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Environmental Survey Preliminary Report

Laboratory for Energy-Related Health Research
Davis, California

March 1988

PREFACE
TO
THE DEPARTMENT OF ENERGY
ENVIRONMENTAL SURVEY PRELIMINARY REPORT
FOR THE LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH

This report contains the preliminary findings based on the first phase of a Survey at the Department of Energy (DOE) Laboratory for Energy-Related Health Research (LEHR) located at the University of California at Davis, California. The Survey is being conducted by DOE's Office of Environment, Safety and Health.

The LEHR 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 the results from the Sampling and Analysis phase of the Survey. The findings are also 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.

March 1988
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Introduction

This report presents the preliminary findings from the first phase of the Survey of the United States Department of Energy (DOE) Laboratory for Energy-Related Health Research (LEHR) at the University of California, Davis (U.C. Davis), conducted November 16 through 20, 1987.

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 LEHR. 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 LEHR, 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 a support contractor. When completed, the results will be incorporated into the Environmental Survey Interim Report for the LEHR at U.C. Davis. The Interim Report will reflect the final determinations of the LEHR Survey.

Site Description

The LEHR facility occupies an area of approximately 15 acres and is located on the campus of the U.C. Davis in Solano County, California. U.C. Davis is 12 miles west of Sacramento, California, and 70 miles northeast of San Francisco, California. The LEHR facility, which opened in the late 1950s, is operated by the U.C. Davis for DOE. The structures of the LEHR are DOE-owned while the land is University-owned and leased to DOE. Portions of the present-day facility under lease by DOE were used in the past by U.C. Davis as a landfill for radioactive, chemical, and sanitary wastes.

The primary function of the LEHR has been to evaluate the biological effects of radiation (primarily strontium-90 and radium-226) on laboratory animals. With the culmination of the major strontium-90 and radium-226 experiments, DOE has announced that it will phase out the remaining DOE-sponsored activities (small-scale research programs) by the end of fiscal year 1989 and terminate the operating contract with U.C. Davis. As part of this phaseout, DOE's San Francisco Operations Office (SAN) and U.C. Davis have implemented a site characterization study to assess the potential environmental problems associated with the past operating practices. Currently, the field Sampling and Analysis tasks are ongoing. A decontamination and decommissioning project is targeted for startup in the second quarter of fiscal year 1989 and is expected to be completed by the end of fiscal year 1992.

<u>Summary of Findings</u>

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

- There are a number of deficiencies at the U.C. Davis Waste Packaging Facility that could result in mishandling and subsequent releases of hazardous, radioactive, and mixed wastes to the environment. The majority of the deficiencies were found in the area storing the LEHR/U.C. Davis waste. U.C. Davis and LEHR have taken steps to correct many of these deficiencies.

- Neither the LEHR, U.C. Davis, nor SAN has a complete listing of radioactive sources for the LEHR facility. This could result in an inadvertent release to the environment, improper disposal, or loss of radioactive material.

- Radioactive and chemical waste burial sites on the LEHR facility constitute potential sources of groundwater contamination. These burial sites include unlined trenches, pits, and holes covered with native soil and/or gravel.

- The Imhoff tanks, inactive septic tanks, and associated leach fields constitute potential sources of groundwater contamination.

- Soils in the southwest corner of the site may be contaminated with organic chemical substances.

- Soils in the dog pen areas at LEHR and the U.C. Davis campus (the site of the original U.S. Atomic Energy Commission beagle project) may be contaminated with chlordane that was sprayed in the pens to control fleas.

- Hazardous and radioactive constituents may have been discharged to the LEHR sewer system, resulting in contamination of the sewer lines at the LEHR and the sewer lines and sludges at the U.C. Davis Sewage Treatment Plant.

- The Cobalt-60 Irradiation Field may be the site of an old landfill, and may be a potential source of surface soil contamination.

Overall Conclusions

The Survey found no environmental problems at the LEHR facility that represent an immediate threat to human life. The environmental problems identified at the LEHR by the Survey team do confirm that the facility is affected by a number of chronic environmental problems. These problems vary in terms of their magnitude and risk, as described in this report. Although the Sampling and Analysis performed by the LEHR Survey will assist in further identifying environmental problems at the facility, 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 of Results

The findings of the Environmental Survey of the LEHR were shared with SAN and the site contractor at the Survey closeout briefing held November 20, 1987. By February 1988, SAN had developed a draft action plan to address the Survey preliminary findings. The Operations Office is expected 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 of receiving this Preliminary Report. Those problems that involve extended studies and multi-year budget commitments will 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 has immediate responsibility for monitoring environmental compliance and the status of the LEHR Survey findings. The Office of Environmental Audit will continue to assess the environmental problems through the program of systematic environmental audits that will be initiated toward the conclusion of the DOE Survey in 1989.

1.0 INTRODUCTION

The purpose of this report is to present the preliminary findings made during the Survey, November 16 through 20, 1987, at the Department of Energy (DOE) Laboratory for Energy-Related Health Research (LEHR), Davis, California. The University of California at Davis operates LEHR for DOE.

The LEHR Survey is part of the larger DOE-wide 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 means of identifying existing and potential environmental problems.

The LEHR 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 LEHR 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.

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 LEHR Survey will be Sampling and Analysis (S&A). The Idaho National Engineering Laboratory (INEL), the S&A team for the LEHR, will collect samples over a 2- or 3-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 to address the preliminary findings presented at the conclusion of the on-site Survey activities and summarized in the LEHR Survey Status Report prepared for the Assistant Secretary for Environment, Safety and Health. The draft action plan for the LEHR 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 of receiving this Preliminary Report. The final action plan for the LEHR Survey will address all of the preliminary findings cited herein, and incorporate OEG's comments on the draft action plan.

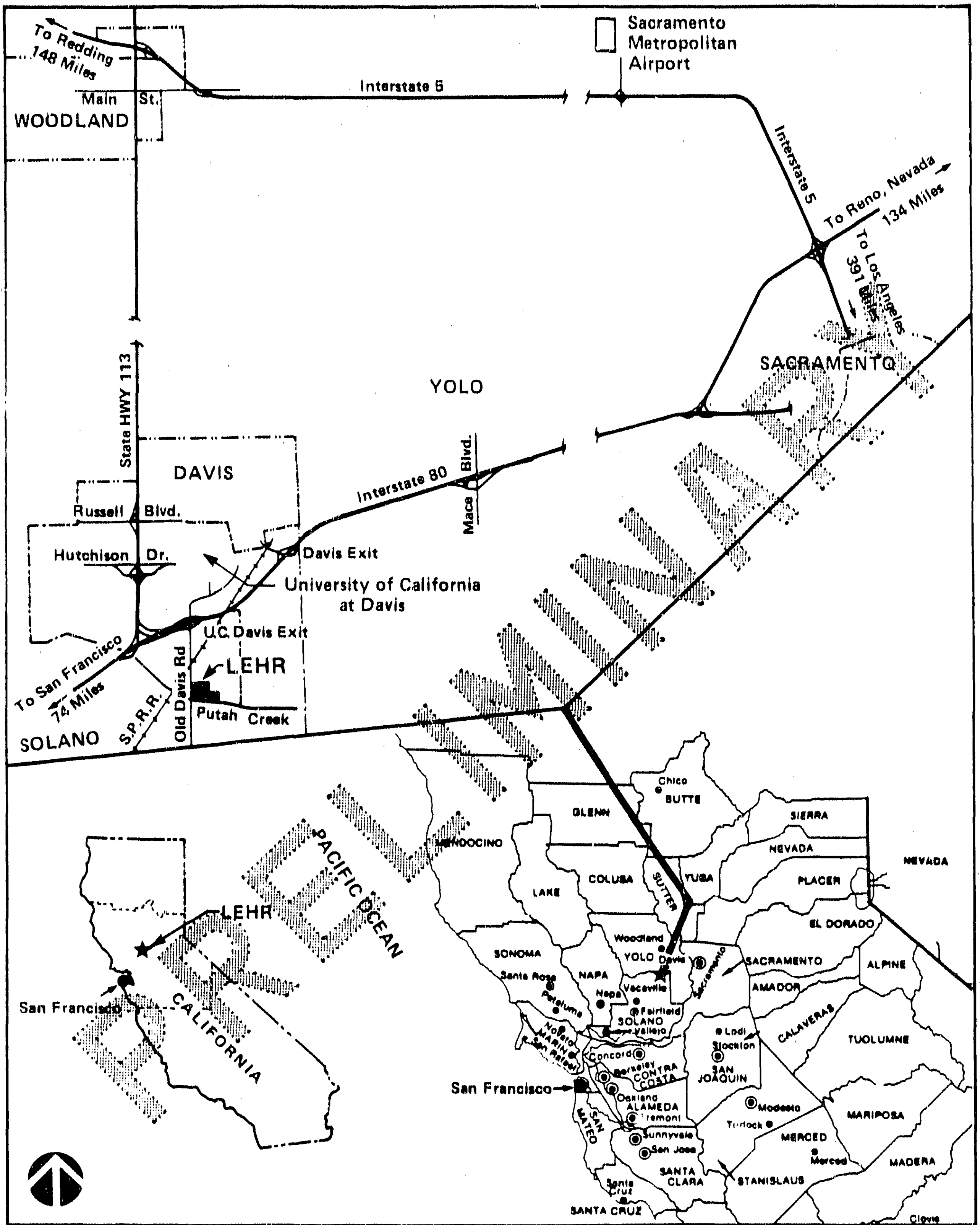
2.0 GENERAL SITE INFORMATION

2.1 Site Setting

The Laboratory for Energy-Related Health Research (LEHR) is located on the campus of the University of California at Davis (U.C. Davis) approximately one-half mile south of Interstate 80 on County Road 79 in Solano County, California. The LEHR at U.C. Davis encompasses approximately 15 acres in an area designated as appropriate for animal research. The site is rural and is located in the southeast quadrant on a remote portion of the campus. Figure 2-1 is a general location map.

The buildings, consisting of laboratory and office space, and animal handling facilities, are titled in the name of the DOE while the land at the LEHR facility is University-owned. The site is associated with the School of Veterinary Medicine and is operated by U.C. Davis for DOE. The San Francisco Operations Office (SAN) is responsible for the oversight of LEHR operations. Construction of the LEHR began in 1958 and operations began in 1960. The major DOE projects at the LEHR are near completion; consequently, DOE has announced its intent to phase out the remaining small-scale projects by the end of fiscal year 1989 and to terminate the operating contract with U.C. Davis. As part of this plan, DOE will conduct a decontamination and decommissioning (D&D) project at the LEHR for the eventual release of the property. The D&D project is targeted for completion by the end of fiscal year 1992. Most of the ongoing experimental work at the LEHR is related to research projects for professors and students at U.C. Davis or for other agencies and/or affiliations. There is a full-time-equivalent staff of approximately 58, of which only a few are principal investigators for DOE.

The LEHR is bounded on the west, east, and north by U.C. Davis property. The southern border of the facility is a levee on the north side of the South Fork of Putah Creek. The LEHR is located on the U.C. Davis campus, which in 1987 had an enrollment of 19,444 students, 4,569 non-student employees, and approximately 2,800 on-campus residents. Sacramento, California, is approximately 12 miles east of the LEHR. San Francisco, California, lies approximately 70 miles to the southwest. The average population density in the counties that surround the LEHR ranges from 112 to 806 people per square mile. Major population centers within approximately a 25-mile radius of the LEHR are listed below (U.S. Bureau of the Census, 1983).



Source: Adapted from LEHR, 1987

GENERAL LOCATION MAP OF THE LEHR SITE FIGURE 2-1

City Name	Distance from the LEHR in Miles	Direction from the LEHR	1980 Population
Sacramento	12	east	275,741
Vacaville	17	southwest	43,367
Davis	3	northeast	36,640
Woodland	12	north	30,235

The four counties that surround the LEHR (Sacramento, Solano, Yolo, and Napa) have a combined total population of 1,231,157 (U.S. Bureau of the Census, 1983). Population growth has varied in the counties that surround the LEHR; however, between 1970 and 1980 all counties experienced growth.

As previously stated, the LEHR is located in the southeast quadrant on a remote portion of the U.C. Davis campus. This area is designated as appropriate for animal research. The use category of the land surrounding U.C. Davis is intensive agriculture, with 76.8 percent of all land used for this purpose. Irrigation is used on 41 percent of the agricultural land. Major crops are fruits, nuts, and grains; various animals are also raised.

The climate at the LEHR is temperate with mild winters and long summers. In winter, the average temperature is 46.9 degrees Fahrenheit (°F), and the average daily minimum temperature is 37.6°F. The lowest temperature on record, which occurred in December 1932, is 12.2°F. In summer, the average temperature is 73.0°F, and the average daily maximum temperature is 92.3°F. The highest recorded temperature, which occurred in July 1950, is 113°F.

The mean annual precipitation is 16.5 inches. Of this, only 2.2 inches, or about 14 percent, usually falls from April through September, which includes the growing season for most crops. The heaviest 1-day rainfall on record was 3.0 inches in December 1955.

The average daily relative humidity is about 80 percent in the winter and 40 percent in the summer and early fall. Humidity is higher at night. The average seasonal relative humidity is about 90 percent in the winter and 60 percent in the summer and early fall.

The sun shines about 95 percent of the time in summer and about 45 percent in winter. Fogs obscure the sun up to about 20 percent of the time in late fall and winter months.

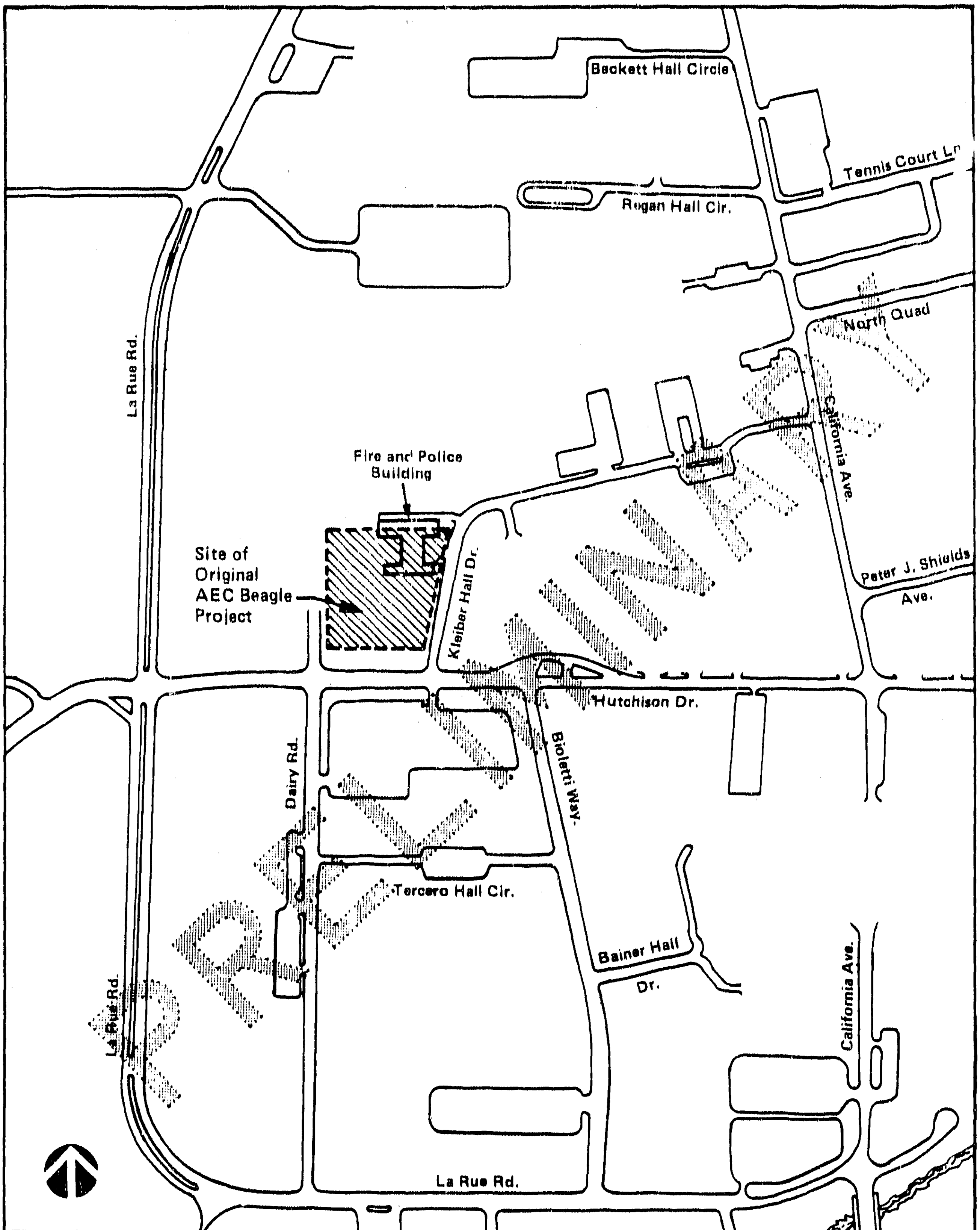
Prevailing winds are from the south, reflecting the frequent incursion of marine air through the Carquinez Straits into the Sacramento Valley. Commonly, the winds change directions, flowing from the northwest diurnally. Wind velocities are higher in these directions. Several times a year, strong winds blow from the north. When winds are apparent, about 40 percent of the time the velocities are less than 3.7 mph; 50 percent of the time they are less than 8.1 mph; and only about 10 percent of the time do they exceed 16.2 mph for short periods.

2.2 Overview of Major Site Operations

This section includes a history of activities that have taken place at the LEHR at the U.C. Davis. Knowledge of past activities is necessary to understand environmental problems that currently exist at the LEHR facility. Current DOE activities consist of a site characterization study and a facility assessment prior to terminating the current operating contract and releasing the LEHR buildings and facility structures. There are currently only several small DOE research projects ongoing at the LEHR facility.

Founded in 1951 by the U.S. Atomic Energy Commission (AEC), what is currently named the LEHR was established to evaluate the biological effects of X-rays on laboratory animals. The initial study involved the irradiation of beagles with a cobalt-60 source at the U.C. Davis main campus. These facilities were located in the area of the current Fire and Police Building at the corner of Hutchison Drive and Kleiber Hall Drive (see Figure 2-2). Eventually, the irradiation experiments were no longer performed at this location and the site was used only to house the breeding colony that would supply beagles for the studies.

In 1957 a major project was initiated by the AEC to study the biological effects associated with chronic low-level exposure of the skeleton to beta particle irradiation from deposits of the bone-seeking radionuclide, strontium-90. Eventually, more than 1,000 beagles would be utilized in this study. The beagle was chosen as the experimental subject that could be studied in sufficient detail to scale the results to human populations that might be exposed. To assist in this scaling



Source: U.C. Davis Campus Map, 1986

LOCATION OF ORIGINAL AEC BEAGLE PROJECT ON U.C. DAVIS MAIN CAMPUS

FIGURE 2-2

from results in beagles to expected risks in humans, a parallel study was performed utilizing the bone-seeking radionuclide radium-226. In these studies, one group of beagles was fed a diet containing strontium-90 or was intravenously injected with strontium-90 and another group of beagles was intravenously injected with radium-226.

Construction began in 1958 at the current location of the LEHR facility and in 1960, the study was moved to this new location. During this 1958 to 1960 period, pilot-scale tests using strontium-90 were conducted in a temporary building at the Davis airport. Full-scale experimental use of radioactive material began at the new location off Old Davis Road. The original site facilities on the main campus and the temporary building at the airport have been removed and no longer exist. This main study was the basis for the formation of the Radiobiology Laboratory in 1965 as an organized research unit of the U.C. Davis, and the building and administration of the Radiobiology Laboratory by the AEC. The main study is now near completion, some 28 years after the first beagles were fed or injected with the radionuclides. Only some data reduction and the interpretation of results remain to be evaluated.

In the middle and late 1960s, several programs were conducted at the U.C. Davis' Hopland Field Station. These programs studied various metabolic, translocation, and uptake pathways of radionuclides in sheep and deer. The radionuclides were fed to or injected into the subject animals.

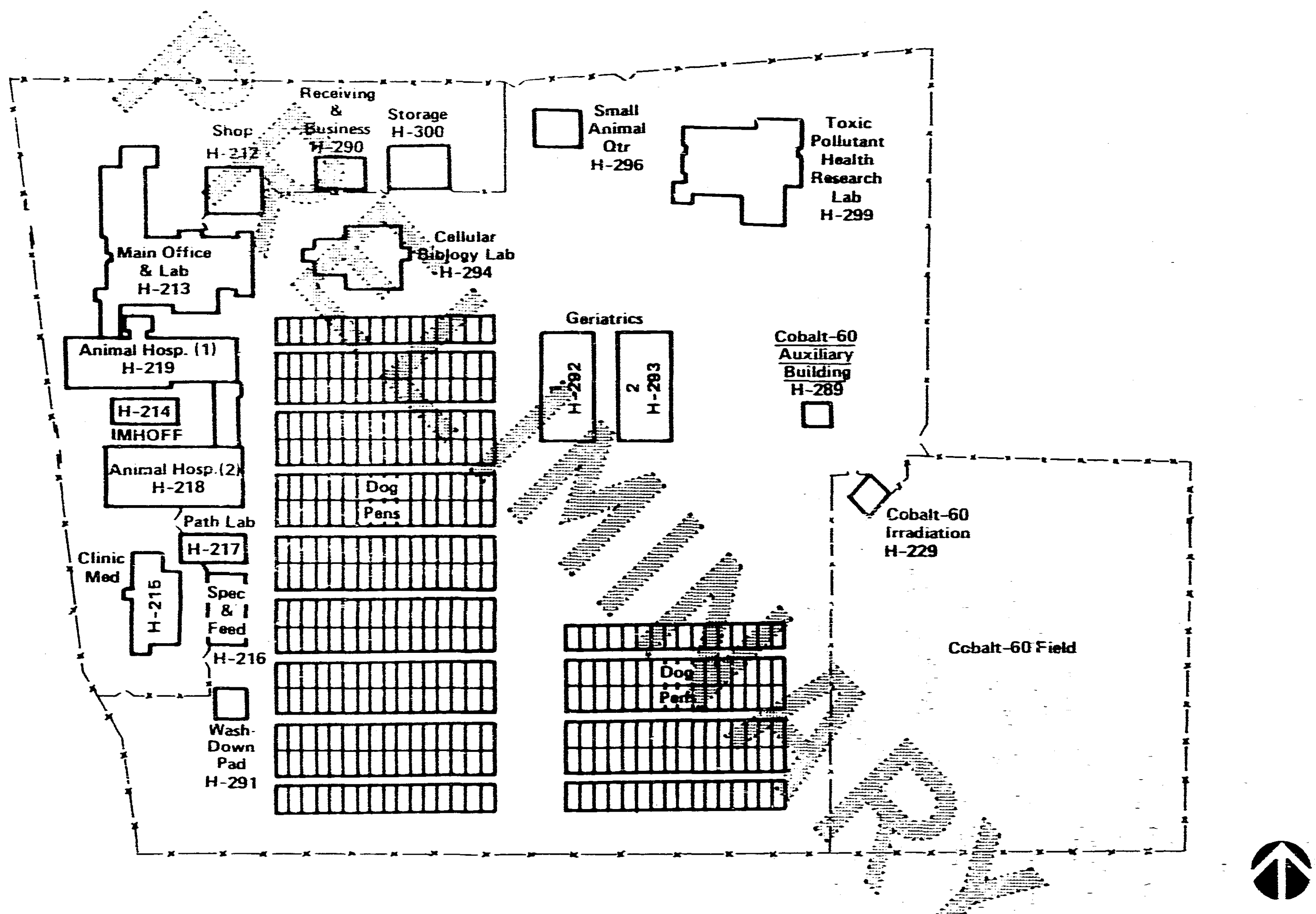
The Radiobiology Laboratory grew as the main project expanded, and the research interests of the laboratory broadened to consider all aspects of the radiobiological effects of the irradiation of the skeleton. Special interest in cellular biology focused on the blood-forming and immunological functions of bone marrow cells and their alterations by ionizing radiation. In the early 1970s, an outdoor Cobalt-60 Irradiation Field was constructed to study the effects on bone marrow cells of beagles from chronic exposure to penetrating gamma ray irradiation. However, in 1985, the decision was made to permanently suspend the use of the outdoor irradiator, and the study was terminated. The decision was made after an investigation by the SAN revealed that no feasible corrective actions would reduce possible exposures at the LEHR boundary below the DOE 25-millirem-per-year action level during continued outdoor use. In 1986, the LEHR requested and was granted permission by the SAN to use the cobalt-60 irradiator for indoor irradiations of specimens.

In 1975 the Radiobiology Laboratory initiated a program in basic aerosol science to link the evaluation of airborne materials and the laboratory study of these materials utilizing cellular and animal models. This program was funded by the Energy Research and Development Administration (ERDA) with interagency support from the U.S. Environmental Protection Agency (EPA). Research activities in this program focused on the potential health effects of release to the atmosphere of combustion products from fossil fuel power plants with emphasis on coal flyash.

In 1980 the Radiobiology Laboratory's name was changed to LEHR to more properly reflect the expanded mission and research orientation. In 1983 construction of the Toxic Pollutant Health Research Laboratory (TPHRL) was completed at the LEHR. This facility was designed for the total containment and safe study of highly toxic and carcinogenic agents including both radioactive and chemical materials. These studies utilize laboratory animals and study exposures to toxic materials by dermal, intravenous, oral-gastrointestinal, intratracheal and inhalation routes. Current work at TPHRL includes studies of plutonium-241 and americium-241 behavior in beagles and monkeys, radioactive and toxic gas-particle mechanistic aerosol studies, monodisperse aerosol inhalation deposition studies, intratracheal applications of carcinogen-coated particles, and an organic vapor uptake study utilizing beagles.

Major LEHR facility structures are listed below along with the corresponding building number. Figure 2-3 shows the location of the major LEHR facility structures.

Building Name	Building Number
Main Office and Laboratory	H-213
Animal Hospital 1	H-219
Animal Hospital 2	H-218
Imhoff	H-214
Pathology Laboratory	H-217
Clinical Medicine	H-215
Specimen Storage and Feed Mix	H-216



Source: Speed and Badger, 1984

MAJOR LEHR FACILITY STRUCTURES

FIGURE 2-3

Washdown Pad	H-291
Cellular Biology Laboratory	H-294
Shop	H-212
Receiving and Business	H-290
Storage	H-300
Small-Animal Quarters	H-296
Toxic Pollutant Health Research Laboratory	H-299
Cobalt-60 Auxiliary Building	H-289
Cobalt-60 Source	H-229
Geriatrics 1	H-292
Geriatrics 2	H-293

2.3 State and Federal Concerns

Representatives of the Survey team met with members of the California Department of Health Services and the Solano County Environmental Management Department on October 8, 1987, as part of the pre-Survey visit to the laboratory. A telephone conversation was held with EPA Region IX to solicit information on environmental concerns about the LEHR facility. The issues of concern raised by representatives of these agencies included the following:

- Probable commingling of wastes from prior U.C. Davis and DOE activities at the site and the difficulty involved in establishing "ownership" of discrete disposal areas.

- Historic disposal of hazardous wastes, with the same concerns for commingled wastes as mentioned previously.

- Possible off-site groundwater migration of radon from uses of radium-226 at the facility.

- Potential for contamination/migration through seasonal fluctuations in the aquifer gradient and distribution within the aquifer.

- Identification of burial areas, in light of certain material that has been discovered in areas not known to be disposal sites.

- Possible contamination resulting from projects that were conducted in DOE facilities, but that were not a part of the DOE projects and did not receive funding from DOE.

- Potential for environmental releases and residual contamination from the recent americium/plutonium project.

- The necessity for maintaining communication with the state and EPA throughout the decontamination and decommissioning effort, specifically with respect to the requirements of the Superfund Amendments and Reauthorization Act (SARA), the definition of solid waste management units, the amounts and locations of any remaining residual contamination, and the disposal technique for radioactive wastes removed in the process.

- The potential for environmental release of or residual contamination by iodine-131.

- The impact on future land use from hazardous or radioactive residues that remain after decontamination.

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 Laboratory for Energy-Related Health Research (LEHR) at the University of California at Davis (U.C. Davis). 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 found by the Survey team as they relate to each medium.

3.1 Air

3.1.1 Background Environmental Information

The LEHR facility is located in Solano County, California, which is part of the Sacramento Valley Intrastate Air Quality Control Region (AQCR) 28. Radioactive and nonradioactive air emissions from the LEHR and other sources within this area are controlled by the requirements of the Yolo-Solano Air Pollution Control District, 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 Airborne 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 to monitor fallout from nuclear devices and other forms of radioactive contamination of the environment. The closest EPA monitoring station to the LEHR is in Berkeley, which is about 57 miles southwest of LEHR. The most recent Berkeley data available as of this writing are summarized below:

Radionuclide	Average Concentration (pCi/m³)[a]
Gross Beta[b]	0.03
Pu-238[c]	1.9×10^{-6}
Pu-239[c]	0.4×10^{-6}
U-234[c]	7.5×10^{-6}
U-235[c]	1.0×10^{-7}
U-238[c]	7.2×10^{-6}

Source: EPA, 1986a, 1986b, 1987
a. $pCi/m^3 = 10^{-12}\ Ci/m^3$
b. Data collected from October 1985 to September 1986
c. Data collected from January 1986 to June 1986

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 Solano County in AQCR 28 has been designated by EPA as being (a) unclassifiable, or better than the NAAQS for total suspended particulates (TSP), sulfur dioxide (SO_2), carbon monoxide (CO), and nitrogen dioxide (NO_2); and (b) not meeting primary standards for ozone (O_3) (Bureau of National Affairs, 1986). It is likely that high O_3 concentrations in predominantly rural Solano County are largely caused by the regional transport of pollution from distant urban areas and power plants. Because sufficient particulate matter ambient data are not yet available, EPA has not determined the particulate matter attainment status for particulate matter smaller than 10 microns (PM_{10}) for the AQCRs.

Table 3-2 presents 1986 background ambient air quality data measured at Woodland, California, which is about 12 miles north of the LEHR (California Air

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/m³ - 150 µg/m³	50 µg/m³ - 150 µg/m³	- 30 µg/m³ 50 µg/m³
Sulfates	24-Hour	-	-	25 µg/m³
Lead	30-day Average Calendar Quarter	- 1.5 µg/m³	- 1.5 µg/m³	1.5 µg/m³ -
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: California Air Resources Board, 1987

a. Federal standards, other than ozone, particulate matter, 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 particulate matter standard, no more than one expected exceedance per year is allowed.

b. California standards, other than carbon monoxide, sulfur dioxide (1 hour), nitrogen dioxide and particulate matter, are values that are not to be equaled or exceeded. The carbon monoxide, sulfur dioxide (1 hour), nitrogen dioxide and particulate matter 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 which is attained or surpassed around at least half of the horizon circle, but not necessarily in continuous sectors.

TABLE 3-2

1986 BACKGROUND AMBIENT AIR QUALITY MEASUREMENTS

Pollutant	Averaging Time	Federal Standard[a]	2nd Highest Measured Concentration[b]	California Standard[c]	Highest Measured Concentration[b]	Average Measured Concentration[b]
Ozone[d]	1-Hour	0.12 ppm	0.11 ppm	0.10 ppm	0.12 ppm	-
Carbon Monoxide	8-Hour	9.0 ppm	4.6 ppm	9.0 ppm	6.0 ppm	-
	1-Hour	35 ppm	12.0 ppm	20 ppm	13.0 ppm	-
Particulate Matter (PM_{10})	Annual Arithmetic Mean	50 μg/m³	-	-	-	36.5 μg/m³
	Annual Geometric Mean	-	-	30 μg/m³	-	32.5 μg/m³
	24-Hour	150 μg/m³	80 μg/m³	50 μg/m³	94 μg/m³	-

Source: California Air Resources Board, 1987

a. For the pollutants listed, the primary standard is equal to the secondary standard. Federal standards, other than ozone, particulate matter, 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 particulate matter standard, no more than one expected exceedance per year is allowed.
b. As measured at Woodland, California, about 12 miles north of the LEHR facility.
c. California standards, other than carbon monoxide and particulate matter, are values that are not to be equaled or exceeded. The carbon monoxide and particulate matter standards are not to be exceeded.
d. The California standard regulates oxidant, measured as ozone.

Resources Board, 1987). The Woodland Station is the nearest site that routinely monitors several of the regulated air pollutants. The table shows that ARB ambient standards for oxidants (measured as ozone), and particulate matter (both annual geometric mean and 24-hour standards) were violated in 1986. Ozone data collected during a special study in Davis also showed violations of the oxidant standard. Emissions from the LEHR would not have contributed to these violations because the magnitude of precursor pollutant releases from the facility that form ozone (namely, nitrogen oxides and volatile organic compounds) is negligible. During 1986, Federal ambient standards were met at the Woodland Station.

3.1.1.3 Meteorology

Davis and the lower Sacramento Valley have a mild climate with abundant sunshine most of the year. A nearly cloud-free sky prevails throughout the summer and in much of the spring and fall. The summers are usually dry with warm to hot afternoons and mostly mild nights. The rainy season generally is November through March.

The LEHR facility is located approximately 12 miles west of Sacramento Executive Airport, which is the nearest Weather Service Office with long-term climatological data. Predominant winds at Sacramento are southeast through southwest every month except November, when they are from the north-northwest. Topographic effects, the north-south alignment of the Sacramento Valley, the Coast Range, and the Sierra Nevada strongly influence wind flow in the valley. A sea-level gap in the Coast Range permits cool oceanic air to occasionally flow into the valley during the summer, with a marked lowering of temperature through the Sacramento-San Joaquin River Delta to the City of Sacramento. In the spring and fall, a large north-to-south pressure gradient develops over the northern part of the state. Air flowing over the Siskiyou Mountains to the north warms and dries as it descends to the valley floor. This gusty, blustery north wind is a local variation of the chinook (NOAA, 1985).

The mixing height and the average wind speed within the mixing height are important parameters in a general appraisal of air pollution potential. The mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Hence, much man-made air pollution is transported and dispersed within the mixing layer. Estimated afternoon mixing heights in the Davis area range from a winter mean of about 3,000 feet to a spring mean of about 5,250 feet, which are generally less than mixing heights found in other non-coastal U.S. locations, but are greater than mixing heights occurring along the California coast. The intense subsidence inversion that occurs on the eastern side of the quasi-stagnating Pacific Anticyclone during the summer months causes very shallow mixing heights along the California coast and affects the mixing heights in the Davis area (Holzworth, 1969). Also, mean wind speeds within the mixing height are lower in California, Oregon, and Washington than in other areas of the country. The combination of relatively shallow mixing heights and low transport wind speeds indicates that meteorological conditions conducive to the occurrence of air pollution episodes are frequently present in the Davis region and the rest of the state (Hol .worth, 1972).

3.1.2 General Description of Pollution Sources and Controls

Most air releases from the LEHR originate from laboratories at a number of on-site buildings. In laboratories in which carcinogenic or radioactive particulates may be generated, U.C. Davis' Office of Environmental Health and Safety (EH&S) requires the use of high-efficiency particulate air (HEPA) filters on exhaust gas streams. Likewise, for experimental studies in which hazardous vapors might be emitted, charcoal filters are required. In addition, standard operating procedures for laboratory fume hoods require annual airflow testing to meet minimum air velocity requirements. The Survey team noted that dates logged on stickers on each of the fume hoods identifying when the last face velocity test was carried out demonstrated that this requirement had been met. EH&S criteria also call for annual testing of HEPA filter efficiency, continuous monitoring of the HEPA filter pressure differential, and quarterly testing of charcoal filters used in a U.S. Department of Defense dilute nerve agent project.

The EH&S staff indicated that air permits to operate are not required of any of the LEHR sources. In addition, no permits were identified as a result of the on-site Survey activities.

3.1.2.1 Toxic Pollutant Health Research Laboratory

The Toxic Pollutant Health Research Laboratory (TPHRL) is a specialized facility for exposure studies of laboratory animals to toxic materials. Current work in the TPHRL includes studies of plutonium-241 and americium-241 behavior in beagles and monkeys, radioactive and toxic gas-particle mechanistic aerosol studies, aerosol inhalation deposition studies, intratracheal applications of carcinogen-coated particles, and an organic vapor uptake study in beagles (LEHR, 1987a).

The TPHRL has a sophisticated air emission control system designed to achieve very high contaminant removal efficiencies. Much of the exhaust air from the building goes through three or four stages of HEPA filtration. Additionally, a major portion of the exhaust air is charcoal-filtered to remove gaseous vapors. The emission control system consists of roughing filters, HEPA filters, charcoal filters, and a perchloric acid fume scrubber to treat effluent gas. The effluent from the exposure rooms (e.g., in which research activities involve radioactive and toxic agents) is passed through a HEPA filter downstream of the glove boxes, through a HEPA filter in the loft, through a double HEPA filter and charcoal filter in the Machine Room, and exhausted to the atmosphere through a single exhaust vent. The bank of filters in the Machine Room consists of 16 columns of filters (i.e., each column consisting of a HEPA filter-charcoal filter-HEPA filter in sequence), with the effluent passing in parallel through these 16 columns. The five HEPA filters in Room 709 and the bank of filters in the Machine Room have not been efficiency-tested since installation because of the absence of sampling ports. In the past, hazardous radioactive and toxic agents such as plutonium-241, americium-241, carbon-14, and asbestos have been used in the exposure rooms and vented to the Machine Room filter bank. There is a redundant ventilation system for the effluent that passes through the Machine Room such that a secondary fan would become operational if the primary fan fails. In Room 713, perchloric acid and nitric acid are used in the perchloric acid fume hood to dry bones, and the effluent containing acid and salts is vented to a perchloric acid scrubber.

A 350-kW emergency diesel generator on the east side of the TPHRL is available for use in the event of a loss of electric power to the building. This generator is tested weekly to ensure its operability. The generator is a very minor source of air pollutants.

3.1.2.2 Cellular Biology Laboratory

The Cellular Biology Laboratory was established for conducting research in cellular biology focusing on the blood-forming and immunological functions of bone marrow cells and their alterations by ionizing radiation. Research experiments currently carried out involve cell reproduction, and tissue and cell culture work. All the fume hoods in the building are HEPA-filtered. Although the filters are changed according to a planned maintenance schedule, they are not routinely tested. This is because the filtration system was designed in accordance with the original research scneme to treat more hazardous emissions than have actually been released from the facility. Presently, acids (i.e., hydrochloric, acetic), bases, buffering chemicals to prepare cell cultures, and chlorinated, nonc. '¬rinated, and organic solvents are used.

In Rooms 515 A/B, culture tubes are prepared using highly diluted nerve agent working solutions. The nerve agents used at the LEHR are GA-Tabun, GB-Sarin, GD-Soman, VM, VX, and Vx; these are organophosphate compounds, which are more potent versions of the organophosphate pesticides used by the agricultural industry (Foreman, 1985). The fume hood in which this work is carried out has a charcoal filter with an alarm that is activated if the airflow is too low. The effluent is ducted from the fume hood to a vent on the roof. Maintenance logs indicate that the charcoal filter is leak-tested quarterly.

3.1.2.3 Other Sources

Animal Hospital 1

Currently, few research activities involving air emissions are conducted at Animal Hospital 1 (AH-1), in comparison to past activities. In Room 212, dilute nerve agent is further diluted in a fume hood. The fume hood has a charcoal filter that is leak-tested quarterly and an airflow failure alarm. A natural gas-fired boiler rated at 0.5 horsepower is located on the north side of AH-1.

Animal Hospital 2

In Room 311, there is a canister of krypton-85 (with a source strength of 3 curies) in a fume hood from which aliquots are extracted for various experiments. There are no controls on the effluent gas, which contains small amounts of krypton-85.

Main Office and Laboratory

There are a number of active laboratories in the Main Office and Laboratory Building (Rooms 123, 112, 110, 106), none of which have HEPA filters. Since only small quantities of radiotracers and chemicals are used in these laboratories, emission controls are not installed. In Room 106, small quantities of highly dilute nerve agent are added to tissue culture flasks in a fume hood, which is charcoal-filtered.

Small-Animal Housing Facility

Administration of highly diluted nerve agent working solutions to experimental animals is carried out in the front of the fume hood of the Small-Animal Housing Facility. The fume hood has a charcoal filter that is leak-tested quarterly and an airflow failure alarm.

Geriatrics I

In the Geriatrics I facility there is a gas-fired steam generator that produces steam to clean animal cages. Nitrogen oxides and steam are released from a vent on top of the building.

3.1.3 Environmental Monitoring Program

No routine emissions monitoring or ambient air quality monitoring is carried out at the LEHR facility. In connection with the SAN site characterization study involving soil and groundwater sampling in the southwest corner of the site, ad hoc meteorological and ambient TSP monitoring has been conducted for measuring impacts downwind from the excavation of burial trenches and pits.

3.1.4 Findings and Observations

3.1.4.1 Category I

None

3.1.4.2 Category II

None

3.1.4.3 Category III

None

3.1.4.4 Category IV

1. Lack of assessment of LEHR air quality impact. The lack of characterization of air emissions at the LEHR facility precludes an assessment of ambient impacts of LEHR operations. Although there is no information to indicate that on-site or off-site impacts occurred from either past or present operations, there are no data to support or refute this assumption.

   Information gathered during the Survey suggests that air emissions from the LEHR facilities are not significant, and there is little risk to the populace from routine or accidental releases in view of in-place emission controls and standard operating practices. However, small quantities of radioactive and nonradioactive contaminants are released to the ambient environment from a few LEHR buildings. A comprehensive inventory of these emissions has not been compiled.

   Subpart H of the National Emission Standards for Hazardous Air Pollutants (NESHAP) requires that radionuclide emissions be determined and that a dose assessment be conducted to demonstrate compliance with dose standards. DOE Order 5484.1 imposes similar requirements for both radioactive and nonradioactive pollutants.

2. Lack of routine efficiency testing of TPHRL filters. If damaged while in use, some of the TPHRL charcoal and HEPA filters could potentially allow greater-than-expected quantities of radionuclides and carcinogens to be discharged, because these filters have not been routinely tested for removal efficiency since installation. The Survey identified the following filters of concern:

- Room 709 - The five HEPA filters serving the five fume hoods have not been efficiency-tested on a routine basis since installation because sampling ports had not been installed; and

- Machine Room - The 16 charcoal filters have not been efficiency-tested on a routine basis since installation in 1982. Standard operating procedures require periodic testing of filters.

The effluent from the five fume hoods in Room 709 is exhausted from a single vent without further treatment. The activities in Room 709 consist of preparation of solutions for liquid scintillation to detect radioactivity resulting in the release of nonradioactive aromatic compounds, and of laboratory work involving the use of strontium, radium, and tritium.

The efficiency of the bank of 32 HEPA and 16 charcoal filters in the Machine Room has not been tested since installation in 1982 because of the absence of sampling ports. The charcoal filters are the only controls in the Machine Room for gaseous contaminants. Without routine testing, there is potential that the charcoal filters could become saturated without being detected, allowing the breakthrough of gaseous pollutants.

The HEPA filters in Room 709 and in the Machine Room were certified at installation to be leak-tight. A work order for the installation of sampling ports in Room 709 and in the Machine Room has been submitted, but it has not been funded.

3.2 Soils

3.2.1 Background Environmental Information

In general, soils at the Laboratory for Energy-Related Health Research (LEHR) have formed as a result of alluvial deposition from Putah Creek over rocks of mainly marine sedimentary origin--sandstones and shales. These soils are derived from eroded soils and weathering rock (sandstones, shales, volcanic flow, and serpentine) in the eastern foothills and mountains of the Coast Range. Variable patterns of coarse and fine surface soil and substrata textures reflect the past variability in flooding and deposition of materials from a series of former smaller distributaries of Putah Creek.

All the LEHR soil is in the Yolo series with a surface texture of fine sandy loam to very fine sandy loam. The dominant upper subsoil texture is sandy and the dominant lower subsoil texture is gravelly loamy sand. The characteristics of this soil are a deep, permeable profile, brown to light-brown color, and good drainage in both the surface and subsurface cross-sections.

Background soil concentrations in the vicinity of the LEHR for radionuclides and chemicals used at the facility are not analyzed by the LEHR, 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 3-3 presents radium-226, thorium-232, and uranium-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. As the LEHR has never sampled for these parameters and no comparison with background values could be presented, they are not discussed.

3.2.2 General Description of Pollution Sources and Controls

The major pathways for potential contamination of soil at the LEHR are the result of past practices and can be divided into three broad categories. These categories,

TABLE 3-3

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. pCi/g = 10^{-12} Ci/g

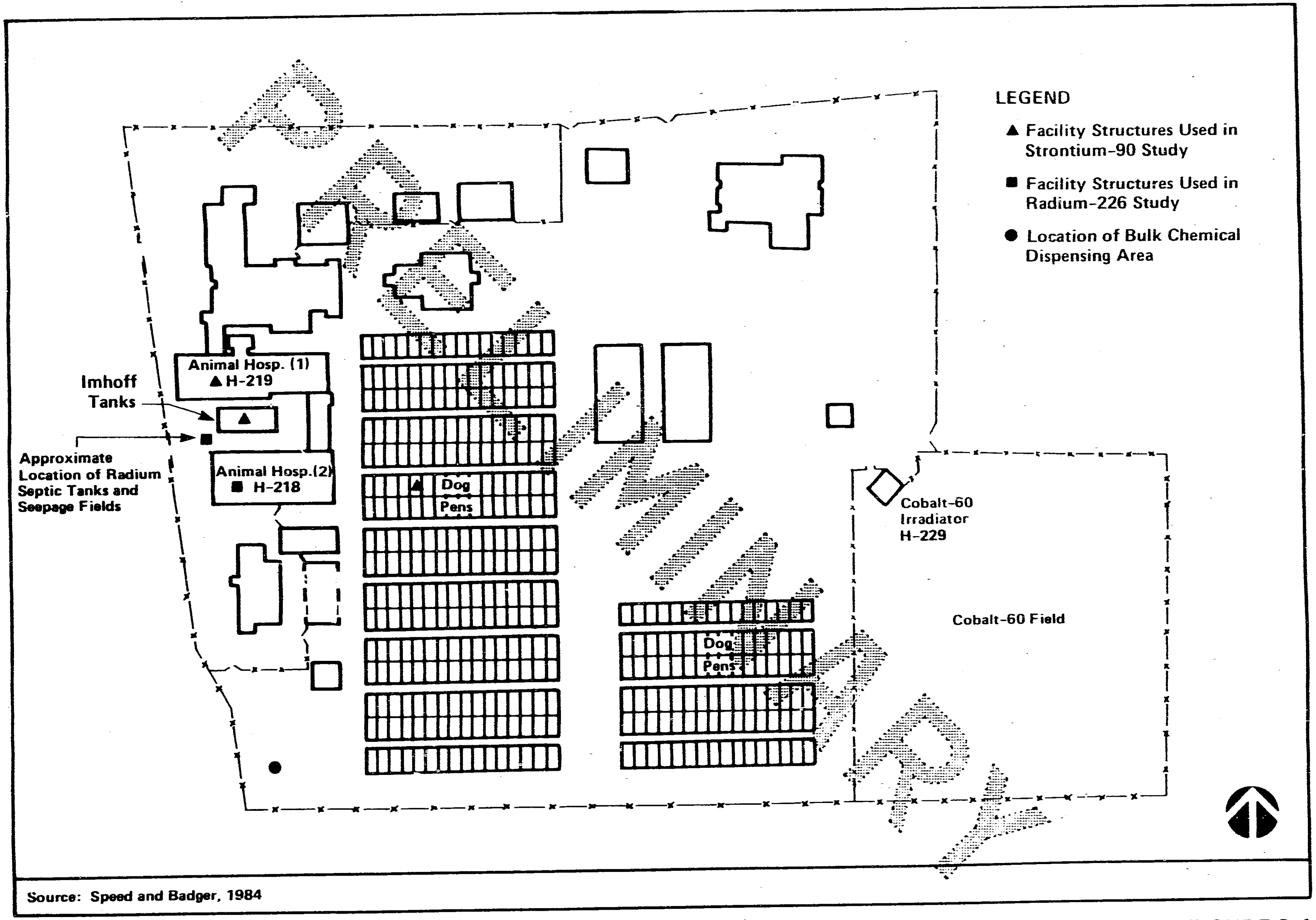
which will be discussed in this section, are animal waste processing and handling, radioactive and nonradioactive waste burial, and chemical use.

3.2.2.1 Animal Waste Processing and Handling

In the 1950s, two studies began involving feeding and injecting strontium-90 and injecting radium-226 into beagles. Since the radioactive material is initially excreted in the urine and feces of the animals, two systems for processing and handling these wastes were designed.

The strontium-90 study involved feeding 380 beagles diets containing strontium-90 at different levels and injecting 46 beagles with strontium-90 from January 1961 through January 1969. During this feeding and injection period, and for 30 days after ingestion or injection of the strontium-90 was discontinued, the beagles were housed in Animal Hospital 1 (see Figure 3-1). The animal excreta were collected and, via a pipe network, processed through the Imhoff treatment system. (For a more detailed discussion of the Imhoff treatment system, see Section 4.5.1.) In total, the beagles were fed or injected with 964.57 millicuries (mCi) of strontium-90, and retained as their body burdens approximately 21.77 mCi (2 percent). The remaining 98 percent was excreted in the radioactive waste stream from Animal Hospital 1. The total throughput to the Imhoff treatment system was 943.2 mCi of strontium-90. After the waste was processed through the Imhoff treatment system, a total of approximately 2.55 mCi of strontium-90 was released to the Imhoff leach field and into the subsurface soil (Goldman, 1985). The half-life of strontium-90 is 29 years, and as a result, only approximately 1.5 mCi of strontium-90 could currently remain in the subsurface soil.

The radium-226 study involved injecting 246 beagles with radium-226 from October 1963 through January 1969. During this period, and for 30 days after injection of the radium-226 was discontinued, the beagles were housed in Animal Hospital 2 (see Figure 3-1). The animal excreta were collected and, via a pipe network, processed through the radium septic tanks, seepage pits, and leach line. In total, the beagles were injected with 6.129 mCi of radium-226, and retained as their body



Source: Speed and Badger, 1984

LOCATION OF MAJOR LEHR FACILITY STRUCTURES ASSOCIATED WITH POTENTIAL SOIL CONTAMINATION

FIGURE 3-1

burdens approximately 2.302 mCi (38 percent). The remaining 62 percent was excreted in the radioactive waste stream from Animal Hospital 2. The total throughput to the radium septic tanks, seepage pits, and leach line and into the subsurface soil was 3.827 mCi of radium-226 (Goldman, 1985). (For a more detailed discussion of the radium septic tanks, seepage pits, and leach line, see Section 4.5.1.)

Since there is no evidence to refute the possibility that beagles used in the strontium-90 or radium-226 studies were not temporarily placed in the other study's Animal Hospital building, the two systems above could have handled both radionuclides. Additionally, records indicate that tritium, vanadium-48, ytterbium-169, americium-241, and plutonium-241 were processed through the Imhoff treatment system, and may have been processed through the radium septic tanks, seepage pits, and leach line. Finally, veterinary-associated substances such as arsenic (contained in heartworm medication) and chlordane (used for flea control) may also have been processed through the two treatment systems.

After the beagles' stay in the animal hospitals, they were housed in outdoor pens. Soil in these pens is covered with gravel. In the pens, the beagles continued to excrete radioactively contaminated urine and feces because of the biological half-life of strontium and radium. The source of this radioactivity was the body burdens that remained in the beagles. The biological half-lives in bone for strontium-90 and radium-226 are 49.3 and 43.8 years, respectively. Over the lifetime of the project, the calculated release to the outdoor pens of strontium-90 in excreta was 4 mCi. Half of this activity was in the urine (2 mCi) and was deposited on the soil. The other half of the activity was in feces (2 mCi), which were removed daily. The calculated release to the outdoor pens of radium-226, over the lifetime of the project, was 1.0 mCi. Half of this activity was in the urine (0.5 mCi) deposited on the soil. The remaining half of the activity was in the feces (0.5 mCi), which were removed daily (Goldman, 1963). The radioactive feces from both studies were buried on-site in trenches (see Section 4.5.1).

The dog pens occupy an area of 2 acres. There are 4×10^9 grams (g) in 2 acre-feet. Dividing the total strontium-90 and radium-226 activities released to the soil in the dog pen areas by the number of grams in the top foot of soil in this area gives concentrations above background of 0.5 pCi/g for strontium-90 and 0.125 pCi/g for radium-226. As shown in Table 3-3, the background concentration of radium-226 in soil for California is 0.77 ± 1.0 pCi/g. The current strontium-90 concentration would be even lower, approximately 0.30 pCi/g, because of radioactive decay since the completion of the study.

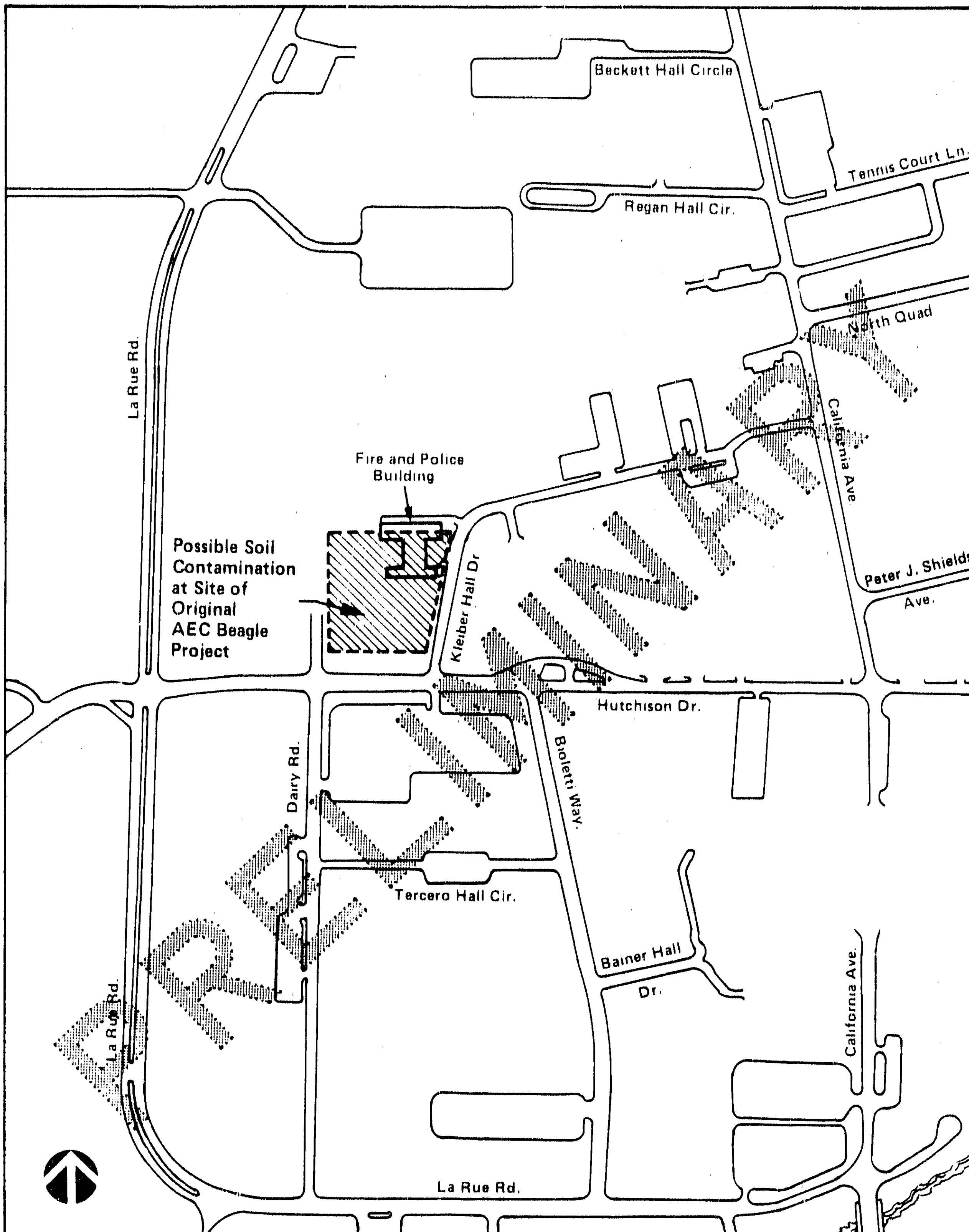
3.2.2.2 Radioactive and Nonradioactive Waste Burial

The LEHR facility and the University of California at Davis (U.C. Davis) buried radioactive and organic chemicals in numerous trenches and pits at the LEHR site. Radioactive material was also buried by the LEHR on an off-site University-owned property known as the Hopland Field Station. Additionally, parts of the LEHR site were used as landfills in the past. This practice may have contaminated the subsurface soil in these areas. (See Section 4.5.1 for a more detailed discussion.)

3.2.2.3 Chemical Use

The LEHR facility used various bulk chemicals including but not limited to acetone, ethyl alcohol, formalin, kerosene, wheat oil, and chlordane. These chemicals were stored in the bulk chemical dispensing area at the southwest corner of the site (see Figure 3-1). The area consisted of an open-sided, roofed wooden structure with no impermeable base. Chronic leaks and spills typical of chemical storage areas may have contaminated the soil in this area. The bulk chemical dispensing area was in use until approximately May 1987. Additionally, there are trenches in this area where radioactive wastes are buried and where organic chemicals may be buried. (See Section 4.5.1 for a more detailed discussion of the burial trenches.)

During the studies on beagles, the dogs developed a flea problem. Interviews with site personnel and a former employee indicated that chlordane was sprayed in the dog pens and the beagles were dipped in a chlordane-water and chlordane-kerosene emulsion to control the fleas. It is believed that the dip, when spent, was dumped in the pen areas or the trash pits active at that time. These trash pits were located in the southwest corner or southern border of the LEHR site. (See Section 4.5.1 for a more detailed discussion of the trash pits.) Interviews also indicated that chlordane was used at the original U.S. Atomic Energy Commission (AEC) beagle project site on the U.C. Davis main campus from 1957 until its closure in the early 1970s (see Figure 3-2). Chlordane was used at the LEHR from its startup in 1960 until



Source: U.C. Davis Campus Map, 1986

LOCATION OF POSSIBLE SOIL CONTAMINATION AT THE ORIGINAL AEC BEAGLE PROJECT SITE ON U.C. DAVIS MAIN CAMPUS **FIGURE 3-2**

the early 1970s. Annual usage was reported to have been between 25 and 50 gallons.

3.2.3 Environmental Monitoring Program

The LEHR has not conducted and does not conduct environmental monitoring of soil, vegetation, milk, or foodstuffs. In 1984, an initial assessment study of the LEHR site at U.C. Davis was performed by Rockwell International (Speed and Badger, 1984). Soil samples were taken and analyzed during the study. However, interviews with San Francisco Operations Office (SAN) personnel concerning the locations sampled and actual media sampled raised questions about the appropriateness and possibly the validity of the data. As a result, the data are not presented or discussed in this report. The LEHR is currently conducting a soil sampling program that duplicates much of the sampling performed in Rockwell's initial assessment.

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

1. Possible soil contamination in southwest corner. Soil in the southwest corner of the site (i.e., the former bulk chemical dispensing area and location of burial trenches), may be contaminated with organic compounds and radioactive wastes. These constituents could be a source of contamination to the surrounding environment through surface water, groundwater, and wind transport.

   Bulk chemicals including acetone, ethyl alcohol, formalin, kerosene, chlordane, and possibly others were stored at the bulk chemical dispensing area. This area consisted of an open-sided, roofed structure with no impermeable base. Chronic leaks and spills typical of chemical storage areas may have contaminated the soil. The dispensing area was in use until May 1987.

There are also trenches in the southwest corner that were used for radioactive waste burial and possibly for organic chemical waste disposal. In time, any released contaminants may have contaminated the subsurface soil.

A SAN-funded groundwater and soil sampling program is currently under way at the LEHR. Groundwater samples are being analyzed for organics, chlordane, metals, and radionuclides. However, no soil samples from this area are being analyzed for organics or chlordane.

During the Sampling and Analysis phase of the Survey, soil gas samples will be collected from the southwest corner of the LEHR site and analyzed for volatile organic compounds as an indicator of chemical contamination. Also, soil core samples will be collected and analyzed to determine the presence of radioactive and/or chemical contamination.

2. <u>Possible chlordane contamination of soil</u>. Soils in the dog pen areas at the LEHR and the U.C. Davis main campus (i.e., the site of the original AEC beagle project) may be contaminated with chlordane. This residual chlordane concentration could contaminate the environment through surface water, groundwater, and wind transport.

Chlordane was sprayed in the dog pens to control fleas. Additionally, the beagles were dipped in a chlordane-water and chlordane-kerosene emulsion. The dip, when spent, was dumped in the pen areas or the trash pits active at that time. Interviews with site personnel indicated that chlordane was used at the original AEC beagle project site on the U.C. Davis main campus from 1957 until its closure in the early 1970s. Chlordane was used at the LEHR from its startup in 1960 until the early 1970s. Annual usage was reported to have been between 25 and 50 gallons. Chlordane is an environmentally persistent chemical and may have become concentrated in the soil of these areas.

A SAN-funded groundwater and soil sampling program is currently under way at the LEHR. Groundwater samples are being analyzed for chlordane. However, soil samples from the LEHR dog pens are not being analyzed for chlordane. Additionally, no soil sampling is being performed at the U.C. Davis main campus site.

During the Sampling and Analysis phase of the Survey, soil samples will be collected and analyzed to determine the presence of chemical contamination.

3.2.4.4 Category IV

1. Lack of a comprehensive soil monitoring program. The lack of a comprehensive soil monitoring program at the LEHR precludes assessment of past and present environmental impacts on soil from LEHR operations.

   Interviews with SAN personnel revealed that SAN granted the LEHR an exemption from preparing an Annual Environmental Monitoring Report, allowing the LEHR instead to prepare an Annual Environmental Summary. This exemption was granted under the provisions in DOE Order 5484.1. However, the exemption does not eliminate the requirement to monitor or in some way assess the environmental impacts from LEHR operations. Currently, a SAN-funded site study and characterization plan is being implemented. The present phase is a groundwater and soil sampling program that is directed toward investigating the environmental impact from the LEHR's inactive waste disposal sites and past operational practices.

3.3 Surface Water

Background environmental information for the Laboratory for Energy-Related Health Research (LEHR) at the University of California at Davis (U.C. Davis) campus is presented in the form of a discussion on hydrology and surface-water supplies, uses, and distribution. A general description of pollution sources and controls is then provided for sanitary, industrial, and stormwater systems at the LEHR. Current and historical environmental monitoring programs and studies are discussed for nearby surface-water bodies as well as on-site wastewater sources. Finally, the categorized findings and observations noted by the Survey team for the surface-water discipline are listed and discussed.

3.3.1 Background Environmental Information

3.3.1.1 Hydrology

Geography and Topography

The City of Davis is located 15 miles west of Sacramento and 72 miles northeast of San Francisco at the intersection of Interstate 80 and Highway 113 North. The main campus of the University straddles the Yolo-Solano County line with most of the University land located in Yolo County. The campus is bordered on the north and east by the City of Davis. Bordering the west edge of the campus are agricultural fields in Yolo County; the southern border, along which the LEHR is located, is formed by the Yolo-Solano County line and the South Fork of Putah Creek.

Situated on prime agricultural land in the Sacramento Valley, the campus and the City of Davis form a developed island in the middle of agricultural fields. Although the area is generally considered flat, the elevation ranges from 60 to 125 feet within the City of Davis limits (George S. Nolte and Associates, 1983).

Runoff from some 600 square miles of mountainous area collects in Putah Creek, and runoff from about 60 square miles of hilly area collects in 6 small streams to the south (Thomasson, Olmsted, and Le Roux, 1960). The runoff occurs largely as flash floods, and in most years the low summer flows are all diverted for irrigation or are absorbed in the valley area as groundwater recharge.

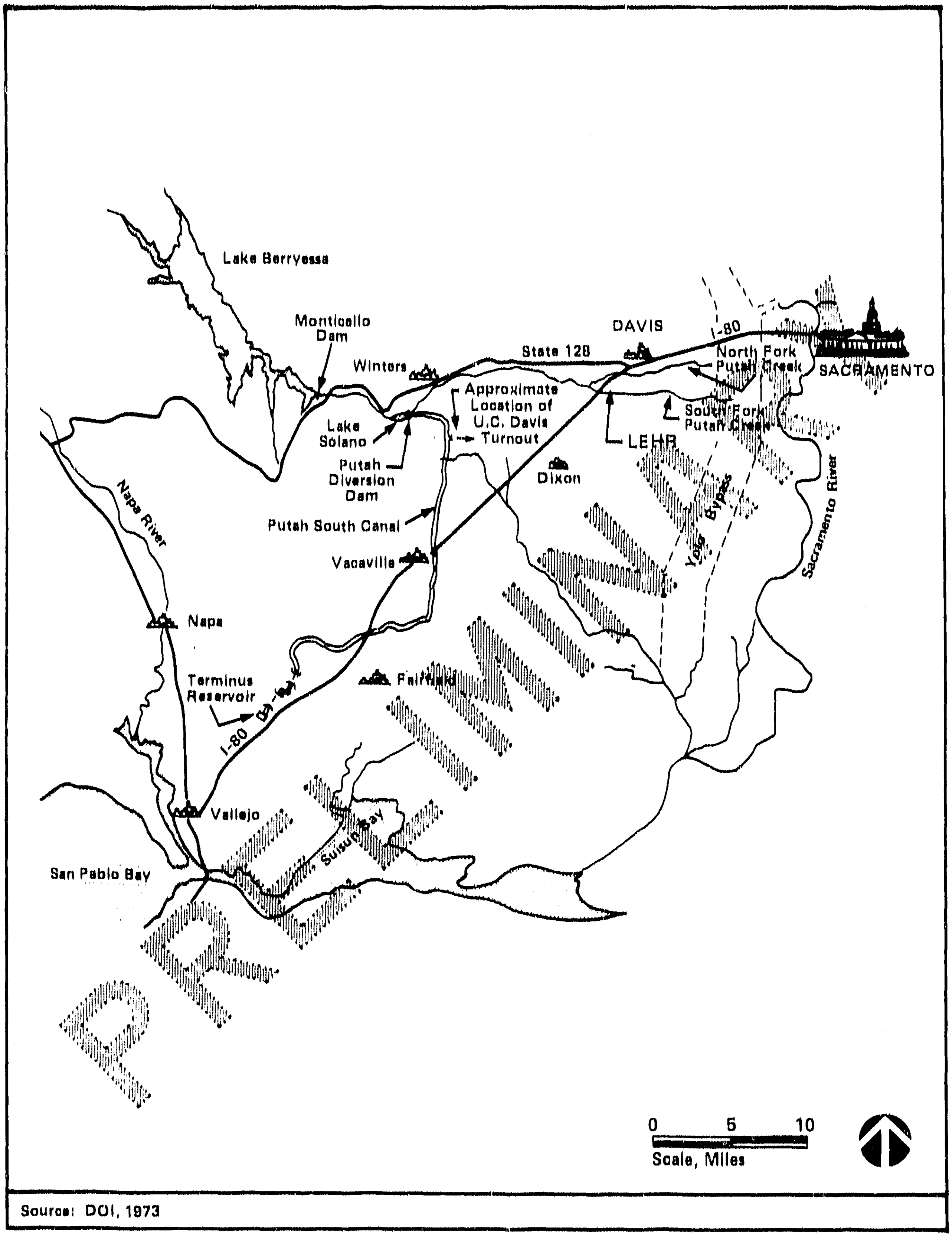
Hydrologic Features

The principal hydrologic features of the Davis campus are the South Fork of Putah Creek, the Lower Cache-Putah groundwater basin, and the deep confined aquifer. Putah Creek is discussed below, as it is the sole surface-water body in the vicinity of the LEHR. The Lower Cache-Putah groundwater basin and the deep confined aquifer are discussed in detail in Section 3.4.

The South Fork of Putah Creek, the principal surface-water feature of the region, meanders along the southern border of the Davis campus, and the levee on its north bank forms the southern border of U.C. Davis and of the LEHR. Putah Creek heads in the St. Helena Mountains, flows eastward into and out of Lake Berryessa, and ultimately spills into the Yolo Bypass, as shown on Figure 3-3.

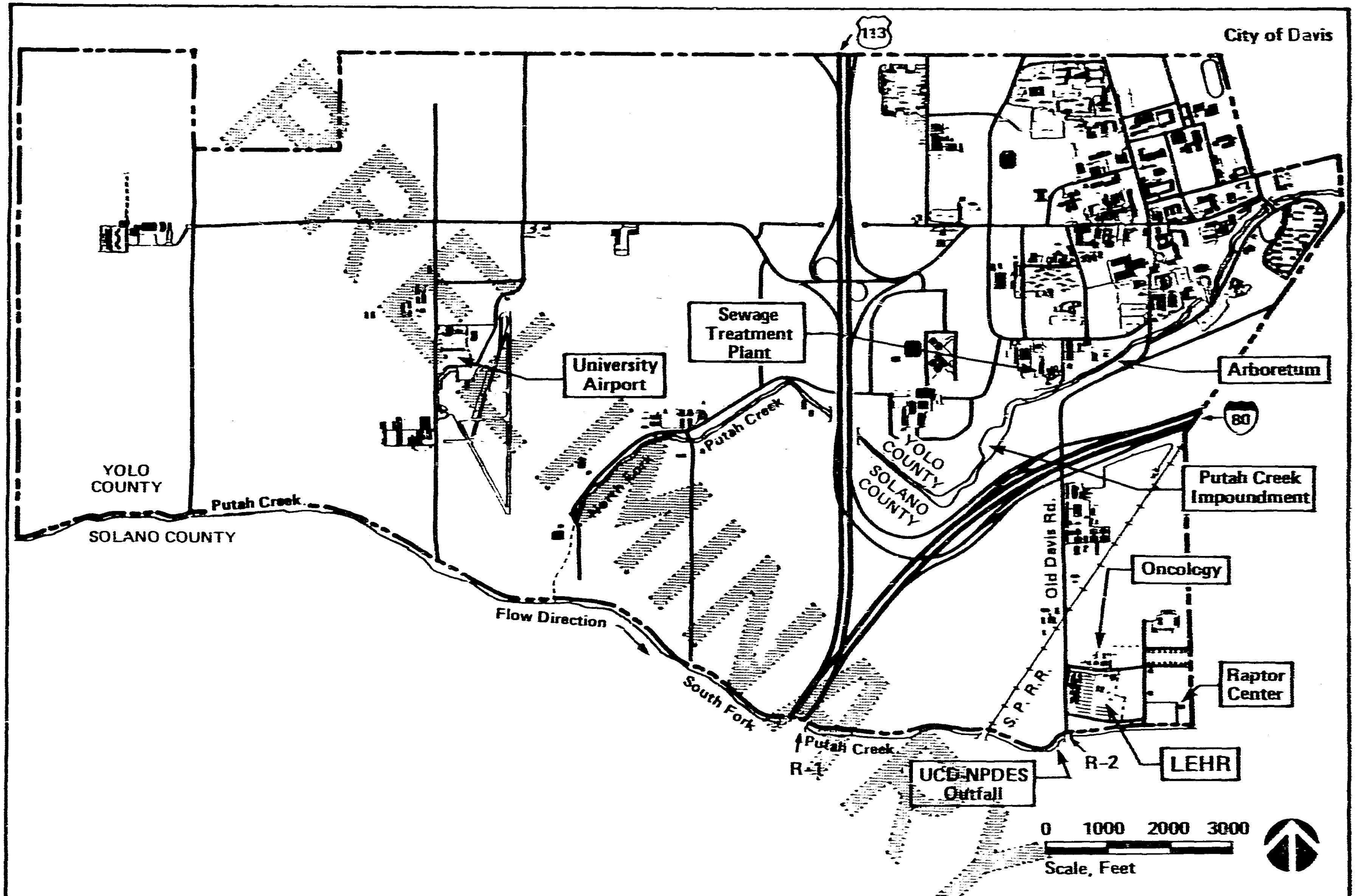
Putah Creek splits into north and south forks west of Highway 113, as shown on Figure 3-4. This split originated in 1880, when farmers dug a new channel south of the existing creek, creating the South Fork of Putah Creek. Over the years, the South Fork naturally widened, carrying a greater fraction of the flow every year. In 1948, the U.S. Army Corps of Engineers dredged the South Fork and dammed off the North Fork west of Highway 113, making the South Fork the only through-channel (George S. Nolte and Associates, 1983). The North Fork has undergone some significant changes since being dammed off from natural flows. Farming east of the campus has gradually encroached into the channel area and has effectively filled in the old channel. The North Fork is now considered a eutrophied or "dead" creek, although an extensive and diverse arboretum has been developed along its banks on campus, and U.C. Davis has converted a portion of the original channel passing through campus into a landscape impoundment.

Flow in the South Fork of Putah Creek is regulated by releases from Monticello Dam and the Putah Diversion Dam, as shown on Figure 3-3. By law, a minimum flow of 5 cfs must be maintained at the Davis gage of the creek. However, data obtained from the California Department of Water Resources indicate that the flow at the



LOCATION MAP OF PUTAH CREEK AND SOLANO PROJECT

FIGURE 3-3



Source: George S. Nolte and Associates, 1983

LOCATION OF PUTAH CREEK RELATIVE TO THE LEHR AND U.C. DAVIS

FIGURE 3-4

Davis gage has ranged from a maximum of 17,000 cfs to a minimum of 0 cfs for the last 10 years available (1974-1984) (California Department of Water Resources, 1987). The South Fork also receives effluent from the campus sewage treatment plant (STP) via a pipeline from the plant. During parts of the late summer, no stream flow exists upstream from the University outfall, and the campus effluent is therefore the only source of flow in a limited stretch of the creek (George S. Nolte and Associates, 1983). Apparently, water from the creek is withdrawn for crop irrigation by farmers downstream from University property and significant infiltration of effluent also occurs during those periods. Evidence of this infiltration and withdrawal of effluent from the creek is that during these low-flow periods flows diminish downstream from the plant and eventually disappear within a few miles from the outfall (George S. Nolte and Associates, 1983). The uses of Putah Creek are discussed further in the following section.

The Putah Diversion Dam diverts water to the Putah South Canal, primarily for use in Solano County. However, the University purchases a small fraction of this water for agricultural irrigation. The approximate location of the U.C. Davis turnout from the canal is indicated on Figure 3-3.

Putah Creek has been known to recharge groundwater as well as receive groundwater discharge. Upstream from the LEHR, the seepage gains and losses along Putah Creek downstream from the gaging station near the Town of Winters from 1932 to 1952 ranged from a net gain of 8 or 9 cfs to a net loss of perhaps 25 cfs during such times as water in this amount was available in the creek. During 1948 to 1952, the estimated average yearly groundwater recharge from the creek was 13,000-14,000 acre-feet, whereas in 1941 the net groundwater discharge to the creek was about 6,000 acre-feet. Under optimum conditions of greatly lowered water levels and regulated flow in Putah Creek, the potential recharge from this channel is estimated to be about 25,000 acre-feet/year (Thomasson, Olmsted, and Le Roux, 1960). Recent information obtained for the gaging station on the Old Davis Road bridge over the South Fork indicates that the gage height has fluctuated from 0 - 23.05 feet from October 1974 to January 1987 (California Department of Water Resources, 1987).

3.3.1.2 Surface-Water Supplies, Uses, and Distribution

U.C. Davis currently has three classifications of water supply needs, consisting of agricultural water, utility water, and domestic water. These needs are met by three separate sources of water: surface water from the Solano Project, groundwater from shallow-intermediate-depth aquifers, and groundwater from a deep-aquifer system. Groundwater supplies and uses for both the LEHR and U.C. Davis are discussed in detail in Section 3.4.1. Information pertaining to surface water is given below.

Surface-Water Supplies and Uses

In compliance with Public Law 92-500 Section 303(e), the Water Quality Control Plan for the Putah Creek Basin was adopted by the Regional Water Quality Control Board (RWQCB), Central Valley Region, in 1975. This plan considers existing water quality, defines beneficial uses, and establishes specific objectives that will ensure the protection of these beneficial uses (George S. Nolte and Associates, 1983). The beneficial uses defined in this plan for both the groundwater and surface waters in the Putah Creek Basin are presented in Table 3-4.

Surface waters from Putah Creek are currently used only for agricultural purposes at U.C. Davis, as discussed in the following section. No surface waters are currently in use at the LEHR, as no agricultural water is utilized at the facility.

U.C. Davis has a contract with the Solano County Flood Control and Water Conservation District (SCFCWCD) for the delivery of surface water from the Solano Project. Water is supplied from a controlled release from Lake Berryessa behind Monticello Dam. Water flows down Putah Creek to the Putah Diversion Dam, where a major portion of the water is diverted to the Putah South Canal. Water for the University is pumped from the Putah South Canal, and is diverted to University storage facilities located on the agricultural lands west of Highway 113. The Solano Project is operated by the Bureau of Reclamation under a water rights permit from the SWRCB (George S. Nolte and Associates, 1983).

TABLE 3-4

BENEFICIAL USES SUMMARY - PUTAH CREEK BASIN

Water Body	Mun	Agriculture		Industry			Recreation			Freshwater Habitat		Migration		Spawning		Wild	Nav
	Municipal and Domestic Supply	Irrigation	Stock Watering	Process	Service Supply	Power	Contact	Canoeing and Rafting	Other Non-Contact	Warm	Cold	Warm	Cold	Warm	Cold	Wildlife Habitat	Navigation
Putah Creek	●	●	●				●	●	●	●	○			●		●	
Southern Yolo County Groundwater	●	●	●	●													

Source: George S Nolte and Associates, 1983

● Existing Beneficial Use
○ Potential Beneficial Use

The quality of the Solano Project water is good for agricultural uses. The major constituents indicate that it is generally a calcium-magnesium bicarbonate water, low in both total dissolved solids and hardness. Based on the data summarized in Table 3-5 for Putah Creek, no significant variations in water quality are apparent for the years 1970-1975. No data are available regarding the concentrations of chemical substances or radionuclides in Putah Creek.

The landscape impoundment on the U.C. Davis campus (North Fork of Putah Creek) is used to collect campus storm drainage, local runoff, and building cooling water. During the winter months, stormwater contributions into the impoundment exceed the losses due to evaporation and percolation, and the excess is pumped out the west end of the impoundment to the South Fork of Putah Creek. The water quality of the impoundment has been of great concern since its construction in 1968 due to the nutrient-laden inflow, as well as erosion of the steep banks during the winter, which add to the sediment load of the impoundment (George S. Nolte and Associates, 1983).

Surface-Water Distribution

U.C. Davis diverts its surface water from the Putah South Canal into a pipeline where it flows by gravity to the western edge of campus. At its terminus, the water can be stored in a 70-acre-foot reservoir or diverted directly into the agricultural water transmission system. The transmission system consists of a pipe network which distributes the water to the various individual field distribution systems. Seven small reservoirs are connected to the transmission network and effectively equalize flow variations caused by varying water supply and demand rates. Both surface water and groundwater supplies are available to most, though not all, areas of the agricultural fields. A schematic layout of the agricultural water transmission and distribution system is shown on Figure 3-5 (George S. Nolte and Associates, 1983). Areas served by only the surface water or well water distribution systems are also identified on this map.

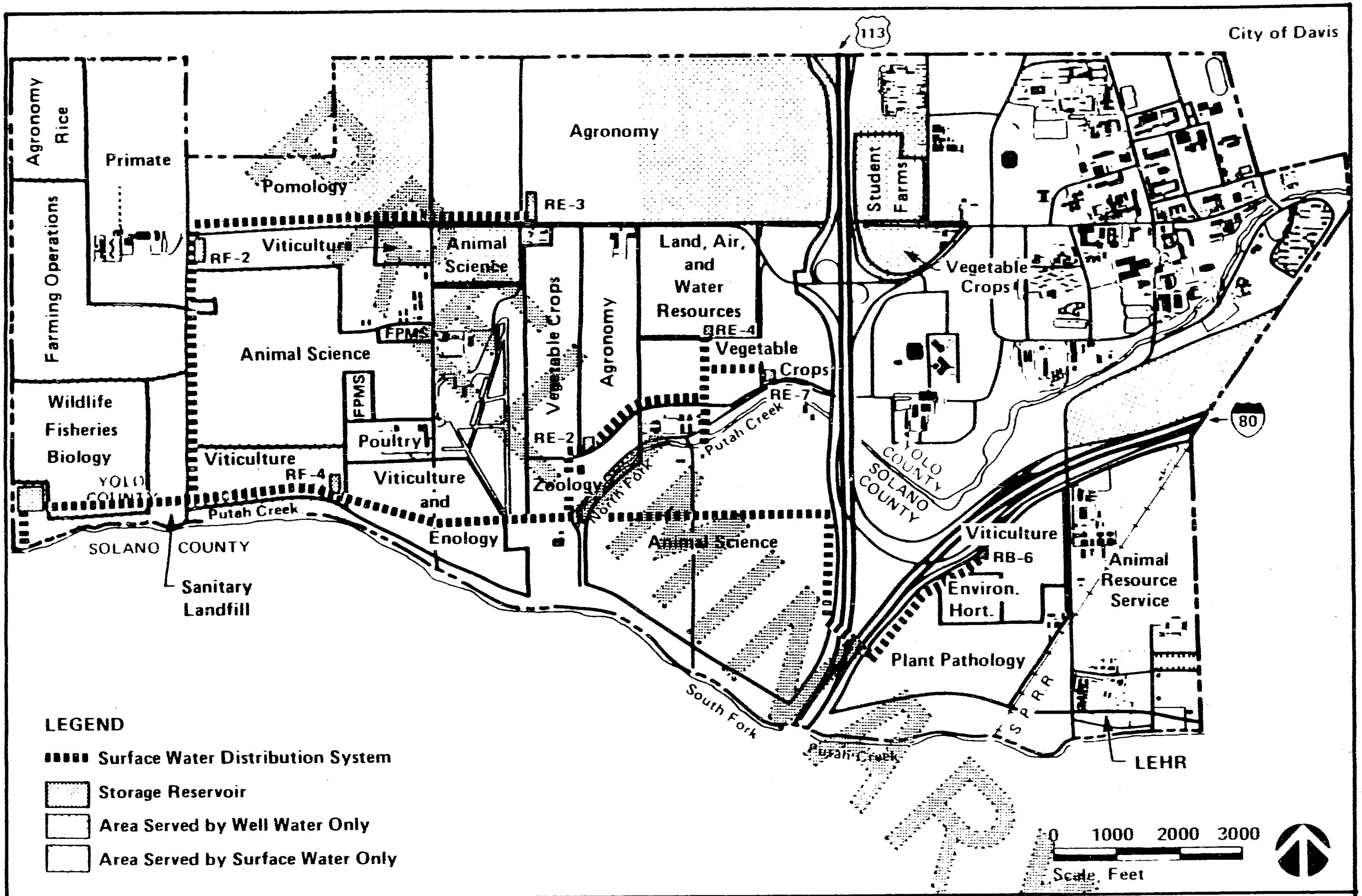
A portion of the agricultural water demands is also met by groundwater. Groundwater deliveries from the shallow-intermediate aquifer are made from a series of 20 wells ranging in depth from 250 to 600 feet. The wells, which are

TABLE 3-5

U.C. DAVIS AGRICULTURAL WATER QUALITY, SURFACE WATER (PUTAH CREEK)

Year	Constituents									
	EC (µmho/cm)	TDS (mg/L)	Ca (me/L)	Mg (me/L)	Na (me/L)	B (mg/L)	Cl (me/L)	CO_3/HCO_3 (me/L)	NO_3-N (mg/L)	Total Hardness as $CaCO_3$ (mg/L)
1970	0.30	192	1.20	1.60	0.23	0.17	0.12	2.16	0	140.0
1971	0.34	218	1.04	2.01	0.33	0.37	0.13	2.89	1.0	152.5
1972	0.33	212	1.27	1.58	0.41	0.28	0.13	3.00	1.0	142.5
1973	0.34	218	0.90	2.10	0.50	0.30	0.22	2.80	1.0	150.0
1974	0.29	186	0.93	1.75	0.18	0.22	0.11	2.58	1.0	134.0
1975	0.32	205	NA	NA	0.27	0.26	0.09	2.70	1.0	NA
Average	0.32	205	1.07	1.81	0.32	0.27	0.13	2.69	1.0	143.8

Source: George S. Nolte and Associates, 1983



Source: George S. Nolte and Associates, 1983

SCHEMATIC LAYOUT OF THE U.C. DAVIS AGRICULTURAL WATER SUPPLY SYSTEM AND LAND ASSIGNMENTS

FIGURE 3-5

generally more than 20 years old, discharge directly into the field distribution systems. This is further discussed in Section 3.4.1.3.

Historically, the principal objective in operating the agricultural water supply system is to use the entire 4,000 acre-feet of surface water. However, the capacity of the surface water distribution system in certain areas during certain times of the year is inadequate to totally supply high-demand crops with water, and local wells are therefore used to produce supplemental supplies when needed. The agricultural water demands from 1971 to 1982 are summarized in Table 3-6. Average water usage for agricultural irrigation is approximately 4,500 acre-feet/year, with approximately 80 percent supplied by surface water and 20 percent by wells. Drainage throughout the agricultural land is poor and, as a result, there is little runoff or reuse of excess applied water (George S. Nolte and Associates, 1983).

3.3.2 General Description of Pollution Sources and Controls

Wastewaters produced from the LEHR at U.C. Davis can be grouped into three categories: sanitary wastewater, industrial wastewater (containing both chemical and/or radiological contaminants), and stormwater. The sources of these wastewaters as well as their treatment or disposal methods are discussed in the following sections.

3.3.2.1 Sanitary Wastewater Generation

Sanitary wastewater is generated in virtually every building at the LEHR except the warehouse (Building H-300). Building locations at the LEHR are shown in Figure 3-6 along with the sanitary sewer line hookups for each building. Major sources of sanitary wastewater include lavatories, excreta from experimental animals, locker rooms containing shower facilities, drinking water fountains, sinks, and floor drains. Some industrial wastewater also enters the sanitary wastewater stream. This is discussed in more detail below.

3.3.2.2 Industrial Wastewater Generation

The majority of industrial wastewater generated in individual laboratories at the LEHR are segregated according to waste type and held for collection by U.C. Davis

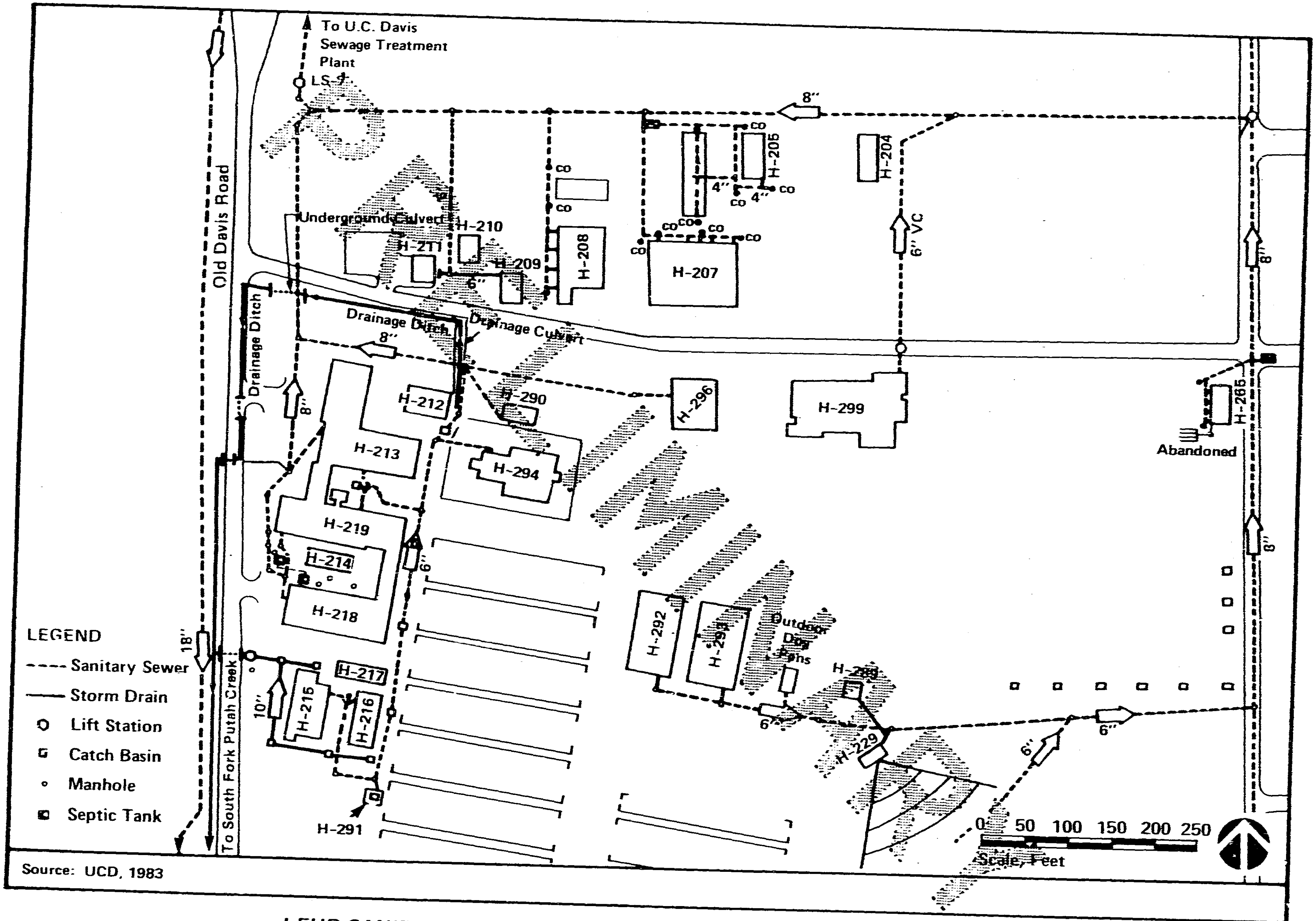
TABLE 3-6

AGRICULTURAL WATER USAGE SUMMARY

Year (Fiscal)	Well Water (Acre-Feet)	Surface Water (Acre-Feet)	Total (Acre-Feet)
1971-72	1,394	3,885	5,279
1972-73	1,225	2,934	4,160
1973-74	876	3,407	4,283
1974-75[a]	1,232	3,602	4,834
1975-76[b]	1,678	4,752	6,429
1976-77[b]	968	4,530	5,498
1977-78	374	2,745	3,120
1978-79	405	3,289	3,694
1979-80	535	3,702	4,236
1980-81	599	3,811	4,410
1981-82	441	3,165	3,606
Average Water Usage	884	3,620	4,504
Average Percentage of Water Use	20%	80%	100%

Source: George S. Nolte and Associates, 1983

a Construction of Highway 113 decreased the acreage of irrigated land. Land east of Highway 113 was irrigated exclusively with well water.
b Drought years.



LEHR SANITARY SEWERS AND STORMWATER COLLECTION SYSTEM

FIGURE 3-6

Environmental Health and Safety (EH&S) personnel. According to the laboratory's safety manual (UCD, 1986), no industrial wastes are to be disposed of down the laboratory drains unless prior approval is received from EH&S, as the drains are connected to the U.C. Davis biological STP. Substances permitted to be disposed of down the drains include buffer solutions, non-metallic salts, dilute protein solutions, sugars, and acids or caustics neutralized to pH 5-9. For radioactively contaminated liquids, the following guideline is used:

If $CPM_{BKG} + (CPM_{BKG})^{1/2} \geq CPM_{LIQ}$ then the liquid is considered to be radioactive

If $CPM_{BKG} + (CPM_{BKG})^{1/2} \leq CPM_{LIQ}$ then the liquid is considered to be nonradioactive

where CPM = Counts per minute, BKG = Background, and LIQ = Liquid

Liquids are counted with a gamma well or liquid scintillation counter in the above determination. Non-toxic liquids (i.e., water, soap, mild buffers) meeting this criterion can be disposed of down the drain; other liquids must be treated as chemical waste. Upon pickup of radioactive liquid wastes from the individual laboratories, U.C. Davis EH&S staff assess the potential impact of disposal via the U.C. Davis STP from an emissions standpoint. On this basis, up to 1 Ci/yr may be disposed of through EH&S via the STP (UCD, 1987c). This is also in accordance with the limit set by the U.S. Nuclear Regulatory Commission (NRC) for sanitary sewer disposal of radionuclides. The methods of hazardous chemical and radioactive waste segregation and disposal are discussed in more detail in Section 4.1.

In addition to laboratory wastes, other sources of industrial wastewater discharged at the LEHR include:

- Cooling tower blowdown; and
- Washwater from the Washdown Pad (Building H-291) that has been used to clean vehicles, dog cages used for experimental animals, and various types of equipment.

Discharges from both of these sources are currently sent to the U.C. Davis STP.

Potential sources of contamination remain as a result of the past generation of industrial wastewater. These sources include contaminated plumbing and sludges possibly remaining as a result of domestic septic tank system usage prior to the LEHR connection to the U.C. Davis STP; contaminated plumbing in Animal Hospital 1 (AH-1) due to strontium-90 wastewater flowing to the Imhoff treatment system; and contaminated plumbing in Animal Hospital 2 (AH-2) due to radium-226 wastewater flowing to the septic tanks, seepage pits, and leach line. The historical operation of each of these wastewater treatment/disposal systems is described in Section 4.5.1. The potential for continuing releases from these sources as a result of current operations is discussed below.

a) Domestic septic tank system plumbing

The six domestic septic tank systems identified in Section 4.5.1 were used to receive all liquid wastewater from the LEHR, except that which went to the Imhoff treatment system or to the radium-226 septic tanks, seepage pits, and leach line, prior to its connection to the U.C. Davis STP. This connection was estimated to have been completed in 1971, when the LEHR lift station was built. The connections to the STP were made at the junction of the septic tanks; therefore, some of the same piping is now used to direct wastewaters to the STP. This piping may contain chemical or radioactive substances that previously went to the septic tanks, either in the form of sludges on the walls of the pipes or in fixed (radioactive) contamination. Specific areas where this potential is believed to be highest include:

- Septic tank Number 2 located west of the Imhoff Building (Building H-214), which was previously connected to the control dog cages in AH-1 and to a lavatory and floor drains in western AH-2. After the strontium-90 study, the cages in AH-1 were used for other experiments, which may have discharged contaminants to the septic system. Also, any overflows of the radium-226 septic tanks (e.g., that which occurred in 1985 and is described in Section 4.5.1) may have caused contaminants to back up into septic tank Number 2 and contaminate plumbing now leading to the STP.

- Septic tank Number 4 from the Pathology Office and Laboratory (Building H-217), which received all wastes from the building, including wastes from the X-ray room (Room 418A) which may have contained washwater, film developer, and fixer (containing silver). During the Survey, a surface depression was observed in this area, and a tree growing in the area died a few years ago, possibly as a result of subsurface contamination.

- Septic tank Number 6 from the Main Office and Laboratory (Building H-213), which may have received chemicals from Room 112 (i.e., the biochemistry laboratory, previously the inorganic chemistry laboratory) and other laboratories in the building, as well as from the mechanical room of AH-1.

- Septic tank Number 7 from the Imhoff Building (Building H-214); Rooms 322 and 323, which was possibly used for the laboratory sinks and for the lavatory. Although the laboratory sink drains in Room 322 have been capped, the lavatory in Room 323 is still in use. The building is not connected to the STP. Therefore, this septic tank is considered to be active.

b) AH-1 plumbing

Most of Building AH-1 (Building H-219) is no longer in use except for office and laboratory space. Currently, Rooms 201 and 202 are reported to be in use. Room 219 contains a lead/bismuth generator. The water supply to the building has not been shut off, but all the valves leading to the Imhoff treatment system have reportedly been closed. Although the drains leading to the Imhoff treatment system have been temporarily capped, a trickle of water still enters the Imhoff sump from one of the two influent lines. The source of this water is not known. The sink in Room 203 did have a supply of water; a constant flow was not present, however. According to site drawings (Koblik, 1962), this sink leads to the Imhoff system. The plumbing leading from the Imhoff system to the leach field has not been capped; hence, uncontrolled releases to the leach field may still occur.

As previously stated, effluent in AH-1 went either to the Imhoff treatment system or to septic tanks Number 6 and 7 in the past.

Currently, all wastewater is believed to be routed to the STP. The sources of this wastewater include sinks, the shower and lavatory off Room 215, and the strontium-90 control dog cages in the western portion of AH-1.

Drains from cage rows A-F, which were used to house dogs used in the strontium-90 study, and the floor drains in the cage room (Rooms 200A, B, and C) all lead to the Imhoff treatment system. They reportedly contain "fixed" radioactivity from past discharges of strontium-90, are affixed with "radioactive" labels, and are temporarily capped. The original, portable cages in AH-1 are the most contaminated, and previously contained different drains. Plumbing in the building is cast iron and polyvinyl chloride (PVC). The cages in AH-1 have been used for other experiments since the strontium-90 study.

In addition to being used for the strontium-90 study, AH-1 was also used for recent studies using americium and plutonium-241, with the potential to contaminate the floor drains and plumbing. The plutonium-241 study, using 2 mCi, began in Room 213 and was later moved to the Toxic Pollutant Health Research Laboratory (TPHRL) (Building H-299). Excreta from the animals (monkeys) were collected, but washwater went down the drains. Plutonium-241 and americium were processed through the Imhoff tanks and contaminated tank Number 3 (5,000-gallon capacity; see Section 4.5.1). Other substances that may have been used in AH-1 or AH-2 include ytterbium-169, vanadium-48, and tritium.

The strontium-90 and other possible contamination that may be present in the plumbing of AH-1 may become mobilized if strong acids or bases are added to the piping. This may occur via facilities that are still in use in AH-1, or outside AH-1 in lines having cross-connections to the STP.

c) AH-2 plumbing

Building AH-2 (Building H-218) is still used as an animal hospital, and nearly the entire building is in use. The building was previously used to house dogs used in the radium-226 study. Radioactive wastewater from the dog cages in Room 310 was piped to the radium-226 septic tanks (shown on Figure 4-4), seepage pits, and leach line. Other sources of wastewater were routed to septic tanks Number 2 and 5 for the western and eastern portions of AH-2, respectively. A possible connection to a third septic tank is indicated on a facility plan (Koblik, 1962) for a nonradioactive line from the dog cages. The valve from AH-2 to the radium-226 septic tanks is now closed but the lines are not permanently severed or capped.

Building AH-2 is now connected to the U.C. Davis STP. This connection has three sources: one is the plumbing which formerly flowed to the radium-226 septic tanks; the other two are from the areas of AH-2 and AH-1 which formerly went to septic tank Number 2. The drain lines and cages in AH-2 were tested by flushing water through the lines leading to the STP; no significant radioactivity was reported in the water samples. The radium-226 septic tanks were sampled in 1985 in connection with an overflow incident (see Section 4.5.1). Results indicated the presence of radium-226 in the tanks as follows:

Sample Location	Radium-226 (pCi/L ± 2σ)	Collection Date
East tank	0.40 ± 0.04	11/29/85
West tank	4.5 ± 0.2	12/3/85
Background sample (tap water)	0.05 ± 0.02	11/29/85

The EPA drinking water limit for radium-226 is 5 pCi/L (Owen, 1986). After the overflow incident, the valve to the septic tanks was closed and no more liquids should have flowed to this system. Water is still supplied to AH-2. It is industrial water, however, and not suitable for potable use.

It is believed that 6.129 mCi of radium-226 was used in the study, and 3.827 mCi went to the septic tanks, seepage pits, and leach line. Room 302 was formerly utilized for necropsy of dogs used in the radium-226 and strontium-90 studies. Currently studies are being done on non-toxic aerosols in AH-2. Krypton-85 is the only radioactive substance in use. This involves a 3-curie source which is used in experimental aliquot distribution. Cages previously used to house control dogs have recently been utilized to house dogs employed in other experiments. In conjunction with ongoing activities in AH-2, there is a potential for acids or bases to be released to the drains leading to the STP, and to mobilize any contaminants (e.g., radium-226) which may be present as a result of past activities. Although personnel have been made aware of this, some sinks in the building were observed not to be labeled to remind employees of this danger.

3.3.2.3 Stormwater Runoff

Significant quantities of stormwater runoff are produced on both paved and unpaved areas at the LEHR during rainfall. Stormwater was observed to pond in various areas of the facility, due largely to the relative flatness of the land. As described in Section 3.2, two main areas of potential soil contamination exist on the LEHR site where stormwater may pick up contaminants. These potential sources include the southwest corner of the site, where chemical dispensing occurred in the past, and the dog pen area. Stormwater was observed to collect near the Imhoff Building (Building H-214), especially in the northwest corner. LEHR personnel have indicated that water levels in the tanks at the Imhoff Building increase when it rains. No leak-testing of these tanks has ever been performed to assess their integrity.

3.3.2.4 Sanitary and Industrial Wastewater Treatment

As previously discussed, strontium-90 and radium-226 wastewater historically went to the Imhoff treatment system, and to the radium-226 septic tanks, seepage pits, and leach line, respectively. All other sources of wastewater went to the domestic septic tank systems. The influents to the Imhoff treatment system and radium-226 septic tanks have been shut off and all domestic septic tanks (except Number 7) have been abandoned.

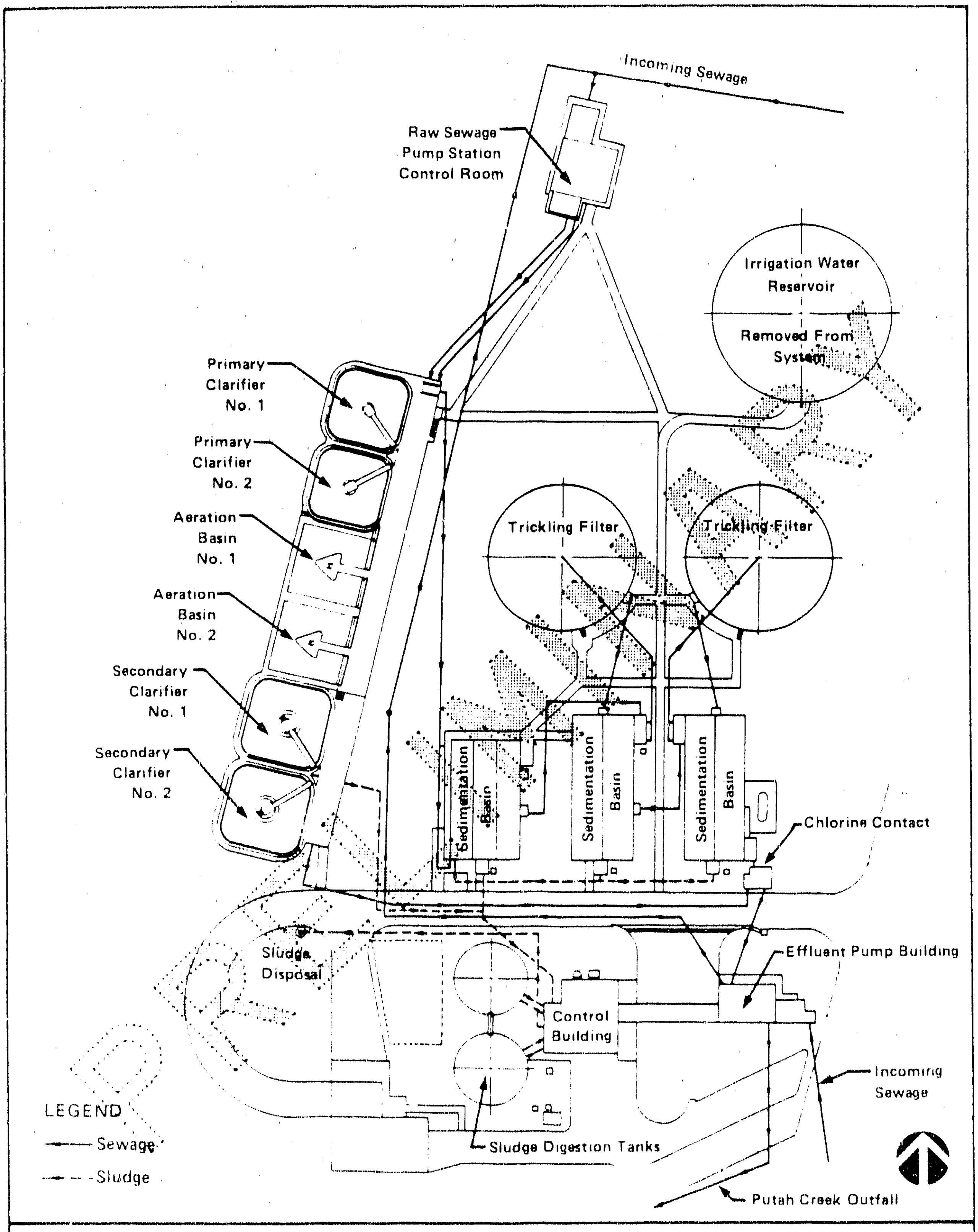
Since 1971, the LEHR has been connected to the U.C. Davis STP. All sanitary and industrial wastewater, except that segregated and picked up by U.C. Davis EH&S staff, as well as some stormwater, is now directed to this system as shown on Figure 3-6).

Prior to the construction of the current STP (and prior to the LEHR), a primary sewage treatment system (Imhoff type) was used east of the Cobalt-60 Irradiation Field at the LEHR, at what is now the U.C. Davis raptor center. This system was abandoned in 1949, and the current STP at U.C. Davis began with the construction of a 2.16-mgd trickling filter plant serving the Davis campus. At the time, the plant effluent was chlorinated and either pumped to a million-gallon storage reservoir for reclaimed-water irrigation or was discharged to the South Fork of Putah Creek by gravity flow. In 1970, the facilities were expanded to include a new 2-mgd activated sludge treatment process, bringing the total average plant capacity to 4.16 mgd with a peak load capability of 5.5 mgd. Most wastewater reclamation was discontinued in that year because central campus expansion had pushed the agricultural fields beyond the service area. Presently, reclaimed water is used only for irrigation of landscaping at the campus STP (George S. Nolte and Associates, 1983).

A schematic flow diagram of the STP is presented on Figure 3-7. Under the present mode of operation, the activated sludge system receives a constant flow of 1.0 mgd and the trickling filter receives all flows in excess of that amount. The current peak flow is about 3 mgd, with the average at 1.8 mgd. The combined effluent from the trickling filter and activated sludge systems flows by gravity to the chlorine mixing structure where chlorine is injected based on flow and rapidly mixed for disinfection. The current system cannot adjust to variations in chlorine demand, however, and does not maintain precise chlorine residual control in the effluent. In addition, no provisions for dechlorination exist in the disinfection scheme. Sludge produced from both the trickling filter and the activated sludge plants is pumped first to anaerobic digesters, and then to sludge drying beds for thickening. Sludge from the drying beds is disposed of at the U.C. Davis sanitary landfill.

3.3.2.5 Stormwater Control

In the past, stormwater from the LEHR was controlled with dry wells, which were subsurface rock-filled holes or trenches. One known dry well is believed to have



Source: UCD, 1971

SCHEMATIC DIAGRAM OF SEWAGE TREATMENT PLANT AT U.C. DAVIS

FIGURE 3-7

been located between the Clinical Pathology Building and the Feed Mix/Specimen Storage Building (Buildings H-215 and H-216, respectively). Locations of other dry wells are not known, but the Survey team was told that another dry well was located near the Washdown Pad (Building H-291). This has not been confirmed, however.

Currently, the LEHR uses a series of catch basins, culverts, and ditches for stormwater management. South of the Clinical Pathology and Feed Mix/Specimen Storage Buildings (Buildings H-215 and H-216), stormwater is collected via a series of catch basins and is routed west and north to a lift station, as shown on Figure 3-6. Water collected in this sump is pumped under Old Davis Road and enters a ditch that flows south to the South Fork of Putah Creek. There was no flowing water in this ditch, but standing water did occur after a heavy rainfall. This sump receives stormwater from the southwestern portion of the LEHR.

A cement drainage culvert is located between the Shop (Building H-212) and the Annex (Building H-290). This culvert receives stormwater from the surrounding paved areas and discharges to a ditch that parallels the fence along the northern border of the LEHR, as shown in Figure 3-6. The water in the ditch flows westward to a culvert at the northwestern corner of the LEHR property, where it flows south along a ditch east of Old Davis Road. This ditch discharges to a culvert west of the southwestern corner of the Main Office and Laboratory (Building H-213), flows under Old Davis Road, and empties into the ditch into which the previously described lift station discharges further south.

The remaining stormwater collected at the LEHR enters a series of catch basins that are believed to flow to the STP. These catch basins are located west of the dog pens and the Cellular Biology Laboratory (Building H-294), and east of Buildings H-213, H-219, H-218, H-217, H-216 and H-291, as shown on Figure 3-6. Stormwater runoff from the surrounding paved areas and the dog pens flows to these catch basins.

No stormwater control was observed near any of the buildings east of the above area. Stormwater runoff from the paved areas surrounding these buildings is likely to run off to the unpaved areas and infiltrate into the soils.

3.3.3 Environmental Monitoring Program

The LEHR has no program for periodic monitoring of discharges to surface waters (i.e., the South Fork of Putah Creek). The only monitoring performed on a regular basis is that for the U.C. Davis STP National Pollutant Discharge Elimination System (NPDES) permit, described below. The STP services all areas of the campus except the primate center, which has its own package treatment plant. Sporadic surface-water monitoring that has been performed near the LEHR is also discussed below.

3.3.3.1 NPDES Monitoring

The U.C. Davis STP was issued NPDES permit number CA0077895 by the California Regional Water Quality Control Board, Central Valley Region, on April 27, 1979. Effluent from the plant discharges to the South Fork of Putah Creek west of Old Davis Road, as shown on Figure 3-4. In addition to the NPDES outfall, two other monitoring locations are in use in the receiving stream (South Fork of Putah Creek). These are:

R-1: At I-80 bridge
R-2: At low water bridge on Old Davis Road

These locations are also shown in Figure 3-4. A third location, R-3, was required until the last NPDES permit was issued in 1984. It was located further downstream in the South Fork of Putah Creek at Mace Boulevard. The NPDES sample collection methods were observed at the outfall. The sample was collected approximately 10 feet below the outfall pipe in a small stream which discharged into the South Fork of Putah Creek, 50 to 75 feet away. A small amount of foam from an unknown source was present in the stream near the outfall, and the odor of chlorine was prevalent. At location R-1, clear, flowing water was observed. Location R-2, 100 yards downstream and east of the Old Davis Road bridge, is in a marshy area. Sampling methods at these two locations were not observed. All NPDES analyses are done by the employee who collects the samples and are performed at the STP; therefore, no sample chain-of-custody paperwork is initiated.

A list of the NPDES permit requirements for the effluent discharge is given in Table 3-7. A summary of the NPDES Discharger Self-Monitoring Report for the last 3

TABLE 3-7

NPDES EFFLUENT LIMITATIONS FOR DISCHARGE TO THE SOUTH FORK OF PUTAH CREEK

Constituent	30-Day Average	7-Day Average	30-Day Median	Daily Maximum	Sample Type/Frequency
5-Day BOD, mg/L					
Summer[a]	10	15	--	25	24-hour Composite/ Weekly
Winter[b]	20	30	--	50	
5-Day BOD, lb/day					
Summer[a]	250	325	--	575	24-hour Composite/ Weekly
Winter[b]	500	750	--	1150	
Total Suspended Matter, mg/L					
Summer[a]	10	15	--	25	24-hour Composite/ Weekly
Winter[b]	20	30	--	50	
Total Suspended Matter, lb/day					
Summer[a]	250	325	--	575	24-hour Composite/ Weekly
Winter[b]	500	750	--	1150	
Settleable Matter, mg/L	--	--	[illegible]	0.1	Grab/Daily
Total Coliform Organisms, MPN/100 mL	--	[illegible]	23	500	Grab/Weekly
Chlorine Residual, mg/L[c]	--	[illegible]	--	0.1	Grab/Daily

Source: Phillippe, 1979

pH: 6.5-8.5 (Grab, measured daily)
Maximum Dry Weather Discharge: 4.16 MGD (Measured daily)
Receiving Water Dissolved Oxygen (South Fork of Putah Creek): $\geq$ 5.0 mg/L (Grab, measured weekly)

a Summer refers to the period between May 1 and October 31.
b Winter refers to the period between November 1 and April 30.
c Interim chlorine residual limitation was 0.1 mg/L as measured 300 feet below outfall, from 4/26/85 until 5/1/87.

months available (August, September, and October 1987) is shown in Table 3-8. According to the STP operator, permit limits were exceeded a number of times in October for unknown reasons. Parameters which exceeded their limits for that month include biochemical oxygen demand (BOD), suspended matter, coliform, and chlorine residual.

Levels of chlorine residual in excess of permit limits have been noted at the plant since 1974. A Cease and Desist Order was issued for the violation on April 26, 1985, and the plant had until May 1, 1987 to comply with the limit of 0.1 mg/L chlorine residual in the receiving water 50 feet below the outfall. Wastewater Discharge Requirements Order No. 85-073 changed the limitation from 0.1 mg/L in the receiving water to 0.1 mg/L in the effluent. The interim limitation was 0.1 mg/L as measured 300 feet below the outfall.

U.C. Davis awarded the bid for a new wastewater chlorination/dechlorination facility while the on-site Survey was being conducted. The project consists of a chlorine contact basin, chlorine mixing basin, concrete-block building to house chlorinators, sulfonators, and gas cylinder storage, replacement of two vertical turbine pumps, and related piping, electrical, instrumentation, and site work (UCD, 1987b). The new facility is expected to be in operation in August 1988.

Available information on the effluent quality from the plant for a number of parameters is given in Table 3-9 (George S. Nolte and Associates, 1983). Trace metal analyses for 1977 and 1978 (the most recent data available) are given in Table 3-10. This includes data for influent, effluent, aeration, and/or sludge digestion streams, and the calculated percent removal for each element.

Data for the quantities of sludge generated and subsequently fed to the digesters are shown in Table 3-11 for July 1970 through June 1987. Sludge removed from the digesters is taken via tankers to the sludge drying beds and eventually disposed of at the U.C. Davis sanitary landfill.

In 1984, sludge from the STP was analyzed for metals and polychlorinated biphenyls (PCBs). The results, given in Table 3-12, indicate the presence of some metals but no detectable levels of PCBs.

TABLE 3-8

SUMMARY: NPDES DISCHARGER SELF-MONITORING REPORTS
AUGUST - OCTO. ER 1987

Station Description:	Influent				Effluent										R 1	R 2	
Constituent Name. (Units)	BOD (mg/L)	BOD (lb/day)	Susp Matter (mg/L)	Susp Matter (lb/day)	Flow (mgd)	BOD (mg/L)	BOD (lb/day)	Susp Matter (mg/L)	Susp Matter (lb/day)	Sett Matter (mg/L)	Tot Coliform (MPN/100mL)	pH (number)	Chlorine Res (mg/L)	Spec Cond (µmho/cm)	DO (mg/L)	DO (mg/L)	Chlorine Res (mg/L)
Sample Type:	24-hr comp	24-hr comp	24-hr comp	24-hr comp	Cumula-tive	24-hr comp	24-hr comp	24-hr comp	24-hr comp	Grab	Grab	Grab	Grab	Grab	Grab	Grab	Grab
Frequency:	Monthly	Monthly	Monthly	Monthly	Daily	Weekly	Weekly	Weekly	Weekly	Daily	Weekly	Daily	Daily	Monthly	Weekly	Weekly	Weekly
<u>August 1987</u>:																	
Monthly Average:	86	1186	144	1997	1 515	7	[illegible]	5	80	<0 1	<2	7 3	5 3	–	9 4	8 3	0 8
Monthly High:	100	1671	184	3075	2 009	9	113	7	89	<0 1	14	7 4	11 2	750	9 9	9 5	2 7
Monthly Low:	51	619	88	1068	1 225	5	64	5	63	<0 1	<2	7 2	1 7	–	8 8	7 9	0
Total Recordings Month:	4	4	4	4	31	4	4	4	4	21	5	21	20	1	4	4	4
No Exceedances:	–	–	–	–	0	0	0	0	0	0	0	0	–	–	–	0	2
<u>September 1987</u>:																	
Monthly Average:	98	1258	164	2072	1 422	10	124	9	114	<0 1	4	7 2	3 9	1100	10	7 4	0 4
Monthly High:	140	1889	244	3040	1 639	12	162	14	176	0 1	14	7 4	8 9	–	10 6	7 7	1 1
Monthly Low:	76	936	120	1619	1 180	7	88	5	62	<0 1	<2	7 1	0 8	–	9 2	6 9	0 2

TABLE 3-8

**SUMMARY: NPDES DISCHARGER SELF-MONITORING REPORTS
AUGUST - OCTOBER 1987 (Continued)**

Station Description:	Influent				Effluent										R 1	R 2	
Constituent Name (Units)	BOD (mg/L)	BOD (lb/day)	Susp Matter (mg/L)	Susp Matter (lb/day)	Flow (mgd)	BOD (mg/L)	BOD (lb/day)	Susp Matter (mg/L)	Susp Matter (lb/day)	Sett Matter (mg/L)	Tot Coliform (MPN/100mL)	pH (number)	Chlorine Res (mg/L)	Spec Cond (µmho/cm)	DO (mg/L)	DO (mg/L)	Chlorine Res (mg/L)
September 1987 (Continued)																	
Total Recordings Month:	4	4	4	4	30	4	4	4	4	21	3		21	1	5	5	5
No Exceedances	–	–	–	–	0	0	0	0	0	0	0	0	–	–	–	0	5
October 1987																	
Monthly Average	100	1401	170	2375	1 552	13	184	12	154	<0 1	125	7 3	5 8		9 5	7 9	0 85
Monthly High	128	1826	212	3025	1 775	18	257	14	195	0 1	220	7 4	8 3	1100	9 8	8 5	1 5
Monthly Low	81	1127	136	1841	1 245	9	122	9	122	<0 1	8	7 3	4 2	–	9 1	7 6	0 3
Total Recordings Month:	5	5	5	5	31	5	5	5	5	22	–	215	22	–	4	4	4
No Exceedances	–	–	–	–	0	5	1	3	0	0	3	0	–	–	–	0	4

Source: Koehler, 1987

TABLE 3-9

U.C. DAVIS SEWAGE TREATMENT PLANT EFFLUENT QUALITY CHARACTERISTICS

Constituent	Concentration[a]	Constituent	Concentration[a]
BOD_5	1.7[c]	Calcium (Ca)	21.0
Suspended Solids	7.1[c]	Sodium (Na)	87.0
Total Coliform, MPN/100 mL	93.5[b]	Total hardness as $CaCO_3$	144.0
Total Dissolved Solids	428.0	Alkalinity as $CaCO_3$	24.2[e]
Turbidity, FTU	5.3[d]	Boron (B)	0.74[e]
pH	7.4[c]	Conductance, µmhos/cm	1050.0
Chloride (Cl)	70.8	Sodium adsorption ratio, (adj)	3.2
Phosphate (PO_4)	2.6	Cadmium (Cd)	<.0005
Sulfate (SO_4)	51.0[d]	Copper (Cu)	0.20
Sulfide (H_2S)	<0.10	Mercury (Hg)	<0.002[e]
Ammonia as NH_4-N	2.4	Nickel (Ni)	<0.01[d]
Nitrite as NO_2-N	1.8[d]	Zinc (Zn)	<0.02
Nitrate as NO_3-N	4.8	Gross Alpha Radioactivity, pCi/L	0.8 ± 1.6
Potassium (K)	10.2	Gross Beta Radioactivity, pCi/L	14.8 ± 6.0

Source: George S. Nolte and Associates, 1983

a Concentrations reported in mg/L and represent the average of five 24-hour composite samples.
b 4-year geometric mean.
c 4-year average.
d One 24-hour composite sample.
e Average of four 24-hour composite samples.

TABLE 3-10

U.C. DAVIS SEWAGE TREATMENT PLANT TRACE METAL ANALYSES

Element	February 1977a** (mg/L)				February 1978b (ppm)				
	Influent	Aeration Tank	Effluent	Percent Removal	Total Influent***	Total Aeration	Total Digestion	Total Effluent	Percent Removal
Potassium (K)	.147	1.190	.0110	93	.1744 ± .0275	.7465 ± .1359	34.081 ± 3.4	.0370*	79
Calcium (Ca)	.666	10.500	.0710	89	.5964 ± .0679	6.2836 ± .6391	268.161 ± 26.8	.0376 ± .0247	95
Titanium (Ti)	.324	3.320	.0060	98	.116 ± .0106	2.5057 ± .256	75.0576 ± 8.175	.0261 ± .0031	78
Barium (Ba)	.038	.283	.0190	50	.049*	.304*	13.4795 ± 4.84	.0150*	*
Vanadium (V)	.043	.080	.0050	88	.015*	.0396 ± .0135	6.061 ± 1.568	.005*	*
Chromium (Cr)	.127	4.770	.0250	80	.0764 ± .0033	.9634 ± .0989	35.336 ± 3.8	.0111 ± .012	57
Manganese (Mn)	.003	.213	.0030	—	.0259 ± .0027	.2227 ± .029	14.41 ± 1.67	.0044 ± .0006	83
Iron (Fe)	.342	8.710	.0290	92	.8609 ± .075	6.1907 ± .6014	362.75 ± 32.6	.118 ± .0104	86
Nickel (Ni)	.025	.037	.0040	84	.0059 ± .0007	.0394 ± .0045	2.2795 ± .359	.0007 ± .0002	88
Copper (Cu)	.193	.890	.0200	90	.0344 ± .002	.6748 ± .0644	34.87 ± 3.22	.0079 ± .0005	77
Zinc (Zn)	.270	3.090	.0180	93	.0673 ± .0058	1.0045 ± .0979	43.283 ± 4.132	.020 ± .0018	70
Arsenic (As)	.006	.350	.0060	—	.002*	.012*	1.105*	.002*	*
Lead (Pb)	.015	.216	.0010	93	.0419 ± .0041	.1584 ± .0151	9.2401 ± .9156	.0046 ± .0004	89
Selenium (Se)	.007	.022	.0003	96	NA	NA	NA	NA	NA

TABLE 3-10

U.C. DAVIS SEWAGE TREATMENT PLANT TRACE METAL ANALYSES (Continued)

Element	February 1977[a]** (mg/L)				February 1978[b] (ppm)				
	Influent	Aeration Tank	Effluent	Percent Removal	Total Influent***	Total Aeration	Total Digestion	Total Effluent	Percent Removal
Bromine (Br)	.001	.008	.0001	90	.0014 ± .0003	.0237 ± .0034	.7955 ± .190	.0014 ± .0002	0
Rubidium (Rb)	.001	.005	.0004	60	.003*	.017*	1.665*	.0003 ± .0001	*
Strontium (Sr)	.008	.179	.0004	95	.0099 ± .001	.1119 ± .0118	5.146 ± .609	.0036 ± .0004	64
Yttrium (Y)	.001	.010	.0004	60	NA	NA	NA	NA	NA
Zirconium (Zr)	.002	.036	.0009	55	.003 ± .0007	.031*	2.661 ± .468	.002*	*
Molybdenum (Mc)	.010	.038	.0007	93	.010*	.054*	5.2280*	.004*	*
Mercury (Hg)	BDL	BDL	BDL	—	NA	NA	NA	NA	NA
Cadmium (Cd)	BDL	BDL	BDL	—	NA	NA	NA	NA	NA

a Source: UCD, 1977
b Source: UCD, 1978

* Denotes upper limits of these elements not found.
** Trace metal assay. Determinations made from wastewater samples using X-ray spectrum analysis by Crocker Nuclear Lab, UCD.
*** Totals represent sum of particulate and dissolved analyses.
NA: Not Analyzed.
BDL: Below detectable limit.

TABLE 3-11

U. C. DAVIS SEWAGE TREATMENT PLANT SLUDGE GENERATION (GALLONS)

	Primary Digester			Secondary Digester		
		Withdrawals			Withdrawals	
Year*	Additions	Supernatant	Sludge Tanker**	Additions	Supernatant	Sludge Tanker**
1970-71	1,442,190	671,227	706,870	821,187	377,430	397,940
1971-72	1,942,955	309,400	1,630,936	1,853,976	690,960	1,051,356
1972-73	1,667,231	197,930	1,302,180	1,989,660	701,470	1,810,170
1973-74	1,594,710	559,460	857,730	763,916	466,690	694,180
1974-75	1,441,230	561,300	477,250	1,225,870	530,160	937,390
1975-76	1,595,260	454,590	622,708	1,040,118	775,980	689,050
1976-77	1,197,545	614,760	527,590	1,087,420	605,690	535,909
1977-78	1,135,120	689,932	375,970	1,088,636	643,360	463,430
1978-79	972,270	242,750	506,146	1,026,340	582,940	532,650
1979-80	1,182,700	637,322	542,920	995,290	613,143	342,820
1980-81	1,334,750	627,250	609,760	1,476,940	898,490	598,390
1981-82	1,422,288	548,150	769,078	1,414,394	501,572	911,564
1982-83	2,090,264	613,770	1,166,536	1,615,347	996,541	819,801
1983-84	2,064,760	389,551	429,907	1,209,726	414,250	1,343,634
1984-85	1,589,574	876,718	723,396	1,662,728	959,459	591,345
1985-86	1,417,185	572,156	787,044	1,452,216	624,498	830,765
1986-87	1,291,168	684,342	614,132	1,465,076	756,595	713,964

Source: UCD, 1987a
* From July of first year through June of second year.
** Taken to sludge drying beds and then disposed of in U.C. Davis sanitary landfill.

TABLE 3-12

U.C. DAVIS SEWAGE TREATMENT PLANT SLUDGE ANALYSIS *

Analysis	Digested Sludge
Selenium	0.050
Zinc	36.0
Lead	4.1
Copper	2.05
Nickel	1.24
Cadmium	0.28
Mercury	0.67
Arsenic	< 0.004
Silver	< 0.01
Chromium	12.0
PCB-Arochlors (µg/L)	
1016	< 10
1221	< 10
1232	< 10
1242	< 10
1248	< 10
1254	< 10
1260	< 10

Source: Anlab Analytical Laboratory, 1985

* All results in mg/L except where indicated.

3.3.3.2 Putah Creek Monitoring

A water level gaging station exists on the Old Davis Road bridge over the South Fork of Putah Creek. The U.S. Geological Survey (USGS) monitored it from 1948-1962 (USGS number 111455000), and the California Department of Water Resources, Central District, has monitored it from 1957 to the present (Station number A09115). Data available for October 1974 to January 1987 indicate a flow range of 0-17,000 cfs and a gage height range of 0 to 23.05 feet (California Department of Water Resources, 1987).

An ongoing study of the LEHR by Wahler Associates involves taking water levels of the South Fork of Putah Creek from the Old Davis Road gaging station. Water elevation levels taken during the on-site Survey activities were constant at approximately 30.4 feet.

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

1. Potentially contaminated stormwater runoff. Stormwater runoff control at the LEHR facility is inadequate and may have resulted in off-site discharges of potentially contaminated stormwater.

   Runoff from the southwest portion of the site was observed to discharge to the lift station east of Old Davis Road, where it is pumped underneath the road and then flows south to the South Fork of Putah Creek. Contaminants potentially present in the stormwater may enter the creek and degrade the quality of the water, which is used for irrigation by farmers downstream of the LEHR.

The southwest corner of the LEHR has been used for a variety of activities and is suspect for soil contamination, as discussed in Section 3.2. Suspected contaminants include solvents and chlordane from chemical dispensing activities, and strontium-90 and possibly other contaminants from a tank truck parked in the area reportedly used on at least one occasion to pump out the Imhoff tanks. In addition, a trench containing radioactive and possibly hazardous material is located in the southwest corner and may constitute a source of contaminants moving laterally toward the sump and lift station along a subsurface clay layer.

Survey-related sediment sampling is planned at the lift station, in the ditch on the west side of Old Davis Road, and in the South Fork of Putah Creek as a background (upstream) sample to determine whether stormwater runoff is contaminated with chemical and/or radiological substances that may migrate off-site and enter the creek.

2. <u>Potentially contaminated sewer lines.</u> Hazardous and radioactive constituents may have been discharged to the LEHR sewer system, resulting in contamination of the LEHR sewer lines and the sewer lines and sludges at the U.C. Davis STP.

Although the Survey team did not observe this to be a current problem, the discharge of acids or caustics from activities at the LEHR could mobilize any contaminants present in the LEHR sewer system, resulting in potential toxic discharges via the effluent line to the South Fork of Putah Creek and toxic accumulations in the sludge. The plant effluent has been and is being used for campus irrigation. Sludge from the STP is disposed of at the U.C. Davis sanitary landfill as nonhazardous waste, and may leach contaminants to the subsurface soil and groundwater.

No monitoring for organics, heavy metals, or radiological substances is performed regularly on the U.C. Davis effluent outfall to the South Fork of Putah Creek, the STP sludges, or the influent from the LEHR to the U.C. Davis sewer system. Potential sources of contamination from the LEHR observed during the Survey include:

- Disposal of organics via sinks and drains (Building H-213, Room 106 and Building H-217, Room 418 - methanol, acetone)

- Potential spills to floor drains (Building H-216, Room 422 - reagent-grade chemicals; Building H-290, Room 505 - acids)

- Discharges into storm sewers connected to the U.C. Davis STP (potentially contaminated stormwater runoff; unknown chemicals in past discharges from cooling towers north of Building H-219, Room 203; west of AH-2; and west of the shop)

- Mobilization of any contaminants (radioactive and/or chemical) in AH-1, AH-2 (X-ray developer; Room 310-potential caustics), Pathology Office and Laboratory, and Main Office and Laboratory sanitary sewer lines now connected to the U.C. Davis STP (formerly on septic systems).

There is some evidence of uncontrolled and unregulated discharges to the U.C. Davis STP and subsequently into the South Fork of Putah Creek. However, there is no indication that these discharges are solely attributable to effluent from the LEHR. During the winter of 1986-1987, the STP experienced an upset thought to be due to the discharge from a cooling tower during cleanout. A second incident occurred during the Survey, when a large amount of foam was observed discharging from the NPDES outfall into the South Fork of Putah Creek. (A smaller amount was observed on a previous day at the NPDES outfall.) This incident is in violation of the STP's NPDES permit, which prohibits "visible oil, grease, scum or foam in the receiving waters or watercourses" (Phillippe, 1979). Thirdly, the STP also is in violation of its NPDES chlorine residual limit, and the odor of chlorine is evident at the outfall. These three incidents, though not known to be a result of LEHR activities specifically, are evidence of the potential for future unregulated discharges of toxics or other objectionable substances to the U.C. Davis STP and eventually to the South Fork of Putah Creek.

Survey-related sampling of the sludges in the LEHR sewer lines leading to the U.C. Davis STP is planned to determine whether any chemical or radiological substances have been discharged to the lines leading to the STP.

3.3.4.4 Category IV

1. Lack of a comprehensive surface-water monitoring program. Lack of a comprehensive surface-water monitoring program at the LEHR precludes assessment of past and present environmental impacts of LEHR operations on nearby surface waters (i.e., the South Fork of Putah Creek). Although there is no information to indicate that significant off-site impacts occurred from either past or present operations, there are no data to support or refute this assumption.

   Interviews with SAN personnel revealed that SAN granted the LEHR an exemption from preparing an Annual Environmental Monitoring Report, allowing the LEHR instead to prepare an Annual Environmental Summary. This exemption was granted under the provisions of DOE Order 5484.1. However, the exemption does not eliminate the requirement to monitor or in some way assess the environmental impacts from LEHR operations. The LEHR facility does not monitor liquid effluents nor, as a substitute, does it calculate liquid effluent releases to compare to applicable standards. Furthermore, no ambient surface-water monitoring is done to put any LEHR liquid effluent releases into perspective.

3.4 Hydrogeology

3.4.1 Background Environmental Information

3.4.1.1 Geology

The Laboratory for Energy-Related Health Research (LEHR) is located in the Putah area of the Sacramento Valley. The Putah area is in the southwestern corner of the valley, a topographic and structural basin underlain by a thick section of sediments derived from the erosion of the surrounding hills and mountains by the Sacramento River and its tributaries. Along the western boundary of the Sacramento Valley, the eastern Coast Ranges and foothills rise as a north-trending belt of Cretaceous-age to Recent-age sedimentary rocks. The rocks are tilted to the east with successively younger strata eastward. The undeformed Pleistocene and Recent deposits that underlie the valley rest unconformably on the tilted sediments of the foothills.

Most of the streams that drain the Putah area have their headwaters east of the ridge of Cretaceous rocks that marks the western boundaries of Solano and Yolo Counties. Putah Creek, the largest stream in the area, rises west of the ridge and cuts a deep, narrow canyon through it. Putah Creek and the smaller streams have built an alluvial plain, which slopes eastward toward the Sacramento River, and have developed a branching set of channel ridges or natural levees during times of flooding.

The rocks of the Putah area range in age from Cretaceous to Recent (Figure 3-8). They have been divided into eight geologic or stratigraphic units (Thomasson, Olmsted, and Le Roux, 1960):

1. Stream channel deposits
2. Younger alluvium
3. Older alluvium
4. Tehama Formation and related continental sediments
5. Volcanic sedimentary rocks
6. Basalt
7. Undifferentiated sedimentary rocks of Paleocene and Eocene age
8. Undifferentiated rocks of Cretaceous age

System	Series	Geologic unit	Thickness (feet)	General character	Water-bearing properties
Quaternary	Recent	Stream channel deposits	0-10	Loose coarse sand and gravel along channel of Putah Creek and on floodplain west of Winters in part actively moving downstream and shifting	Highly permeable, but limited thickness and extent and susceptibility to flooding eliminate these deposits from consideration except as a ground-water intake area
		Younger alluvium	0-40 +	Loose grayish-brown silt and fine-grained sand, some silty clay, medium- to coarse-grained sand, and gravel. These floodplain deposits are characterized at the land surface by soils having immature profiles.	Moderately permeable, but largely above the water table. Most of the soils transmit water downward readily except in and adjacent to the Yolo basin
		Local unconformity			
	Pleistocene	Older alluvium	0-150 +	Stream-laid silt, silty clay, gravel, and sand. The fine-grained deposits predominate throughout most of the area; the gravel and sand, which average about one-fourth the thickness, occur as tongues and lenses rather than continuous sheets. Deposits are loose to moderately compacted, and are characterized at the land surface by soils having mature profiles containing a B horizon of dense clay. Thickness throughout most of the Putah plain ranges from 60 to 130 feet.	Permeability extremely variable. Coefficients of permeability average about 3,000-4,500 gpd per sq ft for gravel-and-sand aquifers in the vicinity of Winters and Dixon but are less than 1 gpd per sq ft for some of the interbedded silts and silty clays. Discharges of irrigation wells tapping mainly older alluvium are about 500-700 gpm near Winters, 500-1,000 gpm near Dixon, 300-900 gpm near Davis, and 50-150 gpm near Vacaville. Soils at the land surface transmit water downward very slowly because of presence of B horizon of dense clay. Water is of the calcium magnesium bicarbonate type and is of excellent quality for irrigation but too hard to be desirable for domestic use
		Local angular unconformity			
Quaternary / Tertiary	Pleistocene / Pliocene	Tehama Formation and related continental sediments	0-2,500 +	Fluviatile and lacustrine (?) sediments consisting of moderately compacted silt, clay, and silty fine sand enclosing lenses of sand and gravel, silt and gravel, and conglomerate cemented with calcium carbonate, beds of reworked pumiceous tuff in basal portion. The unit consists mostly of the Tehama Formation but includes possible correlatives of the Red Bluff Formation and unnamed post-Red Bluff stream-terrace deposits. The subsurface contact with the older alluvium is not well defined at many places and may be gradational beneath much of the Putah plain. Thickness beneath most of the Putah plain ranges from about 1,500 to 2,500 feet	Permeability variable. Gravel-and-sand aquifers are generally less permeable than those in the older alluvium, and a greater additional footage of well is required to obtain a given increase in production in the Tehama than in the older alluvium. Locally the aquifers yield large quantities of water to irrigation wells, and most wells in the Putah area producing more than 1,000 gpm tap the Tehama Formation as well as the older alluvium. The water in most aquifers in the Tehama Formation is under some artesian pressure, the degree of confinement increasing with depth. The water in the topmost aquifers is similar in chemical quality to that in the older alluvium, however, waters in three wells more than 1,000 feet deep near Davis contain more than 60 percent of sodium, which is somewhat high for continued irrigation use. As of 1951, approximately only the upper half of the unit had been penetrated by water wells, except in the English Hills, where a few water wells penetrate to the base.
Tertiary	Pliocene (?) Miocene (?)	Volcanic sedimentary rocks	0-400 +	Fluviatile, lacustrine, and shallow-water marine sedimentary rocks consisting of white, gray, blue, pink, and purple siltstone, sandstone, shale, and conglomerate made up largely of andesitic detritus; white ash and basalt conglomerate in vicinity of Putnam Peak. May be much thicker than 400 feet beneath southern part of Putah plain. Possible correlatives include Mehrten Formation, Neroly Formation, Kirker tuff, Sonoma volcanics, lower part of Wolfskill formation of Weaver (1949)	Permeability of most of unit very low. A few friable medium- to coarse-grained sandstone beds contain fresh water which is yielded in small quantities to several wells near Vacaville. Electric logs of gas and gas-test wells in the southern Putah plain indicate that the water contained in the volcanic sedimentary rocks, which there are at depths of more than 3,000 feet, may be of doubtful quality for irrigation use
	Oligocene (?)	Basalt	0-130	Dark dense basalt of flow origin at Putnam Peak, Drakes Point, and several intervening localities in English Hills; also at a few localities at or near the base of the Tehama formation and related continental sediments in the foothills north of Putah Creek where it occurs locally as dikes.	Not water bearing, except in fractures and vesicles. Not known subsurface in the Putah area except in one well in sec. 36, T. 6 N., R. 1 W. Of no importance as a present or possible future source of groundwater
		Angular unconformity			
	Eocene and Paleocene (?)	Undifferentiated sedimentary rocks	7,000 ±	Sandstone, siltstone, shale, and some conglomerate, all of marine and lagoonal origin. Includes Markley sandstone member and Nortonville shale member of Kreyenhagen Formation, Domengine Formation, Capay shale of Weaver and others (1944), Meganos formation and possibly the Martinez formation (Paleocene).	Permeability of most of unit very low. Several wells in Vaca and Pleasants Valleys and in the English Hills obtain a few gallons per minute of fresh water from moderately friable sandstone beds. However, the few relatively permeable zones at depths of several thousand feet beneath Putah plain contain either connate to dilute connate marine water or natural gas.
		Local unconformity;			
Cretaceous	Upper Cretaceous	Undifferentiated rocks	15,000 ±	Siltstone, sandstone, shale, and conglomerate, all of marine origin, and all more or less indurated or cemented. Includes the following formations of Kirby (1943a): Venado, Yolo, Sites, Funks, Guinda, and Forbes.	Not penetrated by water wells in Putah area, depth to top of unit is more than a mile throughout most of Putah plain. Overall permeability is extremely low, and the few relatively permeable zones contain connate marine water

Source: Thomasson, Olmsted, and Le Roux, 1960

FIGURE 3-8

GEOLOGIC UNITS OF THE PUTAH AREA

Stream channel deposits are loose sand and gravel, which are constantly moving and shifting in the channel of Putah Creek.

The younger alluvial materials are floodplain deposits of Recent age which underlie Putah plain and the small valleys in the foothills north of Putah Creek.

The older alluvium consists primarily of fine-grained sediment with lenses, tongues, and tabular bodies of coarse, gravelly sands. The older alluvium is probably late Pleistocene in age. Its contact with the older Tehama Formation and related continental sediment is ill-defined and has been inferred to be at the bottom of an irregular zone of coarse deposits, which occur from 50 feet to more than 150 feet below the land surface. The older alluvium was deposited by Putah Creek in a triangular area bounded by Winters, Davis, and Dixon.

The Tehama Formation and related continental sediments have been grouped (Thomasson, Olmsted, and Le Roux, 1960) into one stratigraphic unit because of the difficulty in separating them in both outcrop and the subsurface. The "related continental sediments" are possible correlatives of the Red Bluff Formation and post-Red Bluff stream terrace deposits. Vertebrate fossil evidence has been used to assign the Tehama Formation to the upper Pliocene to lower Pleistocene. The Red Bluff Formation and post-Red Bluff stream terrace sediments are probably Pleistocene in age.

Correlation of subsurface beds within the Tehama is virtually impossible, although zones of predominantly fine to coarse material can be traced beneath parts of the Putah plain.

A sequence of volcanic shale, sandstone, and conglomerates underlies the Tehama Formation and related continental sediments. The age of these rocks is uncertain, but they are probably Miocene to Pliocene (Thomasson, Olmsted, and Le Roux, 1960). They are largely fine-grained but include some coarser grained rocks, which are probably water-bearing.

A dark, fine-grained basalt, which occurs as flows and dikes in the foothills north of Putah Creek, is post-Eocene and in places as young as Pliocene.

The seventh and eighth stratigraphic units in the Putah area are marine sedimentary strata, which are essentially non-water-bearing. They range from Cretaceous to Paleocene in age. Both units consist of siltstones, sandstones, shale, and conglomerate.

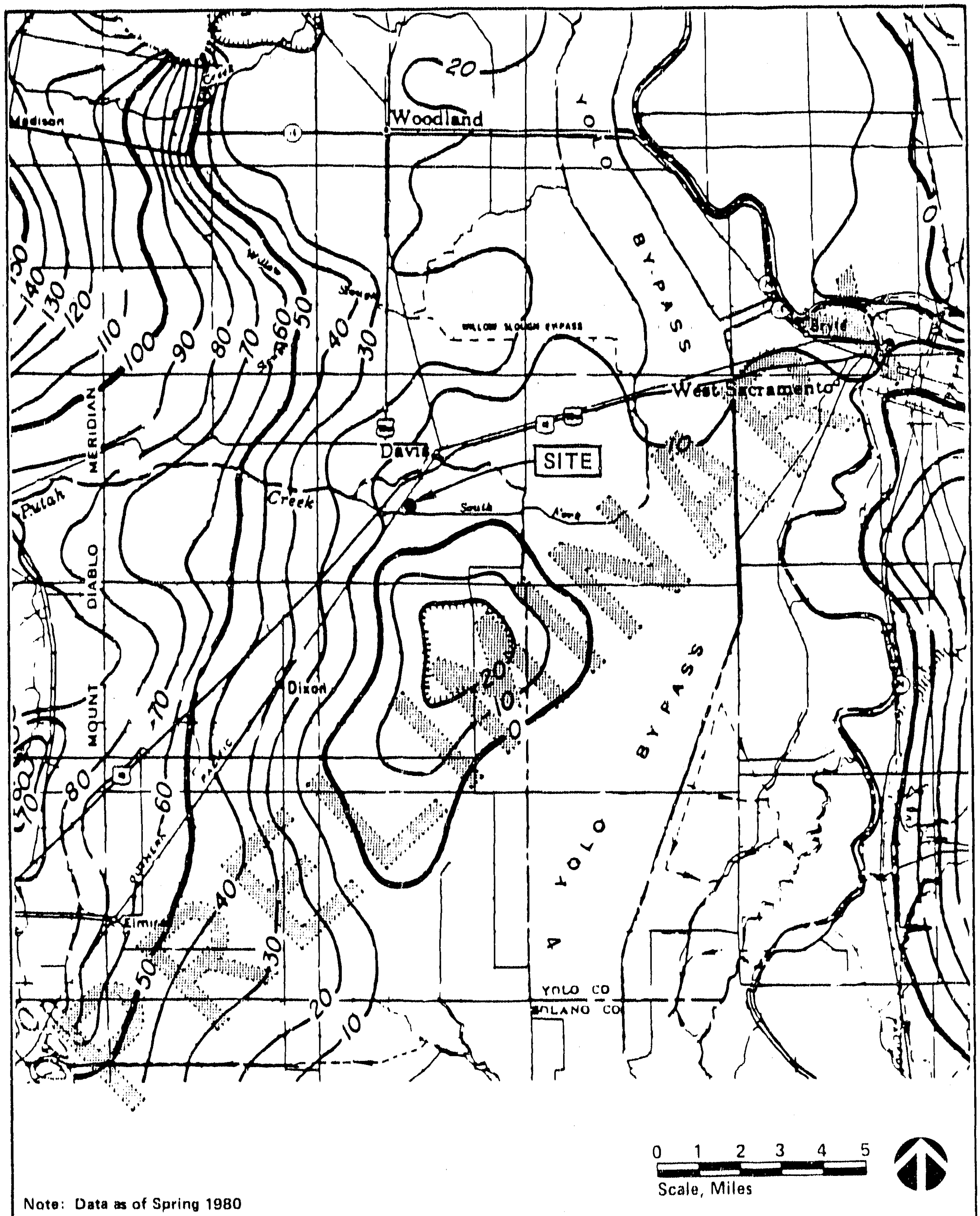
3.4.1.2 Hydrogeology

The major groundwater sources for public and private water supplies are the unconsolidated sediments of Pliocene and Pleistocene age, chiefly in the Tehama Formation and related continental deposits and the older alluvium. The older alluvial sediments are referred to as the shallow-intermediate aquifer and the Tehama and related continental deposits as the deep aquifer (Scalmanini, 1978). The aquifers are separated by thick sections of clay and silt that act as aquitards; however, the possibility of some interconnection between aquifers cannot be ruled out. Regional groundwater movement is generally eastward toward the Sacramento Valley. In the vicinity of the LEHR, groundwater flow is southeasterly, influenced by high-volume pumpage of well fields east of Dixon (Figure 3-9). Although the California Department of Water Resources publication from which Figure 3-9 was taken does not specify which aquifers the wells that supplied the data were completed in, it is likely that the shallow-intermediate and deep aquifer flow directions are the same.

The younger alluvial deposits beneath the LEHR include several sandy layers of varying thickness and horizontal extent. Monitor wells installed during October and November 1987 by Wahler Associates were completed in the saturated sandy layers (Figure 3-10). The first saturated sandy layer is encountered at depths varying from 35 to 40 feet beneath the site and is 15 to 20 feet thick (Figures 3-11 and 3-12). The direction of groundwater flow in this aquifer as determined from water level elevation measurements in the monitor wells is to the northeast. It is not likely that this aquifer is used as a groundwater source, given its shallow depth and the variability of the thickness and areal extent of floodplain deposits.

3.4.1.3 Groundwater Use

Most of the groundwater in the region is of very good quality for irrigation use, but is too hard to be desirable for domestic and processing use. Water from

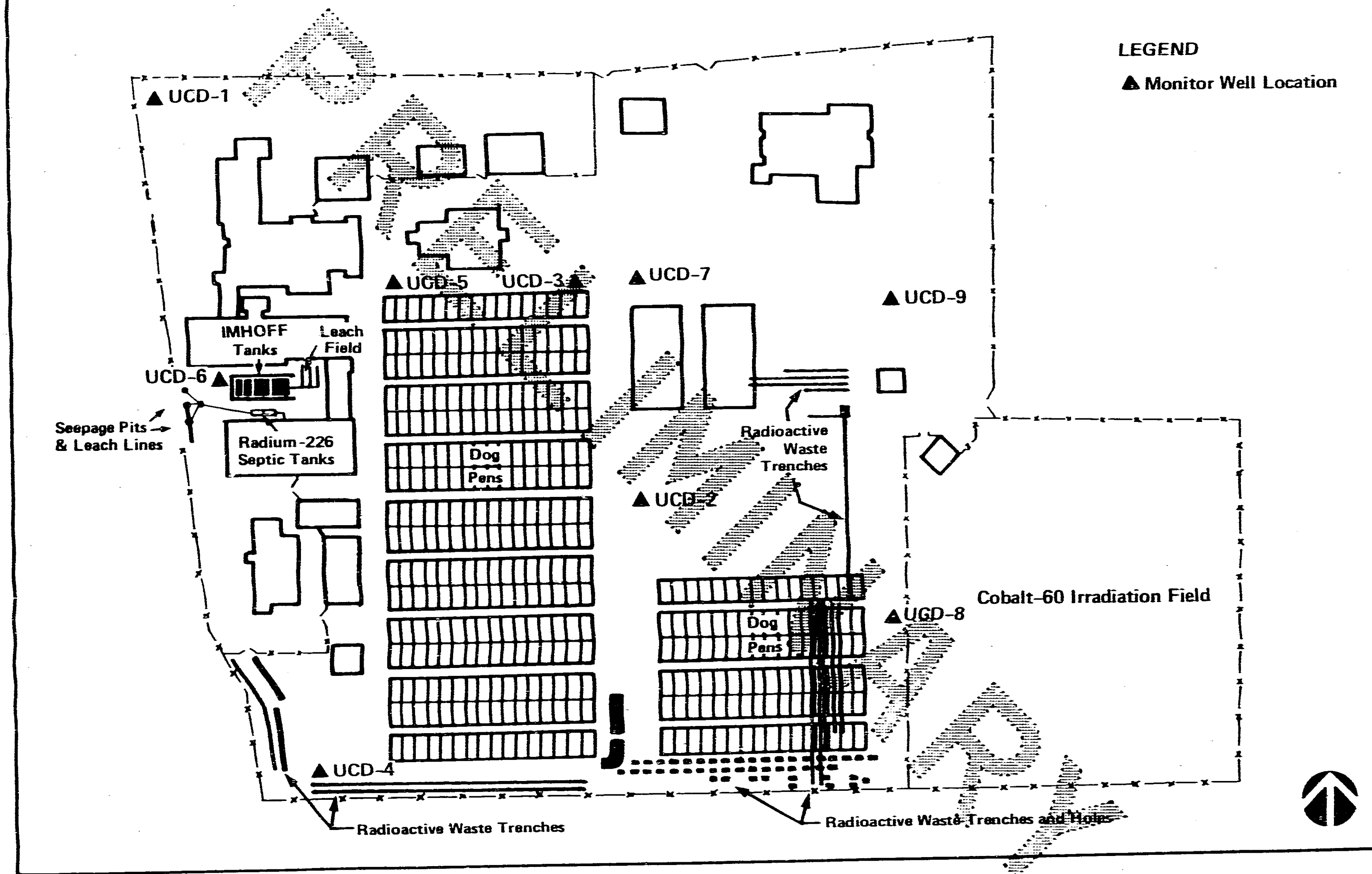


Note: Data as of Spring 1980

Source: California Department of Water Resources, 1980

LINES OF EQUAL ELEVATION OF WATER IN WELLS LOCATED IN LOWER SACRAMENTO VALLEY AND SAN JOAQUIN COUNTY

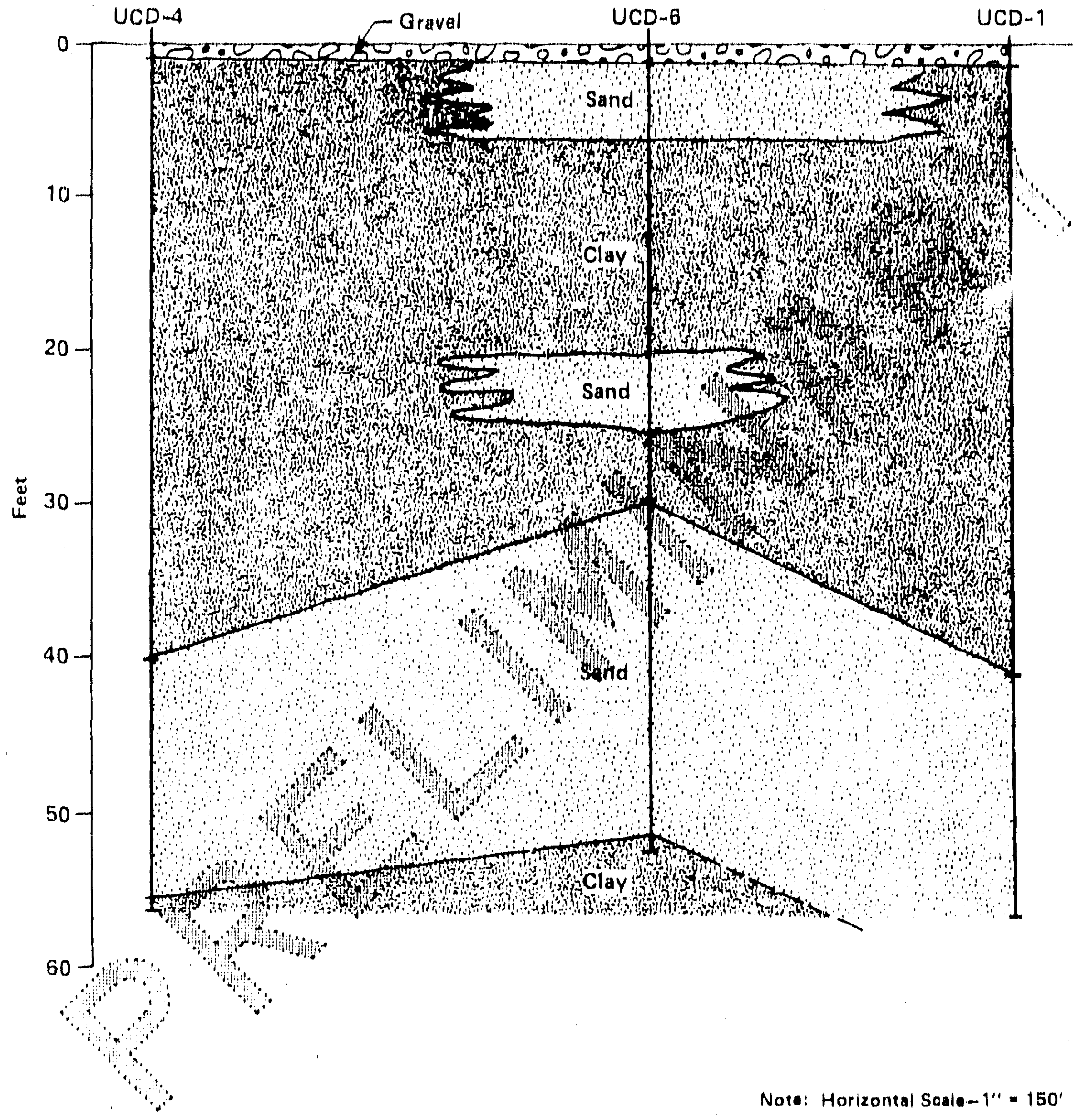
FIGURE 3-9



Source: Wahler Associates, 1987

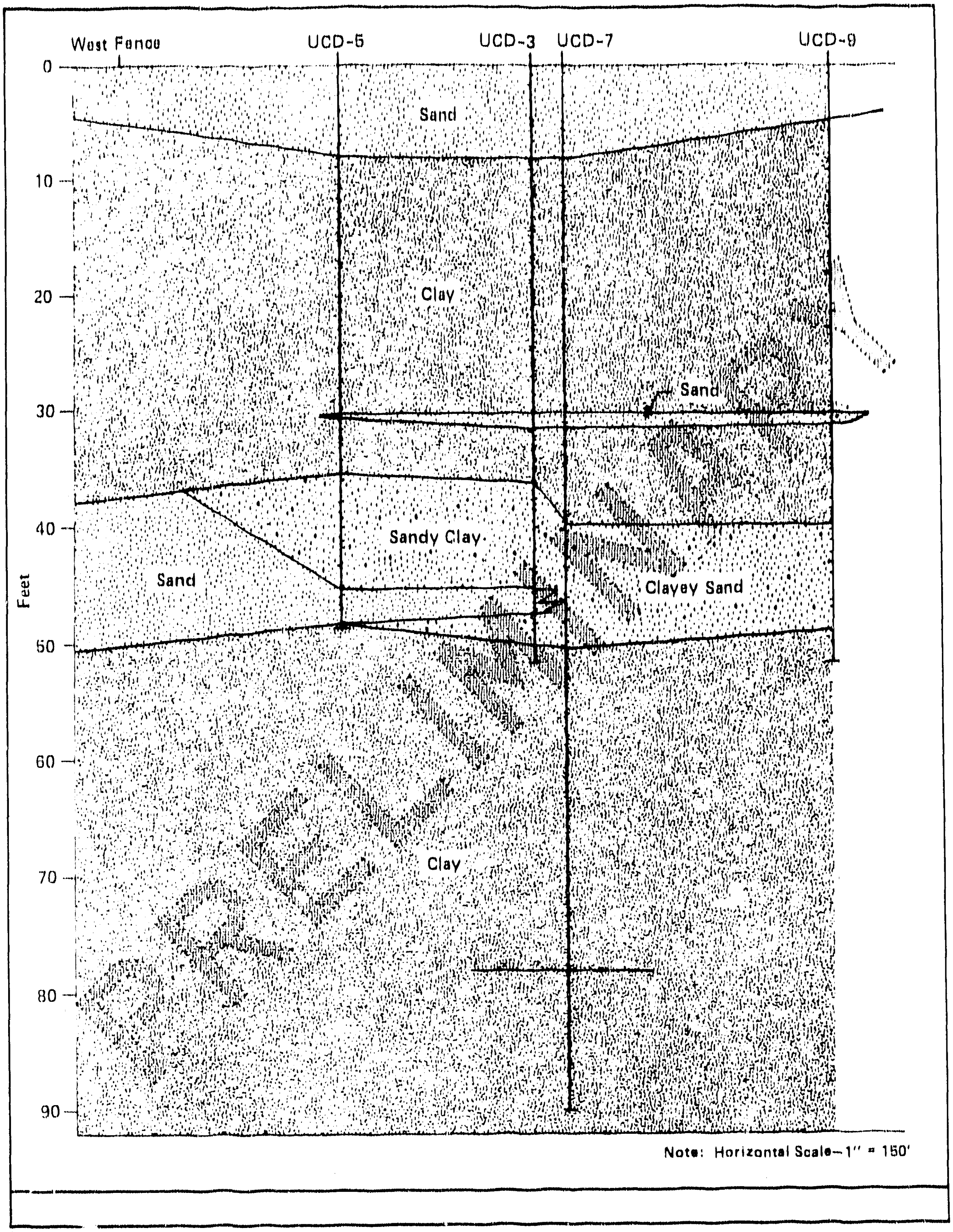
U.C. DAVIS-LEHR MONITOR WELL LOCATION PLAN

FIGURE 3-10



GEOLOGIC CROSS SECTION THROUGH
UCD-4, UCD-6, UCD-1
U.C. DAVIS-LEHR

FIGURE 3-11



GEOLOGIC CROSS SECTION THROUGH
UCD-5, UCD-3, UCD-7, UCD-9
U.C. DAVIS-LEHR

FIGURE 3-12

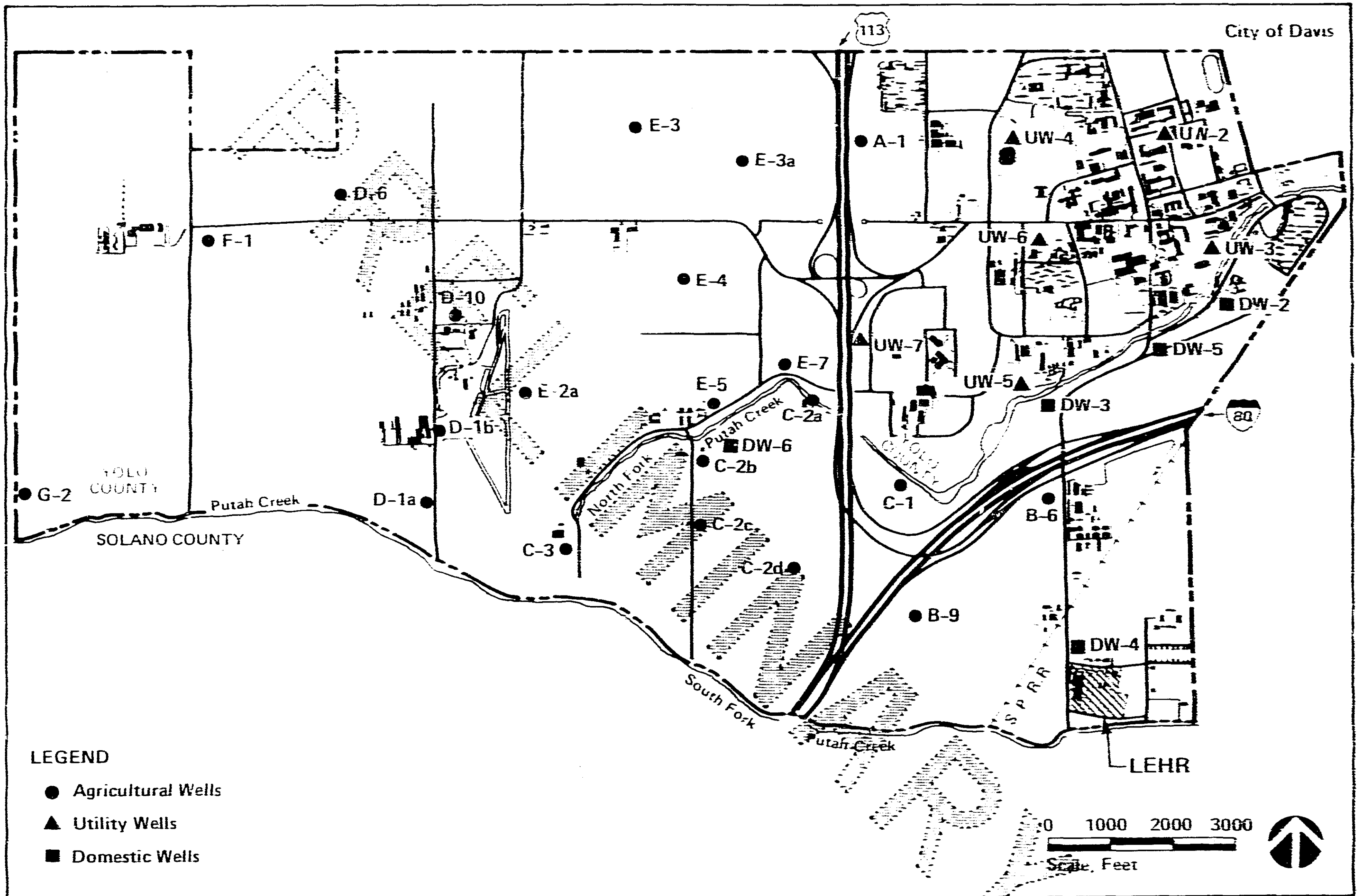
aquifers within the first 500 feet below land surface is of the magnesium bicarbonate or the calcium magnesium bicarbonate type (Thomasson, Olmsted, and Le Roux, 1960). Below 500-foot to 1,000-foot depth, the water is considerably softer.

The University of California at Davis (U.C. Davis) has three categories of water supply; domestic, utility, and agricultural (Scalmanini, 1978). U.C. Davis operates five wells exclusively for domestic water supply (Figure 3-13). Domestic water is used for drinking water, laboratories, heating, and cooling (Table 3-13). Four wells are completed in the deep aquifer at a depth of approximately 1,500 feet below land surface. The fifth well, DW-7, is completed in the shallow-intermediate aquifer at a depth of approximately 600 feet below land surface (UCD, 1987c).

Water supplied for nonagricultural irrigation, greenhouse use, and some laboratories is designated utility water. Six wells completed in the shallow-intermediate aquifer to a depth of 600 feet below land surface supply the utility system (Figure 3-13). The shallow-intermediate aquifer is also used by U.C. Davis for its agricultural irrigation wells, the City of Davis for its municipal water supply, and by local farmers. Although utility system water meets drinking water standards for quality, it has higher hardness and dissolved solids concentrations than does drinking water (Table 3-14). Utility system water is adequate for use as a backup source for the domestic system. For emergency backup purposes, it has an interconnection with the domestic system but has not been mixed with the domestic water system for at least 4 years (UCD, 1987c). The utility water system also has a cross-connection with the City of Davis municipal water system.

The third water system at U.C. Davis consists of 21 wells, which, in conjunction with surface water, supply water for the irrigation of crops and watering of livestock (Figure 3-13). All the wells are completed in the shallow-intermediate aquifer to a depth of 650 feet (Scalmanini, 1978). This water is a calcium magnesium water high in both hardness and total dissolved solids (Table 3-14). These wells are not cross-connected with either the domestic or the utility water systems.

The LEHR receives all of its water from a single source: U.C. Davis domestic water system well DW-4, which is located approximately 100 yards north of the facility. Although it is used as "domestic water" for drinking fountains, restrooms, etc., it is



Source: UCD, 1976

U.C. DAVIS SUPPLY WELLS

FIGURE 3-13

TABLE 3-13

U.C. DAVIS DOMESTIC WATER QUALITY GROUNDWATER

Year	Constituents									
	EC (mmho/cm)	TDS (mg/L)	Ca (me/L)	Mg (me/L)	Na (me/L)	B (mg/L)	Cl (me/L)	CO_3/HCO_3 (me/L)	NO_3-N (mg/L)	Total Hardness as $CaCO_3$ (mg/L)
1971	0.58	372	1.03	1.69	3.06	0.82	0.64	4.42	1.0	135.5
1972	0.57	365	0.99	1.75	3.01	0.80	0.57	4.30	1.02	137.0
1973	0.58	372	0.91	1.85	2.93	0.81	0.56	4.34	1.10	138.0
1974	0.54	346	0.96	1.85	2.58	0.76	0.58	4.10	1.02	140.5
1975	0.55	353	0.90	1.76	2.78	0.87	0.57	4.17	1.04	133.0
1976	0.54	346	0.82	1.57	3.57	0.83	0.59	3.90	1.0	119.5

Source: Scalmanini, 1978

TABLE 3-14

U.C. DAVIS AGRICULTURAL AND UTILITY WATER QUALITY GROUNDWATER

Year	Constituents									
	EC (mmho/cm)	TDS (mg/L)	Ca (me/L)	Mg (me/L)	Na (me/L)	B (mg/L)	Cl (me/L)	CO_3/HCO_3 (me/L)	NO_3-N (mg/L)	Total Hardness as $CaCO_3$ (mg/L)
1971	1.02	654	2.45	6.16	1.65	0.85	0.99	8.77	4.83	430.5
1972	1.20	769	2.57	7.58	1.94	1.08	1.11	10.26	5.14	507.5
1973	1.21	776	2.35	6.84	2.83	1.10	1.05	9.84	4.68	459.5
1974	1.15	737	2.40	7.03	1.67	1.06	1.05	9.77	5.54	471.5
1975	1.09	699	2.24	6.93	1.98	1.13	0.92	9.40	4.94	458.5
1976	1.23	788	2.46	7.57	4.77	1.35	1.11	10.23	6.24	501.5
1977	1.21	776	2.31	7.67	3.71	1.26	1.07	10.30	6.23	499.0

Source: Scalmanini, 1978

also designated as "industrial water" where it is supplied for use in laboratory sinks, dishwashing, etc. In addition, deionized water is provided to laboratories from ion exchange units in the Shop Building. LEHR does not use any agricultural water at the facility.

An abandoned water well is reported to be located beneath the concrete floor of the Shop Building at LEHR. There is no information available about the depth, construction or former use of this well, or the method used, if any, to seal it.

3.4.2 General Description of Pollution Sources and Controls

Potential sources of groundwater pollution at LEHR consist of known and suspected disposal areas, and of areas where the potential for contamination exists as a result of site operations.

3.4.2.1 Radioactive Liquid Effluent Disposal Sites

At the LEHR facility, two on-site systems were used for disposal of radioactively contaminated wastewater - the Imhoff treatment system and the radium-226 septics tanks with the associated seepage pits and leach line. Effluent from these systems was ultimately discharged to subsurface soils and constitutes a potential source of groundwater contamination. These potential sources are briefly discussed below; a more detailed discussion is provided in the Inactive Waste Sites and Releases Section 4.5.1.

- Radium-226 Septic Tanks, Seepage Pits, and Leach Line - Percolation of liquid effluent containing radium-226 into subsurface soil surrounding the seepage pits and leach line may have contaminated the groundwater. Excreta from dogs used in the radium-226 study and housed in Animal Hospital 2 (AH-2) were collected and processed through the radium septic tank. Liquid effluent was discharged into three seepage pits and the leach line.

- Imhoff Tanks and Leach Field - Percolation of liquid effluent containing strontium-90, and possibly plutonium-241, americium-241, and ytterbium-169, into subsurface soil beneath the leach field may have contaminated the groundwater. Also, the integrity of the Imhoff tanks has not been tested since the system was put into operation in 1961 and thus the tanks may be a source of radioactive leachate migrating into the subsurface soils. The tanks received excreta and other radioactive wastes from dogs used in the strontium-90 study and housed in AH-1 as well as wastes containing plutonium-241, americium-241, and ytterbium-169. The liquid effluent from the tanks was piped to the leach field.

3.4.2.2 Landfills and Burial Sites

Portions of the LEHR facility have been used for burial of radioactive and chemical solid waste. At some of the burial sites, both containerized and bulk liquids were also disposed of. Detailed descriptions of these potential sources of groundwater contamination are provided in the Inactive Waste Sites and Releases Section 4.5.1. A brief account is provided below.

- Radioactive Waste Burial sites - Radionuclides may have leached from 68 radioactive waste burial sites and contaminated the groundwater. Wastes containing 26 different radioisotopes totaling 1.7 curies have been buried at these sites.

- Chemical Waste Burial Sites and Abandoned Dump Site - Disposal in unlined pits of chemical wastes, rubbish, petroleum distillates, used oil, and incinerator ash from the U.C. Davis campus took place from 1956 to 1967. In the late 1940s and early 1950s, a dump site for general sanitary wastes was operated by U.C. Davis in the vicinity of the Cobalt-60 Irradiation Field. Leachate from these sites may have contaminated the groundwater.

3.4.2.3 Miscellaneous

During the past operation of the LEHR facility, chemical spills are likely to have occurred and may have resulted in soil contamination. Also, the historical practices used for flea control in the beagle colony may have contaminated soil. Descriptions of these potential groundwater contamination sources are provided below. Further details are provided in the Soil Section 3.2.1.

- Spills - Historically, a bulk chemical storage and dispensing area was located in the southwestern corner of LEHR. Although there are no reports of spills, accidental spills probably occurred during the 10 to 15 years this area was in use and may have contaminated the groundwater with acetone, ethyl alcohol, formaldehyde, kerosene, and other miscellaneous solvents.

- Dog Pens - Outdoor pens that housed dogs with body burdens of strontium-90 and radium-226 were constructed on gravel-covered soil. From 1960 to the early 1970s, chlordane was sprayed in the pens to control flea infestations. It was also used as a dip for the dogs. It is believed that the spent dip was either dumped in the pen areas or in the waste pits that were active at the time. Chlordane may have been carried vertically down to the groundwater by precipitation.

3.4.2.4 Controls

No controls of potential groundwater pollution are in place at the LEHR facility.

3.4.3 Environmental Monitoring Program

3.4.3.1 Site Characterization Study

Prior to October 1987, there was no program to monitor groundwater pollution at the LEHR. In October 1987, Wahler Associates, Palo Alto, California, began the installation of nine groundwater monitor wells for site characterization. It is anticipated that these wells will continue to be used for groundwater monitoring in the future. The well installation work was completed in early November 1987.

Well Locations

Nine groundwater monitor wells were installed at the LEHR facility at the locations shown in Figure 3-10. Initially, three monitor wells (UCD-1, UCD-2, and UCD-4) were constructed and developed in the first-encountered saturated sandy zone, which occurs at a depth of approximately 45 feet below ground surface. Groundwater elevation measurements were made in these wells and from these data, the groundwater flow direction was determined to be to the northeast. The remaining six monitor wells were then installed so that they would be downgradient from potential sources of groundwater pollution. Five of these wells (UCD-3, UCD-5, UCD-6, UCD-8, UCD-9) were completed in the same aquifer as the first three monitor wells. The sixth well, UCD-7, was completed in the next-deeper aquifer. Well depth and screen length for each well are given in Table 3-15.

Monitor Well UCD-2 was drilled through an old landfill. Notes of the Wahler Associates' field technician on the well log record encountering refuse (wood, glass, metal, wire, chain, etc.) from approximately 2.0 feet to at least 7.2 feet below the ground surface. The upper 10-foot length of the borehole was not sealed off before the boring was completed and the monitor well installed.

Monitor Well UCD-4 may be of limited value in distinguishing sources of groundwater pollution attributable solely to DOE-related activities at the LEHR. The monitor well is not downgradient of the waste trench area in the southwest corner of the site which is believed to contain waste only from DOE-sponsored projects. The well appears to be downgradient of the western end of two radioactive waste disposal trenches that were used for disposal of waste generated on the U.C. Davis campus and is therefore unusable as a background well. SAN plans to install additional monitor wells when the locations of the trenches are better defined by Wahler Associates through the next phase of its work plan (Wahler Associates, 1987).

<u>Well Construction</u>

The monitor wells are constructed of 2-inch-inside-diameter polyvinyl chloride (PVC) solid riser pipe and 2-inch-inside-diameter machine-slotted PVC screens. The annular space around the screens was gravel-packed and a bentonite seal placed above the pack. The remainder of the annular space around the riser pipe was grouted. A lockable steel surface casing was placed around each monitor well for protection from physical damage and for security. The monitor well identification number was painted on the removable PVC well casing cap and on the lockable steel surface casing. However, the PVC well casing did not have its identifying

TABLE 3-15

MONITOR WELL CONSTRUCTION

Monitor Well Designation	Depth (Feet Below Ground Surface)	Depth (Feet Below Ground Surface)	
		Top of Screen	Bottom of Screen
UCD-1	56.5	46.5	56.5
UCD-2	59.0	44.0	59.0
UCD-3	49.0	39.0	49.0
UCD-4	55.0	45.0	55.0
UCD-5	48.0	38.0	48.0
UCD-6	50.0	40.0	50.0
UCD-7	90.0	80.0	90.0
UCD-8	53.5	43.5	53.5
UCD-9	50.0	40.0	50.0

Source: UCD, 1987c

number painted on it. The ground surface around the wells was graded to prevent the accumulation of surface water around the wells, except for UCD-7, UCD-8, and UCD-9. A depression was left around these wells when the 8-inch hollow-stem auger hole was backfilled.

Groundwater Analysis

Groundwater samples collected from these wells will be analyzed for radium-226, strontium-90; gross alpha, beta, and gamma; volatile organics; polychlorinated biphenyl (PCB); pesticides; nitrates; and the 17 metals listed in Table 3-16 (Wahler Associates, 1987).

The Survey team observed the collection of water samples from Monitor Wells UCD-1, 5, and 6. All the samples were observed to be light to dark brown in color. The presence of excessive suspended solids indicates that the wells were improperly developed. SAN instructed the contractor (Wahler Associates) not to submit the samples for analysis and to ensure proper development of the nine monitor wells. Additionally, Monitor Well UCD-6 was not purged of three well volumes before water samples were collected.

3.4.3.2 Environmental Monitoring Data

There are no historical groundwater monitoring data available at LEHR since no program was in place. Groundwater monitoring data from the ongoing study were not available since monitor well development had not been completed at the time of the on-site phase of the Survey.

3.4.4 Findings and Observations

3.4.4.1 Category I

None

3.4.4.2 Category II

None

TABLE 3-16

CALIFORNIA WET EXTRACTION TOXIC METALS

Antimony	Mercury
Arsenic	Molybdenum
Barium	Nickel
Beryllium	Selenium
Cadmium	Silver
Chromium	Thallium
Cobalt	Vanadium
Copper	Zinc
Lead	

Source: California Administrative Code, 1986

3.4.4.3 Category III

None

3.4.4.4 Category IV

1. Lack of a comprehensive groundwater monitoring program. The lack of a comprehensive groundwater monitoring program at the LEHR precludes assessment of past and present environmental impacts of LEHR operations.

   Interviews with SAN personnel revealed that SAN granted the LEHR an exemption from preparing an Annual Environmental Monitoring Report, allowing the LEHR instead to prepare an Annual Environmental Summary. This exemption was granted under the provisions in DOE Order 5484.1. However, the exemption does not eliminate the requirement to monitor or in some way assess the environmental impacts from LEHR operations. Although there is no indication that significant off-site impacts occurred from either past or present operations, there are no data to support or refute this assumption.

   Prior to October 1987, there was no program to monitor groundwater pollution at the LEHR facility. In October 1987, work was started on the installation of nine groundwater monitor wells. Work was completed in early November 1987. When development of these wells is completed, groundwater samples will be collected and analyzed for radium-226; strontium-90; gross alpha, beta, and gamma; volatile organics; PCB; pesticides (including chlordane); nitrates; and the 17 metals listed in Table 3-16 (Wahler Associates, 1987).

2. Potential contamination of groundwater aquifer from Well UCD-2. Well UCD-2 may serve as a conduit for contamination to the aquifer because it was drilled through a landfill.

   The upper 10-foot length of the boring for Monitor Well UCD-2, which penetrated a landfill, was not sealed before the boring was completed and the monitor well installed. If contamination should be detected in well samples, it will be difficult to determine whether the contamination is from the aquifer or from contaminants in the landfill that have moved down along the well casing.

3. Deficiencies in well development and well sampling. Although no data have been collected from the monitor wells, the following deficiencies, unless corrected, would make any analytical data collected suspect:

   a) Based on observations made during the on-site portion of the Survey, Wells UCD-1, 5, and 7 were improperly developed, resulting in excessive suspended solids in the samples. The presence of suspended solids in the sample can affect the analytical results for metals. Also, information received from SAN following the on-site Survey activities indicates that Wells UCD-2, 3, 6, and 9 were improperly developed;

   b) During sampling of UCD-6 by the sampling contractor, the Survey team observed that the well was not purged adequately (three well volumes) prior to taking the sample. The sample was discarded and the contractor was instructed by SAN to purge the well correctly;

   c) The ground surface around Wells UCD-7, 8, and 9 is not graded to prevent the accumulation of rainwater runoff around the well casing. This could result in surface contaminants moving down along the well casing. Based on direction from SAN, the contractor has regraded the areas around the wells since the completion of the on-site Survey;

   d) Chain-of-custody documents for field samples are not filled out in the field, thereby breaking the chain of custody. The documents are not filled out until the field technician returns the samples to the sampling contractor in Palo Alto. Information received from SAN following the completion of the on-site Survey indicates that the contractor has corrected the chain-of-custody documentation procedures; and

   e) Well casings lack physical identification markings. Although the caps have such markings, they are removable, which could result in misidentification of a well and/or sample. Proper markings have been made since the completion of the on-site Survey.

4. <u>Potential migration of contaminants to groundwater from abandoned well.</u> There is no information on the depth, construction details, or method of sealing, if any, of an abandoned well beneath the Shop Building.

The abandoned well is downgradient of potential sources of groundwater contamination. This well can serve as a direct conduit for contaminant migration to the groundwater. The closest active well that might receive contaminants is U.C. Davis domestic water supply well DW-4, which is approximately 100 yards north of the abandoned well.

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

4.1.1 General Description of Pollution Sources and Controls

This section describes the currently generated wastes and active waste management units at the Laboratory for Energy-Related Health Research (LEHR) at the University of California at Davis (U.C. Davis). This section also discusses the management procedures used to handle wastes at the LEHR facility. Waste management at the LEHR is handled by the U.C. Davis Environmental Health and Safety (EH&S) office at the U.C. Davis Waste Packaging Facility. A description of the Waste Packaging Facility is presented in Section 4.1.1.5.

The wastes are grouped according to the following four categories: hazardous wastes, as defined under the Resource Conservation and Recovery Act (RCRA) and the California Hazardous Waste Management Regulations; radioactive wastes; mixed wastes, containing both hazardous and radioactive constituents; and solid wastes, which are neither hazardous nor radioactive.

4.1.1.1 Hazardous Waste

The primary codes regulating hazardous waste management at U.S. Department of Energy (DOE) sites are DOE Orders 5480.2 (Hazardous and Radioactive Waste Management) and 5820.2 (Radioactive Waste Management), the RCRA (40 CFR 260-272), and the California Hazardous Waste Management Regulations (California Administrative Code, Title 22, Division 4, Environmental Health, Chapter 30 --

Minimum Standards for Management of Hazardous and Extremely Hazardous Wastes).

The California regulations are, for the most part, identical to the U.S. Environmental Protection Agency (EPA) regulations, with a few important differences. Under the California regulations, the definition of hazardous waste encompasses more wastes than does the Federal definition. Wastes can be considered hazardous because they contain leachable levels of hazardous constituents or because the waste itself contains levels of hazardous constituents which exceed the Total Threshold Limit Concentration (TTLC) limits designated to protect human health and the environment.

The California regulations also include in the list of hazardous wastes and waste constituents several specific materials not included in the Federal hazardous waste regulations. Wastes laden with polychlorinated biphenyls (PCBs) are required to be regulated as hazardous wastes if PCB concentrations are at least 50 ppm, or if leachable PCB meets or exceeds the Soluble Threshold Leach Concentration (STLC) of 5 ppm. Waste oils, not considered hazardous waste under Federal regulations, are defined as hazardous under the California code, and must be managed accordingly. Finally, the list of hazardous constituents identified in Article 9 of the California regulations includes more chemicals than does the corresponding Federal list from 40 CFR 262.

There are no known hazardous waste storage tanks at the facility, so the tank regulations of 40 CFR 264.190-199 and Section 280 do not apply.

<u>Sources of Hazardous Wastes</u>

Operations at the LEHR facility primarily involve laboratory research on the health effects of radioactive isotopes and toxic chemicals, using animal subjects. Hazardous wastes are generated at the LEHR from most laboratory research operations, from regular maintenance such as painting or machine repair, and from ancillary activities such as X-ray film developing. Among the types of hazardous wastes generated are spent reagents such as formalin solutions, spent acids, bases, flammable solvents, and some regulated carcinogens. Table C-1 contained in

Appendix C identifies specific types of wastes generated at the LEHR, points of generation, and the quantities of each waste type.

Hazardous and potentially hazardous wastes were identified in nine buildings or areas at the LEHR site. Most of these wastes were generated either as spent materials from active research projects, or as discarded material from laboratories that have been closed. Many entries in Table C-1 indicate that waste constituents are unknown, or are unspecified solvents or corrosives. Some of these materials may not actually be hazardous, but were not properly labeled (i.e., no identification of the waste constituents contained).

Hazardous Waste Management Procedures

The LEHR chemical and hazardous waste accumulation and management procedures have been prescribed by the U.C. Davis EH&S Office in its campus-wide program, as discussed in its "Hazardous Chemical Waste Management Procedure Manual" (UCD, 1985). All waste accumulation areas on the LEHR premises are considered to be satellite accumulation areas. Wastes must be accumulated within each laboratory in approved containers, which include 5-gallon black plastic containers or old reagent containers which are clearly labeled "waste" and have been sufficiently cleaned so that there is no potential for mixing of incompatible materials.

Laboratories have specific limits set by the fire marshal of U.C. Davis on the total quantities of flammable materials, including both reagents and wastes, which can be stored at any time. Laboratories have no limits on the length of time that wastes may remain in storage (e.g., chemical wastes may be stored within a lab for a couple of weeks to a couple of years). When the laboratory determines that it needs to have its waste removed, it notifies EH&S. The laboratory must properly prepare wastes for pickup by attaching a label which identifies the chemical and physical properties, the point of generation, the laboratory's point of contact, and the date. EH&S will pick up the waste within about 1 week of the pickup request. EH&S will pick up only wastes that are properly labeled and held in storage containers that are in good condition.

None of the hazardous waste accumulations at the LEHR site are labeled as to the date of initial accumulation and U.C. Davis procedural requirements do not require it. During normal laboratory operations the containers receiving wastes are not labeled as to the chemicals contained, although labels denoting the chemicals in each accumulation container are usually placed on the container just prior to pickup by EH&S. The extent to which wastes are segregated and secondary containment is available varies between laboratories. For the most part, large (5-gallon) waste containers are segregated and stored within plastic tubs, while smaller (1-gallon and less) containers are not segregated and are usually not stored within secondary containment such as plastic tubs.

Hazardous and Chemical Waste Accumulation Points

Two laboratories at the LEHR facility had particularly large accumulations of chemical wastes, one in Building H-213 and the other in Building H-299. The bottles of chemicals were stored in the boxes without any segregation of potentially incompatible wastes. Secondary containment was not provided for either of the above accumulation areas.

4.1.1.2 Radioactive Waste

This section describes the current generation and management of radioactive wastes at the LEHR. Included is a discussion of the sources of radioactive wastes, the LEHR radioactive waste management procedures and facilities, the U.C. Davis radioactive waste management procedures, and the off-site management of radioactive wastes generated at the LEHR.

Sources of Radioactive Wastes

Radioactive wastes at the LEHR facility include excreta from animals used in radioisotope experimentation, carcasses and parts from exposed animals, spent or discarded radioactive reagents, contaminated laboratory clothing and equipment, and partially consumed sources no longer of use to the facility. Most of these wastes are generated in the laboratories. In addition, some radioactive wastes are stored in the Imhoff tanks.

The following radioisotopes are currently in use at the LEHR facility, or are contaminants of wastes stored at the facility: strontium-90, radium-226, tritium, sulfur-35, carbon-14, americium-241, plutonium-241, ytterbium-169, cobalt-60, tellurium-123, and iodine-131. Many other radioisotopes have been used in previous studies and may also be present at low levels in wastes still stored at the LEHR facility.

Radioactive Waste Accumulation Points

Nineteen rooms with radioactive waste accumulations were identified during the Survey. Table C-2 in Appendix C lists the radioactive waste accumulation areas at the LEHR. Except in two cases, radioactive waste accumulation points at the LEHR facility are physically separated from other waste and material accumulation and storage areas. Radioactive waste tags provided by EH&S are used throughout the LEHR facility on containers of radioactive wastes, but less than half of these labels had been filled out by the researchers to identify the radioisotopes contained. Only one laboratory included identification of the chemical matrix of the radioactive wastes as part of the labeling and waste monitoring procedure. This laboratory maintained a handwritten log of the radioisotopes, chemical solutions, and quantities of wastes accumulating in 5-gallon plastic containers. No other radioactive waste accumulations were identified as to the specific chemical nature of the wastes contained. For the most part, liquid radioactive waste accumulation containers were stored in plastic tubs, providing adequate secondary containment.

There is only one large-volume radioactive waste accumulation at the LEHR facility, the biological sludge contained in the Imhoff tanks. This sludge is made up primarily of the excreta of dogs studied during the strontium-90 investigation. The total volume of sludge in the tanks is approximately 12,300 gallons and it is known to be contaminated with strontium-90. The Imhoff tanks are in-ground, concrete tanks with a combined capacity of 46,000 gallons; they have no secondary containment, leak detection, or leak collection systems. Waste is no longer being sent to the Imhoff tanks. The chemical nature of the sludge in the Imhoff tanks has not been determined. These tanks are discussed in more detail in Sections 3.3 and 4.5.

There are numerous radioactive materials at the LEHR site which may be discarded when the DOE operations cease, including animal carcasses and materials currently used in the LEHR labs. Additionally, the closeout operations will generate such radioactive wastes as contaminated clothing and equipment. These wastes will need to be disposed of at an authorized radioactive waste treatment or disposal facility.

Radioactive Waste Management Procedures

Radioactive waste accumulations at the LEHR are required to follow a set of procedures designed to protect human health and to meet the various regulatory requirements. The U.C. Davis EH&S Health Physics group picks up all radioactive wastes from the research laboratories after receiving a telephone request from the researcher. At a minimum, the researcher must label each container to be picked up with the isotope, the mCi of activity, the surface dose rate, and the Radiation Use Authorization (RUA) number. Containers that are not properly labeled or that exceed 100 mrem/hr surface dose rate are not removed; the researchers are instructed to remedy the problem before Health Physics will remove the waste.

Once picked up, wastes are transported to the Waste Packaging Facility in a small-bed pickup truck. Health Physics supplies the research laboratories with dry-waste boxes and with 5-gallon containers for liquid wastes. Liquid scintillation cocktail (LSC) vials are transported in the original package of flats, and biological waste is double-bagged and frozen.

4.1.1.3 Mixed Waste

There is no program at the LEHR to specifically address the regulatory and management issues associated with the generation, accumulation, storage, and off-site disposal of mixed wastes, although some steps have been taken to prevent inappropriate management of specific waste streams. The EH&S practice is to manage any waste contaminated with radioactivity as a radioactive waste, and to manage nonradioactive wastes as hazardous if such management is warranted. The LEHR facility follows the procedures specified in the U.C. Davis procedures manual. Recently, EH&S distributed new radioactive waste tags to all laboratories which would identify not only the radioisotopes within a liquid waste, but also the chemical nature of the waste, including such information as specific chemicals placed into the container and whether the waste is corrosive, ignitable, reactive, or flammable. Only a few of the waste accumulation containers observed at the LEHR were labeled with these new tags.

Sources of Mixed Waste

Since the chemical matrix was unidentified on nearly all the containers of radioactive wastes at the LEHR facility, it is impossible to accurately estimate the quantity of mixed wastes in accumulation areas. It is expected that at least some of the radioactive waste accumulations could be mixed wastes, for several reasons. First, the regulations define the entire volume of a waste mixture that includes any amount of a listed hazardous waste as hazardous. For example, a LSC is usually made up of xylene and toluene, two organic solvents considered to be listed hazardous wastes. Any radioactive waste accumulation that includes even a small amount of waste LSC would be a mixed waste. The laboratories use many other solvents in small amounts that could also result in this situation. Second, frequently the carrier for a radioisotope will be an acid solution. Acids that have a pH less than 2.0 are considered hazardous because they exhibit the characteristic of corrosivity. Finally, many metal-bearing reagents are in use in the research laboratories. If certain heavy metals in the waste cause the waste to fail the Extraction Procedure limits, then the waste will be considered hazardous as well as radioactive.

It is possible that the waste accumulated in the Imhoff treatment system may be a mixed waste. The waste, which has not been tested for chemical or hazardous characteristics, may contain chlordane residuals from past flea-control programs; silver from photochemical residuals which may have been washed down the drains; lead from various rinsates which may have been washed down the drains; or virtually any other chemical reagent which was spilled or intentionally poured into sinks or drains which connected to the Imhoff system.

4.1.1.4 Solid Waste

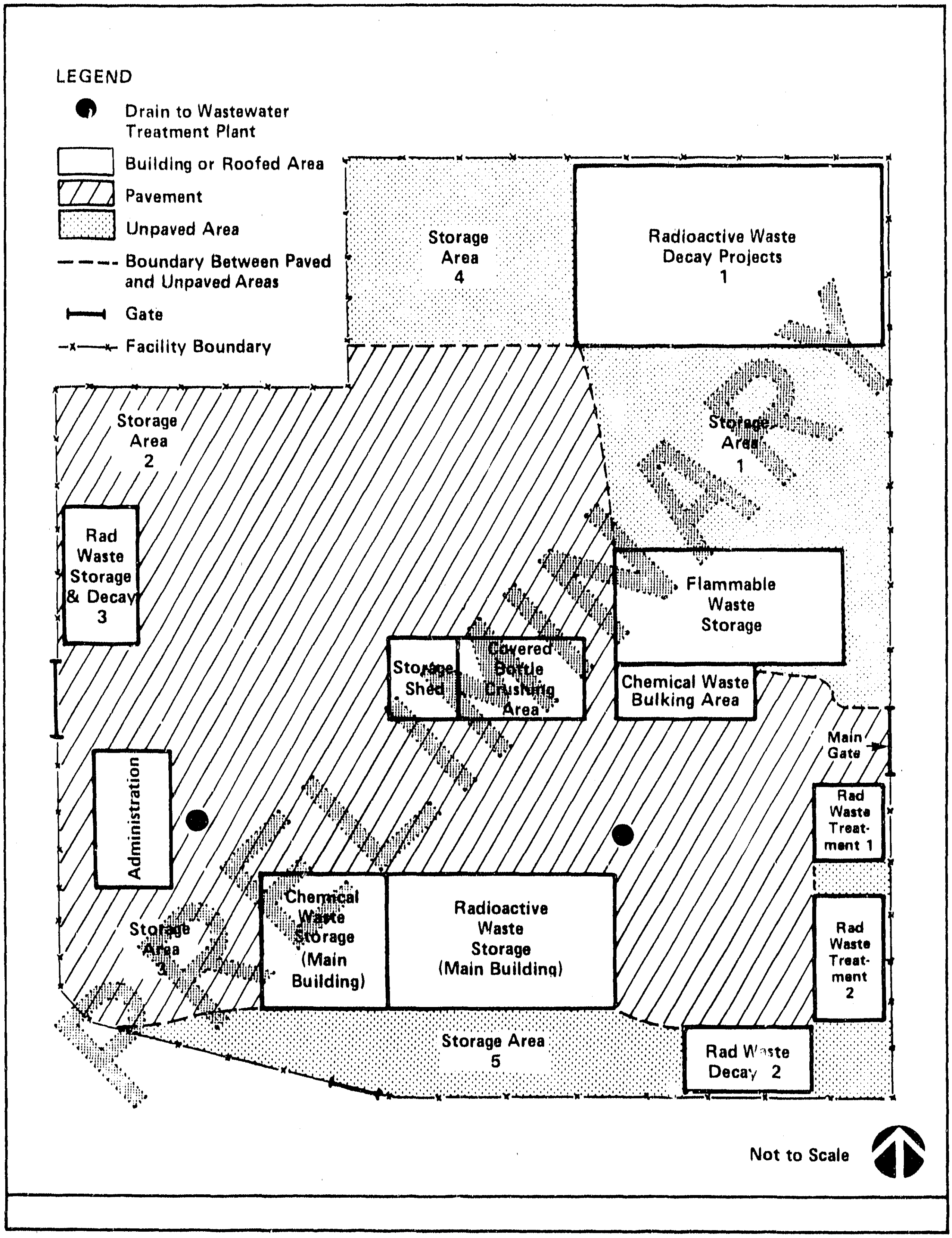
Nonhazardous and nonradioactive solid wastes generated at the LEHR facility include uncontaminated trash and garbage, uncontaminated animals and animal parts, and uncontaminated animal excreta. Municipal trash is collected at the site in two dumpsters, which are picked up once to twice each week for disposal in the U.C. Davis sanitary landfill. Uncontaminated animals and animal parts are frozen and/or double-bagged, and are picked up by EH&S for incineration in the U.C. Davis pathological incinerator. Uncontaminated excreta are collected in a third dumpster at the site (in the southwest corner of the facility), and are disposed of at the U.C. Davis sanitary landfill.

The U.C. Davis sanitary landfill, located west of the campus near the U.C. Davis airport, has been operating since April 1966. The facility last received a permit in 1978 and has been communicating with the state regarding permit renewal since 1981. Operations at the sanitary landfill are maintained in compliance with appropriate regulations, and are carried out in such a way as to ensure protection of human health and the environment. A groundwater monitoring system consisting of six wells is being used to further ensure that no potentially hazardous contaminants migrate off-site.

4.1.1.5 U.C. Davis Waste Packaging Facility

Waste management at the LEHR is the responsibility of the U.C. Davis EH&S Office. Waste generated at the LEHR (i.e., hazardous, radioactive, and mixed waste) is handled at the U.C. Davis Waste Packaging Facility.

Once waste leaves the LEHR site, EH&S assumes responsibility for its handling, storage, and ultimate off-site disposition. U.C. Davis is permitted as a hazardous waste generator, with generator ID number CAD047120084, and as such is allowed to accumulate hazardous wastes for up to 90 days prior to off-site disposition. Short-term storage, segregation, and bulking of wastes takes place at the EH&S Waste Packaging Facility located at the main campus in the vicinity of the U.C. Davis wastewater treatment plant. The facility is a small (less than 1 acre) area shared with the EH&S radioactive waste management operations. Figure 4-1 is a rough diagram of the layout of the waste management area, identifying areas, buildings, and containers used by each of the operations. The facility is located immediately west of the wastewater treatment plant. Southeast of the facility is a waste oil storage area and the campus biological waste incinerator. Putah Creek is about 100 yards due south of the Waste Packaging Facility. Fifty feet west of the facility is a 60-kilovolt substation that services U.C. Davis. North of the facility are maintenance



U.C. DAVIS – EH&S WASTE PACKAGING FACILITY FIGURE 4-1 and storage buildings. The facility is completely surrounded by a chain-link fence and building walls to prevent unauthorized entry. The facility is also located within a larger fenced area that incorporates the entire wastewater treatment complex.

Hazardous Waste Management

Hazardous chemical wastes are picked up in one of two small dedicated trucks owned by U.C. Davis, and are brought to the Waste Packaging Facility. Trucks are unloaded in front of the main chemical waste storage building, and wastes are transported in "cube-tainers" into the building. The main chemical waste storage building is used as a holding area for new shipments of wastes from laboratories around campus, as well as interim storage for small containers (5 gallons or less) of nonflammable hazardous wastes. This building also houses all safety manuals and equipment (including absorbents, personal protective equipment, spill control equipment, and fire control equipment), as well as the HazCat kit, which can be used to identify unknown chemicals. Wastes are stored on the floor of the building until they are categorized and sorted. Segregated nonflammable wastes are stored in the chemical waste storage building, while segregated flammables are stored in the flammable-waste storage shed. A hood is available for storage of chemicals that need to be vented. The building has no means to prevent an accidental or uncontrolled spill from getting outside to the adjacent pavement and/or soil.

A log is maintained of waste receipts, which identifies the types of wastes and the storage area to be used. Most wastes are stored until a sufficient quantity is accumulated to warrant "bulking" the contents of several smaller containers into a larger container (usually a 55-gallon drum). Some wastes may be sent to off-site hazardous waste management facilities without bulking. Bulking of wastes is done in one of two areas; both areas are paved and protected by roofs or overhangs/eaves. During bulking, drums are placed on pallets; four drums are bulked on a pallet. Wastes are transferred to the drums by hand pumping or pouring, using a large funnel to prevent drips and spills, from one container to another. EH&S personnel are equipped with respirators, face shields, hardhats, coveralls, boots, gloves, and other safety equipment, which is used as appropriate during bulking. When a drum is filled, it is closed and labeled with a hazardous waste label. Pallets of bulked drums are moved to a designated storage area to await off-site disposition.

The "Hazardous Waste Management Procedures Manual" requires that bulked hazardous waste (i.e., packaged in drums) be removed from the facility within 90 days of the accumulation date marked on the hazardous waste label. U.C. Davis has approved the use of several off-site facilities to transport, store, treat, land dispose, incinerate, and reuse hazardous wastes. These facilities, the wastes they treat or dispose of, and their EPA identification numbers are listed in Appendix C, Table C-3.

Radioactive Waste Management

The U.C. Davis Waste Packaging Facility is also used to handle radioactive waste. A Health Physics technician is assigned full time to the packaging facility. The portions of the Waste Packaging Facility used for radioactive waste include the Main Radioactive Waste Packaging Building, a garage-type building (Radwaste Decay No. 1), 3 trailers (Radwaste Decay Nos. 2 and 3, Radwaste Treatment No. 2), a covered cement mixer (Radwaste Treatment No. 1), and a small office trailer.

Radioactive waste processing at the Waste Packaging Facility includes dry-waste processing, liquid-waste processing, biological-waste processing, and LSC vial repackaging.

- Dry-waste processing: Radioactive dry wastes with half-lives of less than 61 days are stored indoors for approximately 12 half-lives of the longest-lived contaminant in the dry-waste container. Decayed wastes are examined for radioactivity, and are disposed of as solid waste once the radioactivity reaches background levels. Dry waste may also be incinerated if it meets a set of criteria established to limit the effluent concentration by limiting the quantity of radionuclides incinerated. At this time, only tritium and carbon-14 materials are incinerated in the campus incinerator. Finally, any dry waste that is not appropriate for decay or on-site incineration is compacted if necessary in the Health Physics compactor and shipped off-site for disposal at the U.S. Ecology site in Richland, Washington.

- Liquid radioactive waste processing: Liquid wastes readily soluble or dispersible in water may be released in limited quantities to the sewer.

The total quantity of radioactive material for campus and medical center releases combined does not exceed 5 curies of tritium, 1 curie of carbon-14, and 1 curie of all other radionuclides each year, as monitored by Health Physics. Liquid wastes that may not be disposed of through sewerage have, historically, been solidified into epoxy-lined drums using cement and absorbent. Once the cement is set, these drums are sent to U.S. Ecology in Richland, Washington, for disposal.

- Biological radioactive waste processing: Biological radioactive waste processing involves either incineration, following the procedures outlined for dry wastes, or packaging into 30-gallon drums, which are overpacked into 55-gallon drums, for disposal at the U.S. Ecology landfill at Richland, Washington.

- LSC vial repackaging: LSC vials are packed into lined 55-gallon drums and sent to the Quadrex facility in Florida for incineration. Quadrex is permitted to incinerate a limited number of radioisotopes; LSC vials which cannot be accepted at Quadrex are currently being handled in the same fashion as all other mixed wastes at the site (see Section 4.1.1.3).

Mixed Waste Management

Until October 1987, the U.C. Davis Waste Packaging Facility managed virtually all liquid radioactive wastes by decay (basically a storage operation), solidification (a treatment process), controlled disposal to the sanitary sewer system, or by sending wastes off-site for incineration or disposal. The DOE agreement with EPA in May 1987 forced the off-site radioactive waste disposal facilities used by U.C. Davis to reject mixed wastes on the grounds that the facilities were not permitted to manage hazardous wastes. The off-site incinerator of liquid scintillation wastes, although permitted under RCRA to incinerate specific hazardous wastes, can accept only a few radioisotopes, and thus could not relieve the mixed waste accumulation problem at U.C. Davis. In addition, in October, EH&S personnel became aware that solidification of mixed wastes is considered a hazardous waste treatment process, and would require a hazardous waste treatment, storage, and disposal (TSD) facility permit. U.C. Davis has only a hazardous waste generator permit. The result of this situation was a backlog of mixed waste containers. These containers were stored without sufficient secondary containment, without segregation of potential incompatibles, and without labels identifying the hazardous nature of the wastes, the chemical nature of the wastes, or the initial date of waste accumulation. In addition, the wastes were stored on a platform above an unpaved area of the facility.

4.1.2 Findings and Observations

4.1.2.1 Category I

None

4.1.2.2 Category II

1. Mishandling and inappropriate storage of hazardous, radioactive, and mixed wastes. There are a number of deficiencies at the Waste Packaging Facility which may result in mishandling and subsequent releases of hazardous, radioactive, and mixed wastes to the environment.

   Among the deficiencies observed at the Waste Packaging Facility are the following: storage of hazardous wastes longer than 90 days; storage of mixed wastes longer than 90 days; wastes stored in the open and without adequate secondary containment; inadequate waste segregation and labeling; and presence of a conduit (drain) for wastes to enter the U.C. Davis sewage treatment plant. In addition, the proximity of the Waste Packaging Facility to a 60-kilovolt substation increases the likelihood of major fire or explosion.

   Waste accumulation at the U.C. Davis Waste Packaging Facility actually begins when wastes are delivered to the facility. However, accumulation start dates are assumed to be the date that a drum of bulk waste is filled. Wastes in small containers may be stored at the Packaging Facility for several months prior to bulking, and thus may actually exceed the 90-day limit before the accumulation start date is ever noted. In particular, long-term storage of water reactives and picric acid was noted in the flammable-waste storage shed. Unmonitored storage prior to bulking is of particular concern, since waste containers provided by the individual laboratories are not subject to the same quality control as those provided by EH&S, and are therefore more likely to corrode, crack, or break and release hazardous wastes.

Mixed wastes at the Waste Packaging Facility are being stored for longer than 90 days as well. For many of these wastes, this long-term storage is unavoidable due to the lack of available off-site mixed waste treatment and disposal facilities. However, these mixed wastes are not all being stored in an environmentally sound manner, and long-term storage in inadequate conditions increases the likelihood that a release could occur.

Numerous drums of wastes are stored in the open, as discussed in Section 4.1.1.5. Although none of the drums stored on the unpaved areas of the facility were identified as specifically containing LEHR wastes, very few could be stated with certainty to contain no LEHR wastes. Therefore, drums which may contain LEHR wastes are being stored on a surface through which any waste releases could permeate. It is possible that fluids which permeate through the soils at the Waste Packaging Facility will migrate to Putah Creek, which lies about 100 yards south of the facility. The paved areas of the Waste Packaging Facility, although less porous than the unpaved areas, are still sufficiently porous as to be susceptible to permeation by hazardous waste liquids.

Many areas of the Waste Packaging Facility lacked secondary containment. Numerous 55-gallon drums of liquid hazardous wastes were being stored in unbermed, uncurbed areas. Also, a number of 5-gallon containers of radioactive and mixed liquid wastes were stored with inadequate secondary containment. The LEHR wastes stored in Radwaste Storage and Decay Trailer No. 3 were not all provided with sufficient secondary containment. Finally, the waste accumulation areas in the main chemical waste storage building were not provided with secondary containment. In the event of a spill or leak in an area lacking secondary containment, there would be no automatic means of preventing the surface flow of the released liquids to the sewage treatment plant drains, to other low points on the Waste Packaging Facility site, or off-site.

Many wastes at the facility were not properly labeled or segregated. Proper labeling of wastes is important to ensure that incompatible wastes are segregated, and that containers are stored in conditions appropriate for the waste contained. In addition, in the event of an emergency requiring outside assistance (e.g., fire departments or state spill response teams), proper labeling assists emergency response personnel in responding rapidly, efficiently, and correctly to minimize damage, health risk, and environmental release. Many of the drums of wastes stored in the open were not labeled as to their hazardous or chemical nature, nor as to the initial date of accumulation, although this is a required part of the U.C. Davis hazardous waste management procedures. Wastes which have not yet been bulked are for the most part labeled as to chemical nature. Wastes in the receiving areas are not always labeled, and are not segregated by waste type. Mixed wastes are not clearly labeled as to their hazardous nature or chemical makeup. Finally, hazardous, radioactive, and mixed wastes in Radwaste Storage and Decay Trailer No. 3 were poorly labeled and potential incompatibles were not segregated.

The conditions of waste storage in Radwaste Storage and Decay Trailer No. 3 were such that quick-response action was considered necessary to minimize potential threats to human health and the environment perceived at this storage area. EH&S personnel initiated remedial activities to identify all the LEHR wastes in the trailer, to initiate procedures to remove as much waste as possible to off-site disposal, and to label and segregate all remaining waste, providing all appropriate storage conditions.

Finally, the U.C. Davis Waste Packaging Facility is located only 50 feet from a 60-kilovolt substation that services the university. In the event of a substation fire, the Waste Packaging Facility is close enough to be at risk of fire or explosion. Conversely, in the event of a fire or explosion at the Waste Packaging Facility, the substation may also be adversely affected.

Subsequent to the on-site Survey, U.C. Davis and the LEHR have taken steps to correct many of these deficiencies. An action plan submitted to SAN on November 23, 1987, addresses corrective actions to be taken with respect to this finding.

4.1.2.3 Category III

None

4.1.2.4 Category IV

1. Improper management of hazardous, radioactive, mixed, and solid waste in the generation/accumulation areas at the LEHR facility. Lack of secondary containment, absence of segregation of incompatible wastes, inadequate labeling, and use of inappropriate containers in waste accumulation areas used for temporary storage of wastes could result in the release of hazardous or radioactive constituents in the event of a spill, or in risk to individuals handling waste containers.

Wastes are generated by virtually every research operation at the LEHR facility, and are accumulated in each laboratory before being shipped to the U.C. Davis Waste Packaging Facility. Wastes are accumulated in solid and liquid forms, in individual containers including reagent bottles of varying sizes, sample bottles of varying sizes, 5-gallon plastic carboys, dry waste boxes, plastic bags, packages, etc. Wastes are removed from the accumulation areas when a researcher informs U.C. Davis EH&S of the need, and are trucked to the U.C. Davis packaging facility on the main campus.

Under California and EPA hazardous waste regulations, small quantities of hazardous wastes (i.e., up to 55 gallons of hazardous waste or up to 1 quart of acutely hazardous waste) may be accumulated at the point of generation for up to 90 days, provided that incompatible wastes are segregated, wastes are labeled as to chemical and hazardous nature, and the accumulation containers used are appropriate for the waste material and are in good condition. Although secondary containment is not required by EPA regulations for these small accumulations of hazardous wastes, the absence of secondary containment results in an increased potential for spills to be released to the environment. Secondary containment is required by U.C. Davis procedures for liquid radioactive and mixed wastes in any waste accumulation area. Waste accumulation areas at the LEHR were frequently deficient in that secondary containment was not provided, separation of incompatible wastes and materials was not always provided, labeling was poor, and on one occasion solid wastes were being improperly disposed of.

4.2 Toxic and Chemical Materials

4.2.1 General Description of Pollution Sources and Controls

This section addresses the acquisition, distribution, and control of the toxic chemicals and materials present at the Laboratory for Energy-Related Health Research (LEHR) at the University of California at Davis (U.C. Davis). The focus is on practices and procedures used by the facility to ensure that toxic materials are stored, used, and controlled in a manner that safeguards against unrestrained releases to the environment. The materials covered are polychlorinated biphenyls (PCBs), asbestos, pesticides, laboratory reagents, and bulk chemicals (radionuclides are discussed in Section 4.3.2.2).

4.2.1.1 Toxics Management

The overall policy at the LEHR for toxic materials use, storage, and disposal is established by the U.C. Davis Office of Environmental Health and Safety (EH&S) and the campus Fire Department. This policy is directly administered by laboratory supervisors and project principal investigators and compliance is monitored by the EH&S office.

Procurement

Most hazardous substances procured by the LEHR are laboratory chemicals. Other purchased materials used at the LEHR include janitorial, building maintenance, and office supplies. Commonly used acids, bases, and organic solvents may be obtained from the main campus central stores warehouse. Project-specific chemicals are ordered through the LEHR Business Office. These orders are made by mail with the order stamped with a request for copies of Material Safety Data Sheets (MSDSs). Personnel who place orders by phone are asked to request MSDSs and repeat the request when the phone order is followed with a written purchase order.

Inventory Control

Chemical and radioisotope inventory control at the LEHR is the responsibility of the laboratory supervisors and the project principal investigators. EH&S requires that an inventory be maintained for all the hazardous materials stored at the LEHR. This inventory, which includes the name, quantity, and the date the material was received, should be updated at least once a year. Researchers are therefore required (LEHR, 1986) to examine their stocks of chemicals/radioisotopes and dispose of old, outdated, or unnecessary materials. However, several instances were noted where chemicals had been stored for several years (Room 110A/Building H-213, Room 301/Building H-218, Room 418/Building H-217, and the Decon Room/Building H-294). Part of this problem involves orphan chemicals that are left when projects end. Generally, projects do not have closeout funding to dispose of chemicals, and new projects rarely need all the chemicals remaining from the previous project.

Identification of Hazards

At the LEHR, employee access to hazardous substances information is accomplished primarily through a Material Safety Data Sheet (MSDS) program. The EH&S office requires that an MSDS be provided for each hazardous substance used in the workplace. The MSDS lists toxicity information, flammability and explosion hazard data, handling precautions, and procedures to use in case of spills or contact. Original MSDSs are received by the LEHR Business Office and are kept in a master file, while copies are sent to EH&S and to the person who placed the order. A user's file is maintained in each laboratory. This file consists of a prominently labeled binder kept in a location accessible to all employees on all shifts. Each employee is notified in writing of the location of this file.

Training for personnel working with hazardous substances is provided by immediate supervisors using the guidelines established in the LEHR Safety Manual (LEHR, 1986).

4.2.1.2 Toxic Chemical Storage

There are three general classes of hazardous substances stored at the LEHR; reagent chemicals, maintenance materials, and diesel fuel. Miscellaneous lead materials, stored on an uncovered pallet, were found in the Cobalt-60 Irradiator field. Exposure to the elements will eventually cause lead to be leached from these materials.

Reagent Chemicals

Most reagent chemicals are stored in laboratory satellite areas. These areas were reviewed in the Main Office and Laboratory (Building H-213), Animal Hospital 1 (Building H-219), the Pathology Laboratory (Building H-217), the Cellular Biology Laboratory (Building H-294), and the Toxic Pollutant Health Research Laboratory (Building H-299). In general, the housekeeping was neat and orderly and the shelving units were stable. However, some chemicals were not marked with the date received and others had been stored in excess of several years.

Bulk reagent chemicals are stored in Rooms 504 (solvents) and 505 (acids) of Building H-290. Storage problems were noted in both rooms. In Room 505, bases were stored next to acids; however, the bases were removed to campus central stores and this was verified. The floor drain, which leads to the campus sanitary sewer system, can be a conduit for spilled contaminants. The shelving in Room 504 is bent, not bolted to the wall, and does not have a lip or barrier to prevent the solvent containers from falling off. Also, there is a 4-liter container of ethyl ether stored beyond the maximum 1-year (an EH&S requirement) retention time. Ethyl ether can react with oxygen in the air to form an unstable peroxide which may explode if disturbed by heat, shock, or friction.

Until May 1987, bulk chemicals (acetone, ethyl alcohol, formalin, kerosene, wheat oil, and chlordane) and possibly other chemicals were dispensed from containers stored at the bulk chemical dispensing area in the southwest corner of the site. The area consisted of an open-sided, roofed wooden structure that did not have an impermeable base. For a more detailed discussion, see Section 3.2.2.3.

Maintenance Materials

Three outdoor metal sheds, adjacent to the Shop (Building H-212), are used to store the materials that support Shop activities and site building maintenance. Petroleum products (oils and lubricants) are kept in one shed; paints, paint thinner, and varnishes in another; and caulking materials and hydraulic fluid in a third. The sheds are old and are not supplied with electricity. Although protected from rain, the stored materials are essentially exposed to ambient temperature and humidity.

The paints especially appear to have been stored for a long time, although there was no excessive surface deterioration on the containers. Also, the Shop foreman indicated that materials not in routine use were disposed of periodically as per U.C. Davis Fire Department regulations.

Diesel Fuel

An underground diesel fuel storage tank, located behind the Toxic Pollutant Health Research Laboratory (east of the emergency generator), is the only storage tank at the LEHR. Information (tank inventory 4-30-87) on this tank is listed below:

- Age -- Installed 1981
- Construction Material -- Fiberglass
- Capacity -- 1,000 Gallons
- Tank Contents -- Diesel Fuel
- History of Leaks -- No Leaks
- Tightness Testing -- 10/20/87, Passed (document received on the site)
- Inventory Monitoring -- Dipstick, Weekly (no external leak detection)
- Inspection Schedule -- Annual
- External Protection -- Single Wall
- Usage -- Fuel for the Toxic Pollutant Health Research Lab Emergency Generator

Normally, the inventory monitoring method (dipstick) is not accurate enough to detect a continual low-volume leak. However, since this tank is not used to dispense fuel, there is insufficient inventory turnover to mask such a leak. Also the age of the tank (1981) lessens the probability of a leak.

4.2.1.3 Polychlorinated Biphenyls

There is no PCB electrical equipment (i.e., equipment containing greater than 500 ppm PCBs) or PCB-contaminated (i.e., greater than 50, less than 500 ppm) electrical equipment at the LEHR. There are three transformers mounted on concrete pads in a fenced-in area adjacent to the Shop (Building H-212) and information on these units is presented in Table 4-1. There are also three pole-mounted transformers, located just outside the east boundary of the site, which service the Cobalt-60 Irradiator Building. The dielectric oil in each of these transformers contains less

TABLE 4-1

PCB ANALYSIS DATA ON THE LEHR TRANSFORMERS

Serial Number	Description	PCBs (ppm)	Date Analyzed
C170696	GE 167 KVA	3.3	11-02-81
C170698	GE 167 KVA	<3.0	11-02-81
C171526	GE 167 KVA	4.1	11-02-81

Source: UCD, 1987e

than 3 ppm PCBs. All the PCB analyses were conducted by the Environmental Toxicology Laboratory on the main campus. Finally, there are approximately 12 one-quart cans of hydraulic fluid (dated May 1974) stored in a metal shed just west of the Shop (Building H-212). EH&S will arrange to have this material analyzed at the Environmental Toxicology Laboratory for PCBs.

4.2.1.4 Asbestos

The locations of asbestos-containing materials at the LEHR are given in the facility Asbestos Survey (UCD, 1980). Table 4-2 list these locations, which were sampled and tested under the direction of the U.C. Davis EH&S office.

Lagging, ceilings, and walls were sampled and analyzed for asbestos but only the lagging tested positive (i.e., 15 percent amosite in each case). The lagging in Animal Hospitals 1 and 2 was inspected and was in excellent condition. However, a section of loose asbestos (approximately 1 foot) and a section of abandoned pipe (approximately 20 feet) covered with asbestos lagging was observed adjacent to an air intake for Room 204 containing the mechanical equipment for Animal Hospital 1. Although the asbestos did not appear friable, it will deteriorate with age, and could enter the air intake and pose a respiratory threat to building personnel. No removal program is planned at the LEHR for the remaining lagging material. When necessary, sections of asbestos-containing materials are removed during maintenance and repair operations.

4.2.1.5 Pesticides

The pest management program at the LEHR is conducted by the U.C. Davis EH&S office, which uses pesticides for insect and rodent control. Herbicides are not used and weed control consists of periodically tilling the soil. Pesticides used by EH&S are stored on the main campus although a 1-gallon can of pesticide was observed to be improperly stored in the Shop petroleum, oil, and lubricant shed. EH&S selects the pesticide to be applied and requires written authorization from the person responsible for the premises before using any chemical in or near a main campus or LEHR building.

TABLE 4-2

LEHR ASBESTOS INVENTORY

Building	Room
Animal Hospital 2 (H-218)	301
	303
	310A
	316
Animal Hospital 1 (H-219)	200A
	200B
	200C
	203
	204
	207
	208
	213
	214
	215
Clinical Pathology (H-215)	433
	437A
	442
Feed Mix (H-216)	420
Pathology Lab (H-217)	418
Main Office and Lab (H-213)	104
	105
	112C
	115
	117
	126
Shop (H-212)	184[a]

Source: UCD, 1987g

a The asbestos was removed from this room (~ 1981) and, according to personnel interviewed, was sent to the Richland, Washington, disposal facility. Disposal documentation was not readily available on-site.

At one time, chlordane was used for flea control in the dog pen areas but there were no site records readily available to determine when these applications stopped. For more details, see Section 3.2.2.3.

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. Improper storage of asbestos. A section of loose asbestos (approximately 1 foot) and a section of abandoned pipe (approximately 20 feet) covered with asbestos lagging were observed adjacent to an air intake for Room 204 containing the mechanical equipment for Animal Hospital 1. Although the asbestos did not appear friable, it will deteriorate with age and could enter the air intake and pose a respiratory threat to building personnel. The section of asbestos lagging has been removed since the completion of the on-site Survey.

2. Improper storage of toxic chemicals. The following examples of improper chemical storage were observed:

   - Chemicals are stored beyond their useful shelf life. A 4-liter container of ethyl ether in Solvent Storage Room 504 has been stored beyond the 1-year EH&S-required maximum retention time. Ethyl ether can react with oxygen in the air to form an unstable peroxide which may explode if disturbed by heat, shock, or friction. Also, some chemicals in Room 110A/Building H-213, Room 301/Building H-218, Room 418/Building H-217, and the Decon Room/Building H-294 were not labeled with the date received or were stored in excess of several years. After the on-site Survey, the can of ethyl ether was removed.

- Bases were stored next to acids in Acid Storage Room 505. Also, a flammable reagent (toluene) was stored next to a corrosive (hydrochloric acid) in Room 514/Building H-294. Both situations were corrected and verified by team personnel.

- The floor drain in Acid Storage Room 505, which leads directly to the sanitary sewer system, is a potential conduit for contaminants. Subsequent to the on-site Survey, the floor drain was sealed.

- The shelving in Solvent Storage Room 504 is bent, not bolted to the wall, and lacks a lip or barrier to prevent containers from falling off. The LEHR has indicated that the shelving has been replaced following the on-site Survey.

- A 1-gallon can of Robert's Fly-Die Pesticide is improperly stored in the Petroleum, Oil and Lubricant shed adjacent to Building H-212 (Shop). The pest management program at the LEHR is conducted by the U.C. Davis EH&S office, which stores pesticides on the main campus. If left in the shed, the can will deteriorate with age, increasing the risk of contaminant release. Subsequent to the on-site Survey, the pesticide was removed.

3. Improper storage of lead materials. Miscellaneous lead materials are being stored on an uncovered pallet in the Cobalt-60 Irradiation Field. Weathering effects may eventually cause lead to be leached from these materials. Subsequent to the on-site Survey, the lead was moved to an indoor storage area.

4.3 Radiation

4.3.1 Background Environmental Information

Background radiation in the vicinity of the Laboratory for Energy-Related Health Research (LEHR) at the University of California at Davis (U.C. Davis), is composed of both natural and man-made sources. These sources include cosmic radiation, natural radiation from the ground, radionuclides in food, drinking water, and air, and fallout from past atmospheric weapons detonations. The most significant of these sources is exposure to the lung from background levels of radon. The annual average effective dose equivalent (EDE) to humans from natural background radiation in the United States is 189 millirem (mrem) (EPA, 1986c). This dose is detailed in Table 4-3. The estimates in Table 4-3 were derived using the approach of the International Commission on Radiological Protection (ICRP) in ICRP Reports 26 and 30, which allows direct comparison of the dose equivalent (DE) for different organs. About one-half of the annual EDE is attributable to the inhalation of radon-222 and its decay products. Previously accepted estimates of the background dose did not include the radon contribution and were set at about 100 mrem/yr EDE.

In addition, the U.S. Environmental Protection Agency (EPA) reports on a quarterly basis background direct penetrating radiation exposure rates, including those from cosmic radiation, for selected locations throughout the continental United States. These background direct penetrating radiation exposure rates do not measure the contribution attributable to the inhalation of radon-222 and its decay products. The latest available data are for the 12-month period from October 1985 to September 1986. For this period, the EPA reported background direct penetrating radiation exposure rates equivalent to annual doses of between 134 ± 42 mrem DE in Denver, Colorado, and 61 ± 55 mrem DE in Orlando, Florida. The annual dose for the same period was 63 ± 55 mrem DE in Berkeley, California. The average measured external gamma exposure rate equivalent to an annual dose at the 22 locations monitored was 92 ± 39 mrem DE (EPA, 1986a, b, 1987).

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

TABLE 4-3

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, 1986c

the LEHR at U.C. Davis 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 (natural background and medical exposures excluded) for all pathways to any member of the general public for a prolonged exposure from normal DOE operations. In addition, as stated in 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 to the whole body or 75 mrem/yr DE to any organ from normal DOE operations.

4.3.2 General Description of Pollution Sources and Controls

This section discusses the LEHR's dose assessments for the general public and the dose models and radioactive releases used in the dose assessments. A comparison of each reported dose assessment of the radiological releases at the LEHR will be made with the applicable standards. The radioactive sources and controls 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). Radioactive sources inventory control and direct penetrating radiation sources and controls are discussed in Sections 4.3.2.2 and 4.3.2.3, respectively.

4.3.2.1 Summary of Exposures

In the 1986 Annual Environmental Monitoring Report, the LEHR reported that 65 microcuries of strontium-90 were released to the on-site leach field (LEHR, 1987b). Other than this release, the report states that there were no releases of radionuclides on- or off-site to air, soil, surface water, groundwater, or the campus sanitary sewage system from the LEHR facility. The report also stated that there were no pertinent perimeter dosimetry values recorded from the LEHR facility. Review of the data by the Survey team members did not support these statements (see Sections 3.1, 3.2, 3.3, 3.4, and 4.5).

The 1986 Annual Environmental Monitoring Report states that no radionuclides were released or direct radiation values recorded from the LEHR facility; therefore no dose assessment for the general public was performed by the LEHR. Interviews with site personnel indicated that no routine radiological environmental monitoring is performed for air, soil, surface water, or groundwater (see Sections 3.1.3, 3.2.3, 3.3.3, and 3.4.3, respectively). However, routine perimeter dosimetry monitoring has been performed since 1985. Review of the latest quarterly results (April-June 1987) revealed values above background. These data were not discussed or interpreted in the Annual Environmental Monitoring Report (see Section 4.3.3).

As previously stated, the DOE imposes a dose limit of 100 mrem/yr EDE, natural background and medical exposures excluded, for all pathways to any member of the public for a prolonged exposure from normal DOE operations. The conclusion made from the LEHR Annual Environmental Monitoring Report is that for 1986 the dose to the public from operations at this site was 0 mrem EDE. This dose is, as concluded from the Annual Environmental Monitoring Report, well below the DOE limit. Review of the data by Survey team members did not support this conclusion (see Section 4.3.3).

4.3.2.2 Radioactive Sources Inventory Control

Radioactive materials are stored at many laboratories similar to the LEHR. These radioactive sources should be stored in secure and posted radioactive material storage areas. Additionally, these sources should be listed on the radioactive materials inventory for that facility.

Areas and rooms at the LEHR where radioactive materials are used or stored are posted with the proper warning signs. Laboratory work is conducted in fume hoods where the radionuclides (millicurie levels) are kept behind lead bricks. When not in use, these radionuclides are stored in locked rooms. There is also a central storage area located in the Cobalt-60 Irradiator Building, which consists of a lead-lined safe (locked). Millicurie amounts of miscellaneous radionuclides are stored in this safe. A master list of all radioactive materials at the LEHR is kept by the U.C. Davis Environmental Health and Safety (EH&S) office. Laboratory supervisors and principal investigators are responsible for individual project inventories.

The tracking of radioactive materials at the LEHR is accomplished through the U.C. Davis Radiation Use Authorizations (RUAs). These RUAs list authorized isotopes and amounts, personnel, locations, experimental use, and conditions or restrictions. The RUAs are reviewed and approved by the Radiation Safety Officer and Radiation Use Committee before they become valid. Additionally, a Quarterly Radiation Inventory

Report is issued for each RUA, listing the current radiation inventory along with any radionuclides obtained or disposed of during the most recent quarter.

Inspection of records and storage areas indicated that the above procedures were being implemented. However, interviews with site personnel revealed the existence of two 300-curie cobalt-60 sources in a single irradiation unit used to irradiate cow udders. These sources are currently in Alaska. They were shipped there when a researcher left the LEHR to work at the University of Alaska. These sources were not listed on the radioactive sources inventory and no documents could be produced by LEHR, U.C. Davis, or San Francisco Operations Office (SAN) personnel to establish ownership or transfer of ownership for these sources.

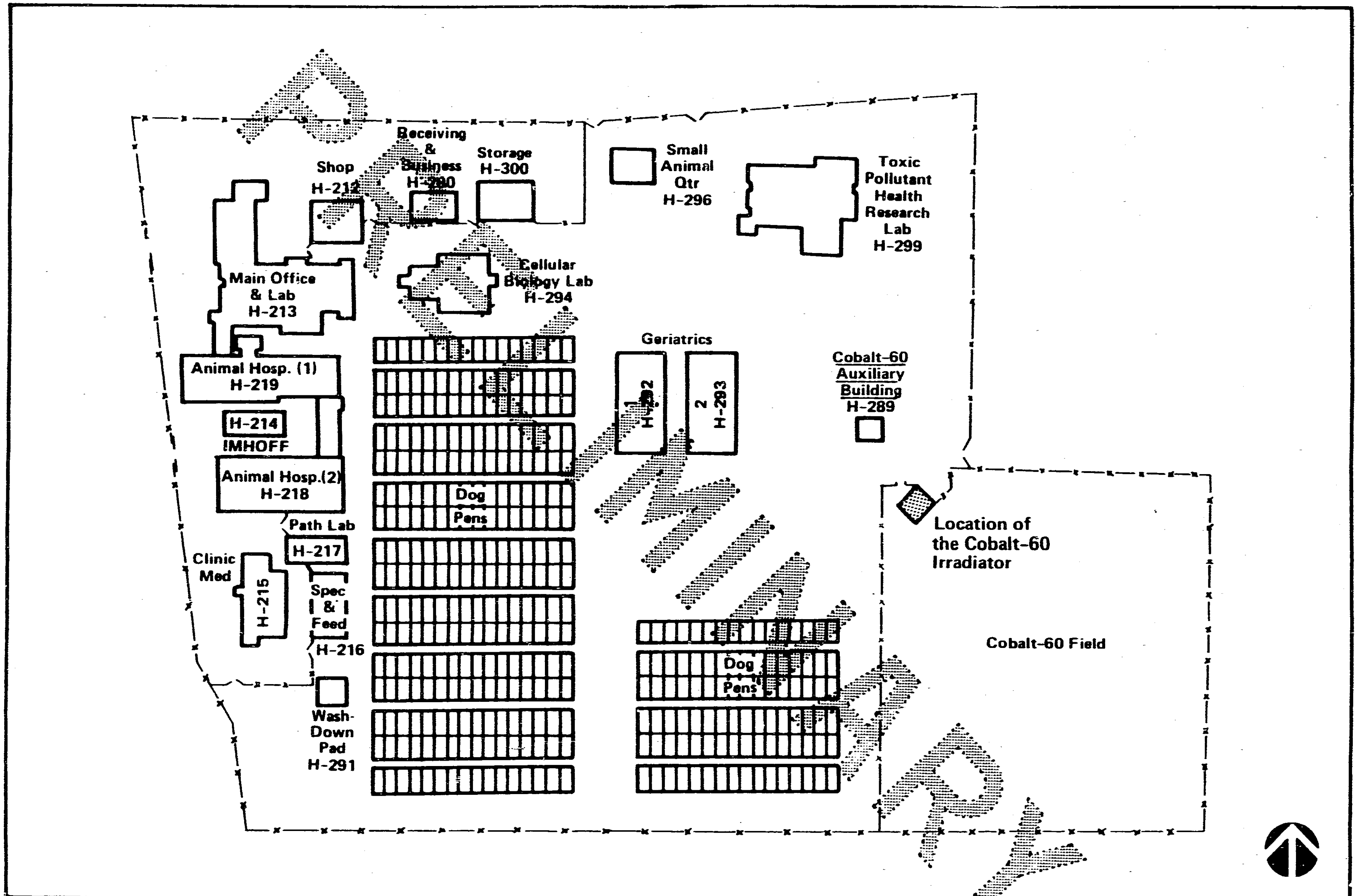
4.3.2.3 Direct Radiation Sources and Controls

The major source of direct radiation at the LEHR is the Cobalt-60 Irradiator. The irradiator consists of a 349-curie source of cobalt-60, which is mounted on the roof of a concrete building in such a manner as to provide independent irradiation of a segment of an outdoor field with a 170-curie equivalent source strength, and/or the enclosed room beneath the source. See Figure 4-2 for the location of the Cobalt-60 Irradiator.

The Cobalt-60 Irradiator was constructed in the early 1970s. It was in use on the outdoor field until October 1985. At that time the decision was made by both the LEHR and the SAN to shut down the Cobalt-60 outdoor Irradiator because of a change in the DOE exposure guidelines for the public. This decision was made after an investigation by the SAN revealed that no feasible corrective actions would reduce possible exposures at the LEHR boundary below the DOE 25-mrem/yr EDE action level during continued outdoor use. In January 1986 the LEHR asked for and was granted permission by the SAN to use the Cobalt-60 Irradiator for indoor irradiation of specimens. As a result, a comprehensive operational plan for the LEHR Cobalt-60 Irradiator was instituted in January 1986 to ensure that exposures to the general public did not exceed the DOE action level.

4.3.3 Environmental Monitoring Program

The LEHR has performed routine thermoluminescent dosimeter (TLD) monitoring around the Cobalt-60 Irradiator since 1985. The TLDs measure direct ionizing



Source: Speed and Badger, 1984

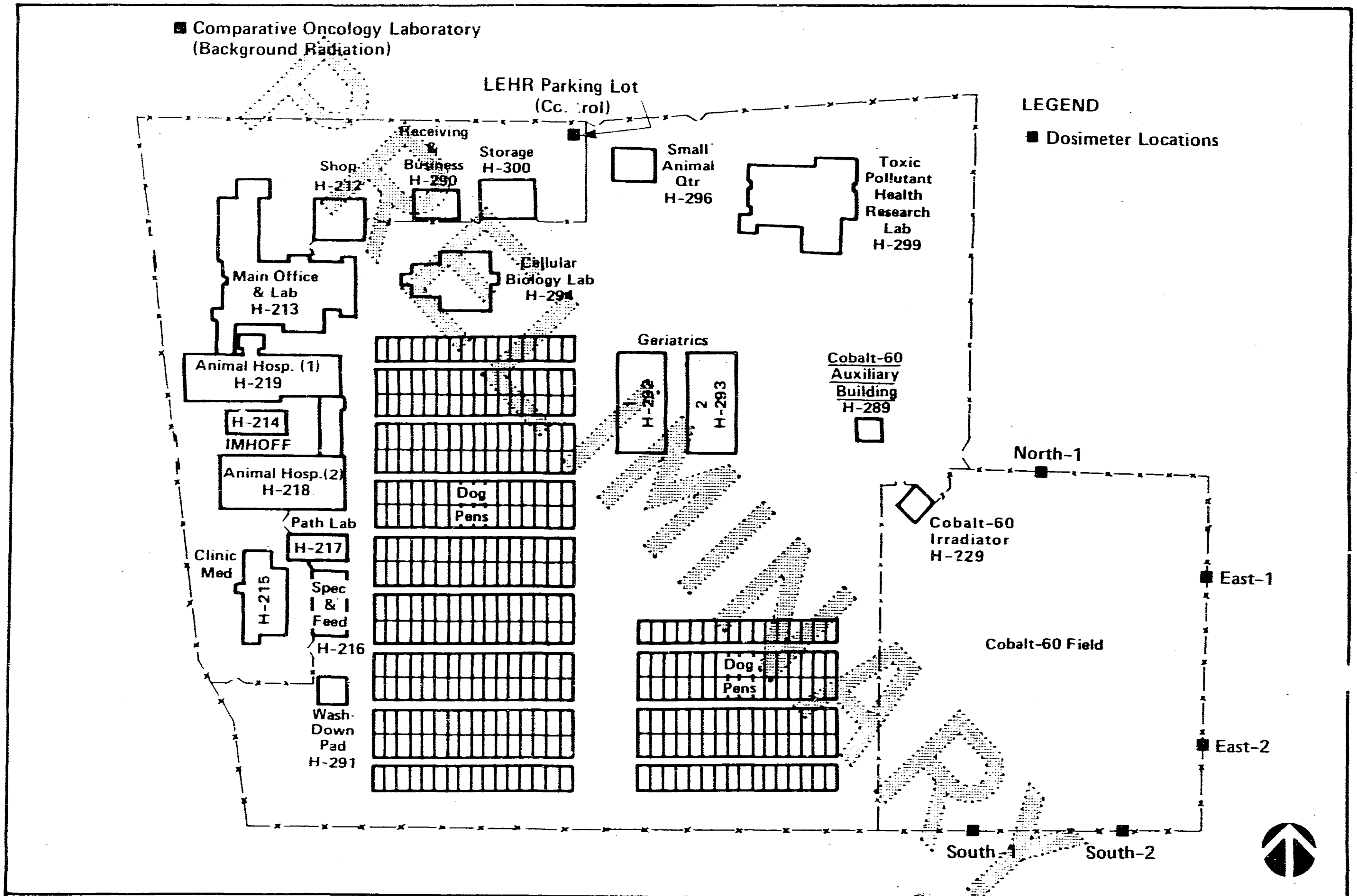
LOCATION OF COBALT-60 IRRADIATOR AT THE LEHR

FIGURE 4-2

radiation exposures from natural and man-made radioactivity in the air and soil, from cosmic radiation, and from radioactivity from LEHR operations. The measurements are made to determine if activities of the LEHR are contributing to the direct penetrating radiation levels in the vicinity of the LEHR.

The TLD locations are shown in Figure 4-3. The TLDs are placed and retrieved on a quarterly schedule (January-March, April-June, July-September, October-December). The TLD locations are inspected during the quarter by a health physicist from the U.C. Davis Office of EH&S to ensure that the TLDs have not been removed or vandalized. The Radiation Detection Company (RDC) is the vendor and processing laboratory for the TLDs. RDC is certified and participates in the Environmental Dosimetry Inter-Comparison Project managed by the Environmental Measurement Laboratory in New York. The latest quarterly results (April-June 1987) are shown in Table 4-4. Additionally, the equivalent yearly direct penetrating radiation exposures and resulting dose equivalent to a person [i.e., an "f" factor of 0.96 is used to convert from milliroentgen (mR) in air to mrem in tissue] are shown in Table 4-4. This dose equivalent to a person would be received by an individual who resided at the specific TLD location for the entire quarter or year, respectively. This type of information was not included or interpreted in the Annual Environmental Monitoring Report.

The Annual Environmental Monitoring Report generated by the LEHR is actually an Annual Environmental Summary by the definition contained in DOE Order 5484.1. Interviews with SAN personnel revealed that SAN granted the LEHR an exemption from preparing an Annual Environmental Monitoring Report, allowing the LEHR instead to prepare an Annual Environmental Summary, and an exemption from monitoring effluents. These exemptions were granted under the provisions in DOE Order 5484.1. However, preparing an Annual Environmental Summary still requires a DOE facility to summarize and interpret the levels of radioactive and nonradioactive pollutants in the environs of DOE sites resulting from facility operations in relation to applicable standards. Additionally, it should be inclusive enough to determine the environmental impact of facility operations.



Source: Speed and Badger, 1984

LEHR TLD LOCATIONS

FIGURE 4-3

TABLE 4-4

LEHR ENVIRONMENTAL DIRECT RADIATION EXPOSURES

TLD Location	Direct Radiation Exposure above background mR		Dose Equivalent to a person (mrem)[a]	
	Quarter (April-June 1987)	Yearly Equivalent	Quarter (April-June 1987)	Yearly Equivalent
Background	0	0	0	0
Control	0	0	0	0
North 1	12	48	12	46
East 1	18	72	17	69
East 2	3	12	3	12
South 2	3	12	3	12
South 1	4	16	4	15

Source: UCD, 1987c

a This dose equivalent to a person would be received by an individual who resided at the specific TLD location for the entire quarter or year, respectively.

4.3.4 Findings and Observations

4.3.4.1 Category I

None

4.3.4.2 Category II

1. Lack of a complete listing of radioactive sources. Neither the LEHR, U.C. Davis, nor SAN has a complete listing of radioactive sources for the LEHR facility. This could result in an inadvertent release to the environment, improper disposal, or loss of radioactive material.

   Interviews with site personnel revealed the existence of two 300-curie cobalt-60 sources in a single irradiation unit used to irradiate cow udders. These sources are currently in Alaska. They were shipped there when a researcher left the LEHR to work at the University of Alaska. These sources were not listed on the radioactive sources inventory and no documents could be produced by the LEHR, U.C. Davis, or SAN personnel to establish ownership or transfer of ownership for these sources. This situation brings into question the completeness of the remaining radioactive sources on the inventory. Additionally, radioactive sources of this size would be included on an assets list. However, no complete assets list exists for the LEHR. After completion of the on-site Survey, an investigation by U.C. Davis and SAN personnel produced information on these two sources. No documents have been received, but verbal communications with site personnel indicate that responsibility for the sources was transferred to the Richland Operations Office.

4.3.4.3 Category III

None

4.3.4.4 Category IV

1. Lack of a comprehensive environmental monitoring program. The lack of a comprehensive environmental monitoring program at the LEHR precludes assessment of past and present environmental impacts of LEHR operations.

   Interviews with SAN personnel revealed that SAN granted the LEHR an exemption from preparing an Annual Environmental Monitoring Report, allowing the LEHR instead to prepare an Annual Environmental Summary. This exemption was granted under the provisions in DOE Order 5484.1. However, the exemption does not eliminate the requirement to monitor or in some way assess the environmental impacts from LEHR operations. Although there is no information to indicate that on-site or off-site impacts to the environment occurred from either past or present operations, there is a lack of data to support or refute this assumption. Currently, a SAN-funded site study and characterization plan is being implemented. The present phase is a groundwater and soil sampling program that is directed toward investigating the environmental impact from the LEHR's inactive waste disposal sites and past operational practices.

2. Failure of LEHR Environmental Summary to meet criteria of DOE Order 5484.1. The LEHR Annual Environmental Summary is not inclusive enough with respect to the criteria of DOE Order 5484.1.

   The Annual Environmental Monitoring Report generated by the LEHR is actually an Annual Environmental Summary by definition contained in DOE Order 5484.1. This report is incorrectly titled. Interviews with SAN personnel revealed that SAN granted the LEHR an exemption from preparing an Annual Environmental Monitoring Report, allowing the LEHR instead to prepare an Annual Environmental Summary. This exemption was granted under the provisions in DOE Order 5484.1. However, the exemption does not eliminate the requirement to monitor or in some way assess the environmental impacts from LEHR operations. Assessment of the environmental impact of LEHR operations is not possible from review of the Annual Environmental Summary. DOE Order 5484.1 requires the site to summarize and interpret the levels of radioactive and nonradioactive pollutants, in its environs, resulting from facility operations in relation to applicable standards. The LEHR facility does not conduct monitoring of radioactive airborne or liquid effluents. Additionally, the LEHR does not, as a substitute, calculate radioactive airborne or liquid effluent releases. Since no releases are measured or calculated, they cannot be compared to applicable standards. The applicable standards themselves are not presented in the Environmental Summary. The LEHR has performed routine TLD monitoring around the Cobalt-60 Irradiator since 1985 but does not discuss, summarize, or interpret the results in the Annual Environmental Summary. The Annual Environmental Summary should be inclusive enough to determine the environmental impact of facility operations. Finally, no ambient monitoring is performed to put the LEHR radiological emissions into perspective.

4.4 Quality Assurance

4.4.1 Environmental Monitoring Program

The Laboratory for Energy-Related Health Research (LEHR) has no routine environmental monitoring program or a program to monitor site effluents.

The LEHR does perform some thermoluminescent dosimetry (TLD) monitoring at the perimeter of the Cobalt-60 Irradiation Field. The TLD program is contracted to the Radiation Detection Company, which is certified by the State of California and participates in the Environmental Dosimetry Inter-Comparison Project managed by the U.S. Department of Energy (DOE) Environmental Measurement Laboratory in New York. Details on the TLD program are presented in Section 4.3.3, Radiation.

The University of California at Davis (U.C. Davis) campus Sewage Treatment Plant routinely analyzes samples of its outfall to meet the requirements of the National Pollutant Discharge Elimination System (NPDES) permit. The plant Quality Assurance (QA) plan (UCD, 1982) was reviewed and found acceptable. The QA plan guidelines for sample collection and analysis are based on the Standard Methods for the Examination of Water and Wastewater (APHA, 1981) and the EPA Methods for Chemical Analysis of Water and Wastes (EPA, 1979) reference texts. For observations covering samples collected by Sewage Treatment Plant personnel, refer to Section 3.3.3, Surface Water.

An exploratory study to determine the presence of radiological and chemical contaminants at the LEHR was conducted by Rockwell International and the results were reported in 1984 (Speed and Badger, 1984). Samples were analyzed according to EPA organic analysis protocol for volatiles (method 624), semi-volatiles (method 625), pesticides (method 608), and metals (California Wet Extraction Toxic Metals method). Also, radiological instruments were calibrated against National Bureau of Standards (NBS) traceable standards.

A more extensive study, to evaluate the lateral and vertical extent of contamination in the soil and groundwater at the LEHR, was initiated (June 1987) by Wahler

Associates of Palo Alto, California. Analyses were subcontracted to TMA/NORCAL Corporation. The QA manual (Nackford and Herd, 1987) covering these analyses was reviewed and, if the guidelines presented are followed, the analytical data generated will have a high probability of being of acceptable quality. For example, analysts confirm that all control criteria have been met for a given set of analytical results, and precision and accuracy performance measurements (spike, blanks, splits, method standard, internal standard) normally account for 10 to 20 percent of the data points generated by TMA/NORCAL.

The Survey team observed the water sampling techniques of Wahler Associates, and details are presented in the Hydrogeology section (3.4.3).

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

None

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 the inactive waste sites associated with the Laboratory for Energy-Related Health Research (LEHR) facility and with other U.S. Department of Energy (DOE)-sponsored activities that were conducted by the LEHR but were located in areas outside the present-day laboratory facility. The property occupied by the LEHR is controlled by the University of California (U.C.) through a land grant from the state, and was once used as a landfill for wastes generated by the U.C. Davis campus. These inactive waste burial areas used by U.C. Davis are also discussed in this section.

The Federal regulation that requires evaluation of the potential environmental and/or human health impacts associated with inactive waste sites is known as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. CERCLA, also referred to as "Superfund," is broad in scope and authorizes the U.S. Environmental Protection Agency (EPA) and state agencies to undertake or to order study or cleanup when there is a release or the substantial threat of a release of a hazardous substance to the environment. Superfund was substantially expanded by the Superfund Amendments and Reauthorization Act (SARA) of 1986. Among the changes, SARA obligates Federal facilities to comply with the same regulations and policies as other entities. Hence, except for certain limited national security waivers, Federal facilities must investigate their potential pollution sources and, for those placed on the National Priorities List, the plans for cleanup must undergo EPA review and concurrence.

In response to these Federal regulations, DOE issued Order 5480.14 to address the inactive waste sites and releases at DOE facilities. The Order presented a phased, investigative approach for the facilities to follow that corresponds to the CERCLA process. The first step in the process is known as an Installation Assessment, with the major purpose of identifying the facility's inactive waste sites. At the LEHR, U.C. Davis did not identify any inactive hazardous waste disposal sites (Foreman, 1986). Consequently, the laboratory requested that it be exempt from the remaining phases outlined in the Order.

Between 1984 and 1986, DOE was requested to evaluate the status of the contract with U.C. Davis for the operation of the LEHR. In 1986, DOE officially announced its intent to phase out the DOE-sponsored activities at the LEHR by October 1989. As part of the transition, U.C. Davis has the option of purchasing the buildings and other structures at LEHR (i.e., the government-owned real property). Given the possibility that the LEHR may be transferred to U.C. Davis, the San Francisco Operations Office (SAN) initiated an assessment of the facility to determine the appropriate decontamination and decommissioning (D&D) effort that would be required (SAN, 1986). This assessment identified several radioactive waste disposal areas at the LEHR and areas that are potentially chemically contaminated. SAN expanded this assessment to include a site characterization study that was ongoing at the time of the Survey.

Concomitantly, the U.C. Davis began investigating past waste disposal practices that occurred at the present-day LEHR facility. The campus' past disposal activities were located on the eastern portion of the laboratory, generally east of the main group of dog pens. The LEHR acquired permission to expand its operation on this eastern portion of the property in the mid to late 1960s. The U.C. Davis broadened the scope of its investigation to include a site characterization study as well. This study is closely coordinated with the SAN study and was also ongoing at the time of the Survey. One of the main distinctions between the U.C. Davis study and the SAN study at LEHR is that U.C. Davis focused on the eastern side of the laboratory where the campus was responsible for waste disposal and SAN focused on the western side of the facility where wastes generated by DOE-sponsored activities were disposed of.

The assessment work performed through SAN and the U.C. Davis has resulted in the compilation of a number of historical memorandums and photographs. Information also has been developed through interviews with former and long-time U.C. Davis employees. During the Survey, this information was reviewed and additional interviews were conducted with laboratory personnel, including scientists and caretakers who worked on LEHR projects in the 1950s and 1960s. Also, all of the known or suspected inactive waste sites at the LEHR facility were visited during the Survey.

Generally, the inactive waste sites and releases on the LEHR facility can be grouped as follows:

- Radioactive liquid effluent sites
- Nonradioactive liquid effluent sites
- Radioactive solid waste sites
- Chemical/sanitary solid waste sites
- Spills and other potential releases
- Miscellaneous

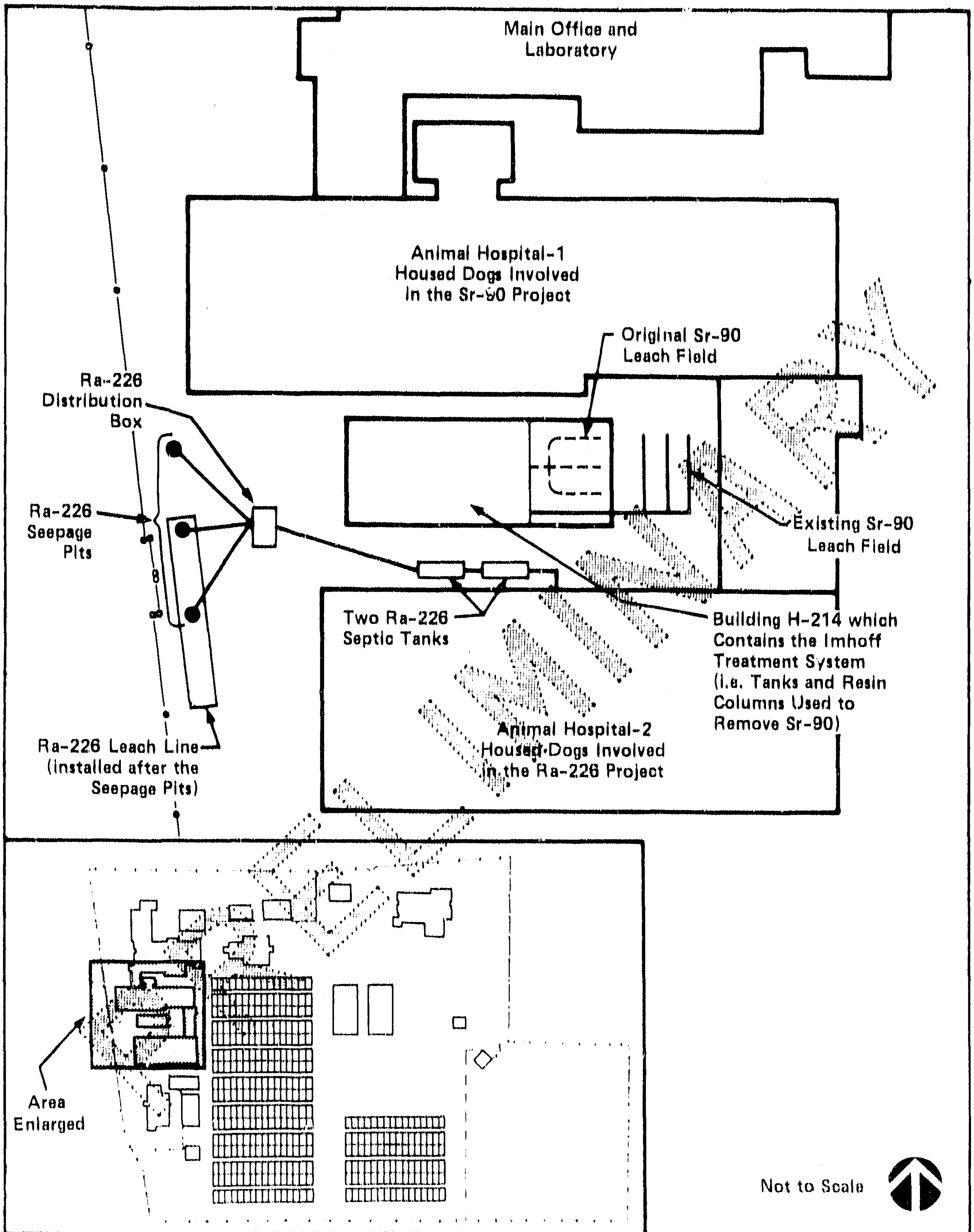
The following subsections describe the sites in each of these general categories.

4.5.1.1 Radioactive Liquid Effluent Sites

Two sites on the LEHR facility have been used for disposal of radioactive liquid effluent. The one first placed in operation is known as the Imhoff treatment system and was designed to treat strontium-90-contaminated liquid generated in Animal Hospital (AH)-1 (Building H-219). The other system was designed for disposal of radium-226-contaminated liquid generated in AH-2 (Building H-218) and is known as the radium-226 septic tanks, seepage pits, and leach line. Both systems discharged effluent to subsurface soils on the LEHR facility and are located adjacent to one another as shown on Figure 4-4. The following paragraphs describe these liquid disposal sites in detail.

Imhoff Treatment System and Associated Leach Field

A long-term study of the effects of strontium-90 ingestion and intravenous injection on a colony of beagle dogs was initiated at the LEHR in 1960. A total of 380 beagles were fed strontium-90 diets, and 46 beagles were injected with strontium-90 from January 1961 until January 1969. The dogs were fed 955.25 mCi and injected with 9.32 mCi of strontium-90 (Goldman, 1985). The strontium-90 study was terminated in 1984. During the 540 days that strontium-90 was administered to the beagles, and for an additional 30 days following administration, the dogs were housed in AH-1. Strontium-90-contaminated wastes from AH-1 were routed to the Imhoff treatment system in Building H-214. The wastes were comprised of dog feces and urine, uneaten food that was enriched with strontium-90, and wastewater from



Source: UCD, 1987c

LOCATION OF THE IMHOFF TREATMENT SYSTEM AND THE RADIUM-226 SEPTIC TANKS, SEEPAGE PITS, AND LEACH LINE

FIGURE 4-4

cleaning out the dog cages. An estimated 200 to 500 gpd of wastewater was discharged to the Imhoff treatment system from AH-1.

A schematic of the Imhoff treatment system is shown in Figure 4-5. This system utilized the principles of primary sedimentation, aeration, chemical clarification, and filtration prior to the passage of the wastewater through 5 cubic feet of cation exchange resin. Treated wastewater from the system was discharged to a leach field east of the building.

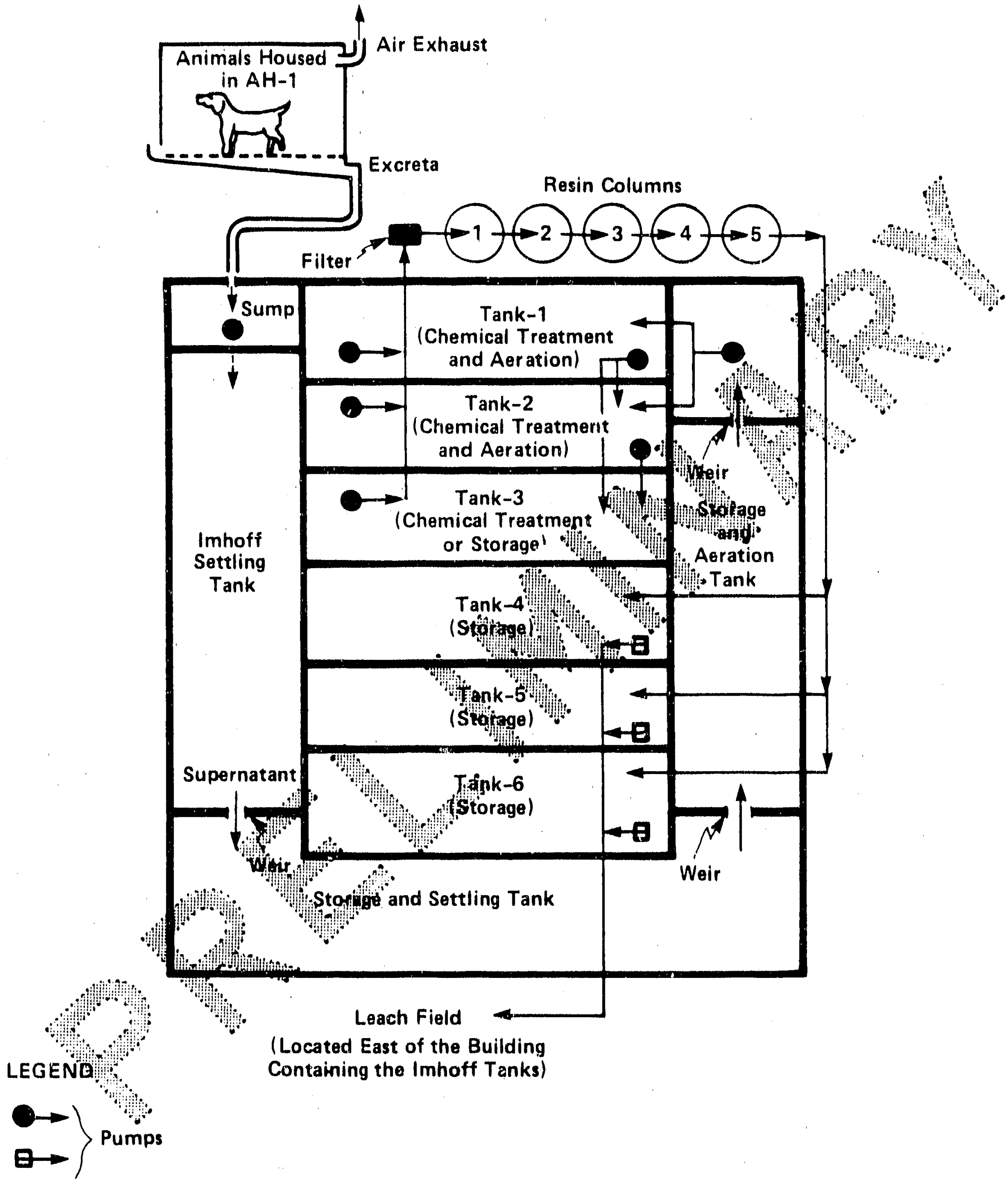
The first of the three perimeter tanks was used to settle solids and the other two were used for both storage and aeration. The wastewater was then pumped into Tank 1, 2, or 3 and typically handled from this point on in batches of 5,000 gallons. Tanks 1, 2, and 3 were used for aeration, chemical treatment, and/or flocculation. The supernatant was then pumped through a pressure filter (consisting of sand, activated charcoal, and a cotton filter designed to remove particles $\geq$5 microns in size) and an ion exchange resin bed (Goldman, 1963).

The resin bed was comprised of five columns, totaling 5 cubic feet. The columns contained canisters charged with 1 cubic foot of Dowex 50 x 8, 20-50 mesh cation resin in sodium form. The supernatant was pumped through the columns at a rate of 1 gal/min/square foot of resin (Goldman et al., 1963).

The resins from the ion exchange columns were routinely changed and the spent resin disposed of at Beatty, Nevada, by Nuclear Engineering Corporation. The resin was considered spent when the activity became constant. The columns were recharged after treatment of only one batch of wastewater if the batch had an unusually high activity (UCD, 1987c; UCD, 1950s-1970s).

From the resin bed, the treated effluent entered Tank 4, 5, or 6. These tanks were used for storage until the effluent was discharged to one of two leach fields east of the group of tanks (Goldman et al., 1963). Approximately 48 hours was required to empty one batch into the leach field (UCD, 1987c).

Two leach fields have been used for disposal of treated effluent from the Imhoff treatment system. The original leach field is located under Room 322 of Building H-214, as shown in Figure 4-4. This leach field was used prior to the addition of Room



Source: Goldman, M., et al, 1963

SCHEMATIC REPRESENTATION OF THE IMHOFF TREATMENT SYSTEM

FIGURE 4-5

322 to the building. In 1962, a new leach field was constructed east of the expansion to Building H-214, and was used until the system was shut down in 1987 (UCD, 1987c). The newer leach field is a series of gravel-filled trenches. Engineering drawings showing details of the subsurface distribution system have not been available.

The treatment system operated on a continuous basis from 1960 until 1987. Sampling for beta activity was conducted prior to the first ion exchange column and after the last ion exchange column for every 1,000 gallons of waste processed (UCD, 1987c). Table 4-5 provides annual data on the volume of waste processed, the strontium-90 activity of the resin column influent, and the activity of the effluent discharged to the leach field. Although the average concentration of strontium-90 released to the leach field was below the limit of 3 x 10^{-7} mCi/mL established by U.S. Nuclear Regulatory Commission regulations (10 CFR 20) and DOE Order 5480.1, this concentration was occasionally exceeded in individual batch discharges, reportedly due to faulty valves that permitted raw waste contamination of treated batches.

Radionuclides other than strontium-90 have also been processed through the Imhoff system. Between 1982 and 1984, effluent from an experiment using plutonium-241 and americium-241 was routed to the system. The estimated total inventory of these two isotopes entering the treatment system is provided below.

Year	Volume (gal)	Total Pu-241 (μCi)	Total Am-241 (μCi)
1982	44	0.722	0.083
1983	24	0.868	0.053
1984	N/A	38	--
Total	>68	39.59	0.136

Source: LEHR, 1982, 1983, and 1984

N/A Data Not Available

TABLE 4-5

ANNUAL QUANTITY OF STRONTIUM-90-CONTAMINATED WASTEWATER PROCESSED THROUGH THE IMHOFF TREATMENT SYSTEM FROM 1960 TO 1987

Year	No. of Batches	Total Gallons	Clarified Waste (mCi)[a]	Decontamination Effluent (μCi)[b]
1960-1961	16	6,300	4	19
1962	17	8,500	18	5
1963	19	9,400	15	11
1964	57	250,800	48	20
1965	53	226,800	83	216
1966	57	234,900	138	89
1967	70	280,700	144	389
1968	55	245,100	143	248
1969	30	151,200	25	150
1970	35	178,300	10	91
1971	37	192,400	2	181
1972	37	192,200	5	75
1973	37	192,400	2.64	81
1974	35	182,000	2.46	175
1975	33	171,600	1.43	332
1976	31	161,200	1.06	61
1977	26	130,000	0.991	50
1978	10	52,000	0.472	13
1979	25	135,000	0.659	25
1980	15	78,000	0.275	22
1981	7	36,400	0.165	31
1982	4	20,800	0.110	10
1983	4	20,800	0.078	5.5
1984	N/A	41,600	N/A	31
1985	N/A	54,000	N/A	26
1986	N/A	20,800	N/A	65
1987	N/A	15,600	N/A	139.5
Total[c]	710	3,288,800	645.340	2,555

Source: Owen, 1987c

a. Entering resin columns

b. Discharged to leach field

c. Totals using available data

N/A Data not available.

For an unknown period of time, a washing machine was located in Building H-214, and the washwater was directed into Tank 3 of the Imhoff system. The machine was used to launder contaminated clothing, including that from an actinide study using ytterbium-169.

The Imhoff tanks in Building H-214 are below-grade and lined with concrete that is covered with a plastic sealant. The total capacity of the tanks is 46,000 gallons. During the years of operation, some or all of the tanks filled up with sludge. According to LEHR personnel, Nuclear Engineering Corporation was contracted to pump out the sludge on one or two occasions and to dispose of it off-site. The laboratory also acquired a tank truck which apparently was used to temporarily store sludge from the Imhoff tanks to prevent them from overflowing. It is unclear whether any of the sludge stored in this tank truck was disposed of on the LEHR facility in the trenches on the southwest corner of the property instead of being transferred back into the Imhoff tanks or to Nuclear Engineering Corporation.

In 1984, estimates were made of the quantity of sludge remaining in the Imhoff tanks, and the radioactivity was measured (Speed and Badger, 1984). Manholes of only four tanks could be accessed at the time to collect sludge samples. The results are presented below:

Tank Identification	Maximum Capacity (gal)	Amount of Sludge (%)	Radioactivity (mCi)
North Perimeter	5,027	100	180.2
West Perimeter	6,127	80	105.9
South Perimeter	3,928	10	0.7
Tank 3	5,200	38	33.9

In the spring of 1987, SAN advised the LEHR to cease all use of the Imhoff treatment system (Simmons, 1987). Water samples from Tanks 1, 2, and 3, and the south perimeter tanks were collected in June 1987, following an accidental deionized-water spill where approximately 2,600 gallons of water entered the tanks (UCD, 1987f). The samples were analyzed for gross alpha and beta activity; specific isotopic analyses were not performed. The results indicated gross beta contamination in all the tanks sampled and elevated gross alpha levels in Tank 1 (Owen, 1987c). Organic chemical and/or metal analyses of the sludge or water in the Imhoff tanks have never been performed.

The Imhoff treatment system is currently inactive. Some drain lines leading to the system have been plugged. Also, the water supply to AH-1 has been shut off to prevent an accidental release of additional liquid to the system. The connection to the leach field remains open. The contents of all the tanks were observed and as found in 1984, the same four tanks still contained sludge. In addition, Tanks 1, 2, and 3 contained liquid and Tanks 4, 5, and 6 were dry. The plastic sealant was noted in all the tanks to be cracked and blistering, leaving the original concrete siding exposed. A constant trickle of water (estimated at a rate of 300 gal/day) was noted entering the sump of the Imhoff system, from one of two pipes. The source of this water is unknown; however, LEHR personnel speculated that it may be groundwater inflow into the drainlines coming from AH-1. The integrity of the Imhoff treatment system tanks has not been tested. The tanks have no secondary containment, leak detection, or leak collection systems.

In addition to processing radioactively contaminated effluent, Building H-214 has been used to store containers of radioactive and hazardous wastes. In 1987, SAN learned of this practice and requested the laboratory to remove the containers of waste. Consequently, the wastes were transported to the U.C. Davis Waste Packaging Facility on the main campus (see related discussion in Section 4.1).

Radium-226 Septic Tanks, Seepage Pits, and Leach Line

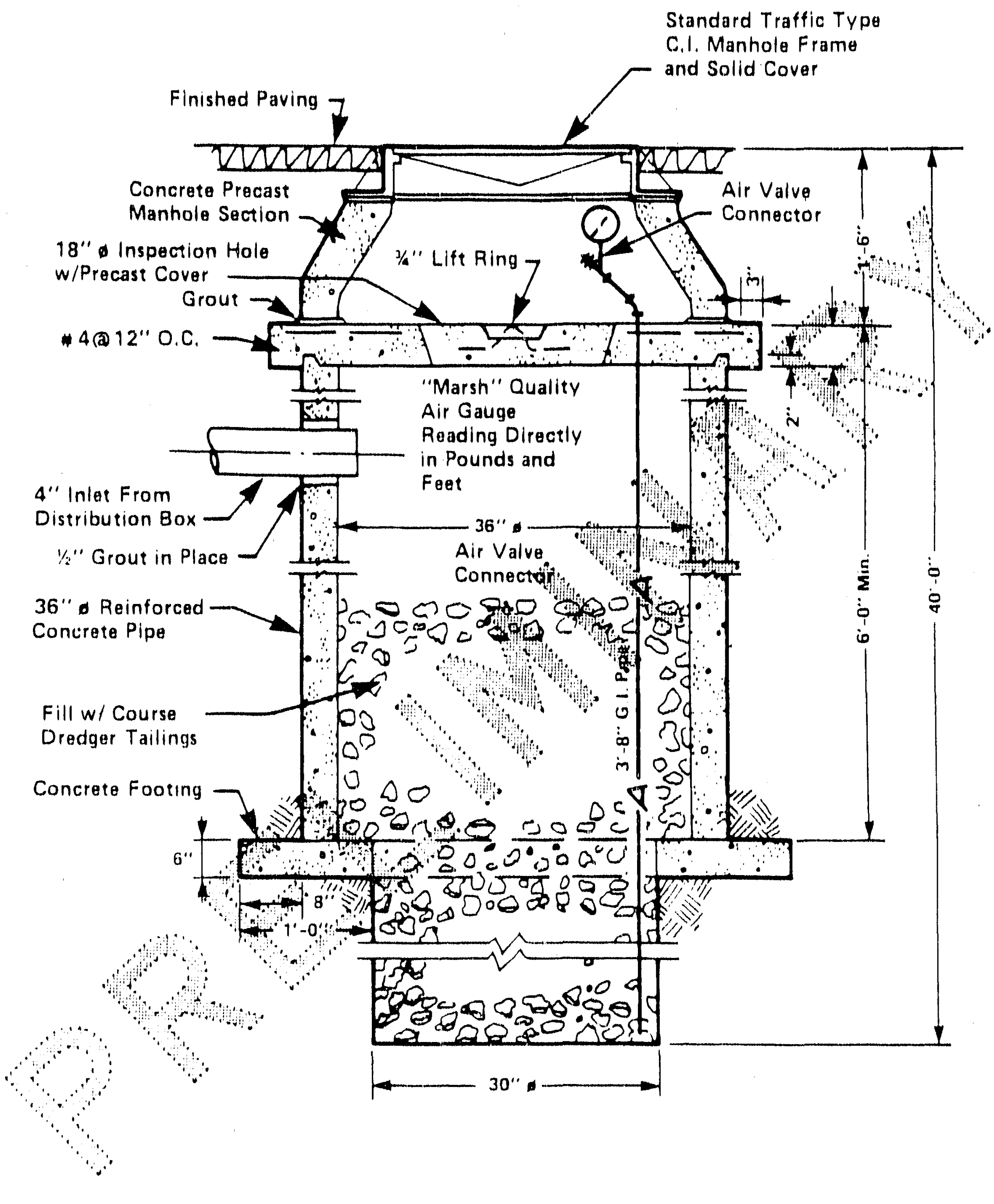
In 1963 a study parallel to the strontium-90 study was initiated at the LEHR. This study involved injecting 246 beagles with various activities of radium-226 from October 1963 through January 1969 and evaluating the biological effects of this bone-seeking radionuclide. The purpose of the radium-226 study was to assist in scaling the results in beagles to expected risks in humans from the strontium-90 study. During the injection period and for 30 days after injection of the radium-226 was discontinued, the beagles were housed in AH-2. In total, the beagles were injected with 6.129 mCi of radium-226 and retained as their body burdens approximately 2.302 mCi (38 percent). They excreted the rest in urine and feces (Goldman, 1985). Much of the radioactive material is initially excreted in the urine and feces of the animals; therefore, a system for processing this waste was designed and constructed in 1963.

The location and components of the radium septic tanks, seepage pits, and leach line are shown in Figure 4-4. Wastewater exited AH-2 via a pipe network and entered either of two septic tanks north of the building. These two septic tanks operated in parallel. The combined capacity of the septic tanks is 14,400 gallons. Each tank has two compartments and each compartment has a capacity of 3,600 gallons. The septic tanks allowed for the settling of solids, and the supernatant was discharged to a common line, which flowed west to a distribution box, then to one of three vertical seepage pits. The vertical seepage pits are approximately 40 feet deep. The construction of these vertical seepage pits is detailed in Figure 4-6.

Frequent failures of the vertical seepage pits occurred. The failures were the result of formation of hair mats which impeded the percolation of the supernatant waste through the gravel and soil. The hair mats formed as a result of the transport to the vertical seepage pits of hair floating on the supernatant's surface in the septic tanks. Periodically, LEHR added sodium hydroxide to the system to try to dissolve the hair mats. In 1965, a surface weir was added to the septic tanks to prevent the floating hair from entering the seepage pits. Additionally, a 91-foot-long, 14-foot-deep, and 3-foot-wide leach line was installed in the same year to improve percolation of the deteriorated vertical seepage pits. This leach line extended from the existing vertical seepage pits to the south.

Although no monitoring of the wastewater entering the radium septic tanks, seepage pits, and leach line was performed, the calculated throughput to the system is the difference between the total activity of radium-226 injected into the beagles (6.129 mCi) and that retained as their body burdens (2.302 mCi). This equals 3.827 mCi of radium-226 discharged in the waste stream (Goldman, 1985).

An overflow of one of the radium-226 septic tanks occurred on November 23, 1985 (Owen, 1986), due to a plastic bone lodging in a sanitary sewer line exiting AH-2. The blocked sanitary line, which was interconnected to the septic tanks, caused sewage to back up into the eastern radium-226 septic tank. The material in the septic tank was pumped directly into the distribution box leading to the seepage pits. Water samples from the east and west septic tanks were obtained on



Source: UCD, 1962

CONSTRUCTION DETAILS OF THE RADIUM-226
VERTICAL SEEPAGE PITS

FIGURE 4-6

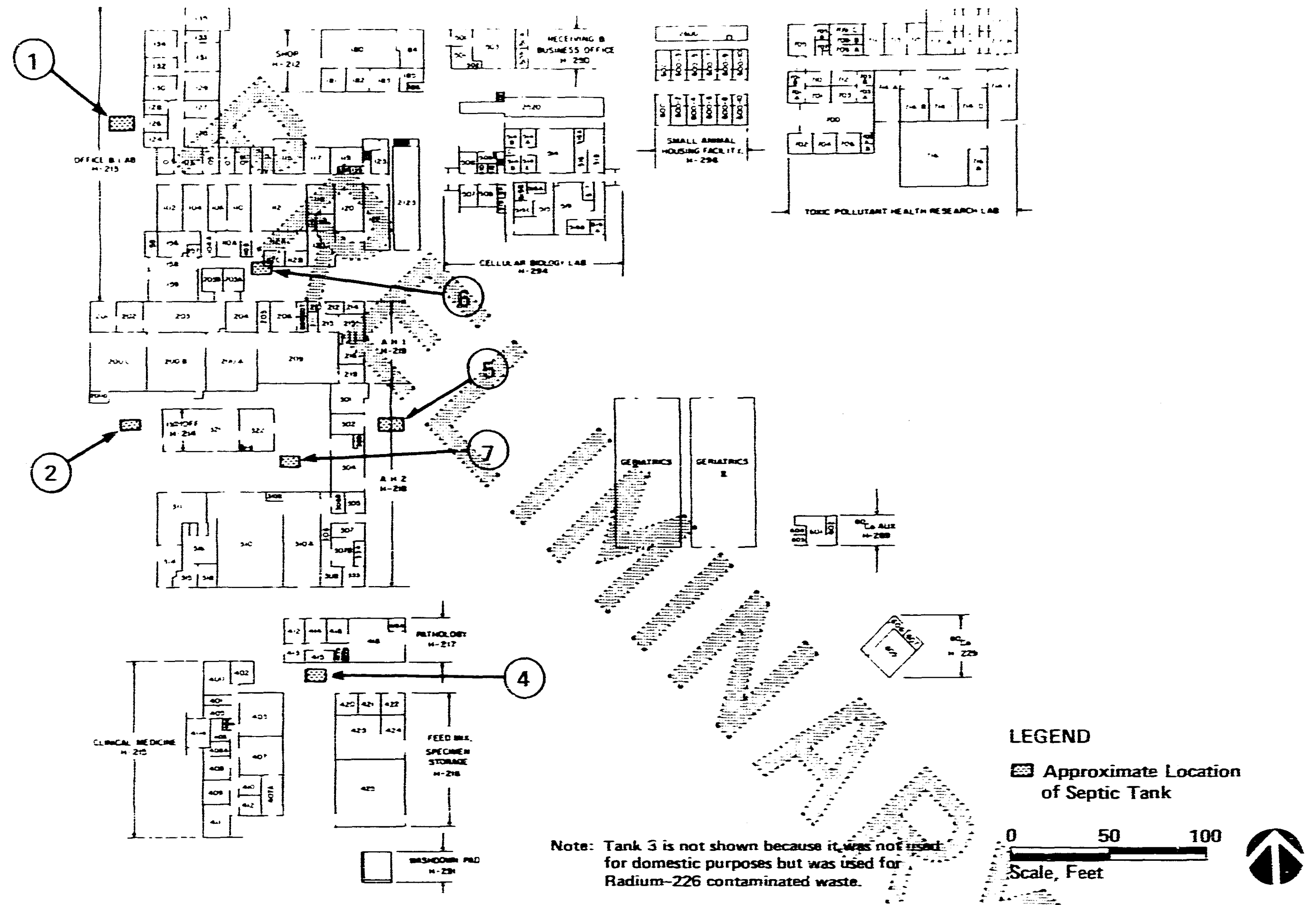
November 29 and December 3, 1985. The results indicated a level of 0.40 ± 0.04 pCi/L in the east tank and 4.5 ± 0.2 pCi/L in the west tank of radium-226. The EPA drinking water standard for radium-226 is 5 pCi/L.

Subsequent to this incident, the valve on the sanitary sewer line leading to the radium-226 septic tanks was closed, and the manhole covers, distribution box, seepage pit covers, and shutoff valves for the plumbing in AH-2 were labeled. According to U.C. Davis, one of the septic tanks is empty (Owen, 1987c). Further information concerning the plumbing used for radioactive wastewater transport in AH-2 is discussed in Section 3.3.

4.5.1.2 Nonradioactive Liquid Effluent Sites

Nonradioactive liquid waste generated by the various laboratories at the LEHR was routed to on-site septic tanks for disposal, prior to the LEHR's hookup to the U.C. Davis sewage treatment plant (STP) in 1971. Six domestic septic tank systems were identified at the LEHR from a review of available information. These systems, shown as numbers 1, 2, 4, 5, 6 and 7 on Figure 4-7, were used to receive all liquid wastes from LEHR activities except for the strontium-90 and radium-226 projects. The radium-226 septic tanks were designated numbers 3A and 3B.

Five of the domestic septic tank systems are believed to have been disconnected. Tank 7, which was reported to have been connected to the lavatory (Room 323) of the Imhoff Building (Building H-214), is still considered to be in use. This tank is not indicated on any available facility plans but was reported by a LEHR employee to have existed. Prior to connection to the STP, the septic tanks were filled with sand and abandoned in place, and the influent and effluent lines were severed and capped. The connections to the STP were then made at the former connection to the septic tank. Any sludges that may have been present in the tanks are not believed to have been pumped out prior to filling the tanks with sand. The past use and suspected contamination which may have been discharged into each tank are provided below. Further information on the sources of wastewater disposed of in these septic tanks is provided in Section 3.3.



Note: Tank 3 is not shown because it was not used for domestic purposes but was used for Radium-226 contaminated waste.

Source: Adapted from Speed and Badger, 1984

APPROXIMATE LOCATION OF DOMESTIC SEPTIC TANKS AT THE LEHR FACILITY

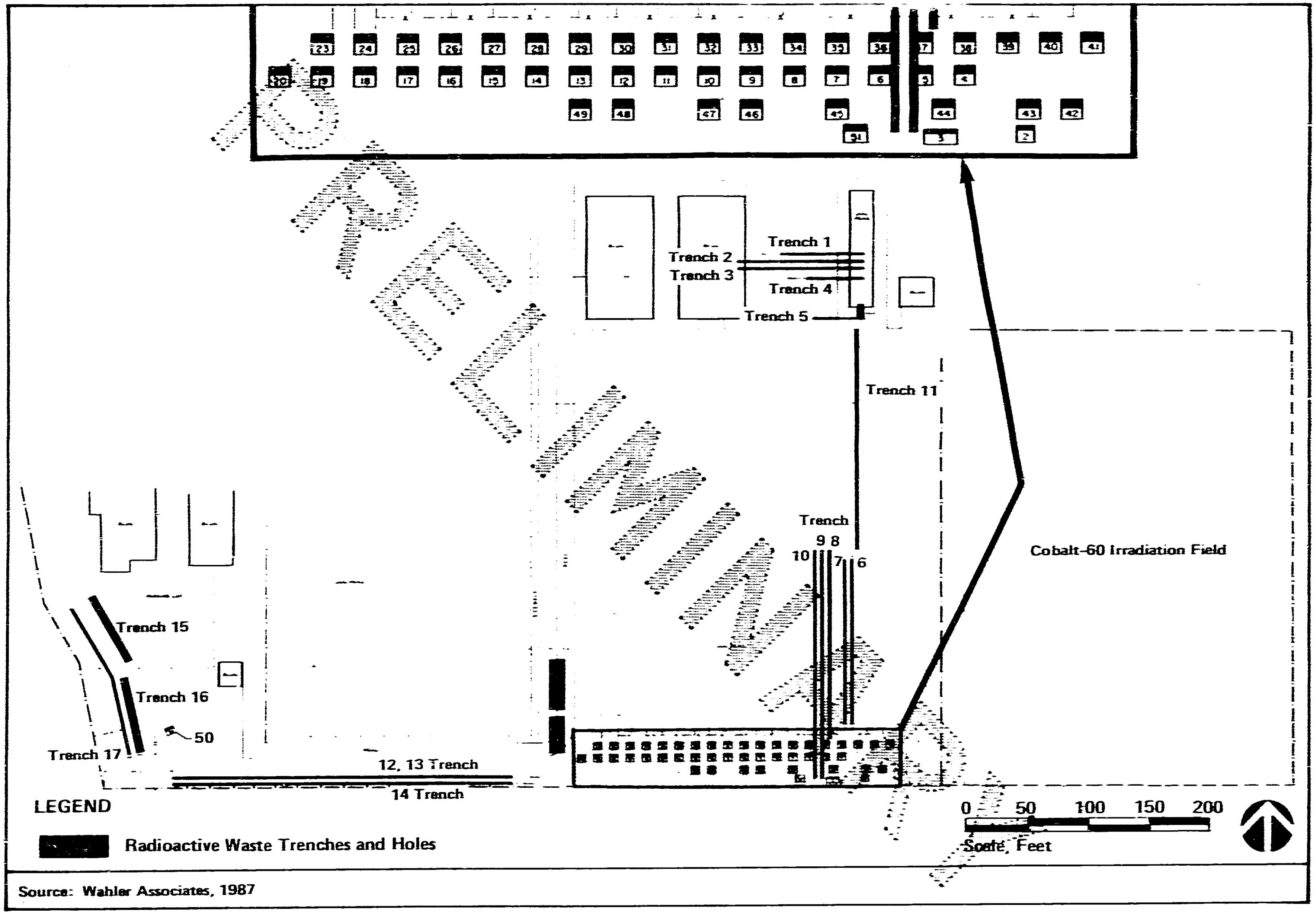
FIGURE 4-7

Tank No.	Past Use/Suspected Contaminants
1	Served Main Office and Laboratory, possible contaminants unknown.
2	Suspected radium-226 contamination due to a backup in the radium-226 septic tank system; possible other contaminants unknown.
4	Served Pathology Office and Laboratory, possible chemical contamination suspected but unknown.
5	Served western portion of AH-2, believed to have received sanitary wastes only.
6	Served Biochemistry Laboratory and lavatory in the Main Office and Laboratory Building, served mechanical room in AH-1; possible chemical contamination suspected but unknown.
7	Served Laboratory and lavatory in Imhoff treatment system building. Considered to be still in use.

4.5.1.3 Radioactive Solid Waste Sites

The first use of the LEHR facility as a radioactive solid waste disposal site was in April 1956 (Holdstock, 1986). The U.C. Davis was responsible for this activity and according to U.C. Davis Environmental Health and Safety (EH&S) personnel, disposal of low-level radioactive waste generated on the campus was permitted through an AEC license. Prior to the mid-1950s, radioactive waste from the University was taken to sea for disposal (Owen, 1987a). In 1965, the State of California acquired authority for permitting, and U.C. Davis continued radioactive waste disposal under a State permit (No. 134-57), which is a Type A, broad-scope license (UCD, 1987c). The LEHR facility operated under an AEC exemption and the wastes were handled by U.C. Davis. The last recorded date of radioactive waste burial on the LEHR facility is July 1974.

The wastes were buried in trenches and holes, the majority of which were located on the central portion of the site as shown in Figure 4-8. A total of 68 radioactive waste burial areas have been identified: 19 trenches and 49 holes. The trenches were typically 2 feet wide and ranged in length from 33 to 270 feet. Holes were usually 4 feet by 4 feet. Both types of disposal units were estimated to be between 8 and 10 feet deep (Warren, 1985). The procedures in place at the time required that a minimum of 4 feet of cover material be placed over the waste (Warren, 1985); however, the waste disposal logs do not address whether these procedures were routinely followed.



LOCATION OF RADIOACTIVE WASTE TRENCHES
AND HOLES ON THE LEHR FACILITY

FIGURE 4-8

Of all the radioactive waste buried at the LEHR, less than half the total volume is considered attributable to the LEHR. The majority of the waste was generated by U.C. Davis activities on the main campus. Trenches 15, 16, and 17, which are located on the southwest corner of the facility, are believed to contain exclusively LEHR-generated wastes. Also, the long trenches on the southern border (designated 12, 13, and 14) may have been regularly used for disposal of radioactive wastes generated by the LEHR, due to their location on the portion of the property that was occupied by the laboratory since the late 1950s. Two trenches, located next to the main set of dog pens, have no numerical designation and are believed to contain radioactive animal carcasses from an experiment that took place partially at the Hopland Field Station (see related discussion in Section 4.5.1.7). The trenches and holes located on the mid-portion of the site are believed to contain wastes generated predominantly by the campus. However, since these burial sites were in use during the operation of the LEHR, it is possible that radioactive wastes generated by the DOE-sponsored experiments were occasionally disposed of in these trenches and holes.

Neither the form of this waste nor the adequacy of packaging at the time of receipt on the LEHR have been described in available documentation. Plastic bags or cardboard boxes were used to contain some of the waste (UCD, 1987c). Some of the waste was biological (i.e., radioactively contaminated animal carcasses). According to a former U.C. Davis employee, it is probable that small quantities of chemicals, such as scintillation vials, were included with the waste taken to the radioactive trenches on the LEHR.

Based on available records, there is no inventory of the wastes placed in the trenches. Records do exist for the holes, however, and indicate that they received 26 different radioisotopes totaling 1.7 Ci. Eight of the radioisotopes have a relatively long half-life and account for 1.3 Ci of the total inventory (Warren, 1985). Table 4-6 presents the distribution of these eight isotopes in the 49 holes, along with those holes where the type of radionuclide disposed of is unknown. Each of the remaining 18 isotopes, after correcting for decay, is present in less than 1-pCi amounts.

TABLE 4-6

DISTRIBUTION OF LONG-LIFE RADIONUCLIDES IN THE WASTE HOLES AT THE LEHR

Hole No.	Date	Units (mCi)								
		C-14	H-3	Cs-137	Na-22	U-238	Ra-226	Co-60	Cl-36	Unknown
1	Unknown									X
2	1956									X
3	1961									X
4	Unknown									X
5	Unknown									X
6	Unknown									X
7	Unknown									X
8	Unknown									X
9	1963									X
10	1963									X
11	1963									X
12	1963	0.54								
13	1963									
14	1963									
15	1963									
16	1964	0.05								
17	1964	4.00								
18	1964	1.15								
19	1964		0.10							
20	1964			0.06						
21	1964	0.10								
22	1965									
23	1965									
24	1965									
25	1965	0.20	0.10							
26	1965	0.33	0.01		0.02					
27	1966	0.80								
28	1966	0.16				0.002	0.02			
29	1968	11.17	10.00	0.05						
30	1968	32.20						0.23		X
31	1968	18.28	2.21	0.15				0.00		
32	1969	44.77								

TABLE 4-6

DISTRIBUTION OF LONG-LIFE RADIONUCLIDES IN THE WASTE HOLES AT THE LEHR (Continued)

Hole No.	Date	Units (mCi)								
		C-14	H-3	Cs-137	Na-22	U-238	Ra-226	Co-60	Cl-36	Unknown
33	1969	27.03								
34	1969	32.25	55.28							
35	1970	42.70	26.39							
36	1970	45.25	24.90					0.01		
37	1970	47.94	4.41							
38	1971	33.32	19.62							
39	1972	32.39	24.45							
40	1972	30.00	93.40							
41	1972	33.10	38.85							
42	1972	15.29	44.04							
43	1973	35.10	26.00							
44	1973	60.10	75.00							
45	1973	32.55	42.70							
46	1973	45.55	51.96							
47	1973									X
48	1974	25.53	45.29						0.25	
49	1974	24.51	83.98							
TOTAL		676.37	668.68	0.26	1.32	0.002	0.02	0.24	0.25	N/A

Source: Warren, 1985

N/A Not Applicable

A gross estimate of the total waste quantity placed in the trenches was developed from handwritten notes on a 1958 engineering drawing of the radioactive waste disposal area at the LEHR. An estimate of the dimensions of the trenches is provided in Table 4-7. Assuming the trenches were a maximum of 10 feet deep and that the wastes were covered with 4 feet of native soil, approximately 30,150 cubic feet were used for waste burial. This volume does not take into account the possibility that wastes were periodically compacted in the trenches.

A similarly gross estimate of the total waste quantity placed in the holes can be derived assuming the dimensions of the holes were consistent and that U.C. Davis covered the wastes with 4 feet of soil. Given these assumptions, the volume of waste placed in the holes is approximately 3,000 cubic feet, or 10 percent of the total volume of radioactive solid waste buried at the LEHR.

4.5.1.4 Chemical and Sanitary Solid Waste Sites

On the LEHR facility, three areas have been identified as locations of past landfilling activities for chemical and/or sanitary wastes. Two of the areas were operated by U.C. Davis, and the third was a practice handled by the LEHR facility. These areas are as follows:

Name	Operator
Abandoned Dump Site	U.C. Davis
Industrial and Sanitary Waste Pits	U.C. Davis
Trash Pits	LEHR facility

Each of these areas is discussed in the following paragraphs.

Abandoned Dump Site

At some period during the late 1940s or early 1950s, portions of the LEHR facility were used as a dump site by U.C. Davis for general sanitary wastes. According to a 1958 engineering drawing, the dump was located in the vicinity of the present-day Cobalt-60 Irradiation Field and near the fence on the southern border of the site as

TABLE 4-7

ESTIMATED DIMENSIONS OF THE WASTE TRENCHES AT THE LEHR

Trench No.	Date	Width (ft.)	Length (ft.)	Assumed Depth of Waste (ft.)	Total Volume (cu.ft.)
1	Unknown	2	66	6	792
2	1957	2	100	6	1,200
3	1957	2	100	6	1,200
4	1958	2	45	6	540
5	1958	2	33	6	396
6*	1958	2	123	6	1,476
7	1959	2	123	6	1,476
8*	1960	2	155	6	1,860
9*	1960	2	185	6	2,220
10*	1960	2	185	6	2,220
11	1961	2	180	6	2,160
12	1958	2	8	6	96
13*	1959	2	265	6	3,180
14*	1960	2	275	6	3,300
15	Unknown	2	60	6	720
16	Unknown	2	60	6	720
17	Unknown	2	130	6	1,560
No #	Unknown	12	40	6	2,880
No #	Unknown	12	30	6	2,160
Total					30,156

Source: Warren, 1985

*Dimensions are uncertain

depicted in Figure 4-9. A more precise definition of the dump site boundaries was not available in the background information.

Little is known about the types of wastes disposed of at this dump site, other than that the wastes were most likely generated by the campus. During the 1940s, an STP was located adjacent to the suspected dump area and U.C. Davis personnel speculate that the sludge from this plant was periodically disposed of at this dump. One report from a former U.C. Davis employee indicates that a dumpster full of bottles of waste chemical reagents from a campus laboratory was disposed of in a pit in the vicinity of this dump.

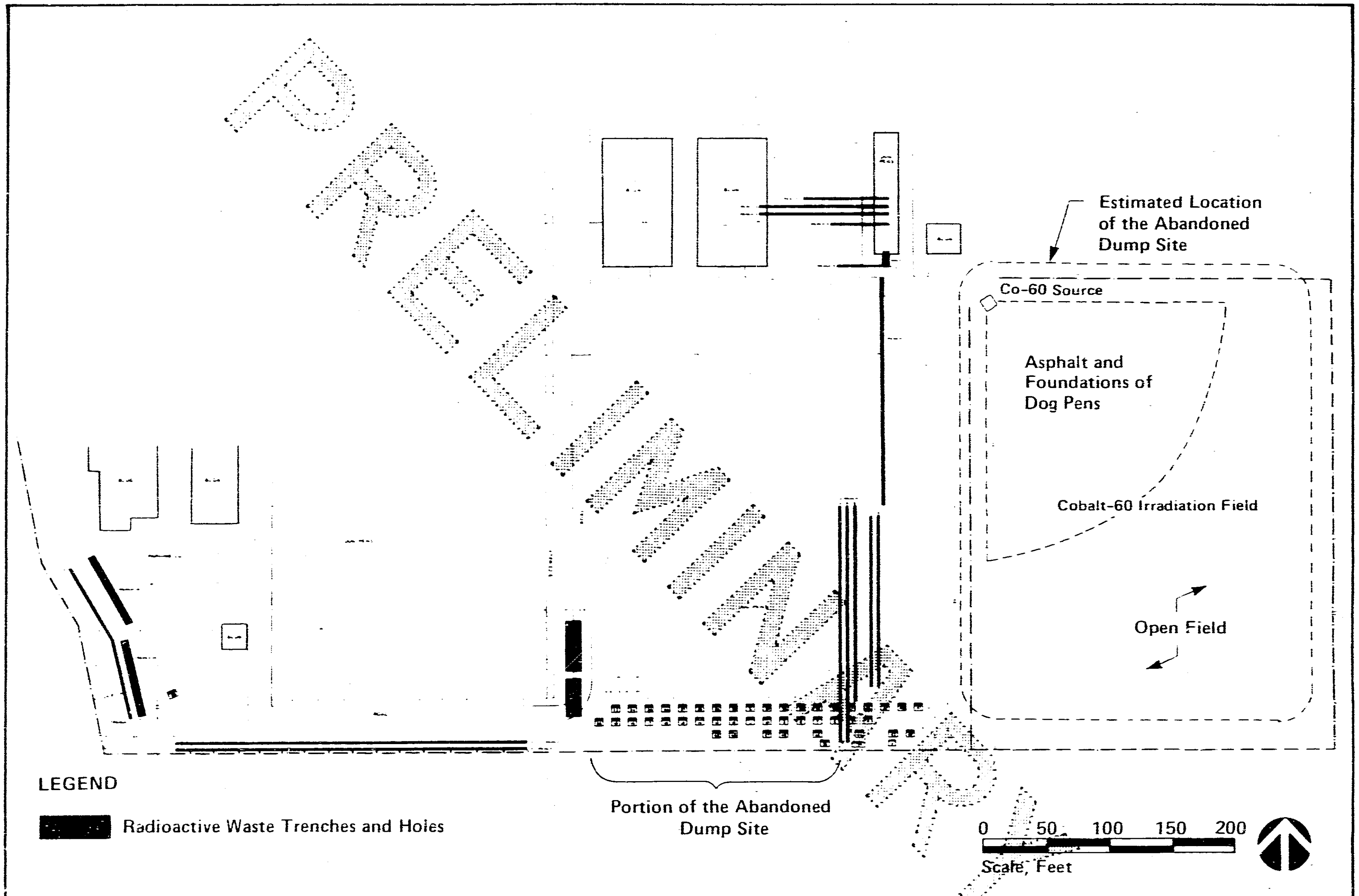
The major change in the area believed to be the dump site has been construction of a building housing a cobalt-60 radiation source. In addition, the northwestern portion of the area has been covered by asphalt and the remains of the foundations of dog pens that were used in the cobalt experiments. The majority of the Cobalt-60 Irradiation Field is open land that has not been used by the LEHR. The field is occasionally tilled to reduce weed growth.

<u>Chemical and Sanitary Waste Pits</u>

From 1956 to 1967, U.C. Davis operated a sanitary waste landfill on the mid-portion of the LEHR facility. In the background documentation, these burial sites are distinguished from the radioactive waste burial areas by referring to them as rubbish pits or chemical waste pits. The wastes were brought to the LEHR from the U.C. Davis campus and disposed of in a series of pits that occupied approximately 3 acres in the general vicinity of the two Geriatrics Buildings and the eastern set of dog pens (Holdstock, 1986). The pits were oriented east-west, whereas most of the radioactive waste pits were oriented north-south. A total of 12 pits have been identified and their approximate locations are illustrated on Figure 4-10.

The pits were unlined and averaged 10 feet in depth. Two to 3 feet of cover material consisting of native soil was placed over the waste. According to U.C. Davis, the total volume of waste is 19,260 cubic yards (Holdstock, 1986).

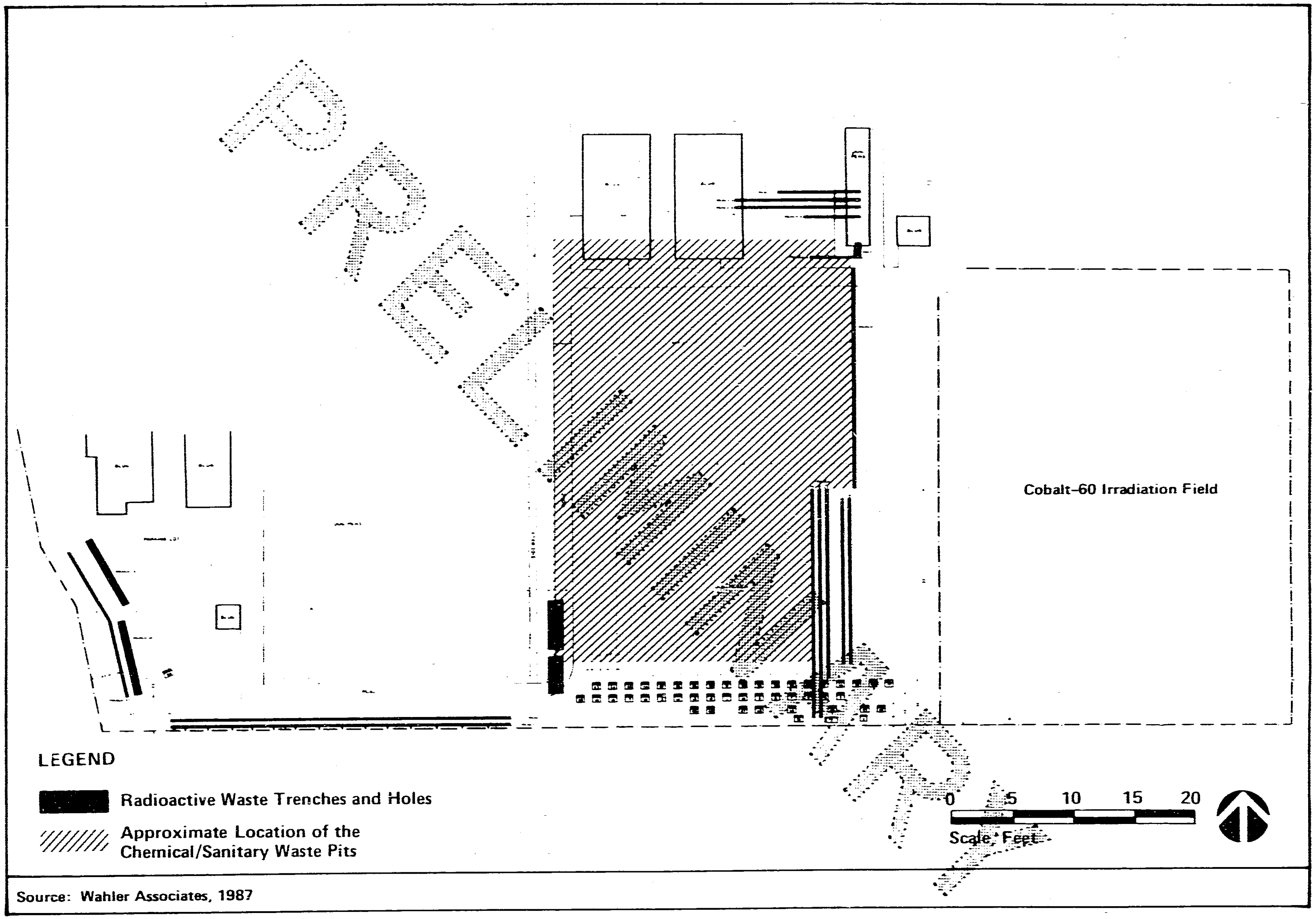
Records were not kept of the types of wastes disposed of in these pits. However, in a response to a questionnaire regarding this site, U.C. Davis reported that 75



Source: Wahler Associates, 1987

APPROXIMATE LOCATION OF THE ABANDONED DUMP SITE AT THE LEHR FACILITY

FIGURE 4-9



APPROXIMATE LOCATION OF THE CHEMICAL/SANITARY WASTE LANDFILL AT THE LEHR FACILITY

FIGURE 4-10

percent of the solid waste was residential and 25 percent was classified as "Other". Further description of the "Other" category explained that 98.5 percent was straw and/or sawdust, 1 percent was animal parts, and 0.5 percent was "steamed soil". U.C. Davis personnel added that ash from the campus incinerator and other items that were difficult to burn in the incinerator were disposed of at this landfill.

Liquids were also accepted at this landfill and included the following:

Type	Annual Quantity (gal.)
Petroleum Distillates (parts washing)	250
Used Oils	180
Laboratory Chemicals	Unknown

The petroleum distillates were reportedly allowed to percolate/evaporate, the used oils were applied to roads, and the laboratory chemicals were burned. Open burning was a routine practice during the operation of this landfill until 1966. In some instances, reactive chemicals were intentionally combined to ignite a fire. At other times, various flammable liquids were added to the waste pits to ignite and accelerate burning. The types and/or amounts of liquids used for this purpose were not reported (Holdstock, 1986).

Since the time the landfill was closed in 1967, the LEHR expanded its facilities to include two buildings, known as the Geriatrics Buildings, which were constructed on concrete slabs. Also, four rows of dog pens were built on top of the fill area. A portion of the landfill remains as open land. Gravel has been placed over portions of the area, presumably from storage of clean gravel or from disposal of gravel taken out of the dog pens.

<u>Trash Pits</u>

According to a former LEHR employee, debris and general trash generated by the laboratory were placed in small pits located throughout the facility. The specific location of these pits is unknown, but predominantly they were on the southern border and in the southwest corner of the property. Occasionally, nonradioactive animal carcasses were disposed of in the pits. Feces from the dogs in outdoor pens were routinely collected, placed in a pit, and covered with lime. Also, the remaining portions of batches of a chlordane/water mixture or a chlordane/kerosene mixture, used to control flea infestation on the dogs and in their pens, were believed to be dumped into these pits. Also, the spent chlordane mixture may have been dumped in the dog pens.

4.5.1.5 Spills and Other Potential Releases

In the background information for the LEHR facility, there are no reports of chemical spills or accidental releases of long-life radioactive materials. One area of the laboratory was used in the past for product chemical storage and dispensing where spills may have occurred. This area is located in the southwest corner of the site. Products were stored beneath and/or beside an open-sided wooden shed. Chemicals used in sufficient quantity to be purchased in bulk reportedly include acetone, ethyl alcohol, formaldehyde, and kerosene and other miscellaneous solvents. Based on historical aerial photographs, this area was used for approximately 10 to 15 years. This area is currently inactive.

4.5.1.6 Miscellaneous

On the southwest corner of the LEHR facility, a tank truck is stored that was used to hold sludge from the Imhoff treatment system. U.C. Davis tested the hose inlet of the tank and confirmed that it was contaminated with strontium-90. The concentration of strontium-90 was reported to be 6.22 x 10^{-4} micrograms per gram (µg/g), with a measured radiation field approximately five times background. The inside of the tank was not sampled; therefore, the results of the one sample may not be representative of the entire tank truck according to the report (Owen, 1987d). No steps have been taken to decontaminate the truck and the LEHR has no future plans to use the tanker. At least one compartment in the truck was noted as containing liquid.

Another miscellaneous inactive waste site is located along the banks of the levee adjacent to Putah Creek. In the past, the laboratory disposed of inert materials, such as dirt, wood, and concrete debris, along the levee. Reportedly, no hazardous or radioactive waste was placed along the levee.

4.5.1.7 Off-Site Waste Disposal Areas

The LEHR facility was responsible for conducting two experiments on University-owned property known as the Hopland Field Station. One experiment was conducted in 1965 and the other in 1968, both involving radioisotope injections into deer and sheep. A total of 60 animals, all of which were sacrificed, were subjects in the experiments. The animals lived 30 days after the radionuclide injections in the 1965 project and between 24 hours to 8 days after the injections in the 1968 project. The animals' excreta and bedding material were buried at the field station. According to U.C. Davis personnel, the 36 animals used in the 1965 experiment were buried at the Hopland Field Station, while the 24 animals used in the 1968 experiment were buried on the U.C. Davis campus, presumably in the two trenches with no numerical designation at the LEHR facility (see related discussion in Section 4.5.1.3) (Owen, 1987b).

The following lists the isotopes, the total quantity used, and the decay-corrected value as of December 1987 (Owen, 1987b). The decay-corrected value is provided as a conservative estimate of the radioactive inventory possibly disposed of at the field station, assuming that none of the material was metabolized by the animals and instead that all of the inventory was buried.

Isotope	Original Quantity	Decay-corrected Value
1965 Project		
Ca-45	4.0 mCi	<1 pCi
Sr-85	0.5 mCi	<1 pCi
K-42	0.2 mCi	<1 pCi
P-32	2.0 mCi	<1 pCi
Cs-137	0.5 mCi	0.32 mCi
S-35	4.0 mCi	<1 pCi
1968 Project		
I-131	0.5 mCi	<1 pCi
Cs-137	0.5 mCi	0.32 mCi
Cs-132	0.5 mCi	<1 pCi

The radioactive waste disposal procedure at the time required that a minimum of 4 feet of cover be placed over the wastes. There are no records of either experiment to substantiate whether this procedure was followed.

In August 1987, personnel from U.C. Davis EH&S visited the Hopland Field Station and interviewed a caretaker who was employed at the time the experiments took place. Two radioactive waste burial areas were identified during this visit, one approximately 15 feet by 12 feet and the other 6 feet by 6 feet. The signs marking the disposal areas were found to be deteriorating; therefore, U.C. Davis took action to replace them. The Hopland Field Station continues to be operated by the University, and access to the area is controlled (Owen, 1987b).

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 groundwater contamination from radioactive and chemical/sanitary waste burial sites. Groundwater may potentially be contaminated as a result of approximately 80 radioactive and chemical/sanitary waste burial sites at the LEHR facility. Additional areas of unknown acreage have been used as general trash/dump sites which may also contain toxic substances and pose a threat to groundwater.

   The radioactive and chemical/sanitary waste burial sites, which include unlined trenches, holes, and pits, are located on the southern border and mid-portion of the present-day laboratory property. The disposal sites are approximately 10 feet deep and are covered with native soil and gravel that was used (or intended to be used) in the dog pens at the LEHR. The number of burial sites and the general waste type buried, based on existing records and Survey interviews with past and present LEHR/U.C. Davis employees, are presented below:

Description	Number Identified	Waste Type		
		Radioactive	Chemical	Sanitary
Trenches	19	X		
Holes	49	X		
Pits	12		X	X
TOTAL	80			

In addition to these 80 known sites, a portion of the LEHR facility was used in the 1940s and possibly in the early 1950s as a general trash/dump site by the U.C. Davis. The exact location and acreage involved in this early dump site are unknown, but generally the dump was located in the area of the Cobalt-60 Irradiation Field and on the southern border. Also, there are some reports of small trash pits placed indiscriminately around the southern end of the laboratory that were used for fecal wastes, some animal carcasses, and possibly the residue from a chlordane/water or chlordane/kerosene mixture used to control fleas on the dogs and in their pens.

Inventories of the radioactive wastes disposed of on the LEHR between 1956 and 1974 are incomplete. Using the reported dimensions of the waste trenches and holes, the estimated total radioactive waste volume is 30,150 cubic feet. Records of the types and quantity of radioactivity were maintained for the 49 holes, which comprise only 10 percent of the total radioactive waste volume. These records indicate that 26 different radioisotopes were buried in the holes, totaling 1.7 curies. Eight of the isotopes have a sufficiently long half-life that they would be expected to still be present. At the time of disposal, these eight isotopes represented 1.3 curies of the total inventory buried on the site.

Records of the chemical wastes disposed of at the LEHR in the 12 identified pits are similarly incomplete. The wastes were generated by the U.C. Davis campus and largely consisted of residential trash. However, the wastes also included laboratory chemical reagents, flammable liquids, and used petroleum distillates that were burned and/or buried on the site. Some of the liquids disposed of in the pits were not containerized, but rather were poured into the pits to enhance burning. Ash from the campus incinerator and other items that were difficult to incinerate were also disposed of in these pits. According to U.C. Davis reports, the total waste volume buried in the 12 pits is 520,000 cubic feet.

Past methods used for radioactive and chemical waste disposal at the LEHR afford no substantial protection to shallow groundwater. The waste sites were unlined and covered with 2 to 4 feet of native soil and/or gravel. The disposal of bulk liquids directly into these pits constitutes a potential source of groundwater contamination. Furthermore, rainfall percolation and infiltration may enhance leachate generation from the solid wastes disposed of in these sites and contribute to the migration of contaminants to the groundwater.

During the Sampling and Analysis phase of the Survey, soil gas samples will be collected from the vicinity of the 12 pits and analyzed for volatile organic compounds as an indicator of chemical waste contamination. Also, groundwater samples will be collected from existing monitoring wells and analyzed to determine the presence of radioactive and/or chemical contamination.

2. <u>Potential surface soil contamination from an abandoned dump</u>. An abandoned dump located in the Cobalt-60 Irradiation Field may be a potential source of surface soil contamination. Although the types of wastes disposed of at this dump were not recorded, they were presumably largely trash with some campus laboratory wastes.

Portions of the LEHR facility were used in the 1940s as a dump site by U.C. Davis for waste generated by the campus. The extent of the landfill is unknown, but according to notes on a 1958 engineering drawing, the area included the present-day Cobalt-60 Irradiation Field and some of the southern border. One report from a former U.C. Davis employee suggests that a trash dumpster filled with waste chemical bottles from a campus laboratory was disposed of at this dump site. Also, U.C. Davis personnel speculate that sludge from the old STP may have been disposed of at this dump. Members of the Survey team observed broken glass, bottle caps, and a bottle on the surface of the Cobalt-60 Irradiation Field, all of which are indications of a burial site. Periodic tilling to reduce weed growth may be a contributing factor to possible surface exposure of wastes potentially buried at this site.

During the Sampling and Analysis phase of the Survey, surface soil samples will be collected from the Cobalt-60 Irradiation Field and analyzed to determine whether contaminants are present. Also, soil gas samples will be collected and analyzed for volatile organic compounds as an indicator of further subsurface burial of wastes.

3. <u>Potential groundwater contamination from inactive liquid waste disposal sites</u>. The Imhoff tanks, the radium-226 septic tanks, and the inactive domestic septic tanks and associated leach fields are potential sources of groundwater contamination with strontium-90, radium, chemical and other radiological substances.

The Imhoff tanks and radium-226 septic tanks contain sludge that is radioactively contaminated. The sludge in the Imhoff tanks may contain strontium-90, plutonium-241, americium-241, and ytterbium-169 from past discharges to the treatment system. In addition, the Imhoff Building was used as a storage area for containers of radioactive and hazardous chemical wastes generated throughout the LEHR. Spills may have occurred at this storage area and accidentally entered the Imhoff tanks. This could result in a "mixed" waste (i.e., waste containing both hazardous chemical and radioactive substances), and would constitute an additional concern for U.C. Davis and DOE regarding disposal of the wastes once the decontamination and decommissioning (D&D) efforts at the LEHR are under way. Furthermore, these chemical and radioactive substances may have been discharged to the leach field east of the Imhoff Building and may leach hazardous constituents to the groundwater. An accident in June 1987 resulted in up to 3,000 gallons of deionized water being discharged inside the Imhoff Building. Some of this water entered the subsurface tanks, and may have introduced other contaminants from the Imhoff Building floor to the tanks. Wastes in the Imhoff system have never been analyzed for nonradioactive (chemical) constituents.

Although the deliberate discharge to the Imhoff treatment system has ceased, substances may still be discharged to the leach field. A trickle of water from an unknown source still enters the sump of the Imhoff system at a rate estimated at approximately 300 gal/day. Fluctuations in water level in the tanks are noted to occur during periods of heavy rainfall. Stormwater, which accumulates around the building on the northwest side, may also infiltrate to the tanks. No leak-testing of the tanks has ever been performed, nor have any mass balances on the overall system been calculated. Thus, the integrity of the system is not known.

The radium septic tanks, seepage pits, and leach line received an estimated 3.827 mCi of radium-226. This radium-226 activity was released to the subsurface soil and therefore is a possible source of groundwater contamination.

The domestic septic tanks received liquid discharges from the laboratories at the LEHR until they were connected to the U.C. Davis STP in 1971. These discharges may have included chemical and radioactive substances, which then would have discharged to subsurface leach fields. Septic Tank Number 7, located east of the Imhoff Building, may still be in operation for wastes from the lavatory in the Imhoff Building. Although all other septic tanks are believed to have been severed and filled with sand, sludges possibly remain in these tanks. The sludges have never been sampled for chemical or radioactive substances. If present, the sludges represent a possible source of groundwater contamination should the integrity of the tanks be poor.

4.5.2.4 Category IV

None

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APPENDIX A

SURVEY PARTICIPANTS

LEHR at U.C. Davis
Survey Participants
November 16-20, 1987

<u>DOE</u>

Team Leaders	V. Fayne
	L. Weiner
Assistant Team Leader	M. Kleinrock
Operations Office Representative	M. Gonzalez

<u>NUS Corporation</u>

Coordinator/Inactive Waste Sites	J. Clay
Air	T. Koss
Surface Water	M. Hiavacik
Hydrogeology	R. Germeroth
Toxic and Chemical Materials/ QA	D. Olson
Radiation	E. Harr

<u>ICF Technology</u>

Waste Management	L. Hetherington

APPENDIX B

SURVEY PLAN

ENVIRONMENTAL SURVEY
UNIVERSITY OF CALIFORNIA AT DAVIS
LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH
November 16 through 20, 1987
Davis, 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 Laboratory for Energy-Related Health Research (LEHR) is operated by the University of California (U.C.) and is located at the U.C. Davis campus. This Survey will address the LEHR facility activities and other facilities on the U.C. Davis campus that receive and/or treat wastes generated by LEHR.

The Environmental Survey at the U.C. Davis, LEHR facility will be managed by DOE Team Leader Vincent Fayne and Assistant Team Leader, Michael Kleinrock. William Holman 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: Mara Hlavacik, NUS Corporation

Waste Management: Liane Hetherington, ICF Technology

Inactive Waste Sites/Releases: Jennifer Clay, NUS Corporation

Hydrogeology/Drinking Water: Robert Germeroth, NUS Corporation

QA/Toxic & Chemical Materials: David Olson, NUS Corporation

2.1 Pre-Survey Activities

Survey team members began reviewing the U.C. Davis LEHR facility general environmental documents and reports in August 1987. Mr. Fayne and former Assistant Team Leader, Mr. Mark Smith, along with Ms. Clay and Ms. Hlavacik conducted a pre-Survey site visit on October 5-8, 1987 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 August 14, 1987 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 State of California Department of Health Services and the Solano County Environmental Management Department on October 8, 1987 to review environmental issues and to explain the purpose and scope of the Survey. EPA Region 9 was contacted by telephone to solicit their opinion on the environmental status of LEHR. These discussions identified issues of Federal, state and county governmental concern on which the Survey team will focus.

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 November 16-20, 1987 at the U.C. Davis LEHR facility. The agenda is a 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 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

Based on available site environmental information and the results of the on-site Survey activities, the Sampling and Analysis (S&A) phase of the Survey process will be implemented approximately 14 weeks after completion of the Survey. This effort will have a 2-3 week duration and will be conducted by the Idaho National Engineering Laboratory (INEL). Results of the S&A effort will be transmitted to the Survey Team Leader for incorporation into the Interim Report. If data are determined to be reportable pursuant to regulatory requirements, they will be immediately provided to SAN.

TABLE 1
LEHR ON-SITE SURVEY AGENDA

Week of 11/16/87	Air	Radiation	Surface Water	Waste Management	Inactive Waste Sites/Releases	Hydrogeology/Drinking Water	QA/TSCA
Monday AM	Site Briefing and Tour	Site Briefing and Tour	Site Briefing and Tour	Site Briefing and Tour	Site Briefing and Tour	Site Briefing and Tour	Site Briefing and Tour
PM	Visit TPHR, Cell Bio Lab Geriatrics, Sm. Animal, Co 60 Aux Bldgs	Visit Main Lab, AH 1, AH-2, Clinical Path., Spec. & Feed, Shop Offices, Equip Wash Bldgs	Observe surface water/NPDES sampling, Putah Creek outfall(s), gauging station, and visit Main Laboratory	Review LEHR waste documentation, meet with U.C. Davis Waste Removal Programs representatives and review documentation	Visit "campus" trenches, southern border trench/pit area, southwestern corner trench area, dog pens, gravel disposal areas, chlordane issue	Observe groundwater sampling, review drinking water supplies and irrigation water uses	Review LEHR waste documentation, meet with U.C. Davis Waste Removal Programs representatives and review documentation
Tuesday AM	Visit Imhoff system, Ra 226 leach field and Cellular Biology Laboratory	Overview of Imhoff system, leach field and radium injection wells. Particular attention to total curies processed and time periods used	Visit AH-1/Imhoff system, AH-2/septic tanks/seepage pits/leach line, Path Lab, Clinical Medicine, Specimen and Feed Building	Visit Main Laboratory, Cellular Biology Laboratory and Chemical Storage Building	Visit Imhoff system, Sr 90 leach field, Ra 226 tanks and leach field, and Equipment Wash Area	Visit Imhoff leach field, Ra 226 tanks and leach field, deep well locations, and abandoned well location	Visit Main Laboratory, Cellular Biology Laboratory and Chemical Storage Building
PM	Visit TPHR, diesel generator, Small Animal Quarters and Shop	Overview of Environmental Monitoring program. Particular attention to site selection criteria, location reviews, analyses, QC and dose calculations and models used	Visit Wash down Building, dog pens, Small Animal Quarters, Geriatrics, septic tanks	Visit TPHR, Clinical Pathology Laboratory, Shop, and other buildings	Visit equipment storage areas, past and active solvent/chemical storage, and walk site perimeter	Observe monitor well installation, review boring logs and as-built drawings, visit A&E Group - U.C. Davis	Visit TPHR, Clinical Pathology Laboratory, Shop and other buildings
Wednesday AM	Visit incinerator used by LEHR on the U.C. Davis Campus, dog pen areas, cobalt irradiator, and radioactive waste burial areas. Preparation of Sampling and Analysis Requests	Visit incinerator used by LEHR on the U.C. Davis Campus, dog pen areas and cobalt irradiator facility. Visit radioactive waste burial areas with particular attention to total curies disposed and time periods used. Inspect environmental monitoring locations. Preparation of S&A Requests	Visit U.C. Davis wastewater treatment plant, review of operating manual/records, NPDES monitoring/noncompliance reports, preparation of Sampling and Analysis Requests	Visit radioactive waste disposal trenches and pits (DOE and U.C. Davis), dog pens and gravel disposal areas, preparation of Sampling and Analysis Requests	Visit main campus site, briefing on Hopland Field Station, review Spill and/or Unusual Occurence Reports, S&A Request Form Preparation	Visit radioactive waste disposal trenches and pits (DOE and U.C. Davis), dog pens and gravel disposal areas, and preparation of S&A Request Forms	Tour of PCB Equipment, pesticide/herbicide storage areas, bulk chemical storage tanks, buildings for presence of asbestos, preparation of Sampling and Analysis Requests
PM	Sampling and Analysis Meeting	Sampling and Analysis Meeting	Sampling and Analysis Meeting	Sampling and Analysis Meeting	Sampling and Analysis Meeting	Sampling and Analysis Meeting	Sampling and Analysis Meeting
Thursday All Day	Pre Closeout Meeting with Survey Team Leader, follow up activities and document review	Pre Closeout Meeting with Survey Team Leader, followup activities and document review	Pre Closeout Meeting with Survey Team Leader, review SPCC Tanks, stormwater management, document review (SPCC, misc wastewater sources/followup)	Pre Closeout Meeting with Survey Team Leader, followup activities and document review	Pre Closeout Meeting with Survey Team Leader	Pre Closeout Meeting with Survey Team Leader and tour of area outside of site boundaries, including Putah Creek	Pre Closeout Meeting with Survey Team Leaders and site tour with Sampling and Analysis Team
Friday	Closeout Meeting	Closeout Meeting	Closeout Meeting	Closeout Meeting	Closeout Meeting	Closeout Meeting	Closeout Meeting

TABLE 2

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH AREAS OF INTEREST FOR TECHNICAL SPECIALISTS

AIR	
Ted Koss	Meteorology Local Air Quality Data 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 - Rad Laboratory Analysis - Rad Radioactive Waste
SURFACE WATER	
Mara Hlavacik	Effluent Sources Wastewater (Process and Sanitary Treatment Facilities) Environmental Monitoring-Water Cooling Water System Drinking Water Distribution Stormwater Management Spill Prevention, Control and Countermeasure Plan
WASTE MANAGEMENT	
Liane Hetherington	Hazardous Waste Radioactive Waste Non-Hazardous Solid Waste Underground Storage Tanks RCRA/Solid Waste Permits Mixed Waste
INACTIVE WASTE SITES/RELEASES	
Jennifer Clay	Characterization Studies Remediation Work Past Waste Site Locations Spill/Accident Locations Former Research Locations

TABLE 2 (Continued)

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH
AREAS FOR INTEREST FOR TECHNICAL SPECIALISTS

HYDROGEOLOGY/DRINKING WATER	
Robert Germeroth	Waste Storage and Disposal Sites (Past and Active) Spill/Accident Locations Regional Geology and Groundwater Well Inventory and Construction (drinking water supplies, irrigation, private and monitoring wells) Groundwater Monitoring Program and Studies
QUALITY ASSURANCE	
David Olson	Environmental Sampling Program Environmental Analytical Program Data Management and Handling QA Program Overview
TOXIC AND CHEMICALS MATERIALS	
David Olson	Process Chemicals and Substances Inventory Asbestos Removal and Disposal PCBs In-Service, Storage, and Disposal Pesticide Use, Storage, and Disposal Warehousing and Storage Tanks for Process Chemicals

2.4 Conclusions and Reporting on the Survey

A closeout briefing will be conducted at 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 LEHR. Within 10 weeks of the availability of the analytical results from the Sampling and Analysis phase of the Survey, an Interim Report will be completed.

3.0 AIR

3.1 Issue Identification

The radioactive and regulated/hazardous air-related Survey activities involve an assessment of the plant-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 emissions of radionuclides and toxic pollutants, and potential emissions of acid fumes, organics, and volatile hydrocarbons (VOCs). Operational and procedural practices associated with emission controls and emissions 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 investigated.

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, and other relevant documents to identify significant sources of air emissions. Following the document review will be the physical inspection of significant processes, control and monitoring equipment, and potential fugitive sources. The Survey will identify air contaminants from significant processes and fugitive sources at the laboratory, identify and evaluate the existing control equipment for the 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:

- Emissions and emission controls associated with "work for others";

- Identification of carcinogens and emissions controls at the Toxic Pollutant Health Research Laboratory;

- Potential for environmental releases and residual contamination from the recent americium/plutonium project; and

- Vent and fugitive airborne releases of radionuclides, including potential for accidental releases.

3.2 Records Required

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

- Source and emissions inventories for both radiological and regulated/hazardous emission sources and chemical inventory lists;

- Description of current air contaminant-producing operations (flow diagrams, narratives, and sketches);

- Copies of air permits;

- Local ambient air quality data for both radiological and criteria pollutants (e.g., ozone);

- Identification of significant fugitive/accidental release points;

- Ambient air dispersion and dose calculations;

- Descriptive documentation on existing add-on emission controls and ventilation system drawings;

- Operating, testing, and maintenance procedures for control equipment;

- Correspondence between LEHR and regulatory agencies related to air/radiological issues;

- Reports on accidental releases/unusual occurrences relating to radiological and regulated/hazardous and toxic airborne releases; and

- Radiological stack monitoring/sampling program procedures/documentation, including:

  - Calibration procedures and records
  - Stack monitoring/sampling data
  - Laboratory procedures and quality assurance.

4.0 RADIATION

4.1 Issue Identification

The radiological aspects of the Environmental Survey will involve identification of the species and quantities of radioactive materials processed at the facility since its inception and determination of whether hazardous quantities of those materials could or do currently exist. If radionuclides other than radium-226 and strontium-90 have been used, information concerning the past waste streams and atmospheric effluents will be collected, and the possibility of hazardous quantities remaining will be examined.

If current practice is representative of past experience, the Environmental 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. Because of overlaps, the radiological assessment will be coordinated with the air, surface water, waste (CERCLA/RCRA), hydrogeology, and quality assurance specialists.

The assessment 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:

- Documentation on occupancy relating to cobalt irradiator facility exposures;
- Radioactive solid waste including mixed waste management practices, and storage and disposal methods;
- Past and present radiological releases to the on-site leach fields;
- Treatment of liquid radioactive wastes through the Imhoff sewage system;
- Past radiological releases to the injection wells;
- TLD monitoring of the cobalt irradiator; and
- Past animal waste removal practices from dog pen areas.

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
  - Overall effluent monitoring manual

- Overall 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 and 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; and
- Description of dose calculation programs.

5.0 SURFACE WATER

5.1 Issue Identification

The Surface Water specialty area will focus on the discharge of chemical and/or radioactive-contaminated wastewaters (Sr-90) from Building AH-1 to the on-site (Imhoff) treatment system and associated leach fields; the discharge of radioactive wastewater (Ra-226) from Building AH-2 to septic tanks and injection wells; and the discharges from LEHR to the U.C. Davis sewage treatment plant. The control of surface drainage/stormwater on the LEHR facility will also be evaluated with respect to contamination via overland flow through areas of potential toxic contamination or by cross-connection of industrial process discharges with stormwater collection drains. In reviewing wastewater disposal methods, emphasis will be placed on current, as well as historical, sources of wastewater generation to evaluate toxic chemical and radioactive contaminants discharged and their fate, as well as the ultimate disposal of any sludge associated with treatment.

In addition, the Survey will review the effect of prior operations on naturally - occurring surface waters, springs, and/or seeps, such as Putah Creek. These evaluations will be performed in conjunction with the inactive wastes sites and hydrogeology portions of the Survey.

Another area of investigation will be the adequacy of spill prevention, control, and countermeasure procedures for any above-ground storage of petroleum products and hazardous substances that have the potential to enter surface waters (directly or via sewers) if spills or tank ruptures should occur. This effort will be coordinated with the Waste Management and the Toxic and Chemical Materials specialists.

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

- Wastewater treatment sludge from the U.C. Davis sewage treatment plant, its potential for containing toxic substances from LEHR, results of sludge analyses, and ultimate handling;

- Cross-connections between industrial, sanitary, and stormwater sewer systems, specifically, the potential discharge of industrial wastewater into the U.C. Davis sewage treatment system;

- Current or past potential discharges of toxic chemical and/or radiological materials to subsurface disposal systems, including septic tanks and leach fields;

- Historic discharges to and operation of the Imhoff wastewater treatment system for Animal Hospital (AH)-1.

- Historic discharge and operation/problems of septic tanks, injection wells/seepage pits, and leach lines associated with wastewaters from Building AH-2;

- Methods of collection, treatment and disposal of wastes from outdoor dog pens and indoor dog cages (contaminated urine and feces) and any wash-down of dog pens/cages;

- Methods and location of gravel washing from dog pens; and

- Potential discharge of toxic and hazardous materials, including radionuclides, into Putah Creek.

5.2 Records Required

Records that should be available to obtain information during the on-site visit include:

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

- Information submitted by LEHR to U.C. Davis regarding wastewater sampling and analysis data;

- Information pertaining to periodic environmental monitoring of nearby surface waters;

- Correspondence with regulatory agencies regarding wastewater discharges from LEHR and U.C. Davis;

- Available information regarding NPDES permits/compliance issues;

- Analytical data on influent process water and on any wells, springs or seeps on LEHR property that are available;

- Past wastewater treatability or characterization studies;

- Spill prevention, control, and countermeasure (SPCC) plans, data used in their preparation, and any notifications or reports on past spills;

- Identification of flood-prone regions in the area of the LEHR 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 LEHR (e.g., public drinking water intakes, recreational uses, etc);

- Accidental release or unusual occurrence reports that may relate to potential past discharges to the wastewater systems or stormwater system;

- List and drawings of current and abandoned septic tanks and leach fields;

- Operational procedures of the Imhoff system;

- Summary of major building missions over time (current missions do not necessarily reflect activities conducted in the 1950s, 1960s and 1970s);

- Detailed topographic maps of the LEHR facility and surrounding area, and information pertaining to former/altered drainage pathways on-site;

- Historical overview of LEHR water treatment operations, including any on-site and/or off-site (i.e., U.C. Davis) facilities utilized; and

- Identification of on-site and off-site surface water sampling locations, including the gauging station and NPDES outfall to Putah Creek.

6.0 WASTE MANAGEMENT

6.1 Issue Identification

The waste management review will focus on the identification of hazardous waste, solid waste, radioactive waste, and mixed waste generation, storage, treatment, and off-site disposal. Among the areas at which hazardous wastes are expected are the storage building and the Toxic Pollutant Health Research (TPHR) laboratory, as well as the various research laboratories and the Clinical Pathology Laboratory. Radioactive wastes are expected in the animal buildings, the Imhoff treatment facility, the Main Laboratory, and in small quantities in the research laboratories. Solid wastes are likely to be generated in virtually any building or area at LEHR. The Survey will assess the extent to which mixed wastes are generated and handled in different facilities at LEHR, and will evaluate the LEHR and U.C. Davis hazardous and radioactive waste management activities with respect to prevention of unauthorized releases to the environment. The U.C. Davis hazardous waste permit status will be reviewed and evaluated. In addition, records of off-site waste management will be examined to verify that all TSDFs operate in an environmentally sound manner. Solid waste management units, operating and inactive, will be identified and assessed as appropriate.

The waste management review will be coordinated with the air, toxic and chemical materials, surface water/drinking water, and inactive waste sites/releases investigations to help identify possible releases. The LEHR facilities will be examined to determine the points at which hazardous, non-hazardous, and radioactive wastes are generated, the extent to which these wastes are mixed prior to disposal, on-site storage locations and periods, on-site treatment operations, currently used disposal facilities, and historical waste management practices.

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

- Locations of hazardous waste generation;
- Storage locations and periods (including lab packs);

- Disposal and storage of animal carcasses;
- Off-site hazardous waste management procedures;
- Solid waste disposal procedures and waste segregation practices;
- Radioactive waste generation, storage, and accumulation;
- Mixing, current and past, of hazardous with radioactive waste;
- Clarification of past waste management practices, both on- and off-site; and
- Storage and disposal of salvage and scrap materials, including asbestos removed during building renovation.

6.2 Records Required

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

- U.C. Davis hazardous waste permits and permit applications;
- Manifests recording the off-site disposition of all hazardous wastes;
- Records documenting the off-site disposition of all radioactive wastes;
- Waste inventory and waste generation documentation;
- Inspection documentation;
- Standard procedures used by the U.C. Davis campus waste removal system;
- Any enforcement action or violation documentation;

- Waste characterization or sampling data, if available; and

- An inventory of reagents and chemicals remaining in storage.

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.

Information on potential or documented disposal sites will be examined to better assess nvironmental contamination from inactive waste sites. Since groundwater contamination is often a result of buried waste, the CERCLA/SARA portion of the Survey effort will be closely coordinated with the hydrogeological portion of the Survey to document these waste sources. Furthermore, past wastewater treatment activities at the site will be evaluated to aid in determining the source(s) of any present or potential environmental contamination. Information pertaining to stormwater and surface drainage or unknown/unpermitted subsurface disposal of waste that may form a migration pathway will be obtained. A determination will also 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.

Several areas of concern have been identified during a review of available documentation. Major areas of investigation include:

- Strontium-90 leach field associated with the Imhoff Waste Treatment Facility;

- Radium-226 tanks and leach field associated with Animal Hospital (AH)-2;
- Southwestern corner of LEHR where an unspecified number of shallow trenches were used for waste disposal;
- Past solvent/chemical storage and dispensing areas;
- Residual contamination associated with the dog pens, including gravel disposal areas;
- Trenches and pits used for waste disposal on the southern border of LEHR and the eastern portion of the facility;
- Past equipment decontamination, washing, and/or maintenance areas;
- Open storage areas for surplus equipment and parts; and
- Past spill or release incidents that may have resulted in residual contamination.

Other possible areas of investigation include:

- Existing and former facilities that have handled hazardous, mixed, and low-level radioactive wastes;
- Areas where past undocumented disposal may have occurred;
- Areas where leaks, spills, or inadvertent disposal may have created ongoing sources of contamination of traceable plumes of surface or subsurface contamination; and
- Additional past waste disposal areas not previously identified.

Information received during the pre-Survey visit indicated that DOE-sponsored activities were conducted at the Hopland Field Station. Information on this field station and any others used by LEHR for DOE projects should be made available to ensure that any potential CERCLA/SARA issues are addressed for these locations.

7.2 Records Required

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

- 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/DRINKING WATER

8.1 Issue Identification

The preliminary review of the documents supplied for the U.C. Davis LEHR 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 or the groundwater regime. Wastewater containing radionuclides from buildings AH-1 and AH-2 had been routinely discharged into leaching fields and cesspools adjacent to the Imhoff Building. Wash-down water from outdoor dog pens has been allowed to seep into the ground. Large quantities of pesticides have been used in the past to control insect infestation in dogs housed in these pens and in the gravel beneath the pens. Additionally, urine and feces of these dogs contained Sr-90 and Ra-226. Radioactive wastes have been buried in trenches and pits in a number of locations on the site.

The groundwater monitoring system currently being installed by Wahler Associates will be evaluated to assess whether the system is adequate to characterize the environmental impacts of past and present operations at LEHR. The reliability, construction and placement of groundwater monitoring wells will be examined to gain a better understanding of the geology 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 the shallow or "A" aquifer. In addition, information will be reviewed on the regional geology and data will be collected for the drinking water, irrigation, and private wells located in the vicinity of the LEHR facility.

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

- Imhoff leach fields;
- Ra-226 seepage pits and leach line;
- "Deep Well" locations - Rockwell Report - 1984;
- Sr-90 trench area;
- Campus radioactive waste trenches;
- Dog pens and gravel disposal area;
- Abandoned well in shop area; and
- Chemical storage and dispensing areas.

8.2 Records Required

The following documents should be available for on-site review. The first six documents listed below should be made available for review on the first day of the Survey.

- Department of Water Resources (DWR), 1979, "Well Qualification Report for the Yolo County Portion of the Sacramento Valley Ground Water Basin, Basin No. 5-21;

- DWR, 1980, Map - "Lines of Equal Elevation of Water in Wells in Lower Sacramento Valley and San Joaquin County, Spring 1980", California;

- Huntington, Gordon L., et. al., 1981, "Soil Survey of the University of California, Davis", UCD Department of Land, Air and Water Resources;

- Wahler Associates, April 1982, "Geologic Report, Cache Creek Aggregate Resources, Yolo County, California";

- Woodward-Clyde Consultants, 1976, Aggregate Extraction in Yolo County, a Study of Impacts and Management of Alternatives: Prepared for Aggregate Resources Advisory Committee, County of Yolo Planning Department;

- Originals of "e" logs and boring logs for two "Deep Wells" mentioned in Rockwell International's report - 1984;

- New and recent data and reports on groundwater quality;

- Well sampling procedures;

- Well installation reports, boring logs and as-built drawings;

- Off-site well inventories which include location, depth and length of screened area and owner of the well;

- Historic memos, aerial photographs, and topographic maps; and

- Groundwater work plans.

9.0 QUALITY ASSURANCE (QA)

9.1 Issue Identification

The LEHR facility laboratory QA programs will be reviewed to determine the degree to which site environmental data can be utilized by the Survey. This review will identify environmental data gaps and where the Survey will conduct sampling and analysis. Laboratory protocols covering sampling, analysis, data handling, and report preparation will be reviewed. Tours of the labs will be conducted and any available data from off-site laboratories will be evaluated. The analytical work currently being conducted by Wahler Associates will also be reviewed.

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

- Training records for personnel (laboratory and sampling);
- Equipment and instrument calibration/maintenance;
- 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.

9.2 Records Required

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

- Facility QA manual and implementation guidelines;
- 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);
- Operator and technician training records (laboratory and sampling);
- Instrument maintenance and calibration records (laboratory and sampling); and
- Laboratory and sampling calculations, workbooks, 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 use, handling, and disposal of hazardous chemicals, polychlorinated biphenyls (PCBs), asbestos, and pesticides at the LEHR facility.

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

- The toxic substances used at the facility and the procedure used to track, control, and manage these materials;
- The PCB-containing equipment, fluids, and contaminated items currently used or stored at the facility;
- The procedures used to remove and dispose of PCB containing items;
- The buildings that contain asbestos insulation or asbestos-containing materials;
- The pesticides used on-site including annual quantities applied and storage and disposal practices; and
- Bulk chemical storage tanks.

10.2 Records Required

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

- Inventory of toxic materials used by LEHR;
- Material Safety Data Sheets;

- Standard Operating Procedures (SOPs) covering the management of toxic materials, i.e., purchasing, labeling, tracking, and hazard communication program;

- Data on the toxicity (health effects) of any hazardous material manufactured on site;

- Procedures covering the treatment, storage, and disposal operations for toxic materials;

- Annual PCB inventory reports and a current inventory of PCB-containing equipment, fluids, and contaminated items used or stored at the facility;

- PCB handling, storage, and disposal procedures as well as storage and disposal records;

- List of buildings that contain asbestos;

- Asbestos disposal records including the location of disposal sites;

- SOPs and disposal records for the handling and storage of pesticides/herbicides (include a current inventory); and

- Location and background information on bulk chemical storage tanks.

APPENDIX C

SUPPORTING INFORMATION FOR SECTION 4.1, WASTE MANAGEMENT

TABLE C-1

SOURCES OF HAZARDOUS WASTES AT THE LEHR FACILITY

Building Number	Building Name	Room Number	Waste Material	Quantity Stored	Storage Conditions
H-213	Office and Laboratories	106	Methanol/water mix	~16 gal	Segregated, labeled, secondary containment not required.
		112	Discarded samples and reagents - various strong and weak acids, biological growth media and nutrients	Undetermined - hundreds of 25-mL to 1-L nalgene and plastic bottles in 12 large cardboard boxes	No segregation of potential incompatibles; incompletely labeled; no secondary containment; not all bottles stored upright.
		117	Methyl alcohol	Trace in 1-gal bottle	Segregated; labeled; no secondary containment.
		120	Unlabeled green liquid	5 gal	Segregated; no label; no secondary containment.
		123	Hazardous waste glove bag	~10 gal bag	Segregated; labeled; in fume hood.
			Wastes - ethyl alcohol, sodium buffer, pumping fluid, propylene oxide, osmium pentoxide, waste fixatives	1 gal each	Not segregated from each other, labeled, no secondary containment.
H-214	Imhoff	322	EDTA Formalin	5 gal 5 gal	Segregated; labeled; no secondary containment. Segregated; labeled; no secondary containment.

TABLE C-1
SOURCES OF HAZARDOUS WASTES AT THE LEHR FACILITY
Page 2

Building Number	Building Name	Room Number	Waste Material	Quantity Stored	Storage Conditions
H-215	Clinical Pathology	437	Histosol	5 gal	Segregated; labeled; no secondary containment.
			Formalin	10 gal	Segregated; labeled; no secondary containment.
H-216	Feed Mix, Specimen Storage	422	Unlabeled bottles	21 pints	Not segregated; not labeled; no secondary containment.
H-212	Shop	North-Side Shed	Expired/unusable paints and thinners	Undetermined; >50 gal	Not segregated; labeled; no secondary containment.
		West-Side Shed	Expired/unusable paints, thinners, caulking, hydraulic fluids	Undetermined; >10 gal	Not segregated; labeled; no secondary containment.
		Shop Yard	Unusable linseed oil	~25 gal	Segregated; labeled; no secondary containment, deteriorating (rusted) storage container.
H-290	Receiving and Business	505	Acid wastes	5 gal	Segregated; labeled; contained.
H-294	Cellular Biology Laboratory	515	Ethyl alcohol	1 gal	Not segregated from soaps, chlorhexidane, etc.; labeled; no secondary containment.
		519	Unlabeled laboratory reagents	<100 mL	Not segregated from regular trash; not labeled; within secondary containment.

TABLE C-1
SOURCES OF HAZARDOUS WASTES AT THE LEHR FACILITY
Page 3

Building Number	Building Name	Room Number	Waste Material	Quantity Stored	Storage Conditions
H-296	Small-Animal Housing Facility	600	Corrosives	5 gal	Segregated; specific chemicals not labeled; no secondary containment.
		North Side, Outdoors	Chemical carcinogens	<5 gal	Segregated; specific chemicals not clearly labeled; secondary containment; drum is rusty and accumulation period is at least several months.
H-299	Toxic Pollutant Health Research Laboratory	709	Acetone	<1 gal	Segregated; labeled; no secondary containment.
		723	Miscellaneous dry chemicals	Undetermined - 13 large cardboard boxes filled with containers of chemicals	Not segregated; labeled; no secondary containment; bottles not stored upright.

Source: Observations during U.C. Davis/LEHR Survey visit, Nov. 16-20, 1987

TABLE C-2

SOURCES OF RADIOACTIVE WASTES AT THE LEHR FACILITY

Building Number	Building Name	Room Number	Waste Material	Quantity Stored	Storage Conditions
H-213	Office and Laboratorres	106	Dry wastes	1 Box	Segregated; isotope not labeled
			Liquid Scintillation Vials	1 Flat	Segregated; isotopes not labeled; contained
			C-14 liquids	5 gal	Segregated; isotope labeled; contained
		110	H-3, P-32, C-14 liquids	25 gal	Segregated; isotopes labeled; not contained
			Dry wastes	2 boxes	Segregated; isotopes not labeled
		110-A	H-3 liquids	5 gal	Segregated; isotopes labeled; contained
H-214	Imhoff Treatment System	Imhoff Tanks	Sr-90, Ra-226 sludge	12,300 gal	Segregated; isotopes labeled; no secondary tank containment system
H-215	Clinical Pathology	435	Unknown radioisotope	5 gal	Segregated; isotope not labeled; contained
H-219	Animal Hospital 1	201	H-3 liquids	15 gal	Segregated; isotopes labeled; contained
			Unknown radioisotope	5 gal	Segregated; isotope not labeled; contained
		202	H-3 liquids	5 gal	Segregated; isotope labeled; contained

TABLE C-2
SOURCES OF RADIOACTIVE WASTES AT THE LEHR FACILITY
Page 2

Bldg. No.	Building Name	Room No.	Waste Material	Quantity Stored	Storage Conditions
H-219 (Cont'd)	Animal Hospital 1 (cont'd)		Dry wastes	3 boxes	Segregated; isotopes labeled on 2 of 3 boxes
		203A, 203B	Carcasses with Sr-90, Ra-226	Up to 1,500 animals	Segregated; isotopes labeled; contained
		203	Rad-contaminated Nalgene bottles (Sr-90, Ra-226)	1 30-gal plastic bag; ~100 bottles	Segregated, isotopes labeled; contained
		209	Dry wastes	1 box	Segregated; isotopes labeled
H-294	Cellular Biology Laboratory	515	S-35 bagged biowastes	1 bucket	Segregated; isotope labeled; contained
			S-35 liquids	5 gal	Segregated; isotope labeled; contained
			Unknown liquids	5 gal	Segregated; isotope not labeled; contained
H-299	Toxic Pollutant Health Research Laboratory	709	C-14 liquids	5 gal	Not segregated; isotopes labeled; not contained
			Liquid scintillation vials	1 flat	Segregated; isotopes not labeled; contained
		715	Am-241/Pu-242 dry waste	2 boxes	Segregated; isotopes labeled
			Pu-241 liquids	5 gal	Segregated; isotopes and chemical matrix labeled; contained

TABLE C-3

OFF-SITE TRANSPORTERS AND TREATMENT, STORAGE, AND DISPOSAL FACILITIES USED BY U.C. DAVIS

Company	Location	Types of U.C. Davis Wastes Managed	EPA ID#
<u>Transporters</u>			
American Environmental Management Corporation	11855 White Rock Road Rancho Cordova, CA 95670	All Wastes	CAD 980884183
Exceltrans, Inc.	7056 Elm Street Benicia, CA 94510	Flammables	CAD 981982663
National Environmental	N/A	Non-flammables	CAD 981438146
R. Coquillette	N/A	Flammables	N/A
<u>Off-Site Treatment, Storage and Disposal Facilities</u>			
Casmalia Resource Site	559 San Ysidro Road P.O. Box 5275 Santa Barbara, CA	Empty Drums, Non-flammables	CAD 020748125
American Environmental Management Corporation (transfer/storage only)	11855 White Rock Road Rancho Cordova, CA 95670	Non-flammables	CAD 980884183
Chemical Waste Management, Inc.	35251 Old Skyline Road P.O. Box 471 Kettleman City, CA 93239	Non-flammables	CAT 000646117
Romic Chemical Corporation	2081 Bay Road E. Palo Alto, CA 94303	Flammables	CAD 009452657
ENSCO/P.S.C.	American Oil Road El Dorado, AR 71730	Flammables	ARD 000404 PCB
Refineries Service	P.O. Box 1171 Patterson, CA 95363	Flammables	N/A
Safety Klean Corporation	2576 Mercantile Drive Rancho Cordova, CA 95670	Flammables	CAT 000613950

Source: UCD, ND; UCD, 1987c

N/A = Not available in U.C. Davis manifests and associated records.

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