U.S. Department of Energy

Oakland Operations Office, Oakland, California

FINAL
ANNUAL SITE ENVIRONMENTAL REPORT
CALENDAR YEAR 1999

for the

LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH
UNIVERSITY OF CALIFORNIA, DAVIS

Submitted to:

United States Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 94612-5208

Prepared by:

Weiss Associates
5801 Christie Avenue, Suite 600
Emeryville, California 94608-1827

September 2000
Rev. 0

DOE Oakland Operations Contract DE-AC03-96SF20686

Weiss Associates
Environmental and Geologic Services

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Approvals Page

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SEP 14 2000

Subject: 1999 Site Environmental Report (SER) for the Laboratory for Energy-Related Health Research (LEHR)

The enclosed 1999 LEHR SER prepared by Weiss Associates (WA) summarizes the environmental protection activities at LEHR for calendar year 1999. SERs are prepared annually for all DOE sites conducting significant environmental activities and are distributed to relevant regulatory agencies and other interested parties.

To the best of my knowledge, the 1999 LEHR SER accurately summarizes results for the 1999 Monitoring Program and Restoration Program at LEHR. This assurance is based upon a thorough review by DOE/OAK and WA, and by documented quality assurance protocols applied to the monitoring and data analysis at LEHR.

The 1999 LEHR SER is also available electronically at http://www.oak.doe.gov/DIVISION/LEHR/document.html. Please provide your comments or suggestions for future versions of the report using the enclosed reader survey form. Additionally, your questions or comments on this report may be made directly to DOE/OAK by contacting Richard Fallejo of the Oakland Environmental Programs Division at (510) 637-1639.

Sincerely,

James T. Davis
Assistant Manager
for Environment and
Nuclear Energy

2 Enclosures

CERTIFICATION OF ACCURACY FOR:

ANNUAL SITE ENVIRONMENTAL REPORT, 1999, FOR LEHR

I certify that the information submitted herein is true, accurate, and complete, based on my familiarity with the information and my inquiry of those individuals immediately responsible for obtaining the information.

Signature: Robert O. Devany Date: 9/15/00
Robert O. Devany, Project Manager

ENVIRONMENTAL REPORT
READER SURVEY

To Our Readers:

Each annual Environmental Report publishes the results of environmental monitoring at the Former Laboratory for Energy-Related Health Research (LEHR) and documents our compliance with environmental regulations. In providing this information, our goal is to give our readership — whether they be regulators, scientists, or the public — a clear accounting of the range of environmental activities we undertake, the methods we employ, and the degree of accuracy of our results.

It is important that the information we provide is easily understood, is of interest, and communicates the Department of Energy's effort to protect human health and the environment. We would like to know from you, our readers, whether we are successful in these goals. Your comments are welcome.

1. Is the technical level ❑ too high? ❑ too low? ❑ uneven? ❑ just right?
2. Is the writing ❑ too concise? ❑ too verbose? ❑ uneven? ❑ just right?

	Yes	No
3. Do the illustrations help you understand the text better?	❑	❑
Are there enough?	❑	❑
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Too many?	❑	❑
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6. Are the data tables of interest?	❑	❑
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Other comments:

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A business reply envelope has been attached for returning these surveys to Weiss Associates, 5801Christie Avenue, Suite 600, Emeryville, CA 94608.

OPTIONAL

Name: _____ Occupation _____

Address: _____

CONTENTS

TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

ASER	Annual Site Environmental Report
bgs	below ground surface
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COC(s)	Constituents of Concern
CRDL	Contract-Required Detection Limit
cu yd	Cubic Yard
CVRWQCB	Central Valley Regional Water Quality Control Board
D&D	Decontamination and Decommissioning
DCG(s)	Derived Concentration Guide(s)
DOE	United States Department of Energy
DTSC	California Department of Toxic Substances Control
EDE	Effective Dose Equivalent
EDPs	Eastern Dog Pens
EE/CA	Engineering Evaluation/Cost Analysis
EHS	Extremely Hazardous Substances
EPA	United States Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know Act
ER/WM	Environmental Restoration/Waste Management
FFA	Federal Facility Agreement
ft	feet
GEPP	General Environmental Protection Program
HSU	Hydrostratigraphic Unit
IRA	interim remedial action
ITEH	Institute for Toxicology and Environmental Health (UC Davis)
LEHR	Laboratory for Energy-Related Health Research
MCL	Maximum Contaminant Level

MDA	Minimum Detectable Activity
MEI	Maximally Exposed Individual
mg/L	milligrams per liter
MOA	Memorandum of Agreement
mrem/yr	millirem per year
MSDS	Material Safety Data Sheets
mSv	milliSievert
MWSF	Mixed Waste Storage Facility
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
PCB	polychlorinated biphenyl
PCD	Putah Creek Downstream
pCi/g	picoCuries per gram
pCi/L	picoCurie per liter
pCi/m^3	picoCurie per cubic meter
PCU	Putah Creek Upstream
PM-10	respirable particulate matter (less than 10 microns)
PNNL	Pacific Northwest National Laboratory
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Removal Action
RBAS	Risk-Based Action Standard
RCRA	Resource Conservation and Recovery Act
rem	Roentgen Equivalent Man
RME	Reasonable Maximum Exposure
RWQCB	Regional Water Quality Control Board
STPO	Wastewater (Sewage) Treatment Plant Outfall
SVOC	semivolatile organic compound
TDS	total dissolved solids

TLD	thermoluminescent dosimeter
UC Davis	University of California at Davis
VOC	volatile organic compound
WDPs	Western Dog Pens
WDR	waste discharge requirement
WRS	Wilcoxon Rank Sum
YSAQMD	Yolo-Solano Air Quality Management District
µg/L	micrograms per liter

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SUMMARY

This Annual Site Environmental Report (ASER) for the Laboratory for Energy-Related Health Research (LEHR) Site (the Site) summarizes 1999 environmental Site monitoring data for air, soil, ground water, surface water, storm water and ambient radiation. The U.S. Department of Energy (DOE) operation of LEHR as a functioning research location ceased in 1989, after the completion of three decades of research on the health effects of low-level radiation exposure (primarily strontium-90 and radium-226), using beagles to simulate effects on human health. During 1999, DOE continued environmental remediation activities at the Site in support of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

Progress of Site Environmental Restoration

Site restoration activities are conducted by DOE and the University of California at Davis (UC Davis) in coordination with the U.S. Environmental Protection Agency (U.S. EPA), the California Department of Toxic Substance Control (DTSC), the Central Valley Regional Water Quality Control Board (CVRWQCB) and the California Department of Health Services.

DOE activities at the Site in 1999 consisted primarily of the Radium/Strontium (Ra/Sr) Treatment Systems Area I Removal Action (RA), shipment of waste generated during the 1998 Southwest Trenches RA and additional soil characterization in the Dog Pens Area. Significant Site restoration progress was made during the year. Ongoing Site monitoring and characterization of air, soil and water were performed to meet data requirements and to evaluate RA options. Significant 1999 activities included:

- ***Federal Facility Agreement:*** A Federal Facility Agreement became effective in December 1999. This agreement will govern cleanup activities and regulatory oversight at the Site, as discussed in more detail in Section 2.
- ***Ra/Sr Treatment Systems Area I RA:*** Approximately 1,276 cubic yards (cu yds) of low-level waste (concrete, cobbles, soil) and 400 cu yds of overburden soil were removed from the Ra/Sr Treatment Systems Area I, located on the western side of the Site. The RA was implemented in two phases: during the first phase of the RA, a Domestic Septic Tank and associated piping, three upper (top ten feet) dry well structures and two leach trenches were removed. The second phase of the Area I RA consisted of defining and removing contamination and structures associated with the lower portions of the dry wells. Confirmation samples were collected at the completion of the excavation activities. Five previously unknown dry well structures unrelated to the Ra/Sr Treatment System were discovered, and the upper structures were removed during this RA.

- ***Waste Disposal:*** Approximately 1,160 cu yds of waste generated during the 1998 Southwest Trenches RA and 0.1 cu yd generated during the Cobalt-60 Field Investigation were disposed off-site at approved facilities.
- ***Eastern Dog Pens (EDPs) Investigation:*** The EDPs Investigation was designed to supplement existing information in the Dog Pens area. Samples were collected from the upper three feet of soil at 43 sample locations that were selected using a random number generator. Concrete curb samples were collected using a concrete coring machine, and gravel samples were collected from soil sampling locations where gravel was present. Radionuclides and other constituents of concern (COCs) were detected at or below the appropriate background levels or risk-based action standards (RBAS).
- ***Western Dog Pens (WDPs) Statistical Analysis:*** WDPs soil analytical data was compared with risk-based soil target levels. These analyses indicated that radionuclides and other COCs are at or below the appropriate risk-based soil target levels.

Overview of 1999 Water Environmental Monitoring Results

The water monitoring program schedule and analyte list were modified slightly in 1999. The revised program focuses on the primary ground water COCs, and shifts the annual sampling event from winter to spring. Two additional ground water monitoring wells were installed, and a new surface water monitoring location was added to the program (Dames & Moore, 2000).

Storm water and surface water samples were collected three times in 1999. The analytic results were consistent with previous years, and no new trends or concerns were identified.

Ground water samples were collected four times, at quarterly intervals. Analytic results were similar to previous years: elevated concentrations of chloroform and associated volatile organic compounds, chromium, total dissolved solids, tritium and carbon-14 are present in Site ground water. However, concentrations of tritium, carbon-14 and chloroform are decreasing in the shallow aquifer, indicating that the UC Davis Interim RA and natural attenuation are containing the contaminant plume.

Overview of 1999 Air Environmental Monitoring Results

The air monitoring program was modified in 1999. The modified program continues monitoring of alpha, beta and radon levels, and provides monitoring of additional compounds before, during and after RAs. Monitoring at off-site station AM-6 has been discontinued, and background information is now monitored at off-site station AM-3.

The results of the radionuclide air monitoring program are similar to previous years. Total alpha and beta activities detected at the Site were similar to off-site background levels. All gamma-emitting radionuclides detected were well below the DOE Derived Concentration Guides (DCGs). The average radon activity detected on-site was lower than the average detectable off-site radon activity and below the DOE DCG of 3.0 picoCuries per Liter (pCi/L).

Radiological Impact Assessment of the LEHR Environmental Restoration Project

The Ra/Sr Treatment Systems Area I RA was the primary focus of DOE environmental activity at the Site in 1999. The removal of waste from this area will reduce the long-term risk of radiological exposure at the Site. The radiological air and ambient data all indicate that the low radionuclide activities detectable at the Site in 1999 are near or below natural background levels, and do not pose a risk to Site workers or the general public.

1. INTRODUCTION

This Annual Site Environmental Report (ASER) describes Calendar Year 1999 U.S. Department of Energy (DOE) Environmental Restoration/Waste Management (ER/WM) activities at the Laboratory for Energy-Related Health Research (LEHR) Site (the Site) at the Univerisity of California at Davis (UC Davis) (Figure 1-1). This report was prepared in accordance with the requirements of DOE Order 5400.1, General Environmental Protection Program (GEPP) and DOE Order 231.1 Environmental Safety and Health Reporting. The purpose of this report is to summarize environmental data, confirm compliance with environmental standards and requirements and highlight significant programs and efforts. This report describes activities conducted by DOE during 1999 in support of the Site environmental restoration efforts, and provides information about the impact of these activities on the public and the environment. The ground water monitoring program, which is performed by UC Davis and includes information important to the overall environmental restoration of the Site, is also briefly summarized. The UC Davis programs discussed in this report are not required follow the requirements of DOE Order 5400.1.

1.1 Site History

The Atomic Energy Commission first sponsored radiological studies on laboratory animals at UC Davis in the early 1950s. Initially situated on the main campus, LEHR was established in 1958 at its present location (Figure 1-1). Research at LEHR through the mid-1980s focused on the health effects from chronic exposures to radionuclides, primarily strontium-90 and radium-226, using beagles to simulate radiation effects on humans. Other related research was conducted at the Site concurrent with these long-term studies. In the early 1970s, a cobalt-60 (Co-60) irradiator facility was constructed at the Site to study the effects on beagles of chronic exposure to gamma radiation.

A campus landfill with two waste burial units, used from the 1940s until the mid-1960s, is located at the Site. Several low-level radioactive waste burial areas are also present at the Site and have been the subject of several RAs conducted since 1998. Campus and LEHR research waste were buried in these areas until 1974, in accordance with regulations in effect at the time.

In 1988, pursuant to a Memorandum of Agreement (MOA) between DOE and the University of California, DOE's Office of Energy Research initiated activities to close out the research program at LEHR. In 1997, a second MOA divided the responsibility for environmental restoration between DOE and UC Davis.

In 1999, a Federal Facility Agreement (FFA) was signed by DOE and regulatory agencies. The FFA will govern clean up activities and regulatory oversight at the Site, as discussed in more detail in Section 2.

1.1.1 Environmental Restoration

The DOE Oakland Operations Office manages the environmental restoration of the DOE-impacted areas of the Site. From October 1989 through February 1990, an interim contract with UC Davis was implemented to begin Site restoration. From 1990 to 1996, Battelle Environmental Management Operations managed the LEHR ER/WM project. In 1996, ER/WM project implementation was transferred to Weiss Associates (Weiss) of Emeryville, California.

In May 1994, the U.S. Environmental Protection Agency (EPA) added the Site to the National Priorities List. A Site Remedial Investigation and Feasibility Study work plan was developed to ensure that investigation and remediation are conducted in accordance with regulatory requirements. Remedial Project Manager meetings are held monthly to evaluate the progress of remediation and identify actions needed to facilitate the process.

Primary DOE restoration/remediation activities which have been or will be performed at the LEHR Site include: soil and ground water characterization, building assessment, decontamination and decommissioning (D&D) of above-ground structures, waste management, chemical and radiological risk assessment, and remediation of contaminated trenches, soil, and underground tanks. Project management, health and safety and quality assurance (QA) are components of all actions undertaken on behalf of DOE.

1.2 Site Description

The Site is a 15-acre parcel owned by the Regents of the University of California. It is 1.5 miles south of the main UC Davis campus in a rural agricultural area (Figure 1-1), and is presently occupied by the UC Davis Institute of Toxicology and Environmental Health (ITEH). Research at ITEH is directed towards toxicology, epidemiology, radiation biology and radiochemistry.

The Site consists of 15 buildings, including a main administration and office building, two animal hospitals, a laboratory and support buildings. Historical use of specific facilities and/or areas at the Site which have impacted the environment are being investigated and remediated. Former facilities include: radioactive waste water treatment systems, an indoor/outdoor Co-60 irradiator, a radioactive waste burial area, animal hospitals and outdoor dog pens. Potential environmental impacts from the inactive campus landfill units and numerous inactive campus low-level radioactive disposal sites (i.e., trenches and holes) used to dispose waste are also being evaluated for remediation by UC Davis. Figure 1-2 shows areas that have potentially impacted the environment at the Site.

1.3 Population Data

1.3.1 Site Population

Currently, the Site is used by UC Davis and DOE to support ongoing research and remediation, respectively. UC Davis ITEH consists of several research facilities on the Site involving approximately 200 university researchers and support staff. ITEH researchers and student assistants have varying schedules and are not all present at the Site at the same time.

The DOE LEHR ER/WM Project is currently managed and staffed by Weiss and its subcontractors. Total LEHR ER/WM Project on-site personnel currently include up to six full-time workers. This number increases to approximately 15 workers when on-site remediation and waste management projects are in progress.

1.3.2 Local Population

The Site is located in a rural area in northeast Solano County just outside of Davis, California. UC Davis has a student population of approximately 25,000 and employs approximately 15,000 full-time faculty and staff. The estimated 1999 population of Davis is approximately 55,000 and the estimated total population of Yolo County is about 150,000. The more densely populated and metropolitan Sacramento area is approximately 12 miles east of the Site. The current population of Sacramento County is about 1,160,000, and approximately 393,000 people live in the city of Sacramento.

1.4 Environmental Setting

The Site is located on a relatively flat plain bordered on the south by Putah Creek. The Site property is very gently sloping and mostly open, with a few trees and bushes. The Site lies outside the 100-year floodplain.

1.4.1 Land Use

The land within a one-mile radius of the Site is owned both privately and by UC Davis. It is used for animal research, agriculture and recreation (fishing and swimming). Privately owned lands to the south and east of the Site are used to produce wheat, tomatoes, corn, barley and oats and include permanent residences. Private property to the south is separated from the Site by the South Fork of Putah Creek, and private property to the east is adjacent to non-LEHR, UC Davis-owned research facilities. The property immediately west, north and south of the Site (Putah Creek Reserve) is owned by UC Davis and is currently used for various types of animal, agricultural and health research.

1.4.2 Hydrogeology

Unconsolidated Pliocene and Pleistocene deposits are the major ground water sources for public and private water supplies in the Sacramento Valley (DWR, 1978). Both unconfined and confined fresh water aquifers are present in these sedimentary deposits in the uppermost 3,000 feet (ft) of the valley subsurface. Ground water generally flows from the valley sides towards the valley axis. In the vicinity of the Site, regional ground water generally flows east from the Coast Ranges toward the Sacramento River (Dames & Moore, 1993).

At various depths beneath the valley floor, fresh water gives way to saline water as a result of entrapment during the deposition of sediments in a marine environment. The depth to the base of fresh water in the Sacramento Valley varies from 400 ft to over 3,000 ft, and is 2,600 to 3,100 ft below ground surface (bgs) in the Davis area (Division of Oil & Gas, 1982).

The results of previous investigations identified five hydrostratigraphic units (HSUs) beneath the Site (Dames & Moore, 1999). The HSUs identified beneath the Site include the vadose zone, HSU-1, HSU-2, HSU-3 and HSU-4. The vadose zone extends from the ground surface to the top of ground water, which has historically ranged from 15 to 55 ft bgs. The vadose zone consists primarily of unsaturated clay and silt with lesser amounts of interbedded sand and gravel. HSU-1 extends from the bottom of the vadose zone to a depth of approximately 76 to 88 ft bgs. This unit is lithologically similar to the vadose zone and consisted primarily of silt and clay, with lesser amounts of sand and gravel. HSU-2 extends from the bottom of HSU-1 to a depth of approximately 114 to 130 ft bgs. This unit is composed primarily of sand in the upper portion of the unit and gravel in the middle to lower portions of the unit. HSU-3, investigated in off-site areas, extends from the bottom of HSU-2 to a depth of about 250 ft bgs and is approximately 120 ft thick. The unit consists primarily of relatively fine-grained sediments varying from very fine-grained sandy silt to clayey silt and silty clay. HSU-4, investigated in off-site areas, extends from the bottom of HSU-3 to a depth of about 282 ft bgs and is approximately 32 ft thick. This unit consists of coarse sand and gravel. Beneath HSU-4, a sharp contact with a bluish, dark gray silt was encountered at 282 ft bgs in wells UCD4-41 and UCD4-43. The bottom of this unit was not penetrated in any of the Site borings (Dames & Moore, 1999).

The uppermost distinct aquifer beneath the Site has been divided into two HSUs (HSU-1 and HSU-2), based on the stratigraphy of the sediments at the Site and the associated ground water flow and contaminant migration characteristics (Dames & Moore, 1994d). Well drillers' logs indicate that a 90-ft-thick clay unit separates HSU-2 from a second aquifer below (Dames & Moore, 1994).

Irrigation water, rainfall and Putah Creek recharge ground water in the vicinity of the Site (Dames & Moore, 1997). The main component of ground water recharge, however, has been identified as irrigation water infiltration (Weiss, 1998f). Ground water pumping associated with agricultural demands is largely responsible for ground water withdrawal. In addition, UC Davis extracts ground water from HSU-2 as part of its interim remedial actions (IRA).

Generally, there is a 20- to 30-ft seasonal fluctuation in the depth-to-ground water beneath the Site caused predominantly by the lack of surface recharge and agricultural pumping in the summer. Vertical gradients vary both temporally and spatially. The magnitude of the vertical gradient is greatest when ground water elevations are rising or falling sharply. Short-term activities

such as local agricultural pumping can produce downward vertical gradients during periods of an otherwise rising water table.

The HSU-1 lateral gradient across the Site typically ranges from 0.01 to 0.04 ft/ft, and the direction of ground water flow is predominantly northeast. Representative values of HSU-1 horizontal hydraulic conductivity are between 1×10^{-4} and 1×10^{-7} centimeters per second (cm/sec) (Dames & Moore, 1999). The lateral gradient across the Site within HSU-2 typically ranges from 0.005 ft/ft to 0.015 ft/ft. The direction of flow appears to be predominantly northeast although it can occasionally be east-southeast. Based on pumping tests, hydraulic conductivity in HSU-2 ranges from 0.26 to 0.43 cm/sec (Dames & Moore 1997).

Ground water in HSU-1, HSU-2 and HSU-4 has been impacted by Site activities. Based on investigations to date (Weiss, 1997d; Weiss, 1999c), significant ground water impact appears to be associated only with the UC Davis disposal areas.

1.4.3 Water Supply and Quality

Ground water in the vicinity of the Site is used for agricultural and domestic supply. Regional ground water quality has been impacted by nitrates, probably from agricultural sources, and by hexavalent chromium, probably from natural sources.

Local ground water is recharged by streams and rivers, and direct infiltration from precipitation and irrigation. At the Site, recharge rates are highest immediately after precipitation events. Within a day after a heavy precipitation event, continuous water level measuring equipment located in monitoring wells near the creek show a significant increase (DOE, 1996).

1.4.4 Sanitary Sewer Systems

The Site discharges its sanitary wastewater to the UC Davis Wastewater Treatment Plant. UC Davis operates the plant under the conditions specified in its National Pollutant Discharge Elimination System (NPDES) permit, granted by the United States Environmental Protection Agency (U.S. EPA) in conjunction with the Central Valley Regional Water Quality Control Board (CVRWQCB).

1.4.5 Storm Drainage System

Storm water runoff at the Site is collected in an underground drainage system. Storm water from the paved area in the west part of the Site and around the southern buildings in the western area is collected in a storm water drainage system. The drainage system flows to the Site storm water lift station (LS-1 on Figure 1-3) and then to an outfall along the west side of the Old Davis Road, where it is discharged to Putah Creek. Storm water in the northwestern area of the Site drains into a ditch along Old Davis Road. Storm water in the eastern and non-paved southern portions of the Site percolates into the soil, except for a section of the former Co-60 Field where dog pens were once

located, and where drainage is connected to the sanitary sewer. Water ponds during heavy rains in some areas of the Site.

1.4.6 Biological Resources

A number of sensitive biological resources were identified in an Ecological Scoping Assessment (Weiss, 1997c), as potentially occurring in the vicinity of the project Site. These species include the Giant Garter Snake, the Northern Harrier, the Coopers Hawk, the California Horned Lark, the Great Egret, the Burrowing Owl and the Valley Elderberry Longhorn Beetle, which lives in elderberry bushes. Although elderberry bushes are present at the Site, a focussed biosurvey (IT Corp., 1998) found no sensitive species actually present on-site and concluded that the on-site elderberry bushes are not currently hosting the Valley Elderberry Longhorn Beetle.

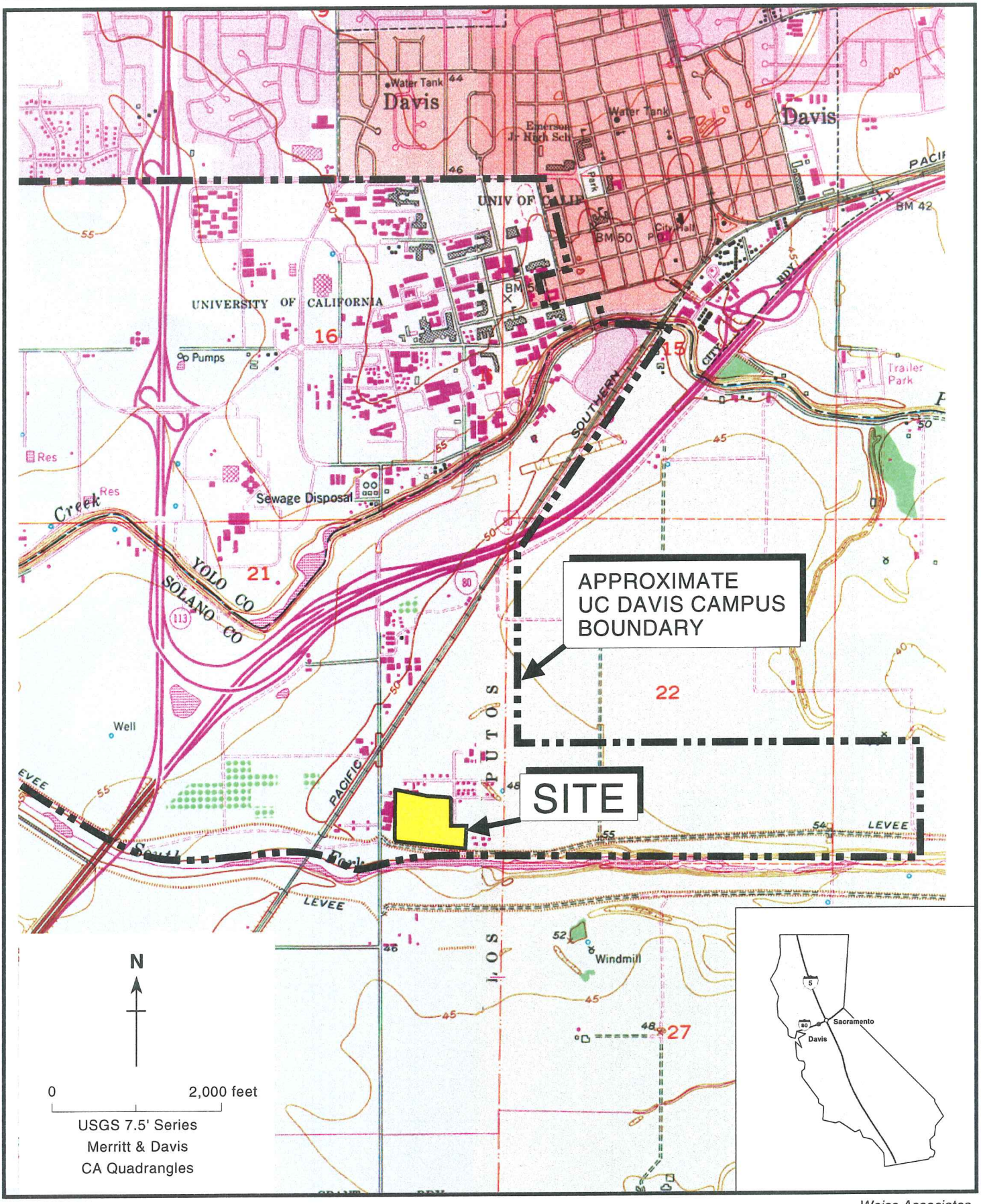

Figure 1–1. Location of the LEHR Site, UC Davis, California

Weiss Associates

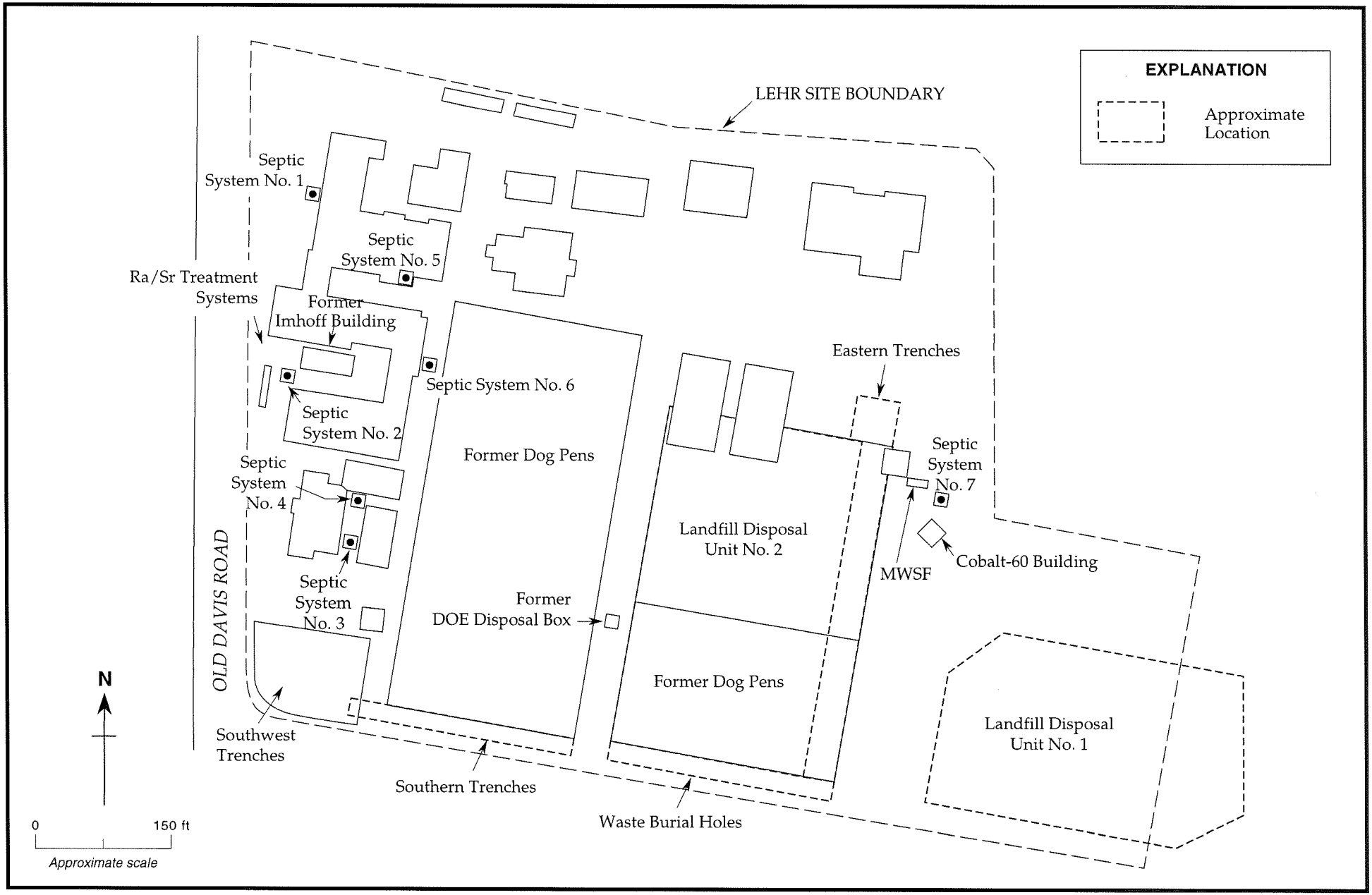

Figure 1-2. Site Features That May Have Impacted the Environment, LEHR Site, UC Davis, California

Weiss Associates

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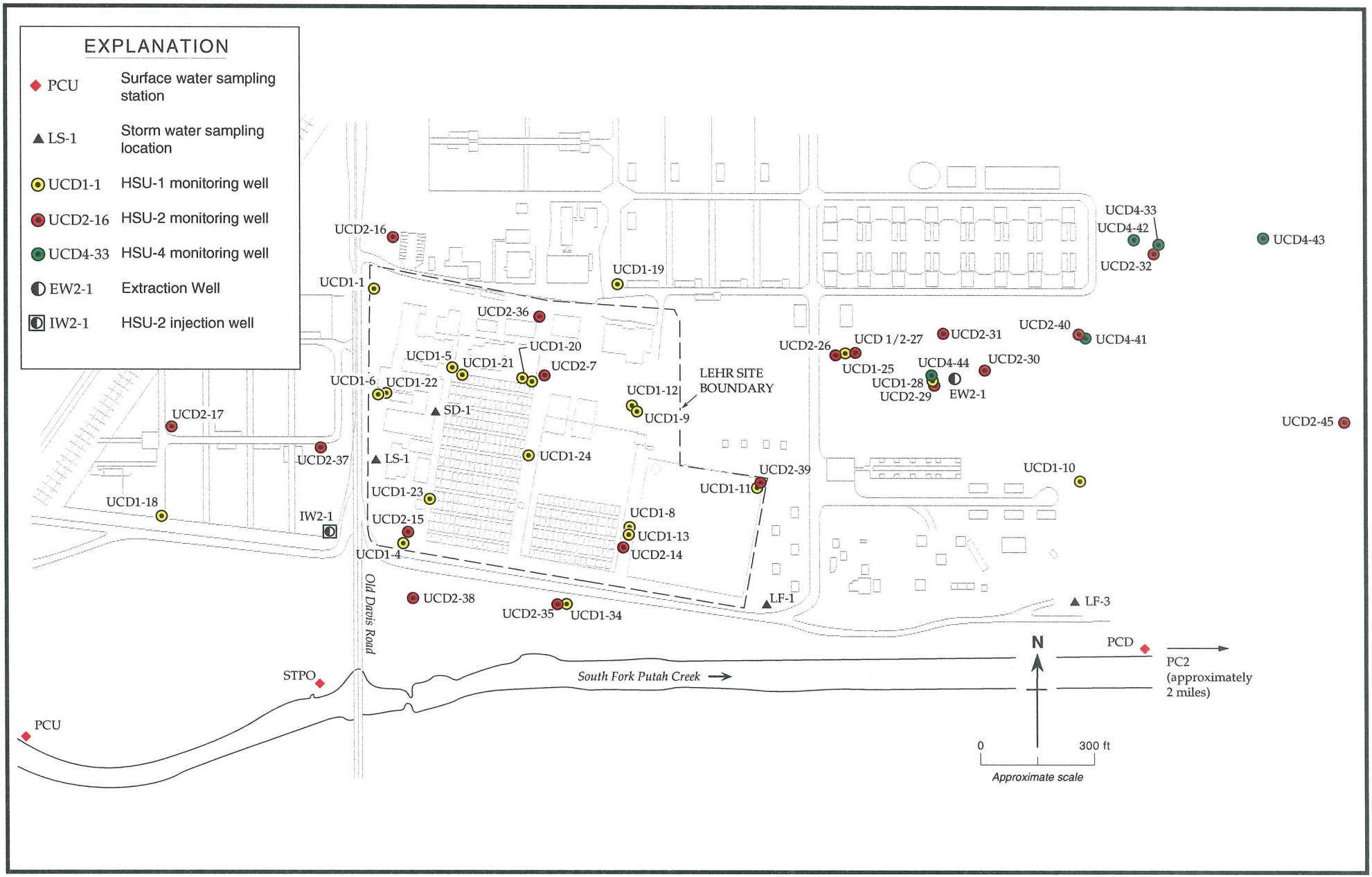

Figure 1-3. Monitoring Well, Storm Water and Surface Water Monitoring Locations, LEHR Site, UC Davis, California

Weiss Associates

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2. COMPLIANCE SUMMARY

This section summarizes primary environmental regulatory compliance status for 1999 LEHR activities. DOE-funded work at the Site centered on ER/WM activities.

2.1 Comprehensive Environmental Response, Compensation and Liability Act

In 1995, a streamlined Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) process was initiated at the Site that encourages an interactive remedial decision-making framework, wherein data are evaluated and cleanup actions are implemented in an ongoing process. An RA and continued characterization of Site soil and air were the primary focus of DOE 1999 CERCLA compliance actions. No violations, fines or penalties were issued for the Site in 1999.

2.2 Resource Conservation and Recovery Act

2.2.1 Site Treatment Plan for Resource Conservation and Recovery Act-Regulated Waste

The Federal Facilities Compliance Act of 1992 waives sovereign immunity for federal facilities for fines and penalties under the provisions of RCRA's hazardous and solid waste management requirements. It requires that a Site Treatment Plan be prepared for each DOE Site that generates or stores mixed waste. After completion of the California Environmental Quality Act (CEQA) Initial Study and public comment, a final Site Treatment Plan was approved and issued in October 1995.

No revisions have been made to this plan, and no mixed waste was generated in 1999.

2.2.2 Mixed Waste Storage Facility

In 1989, UC Davis (as operator) and DOE (as owner) submitted a Part A permit application to EPA for the on-site storage of mixed waste generated during D&D activities. The waste was stored in a mixed waste storage facility (MWSF) located in the eastern part of the Site. The MWSF operated under RCRA interim status. The facility consisted of a pre-fabricated steel chemical storage building with three separate lockers that were used to store mixed waste between 1989 and 1996. All stored waste has been properly characterized, packaged and shipped to off-site locations for treatment or disposal, and the MWSF is now empty.

A closure plan was submitted by the Department of Toxic Substances Control (DTSC) for public comment in April 1999, and DTSC approved closure of the facility in March 2000. The RCRA interim status is therefore no longer applicable at the Site.

2.3 National Environmental Policy Act

An Engineering Evaluation/Cost Analysis (EE/CA) for the Southwest Trenches, Radium-226/Strontium-90 Treatment Systems and Domestic Septic System Areas was completed in early 1998 (Weiss, 1998b). The EE/CA reviews environmental impacts in a manner that is consistent with the National Environmental Policy Act (NEPA) and with DOE environmental compliance guidelines, as required under NEPA. In 1999, the NEPA mitigation measures required in the EE/CA were implemented during the Radium/Strontium (Ra/Sr) Treatment Systems RA.

2.4 California Environmental Quality Act

No CEQA documentation was processed or required in 1999.

2.5 Clean Air Act

The Site is subject to Yolo-Solano Air Quality Management District (YSAQMD) regulations. There are no sources at the Site currently subject to permit requirements by YSAQMD.

Verification of Site compliance with clean air regulations is accomplished through localized air monitoring during RAs. Site ambient air monitoring was conducted from 1995 through 1999 and computer simulations indicate that surface soil contamination does not impact air quality at the Site.

As various environmental restoration activities progress at the Site, the need for additional air monitoring is evaluated during restoration activities. The potential exists for some of the contamination in burial areas to become exposed during tests and excavation. Prior to the start of each phase of the project, an analysis is performed to determine required controls to reduce potential emissions and to evaluate air monitoring requirements. Monitoring data are collected before, during and after the activity to verify that controls are maintained and requirements are met.

2.5.1 National Emission Standards for Hazardous Air Pollutants

The Site complies with the Code of Federal Regulations (CFR), 40 Part 61 Subpart H – *National Emissions Standards for Hazardous Air Pollutants (NESHAP) for Emissions of Radionuclides from DOE Facilities.* The NESHAP regulations require that radionuclide emissions not exceed levels that would result in an 0 (EDE) of 10 millirems per year (mrem/yr).

There are currently no point sources of radionuclide emissions at the Site. The NESHAP requirements primarily target point source/stack emissions. However a Memorandum of

Understanding between the DOE and the EPA (DOE, 1995) applies the same criteria to potential diffuse area sources that are required of point sources.

Calculations were performed to determine the estimated dose to the public from the Site's diffuse area sources. These calculations were based on Site residual surface soil contamination (diffuse sources). The potential sources of emissions at the Site during 1999 were re-entrainment and dispersion of surface soil dust containing potentially elevated concentrations of radionuclides, as well as disturbances from excavation activities which took place in the summer of 1999 at the Ra/Sr Treatment System Area. Estimated contributions to the annual Site EDE from nonpoint source emissions (surface soils) are well below the NESHAP limit, as shown in Table 4-2.

An analysis of potential diffuse airborne radiological effluent sources at the Site was prepared for the 1999 Calendar Year Radionuclide Air Emission Annual Report (under Subpart H of 40 CFR Part 61) (Weiss, 2000b). Fugitive emissions modeling indicated that the maximum annual credible dose equivalent to a member of the public from residual contamination on the Site is 1.35×10^{-3} mrem/yr, far below the 10 mrem/yr NESHAP EDE. This analysis is summarized in more detail in Section 4 of this report.

2.6 National Pollutant Discharge Elimination System

Some surface water discharged from the Site in 1999 was directed to the UC Davis Wastewater Treatment Plant. Wastewater from this plant is discharged to the south fork of Putah Creek. This discharge is conducted by UC Davis under NPDES Permit No.CA0077895 (EPA) and Waste Discharge Requirement (WDR) Order No. 92-040 (CVRWQCB).

2.7 Clean Water Act

The Site discharges its sanitary waste to the UC Davis Wastewater Treatment Plant which is subject to the conditions in NPDES permit CA0077895 and WDR Order No. 92-040, granted by the CVRWQCB. DOE operations at the Site do not include any underground or above-ground tanks that are subject to any county, state or federal permit requirements.

Storm water samples are usually collected twice a year, once near the beginning of the rainy season after the first significant storm of the season, and once near the end of the season. Grab samples were collected from three locations at the Site in 1999: LF-1, LF-3 and LS-1. Storm water sample locations are shown on Figure 1-3. Although the Site does not fall under the industrial categories subject to the State General Storm Water Permit requirements, the storm water sampling program meets the State General Permit requirements and is performed in accordance with the Revised Field Sampling Plan (Dames & Moore, 1998). Best management practices are also in use at the Site to mitigate contamination in storm water runoff.

2.8 Safe Drinking Water Act/California Porter-Cologne Water Quality Control Act/California Safe Drinking Water and Toxics Enforcement Act (Proposition 65)

Current DOE activities at LEHR do not contribute to hazardous discharges. The facilities at LEHR that historically released liquid effluent to the environment, the Imhoff Treatment Facility, the Domestic Septic Tanks and the Radium-226 Septic System, have ceased operation and are included in current or planned remedial actions. DOE research operations at the Site were discontinued in 1989.

Quarterly ground water and surface water monitoring has been conducted since November 1990 and focuses primarily on environmental surveillance activities and monitoring the performance of the UC Davis Ground Water IRA. Ground water and surface water monitoring in 1999 were conducted under the Revised Field Sampling Plan (Dames & Moore, 1998).

2.9 Emergency Planning and Community Right to Know Act

The Site has a Contingency Plan and General Emergency Response Procedures (Weiss, 1998d) as required under 40 CFR Part 265. These have been distributed to the campus fire department, local medical centers and hospitals and are required reading for all on-site workers, including employees of ITEH. To comply with the Emergency Planning and Community Right to Know Act (EPCRA), UC Davis Environmental Health and Safety has also prepared the required emergency and hazardous chemical inventory for all hazardous substances present on University property that require Material Safety Data Sheets (MSDS). This also meets the hazardous material inventory requirements under California Health and Safety Code Section 25509. Compliance with reporting requirements of this regulation is summarized for the Site in Table 2-1.

2.10 Toxic Substances Control Act: 40 Code of Federal Regulations 763; and Demolition/Renovation Involving Asbestos: National Emission Standards for Hazardous Air Pollutants Subpart M, 40 Code of Federal Regulations 61.14

An asbestos-bearing pipe was removed during the Ra/Sr RA. The pipe remains on site, pending characterization and proper disposal.

2.11 Federal Insecticide, Fungicide and Rodenticide Act

Herbicides were used at the Site in 1999 by UC Davis Agricultural Services Department personnel to control weeds. Pesticides were applied following applicable campus, local and federal regulations.

2.12 Endangered Species Act

The Ecological Scoping Assessment (Weiss, 1997c) identified special status species that have a high potential to exist in or near Putah Creek, including two plant species, five invertebrates, nineteen birds, two reptiles, one amphibian and four mammals. These species and other potential receptors of concern are discussed in more detail in the Ecological Scoping Assessment. Habitat for the Valley Elderberry Longhorn Beetle has been identified at the Site, as discussed in Section 1.4 of this report.

These species are considered during planning of remedial activities, so that disturbance to these resources may be minimized.

2.13 National Historic Preservation Act

All areas affected by current remediation activities involve existing structures located on previously graded and developed land. An archeological evaluation was conducted during the *Phase II Soil and Ground Water Characterization of the Site* (DOE, 1992a). No evidence of cultural resources, or historical or agriculturally sensitive areas was encountered.

2.14 Executive Order 11988, "Floodplain Management" and Executive Order 11990, "Protection of Wetlands"

The Site is not on a floodplain, nor is any portion of it designated as a wetland.

2.15 Other Major Environmental Issues and Actions

2.15.1 Federal Facility Agreement

The FFA governing environmental issues for the DOE areas at the Site became effective in December 1999. The FFA document comprises an agreement between DOE and three regulatory agencies: EPA, CVRWQCB and the California Department of Health Services.

The general purpose of the FFA is to:

- Ensure that the environmental impacts associated with past activities at the Site are thoroughly investigated and appropriate response actions are taken as necessary to protect human health, welfare or the environment;
- Establish a procedural framework and schedule for developing, implementing and monitoring appropriate response actions at the Site, in accordance with CERCLA, the National Contingency Plan (NCP), Superfund guidance and policy and applicable State law;

- Facilitate cooperation, exchange of information and participation of the parties in such action; and
- Ensure the adequate assessment of potential injury to natural resources, and the prompt notification, cooperation and coordination with the Federal and State Natural Resources Trustees.

2.15.2 Radium/Strontium Treatment System Removal Action

In 1999, a non-time-critical RA was conducted at the Ra/Sr Treatment System Area I. The RA was implemented in accordance with the NCP 40 CFR Part 300.415.

The Radium-226 and Strontium-90 Treatment Systems are located between Animal Hospital Nos. 1 and 2 (H-219 and H-218) in the western portion of the LEHR facility and together comprise the Ra/Sr Treatment Systems Area (Figure 4-2). These systems were used to treat radioactive liquid wastes generated from the animal experiments.

The Radium-226 Treatment System received low-level radioactive waste, including fecal material and washdown water from Animal Hospital No. 2. The system consisted of two septic tanks each containing multiple compartments separated by weirs, a distribution box, three dry wells and two leach trenches and associated distribution pipelines. Solids settled out in the septic tanks and fluids were pumped from the tanks and fed through the distribution box to one of the three vertical dry wells or the leach trench.

The Strontium-90 (Imhoff) Treatment System received low-level radioactive waste from strontium-90 experiments. Effluent was processed through the Imhoff Treatment System and then was discharged to two leach fields. The Imhoff Treatment System consisted of a series of nine tanks, and primarily used sedimentation, aeration, chemical clarification and filtration to treat the waste. The remaining waste was then passed through a cation exchange resin and discharged to the strontium-90 leach fields.

The Ra/Sr Treatment System Area has been divided into two areas for the RA. Area I consists of Domestic Septic Tank Number 2, the distribution box, piping, three drywells and the Northern and Southern Leach Trenches. Area II consists of the Radium-226 Tanks, Strontium-90 Tanks, the Strontium-90 Tank Leach Field and the influent tank piping.

The objectives of the Area I RA conducted in 1999 were defined in the EE/CA (Weiss, 1998b) as follows:

- Lower the excess cumulative cancer risk to an individual from exposure to Site contaminants to a nominal range of 10^{-4} to 10^{-6}, using 10^{-6} as the point of departure;
- Reduce the non-cancer hazard index to below 1;
- Mitigate potential future impact to ground water;
- Mitigate potential ecological risks during and after the RA; and,

- Minimize impact to on-site University research.

The RA was conducted in accordance with the *Draft Final Work Plan for the Removal Action at Southwest Trenches, Ra/Sr Treatment Systems, and Domestic Septic System Areas* (Weiss, 1999a). Area I RA activities began in May 1999 and were completed by November 1999.

The Area I RA was implemented in two phases. Domestic Septic Tank Number 2 (DT #2), its associated piping, three upper (top ten feet) dry well structures and two leach trenches were removed during the first phase of the RA (Figure 4-2). A total of 804 cu yds of material was removed and packaged for off-site disposal during phase I of the excavation. Following the removal of these subsurface structures and the surrounding contaminated soil, confirmation samples were collected, and backfill and compaction activities commenced. Approximately 1,700 cu yds of soil were required for backfilling the excavations. An off-site source of clean backfill soil was identified, tested and deemed appropriate for use on site. Excavations were backfilled and compacted in accordance with the Work Plan requirements.

The second phase of the Area I RA consisted of defining the extent of contamination surrounding the lower dry well structures, and removal of the structures. To delineate the lateral and vertical extent of contamination in all four compass directions, soil samples were collected from four sides of each dry well, to the water table. Samples were collected using a direct-push drill rig and analyzed for nitrate, radium-226 and strontium-90.

Once the extent of the contamination was defined, the 3 cobble-filled drywells and associated soil were removed to an average depth of 42 feet using 6- and 10-ft diameter augers (Figure 4-2). Excavation screening samples were collected to guide soil removal. Confirmation samples were collected at the completion of the excavation activities. The lower portions of the drywells were then filled with low-strength concrete and backfilled and compacted to grade. A total of approximately 1,276 cubic yards of low-level waste (concrete, cobbles, soil) and 400 cu yds of overburden soil were removed from the Site. Site restoration activities consisted of paving, sewer line replacement and permanently rerouting gas and water lines along the western edge of the excavation. The Area I RA will be presented in more detail in the Ra/Sr Treatment Systems Confirmation Report to be completed after the Area II RA in 2000.

2.15.2.1 Additional Removal Action

During the Area I RA, a series of cross trenches were excavated in the area north of the main excavation to confirm termination of the Northern Leach Trench. This cross trenching uncovered a series of additional, previously unidentified, dry wells and a distribution system (Figure 4-3). Following this discovery, a limited RA was performed in the area.

Five upper dry well structures, a distribution box, piping and surrounding soil were excavated and removed. The area was excavated to an average depth of 8 ft bgs, with a maximum depth of 20 ft near one of the dry wells. Approximately 50 cu yds of soil and debris were removed and stored on site pending characterization and disposal.

Characterization samples were collected from beneath a distribution pipe joint and adjacent to each subsurface structure. Samples were analyzed for a full suite of constituents of concern (COCs). The analytical results of these samples are currently being reviewed.

2.15.3 Dog Pens Investigation

The Eastern Dog Pens (EDPs) Investigation was designed to supplement data collected in the EDPs in 1990 (Dames & Moore, 1993), and in the Western Dog Pens (WDPs) in 1997 and 1998 (Weiss, 1998e). The objectives of the 1999 investigation were to provide additional data to:

- Serve as a baseline data set prior to the area's possible use by UC Davis for waste handing;
- Support negotiations between DOE and UC Davis on the long-term management/environmental cleanup of the EDPs;
- Support future baseline risk assessment; and,
- Provide UC Davis with information to guide remedial decisions regarding Landfill No. 2.

The EDPs Investigation was conducted in March 1999. Forty-three primary and four duplicate soil samples were collected from the upper three ft of soil at sample locations selected using a random number generator. Six concrete curb samples were collected using a concrete coring machine to collect solid cores. Six primary and one duplicate gravel samples were collected from soil sampling locations where gravel was present.

The curb and gravel samples were analyzed for radium-226 and strontium-90. All soil samples were analyzed for tritium and 37 samples were analyzed for additional radionuclides, selected metals, nitrate and organochlorine pesticides. Significant findings of the EDPs Investigation are summarized in Section 4 of this report and discussed in detail in the *Technical Memorandum: Investigation Results of the Former Eastern Dog Pens* (Weiss, 1999c).

2.15.4 Western Dog Pens Statistical Analysis

A statistical comparison of WDPs soil analytical data with risk-based soil target levels was performed in 1999. The selected risk-based soil target levels for the WDPs were the risk-based action standards (RBAS) or the background level, whichever was higher. As discussed in sections 4.6 and 5.2, all COCs are at or below the appropriate risk-based soil target levels.

2.15.5 Waste Disposal

Approximately 1,160 cu yds of waste generated during the 1998 Southwest Trenches Area was disposed in 1999. Approximately 31.5 cu yds of California Hazardous Waste was disposed at Kettleman Hills, California; 221 cu yds of Federal Hazardous Waste was incinerated at Laidlaw/Safety Kleen in Utah; and 908 cu yds of Low-Level Radioactive Waste was disposed at Envirocare.

In addition to Southwest Trenches waste, 0.1 cu yd of Cobalt-60 Field investigation-derived waste was disposed at the Laidlaw/Safety Kleen, Aragonite Facility. Approximately 152 cu yds of

pulverized asphalt that was removed from the Site west of Animal Hospitals 1 and 2 were reused to repave the same area following 1999 RA activities.

2.16 Summary of Permits

There were no permit violations involving Site operations in 1999. The following permits are related to operations at LEHR:

- ***NPDES Permit #CA0077895 (EPA) and WDR Order No. 92-040 (California RWQCB, Central Valley Region):*** UC Davis permits for discharge of wastewater from the UC Davis Wastewater Treatment Plant to the south fork of Putah Creek.
- ***EPA RCRA Interim Status (CAD982469702):*** Part A Permit application for storage of mixed waste. No longer applicable following DTSC-approved closure in March 2000.

Table 2-1. Compliance with Hazardous Material Reporting Under Emergency Planning and Community Right to Know Act

EPCRA 302-303: Planning Notification	[ ] Yes	[ ] No	[x] Not Required
EPCRA 304: EHS Release Notification	[ ] Yes	[ ] No	[x] Not Required
EPCRA 311-312: MSDS/Chemical Inventory	[x] Yes	[ ] No	[ ] Not Required
EPCRA 313: TRI Reporting	[ ] Yes	[ ] No	[x] Not Required

Abbreviations:

EHS	Extremely Hazardous Substances
EPCRA	Emergency Planning and Community Right to Know Act
MSDS	Material Safety Data Sheet
TRI	Toxic Release Inventory

3. ENVIRONMENTAL PROGRAM INFORMATION

Each year DOE monitors the environment at the Site via air, water and soil sampling. This section describes the environmental monitoring program, and summarizes 1999 environmental monitoring activities. The results of this monitoring program are discussed in Sections 4, 5 and 6.

3.1 Summary of Environmental Protection Program

The environmental protection program at LEHR consists of ongoing programs that include compliance monitoring and any other relevant environmental protection requirements. Overall program requirements are defined in DOE Order 5400.1, as well as in applicable federal, state and local environmental regulations. This program consists of, but is not limited to, those actions needed for compliance in the following areas:

- Remedial actions or removal involving cleanup of past actions under CERCLA;
- Ground water, surface water, soil, sediment, air and biota monitoring described in the *Revised Field Sampling Plan* (Dames & Moore, 1998);
- Documentation under NEPA;
- Reports to DOE, including this ASER and other reports required by DOE Orders;
- Hazardous waste management, including waste minimization, storage, segregation, characterization, designation and disposal;
- Hazardous materials inventory and usage and other reports and information as requested or required by regulatory agencies; and,
- EPA permit requirements for storage of mixed waste if it is found during remediation.

3.2 Notification of Environmental Occurrences and Reporting

Requirements for notification and reporting of environmental occurrences are defined in DOE Orders and/or in the regulations governing release of hazardous materials. Environmental monitoring personnel have been instructed to notify appropriate management personnel if monitoring data indicate that hazardous material has been released above reportable quantities.

The DOE LEHR Project Manager is responsible for reporting environmental occurrences under DOE Orders 5484.1 and 232.1-1. The reports are transmitted to the DOE System Safety and

Development Center and DOE Headquarters. The Occurrence Reporting and Processing System is utilized in this process. No reports were filed in 1999.

3.3 General Planning and Reporting

In addition to this ASER, general planning and reporting for the Site environmental management program is facilitated through documentation prepared by the DOE prime contractor, Weiss. This ensures comprehensiveness of the environmental monitoring program at LEHR.

3.4 Environmental Monitoring Programs

The LEHR ER/WM Project performs environmental monitoring in accordance with permit and regulatory requirements to establish background information and to monitor operations related to Site restoration activities. The Weiss Project Manager is responsible for the oversight of these programs, and ensures that plans are reviewed and updated as required by DOE Orders.

3.5 Summary of 1999 Environmental Monitoring

3.5.1 Environmental Monitoring and Surveillance Plan

The environmental monitoring program for the LEHR ER/WM Project is described in the *Environmental Monitoring and Surveillance Plans* (DOE, 1992b and Weiss, 1997a) developed in accordance with DOE Order 5400.1. These plans provide guidelines for the measurement and documentation of environmental releases, should they occur. Data are evaluated to determine the effects of DOE operations at LEHR on the environment, both on-site and off-site. The program supports environmental compliance requirements and promotes goals of the Site environmental management policy. Because remedial action at the Site is being conducted under CERCLA, water, soil and biota are being investigated within the streamlined CERCLA process as discussed in the following sections.

3.5.2 Effluent Monitoring

Storm water runoff and airborne emissions during D&D and RA activities are the only effluent streams monitored by the Site Environmental Monitoring and Surveillance Program. Active liquid effluent discharges to the environment were curtailed in the 1980s at the end of the LEHR research activities. There are now no active radiological or hazardous liquid effluent discharges to the environment from DOE-sponsored activities at the Site. An analysis of potential airborne effluent sources (leach field, chemical dispensing areas, dog pen soils, Imhoff D&D, etc.) determined that non-point diffuse area sources at the Site would generate an EDE below 1.35×10^{-3} mrem/yr (Weiss, 2000b), well below the 10 mrem/yr NESHAP standard.

3.5.3 Ambient Radiation Monitoring

Passive thermoluminescent dosimeters (TLDs) are used to monitor gamma radiation at LEHR. TLDs are placed near perimeter fence lines, radioactive waste storage areas and various work areas around the Site. The TLDs are collected quarterly, and an annual gamma radiation dose is calculated for each location. The TLD data are normalized for each quarter by subtracting Site background activity from each location. The results of the ambient radiation monitoring program are discussed in Section 4.

3.5.4 Surface and Ground Water Monitoring

The Revised Field Sampling Plan (Dames & Moore, 1998) has been developed in accordance with CERCLA as well as applicable state and federal regulations. Water monitoring is conducted as part of the Site environmental restoration program.

Monitoring points have been identified to evaluate water quality and lateral and vertical extent of environmental impact at the Site. The program is guided by data needs for risk analysis and evaluation of Site remediation alternatives. The scope of the program is modified when required to meet objectives (as approved by regulatory oversight agencies) as the CERCLA process and environmental restoration activities progress. This also provides flexibility necessary to obtain temporal and spatial information regarding chemical and radiological constituents.

In 1999 UC Davis performed all ground water and surface water monitoring, and monitored storm water runoff from the UC Davis areas of the Site. DOE monitored storm water runoff from the DOE areas only. The surface water monitoring results are discussed in Sections 4 and 5, and ground water monitoring results are discussed in Section 6.

3.5.5 Air Monitoring

Pacific Northwest National Laboratories (PNNL) conducted a CERCLA one-year baseline air monitoring program at the LEHR Site in August 1995. Data collected from the Site included both radiological and non-radiological parameters for substances previously detected in soil, ground water, and surface water at the Site. Air monitoring locations were based on historical records of Site activities, planned investigation activities and soil and water monitoring data.

On January 1, 1997, Weiss assumed responsibility for the air monitoring activity at the Site. The air monitoring program is ongoing and included monitoring during the Ra/Sr Treatment System RA in 1999.

3.6 Site Environmental Training

Site-specific environmental training has been conducted to instruct environmental restoration project personnel on pollution prevention, waste minimization and procedures to ensure

environmental controls are adequately maintained during remediation activities. This training is conducted as part of the Site orientation training, and prior to any new activity, such as RAs, which could potentially impact the environment. Daily safety meetings reinforce this training and specify steps needed to assure adequate environmental protection during that day's activities.

Before an employee is allowed to begin hazardous Site work, he or she must complete the 40-hour Occupational Safety and Health Administration "Hazardous Waste Operations Training." In addition, prior to working on site, pollution prevention information is provided within the Site-specific "Hazard Communication Training." This training ensures that the worker is aware of proper handling, usage and disposal of chemicals used on the job. It also covers spill prevention and control as well as proper storage and chemical disposal methods. Workers are also trained in radiological control methods to prevent the spread of radioactive contamination to the environment.

3.7 Waste Minimization

The Site Waste Management Plan (Weiss, 1998a) reflects DOE's commitment to reduce the quantity and toxicity of waste generated at the Site during restoration activities. The plan is designed to satisfy the requirements of the Solid Waste Disposal Act, as amended by RCRA, Hazardous and Solid Waste Amendments of 1984 and the Pollution Prevention Act of 1990. It also complies with the intent of NEPA to develop waste management and minimization methodologies to reduce the impact of these wastes on natural resources and the environment.

The plan requires that waste assessments be made for all project activities prior to initiation. Economically practical waste reduction and minimization techniques, including waste abatement, recycling, good housekeeping and treatment are discussed. Methods to promote awareness and recognition of the waste minimization effort are also included. The plan is designed to eliminate or minimize pollutant releases to all environmental media.

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM INFORMATION

DOE activities at the Site in 1999 primarily consisted of the Ra/Sr Treatment Systems Area I RA, further investigation of the Dog Pens Area and Site air and ambient radiation monitoring. Storm water monitoring was performed by both DOE and UC Davis for their respective areas; surface water and ground water monitoring and off-site neighbor well sampling were performed by UC Davis.

Data collection and Site monitoring programs for DOE areas are conducted under the guidance of the Site Environmental Monitoring and Surveillance Plan (DOE, 1992b), and comply with CERCLA requirements. This section provides a brief overview of significant results and trends in radiological Site air, soil and water monitoring data identified in 1999. More detailed discussions of investigations and findings are presented in the reports referenced in each section.

The majority of radionuclide results for Site samples are close to or below the Minimum Detectable Activity (MDA) for the laboratory analysis methods.

4.1 Radiological Air Monitoring

4.1.1 Site Baseline Air Sampling

Atmospheric releases of pollutants from the Site are a potential source of human exposure. Therefore, radioactive and non-radioactive materials in air have been monitored at a number of locations on and around the Site since August 1995. The locations of the current air monitoring stations are shown in Figure 4-1.

The influence of LEHR emissions on local air pollutant concentrations is evaluated by comparing air concentrations measured at a background location to concentrations measured at the Site.

Between August 1995 and August 1996, a one-year baseline air sampling investigation was conducted. The analytical results of the one-year baseline air sampling investigation were presented in *PNNL's Baseline Air Monitoring Report* (Patton, 1996). Weiss continued several elements of the monitoring program through 1999 to provide additional baseline radiological data.

In February 1999, Weiss revised the existing air monitoring program. The revised program is based on the results of the air sampling investigation and sampling requirements mandated in DOE Orders 5400.1 and 5400.5 and DOE/EH-0173T – *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE, 1991). The revised program includes:

- Monthly monitoring at four stations (AM-2, AM-5 and AM-7 and background station AM-3 (Figure 4-1)) for alpha and beta activities. Monitoring was performed before, during and after RAs;
- Quarterly radon sampling of the three on-site stations and the background station; and,
- Continued collection of meteorological data at the on-site meteorological station.

The revised air monitoring program reduced sampling for tritium and non-radiological compounds (chlordane, respirable particulate matter [PM-10], metals, volatile organic compounds [VOCs]). In 1999, monitoring of off-site station AM-6 was discontinued, and AM-3 was selected as the new background air monitoring station (Figure 4-1). Historically, data obtained from AM-3 has been very similar to that obtained from AM-6, and AM-3 was substituted as the background air monitoring station to: 1) reduce costs incurred by travel to and upkeep of AM-6 (located eight miles from the Site); 2) simplify the air monitoring program and; 3) eliminate redundant data gathered from AM-3 and AM-6.

The approach for monitoring radionuclides in air includes continuous air monitoring for particle-associated radionuclides and for radon. Radionuclides to be analyzed in air samples were selected on the basis of: (1) their detection in Site soil or ground water in above-background activities; (2) past Site history and use; and (3) their relative importance in terms of potential dose to man and the environment.

Radon is sampled at the four air monitoring station locations using passive alpha-track air sampling cartridges. The air sampling cartridges are identical to those used for sampling residential radon activities. The cartridges are exchanged quarterly.

Air sampling was performed at the Site during the 1999 Ra/Sr Treatment Systems Area I RA to monitor potential elevated releases of radionuclides into ambient air. Samples for gross alpha, gross beta and radon were collected before and after the RA.

4.1.2 Radiological Results for the Air Monitoring Program

No increased activities were detected during the 1999 Ra/Sr Treatment Systems Area I RA. The activities of all COCs detected at AM-7 (near Area I) were similar to levels detected at background station AM-3.

Both the average and maximum activities of total alpha radiation collected during 1999 were similar for Site perimeter locations and the background location, indicating that the observed levels were from natural sources and worldwide fallout. The 1999 average air activity for the Site locations was 9×10^{-5} picoCuries per cubic meter (pCi/m^3), which was not statistically different from the average activity at the distant location (1×10^{-4} pCi/m^3). The highest 1999 gross alpha air activity for a Site location was at AM-7 (3.1×10^{-4} pCi/m^3). Total beta radiation activities in ambient air collected during 1999 were below the laboratory detection limit for all stations.

Eight air samples collected during 1999 were analyzed for gamma-emitting radionuclides. All gamma-emitting radionuclides were well below the DOE Derived Concentration Guidelines (DCGs) specified in DOE Order 5400.5, "Radiation Protection of the Public and the Environment." The DCG values represent the activity of a radionuclide in air that an individual could continuously inhale at average annual rates without receiving an EDE of greater than 100 mrem/yr.

Three quarterly radon composite samples were collected at each of three on-site and one background air monitoring station. The average total radon activity detected on-site during 1999 was 0.77 pCi per liter (pCi/L), with a maximum activity of 1.2 pCi/L. The average detectable background radon activity was 0.6 pCi/L, with a maximum activity of 0.7 pCi/L. This indicates that radon levels measured at the Site are primarily associated with background sources. All measured radon air activities and detection limits were below the DOE DCG of 3.0 pCi/L, although the highest on-site and background activities exceeded the NESHAP limit of 0.3 pCi/L.

4.2 National Emission Standards for Hazardous Air Pollutants Dose Estimation Calculations

Calculations were performed to determine the estimated dose from Site sources to the public. These calculations were based on Site residual surface soil contamination (diffuse area sources) and maximum waste activities generated from the Area I RA in 1999. Remedial action during the summer of 1999 did not cause any elevated fugitive dust emissions. The other potential area sources of emissions at the Site during 1999 were re-entrainment and subsequent dispersion of surface soil dust containing potentially elevated concentrations of radionuclides. Estimated contributions to the annual Site EDE from non-point source emissions (surface soil) are shown in Table 4-1, and are well below the NESHAP limit.

The potential Site non-point or diffuse sources (areas with known or potential radionuclide contamination resulting from past DOE activities at the Site) include the Ra/Sr Treatment Systems Area, the Southwest Trenches Area, the EDPs and WDPs Area, inactive landfill units and the storm water runoff system. Of these non-point sources, three were determined to have radioactive material in near-surface soil (0 to 3 ft bgs) that could potentially be a source of airborne radioactive material emissions. Those sources are the Ra/Sr Treatment Systems Area, the EDPs Area and the WDPs Area. Emission estimates from these sources are discussed below.

4.2.1 Non-Point/Diffuse Source Emission

Compliance with the NESHAP requirements for diffuse, non-point source emissions was assessed using the EPA-approved DOE atmospheric dispersion/radiation dose calculation computer code, CAP88-PC, Version 1.0. Conservative radionuclide emission rates were estimated using maximum soil activities measured above background for the Ra/Sr Treatment Systems Area and the WDPs and EDPs Areas as fugitive area sources. The emission rates were calculated by using the maximum radionuclide activities from the excavated wastes and assumed the wastes were exposed to the atmosphere for up to several weeks during the RA. These dust emissions rates were used to calculate the total estimated contribution to the EDE. The total contribution was estimated to be

1.35×10^{-3} mrem/year (Table 4-1). The CAP88-PC computer code was then used to calculate the EDE to individual receptors at various distances and from each of the four potential LEHR facility radionuclide emission sources. The estimated EDE to a maximally exposed individual (MEI) at the LEHR facility was determined by summing the contributions from all three potential LEHR facility radionuclide emission sources. Based upon the combined source exposures, the MEI assumed for the LEHR facility would be located on-site in the Reproductive Biology Laboratory. The results of the assessment are shown in Table 4-2.

The CAP88-PC computer code was also used to calculate the collective population dose, as required by DOE order 5400.5. The maximum off-site receptor exposure is estimated to be 1.39×10^{-5} mrem/yr, significantly below the 10 mrem/yr NESHAP standard (Table 4-3).

4.3 Radiological Soil Measurements

The following section summarizes 1999 field activities and important soil analytical results for radiological compounds for the DOE areas at the Site. Results for non-radiological compounds are discussed in Section 5.

Soil sampling in support of the on-going CERCLA remediation was performed in several areas in 1999. Soil samples are shipped to a contract laboratory for the requested suite of analyses. Full descriptions of the soil sampling methods, procedures for sample preparation and shipment, requested analyses and MDA limits, along with the associated quality assurance/quality control (QA/QC) requirements, are contained in the relevant work plans and reports.

Soil sampling was conducted in the EDPs in 1999, and previously collected Dog Pens data were statistically evaluated. The results of these investigations are summarized briefly here, and are discussed in detail in the *Technical Memorandum: Investigation Results for the Former Eastern Dog Pens*, (Weiss, 1999c), *Draft Technical Memorandum: Statistical Comparison of Western Dog Pens Soil Data with Risk-Based Target Levels* (Weiss, 1999b) and *Addendum to Former Dog Pens Technical Memoranda* (Weiss, 2000a).

Soil confirmation sampling was conducted as part of the Ra/Sr Treatment Systems Area I RA to guide the excavation, characterize the waste and determine whether RA objectives had been achieved. Results of the Ra/Sr Treatment Systems RA sampling will be presented in a technical memorandum to be submitted after the Area II RA is completed in 2000.

4.4 Radium/Strontium Treatment System Removal Action—Confirmation Sampling

As discussed in Section 2, a non-time-critical RA was conducted at the Ra/Sr Treatment System Area I in 1999. The RA was implemented in accordance with the NCP 40 CFR Part 300.415.

A total of 38 primary and 4 duplicate confirmation soil samples were collected between 1 and 42 ft bgs from the excavation sidewalls and floor. The objective of the confirmation sampling was to ensure the attainment of cleanup goals using a statistically-based sampling design. The grid size and statistical approach used to determine the required number of confirmation samples were in

accordance with U.S. EPA guidance (U.S. EPA, 1994). The Ra/Sr Treatment System Area I excavation confirmation samples were analyzed for the full suite of radionuclide COCs.

A preliminary data evaluation was conducted and presented to the Remedial Project Managers on February 29, 2000. The preliminary analysis indicated that all residual concentrations in nearly all samples are at or near background and/or RBAS levels. A detailed discussion of the confirmation sampling will be included in the Ra/Sr Treatment Systems Confirmation Report to be prepared after the Area II RA is completed in 2000.

4.5 Dog Pens Investigations

4.5.1 Eastern Dog Pens

The EDPs Investigation was designed to supplement data collected in the EDPs in 1990 (Dames & Moore, 1993) and in the WDPs in 1997 and 1998 (Weiss, 1998e). The objectives of the 1999 investigation are presented in Section 2.15 of this report.

The EDPs Investigation was conducted in March 1999. Forty-three primary and four duplicate soil samples were collected from the upper three feet of soil at sample locations selected using a random number generator. Six concrete curb samples were collected using a concrete coring machine to collect solid concrete cores. Six primary and one duplicate gravel samples were collected from soil sampling locations where gravel was present. Figure 4-4 shows the sample locations.

The curb and gravel samples were analyzed for radium-226 and strontium-90. All soil samples were analyzed for tritium, and 37 samples were analyzed for additional radionuclides. Significant radiological findings of the EDPs Investigation are:

- ***Concrete Curbs***: Radium-226 was detected in all six samples at activities ranging from 0.269 to 1.68 picoCuries per gram (pCi/g). No background levels for radium-226 or strontium-90 have been established for concrete at the Site; however, based on a literature search, radium-226 activity in cement typically ranges from 0.973 pCi/g to 1.38 pCi/g (Ingersoll, 1983; Tso, 1994). Strontium-90 was detected in three of the six samples, ranging from 0.398 to 7.44 pCi/g. These activities are below the 10 pCi/g soil RBAS for strontium-90 developed for the LEHR Site.
- ***Gravel:*** Radium-226 was detected in all 16 samples at activities ranging from 0.196 to 0.396 pCi/g. All the radium-226 results were below the calculated soil background level for radium-226 of 0.752 pCi/g. Strontium-90 was detected in 2 of the 16 samples, and both results are well below the RBAS. Because no gravel-specific background levels have been calculated, the significance of these results has not been fully determined.
- ***Soil to 2-ft depth (beneath the gravel):*** The only radiological constituent detected in the EDPs soil above background levels based on the Wilcoxon Rank Sum (WRS) test was strontium-90. Insufficient data were available to perform a

conclusive WRS test for cesium-137, so the cesium-137 results were compared to the RBAS. Only the maximum concentrations for cesium-137 were above the lowest RBAS. The reasonable maximum exposure (RME) level, defined here as the 95% upper confidence level, for cesium-137 was compared to the lowest RBAS. The RME is below the RBAS.

- ***Comparison with WDPs soil levels:*** The radionuclides detected in the EDPs are similar to those detected in the WDPs. Based on the statistical results, the EDPs and the WDPs soil radionuclide activity levels are very similar.

4.5.2 Western Dog Pens Statistical Analysis

A statistical comparison of WDPs soil analytical data with the risk-based soil target levels was performed in 1999. The objective of this statistical comparison was to determine if the COC levels in WDPs soil exceed the lowest risk-based soil target levels previously established for the LEHR Site (Weiss, 1997b).

Soil investigations were conducted in the WDPs in 1990, 1994, 1996 and 1997/1998. Of these, the 1994 and 1997/1998 investigations were conducted in accordance with CERCLA QA/QC requirements. Data from these investigations, which comprise over 200 soil sampling locations from 45 of the 320 WDPs, were used in the statistical analysis. Of these sampling locations, 106 were selected at random, and 101 were selected to target possible areas of elevated COC levels. Therefore, the data sets used in the statistical analysis are biased towards higher COC levels and are conservative representations of COC levels in the WDPs.

All COCs with one or more result above the detection limit were retained for statistical analysis. Although all detected COCs were retained for analysis, those with detection frequencies of less than 5% were noted.

The WRS test was used to compare WDPs soil levels with the background soil levels established for the LEHR Site. Prior to conducting this test, the Noether calculation method (Noether, 1987) was used to determine if enough WDPs and background soil data points exist for making valid statistical comparisons using the WRS test.

Based on these analyses, all radiological COCs in WDPs soil are at or below the appropriate risk-based soil target levels. Sufficient valid data are available for the WDPs area to conclude that no remedial actions are necessary for the soil. Remedial actions for the WDPs curbing and gravel will be addressed separately in an EE/CA to be completed in Fiscal Year 2000.

4.6 Radiological Surface and Storm Water Monitoring

Quarterly ground water and surface water sampling has been conducted at the Site since 1990 for an extensive list of analytes. In 1997, in accordance with the MOA, responsibility for surface water and ground water sampling was transferred to UC Davis. DOE retained responsibility for storm water runoff sampling in the DOE areas of the Site. Trends and conclusions drawn from the

surface and storm water monitoring results are briefly discussed below. A detailed discussion of results and tables summarizing the analytic data can be found in the *1999 Annual Groundwater Treatment System and Water Monitoring Report* (Dames & Moore, 2000).

4.6.1 Surface Water Monitoring

In 1999, UC Davis collected surface water samples from four locations: Putah Creek Upstream (PCU), Wastewater (Sewage) Treatment Plant Outfall (STPO), Putah Creek Downstream (PCD) and PC2 located approximately 2 miles downstream of PCD (Figure 1-3). Samples were collected during three sampling events in the winter, spring and fall. Carbon-14 was detected at 71.7 pCi/L during the fall sampling event, however carbon-14 is not typically detected in surface water, and this result is considered anomalous. No other radionuclide was detected above the Contract Required Detection Limit (CRDL).

4.6.2 Storm Water Monitoring

Storm water samples are usually collected twice a year; once near the beginning of the rainy season after the first storm of the season and once near the end of the season. In accordance with the MOA between DOE and UC Davis (DOE, 1997), DOE collected storm water from the lift station located on the western border of the Site (LS-1 in Figure 1-3) and UC Davis collected samples from the UC Davis areas of the Site (LF-1 and LF-3).

Storm water samples were collected in January, March and November 1999. The January and March samples represent the beginning and end of the 1998/1999 rainy season, respectively, and the November sample represents the beginning of the 1999/2000 rainy season. Lead-214 and gross beta were the only radionuclides detected above the CRDL in 1999 storm water. Lead-214 was detected at 11 ±5.78 pCi/L, slightly above the 10 pCi/L CRDL. Gross beta was detected at 4.03 ±0.679, slightly above the 3.0 CRDL. Both of these compounds occurred above the CRDL in LS-1 only during the November sampling. Occasional detections of these radionuclides is consistent with historical data.

4.7 Passive Thermoluminescent Dosimeter Monitoring Program

The LEHR ambient radiation monitoring program uses TLDs to monitor gamma radiation throughout the Site. The TLDs are placed near perimeter fence lines, radioactive waste storage areas and various work areas around the Site (Figure 4-5). The TLDs are collected quarterly, and an annual gamma radiation dose is calculated for each location. In 1999, TLD detectors and analyses were provided by Radiation Detection Company, which is certified by the National Voluntary Laboratory Accreditation Program. TLD 35, located at the equine center to the north of the Site, is used to monitor background.

In July 1999 the Site perimeter fence near the Cobalt-60 building in the southeast area of the Site was moved. TLDs 7, 8, 9 and 11 were moved to monitor the revised Site perimeter, and to avoid monitoring site conditions at the UC Davis controlled area east of the Site.

The annual background dose near the LEHR Site (measured by TLD 35) is 80 mrem/yr which is consistent with previous years. The annual dose at the Site exceeded the background at only one location; TLD-29, located near the Imhoff area where the dose was 104 mrem. TLD-29 is located in a fenced DOE controlled area. This area is monitored weekly, and is not accessible to members of the public. The DOE public dose limit for exposure of members of the public as a consequence of routine DOE activities is 100 mrem/yr above background. These results show that ambient radiation detected at the Site is not generally elevated with respect to off-site background, and is well below the DOE dose limit for the general public.

Table 4-1. Estimated Annual Maximum Effective Dose Equivalent

Maximum Individual Dose[1]	EPA and DOE Standard
1.35×10^{-3} mrem/year (1.35×10^{-5} mSv/year)	10 mrem/year (0.1 mSv/year)

Notes:

1 = Maximum effective dose equivalent from Calendar Year 1999 Radionuclide Air Emission Annual Report (Weiss, 2000b). Data are calculated, not measured; therefore, they represent potential or estimated rather than actual doses.

[1 Sievert (Sv) = 100 Roentgen equivalent man (rem)]

Abbreviations

DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
mrem/year	millirem per year
mSv/year	milliSievert per year

Table 4-2. Estimated Dose Equivalent to On-Site Maximally Exposed Individual from Site Non-Point/Diffuse Sources

Nonpoint Source	Dose Equivalent[1]
Ra/Sr Treatment Systems Area	1.3×10^{-3} mrem/yr
Western Dog Pens Area	5.3×10^{-5} mrem/yr
Eastern Dog Pens Area	7.1×10^{-7} mrem/yr
Total Combined Contribution	1.35×10^{-3} mrem/yr

Notes:
[1] = Maximum EDE from Calendar Year 1999 Radionuclide Air Emission Annual Report (Weiss 2000b). Data are calculated, not measured. Therefore, they represent potential or estimated rather than actual doses.

Abbreviations:

mrem/yr	millirems per year
Ra/Sr	Radium/Strontium

Table 4-3. Summary of Estimated Off-Site Collective Population Dose Resulting from Radionuclide Emissions from Each Fugitive Dust Emission Source

Location	Off-Site Maximally Exposed Individual (mrem/yr)[1]	Distance[2]	Collective Population Dose (person-rem/yr)
Ra/Sr Treatment Systems Area	8.61×10^{-6}	250 m North	2.44×10^{-5}
Western Dog Pens Area	4.85×10^{-6}	250 m North	1.40×10^{-5}
Eastern Dog Pens Area	4.31×10^{-7}	250 m North	1.23×10^{-6}
Total Site	**1.39×10^{-5}**		

Notes:
[1] = Maximum off-site effective dose equivalent from Calendar Year 1999 Radionuclide Air Emission Annual Report (Weiss, 2000b). Data are calculated, not measured. Therefore, they represent potential or estimated rather than actual doses.
[2] = Distance and direction from source area center to MEI receptor location.

Abbreviations:

mrem/yr	millirems per year
Ra/Sr	Radium/Strontium

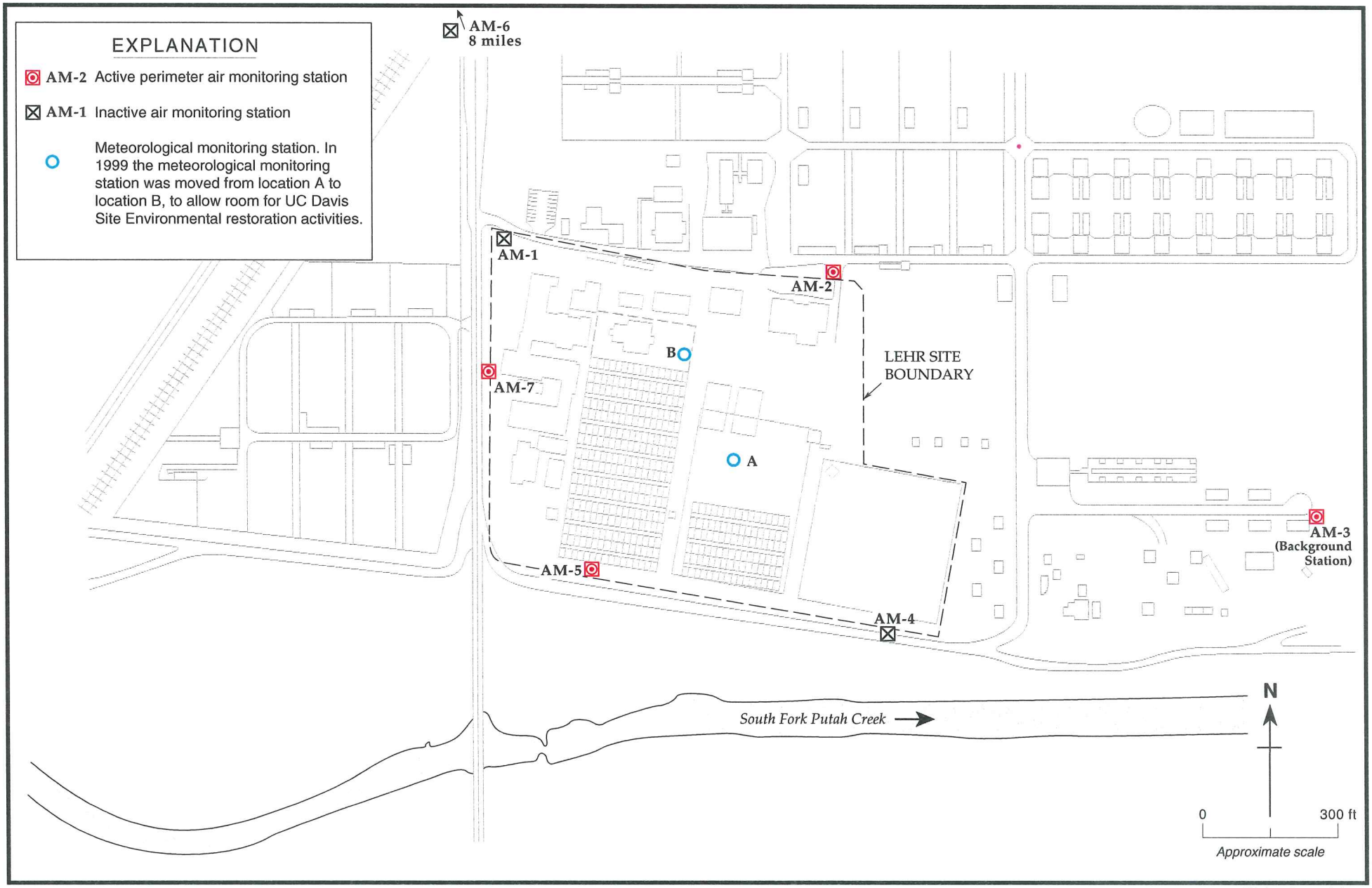

Figure 4-1. Site Air Monitoring Station Locations, LEHR Site, UC Davis, California

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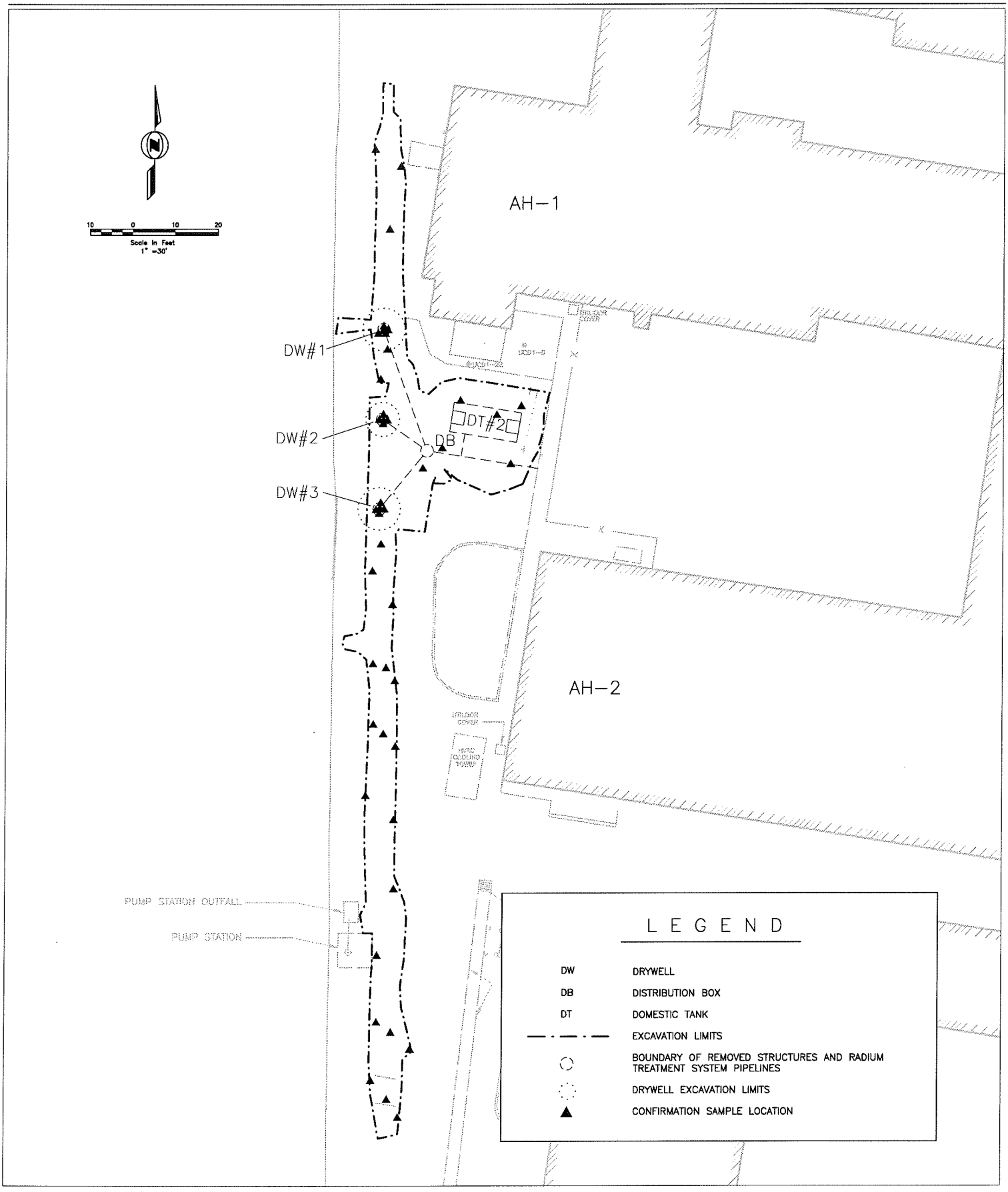

Figure 4-2:
Ra/Sr Treatment System Area I Excavation, LEHR Site, UC Davis, California

WEISS ASSOCIATES
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Figure 4-4. Former Eastern Dog Pens Sample Locations, LEHR Site, UC Davis, California

Weiss Associates

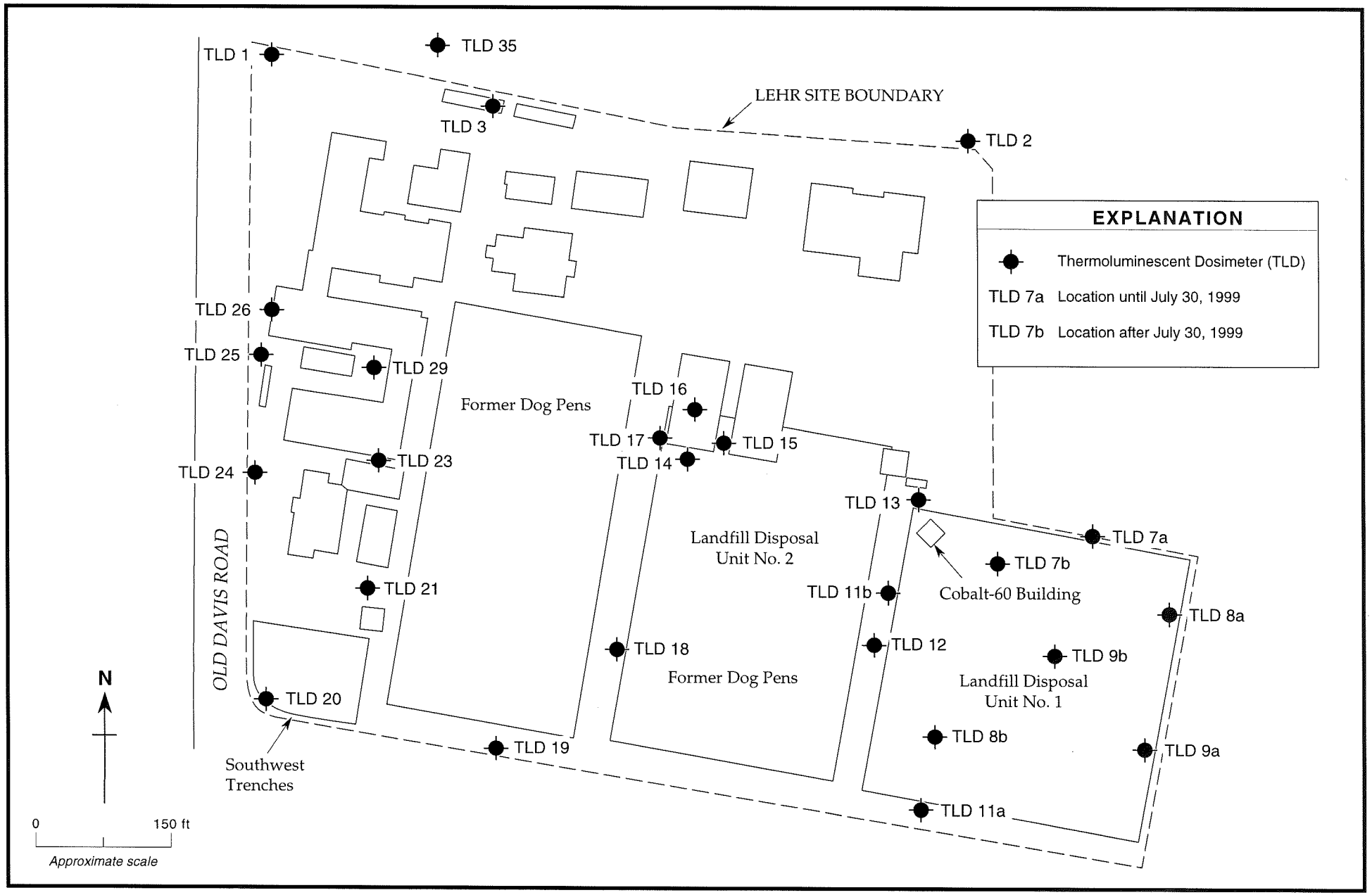

Figure 4-5. Thermoluminescent Dosimeter Location Map, LEHR Site, UC Davis, California

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5. ENVIRONMENTAL NON-RADIOLOGICAL PROGRAM INFORMATION

DOE activities at the Site in 1999 primarily consisted of the Ra/Sr Treatment System Area I RA and additional soil characterization at the EDPs. This section provides a brief overview of significant results and trends in 1999 non-radiological Site air, soil and water monitoring. More detailed discussions of investigations and findings are presented in the reports referenced in each section.

5.1 Non-Radiological Air Monitoring

Air monitoring for non-radiological compounds was performed to detect potential elevated releases of non-radiological compounds into ambient air resulting from the 1999 Area I RA. VOCs, metals, pesticides and PM-10 were sampled before and after the RA. The majority of air contaminants identified during 1999 were below the laboratory detection limits.

Preliminary review of the air analytical data indicates that the maximum VOC detected was acetone at 0.8 parts per billion by volume. Pesticides were detected in only three samples at a maximum concentration of 0.13 micrograms per liter (µg/L). Metals were detected in most samples, with a maximum detection (of iron) of 6.15 $\mu g/cm^3$. Details of non-radiological air compound monitoring will be included in the *LEHR Air Monitoring Report Summary 1995-1999* (Weiss, 2000c), and the Ra/Sr Treatment Systems RA Confirmation Report, to be completed after the Area II RA is performed in 2000.

5.2 Non-Radiological Soil Monitoring

The following sections summarize 1999 field activities and important analytical results for non-radiological compounds from the DOE areas at the Site.

5.2.1 Radium/Strontium Treatment Systems Removal Action—Confirmation Sampling

As discussed in Sections 2 and 4, a non-time critical RA was performed at the Ra/Sr Treatment Systems Area I. A preliminary review of the confirmation sampling results indicate that residual concentrations in nearly all samples were at or near background or RBAS levels.

5.2.2 Eastern Dog Pens

Thirty-seven of the soil samples collected during the EDPs investigation were analyzed for selected metals, nitrate and organochlorine pesticides. Eight soil samples were also analyzed for bulk density and moisture content. The results are summarized below.

- ***Soil to 2-ft Depth (beneath the gravel):*** Alpha- and gamma-chlordane, dieldrin and several other pesticides and polychlorinated biphenyls (PCBs) were detected in one or more soil samples. Alpha-and gamma-chlordane were detected in 12 soil samples in concentrations up to 47.8 and 43.4 mg/kg, respectively. Dieldrin was detected in two samples above the 15 µg/kg RBAS, with one sample containing 223 µg/kg. The only inorganic constituents analyzed in the EDPs soil that are above background levels (based on the WRS test) were total chromium and hexavalent chromium. The WRS test results for mercury and nitrate were inconclusive. The maximum result for each of these constituents was compared to the lowest RBAS established for that constituent. Only the maximum concentrations for dieldrin and mercury were above the lowest RBAS. The RME levels, defined as the 95% upper confidence level, for dieldrin and mercury were compared to the lowest RBAS. The RMEs for both of these constituents are below the RBAS.
- ***Comparison with Western Dog Pen Soil Levels:*** Several pesticides were detected in both the EDPs soil and the WDPs soil; 4,4'-DDE, 4,4'-DDD, 4,4'-DDT and alpha- and gamma-chlordane were detected at similar concentrations in both areas. Radionuclides and most metals detected in the EDPs are similar to those detected in the WDPs. Mercury and dieldren were detected at slightly higher concentrations in the EDPs than in the WDPs.

5.2.3 Western Dog Pens Statistical Analysis

As discussed in Section 4, data from previous investigations were used to perform a statistical analysis. All COCs with one or more results above the detection limit were retained for statistical analysis, although those with detection frequencies of less than 5% were noted.

The only WDPs non-radionuclide COC that is above background levels and has a soil RME level greater than the RBAS is heptachlor epoxide. The LEHR Site RBAS for this pesticide is 0.57 µg/kg and the RME level is 1.91 µg/kg. However, this RBAS is almost entirely (99.7%) driven by the risk associated with off-site residential exposure and the soil leaching to the ground water ingestion pathway, which is considered an incomplete pathway for the WDPs. Therefore, the heptachlor epoxide RBAS is unrealistically conservative for the WDPs. Furthermore, the reporting limit specified for heptachlor epoxide by method CLP SOW OLM 03.0 is 1.8 µg/kg, which is greater than the RBAS of 0.57 µg/kg. Heptachlor epoxide was detected above this 1.8 µg/kg detection limit in only 8 of 197 (approximately 4%) WDPs soil samples analyzed.

Based on these results, all non-radiological COCs in WDPs soil are at or below the appropriate risk-based soil target levels.

5.3 Non-Radiological Surface and Storm Water Monitoring

In 1999, ground water and surface water sampling were conducted and reported by UC Davis. DOE sampled only storm water runoff from DOE areas at the Site. Trends and conclusions drawn from the surface and storm water monitoring results are discussed briefly below. A detailed discussion of results and tables summarizing the analytic data can be found in the *1999 Annual Groundwater Treatment System and Water Monitoring Report* (Dames & Moore, 2000).

5.3.1 Surface Water Monitoring

Surface water samples were collected three times in 1999 at locations PCU, STPO, PCD and PC2 (Figure 1-3). Significant results include:

- Concentrations of VOCs (chloroform, bromodichloromethane, dibromochloromethane and toluene), nitrate as nitrogen, total dissolved solids (TDS) and several metals (molybdenum, vanadium and zinc) were slightly elevated compared to upstream location PCU.
- Aquatic toxicity results indicated no observed effects on mortality, reproduction, or growth in samples collected at PCD or STPO. Adverse effect on biota growth was observed in one sample collected from PC2, and adverse growth or survival was observed in all three samples collected from PCU.

5.3.2 Storm Water Monitoring

Storm water samples were collected in January, March and November 1999. The January and March samples represent the beginning and end of the 1998/1999 rainy season, respectively, and the November sample represents the beginning of the 1999/2000 rainy season. Analytical results were similar to previous years. Significant results include:

- Chloroform has not been reported above the CRDL in any storm water samples collected from the Site in the last three years.
- Nitrate as nitrogen was detected at up to 5.09 milligrams per liter (mg/L), TDS was measured at concentrations up to 302 mg/L, and total and hexavalent chromium were detected at concentrations up to 20.8 µg/L. These results are consistent with historical trends.
- Arsenic, barium, copper, lead, manganese, nickel, vanadium, and zinc were detected below the primary maximum contaminant level (MCL), at concentrations up to 61.9 µg/L. Iron was detected at concentrations up to 621 µg/L in most samples, with one anomalous detection of 2,490 µg/L in LF-3. Antimony was detected at concentrations up to 13.6 mg/L in LS-1, exceeding the MCL of 6 mg/L. These concentrations are consistent with previous years.

- Oil and grease were detected at concentrations up to 2.45 mg/L in LS-1 and LF-1, and acetone and toluene were detected at concentrations up to 8.1 µg/L in LS-1.
- Aquatic toxicity results show no significant adverse effects.

5.3.3 National Pollutant Discharge Elimination System Data

The Site discharges its sanitary waste to the UC Davis Wastewater Treatment Plant, which is permitted according to NPDES requirements. Current DOE activities do not contribute to hazardous discharges.

6. GROUND WATER PROTECTION PROGRAM

Ground water monitoring has been conducted quarterly for the LEHR ER/WM Project since November 1990. The quarterly monitoring program began as a component of the *Phase II Site Characterization* (Dames & Moore 1993). In 1993, the program evolved to include the development of a Site Water Monitoring Plan, designed to meet the requirements of DOE's GEPP in DOE Order 5400.1. In 1998, a ground water IRA was started by UC Davis.

Water monitoring is conducted in conjunction with the CERCLA process as part of the DOE-sponsored environmental restoration program underway at the Site. Since LEHR has not been an operational site since 1989, the current water monitoring program focuses primarily on environmental surveillance activities for non-operational facilities and monitoring of the UC Davis IRA. Figure 1-3 shows the location of ground water monitoring wells for the Site.

The objectives of the ground water monitoring program are to characterize baseline ground water conditions at the Site by: 1) further evaluating impacts of previous LEHR facility operations on ground water in the area; 2) providing data to support future Site activities (risk assessment and remedial actions); 3) complying with applicable federal, state and local regulations, and; 4) evaluating the effectiveness and progress of the UC Davis IRA.

In 1999, all ground water and surface water monitoring at the Site was performed and reported by UC Davis, except for storm water sampling from DOE areas. The results of the water monitoring are summarized briefly here, and are discussed in detail in the *UC Davis Quarterly Water Monitoring Reports* and the *Annual Ground Water Treatment System and Water Monitoring Report* (Dames & Moore, 2000).

6.1 Uses of Ground Water in the LEHR Vicinity

Local ground water is utilized for both drinking and agricultural purposes. The major ground water sources for both public and private water supplies in the Sacramento Valley are unconsolidated deposits of Pliocene and Pleistocene age, and older alluvium (DOE, 1992b). The first HSU is not used for drinking or irrigating purposes. In the general area near the Site, a number of domestic and irrigation wells produce water from HSU-2.

6.2 Potential Sources of Ground Water Pollution

A number of locations on-site are considered "waste management areas," where a variety of potential wastes were handled and/or buried during former Site operations. Impact from these areas has been evaluated during previous investigations and may be further evaluated during future investigations and/or remedial actions.

Most impacts to ground water that have been identified are localized on the Site near waste burial locations and are within the first HSU, which is not used for drinking water.

6.3 Ground Water Monitoring

In 1997, the MOA between DOE and UC Davis transferred responsibility for surface water and ground water sampling from DOE to UC Davis. The ground water monitoring program discussed in this section is under the jurisdiction of UC Davis. The ground water monitoring program and the 1999 sampling results are summarized here and discussed in more detail in UC Davis's *Annual Groundwater Treatment System and Water Monitoring Report* (Dames & Moore, 2000).

In 1999, the ground water monitoring program schedule and analyte list were modified. The revised program focuses on the primary ground water COCs (chloroform and associated VOCs, chromium, nitrate, total dissolved solids, tritium and carbon-14), and shifts the annual sampling event from winter to spring. In addition, two new monitoring wells, UCD4-44, and UCD2-45 were installed at the Site (Figure 1-3). Trends and conclusions identified by UC Davis during the 1999 ground water sampling program are summarized below. A detailed discussion of concentrations detected and analytic data can be found in Dames & Moore (2000).

6.3.1 Radionuclides

HSU-1: Concentrations of carbon-14 and tritium detected at maximum concentrations of 1,380 pCi/L and 14,700 pCi/L, respectively, continue to decrease in UCD1-13, indicating transport from HSU-1. Bismuth-214, gross alpha, gross beta, lead-214 and radium-226 were detected above the CRDL at low levels, which is consistent with previous years.

HSU-2: Carbon-14 was detected in UCD2-14 at a maximum concentration of 581 pCi/L, which is consistent with historical data. Tritium was detected above the CRDL in UCD2-14 at a maximum of 2,280 pCi/L, which is consistent with previous years, and in UCD2-35 at a maximum of 1,170 pCi/L. The detection in well UCD2-35 occurred in one sample, and appears to be anomalously high. Bismuth-214, gross alpha, gross beta, lead-214, radium-226, lead-210 were detected at low levels above the CRDL, which is consistent with previous years.

HSU-4: Carbon-14 was reported at 32.8 pCi/L in one sample. However, this activity level is not typical of HSU-4 data, and appears to be anomalous. Tritium was not detected above the CRDL in any samples. Lead-210, bismuth-214, gross alpha, gross beta, lead-214, and radium-226 were detected above the CRDL at low levels, which is consistent with previous years.

6.3.2 Non-Radionuclides

HSU-1: Chloroform concentrations in UCD1-12 show a decreasing trend, indicating transport from HSU-1 to HSU-2. The maximum chloroform concentration detected in 1999 was

8,170 µg/L, which significantly exceeds the 100 ug/L MCL. Concentrations of nitrate, TDS, metals and general chemical parameters were detected at levels that are consistent with previous years. SVOCs, pesticides and PCBs were not detected in HSU-1, which is consistent with previous years.

HSU-2: Chloroform concentrations in UCD2-26, UCD2-30, UCD2-31, UCD2-32, UCD2-39 and UCD2-40 appear to be decreasing, indicating that the IRA treatment system is successfully containing the plume. Concentrations of nitrate, TDS and chromium appear to be increasing within the capture zone of the IRA treatment system. SVOCs, pesticides, PCBs and VOCs were generally not detected in HSU-2, which is consistent with previous years.

HSU-4: Irrigation well 22N was abandoned in January 1999, and monitoring well UCD4-44 was installed in April 1999 (Figure 1-3). Concentrations of ground water COCs have generally decreased downgradient of abandoned well 22N, indicating that the well was acting as a conduit to HSU-4. SVOCs, pesticides and PCBs were not detected above the detection limit in 1999.

6.4 Off-Site Neighbor Well Sampling

Sampling of private wells to the south, north, and east of the Site has been conducted since 1989. Because the wells are not uniformly constructed limited comparisons can be made between these wells and Site ground water data. The off-site neighbor well sampling program has provided information about the quality of water in private domestic and irrigation wells regarding the primary Site COCs: VOCs, tritium, hexavalent chromium, nitrate as nitrogen, gross alpha and gross beta. Monitoring of radiological constituents was ceased in 1996 because no radiological contamination that could be attributed to the LEHR Site was found in any neighbor well. Private wells sampled in 1999 are shown in Figure 6-1.

In 1999, UC Davis sampled selected irrigation and domestic wells east of the Site three times. Hexavalent chromium and nitrate as nitrogen were detected in many of the wells. These compounds are present in regional ground water, and no direct link to the Site has been established.

Chloroform was detected above the detection limit, but at concentrations of less than 1.5 µg/l in three off-site wells: 22A, 22J and 22P2. Bromoform was detected in well 15K3 and 1,1-dichloroethene was detected in well 22K above the detection limit, but below 1 µg/L. Additional VOCs were tentatively identified below the detection limit in wells 15P, 22J (chloroform, dibromochloroethane, bromoform), 22A (dibromochloromethane, bromoform), 22K (chloroform, toluene), 15K3 (dibromochloromethane, 1,1-dichloromethane), and 14L (dibromochloromethane, acetone).

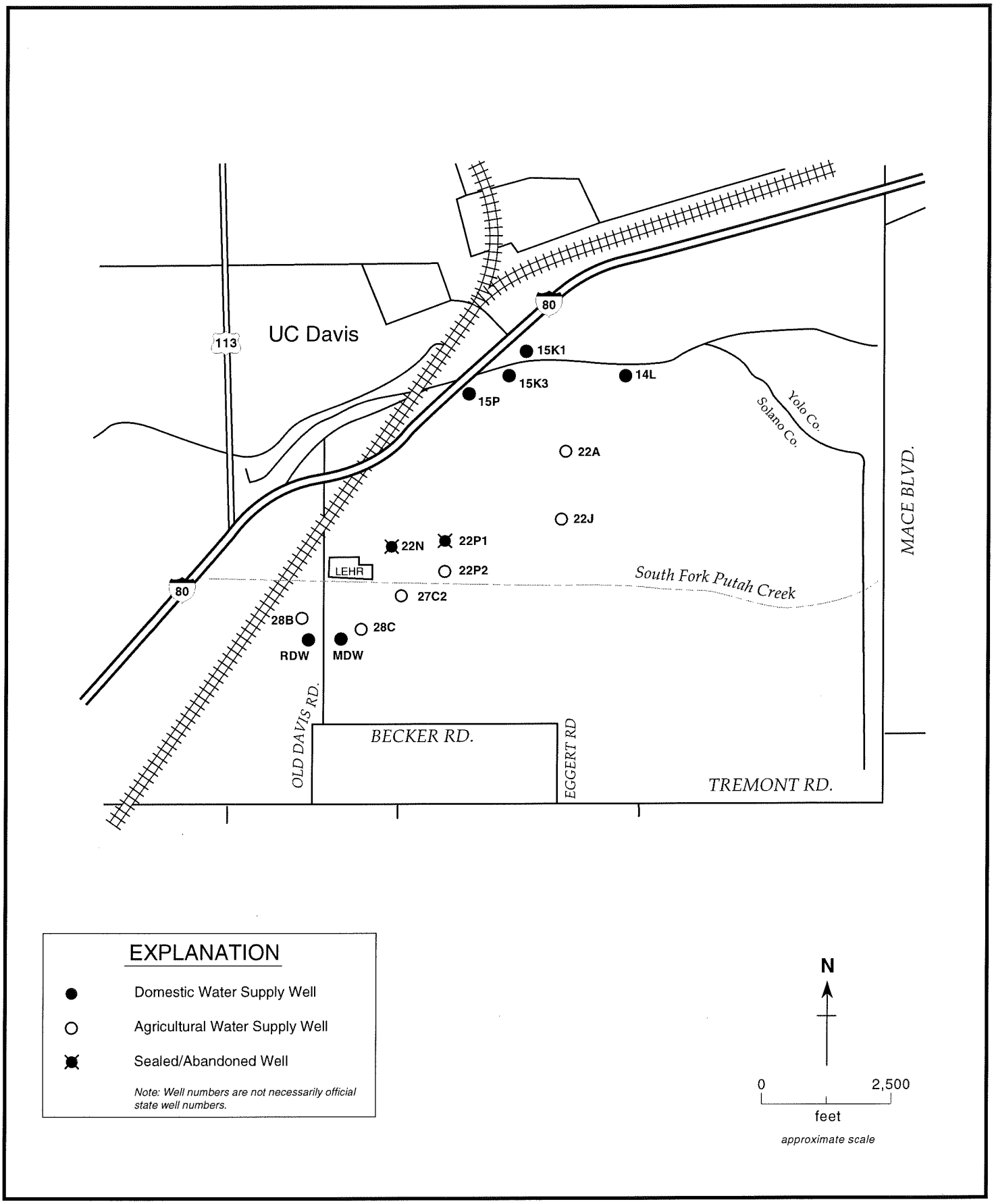

Figure 6-1. Neighbor Well Sampling Program Locations Near the LEHR Site, UC Davis, California

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7. QUALITY ASSURANCE

Quality Assurance is a key element of the environmental protection program for the Site. A Quality Assurance Project Plan (QAPP) that describes the requirements for all quality-related work on the LEHR project has been prepared (Weiss, 1998c). In the planning for each phase of the LEHR ER/WM Project (site characterization, investigation, D&D, etc.) the QAPP and other quality-assuring documents such as Standard Quality Procedures, Standard Operating Procedures and task-specific work plans are followed. The purpose of the QAPP and these other documents is to identify the specifications and methods employed to establish technical accuracy, precision and validity of measurements and statistics, and to provide a sound basis for management decisions that will be based on environmental information collected for the Site. The QAPP for the LEHR ER/WM Project was prepared in accordance with EPA QA/R-5 and National Quality Assurance specifications. It also incorporates guidance from DOE Order 414.4a, the Nuclear Safety Management Quality Assurance Requirements in 10CFR 830.120 and the GEPP as defined in DOE Order 5400.1, to ensure that DOE quality and environmental goals are met.

Environmental samples collected by DOE that are discussed in this report were collected, analyzed and reviewed according to the QAPP and other relevant standard operating procedures and/or task-specific work plans. To assure quality, QC is integrated into all aspects of environmental sampling. Included in the QAPP and related documents are sections identifying QC for sample collection requirements and specific QA objectives for the measurement data. QC samples are run with each sample batch at the laboratory to validate the method of analysis and the proficiency of the analyst. Because holding times are an important factor in the sample quality, these are carefully controlled. To ensure the comparability of analytical data, all samples are analyzed by EPA-approved methods when available. When analytic results are received, they are reviewed according to the defined data quality objectives and data review procedures.

All of the 1999 environmental sample data for Site air, soil and water were collected under the strict QA requirements of the CERCLA process. All of these data have been carefully reviewed and validated as required by the QAPP. All of the 1999 Site air, soil and water monitoring data have been, or will be, presented in separate reports. The specific review and validation process for each data set is presented in these reports, and will not be discussed in detail here.

7.1 Field Quality Assurance

Quality assurance for field sampling is accomplished by using field replicates, decontamination rinseates, trip blanks and field blanks, as appropriate for the type of sample collected. For each round of sampling, duplicate samples are collected from a selected sample point at the same time as the original sample to check for consistency in the sampling process. The duplicate sample serves as a check on the precision of the sampling and analytical procedures. Decontamination rinseates are analyzed whenever the potential exists for cross-contamination from

sampling equipment. Trip blanks are sent with each shipment of water samples requiring analysis for volatiles. Field blanks are collected to check for contamination during the water sampling process. Calibration records for each field instrument are maintained in the contractor QA files.

7.2 Laboratory Quality Assurance

Contracted laboratories providing analytical services for the LEHR ER/WM Project are evaluated by Weiss and/or UC Davis to ensure compliance with the QA program requirements. Laboratory QA is analyzed externally by submitting split samples, spiked samples, and blanks to the laboratories analyzing environmental samples. Laboratories must submit their analytical procedure for review if it differs from standard procedures. Each contract laboratory is required to maintain participation, as applicable, in DOE, State of California, and/or EPA approved inter-laboratory QA programs such as DOE's Environmental Measurement Laboratory inter-laboratory comparison program or EPA's Water Pollution/Water Supply Program.

7.3 Compliance Audits

Aspects of the LEHR program are audited periodically to ensure compliance with project standards. Several Health and Safety and QA audits or surveillances, an annual QA program Assessment, and a Radiation Protection Program audit were performed in 1999. All findings and observations identified during the audits have been, or will be, resolved.

7.4 Summary of Quality Control Data Validation

The overall QA objective is to collect and analyze environmental samples from the Site in a manner that ensures technical data are accurate and representative, are able to withstand scientific and legal scrutiny, and are useful for evaluating Site conditions and remedial actions. The criteria used to specify QA goals are precision, accuracy, representativeness, completeness and comparability for evaluation of QC data. These parameters are evaluated through data validation. Table 7-1 summarizes the components that are used to monitor and evaluate the quality of LEHR environmental data.

Table 7-1. Components of the LEHR Quality Control Program in Support of Data Quality Objectives

Data Quality Objective	Quality Control Component	Evaluation Criteria
Precision	• Field duplicate • Matrix spike • Matrix spike duplicate	Relative percent difference
Accuracy	• Matrix spike • Matrix spike duplicate • Surrogate spikes	Percent recovery
Representativeness	• Trip blanks • Field duplicate • Method blanks	Qualitative degree of confidence
Completeness	• Holding time • Valid data points	Percent valid data
Comparability	• Analytical methods • Field duplicates	Qualitative degree of confidence

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