed on gamma irradiators; and
- Radiochemical laboratories', release controls, effluent monitoring and waste handling practices.

4.2 Records Required

The following records should be available for on-site review:

- Radiological sampling and analysis methods and data, such as:
 - Radioactive material inventory
 - Radioactive waste shipments
 - Effluent monitoring manual
 - Environmental program manual
 - Effluent sampling schedule
 - Effluent data (radionuclides, concentrations, and curies released by release point/facility)
 - Environmental sampling schedule (soil, ambient air, surface water)
 - Environmental sampling data (related to facility or area if possible)
 - Radioanalytical procedures, related QA procedures and documentation
- Radioactive emission reports (air and surface water discharges);
- Environmental monitoring, sampling equipment, calibration and maintenance records;
- Documents on the selection of sampling locations and design of monitors;

- Status reports on effluent and environmental controls and monitoring systems upgrades;
- Radioactive waste management procedures;
- Reports on accidental releases;
- Reports on radioactive wastewater storage tanks;
- Description of dose calculation programs; and
- Data on soil sampling performed for radiological or non-radiological constituents.

5.0 SURFACE WATER/DRINKING WATER

5.1 Issue Identification

The primary focus of the surface water/drinking water portion of the Survey will be on the potential or actual release of contaminants to surface waters from past and present activities at the Lawrence Berkeley Laboratory (LBL). Potential pathways of contaminants include discharges of radiological or chemical substances to the sanitary sewer or to the stormwater system through inadvertent or deliberate means. The secondary focus of this discipline will be on the potential for contamination of the LBL drinking water supply through cross-connections with piping containing hazardous materials.

The sanitary sewer at LBL leads to the East Bay Municipal Utility District (EBMUD) treatment plant, where it undergoes primary and secondary treatment prior to being released to the San Francisco Bay. Contaminants from LBL may enter this system via any of the following scenarios:

- Inadvertent discharges and disposal via sinks and drains in LBL laboratories;

- Inadequate treatment of acidic and metals-containing wastewaters from Buildings 25 and 77, and acidic wastewaters from Buildings 70/70A;
- Inadequate hold-up or inadvertent discharge from waste holding tanks from Buildings 70/70A, 71, and 74;
- Inadequate operation of the Building 76 solvent/waste oil collection unit; and
- Potential contaminants in LBL cooling tower discharges.

Releases to the stormwater system at LBL flow to either Blackberry or Strawberry Creeks, which eventually lead to the San Francisco Bay via the City of Berkeley storm drain system. Potential sources of contaminants include:

- Stormwater runoff from contact with contaminated soils;
- Inadvertent spills or discharges into the storm sewers; and
- Runoff from parking lots and other paved areas.

The effects of prior operations on naturally occurring springs, seeps, and/or surface waters, such as Blackberry and Strawberry Creeks, will be reviewed in conjunction with the inactive waste sites and hydrogeology portions of the Survey. Emphasis will be placed on past liquid effluent management practices, e.g., the routing of liquid effluents prior to discharge or treatment.

The Survey will assess the potential for inorganic, organic, and radioactive contamination of wastewaters, as well as review present conditions of wastewater control, collection, monitoring and treatment. Liquid waste collection, treatment, and handling equipment will be examined and records of operation will be reviewed, as will the methods of sludge disposal as a result of these treatment processes.

The Survey will include identification of potential discharges to surface waters from LBL which may not be addressed in operating permits or other documents. This will include an investigation of the site for evidence of possible breaks or obstructions in the sewer system which could result in releases of wastewater to the environment.

The Survey will also address the possibility of cross-contamination of the potable water supply system by either the sanitary or stormwater systems. Copies of standard operating procedures (SOPs), operating logbooks, and maintenance records will be reviewed with respect to wastewater monitoring and treatment systems, and LBL field practices will be observed to determine how closely SOPs are being followed. Site managers and operators of monitoring equipment and treatment systems will be interviewed in order to understand modifications or significant deviations, if any, from written SOPs.

A walk-through of selected buildings will be made to observe normal routines, including maintenance activities, which generate wastewaters. Various discharge and monitoring points will be reviewed, and actual sampling and analytical procedures will be observed at the wastewater treatment facilities and other liquid environmental monitoring locations. Emphasis will be placed on the major contributors to wastewater generation, i.e., Bldgs. 25/25A Mechanical Technology/Electronics Development; Bldg. 62 Materials and Molecular Research; Bldgs. 70/70A Nuclear Science, Applied Science, Earth Sciences and Materials and Molecular Research; Bldg. 71 HILAC; Bldg. 74 Biomedical Laboratory; Bldg. 76 Craft and Maintenance Shops; and Bldg. 77 Mechanical Shops.

The sanitary wastewater collection, holding and treatment systems will be evaluated under normal operating conditions, as will the final effluent monitoring and sampling stations. Site surface drainage characteristics, such as culverts and retention basins, will also be examined, along with any man-made efforts to control surface runoff and runoff. The impact of changes resulting from construction of new facilities will also be evaluated.

5.2 Records Required

Files from LBL will be reviewed as part of the Survey, including documents not yet reviewed or received (e.g., classified documents, individuals' files, documents not yet identified). Specific records which should be available for on-site review include:

- Water distribution and sewer plans (current and historical) for all 7 functional planning areas;

- Information submitted by LBL to EBMUD regarding sanitary sewer and wastewater sampling and analysis data;
- Information regarding the generation of sludges from the on-site wastewater pretreatment operations, its potential for containing toxic substances, results of sludge analyses, and ultimate handling;
- Information pertaining to periodic environmental monitoring of nearby surface waters, storm drains, and potable water;
- Correspondence with regulatory agencies regarding wastewater discharges from LBL and U.C. Berkeley;
- Analytical data on influent process water and on any wells, springs or seeps on LBL property that are available;
- Past wastewater treatability or characterization studies;
- Identification of flood-prone regions in the area of the LBL facility, including floodplain maps;
- Water balance calculations and drawings, and records of water consumption;
- Identification of any uses of surface water in the area downstream of LBL (e.g., public drinking water intakes, recreational uses, etc);
- Accidental release or unusual occurrence reports that may relate to potential past discharges to the sanitary system or stormwater system;
- Information regarding current or past potential discharges of toxic chemical and/or radiological effluents to subsurface disposal systems, including septic tanks and leach fields;

- List and drawings of any current and abandoned septic tanks and leach fields;
- Information on the methods of collection, treatment, and disposal of wastes from the outdoor animal pens and any washdown of the pen areas;
- Operational procedures of the wastewater treatment systems;
- Summary of major building missions over time (current missions do not necessarily reflect activities conducted from the 1940s to the present);
- Detailed topographic maps of the LBL facility and surrounding area, and information pertaining to former/alterd drainage pathways on-site;
- Historical overview of LBL water treatment operations, including any on-site and/or off-site facilities utilized;
- Identification of on-site and off-site surface water sampling locations;
- Recent analytical data on wastewater releases to the on-site creeks;
- Notices of violation relating to wastewater releases;
- Operators logbooks, treatment plant reports, and monitoring equipment maintenance records;
- Standard operating procedures for wastewater collection, holding, and treatment;
- Sampling protocols and logbooks, and wastewater lab tracking reports;
- Detailed drawings of the domestic water supply, storage and distribution system;
- Records of drinking water quality;

- Internal memos and correspondence relating to surface water/drinking water problems (e.g., back-flow prevention measures); and
- Internal memos and correspondence relating to exfiltration losses from sanitary sewers and on-site losses to groundwater.

6.0 WASTE MANAGEMENT

6.1 Issue Identification

The waste management review at LBL will focus on the identification of hazardous waste, solid waste, radioactive waste, and mixed waste generation, storage, treatment, and off-site disposal. The documents reviewed show hazardous and mixed waste generation at LBL as being characterized by a small number of large volume generators (e.g., the Building 77 mechanical shops, the Building 25 electronic shops, and the Building 69 maintenance shops) and numerous small volume generators (e.g., individual research laboratories). Radioactive waste generation, other than generation of small amounts of liquid wastes in laboratories, was not well characterized in the documents reviewed. Solid waste (i.e., nonhazardous, nonradioactive) generation was not well characterized, but such wastes are expected to be generated at virtually all LBL facilities. The documents reviewed indicated that waste management activities at LBL include on-site treatment of some liquid hazardous and radioactive wastes (e.g., treatment of plating and acidic wastes at Buildings 25, 70/70A, and 77, and solidification of liquid radioactive wastes). Waste management activities also include on-site storage of hazardous, radioactive, and mixed wastes followed by off-site disposal. Solid wastes are collected and disposed of off-site. No on-site disposal of any wastes has reportedly occurred.

The waste management portion of the Survey will include a review of waste management records, procedures, and practices and inspection of facilities where wastes are generated, handled, treated, and stored. Areas for investigation identified as a result of the document review include:

- Identification of points of generation of hazardous, radioactive, and mixed wastes, including off-site locations (e.g., U. C. Berkeley, Emeryville);
- Practices and procedures for designation and segregation of hazardous, radioactive, mixed, and solid wastes;
- Generation, accumulation, storage, and disposal of small volume chemical wastes from laboratories (i.e., lab packs);
- Generation, accumulation, storage, and disposal of liquid and solid radioactive wastes;
- On-site treatment and storage of hazardous and mixed wastes; and
- Off-site disposal of hazardous, radioactive, and mixed wastes.

The on-site activities will include visits to all major hazardous, radioactive, and mixed waste generators, as identified in the document review. The emphasis of the visits will be to identify the types and amounts of wastes generated and waste management practices. Visits will also be made to a number of other facilities which generate, or potentially generate, hazardous, radioactive, and mixed wastes. Since not all facilities can be visited during the Survey, facilities have been selected which represent the various types of laboratories (i.e., biological, medical, chemical, physical) and shops (i.e., electronic, mechanical) at LBL. Again, waste generation and management will be the focus of the visits to these facilities. Also visited will be waste treatment and storage facilities. The focus of these visits will be to identify waste management practices.

The waste management review will be coordinated with the surface water review for those operations which include liquid effluents (e.g., pretreatment of plating wastes) and with the toxic and chemical materials review for those facilities managing PCB wastes.

6.2 Records Required

The following records should be available for on-site review:

- Written procedures for waste generators describing waste analysis, designation, segregation, and minimization;
- Operating procedures for LBL staff responsible for hazardous, radioactive, mixed, and solid waste collection, packaging, transportation, and storage;
- Waste analysis and monitoring records;
- Waste manifests, disposal requests, and other records documenting the disposition of wastes sent off-site;
- Hazardous and mixed waste permit applications, operational plans, and annual reports;
- Records describing and documenting inspections of waste management facilities;
- Records documenting the inventories and disposition of hazardous materials; and
- Correspondence with regulatory agencies related to waste management activities.

7.0 INACTIVE WASTE SITES/RELEASES

7.1 Issue Identification

The inactive waste sites/releases specialty area review will identify environmental problems associated with the historical handling, storage and disposal of hazardous and radioactive substances at the site. The Survey will focus on current and future environmental problems related to past land use and disposal practices, and past

spills/releases. The review will evaluate information developed in response to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA) regulations.

The LBL background information indicates that there has been no waste burial on the property occupied by the laboratory. Therefore, the inactive waste sites/releases portion of the Survey will be focused on areas where possible spills or releases occurred in the past. Such releases potentially may have resulted in groundwater contamination or sediment contamination of the stormwater drainage system. Consequently, the CERCLA/SARA review effort will be closely coordinated with the Hydrogeology and Surface Water Specialists. A determination will be made of the influence of past handling and disposal of hazardous and mixed chemicals/wastes with regard to the existence of undocumented inactive waste sites/releases. Also, during the pre-Survey visit arrangements were made to review historical photographs on the first day of the Survey.

Several areas of concern have been identified during a review of available documentation. These areas will be reviewed in addition to interviewing personnel who have worked at LBL for a number of years. Major areas of investigation include:

- Past activities at Buildings 4, 5, 5A, and 44B that may have resulted in chemical contamination, which possibly was not addressed during the decontamination effort.
- Past leaks or spills that may have occurred at the satellite chemical storage or dispensing areas;
- Information on past maintenance for sumps, connection boxes, and drain lines where cracks may have been repaired;
- Historical waste/product handling at off-site locations, including Emeryville and Berkeley;
- Historical sea burial of radioactive waste at the Farallones;

- Locations used in the past for equipment storage, both salvageable and non-salvageable;
- Information on receipt of waste from other DOE facilities and its subsequent final disposal location;
- Inactive, abandoned, or removed waste storage tanks and product storage tanks that have been included in the LBL Underground Tank Program;
- Buildings and areas with known fixed or induced radioactive contamination, such as Buildings 1, 3, 4, 6, 7, 50, 51, 55, 63, 64, 70, 70A, 71, 71B, 74, 75 80, 88, 90, and 901; and
- Potential contamination associated with the use of chromates in the cooling towers.

Other possible areas of investigation include:

- Existing and former facilities that have handled hazardous, mixed, and low-level radioactive wastes; and
- Areas where past undocumented disposal may have occurred;

Information received during the pre-Survey visit indicated that DOE-sponsored activities were conducted at the several off-site locations. Information on these locations and any others used by LBL for DOE projects should be made available to ensure that any potential CERCLA/SARA issues are addressed.

7.2 Records Required

The following records should be available for on-site review:

- Records of the interviews conducted during the CERCLA assessment effort (Phase I);

- Past and ongoing CERCLA/SARA related studies and remediation reports;
- Records of historical research facilities, locations, operations, processes and substances used, and methods of materials and waste handling and disposal;
- Description and location maps of all inactive waste management facilities, including buried tanks (USTs and septic) and structures;
- Descriptions and notifications (as per CERCLA Section 103) of inactive waste sites and potential areas of contamination;
- Listing of inactive areas used for hazardous substances use, storage, receiving and shipping, and disposal;
- Descriptions of corrective actions;
- Historical standard operating procedures (SOPs) regarding management of hazardous substances, disposal areas, and storage areas;
- Hazardous substances inventories;
- Waste generation reports and characterization studies;
- Waste management plans (past and current);
- Files on past off-site waste handling and disposal (period of use, waste types and quantities, etc.);
- Historical aerial photographs and site plans that may provide clues to undocumented disposal;
- Descriptions and notification of spills/releases (Unusual Occurrence Reports and Minor Release Reports); and
- Records of facility expansion and building rubble disposal.

8.0 HYDROGEOLOGY

8.1 Issue Identification

The preliminary review of the documents supplied for the Lawrence Berkeley Laboratory facility indicates that in the past, there has not been a groundwater monitoring program in place at the facility to assess the environmental impact of its operation on the groundwater regime. Large quantities of diesel fuel, gasoline, waste oils, solvents and other chemicals are stored in underground tanks. Many of these tanks have leaked in the past. Radioactive and non-radioactive wastes are stored on-site and in leased facilities. Additionally, a system of horizontal drains designed to improve the stability of rock and soil slopes discharge groundwater into the stormwater system.

The construction and placement of groundwater monitoring wells and horizontal drainage systems will be examined to gain a better understanding of the geology and hydrogeology beneath the site. A review of groundwater sampling procedures, chain of custody and quality assurance/quality control procedures will be made, and interviews with site personnel will be conducted. Water level elevation readings taken in monitor wells will be reviewed to determine their value in resolving the issue of groundwater movement. In addition, information will be reviewed on the regional geology and data will be collected on the irrigation and private wells located in the vicinity of the LBL facility.

The adequacy of spill prevention control and countermeasures for above ground storage of petroleum products and hazardous substances which have a potential to enter groundwater and surface waters will be examined. This effort will be coordinated with the Surface Water, Waste Management and the Toxic and Chemical Materials Specialists.

Several specific areas of investigation have been identified during the document review. These include:

- Underground tanks, both active and abandoned - review of leak detection methods, monitoring well data, soil testing;

- Spill prevention, control and countermeasures;
- Slope stabilization drainage system;
- Building 77 - Mechanical Shops - electroplating shop method of storage and disposal of hazardous wastes;
- Building 25 - Printed circuit shop;
- Emeryville facility - storage of radioactive and nonradioactive wastes;
- Building 70 and 70A - Toxic chemical storage;
- Building 75 - National Tritium Labeling Laboratory; and
- Seismic risk analysis

8.2 Records Required

The following documents should be available for on-site review

- As-built drawings for slope stabilization drainage systems - (should be available on the first day);
- New and recent data and reports on groundwater quality;
- Well sampling schedules and procedures;
- Well installation reports, boring logs and as - built drawings;
- Off-site well inventories which include location, depth and length of screened interval and the owner of the well;
- Spill prevention, control, and countermeasure (SPCC) plans, data used in their preparation, and any notifications or reports on past spills;

- Underground storage tank registration forms filed with the California Water Resources Control Board;
- Location of all present and abandoned underground storage tanks and methods of leak detection;
- Last two underground tank quarterly reports submitted to the City of Berkeley;
- Copies of data from leak tests performed on underground tanks and lines;
- LBL Annual Environmental Monitoring Report, Part I - 1976;
- Location and background information on aboveground bulk chemical storage tanks; and
- Fault Hazard Study.

9.0 QUALITY ASSURANCE (QA)

9.1 Issue Identification

The LBL analytical Quality Assurance programs will be reviewed to determine the degree to which existing site environmental data can be utilized by the Survey. The review will be used to identify environmental data gaps and to assess the need for additional sampling and analysis. The review will focus on the QA programs covering the analysis of wastewater effluents from the two pretreatment units at Buildings 25 and 77, the analysis of wastewater discharges to EBMUD via the Hearst and Strawberry sewer systems, and the analysis of transformer oils for PCBs. The QA program for the environmental monitoring conducted by the LBL Environmental Health and Safety Department will also be reviewed.

The intent of this review will be to verify the quality assurance procedures for obtaining process effluent and environmental samples, performing the analytical

work to identify pollutants, and the handling and reporting of data. All aspects of the QA program relating to environmental monitoring and analysis at the LBL will be reviewed.

The environmental sampling performed by the Environmental Health and Safety Department will be evaluated by reviewing procedures, data handling, records, and logbooks. Field techniques will be observed by other Survey team members to determine actual sampling practices.

The analytical laboratories will be reviewed through an evaluation of procedures and records, and observation of laboratory operations. Off-site laboratories, including Med-Tox and Thermo Analytical Inc., will be evaluated by using documents at the LBL. No visits to off-site laboratories are anticipated.

Several areas for investigation have been identified during the pre-Survey review of available documentation:

- Training records for laboratory and sampling personnel;
- Equipment and instrument calibration and maintenance logs;
- Precision and accuracy studies;
- Blank, split, and spiked sample analyses;
- Sample handling and chain-of-custody procedures;
- Data reduction and validation;
- Data reporting and documentation; and
- Calculation and logbook reviews.

The QA program for the radiological analyses conducted by LBL will be reviewed by the Survey radiation specialist.

9.2 Records Required

The following records relevant to the analysis of effluent and environmental monitoring samples should be available for on-site review:

- Laboratory QA manual and analytical procedures;

- Sampling QA manual and procedures;
- Previous QA audits of laboratory and sampling programs;
- Reports for precision and accuracy;
- External performance standard results (e.g., DOE Environmental Measurements Laboratory and other outside agencies);
- Training records for the laboratory and sampling personnel;
- Maintenance and calibration records for the laboratory and sampling instruments; and
- Laboratory and sampling logbooks, and standard data reporting forms.

10.0 TOXIC AND CHEMICAL MATERIALS-TSCA

10.1 Issue Identification

The toxic and chemical materials review will address the raw materials and process-related chemicals used at the LBL. The use, handling, and disposal of Polychlorinated Biphenyls (PCBs), asbestos, and pesticides will also be within the scope of this effort.

Several areas for investigation have been identified during the pre-Survey review of available documentation:

- Adequacy of tracking, control, and management of toxic materials purchased through Central Stores or purchased on an individual project basis. Building supervisors will be requested to provide estimates of the quantities of toxic materials used annually;
- The inventory of PCB equipment (12 transformers) and PCB contaminated equipment (16 transformers) has been obtained from LBL

and reviewed. The conditions of this equipment, its potential for leakage, and the quantity of contaminated fluids will be assessed;

- Obsolete or used PCB items and contaminated items in storage will be inspected for proper packaging, adequate storage protection requirements, and inventory controls;
- Disposal practices for current and past PCB inventories will be reviewed to determine the method(s) of disposal and location(s) of disposal sites;
- Procedures for PCB analysis, removal, handling, and disposal will be reviewed;
- The presence of asbestos building materials and insulation at the site will be identified/confirmed based on the facility asbestos locations document of December 16, 1987. Specifications or plans for modification/removal projects will be reviewed with the site construction/operation contractor and subcontractors;
- Training and certification of asbestos workers will be reviewed. Practices will be reviewed to determine disposal methods and locations; and
- The usage of pesticides at LBL will be reviewed, as well as personnel training/certification, application records, and storage and disposal practices.

10.2 Records Required

The following records should be available for on-site review:

- Standard Operating Procedures (SOPs) covering the management of toxic materials, i.e., purchasing, labeling, and tracking;
- SOPs and records for the handling, storage, and disposal of pesticides;
- Site hazardous chemical inventory prepared for the SARA annual report;

- Last two quarterly in-house PCB inspection reports;
- Asbestos removal reports submitted to the BAAQMD; and
- Last two Office of Health and Safety Liaison compliance audits.

PRELIMINARY

APPENDIX D

**OFF-SITE LEASED SPACE AND BUILDINGS ASSIGNED
LBL NUMBERS**

PRELIMINARY

APPENDIX D
OFF-SITE LEASED SPACE AND BUILDINGS ASSIGNED LBL NUMBERS

Building Number	Description	Gross Sq. Ft. Area	Net Sq. Ft. Area
<u>Off-Site Leased Space</u>			
901	1450 64th St., Emeryville, Warehouse	75,894	74,520
934	91 Bolivar Drive, Berkeley, Printing Biomed (Dymo Bldg.)	24,007	18,581
935	Berkeley Business Center, Warehouse	<u>28,000</u>	<u>28,000</u>
Total Off-Site Leased Space		127,901	121,101
<u>Other Buildings/Facilities Assigned LBL Building Numbers</u>			
904	Shasta Water Line (Valve)		
906	Highland Hospital, 2701 14th, Oakland		
907	DOE/SAN Office, Oakland		
911	Richmond Field Station, UCB Richmond	6,990	
924	Los Alamos Laboratory		
950	Stanford Linac, Palo Alto		
951	Geothermal Research, Nevada		
982	Medical Research Laboratory, Oakland		
Total Other Buildings/Facilities Assigned LBL		6,990	
<u>Buildings on UC Berkeley Campus Assigned LBL Building Numbers</u>			
1	Donner Laboratory	44,886	28,308
3	Melvin Calvin Laboratory	30,791	23,092
8	Hearst Memorial Mining	27,497	14,818
11	Hildebrand Hall	35,071	21,435
18	Gilman Hall	14,432	7,921
19	LeConte Hall	15,607	9,522
19A	Birge Hall	20,591	11,025
20	Life Sciences Building (Giaque Hall)	2,022	1,353
21	Low Temperature Laboratory		
22	Latimer Hall	25,768	15,537
24	Etcheverry Hall	29,736	15,116
38	Lewis Hall	12,721	8,270
39	Cory Hall		
57	Donner Pavilion	955	531
905	Hesse Hall	9,467	6,333
921	Stanley Hall		
926	Morgan Hall		
928	Haviland Hall		
952	Moses Hall		

APPENDIX D (continued)
OFF-SITE LEASED SPACE AND BUILDINGS ASSIGNED LBL NUMBERS

Building Number	Description	Gross Sq. Ft. Area	Net Sq. Ft. Area
953	Earth Sciences		
983	Wurster Hall		
984	Davis Hall	4,490	3,080
985	Garage		
986	Harmon Gym		
987	Warren Hall		
988	Boalt Hall		
989	Lawrence Hall of Science		
990	Evans Hall		
991	T-4 (Energy & Resources Program)		
992	Tolman Hall		
993	T-9 (Energy and Research Group)		
Total Buildings on UC Berkeley Campus Assigned LBL Numbers		274,034	166,341

Source: LBL, 1984

REFERENCE FOR APPENDIX D

LBL (Lawrence Berkeley Laboratory), 1984. LBL Site Development Plan (Working Draft), Lawrence Berkeley Laboratory, Berkeley, California.

PRELIMINARY

APPENDIX E

LBL BUILDINGS AND ASSOCIATED OPERATIONAL ACTIVITIES

PRELIMINARY

APPENDIX E

LBL BUILDINGS AND ASSOCIATED OPERATIONAL ACTIVITIES

Building 4. Magnetic Fusion Energy

Area 9,894 sq. ft. Population 41

A two-story reinforced-concrete and wood building completed in 1944. It has 6 laboratories, 16 offices, and 4 multipurpose rooms. Now houses the Magnetic Fusion Energy (MFE) administration and theory group.

Building 5. Magnetic Fusion Energy

Area 7,115 sq. ft. Population 18

A single-story reinforced-concrete and wood building completed in 1943. Contains 10 laboratories, 5 multipurpose rooms, and 1 office suite. Used by the mechanical engineering support group for the MFE project and by the Plasma Physics Group.

Building 6. 184-Inch Synchrocyclotron

Area 36,743 sq. ft. Population 20

A dome-roofed, multisided building which is essentially round, built in 1940 with a wing added in 1962. Has a 30-ton crane with a hook height of 35 feet, and there are some two-story rooms inside the main building. Building and machine foundations are reinforced concrete with the building frame being of structural steel and the outside sheath of transite. Building contains the 184-Inch Synchrocyclotron, heavily shielded by large concrete block, which is used for the Biology and Medicine radiotherapy program. Large experimental area houses the Neutral Beam Engineering Test Facility (NBETF), which is a national facility used to test advanced positive ion sources.

Building 7. Central Stores and Electronics Shops

Area 27,027 sq. ft. Population 64

A two-story building completed in 1943 with wood frame structure and a reinforced-concrete foundation and first floor. Outside sheath is stucco. Contains approximately 11,000 sq. ft. of stores space, plus electronics shops, multi-use rooms, and offices. Building is used as the central laboratory storeroom and houses the electronic installation, and instrumentation repair, calibration, and maintenance shops.

Building 9. Experimental Staging Facility

Area 6,277 sq. ft. Population 2

Completed in 1944. One-third is one story, and the remainder is two-story medium high-bay space with a 10-ton crane. A wood frame structure with a stucco exterior and reinforced-concrete foundation and floor. One-story section houses large motor-generator sets to supply the 184-inch Synchrocyclotron and the other space is used to store, stage, and test experimental equipment.

Building 10. Biomedical Research

Area 15,638 sq. ft. Population 40

A two-story building completed in 1944. One side is a large two-story high bay with a 10-ton crane; the other side is two-storied and divided into office and laboratory spaces. Building is a wood frame structure with a transite exterior and reinforced-concrete foundations and first floor. Building contains 26 laboratories, 2 computer rooms, and 16 offices, used for biomedical research, general photography and processing; staging for accelerator projects is carried out in the high bay.

Building 12. Magnetic Fusion Energy - EBIS/Central Stores Annex

Area 3,018 sq. ft. Population 0

A small single-story wood frame building completed in 1943. Has stucco exterior and reinforced-concrete floor and is used for bulk storage of items such as chemicals.

Building 14. Nuclear Instrumentation

Area 4,219 sq. ft. Population 14

A small single-story building completed in 1944 of wood frame structure, exterior stucco, and reinforced-concrete foundations and floor. Contains electronics shop areas and 10 offices. Activities consist of maintenance and calibration of electronic instruments.

Building 16. Magnetic Fusion Energy Laboratory

Area 10,854 sq. ft. Population 12

Original building of approximately 200 gross sq. ft. completed in 1944, and is a single-story wood frame structure with exterior transite siding, and concrete floor and foundations. A major addition of approximately 5,000 sq. ft. completed in 1948, with one-third being two-story high bay with a 10-ton crane, and the other two-thirds being single-story space. Addition is a steel frame structure with exterior transite siding and reinforced-concrete floor and foundations. Other additions made more recently to give the total area. Building now contains 5 laboratories, electrical and mechanic shops, a large rectifier galley, and 4 office. Building houses the MFE Test Facility.

Building 17. Experimental Set-Up

Area 1,717 sq. ft. Population 0

A small single-story building completed in 1949. Has steel frame, exterior cement-asbestos siding, and concrete floor. Used for experimental set-up by the Applied Science Division and Physics.

Building 25. Mechanical Technology

Area 20,101 sq. ft. Population 36

An L-shaped building evolved from three major additions. Original building, completed in 1947, was a combination two- and one-story structure of steel frame, transite siding, and concrete floor and foundations. A two-story wing was added in 1952 with steel frame, concrete block walls, and concrete floors and foundations. In 1957 mezzanines were added in portions of the two-story high-bay space. Building contains two 5-ton cranes, 26 technician shops, and the electronics printed circuit production shop.

Building 25A. Electronics Development

Area 7,539 sq. ft. Population 18

A two-story building completed in 1963 with a steel frame structure, metal curtain walls, and reinforced-concrete floor and foundations. Contains five laboratories or shops and five offices. Contains the plastics shop of the mechanical technicians, occupying one-third of the space, the electronics fabrication shop, the automated soldering facility, and the quality assurance shop.

Building 26. Medical Services

Area 6,741 sq. ft. Population 26

A two-story building stepped into a hillside with one floor completed in 1964 and the other in 1967. Has a combination concrete and steel frame, exterior of curtain window wall, and concrete foundations. Contains 14 small laboratory work areas, 7 multi-use rooms, and 13 offices. Houses a complete medical clinic, some biomedical research, and an industrial hygiene laboratory.

Building 27. Cable Shop and High Voltage Test

Area 3,288 sq. ft. Population 2

A one-story building completed in 1948 with wood frame, exterior transite siding, and concrete floor and foundations. Contains five shops and two offices. Activities consist of testing and processing cables for the entire laboratory and high-voltage testing of transformers and electrical components.

Building 29. Instrument Science Engineering and Biomedical Research

Area 10,576 sq. ft. Population 32

A two-story building, with a small partial basement at one end, completed in 1947. Has a wood frame, exterior wood siding, and a concrete foundation. Contains 15 laboratories, 5 multi-use rooms, and 21 offices. Houses two groups, science and engineering, and biomedical research.

Building 37. Utilities Service

Area 1,024 sq. ft. Population 0

A small one-story concrete block building built in 1962. Contains a water treatment laboratory and shop. Activity serves the water treatment systems of all the LBL cooling towers.

Building 40. Electronics Warehouse

Area 994 sq. ft. Population 0

A small one-story metal building with a concrete floor completed in 1947. Used to store electronic equipment that is to be tested or modified.

Building 41. Electronics Drafting

Area 994 sq. ft. Population 0

Building is being remodeled and will house computer-aided design and photoplotting.

Building 42. Earth Sciences Field Test Facility

Area 1,214 sq. ft. Population 4

Used for servicing the Earth Science mobile laboratories' trucks.

Building 43. NBTF Guest Experimenters

Area 929 sq. ft. Population 1

Used to house NBTF guest experimenters.

Building 44. Indoor Air Pollution Studies

Area 800 sq. ft. Population 1

A small one-story prefabricated metal building with a concrete floor completed in 1957. Used for indoor air pollution studies.

Building 45. Fire Apparatus

Area 1,691 sq. ft. Population 0

A small one-story prefabricated metal building with a concrete floor completed in 1970 and extended in 1983. Used as garage for fire engines and the LBL's ambulance - Rescue 18.

Building 46. Accelerator Development and Real Time-Systems Group

Area 41,833 sq. ft. Population 94

A long, narrow building 1-1/2 stories high, completed in 1949. Has a steel frame, exterior transite siding, and concrete floor and foundation. Contains 12 laboratories, 6 technician shops, 6 computer rooms, storage space, and 52 offices. Used by the Real Time Systems Group, ALS Design Group, and superconducting magnet development.

Building 46A. Real Time Systems Group

Area 5,504 sq. ft. Population 47

A prefabricated one-story building, erected in 1977, that houses Real Time Systems engineering staff.

Building 47. Advance Accelerator Study

Area 6,132 sq. ft. Population 27

A two-story building completed in 1957 with the first story being a reinforced-concrete structure (including foundation) and the second story having a steel frame and exterior metal window wall. Contains 22 offices and 2 computer rooms. Houses staff for design studies on advanced accelerator systems and heavy ion fusion development.

Building 48. Fire Station

Area 4,221 sq. ft. Population 21

A two-story, concrete block structure built in 1981 that is the headquarters for the LBL Fire Department. Includes a dispatcher's office with radio contacts, a training room, dormitory, kitchen, lounge, and showerroom, as well as general offices.

Building 50A. Physics and Director's Office

Area 67,859 sq. ft. Population 217

An L-shaped building with two rectangular wings, one having two stories with a partial basement, and the other having six stories with a partial basement, completed in 1962. Building is a reinforced-concrete structure (including the exterior walls) with an elevator. Contains 4 computer equipment rooms, 3 laboratories, and 147 offices. Air conditioning is supplied to the entire building. Houses the Director's Office (administrative headquarters of LBL), Office of the Associate Director for Planning and Development, the headquarters of the Engineering and Technical Services and Administration divisions, a portion of the Computer Center, and physics, computer science and mathematics research groups.

Building 50B. Physics and Computer Center

Area 64,985 sq. ft. Population 225

Identical to Building 50A, except for less basement and first-story space, completed in 1967. Contains 10 computer equipment rooms, 5 laboratories, and 112 offices. Air conditioning is available throughout the entire building. Houses the Central Computer Center, computer science and mathematics groups, physics research groups, electronics support, and the Central Library administration.

Building 50C. Office Building

Area 2,964 sq. ft. Population 16

Erected in 1980, houses the Computer Center staff and the Center for Advanced Materials Divisions Office.

Building 50D/50E. Office Building

Area 5,010 sq. ft. Population 24

A single-story prefabricated building with air conditioning. Erected in 1979. Houses MMRD molecular interactions program and a nuclear science group.

Building 51. Bevatron

Area 153,897 sq. ft. Population 97

A building complex that evolved over 20 years. Original building, completed in 1950, consisted of a high multi-sided structure that is almost round with a rectangular wing of the same height joining the circular portion on a tangent. In 1957, an addition to the experimental area was added in the form of an arc on a portion of the circular building, then in 1967 the External Particle Beam Hall was added as a rectangular wing perpendicular to the arc addition. Structures are all the same height (crane hook height of 35 feet) and are a combination of reinforced-concrete and steel frames. Exterior walls are transite except for the hall, which has metal siding. All buildings have 30-ton cranes. Complex houses the Bevatron, all its supporting equipment and functions, including the heavy, thick concrete shielding walls and caves, the extensive utility systems, and the experiment areas for basic research in heavy ion nuclear physics, biomedicine, and astrophysics.

Building 51A. Bevatron Annex

(See Building 51)

Building 51B. External Particle Beam (EPB) Hall

(See Building 51)

Building 52. Magnetic Fusion Energy Laboratory

Area 6,737 sq. ft. Population 3

A single-story, prefabricated metal building with reinforced-concrete floor and foundations completed in 1949. Contains three laboratories, two electronics shops, a high bay, and three offices. Houses the MFE Electronics Shop and Fabrication area as well as the power supply for the Building 16 Test Stand.

Building 53. Accelerator Development

Area 6,806 sq. ft. Population 5

A two-story building completed in 1949. Lower story is a reinforced-concrete structure and upper story is prefabricated metal of medium high-bay height. Contains three laboratories, one computer room, eight shops, and three offices. Entire building is devoted to testing and development of accelerator components.

Building 54. Cafeteria

Area 11,662 sq. ft. Population 7

An irregular-shaped building with original part completed in 1950, with additions in 1959 and 1965. Building is a combination of reinforced concrete, some steel framing, and window walls. Contains complete food preparation, storage, and serving facilities. Provides meals (breakfast and lunch) and food service for special laboratory meetings.

Building 55. Research Medicine

Area 14,135 sq. ft. Population 29

A two-story building with the original part completed in 1951, with additions in 1956, 1967, and 1984. Has a reinforced-concrete structure and concrete block exterior walls. Contains 11 laboratories, 5 computer rooms, and 24 offices, and is used by the biomedical research program and serves as the patient support area for the heavy ion radiotherapy program at the Bevatron.

Building 56. Cryogenic Facility

Area 1,148 sq. ft. Population 0

Cryogenic support facility for the Bevatron.

Building 58. Accelerator Research and Development

Area 9,545 sq. ft. Population 14

A rectangular complex of structures tied to an original building completed in 1951 with additions in 1970. Original building has a medium high bay with a partial basement, a combination steel frame, and reinforced-concrete structures, and prefabricated metal buildings. Complex contains electronic fabrication shops and five drafting offices. Activities are related to development of apparatus for the advanced accelerator systems, such as testing superconductive devices.

Building 58A. Accelerator Research and Development Addition

Area 11,484 sq. ft. Population 2

Used for prototype development of advanced accelerator components and heavy ion fusion devices.

Building 60. High Bay Laboratory

Area 3,400 sq. ft. Population 0

A steel frame high-bay building with sheet metal walls. A crane was built in 1979 and is used for heavy experimental set-ups.

Building 61. Standby Propane Plant

Area 323 sq. ft. Population 0

A single-story prefabricated metal building built in 1969, housing the auxiliary equipment for the standby gas plant. Facility has a 30,000-gallon pressurized tank for storage of propane gas.

Building 62. Materials and Molecular Research

Area 54,058 sq. ft. Population 160

An L-shaped reinforced-concrete building completed in 1965. Central air conditioning is available in two rectangular wings. One wing has three stories and a partial basement and the other wing is of medium high-bay height with a 10-ton crane. Building contains 56 laboratories, an auditorium, mechanics shops, a small library, and 56 offices. Building houses the administrative headquarters of the Materials and Molecular Research Division, and chemistry, chemical engineering, nuclear engineering, ceramics, solid-state physics, and metallurgy research groups.

Building 63/63A. Accelerator Division

Area 2,611 sq. ft. Population 5

A single-story prefabricated metal building set on a concrete slab, completed in 1963. Contains an experimental target laboratory, and an electronics installation shop, both in direct support of the Bevatron experimental program.

Building 64. Accelerator Division

Area 22,995 sq. ft. Population 37

A rectangular building complex with two two-story wings; a high-bay wing was completed in 1951. The other two-story wing was added in 1956; it contains a large equipment room (high-bay space) for a linear accelerator injector for the Bevatron, 3 mechanics technician shops, 2 computer terminal rooms, and 35 offices, all devoted to Bevatron operations and its experimental program.

Building 65. Administration Computing

Area 3,306 sq. ft. Population 11

A small rectangular single-story building with full basement, built in 1957. Basement is a reinforced-concrete structure and the first story has a wood and steel frame with exterior transite siding. Contains two multi-use rooms and nine offices. Used to house the administrative computing group.

Building 68. Upper Pump House

Area 500 sq. ft. Population 0

Houses the diesel pumps for the emergency standby water tanks.

Building 69/69A. Supply Services

Area 15,619 sq. ft. Population 47

A rectangular complex of structures with a medium high-bay reinforced-concrete building, including a raised loading dock and a flammable gas and liquid storage facility that was built in 1969. A Butler-type addition with steel frame was added in 1979. Building has a mezzanine at one end, 2 large storage areas, and 14 offices. Used for transportation, shipping, and receiving, and includes the central mail room as well as record storage and the salvage operation.

Building 70. Nuclear Science and Applied Science

Area 62,253 sq. ft. Population 174

A reinforced-concrete, air conditioned two-story building completed in 1955. Contains a radioactive storage facility, 40 wet laboratories, 26 dry laboratories, an electronics shop, and 113 offices. Is devoted to research groups in nuclear theory and heavy ion physics, applied sciences, chemical process and environmental research, and earth science, geophysics, geomechanics, and geochemistry.

Building 70A. Nuclear Science, Materials, Molecular Research and Earth Science

Area 67,934 sq. ft. Population 144

A reinforced-concrete, four-story building with central air conditioning available. Was completed in 1961 and is connected to Building 70 by a covered walkway. Has 58 laboratories, 4 shops, and 110 offices. Houses the MMRD program in chemical physics and the Earth Science program in geochemistry as well as the administrative headquarters of the Nuclear Science Division.

Building 71. Heavy Ion Linear Accelerator (SuperHILAC)

Area 53,827 sq. ft. Population 62

A rectangular building complex with air conditioning in the original building, which was completed in 1956. Eight additions made to date, with one more planned. Complex is a combination of three-story high-bay space with a 10-ton crane, two-story office-laboratory space, and a single-story equipment space. Construction is a combination of reinforced-concrete and steel frame with concrete and metal siding exterior. Building contains an accelerator room with a large experimental area made up of heavily shielded caves, 2 injector rooms, a technician machine shop, 22 laboratories, 6 computer rooms, 17 shops, and 35 offices. Entire building is devoted to the SuperHILAC operating and experimental program, which is primarily concerned with heavy ions.

Building 71A. SuperHILAC Rectifier

Area 3,500 sq. ft. Population 0

A reinforced-concrete and steel structure completed in 1965. Houses power supplies and utility components for the SuperHILAC.

Building 71B. SuperHILAC Annex

Area 7,187 sq. ft. Population 21

Houses the mechanical support shop for the SuperHILAC and provides offices and conference rooms for residents and outside users of this national facility.

Building 72. National Center for Electron Microscopy

Area 7,996 sq. ft. Population 11

A combination one- and two-story high-bay building completed in 1961 with a major addition in 1983. There is also a three-level steel structure of 4,000 gross sq.

ft. containing a vibration isolation support system. Building 72 houses the Atomic Resolution Microscope (ARM), and the High Voltage Electron Microscope, and it is a national facility for research in chemical and materials science. Complex also contains a 20-k high-resolution electron microscope and associated equipment for ARM such as a microdensitometer and a minicomputer.

Building 73. Atmospheric Aerosol Research

Area 4,304 sq. ft. Population 11

An L-shaped building, completely air conditioned, with two rectangular wings, one completed in 1961 and the other in 1967. The whole structure is wood except for concrete footings. Has a spectrometer room and a laser room, four laboratories, one conference room, and six offices. Activities are devoted to studies in chemical physics using the electron spectrograph and the laser facility.

Building 74. Biomedical Laboratory

Area 42,842 sq. ft. Population 40

A complex of completely air conditioned buildings with the original two-story one being completed in 1962, a three-story addition in 1964, and a single-story parallel wing added in 1968. In 1983, a new 8,000-sq. ft. addition was constructed, which provides for staff and animal needs. Structures are of reinforced concrete, concrete block, and steel frames. There are exterior animal runs, a cobalt-60 gamma irradiation facility, 32 laboratories, 28 animal rooms, 1 computer room, and 32 offices. Entire complex is devoted to biomedical research involving various types of animals.

Building 74B. Biomedical Laboratory Annex

Area 3,752 sq. ft. Population 6

Contains additional biomedical laboratories and offices as well as an isotope processing laboratory.

Building 75. Radioisotope Services

Area 8,545 sq. ft. Population 12

A single-story building completed in 1961, with an addition in 1964. Structure is concrete block with reinforced-concrete floors and foundations. Contains a large decontamination facility, a storage vault for radioisotopes, five laboratories, and five offices; some areas are air conditioned. Building is used by the Environmental Health and Safety Service development and monitoring for handling radioactive materials and decontamination as well as monitoring for environmental hazards. Also houses the National Tritium Labeling Facility.

Building 76. Craft and Maintenance Shops

Area 26,577 sq. ft. Population 138

A two-story building completed in 1964. Lower story is a reinforced-concrete structure and upper story is a combination of steel and concrete block. Contains an automotive maintenance center, storage space, 9 maintenance and craft shops, and 16 offices. Houses the central shops, activities of the Construction and Maintenance Department, as well as automotive maintenance shops.

Building 77. Mechanical Shops

Area 66,762 sq. ft. Population 98

A large three-story building with high-bay space for crane access. Structure is a combination of reinforced concrete and steel with exterior metal siding. Contains two mezzanines and the following central mechanical shops: welding (10-ton crane), sheet metal (5-ton crane), machine (including two heavy-duty 5-ton cranes and a precision 2-ton crane), assembly (15-ton crane), glass, plastic, and plating. There are also 10 offices. The whole is devoted to the activities of the LBL's main mechanical shops.

Building 78. Craft Stores

Area 5,373 sq. ft. Population 0

A long, narrow, single-story building completed in 1966. Structure is reinforced concrete and has series of large doors on one face. Contains 10 storage areas. Used for storage of materials by the Construction and Maintenance Department.

Building 79. Metal Stores

Area 4,278 sq. ft. Population 0

A high-bay space completed in 1965. Structure is a prefabricated metal building erected on a heavy-duty reinforced-concrete slab. Contains a large, open storage space and an office, and is used to store material for the central mechanical shops.

Building 80. General Research Laboratory

Area 24,497 sq. ft. Population 39

A rectangular building completed in 1955 with a reinforced-concrete full basement and a two-story high-bay space with a 15-ton crane. Upper story has a steel frame with exterior metal walls. In 1957 a mezzanine was added to the high-bay area. There are 2 electronic technician shops, 15 shops, a large high-bay staging area for experimental apparatus, the 184-inch Synchrocyclotron control room, 13 laboratories, and 21 offices. High bay is used for staging Physics and AFRD experimental set-ups; also houses the Berkeley X-ray Optics Group.

Building 80A. Telephone Services

Area 947 sq. ft. Population 8

Houses Telephone Services, including the telephone consoles and switching gear and TWX and TELEX services.

Building 81. Liquid Gas Storage

Area 1,124 sq. ft. Population 1

A gas storage shelter with a concrete revetment for a large pressure tank, completed in 1967. Shelter structure is steel framing and metal siding. Used to store and handle hydrogen.

Building 82. Lower Pump House

Area 520 sq. ft. Population 0

Houses diesel motor pumps for the emergency water supply.

Building 83. Cell Culture Laboratory I

Area 6,875 sq. ft. Population 16

A single-story wood frame structure that houses the Chemical Biodynamics and Biology and Medicine tissue culture facilities with supporting laboratories, offices, and meeting rooms.

Building 88. 88-Inch Cyclotron

Area 52,188 sq. ft. Population 57

A rectangular building of varying height completed in 1960. Additions to the original building were made in 1968 and 1970. Building has a basement, a one-story section, a two-story section, and a three-story high-bay section. Structure is a combination of reinforced concrete and steel with exterior walls of concrete and metal siding. High bay has a 30-ton crane. Building contains the high-bay space for the 88-Inch Cyclotron and experimental area, a control room, electronic and mechanical technician shops, 8 laboratories, 7 computer rooms, 2 conference rooms, and 35 offices. Entire building is devoted to the operations and experimental programs of the 88-inch Cyclotron in experimental light and heavy ion research.

Building 90. Earth Sciences, Applied Science, Administration, Engineering

Area 88,271 sq. ft. Population 454

A large four-story building with a partial basement completed in 1960, with additions in 1961 and 1967. Building has concrete floors and foundations with a structural steel frame and exterior curtain window walls. Building has an elevator, and a few spaces are air conditioned. Contains a large conference room, a photographic laboratory and processing unit, a large engineering print room, drafting rooms, and 239 offices. Houses the Applied Science Division and Earth Science Division administrative offices as well as Personnel, Accounting, the Mechanical Engineering Department, the Plant Engineering Department, the Technical Information Department, and the Protective Services Department.

Source: LBL, 1984

PRELIMINARY

REFERENCE FOR APPENDIX E

LBL (Lawrence Berkeley Laboratory), 1984. LBL Site Development Plan (Working Draft), Lawrence Berkeley Laboratory, Berkeley, California.

PRELIMINARY

APPENDIX F

**ANALYSES OF EBMUD SOURCE AND
FINISHED WATERS**

PRELIMINARY

APPENDIX F

ANALYSES OF EBMUD SOURCE AND FINISHED WATERS

Constituent or Property*	Unit	Maximum Contaminant Level	Source Waters (Pardee Reservoir)	Finished Waters (Orinda)
Alkalinity (CaCO ₃)	mg/L		18	22
Bicarbonate (HCO ₃)	mg/L		18	27
Boron	mg/L		0.04	0.04
Bromide	mg/L		<0.05	<0.05
Calcium	mg/L		4.3	8.1
Carbonate (CO ₃)	mg/L		<0.3	0.3
Chloride	mg/L	250 ⁽²⁾	1	3
Color	ACU	15 ⁽²⁾	7	4
Detergent (MBAS ⁽¹⁾)	mg/L	0.5 ⁽²⁾	<0.03	<0.03
Fluoride	mg/L		0.01	0.92
Hardness as constituent				
Total (CaCO ₃)	mg/L		18	24
Non-Carbonate (CaCO ₃)	mg/L		0	2
Carbonate (CaCO ₃)	mg/L		18	22
Iodide	mg/L		<0.01	<0.01
Magnesium	mg/L		1.9	1.3
Nitrate (NO ₃ N)	mg/L	10 ⁽³⁾	<0.01	<0.01
Nitrite (NO ₂ N)	mg/L		<0.01	<0.01
pH	--	6.5-8.5 ⁽²⁾	6.9	7.7
Phosphate (PO ₄ -P)	mg/L		<0.02	<0.02
Potassium	mg/L		0.8	0.77
Silica (SiO ₂)	mg/L		12	11
Sodium	mg/L		2.1	2.2
Specific Conductance	µmho/cm	900 ⁽²⁾	48	63
Sulfate (SO ₄)	mg/L	250 ⁽²⁾	1.2	2.7
Total Dissolved Solids	mg/L	500 ⁽²⁾	46	46

APPENDIX F

ANALYSES OF EBMUD SOURCE AND FINISHED WATERS (Continued)

Constituent or Property*	Unit	Maximum Contaminant Level	Source Waters (Pardee Reservoir)	Finished Waters (Orinda)
METALS				
Aluminum	µg/L		90	250
Arsenic	µg/L	50(3)	<3	<3
Barium	µg/L	1,000(3)	10	7
Beryllium	µg/L		<0.2	<0.2
Cadmium	µg/L	10(3)	<0.1	<0.1
Chromium	µg/L	50(3)	<0.7	5.1
Cobalt	µg/L		2	<2
Copper	µg/L	1,000(2)	<7	<7
Iron	µg/L	300(2)	20	20
Lead	µg/L	50(3)	<3	<3
Lithium	µg/L		0.6	1.8
Manganese	µg/L	50(2)	4	<0.6
Mercury	µg/L	2(3)	0.3	<0.2
Molybdenum	µg/L		<3	<3
Nickel	µg/L		<3	<3
Selenium	µg/L	10(3)	<6	<6
Silver	µg/L	50(3)	0.4	<0.3
Strontium	µg/L		20	30
Zinc	µg/L	5,000(2)	<10	<10
ORGANIC CHEMICALS⁽⁴⁾				
Chlorinated Hydrocarbons				
Aldrin	µg/L		0.04	ND
BHC isomers (lindane)	µg/L	4(3)	0.03	ND
Chlordane	µg/L		0.20	ND
DDE	µg/L		0.04	ND

APPENDIX F

ANALYSES OF EBMUD SOURCE AND FINISHED WATERS (Continued)

Constituent or Property*	Unit	Maximum Contaminant Level	Detection Limit	Source Waters (Pardee Reservoir)
DDD	µg/L		0.1	ND
DDT	µg/L		0.1	ND
Dieldrin	µg/L		0.04	ND
Endrin	µg/L	0.2(3)	0.06	ND
Heptachlor	µg/L		0.03	ND
Heptachlor epoxide	µg/L		0.08	ND
Hexachlorobenzene	µg/L		NS	NS
Methoxychlor	µg/L	100(3)	0.05	ND
PCNB	µg/L		NS	NS
PCB (Aroclors 1242-1260)	µg/L		1.0	ND
Toxaphene	µg/L	5(3)	2	ND
Herbicides				
2,4-D	µg/L	100(3)	0.5	ND
2,4,5-T	µg/L		0.1	ND
Tritium	pCi/L	20,000(3)	1,000	ND
Strontium-90	pCi/L	8(3)	2	ND
2,4,5-TP Silvex	µg/L	10(3)	0.1	ND
RADIONUCLIDES(5)				
Gross Alpha	pCi/L	15(3)	0.1	ND
Gross Beta	pCi/L	50	0.1	ND
Tritium	pCi/L	20,000(3)	1,000	ND
Strontium-90	pCi/L	8(3)	2	ND

Source: EBMUD, 1987

ND = Not Detected

NS = Not Sampled

(1) MBAS - Methylene Blue Active Substances

(2) Secondary Standard based on Consumer Acceptance rather than health considerations

(3) Primary Drinking Water Standard

(4) Samples Collected July 1986. Finished waters (Orinda) not sampled.

(5) Samples Collected June 1983 (required every 4 years). Finished waters (Orinda) not sampled.

* Samples collected May 1986 unless otherwise noted

REFERENCE FOR APPENDIX F

EBMUD (East Bay Municipal Utility District), 1987. LBL Potable Water Source, East Bay Municipal Utility District, Oakland, California.

PRELIMINARY

APPENDIX G

**HISTORY OF WASTE DISPOSAL AT THE
FARALLON ISLANDS**

PRELIMINARY

APPENDIX G

HISTORY OF WASTE DISPOSAL AT THE FARALLON ISLANDS

During the Environmental Survey of the Lawrence Berkeley Laboratory (LBL), the team was informed that in the early years of its operation, the LBL disposed of radioactive waste at an ocean site known as the Farallon Islands. The historical records of this disposal practice are no longer stored at the LBL facility; consequently, the U.S. Environmental Protection Agency (EPA) Office of Radiation Programs was contacted to furnish information on the history of radioactive waste disposal at sea, particularly with respect to the past practices of the LBL. This appendix provides an overview of the primary ocean disposal sites off the coast of the United States that were used for radioactive waste disposal, as related by EPA. More specific information is provided on the types and quantities of radioactive waste shipped from the LBL for disposal at the Farallon Islands site.

Overview of Ocean Disposal of Radioactive Waste

In 1946, the Atomic Energy Commission (AEC), predecessor to DOE, authorized disposal of low-level radioactive waste by ocean dumping. This practice continued until 1970; however, the majority of the waste was disposed of between the period of 1946 and 1962 (Dyer, 1976). The radioactive waste disposed of at sea was generated not only by DOE-sponsored activities, but also by a number of commercial businesses. The following list provides a summary of the number of containers and the estimated radioactivity of the waste disposed of over the history of ocean dumping.

Year	Number of Containers	Radioactivity * (in Curies)
1946 to 1960	76,201	93,690
1961	4,087	275
1962	6,120	478
1963	129	9

Year	Number of Containers	Radioactivity * (in Curies)
1964	114	20
1965	24	5
1966	43	105
1967	12	62
1968	0	0
1969	26	26
1970	2	3
Total	86,758	94,673

Source: CEQ, 1970

* Inventory presented is the estimated activity at the time of disposal.

Three primary sites have been identified as receiving 90 percent of the low-level radioactive waste disposed of by ocean dumping, two in the Atlantic Ocean and one in the Pacific Ocean. The Atlantic sites are 115 and 200 miles off the Maryland-Delaware coast, respectively, and the Pacific site is in the vicinity of the Farallon Islands located about 40 miles off the coast of San Francisco, California. The Farallon Islands site consisted of two subsites, designated A and B.

Table G-1 provides information on the location of these three sites and summarizes the dates used and estimated quantities of waste disposed of at each site (Dyer, 1976). As shown in Table G-1, the Farallon Islands site received over 50 percent of the total number of containers of radioactive waste disposed of at sea. The radioactivity of the waste at the Farallon Islands site represents approximately 25 percent of the total inventory disposed of at these three primary sites. According to records available through EPA, the depth of the Farallon Islands Subsite A was determined to be too shallow, which accounts for its short period of use.

In the 1970s and the early 1980s, EPA participated in several Congressional hearings on the subject of past ocean disposal of radioactive waste. In the 1976 testimony before the Subcommittee on Conservation, Energy, and Natural Resources, EPA personnel provided the following assessment regarding the risk associated with the ocean disposal sites:

TABLE G-1

PRIMARY OCEAN DISPOSAL SITES FOR RADIOACTIVE WASTES

Site	Coordinates	Depth (ft)	Distance from Land (mi)	Years Dumpsite Used	Estimated No. of 55-Gallon Drums Dumped	Estimated Activity in Drums at Time of Packaging (Ci)
Atlantic	38°30'N 72°06'W	9,000	118	1951-1956 1959-1962	14,300	41,400 ^a
Atlantic ^b	37°50'N 70°35'W	12,500	200	1957-1959	14,500	2,100
Pacific Farallon Islands (Subsite A)	37°38'N 123°08'W	3,000	37	1951-1953	3,500	1,100
Farallon Islands (Subsite B)	37°37'N	5,500	48	1946-1950 1954-1965	44,000	13,400

Source: Dyer, 1976

a This does not include the pressure vessel of the N/S Seawolf reactor with an estimated induced activity of 33,000 Ci.

b This site had not yet been investigated by EPA based on the 1976 reference.

- "We can't see how there is any pathway that is going to harm man at the present time, or in the future."
- "We are convinced that the public health problem is, indeed, minimal."
(Subcommittee on Conservation, Energy, and Natural Resources, 1976).

The information on the Farallon Islands disposal site that was available to the Survey team for review was insufficient to support a complete assessment of the potential risks associated with the site.

Description of the Farallon Islands Radioactive Waste Disposal Site

The area designated by the AEC as the Farallon Islands radioactive waste disposal site occupies approximately 350 square miles and is depicted on Figure G-1 (NOAA, 1987). According to EPA, the boundaries of the disposal site should not be considered definitive because the ocean currents influenced where the waste containers eventually settled on the ocean floor after being dumped off the ships or barges (Dyer, 1988). Another area adjacent to and overlapping the Farallon Islands radioactive waste disposal site was a designated chemical munitions dump site. Also, several dredge spoil dump sites are located in the general vicinity of the Farallon Islands site.

The three main contributors of the radioactive waste disposed of at the Farallon Islands site were the Naval Radiological Defense Laboratory, the Lawrence Livermore National Laboratory (LLNL), and the LBL (Dyer, 1988). The Naval Radiological Defense Laboratory no longer exists and according to EPA personnel, there are no records available for review. EPA was successful in compiling documents from the LLNL and the LBL as part of an effort to quantify the waste disposed of at the Farallon Islands site. These documents show that a third DOE laboratory, currently known as the Laboratory for Energy-Related Health Research, also shipped a small amount of waste to the LBL for disposal at sea (Kaufmann, 1957).

A study was conducted at the Farallon Islands site in 1974 and 1975 that was successful in locating and photographing some of the 55-gallon metal drums containing radioactive waste on the ocean bottom. As shown in Table G-1, the

FIGURE G-1

LOCATION OF THE FARALLON ISLANDS
RADIOACTIVE WASTE DISPOSAL SITE

depth at Subsite A is approximately 3,000 feet and that at Subsite B is approximately 5,500 feet. At Subsite A, approximately 150 drums were located. Generally, there was some surface corrosion of the metal drums, but through probing, the metal appeared to be sound (Dyer, 1976). Estimates from EPA indicate that roughly 25 percent of the drums were imploded from the hydrostatic pressure, typically in the mid-section of the drum where the waste was located (Dyer, 1976; Dyer, 1988). The result of this implosion was to create space around the concrete plugs on each end of the drum which provided a conduit for the waste to be released.

The 1974/1975 study included collection and radiological analysis of sediment samples from Subsite A. Details of the study have been published by EPA in the referenced 1976 Dyer report. In summary, the results show that the bottom sediments have been contaminated by plutonium-238, 239, and 240. At one sample station near the group of imploded drums, the level of plutonium-239 and 240 contamination was reported to be over one order of magnitude higher than the expected average fallout values for sediments at this depth and in this area off the coast of California. The area of contamination appeared to be localized around the drums, according to the study results. Elevated levels of cesium-137 and plutonium were also detected at another sample station; however, the source of this contamination was uncertain as there were no drums noted near the sample location. In addition, it was concluded that the source of this contamination was probably not the 150 drums because the ratio of plutonium-238 to plutonium-239/240 was different from that found next to the drums. The report stated that "bioturbation is the most probable factor in the redistribution of plutonium" in the sediments at the Farallon Islands site (Dyer, 1976).

Description of LBL Waste Disposed of at the Farallon Islands

The LBL disposed of radioactive waste through ocean dumping from 1946 to approximately 1963. Over this period, there were basically two types of packaging used to contain the waste - metal drums and concrete blocks. Typically, the waste was placed in the middle of a 55-gallon drum and a concrete plug was placed on each end or the whole drum was filled with concrete. The concrete served as shielding and added the necessary weight (i.e., 550 pounds) to ensure that the drum would sink. Items that were too large to be placed in a drum were placed in concrete blocks. Generally, a form was constructed to match the size of the item.

The item was placed in the middle of the form and concrete poured to surround it, and reinforced with steel as necessary (Kaufmann and Garden, 1958).

Both solid and liquid wastes were packaged for sea burial. The solid waste included items such as contaminated glassware, rubber gloves, paper wipes, various items that had been used in glove boxes, and wastes from animal injection experiments. Large items such as contaminated glove boxes were also disposed of as solid radioactive waste. Equipment and parts that had induced radioactivity as a result of being used in experiments with the accelerator were also disposed of at the Farallon Islands site (Kaufmann and Garden, 1958).

Available records do not specifically describe the types of liquid radioactive waste collected and shipped off-site for ocean disposal. Some of the waste was generated from experiments with plutonium that were conducted in the Gilman Hall building, located on the University of California at Berkeley (UCB) campus (Salo, 1947). Other wastes were generated in buildings on the LBL from various purification and chemical separation experiments involving a number of different radioisotopes. In addition, the LBL received waste from the University of California campuses at San Francisco, Berkeley, and Davis (Garden, 1957).

One LBL document classified the liquid waste into one of three groups: high-level, low-level, and organic. The estimated ratio of waste in each group is listed below:

- High-level 10%
- Low-level 80%
- Organic 10%

Source: Kaufmann and Garden, 1958

The waste that was considered to be high activity was solidified inside a glove box or discharged into special shielded containers before being placed inside a drum or a concrete block. Either concrete or vermiculite was used to solidify the waste. Low activity waste was collected in carboys and transported to the Radioactive Waste Staging and Storage Area (see Section 4.5.1.2) where batches of about 15 gallons were solidified and packaged in a 55-gallon drum. Water-immiscible organic wastes were handled in one of two ways. One method was to mix small quantities of the organic waste, reportedly 3 percent of the total volume, with other aqueous waste

and then to solidify the mixture with cement and/or vermiculite. The other method was to use Napalm to solidify the organic waste (Kaufmann and Garden, 1958).

Records of the total volume of waste disposed of by the LBL at the Farallon Islands are incomplete. The earliest record found of ocean disposal by the LBL is a memorandum which states that 14 55-gallon drums, two of which contained plutonium waste, and 7 small garbage cans filled with assorted waste were disposed of at sea on December 18, 1946 (Salo, 1947). Table G-2 is an excerpt from a 1956 LBL memorandum (O'Dea, 1956) and was found to be the most complete tabulation of the waste shipped to the ocean disposal site from the LBL. This list covers the period from 1947 to March 1956 and indicates that a total of 5,642 drums and 129 concrete blocks were disposed of at the ocean site. Between 1955 and 1958, the yearly average volume of radioactive waste generated over the three-year period, according to one LBL report (Kaufmann and Garden, 1958), was as follows:

- Solid Wastes (unprocessed dry volume) = 4,000 ft³
- Liquid Waste (volume before solidification) = 1,000 gallons

The quantity of waste disposed of by the LBL between 1958 and the early 1960s was not available in the historical documentation, but as discussed in the report by the Council on Environmental Quality (CEQ), the general trend by this time was that the quantity of waste was decreasing. Given that the total number of containers disposed of at the Farallon Islands site is estimated to be 47,500, the available LBL records indicate that the number of waste containers shipped from the LBL facility probably accounts for no more than 10 to 20 percent of the total waste disposed of at the Farallon Islands site.

TABLE G-2
SUMMARY OF RADIOACTIVE WASTE DISPOSED OF AT SEA
BY THE LBL FROM 1947 TO 1956

Year	Number of Drums	Number of Blocks	Dumping Depth in Fathoms	Remarks*
1956 thru March	310	4	1000	Loose material from 184" cyclotron dumped in this period.
1955	922	12	1000	3 large paydirt tanks of active pipes, and the pressed dust from 4 were dumped.
1954	721	13	Changed back to 1000	7 of these blocks were the boxes from the first Livermore Cm run.
1953	990	17	500	
1952	798	11	500	
1951	711	12	Changed to 500	In February we started using the barge. From this time on a block usually contained 4 boxes and weighed 10 tons.
1950	547	25	1000	Until 10/15/50 we used the Army Engineers boat for dumping; after that we used the Navy's boat, and we put 81 drums on the Independence before it was towed to sea.
1949	306	20	1000	During this year we made 10 trips to dump contaminated equipment accumulated during the war.
1948	221	10	1000	
1947	116	5	1000	

Source: An excerpt from O'Dea, 1956

* This does not include any Livermore waste with the exception of the seven blocks containing the equipment from the first Livermore Cm run.

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